Draft Environmental and Social Impact Assessment Report (ESIA)

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

250MW Rantau Dedap Geothermal Powerplant (Phase 1- 92MW) South Sumatra, Indonesia

DRAFT FINAL

April 2017

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2017

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EXECUTIVE SUMMARY

DESCRIPTION OF PROJECT

PT Supreme Energy Rantau Dedap (PT SERD) is a Joint Venture of Supreme Energy, Engie, and Marubeni to develop a geothermal power plant with 250MW installed capacity (the 'Project') crossing two regencies (Muara Enim and Lahat) and one city (Pagar Alam) in South Sumatra Province. The Project location is approximately 225 km from Palembang, the capital city of South Sumatra. PT SERD's Geothermal Working Area Permit covers the Rantau Dedap geothermal prospect area.

Developing geothermal energy is of strategic importance to the Government of Indonesia (GoI) which targets to generate a total of new 35,000MW by 2025 of which 23% (8,100MW) are aimed to be from renewable resources. Of the total renewable energy by 2025 it is expected that geothermal energy will contribute about 80% (or 7,150MW).

Phase 1 of Project development is developing a power plant with a design capacity of 92MW using dual flash technology, a proven technology with reliability close to 100%. PT SERD's exploration commenced in 2012, shortly after signing the Purchase Power Agreement (PPA). By 2013, a total of 5 wellpads (A, B, C, E, I), that are approximately 2 to 3 hectares in size each have been constructed. Twenty-one wells for steam production and injection of brine and condensate have been or will be drilled. Supporting facilities include pipelines (production, injection and fresh water); access roads; Power Plant with office buildings and storage yard; water treatment facilities; GIS substation (built and operated by PT SERD); worker's accommodation (both during construction and operations); concrete batching plant; disposal pits; explosive bunker; re-injection pipelines from access road to well pad B; and associated facilities consisting of the substation in Lumut Balai and the transmission line connecting it from the power plant switchyard (built and operated by PLN). Energy generation is planned to commence in 2020.

SIGNIFICANCE OF PROJECT IMPACTS

This ESIA concludes that while the PT SERD project has potential adverse social and environmental impacts, they are few in number, site-specific, largely reversible, and readily addressed through mitigation measures (e.g., through developing a Biodiversity Action Plan). PT SERD can also reference and learn from numerous geothermal power plants built and operating in Indonesia since the 1970s with current production totaling about 1,200MW.

STUDY OF ALTERNATIVES

PT SERD considered feasible Project alternatives in the preliminary site assessment and project design, to avoid or minimize impacts and balance environmental, social and financial costs and benefits. No physical displacement (relocation of people or loss of shelter) is necessary though economic displacement of 153 households.

Coal is the common alternative used to generate electricity across Indonesia. Because geothermal plants do not burn fuel to generate electricity, their emission levels are relatively low, releasing 1/30 or less than 4% of the carbon dioxide emissions of a coal-fired plant of similar capacity. Geothermal plants also emit 97% less acid-rain-causing sulfur compounds than are emitted by fossil fuel plants. CO2-equivalent emissions for the PT SERD project Phase 1 are calculated at 41,475 tons/year.

ENVIRONMENTAL DESIGN CRITERIA AND BEST AVAILABLE TECHNOLOGIES

Compliance with applicable Indonesian regulations and standards is mandatory for the project. The project is also designed to conform to IFC Environmental and Social Performance Standards (PS) as well as to ADB Safeguard Policy Statements (SPS)—including the IFC General Environmental, Health, and Safety (EHS) Guidelines and IFC EHS Guidelines for Geothermal Power Generation of 2007.

Resource conditions allow the use of a dual-flash plant[1]. Substantially similar to a single-flash plant, a dual-flash plant is capable of capturing more energy from the same flow from the reservoir compared to a single-flash plant. Dual-flash and reinjection of brine water is considered Best Available Technology. In a dual-flash configuration, steam and hot brine water are separated. High Steam Pressure (HP stream) leaves the first separator to be directed to the turbine, while the hot brine water is directed to the second separator where a lower steam pressure (LP steam) is generated and directed to the second inlet of the turbine for additional power production. The increase in resource utilization however comes with a corresponding increase in plant complexity and cost.

DESCRIPTION OF PHYSICAL, BIOLOGICAL, AND CULTURAL ENVIRONMENT

Atmosphere

Located near the Equator in a mountainous area of southern Sumatra, the project area is in a tropical wet climate with rain all year around, though October to May tend to be the wettest months. The rainiest months can average 4 meters of rainfall. Temperatures are also equatorial, seldom ranging outside 15° to 31°C. Wind speeds tend to be low averaging 2.4 to 3.3 m/s (based on observation and modelling by AECOM, 2016). Dominant wind directions at the Power Plant are west-southwest, southeast and east-northeast.

Lithosphere

Erosion and flood hazards within the geothermal concession are generally rated low to moderate.

Hydrosphere

About one third of rainwater tends to flow as runoff, while the remaining balance infiltrates into surface soils dominated by weathered organic soils. Most underlying units are highly permeable as well, and hydrogeologically the area is known for good geothermal prospects/systems.

Surface streams tend to flow permanently with moderate velocities. Surface water quality meets ambient standards; groundwater quality is also fairly good. In shallow wells used for domestic water supplies, water meets standards.

Biosphere

The project affects 124.5 ha of land, most of which is classified as protected forest. The ecosystems and vegetation comprise forest and agriculture. The forest is classified as old secondary forest. The project is located at an altitude between 1,500 to 2,600 meters above sea level. Fauna and flora assessments indicate the presence of sensitive fauna.

[1] Flash steam plants take hot steam from deep inside the earth and used it to drive generator turbines. When the steam cools, it condenses to water and is injected back into the ground to be used again. Most geothermal powerplants are flash steam plants.

Social Sphere

The project directly affects 5 small villages with a total population of around 6,500 people in Muara Enim and Lahat Regencies in South Sumatra. People in the region are mostly from the Basemah and Semendo ethnic groups, who are integrated into general Indonesian culture and participate in the mainstream economy. The majority of the community is Muslim. There are no Indigenous Peoples living in the area.

The project is located mostly in a protected forest and the population in the region is low. The nearby communities have been farming parts of the area (coffee plantation). Farmers mainly grow rice and coffee as well as other food crops and fruit trees. Small-scale animal husbandry is also present. Most farmers are subsistence farmers, and only a small part of crop production is sold in the market, except for coffee.

Field surveys suggest community support for the project, with some concerns about expectations for employment and business opportunities.

ENVIRONMENTAL IMPACTS, MITIGATION AND OFFSET MEASURES

In late 2016, the project obtained government approval of its Environment Impact Assessment (AMDAL in the Indonesian Language) as the major environmental prerequisite for starting the project. AMDAL approval by the GoI also implies that the GoI considers environmental and social risks associated with the project as acceptable, and that the project is in regulatory compliance. At the time of writing this report (December 2016), the company awaits the issuance of the Environmental permits.

The AMDAL process, originally developed with assistance of the World Bank, allows for an integrated and comprehensive assessment of major and significant impacts likely to result from Project development (from exploration over construction and operation to decommissioning). While the AMDAL process is sufficiently comprehensive to address project impacts, the project also committed to additional studies and documentation (this ESIA, Biodiversity Study and Social Mapping) to conform to environmental and social design criteria and requirements set by international financial institutions (e.g. ADB Safeguards and IFC Performance Standards).

Quantitative and qualitative methods are used to assess the significance of potential impacts and environmental management and monitoring plans are established that adhere to regular monitoring and reporting. Environmental management efforts include the following:

Exploration and Construction

- The project does not affect known cultural heritage sites and has established a Chance Finds Procedure for possible finds;
- Largest cleared land area is about 3 hectares (wellpad) and, post-activity, the area is rehabilitated;
- Contaminated effluent is not released to surface water;
- Fresh water demand is low and government permits for surface water use are obtained;
- Drainage controls are installed to control runoff water, prevent erosion prevention and stabilize soil;
- Drilling uses water-based mud;

- Drilling mud ponds use HDPE liners to protect groundwater from filtration;
- Concrete storage areas are used for the temporary storage of drill cuttings;
- The 18 wells are expected to produce drilling cuttings of approximately 10 to 350 m^3 per well.
- Drilling mud ponds are cleaned soon after completion of drilling program; laboratory testing of the pond water demonstrated that regulatory limits are met for all parameters.
- Equipment mobilization and demobilization will occur during the night to avoid traffic impacts; and
- Construction and drilling impacts (mainly noise) are low due to remote location of the site. Also project construction phase is temporary lasting for about 30 months.

Operation

- Steel pipes are used in the wells; and production pipelines will be thermally insulated to reduce energy loss as well as human and animal protection from heat exposure;
- Majority of the pipelines are installed above ground to allow free movement of terrestrial fauna;
- Emissions, wastes and effluents are characterized by low non-condensable gas (NCG), low H_2S content, very low heavy metals including low mercury content in steam, drilling cuttings (solid) and brine (liquid);
- The power plant is located close to Wellpad E away from the nearest community at Yayasan Village, with an efficient design, construction and operation;
- The power plant site is elevated to provide good ventilation for the cooling towers and help the dispersion of uncondensed steam—the elevated site also eliminates the risk of flooding;
- Modeling of atmospheric dispersion indicates that H_2S emissions exceed the 24-hour average odor standard of 28 $\mu g/m^3$ at one sensitive receptor location (coffee farmer hut) only once within three years (with a predicted maximum concentration of 30 $\mu g/m^3$). Most of the time, H_2S emissions range between 0 to 7 $\mu g/m^3$;
- Produced water (brine) is returned to reservoir through injection wells; and
- Static and rotating equipment are monitored by Preventive and Predictive Maintenance and Condition Monitoring.

Decommissioning

- Land will be returned to the government after decommissioning; and
- Rehabilitation and minor earthworks will be completed prior to handover.

CUMULATIVE AND TRANSBOUNDARY IMPACTS

The IFC's Good Practice Handbook for the Rapdi Cumulative Impact Assessment was applied to assess cumulative impacts, which are defined as impacts resulting from successive, incremental and or combined effects of a project development when added to existing, planned or reasonably anticitpated future ones. Other existing and planned developments in the vicinity of the PT SERD project are PLN Transmission line corridor from PT SERD switchyard to the PLN power substations and the Pertamina geothermal power plant developments and Lumut Balai (Units 1, 2, 3 and 4). Two Valued Ecosystem Components were identified as most important or most sensitive recipients of cumulative impacts, that is the forest landscape as natural and critical habitat for several species and

harbor of biodiversity as well as the economic condition of the communities that live in the vicinity of the project developments. The rapid assessment concludes that the cumulative impact of loss of habitat can be considered insignificant given the small footprint of the developments and the potential to control communities encroachment in to the forest. The cumulative impact on the economic condition of the communities on the other hand is assessed as more significant in a positive way, that the multiplier effect from additional employment, increased electricity generation and population growth will create new employement and business opportunities. In order for project affected communities to be competitive skill development programs will be key.

No transboundary impacts are expected, though monitoring of such impacts over the project life will take place and any identified impacts will be addressed.

Climate Change

The 92MW project emits about 41,475 tCO_2-equivalents per year. Coal is the dominant fuel used in Indonesia to generate electricity. Because geothermal plants do not burn fuel to generate electricity, their greenhouse gas (GHG) emission levels are low, releasing 1/30 or <4% of the carbon dioxide emissions of a coal-fired plant of similar capacity. PT SERD registered for the Clean Development Mechanism (CDM) of the UNFCCC regime to sell emission reduction credits. Emission reduction is calculated to be at 452,268 tCO_2 per year

Land Acquisition and Resettlement

The project acquired 124.5 ha of land, of which 115 ha are inside the protected forest and 9.5 ha are private land. Project layout was chosen to avoid physical displacement. Land acquisition and/or compensation were conducted responsibly and in compliance with applicable land procurement laws and regulations as well as PT SERD Land Procurement and Certification Guidelines. Land acquisition and/or compensation was coordinated with and supported by local government officials as well as local community leaders. A review of the land acquisition process suggests that all land owners have been compensated in accordance with existing laws and regulations. Land acquisition and/or compensation were based on the 'willing seller willing buyer' principle and there is no evidence of legacy social issues (grievances) related to land acquisition.

ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM

Supreme energy has 2 other geothermal projects in development and has experience with Asian Development Bank Safeguards and International Finance Corporation standards and guidelines. The PT SERD project leverages Supreme Energy's experience and management systems and has a comprehensive safety, health, and environmental and social management system, including, for projects, a mechanism to identify, analyze and manage significant impacts.

Monitoring and Reporting

Environmental management and monitoring is required by the AMDAL; additional and complimentary management measures are contained in this document (Section 11). Reporting to the GoI is generally bi-annually, addressing physical components (surface and groundwater; air quality and noise); fauna and flora; and social components. Independent monitoring is conducted regularly by local environmental government officials. PT SERD also tracks compliance with the Environmental and Social Management Plan (ESMP) in Section 11.

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LIST OF ABBREVIATIONS/ACRONYMS

ADB	-	Asian Development Bank
AFT	-	Atmospheric Flash Tank
AMDAL	-	environmental and social impact assessment
APL	-	Area of Other Use
BKSDA	-	Regional Environmental Authority/Badan Konservasi Sumber Daya Alam
BLHD	-	Badan Lingkungan Hidup Daerah
C6H8CHCH2	-	Styrene
CALPUFF	-	is an advanced non-steady-state meteorological and air quality modelling system using integrated Lagrangian puff modelling system for the simulation of atmospheric pollution dispersion. It is distributed and maintained by the Atmospheric Studies Group at TRC Solutions.
CDM	-	Clean Development Mechanism
CDP	-	Community Development Plan
(CH3)2S	-	Methyl Sulphide
CH3SH	-	Methyl Mercaptan
CIA	-	Cumulative Impact Assessment and Management
CMT	-	Crisis Management Team
CO	-	Carbon Monoxide
CoC	-	Code of Conduct
COD	-	Commercial Operation
DAI	-	Direct Area of Influence
DCS	-	Distributed Control System
DPR	-	the Indonesian Parliament
DPRD	-	Provincial, or District or legislative councils (DPRD)
EHS	-	Environmental, Health, and Safety
EIA	-	Environmental Impact Assessment
EMT	-	Emergency Management Team
ENGIE	-	GDF Suez
EPC	-	Engineering, Procurement, and Construction (contract/contractor)
ERT	-	Emergency Response Team
ESIA	-	Environmental and Social Impacts Assessment
ESMS	-	Environmental and Social Management System
F	-	Total Fluoride
FEED	-	Front End Engineering Design
Field SCM	-	Field Supply Chain Manager
FS	-	feasibility study
FWS	-	fresh water supply
GHG	-	greenhouse gas
GIIP	-	Good International Industry Practice
GIS	-	Geographic Information Systems (GIS)

GM	-	Grievance Mechanism
GoI	-	Government of Indonesia
GPH	-	IFC Good Practice Handbook
Greencap	-	PT Greencap NAA Indonesia
H2S	-	Hydrogen Sulphide
HC	-	Hydrocarbon
HDPE	-	High Density Polyethylene (liners)
HL	-	protected forest area
HP	-	high pressure (steam)
IFC	-	International Finance Corporation
IFC EHS Guidelines	-	IFC Environment, Health and Safety Guidelines of 2007
IPP	-	Independent Power Producer (projects)
IVI	-	Importance Value Index (IVI)
LIDAR	-	Light Detection and Ranging, is a remote sensing method used to examine the surface of the Earth.
LP	-	low pressure (steam)
MPR	-	the upper house of Parliament
MoEF	-	Ministry of Environment and Forestry
MW	-	Mega watts (unit of electrical power)
NCGs	-	non-condensable gases
NH_3	-	Ammonia
Nm^3	-	Normal cubic meter (1 atmosphere, 25^oC)
NO_2	-	Nitrogen Dioxide
NR	-	Not Regulated
O_3	-	Oxidant / Ozone
PAH	-	project affected households
Pb	-	Lead
PerMenLH	-	Regulation of Ministry for Environment
PLTP	-	Geothermal power plant
$PM_{2.5}$	-	Particulate Matter < 2.5 μm
PM_{10}	-	Particulate Matter < 10 μm
PPA	-	Power Purchase Agreement
PS	-	IFC Environmental and Social Performance Standards
PT PLN	-	Perusahaan Listrik Negara, a state-owned electricity utility company
PT SERD	-	PT Supreme Energy Rantau Dedap
RCIA	-	Rapid Cumulative Impact Assessment (RCIA)
RKL	-	Environmental Management Plan
RPL	-	Environmental Monitoring Plan
SEP	-	Stakeholder Engagement Plan
SE SHE	-	Supreme Energy Safety, Health and Environmental (Policy)
SO_2	-	Sulfur Dioxide
SO_4	-	Sulphate
SOP	-	Standard Operating Procedures

SPS	-	ADB Safeguard Policy Statements
tCO_2-e	-	total Carbon Dioxide equivalent
TOC	-	total oxygen content
ToR	-	ANDAL Term of Reference
TSP	-	Total Suspended Particulates
TSS	-	Total Suspended Solids
VEC	-	Valued Environmental and Social Component
WBM	-	water-base mud
WUP	-	Water Use Permit (WUP) or *Surat Izin Pengambilan dan Pemanfaatan Air* (SIPPA)

1 PROJECT OVERVIEW

Geothermal energy is a compelling option for power generation for Indonesia. Compared to other renewable energy options, geothermal produces a significant amount of power, has minimal environmental and social impacts and operates continuously regardless of weather conditions and time-of-day. Compared to fossil fuel alternatives, geothermal is competitively priced, generates minimal greenhouse gas (GHG) emissions, produces fewer environmental and social impacts and insulates energy consumers from fossil fuel price fluctuations.

Given global concern about climate change and the global drive to lower emissions, the finite nature of fossil-fuels, increasing fossil fuel dependency, geothermal power could also have long-term strategic value for Indonesia. Notably, GHG emission that can be avoided (reduction) as a result of the full project has been calculated at 452,268 tCO_2-e per year or nearly 13.6 million tCO_2-e over a 30 years project life.

Geothermal power development is a priority of the government of Indonesia (GoI), at both the local and national levels. The GoI set targets for new power generation at 35,000MW by 2025, of which 23% (8,100MW) is to be renewables. Of the total renewable energy 2025 target, geothermal energy is expected to comprise about 80% (or 7,150 MW). The GoI's Electricity Law (Law No. 30/2009), enacted in September 2009, fully deregulates the power market by allowing independent power producers to generate and sell electricity to end users. The GoI initiated a two-phase "fast-track" generating program (Presidential Decree No. 4 / 2010 for 2nd fast track program of 10,000MW and listed in the Ministry of Energy and Mineral Resources Decree No. 0074 K/21/MEM/2015). PT Supreme Energy Rantau Dedap (PT SERD) was one of the first companies to capitalize the opportunity under the new regulations and help the GoI achieve its targets.

The project is being carried out in 2 stages. Stage 1 includes the geothermal resource exploration, including well drilling. Development of the steamfield, pipeline network, additional well drilling, power plant and other supporting facilities will be carried out in stage 2. PT SERD has undertaken exploratory drilling to confirm the geothermal resource is sufficient for commercial operation of a 250MW geothermal power plant; the first Phase is development of 92MW.

The PT SERD Project will be carried out in phases and include the following:

Resource Exploration including land clearing, wellpad opening, well drilling, road construction or expansion (this phase has been completed);

Development (exploitation-production) drilling, delivery of steam to the power plant, and return of hot brine water and condensate into the reservoir through injection wells;

Geothermal power plant (PLTP) to convert steam into electricity that is then delivered to a PLN sub-station through a GIS switchyard; and

Power transmission and distribution to end users (by PLN).

1.1 Project Objective and Benefits

The objective of the project is to increase the capacity of electricity generation in Indonesia, a GoI priority. In addition, the use of a renewable energy source will reduce the reliance on fossil fuels that would have occurred if the increased electricity generation demand was met by a fossil-fuel fired powered electricity generation facility, the most likely power generation alternative in Indonesia.

The project will exploit a potential geothermal field in Rantau Dedap, Indonesia. The concession of 353 km2 is located in South Sumatra, approximately 91km south of Muara Enim, 225km to the southwest of Palembang, the capital city of South Sumatra Province and 100km southeast from Bengkulu, the capital of Bengkulu Province . Initial exploration results indicate that the Rantau Dedap geothermal field could support approximately 250MW of electricity generation. The project will support sustainable development:

Economic: The project will supply the growing economy with an increase in the amount of reliable electricity supply from a domestic primary energy source.

Social: The project will create local employment opportunities for both construction and operation offering Indonesian people new experience and skills in a sector that is growing internationally and with great growth potential in Indonesia.

Environmental: The project is fuelled by renewable geothermal heat that has very few greenhouse gas emissions compared to other thermal power projects. An Environmental Impact Assessment (EIA) has been carried out before construction of facilities for production phase to identify any changes that need to be made in order to mitigate or minimize environmental impacts.

Growth: Geothermal energy will therefore diversify the sources of electricity generation in the country. Also, geothermal energy is an indigenous resource which enables sustainable energy production.

1.2 Project Proponent

The project is being undertaken by PT Supreme Energy Rantau Dedap (PT SERD), a Joint Venture of Supreme Energy, Engie, and Marubeni.

1.2.1 PT Supreme Energy (operator)

Supreme Energy is an Indonesian company focused on the development of geothermal energy to support the government program in meeting fast growing energy needs and establishing a more environmentally friendly energy mix with an increased proportion of renewable energy. The management team has vast experience in geothermal development and the oil and gas industry, and pioneered geothermal exploration in Indonesia under the 2014 geothermal law. Supreme Energy is presently developing two other large-scale geothermal projects in Indonesia Muara Laboh and Rajabasa demonstrating its commitment to the sector.

1.2.2 ENGIE

Previously known as GDF Suez, ENGIE with headquarters in Paris, is one of the largest independent power producers globally and in Indonesia with a diverse portfolio of activities, such as power generation, exploration and production of liquefied natural gas, natural gas infrastructure development and energy services. Active in Indonesia for more than 60 years, the Group is working on thermal plant projects as well as geothermal and renewable (hydro, solar, wind) energy projects. Engie has a range of investments in Indonesia, including the Muara Laboh and Rajabasa Geothermal projects (also in partnership with PT Supreme Energy).

1.2.3 Marubeni

Marubeni is involved in the handling of products and provision of services in a broad range of areas encompassing importing and exporting, as well as transactions in the Japanese market, related to

food materials, food products, textiles, materials, pulp and paper, chemicals, energy, metals and mineral resources, transportation machinery, and includes offshore trading.

Marubeni's activities also extend to power projects and infrastructure, plants and industrial machinery, finance, logistics and information industry, and real estate development and construction. The power projects division focuses on:

Overseas Independent Power Producer (IPP) projects

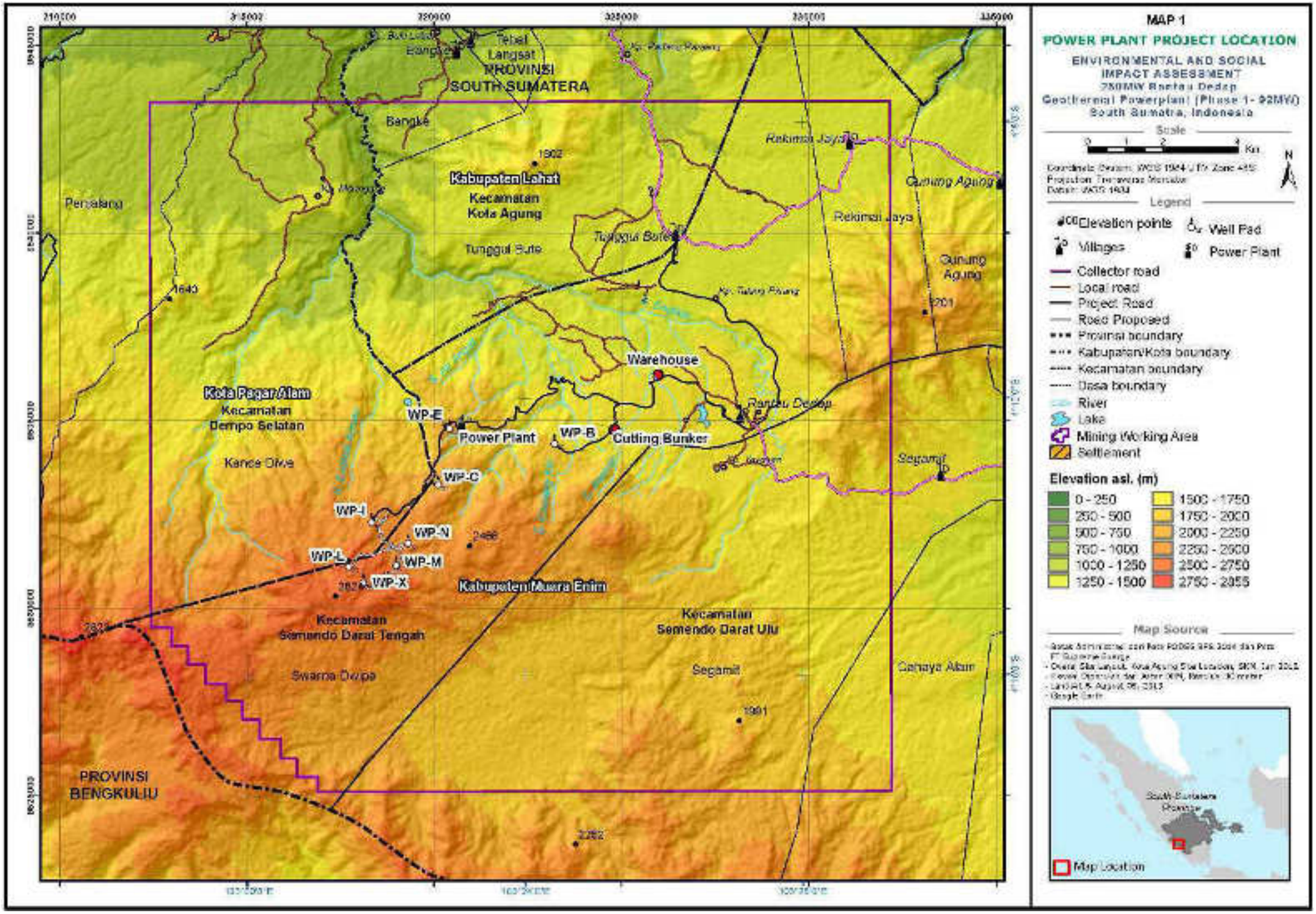
EPC for overseas power projects

Power plant operation and maintenance services

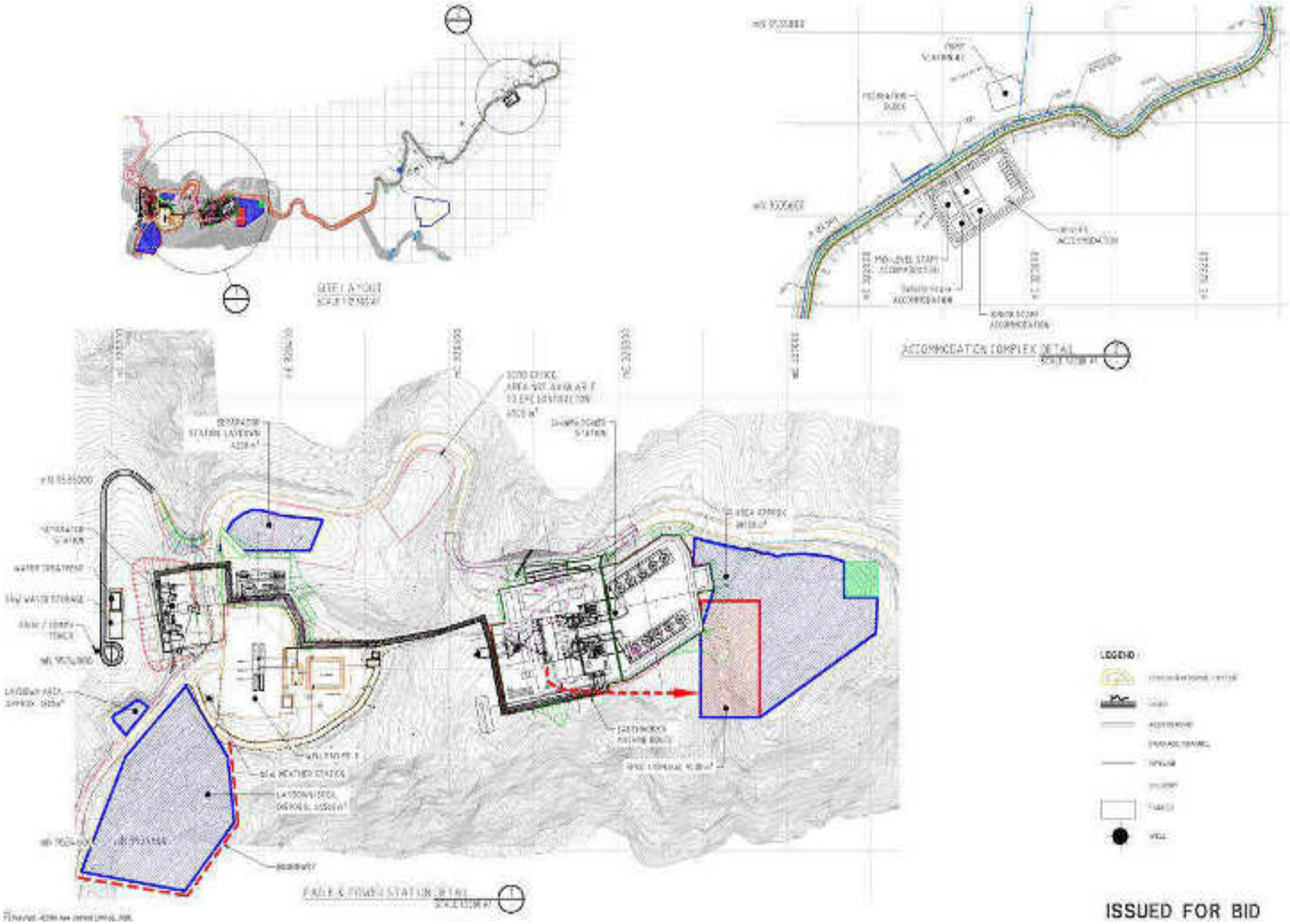
Domestic power generation and power producer and supplier businesses

1.3 Location and Spatial Characteristics

The PT SERD project site is located in the Muara Enim, Lahat Regencies and Kota Pagar Alam of South Sumatra, approximately 225km from Palembang, the capital city of South Sumatra Province. Geographically, the area is situated between 4°7' - 4°15' South Latitude and 103°29' - 103°18' East Longitude. The contract area covers approximately 35,440ha (18.56km x 19.63km) and is situated at an elevation ranging from 1,500 to 2,600 meters on the Bukit Besar volcanic complex, in which the existence of the geothermal system is indicated by a wide distribution of thermal manifestations, particularly on the flanks of it. Map 1~~Map 1~~ and Map 2~~Map 2~~ below show the project site location and layout. The area is remote and undeveloped with steep terrain; most of the area has only walking trails or no access ways at all.



Map 1 Power Plant Project Location



Map 2 Project Layout

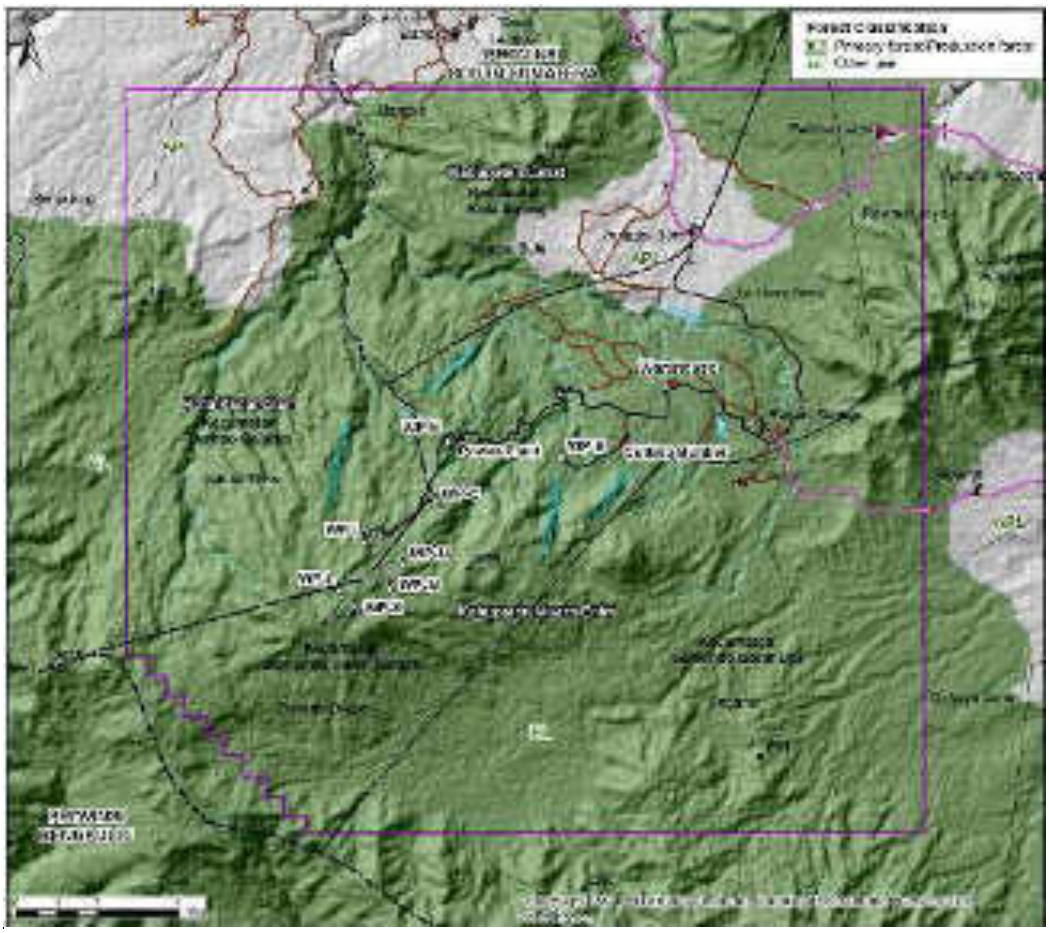
1.3.1 Spatial Characteristics

Land was allocated to the project from a formally designated forest area in the province of South Sumatra and Bengkulu based on the Decrees of the Ministry of Environment and Forestry (MoEF) (No. SK.866 / Forestry-II / 2014, No. SK.784 / Forestry-II / 2012 and No. 420 / Kpt-II / 1999 dated 15 June 1999) as shown in Map 3~~Map 3~~. The project was allocated 124.5ha (from the ± 920,964ha of total forest area) as follows:

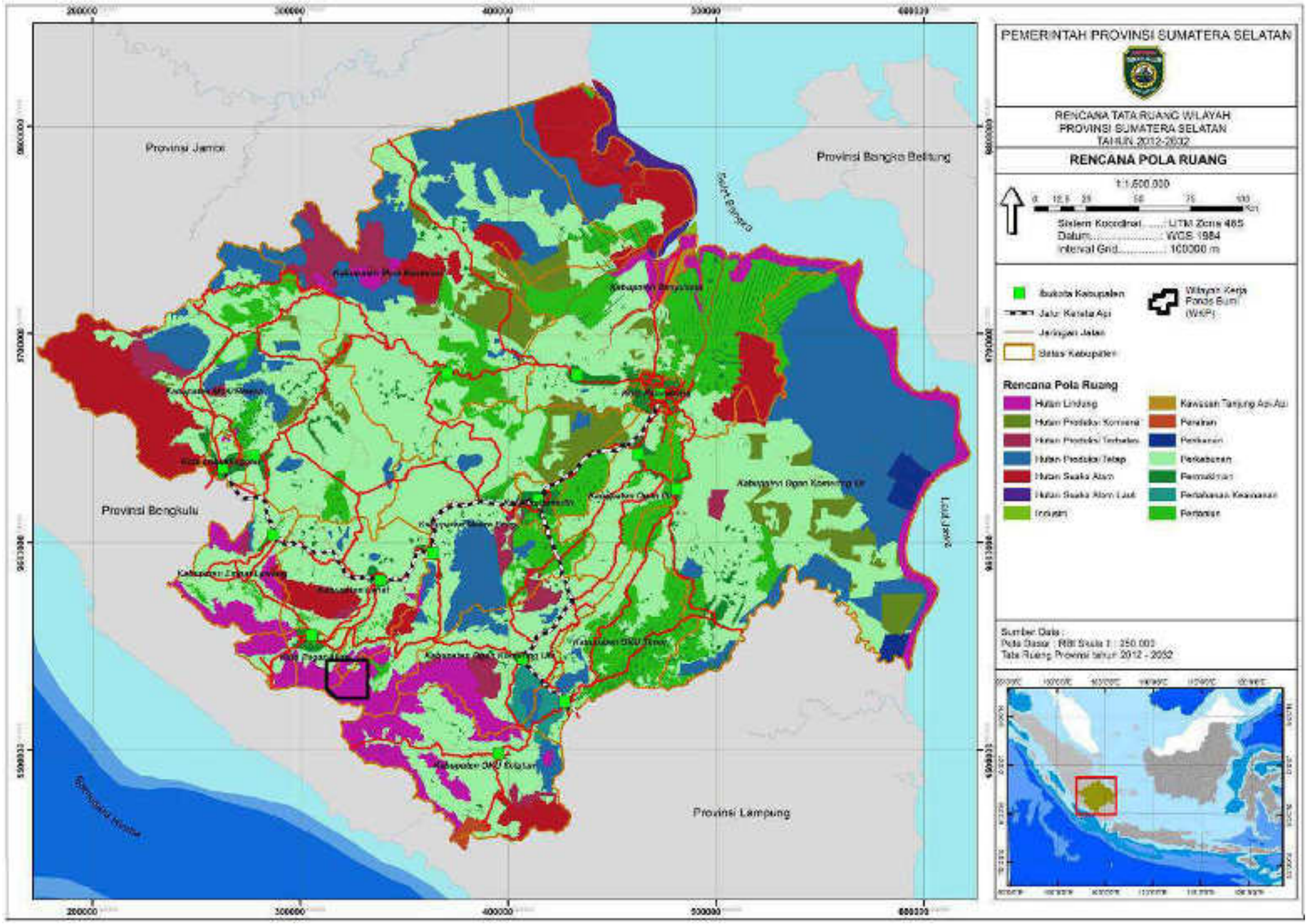
- 92% of the project site is a protected forest area (HL); and
- 8% of the project site is an Area of Other Use (APL).

The spatial plan complies with provincial regulations:

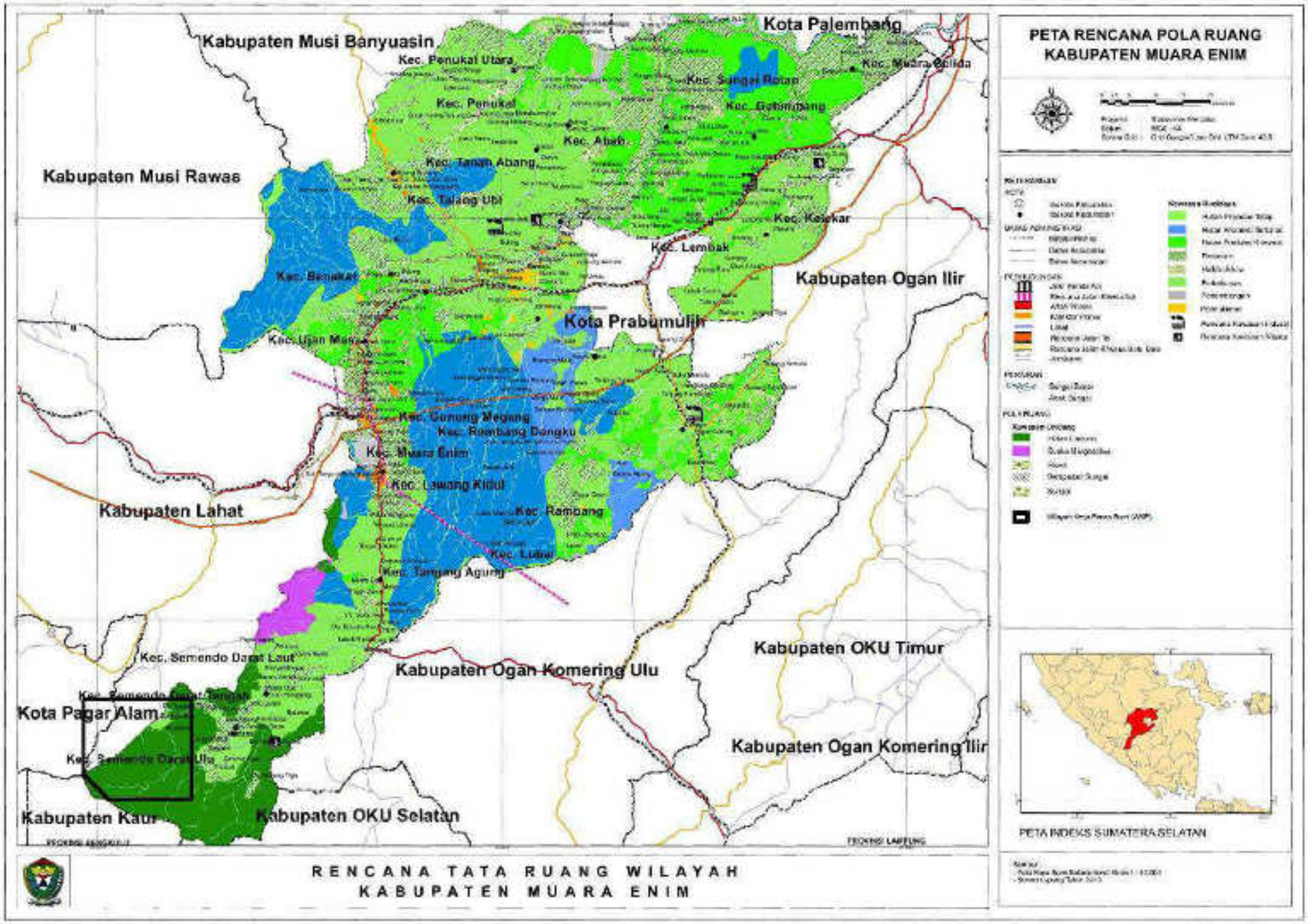
- South Sumatra Provincial Regulation No. 14 of 2006, supported by Recommendation Letter issued by the Regional Development Agency South Sumatra No. 050/2622/Bappeda/2016 (Map 4~~Map 4~~);
- Muara Enim Regional Regulation No. 13 of 2012, supported by Confirmation Letter issued by the Bappeda Kabupaten Muara Enim No. 1100/Bappeda-RLH/2016 (Map 5~~Map 5~~);
- Kota Pagar Alam Regulation No. 7 of 2012, supported by the Confirmation Letter issued by Bappeda Kota Pagar Alam No. 050/542/Bappeda/2014; and
- Lahat Regional Regulation No. 11 of 2012, supported by Confirmation Letter issued by Bappeda Kabupaten Lahat No. 050/529/Bappeda/2016.



Map 3 Forest Status



Map 4 South Sumatra Spatial Planning



Map 5 Muara Enim Spatial Planning

1.4 Project Infrastructure

The full project involves development of a geothermal power plant with 250MW installed capacity. The power plant uses dual flash technology, which is a proven technology with nearly 100% reliability.

Phase 1 of the project involves development of 92MW power plant and wells situated on 4 wellpads:

- 12 wells for steam production
- 4 wells for brine and condensate injection
- 5 wells for contingency (if steam production is under supply to turbine)

Four wells will be drilled for production make up in the future 14 years after COD, and 3 wells including 1 contingency well in 24 years after COD.

Exploration drilling study in 2014-2015 interpreted the data from the 6 wells of the 3 established wellpads (B, C and I) and concluded that 4 of the drilled wells are feasible to be further developed as production wells (RD-I1, RD-I2, RD-C1 and RD-C2). The remaining 2 drilled wells will be developed for brine and condensate injection wells (RD-B1 and RD-B2).

Other project facilities include pipelines (production, re-injection, and fresh water), access roads, office buildings and a storage yard, switchyard and water treatment facilities, worker's accommodations, concrete batching plant, disposal pits, explosive bunker and associated facilities consisting of substations and transmission lines (to be built and operated by PLN)..

The project components are detailed in section 4.2.

1.5 Project Schedule

1.5.1 Past

The Rantau Dedap concession was awarded to the PT SERD consortium in December 2010. The Mining Area License was granted to the project in 2011 (Ministry of Energy and Mineral Resources assignment letter No. 5834/26/MEM.L/2011 dated September 30, 2011).

The exploration program started in 2011. The airborne topographic survey, civil engineering study, heat loss survey and the geo-scientific interpretation were completed in 2012.

On November 12, 2012 the project entered into the Power Purchase Agreement (PPA) with the state-owned electricity utility company Perusahaan Listrik Negara (PT PLN) marking a key milestone as it defines the contractual rights and obligations of the parties during the exploration phase, construction phase and operation phase - conditions necessary to start exploration drilling activities. At this time, socialization efforts with the communities began and the required land was acquired, which included approximately 10ha land outside the protected forest area and 115ha inside. The Protection Forestry Area Permit was obtained in November 2012. Access roads were also built within the protected areas after the completion of the land acquisition process.

PT SERD began civil and infrastructure work in January 2013. Prior to the commencement of exploratory drilling program, sustained stakeholder engagement activities occurred, which included individual and group formal consultations and discussions and individual interviews, as well as a site

visit to Kamojang in Java with the local community (to witness a similar geothermal operation). Required permits were also acquired from the government agencies. In February 2014, the exploratory drilling program commenced with the drilling of the first exploratory well to confirm the size and scale of the geothermal resource.

Following the exploration drilling program, pre-feasibility and feasibility studies were carried out by AECOM in order to select the most suitable technology and determine the viability of the project. Following on, engineering design work was undertaken to define the surface facilities (steamfield, pipelines, power plant, etc.) in more detail. In 2016, the Front End Engineering Design (FEED) was finalized as well as the specifications and scope of work for the project based on the FEED results. Scope of Work and specifications form the basis of the Engineering, Procurement, and Construction (EPC) contract. The next stage of the project will be the full development until Commercial Operation (COD), including additional well drilling and construction of the steamfield, power plant, pipelines and other supporting infrastructure.

1.5.1.1 Indonesian Environmental Permitting (AMDAL) Schedule

A summary of the key AMDAL milestones is presented in Table 1~~Table 1~~.

Table 1 Key AMDAL Milestones

Milestone	Date
KA ANDAL submission	30 June 2016
KA ANDAL presentation meeting	2 May 2016
KA ANDAL approval	26 August 2016
ANDAL, RKL-RPL presentation(with technical experts)	27 September 2016
ANDAL, RKL-RPL presentation (with local government)	29 September 2016
ANDAL, RKL-RPL submission after presentations	17 October 2016
ANDAL, RKL-RPL assistance meeting with MoEF	20 October 2016
ANDAL, RKL-RPL final submission after assistance meeting	24 October 2016
ANDAL, RKL-RPL approval	15 March 2017
Environmental Permit Issuance	15 March 2017

1.5.2 Future

EPC Construction will begin at the end of 2017 and is expected to take 28 months. The geothermal power plant will be ready for operation in 2019/20. The project schedule presented in Table 2~~Table 2~~ assumes no delays.

Table 2 Future Project Schedule

Activity	Current Expected Date
Permits & Agreements	2016/17
Financing	2017
EPC & Development Drilling	2017 to 20
COD	2020 - 2050

1.6 Project Workforce Requirements

The total number of workers for the construction stage is 2,110, as presented in Table 3~~Table 3~~; for operations the total work force is 200 as shown in Table 4~~Table 4~~.

Table 3 Total Cumulative Number of Workforce in the Construction Stage (during peak time)

Position	Total Number	Description
Manager	4	Skilled
Section Head	10	Skilled
Engineer	36	Skilled
Technician	60	Skilled
Operation	200	Skilled
Administration	100	Semi-skilled
Skilled Labor	800	Skilled, sequential
Unskilled Labor	700	Semi-skilled, sequential
Security	200	Semi-skilled, sequential
Total	**2,110**	

Table 4 Total Cumulative Number of Workforce in Operation Stage

Position	Total Number	Description
Superintendent and Staff	3	Skilled
Operator	38	Skilled
Maintenance Staff	11	Skilled
Technician	8	Skilled
Administration	10	Semi-Skilled
Contractor (Security; Driver; General Service, etc.)	130	Skilled and Semi-skilled
Total	**200**	

Note: Skilled – undergraduate degree at minimum and/or with special skill

1.7 Project Alternatives

1.7.1 No Project

As indicated above, power demand is expected to increase in line with Indonesia's economic and population growth. Power development is therefore imperative. Geothermal is amongst the most environmentally, economically and socially responsible options for power generation, especially in Indonesia. Power development must be undertaken to meet GoI targets and plans and the PT SERD project represents a large scale opportunity with minimal environmental and social impacts, especially in comparison to alternatives.

1.7.2 Siting

By its nature, geothermal power is site dependent and projects must be situated at the location of the geothermal resource. Geothermal prospects are present across Indonesia, each with varying commercial viability. The Rantau Dedap geothermal prospect is deemed commercially viable, based on the pre-feasibility and feasibility studies which were carried out by AECOM . Within the prospect

area, avoidance of impacts to receptors from the project components and activities has been a key objective.

1.7.3 Technology

Dual Flash technology was selected because it enables more efficient energy extraction from the steam (compared to single flash).

1.8 Environmental and Social Impact Assessment and Management Plan Overview

1.8.1 Objectives and Regulatory Requirements

The objectives of this Environmental and Social Impact Assessment and Management Plan are to:

- Review the project environmental and social impact assessment (AMDAL) and management system against IFC, ADB, and other lenders' requirements regarding ESIA.
- Where a shortfall is identified, guide the project to achieve sound environmental and social impact management performance.
- Develop a supplementary document that conforms to IFC, ADB, and other lenders' requirements.

Compliance with applicable Indonesian regulatory standards is mandatory, and regulatory compliance is well covered in the project AMDAL documents. The project is however also designed to conform to IFC Environmental and Social Performance Standards (PS) as well as to ADB Safeguard Policy Statements (SPS). Reference is made to the IFC general Environmental, Health, and Safety (EHS) Guidelines and IFC EHS Guidelines for Geothermal Power Generation of 2007.

The Scope of Work for this assessment and management plan meets the following specific objectives:

- Review the Environmental and Social Management System (ESMS) in place or being planned to ensure it is appropriate to the nature and scale of the project;
- Establish an overarching policy defining the environmental and social objectives and principles that guide the project to achieve sound environmental and social performance;
- Characterize the proposed Project's environmental and social aspects and impacts, and develop relevant and realistic mitigation measures;
- Compile a robust Environmental and Social Management Plan, including specific action plans; and
- Advise the project Proponents on compliance with any other relevant environmental policies and guidelines.

1.8.2 Scope

- In-Scope: Power plant, wells and wellpads, pipelines (production, injection and fresh water), as well as support facilities: access roads, office buildings, a storage yard, water treatment facilities, 150kV GIS switchyard, worker's accommodations, concrete batching plant, explosive bunker, pipeline for reinjection of brine and condensate water, disposal pits for spoils, and associated facilities: the transmission lines from PT SERD Power Plant switchyard to PLN 150kV Lumut Balai substation.

- Out-of-scope: Lumut Balai substation and PLN transmission lines from its Lumut Balai substation to the regional grid.

1.8.3 Environmental and Social Project Categorization

1.8.3.1 IFC Categorization

An IFC environmental and social category is assigned to an investment project, based on an appraisal of their environmental and social sensitivity, as follows.

- Category A: Projects expected to have significant adverse social and/or environmental impacts that are diverse, irreversible, or unprecedented.
- Category B: Projects expected to have limited adverse social and/or environmental impacts that can be readily addressed through mitigation measures.
- Category C: Projects expected to have minimal or no adverse impacts, including certain financial intermediary projects.

The project is an IFC Category A, based on the following project site considerations:

- It is mostly located in a protected forest area that contains important landscape, habitat and biodiversity. A biodiversity action plan has been developed which is part of this ESIA.
- The project site is located in an area containing sensitive receptors (flora and fauna). Project components with the greatest potential for significant adverse impacts (i.e. the power plant and production wellpads) are far from the nearest villages. The location of the power plant near Wellpad E is approximately 7 km from Yayasan, the nearest village.
- Potential significant adverse impacts identified relating to H_2S emissions are not significant. Based on the air dispersion model, the frequency of odor in sensitive receptors (e.g. households) exceeding national standards is as little as one-in-three-years, as such potential impact is considered not significant.
- Other potentially significant impacts such as landslide and economic displacement aspects have appropriate mitigations in place, but there is still potential for significant impacts to occur.

1.8.3.2 ADB Safeguard Requirement Categorization

1.8.3.2.1 Safeguard Requirement 1 (Environment)

As with the IFC categorization described above, the project is also Category A for ADB Safeguard Requirement 1 (Environment) which stipulates that: “A proposed project is classified as category A if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An environmental impact assessment is required.”

1.8.3.2.2 Safeguard Requirement 2 (Involuntary Resettlement)

The project is a Category B for ADB Safeguard Requirement 2 (Involuntary Resettlement) which is described as: “A proposed project includes involuntary resettlement impacts that are not deemed

significant. A resettlement plan, which includes assessment of social impacts, is required." The project will not result in any physical displacement.

- The economic displacement (loss of farmland for 153 households) is expected to be partial and livelihood impacts are not expected to be significant.
- All of the land acquisition is complete and was undertaken through 100 percent negotiated settlements, whereby people exercised their right to refuse to sell their land ("willing buyer, willing seller" principle).
- People are not expected to lose access to natural resources, communal facilities and services.
- A resettlement plan was not produced prior to the land acquisition process but PT SERD has consultation and transaction records. (Appendix 8). PT SERD also has a Community Development Plan (Appendices 4a and 4b) that enhances engagement with local communities, as well as promote their economic development.

1.8.4 Summary of Key Environmental and Social Impacts

A summary of environmental and social impacts can be found in the executive summary. Potentially significant impacts are identified in Section 8. Analysis of impacts is found in Section 10 and the impact management plan is detailed in Section 11.

1.8.5 Environmental and Social Impact Assessment Consultant Team

PT SERD has retained PT Greencap NAA Indonesia to provide independent expert advice and analysis to complete this impact assessment and management plan.

Company Name	:	PT Greencap NAA Indonesia
Office Address	:	Intiland Tower, 18th Floor Jl. Jend. Sudirman Kav. 32 Jakarta 10220, Indonesia Phone +62-21-57901344 Fax +62-21-57901348
Person in Charge	:	Dr Karlheinz Spitz, Director

Table 5~~Table 5~~ illustrates PT Greencap NAA Indonesia's ESIA team composition.

Table 5 Consultant Team

Position	Name	Field of Expertise
International Experts	Dr. Karlheinz Spitz MBA	Environmental Engineering
	Dr. Rachel Lorenzen	Socioeconomic and Cultural / ESIA
	Jonathan Gilbey	Environmental Baseline
	Anthony Di Nicola	ESIA
National Experts	Muhammad Zaki	Socioeconomic and Cultural
	Bakhtiar Santri Aji	Biodiversity
	Sugita Suryo	Air Quality, Physical-Chemical Engineering
	Lalita Fitrianti	Environmental and ESIA

1.8.6 Organization of this ESIA Document

As indicated in the ESIA objectives above (section 1.8.1), this assessment and management plan addresses GoI local and national regulations as well as Good International Industry Practice (GIIP) (ADB Safeguards, IFC standards and guidelines). The main sections are:

- Environmental and Social Risks and Impacts Framework. This explains the policies, procedures and standards that govern the impact assessment and management plan.
- Environmental and Social Design Criteria. Presents detailed standards for environmental aspects, drawn from GoI and international requirements and guidelines.
- Project Description. Provides detailed description of project components focusing on their environmental impacts.
- Resource Efficiency and Pollution Prevention. Sets the goals and strategies for efficiency and pollution prevention.
- Labor and Working Conditions. Presents approach to labor and working conditions, in line with GoI and international standards.
- Environmental and Social Setting (Baseline). Provides comprehensive environmental and social baseline information.
- Scoping of Environmental and Social Risks and Impacts. Identifies potential impacts based on comprehensive review of the project and receptors.
- Information Disclosure, Consultation and Participation.
- Assessment of Environmental and Social Risks and Impacts. Predicts and assesses the potential impacts to determine significant impacts.
- Management of Environmental and Social Risks and Impacts. Outlines strategy, tactics and controls to manage and monitor significant impacts.

2 ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS FRAMEWORK

2.1 Environmental and Social Management System

Under the umbrella of PT Supreme Energy two other geothermal projects are being developed. PT Supreme Energy has a comprehensive environmental and social management system characterized by:

- Leadership: Top-down commitment and company culture.
- Policy and strategic objectives: Corporate policies, objectives and procedures with respect to SHE and Social.
- Organization, resources and documentation: Organization of people, resources and documentation to drive performance.
- Evaluation and risk management: Identification and evaluation of SHE and social risks and development of risk reduction measures.
- Planning: Planning work activities to minimize risks and impacts.
- Implementation and monitoring: Monitoring of activities and performance, and making corrective actions and continual improvement when necessary.
- Auditing and reviewing: Periodic assessment of performance and effectiveness.

It consists of the following:

- Environmental and Social Design Criteria
- PT SERD Safety, Health and Environmental Policy and Manual
- Social Management System, including procedures
- Environmental and Social Impact Assessment and Management Plan

These are described in detail below.

2.2 Environmental and Social Design Criteria

Environmental and Social Design Criteria provide the specific regulatory requirements and non-binding guidelines that guide and inform the engineering and other requirements for the exploration, construction, operations and decommissioning phases. They minimize project impacts and also ensure compliance with relevant host country legislation and GIIP. These criteria, including the legal framework, are presented in detail in Section 3 below.

2.3 Safety, Health and Environment System

PT SERD is subject to the Supreme Energy Safety, Health and Environmental (SE SHE) Policy and Manual (Appendix 12) that serves as the SHE management system and reflects applicable GoI laws and regulations, including obligations under international law, and sets environmental, social and health expectations for the project. The Manual (SE-ML/RB/RDSUP-SHEM) opens with the statement: "*The Company is fully committed to conducting operations in an incident-free workplace, all the time, everywhere. Proactive individual involvement, personal responsibility, accountability, and continuous improvement are expected of all employees, clients and subcontractors. The SHE Management*

System is designed to align all stakeholders' efforts to attain these objectives." Section V of the Manual addresses environmental management.

The SHE Policy and Manual is complemented and supported by :

- Contractor Safety Management System
- Waste Management
- Journey Management
- Project Execution Planning - Safety Environmental
- Guidance for Contractor SHE Management Plan
- Excavation and Shoring
- Emergency Response Plan (Section 2.7)
- Incident Command Center
- Incident Accident Reporting and Investigation
- Confined Space Entry
- Hot Work
- Personal Protective Equipment
- Drilling Preparation, Operations, and Production Testing
- Hydrogen Sulfide
- Permit to Work
- Lifting and Lifting Equipment
- Working at Height
- Motor Vehicle Safety and Heavy Equipment
- Energy Isolation Lockout Tagout
- Hazard Identification Risk Assessment and Risk Control
- Job Safety Analysis
- First Aid and Medical Care
- Motorcycle Riding
- Wild Animal Interference
- General Environmental Requirements for Project Design and Production Activities

2.4 Social Management System

Stakeholder engagement is the basis for building strong, constructive and responsive relationships that are essential for successful management of the project's environmental and social impacts. PT SERD is committed to ensuring that stakeholders are proactively engaged before and during construction and operations. It is an ongoing process that involves varying degrees of the following:

- Stakeholder mapping, identification and analysis (influence and interest), with special sensitivity toward vulnerable groups and Indigenous Peoples;
- Disclosure and dissemination of information;

- Consultation and participation;
- Grievance management; and
- Ongoing reporting to and engagement with affected stakeholders.

The nature, frequency and level of effort of stakeholder engagement for the project are scaled and commensurate with the limited social and environmental risks and impacts of the project. PT SERD is committed to disclosing appropriate information about the project to enable affected stakeholders to understand the risks, impacts and opportunities of the project by providing information on the:

- Purpose, nature and scale of the project;
- Duration of proposed project activities;
- Risks to and potential impacts on such stakeholders and relevant mitigation measures;
- Stakeholder engagement procedure;
- Grievance mechanism; and
- Identification of opportunities for employment and the supply of goods and services, including information about how to apply and access.
- Community Development Plan (Appendices 4a and 4b).

The PT SERD engages stakeholders in a manner that provides affected stakeholders with opportunities to express their views on project risks, impacts and mitigation measures, allowing the project to consider and respond to them. From the start of the project, engagement has been documented and follows a two-way process that meets the following principles:

- Begins early in the process of identification of environmental and social risks and impacts and continues on an ongoing basis as risks and impacts arise;
- Provides information that is relevant, transparent, objective, meaningful and easily accessible and understandable (e.g. culturally appropriate, local language(s), tailored, simple format);
- Focuses on engagement with those directly affected (as opposed to those not directly affected) and takes special steps to address disadvantaged or vulnerable groups;
- Is free of external manipulation, interference, coercion, or intimidation; and
- Enables meaningful participation by those affected.

The Stakeholder Engagement Plan (SEP) and Grievance Mechanism (GM) can be found in Appendix 1.

2.5 The Environmental and Social Impact Assessment and Management Plan

PT SERD environmental and social impacts have been assessed through the rigorous and structured approach outlined in this document, meeting both GoI (AMDAL) and GIIP requirements and guidelines. Section 11 contains the management plan for the identified significant impacts, including monitoring, covering the exploration, construction, operations and decommissioning phases.

2.6 Organizational Capacity and Competency

The President Director of Supreme Energy is ultimately responsible for conformance with the Environmental and Social Management System (ESMS), specifically by communicating and

championing the ESMS to all levels of the PT SERD organization. The ESMS is executed and monitored by line management and actions are taken to address gaps and opportunities for improvement.

PT SERD also requires all of its management and employees to adhere to a well-defined Code of Conduct (CoC). The Code of Conduct is (a) prepared in English and Indonesian languages; (b) posted on Company's intranet; (c) referenced in induction programs for new employees; and (d) referenced in the Employee Manual.

Contractors and subcontractors must comply with PT SERD's ESMS, including policies, procedures and the project ESMP (Section 11).

2.6.1 Safety, Health and Environment

Safety, Health and Environment (SHE) Management is a line management responsibility and visible management commitment and involvement is essential at all levels. The fundamental elements of the SHE Management System are:

- Each employee is responsible to know and act in accordance with PT SERD's SHE Management System to protect themself and others, the environment and the property of PT SERD.
- Effective planning and communication is the foundation of risk management.
- Each employee has the obligation to interrupt an activity to prevent an incident.
- Effective SHE performance will be recognized.
- All incidents will be reported.
- Employees are encouraged to identify improvement and corrective opportunities and participate in developing safety improvement plans.

The figures below show the organizational structure of the Department in Jakarta and at the site (**Figure 2**).

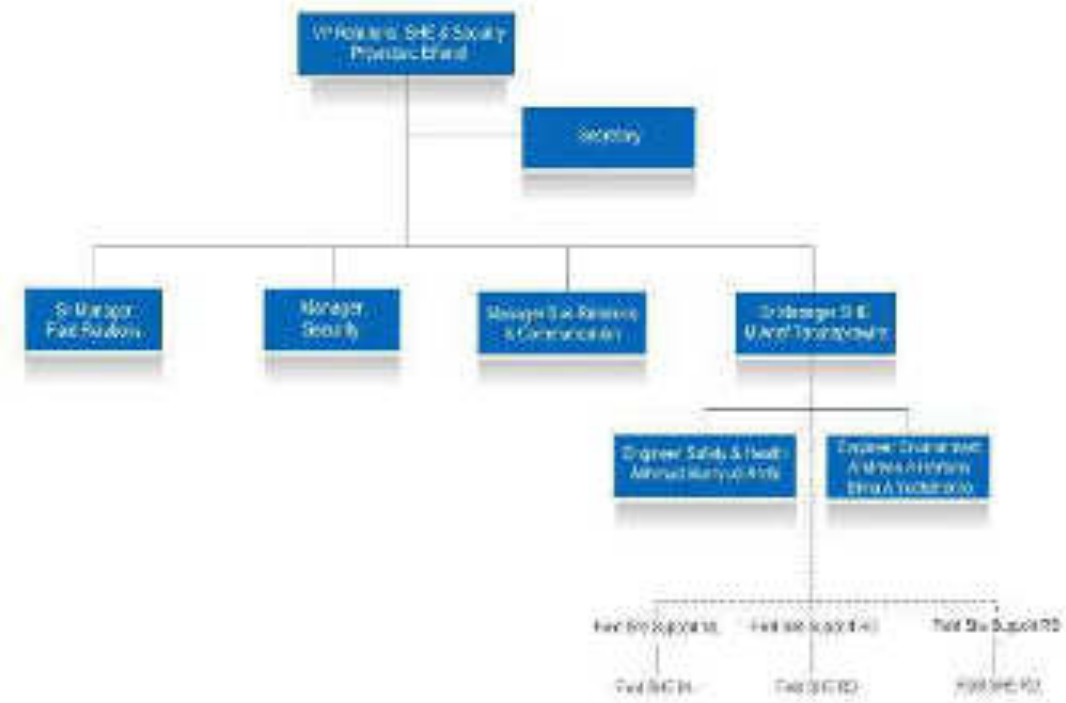


Figure 1 Organogram of PT SERD SHE in Jakarta

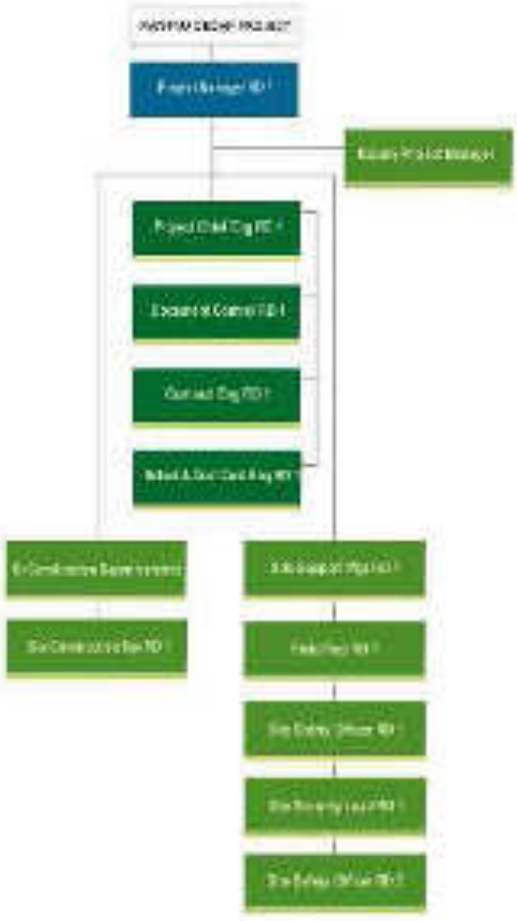


Figure 2 Organogram of PT SERD Project at site

2.6.2 Social Management

The PT SERD Public Affairs/ Relations organization is responsible for executing the Social Management System.

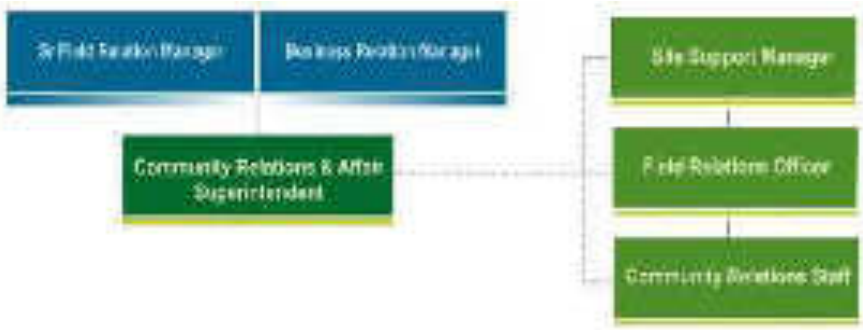


Figure 3 Social Organogram

2.6.3 Environmental and Social Management System Roles and Responsibilities

ESMS roles and responsibilities are outlined in Table 6~~Table 6~~.

Table 6 ESMS Roles and Responsibilities

Role	Responsibilities	Competencies
EPC Construction/ Operations Manager	• Manage day-to-day compliance with the policy outlined in section 2.2, the ESMS and related permits and licenses, including taking necessary corrective actions • Ensure that project ESMS is understood and adequately resourced, and implemented by Supply Chain, Human Resources, SHE, External Relations, Legal, Security and other relevant functions. • Monitor and report ESMS compliance • Integrate ESMS actions into the relevant management systems. • Ensure any third parties understand the commitments of the policy and their specific responsibilities related to it. • Confirm that Stakeholder Engagement, including the Grievance Mechanism, are implemented per plan.	• Understanding of the ESMS and related requirements and procedures. • Facilitative leadership skills.
Site Support and SHE Manager	• Assure compliance with the policy outlined in section 2.2, including leading, resourcing and serving as advocate for the overall ESMS. • Ensure that ESMS progress is tracked and documented and action items are closed-out using a comprehensive register that contains the specific item, person responsible, required resources, performance measures and timing. In some cases, the responsible party might be a contractor or third-party. • Drive ESMS continual improvement, including integrating the ESMS into the project's relevant management systems. • Implement Emergency Preparedness and Response procedure. • Provide subject matter expertise and resources. • Conduct audit and performance reporting activities for the ESMS. • Control ESMS documentation and records.	• Understands the ESMS and how to build cross-functional support for the ESMS, especially with construction and operations staff and integrate ESMS requirements into overall management system. • Understanding of local ESMS-related GoI regulations and policy issues, such as AMDAL. • Leadership, project management, analytical and planning skills. • Understands and undertakes continual improvement steps. • Leverages lessons learned from inside and outside the project and applies best practices

Role	Responsibilities	Competencies
Security Manager	• Assure compliance with the policy outlined in section 2.2, particularly relating to security aspects, to ensure that it is understood, meets commitments of the ESMS and adds value. • Lead the implementation, measurement, audit and continual improvement (of effectiveness and efficiency) on security commitments of the ESMS.	• Understands the ESMS and how to build cross-functional support for the ESMS and integrate supply chain requirements into overall management system. • Understands key stakeholders and their issues relating to security. • Leadership, analytical, planning and project management skills. • Understands and undertakes continual improvement steps. • Leverages lessons learned from inside and outside project and applies best practices • Has completed related training.
Public Affairs/ Relations Manager	• Assure compliance with the policy outlined in section 2.2, including leading, resourcing and serving as advocate for the Stakeholder Engagement Procedure, the Stakeholder Engagement Plan and the Grievance Mechanism, to ensure that it is understood, meets commitments of the ESMS and adds value. (External stakeholder issues primarily relate to Performance Standards 1, 4, 5, 7 and 8.) • Lead the implementation, measurement, audit and continual improvement (of effectiveness and efficiency) of the procedure, plan and Grievance Mechanism. • Maintain and deliver Stakeholder Engagement training • Integrate and align relevant stakeholder information into business planning and decision making. • Develop and maintain a Stakeholder Engagement Plan to document engagement and communications plans and activities. • Carry out regular review of regulatory and other issues that may affect the project and ensure related stakeholders are engaged. • Ensures stakeholder issues are satisfactorily closed out (addressed) in timely manner. • Develop, maintain and implement the project Community Development Plan.	• Understands the ESMS and how to build cross-functional support for the ESMS and integrate supply chain requirements into overall management system. Includes Stakeholder Engagement Procedure, the Stakeholder Engagement Plan and the Grievance Mechanism. • Understanding of the key stakeholders and their issues. • Leadership, analytical, planning and project management skills. • Understands and undertakes continual improvement steps. • Leverages lessons learned from inside and outside the project and applies best practices • Has completed related training. • Understands community development principles and planning processes. • Proficient in engaging stakeholders, per the Stakeholder Engagement Plan.

Role	Responsibilities	Competencies
Human Resources/ Admin Manager	• Assure compliance with the policy outlined in section 2.2, particularly relating to PS 2 (Labor and Working Conditions), to ensure that it is understood, meets commitments of the ESMS and adds value. • Lead the implementation, measurement, audit and continual improvement (of effectiveness and efficiency) for labor and working conditions commitments of the ESMS. • Maintain and deliver training.	• Understands the ESMS and how to build cross-functional support for the ESMS and integrate human resources requirements into overall management system. • Understands key stakeholders and their issues relating to human resources. • Leadership, analytical, planning and project management skills. • Understands and undertakes continual improvement steps. • Leverages lessons learned from inside and outside the project and applies best practices • Has completed related training.
Field Supply Chain Manager (Field SCM)	• Assure compliance with the policy outlined in section 2.2, particularly relating to supply chain aspects, to ensure that it is understood, meets commitments of the ESMS and adds value. • Lead the implementation, measurement, audit and continual improvement (of effectiveness and efficiency) on supply chain commitments of the ESMS. • Benchmark project against competitors and top performers in the region.	• Understands the ESMS and how to build cross-functional support for the ESMS and integrate supply chain requirements into overall management system. • Understands key stakeholders and their issues relating to supply chain. • Leadership, analytical, planning and project management skills. • Understands and undertakes continual improvement steps. • Leverages lessons learned from inside and outside the project and applies best practices • Has completed related training.

2.7 Emergency Preparedness and Response

In the Supreme Energy SHE Manual Chapter 2 is the *Incident Command System - Emergency Management and Crisis Management Plan*. This document describes organizational lines of responsibility and guidelines to be used during all emergencies that could occur within SE operations. The Plan contains guidelines, instructions and procedures to be followed as closely as they are applicable to the actual situation.

The Emergency Response, Emergency Management, and Crisis Management arrangements in the manual are based on three tiers. The Emergency Response Team (ERT) is located at each Project site; the Emergency Management Team (EMT) together with the Crisis Management Team (CMT) are located in Jakarta.

The four main sections of the Plan are:

- *Section 1*: Purpose, scope, and general philosophy of the Plan.
- *Section 2*: Operational Emergency Management Organization, details of callout procedures, Emergency Management Team members and their duties, and internal and external communication procedures during an emergency.
- *Section 3:* Roles, Responsibilities, and Checklists for the Team.
- *Attachments:* Emergency Contact List.

Supreme Energy provides training for its personnel in the skills and techniques necessary to handle fires, explosions, search and rescue of personnel, care and evacuation of casualties, lifesaving appliances, and all emergencies that could occur at SE facilities including H_2S leaks, earthquakes, and civil unrest; the complete list addressed is:

- Fire / Explosion
- Serious Injury / Fatality
- Well Control Situation
- Severe Car Accident
- Failure of Equipment / Damage
- Helicopter Crash
- Hydrogen Sulfide Leak
- Missing Person(s)
- Abandon Rig
- Extortion
- Other Drilling Emergency
- Civil Unrest
- Earthquake - Terrorism / Sabotage
- Volcanic eruption.

Drills are held regularly at Project sites, where these skills and techniques are practiced, along with the use of the communication systems and procedures necessary for these activities. Examples of drills for the following scenarios have carried out in the past: H_2S drill, muster / evacuation drill, injury personnel evacuation, and fire emergency amongst others. Drills are evaluated and the procedures regularly reviewed.

The construction and operations Emergency Response Plan is contained in the list of Standard Operating Procedures (SOP) in Appendix 12.

3 ENVIRONMENTAL AND SOCIAL DESIGN CRITERIA

3.1 Administrative Framework

In accordance with GoI Regulation PP No. 27 of 2012 on Environmental Permits, the AMDAL Commission of the appropriate Environmental Office will be responsible for all matters relating to the AMDAL and Environmental Permit processes.

The related environmental unit from Environment Office and Department of Mining and Energy as well as the environmental unit of the Directorate General of Electricity and Energy Development will review environmental design and engineering and will review all monitoring activities in accordance with the RKL and RPL.

3.2 Legal Framework

The legal basis of the Indonesian State is the 1945 Constitution, which was promulgated the day after the 17 August 1945 proclamation of independence. Since then, thousands of laws and regulations have been issued relating to environmental management in Indonesia. MPR Decree number III of 2000 defines the hierarchy of these laws and regulations as shown in Table 7~~Table 7~~.

Table 7 Indonesian Laws and Regulations Hierarchy

English Name	Indonesian Abbreviation and Name	Remarks
Constitution	UUD/Undang-Undang Dasar	Passed by the upper house of Parliament (MPR)
Law	UU/Undang-Undang	Passed by the Parliament (DPR)
GoI Regulation	PP/Peraturan Pemerintah	Issued by the cabinet, signed by the President
Presidential Regulation/Decree/Instruction	PerPres/Peraturan Presiden KepPres/Keputusan Presiden InPres/Instruksi Presiden	Issued by the President
Ministerial Regulation/Decree	PerMen/Peraturan Menteri KepMen/Keputusan Menteri	Issued by Ministry as determined by law
Local Government Regulation	PerDa/Peraturan Daerah	Issued by Provincial, or District or legislative councils (DPRD)

3.2.1 Laws

Key laws related to safety, health, and environment and relevant for the project follow:

- Law No. 37 of 2014 regarding Land and Water Conservation
- Law No. 21 of 2014 regarding Geothermal
- Law No. 2 of 2012 regarding Land Procurement for Development for Public Interest
- Law No. 11 of 2010 regarding Cultural Preservation
- Law No. 36 of 2009 regarding Health
- Law No. 32 of 2009 regarding Protection and Management of the Environment

- Law No. 18 of 2008 regarding Waste Management
- Law No. 30 of 2007 regarding Energy
- Law No. 1 of 2004 regarding The Amendment of Law No. 41 1999 regarding Forestry
- Law No. 13 of 2003 regarding Employment
- Law No. 41 of 1999 regarding Forestry
- Law No. 5 of 1990 regarding Biodiversity and Ecosystem Conservation
- Law No. 1 of 1970 regarding Occupational Safety

3.2.2 Environmental Permitting

Regulations related to environmental permitting are as follows:

- Ministry of Environment Regulation No. 5 of 2012 regarding the Type of Business and / or Activities that are required to undertake an Environmental Impact Analysis.
- GoI Regulation No. 27 of 2012 regarding Environmental Permit.
- Ministry of Environment Regulation No. 17 of 2012 regarding Guideline for Community Involvement in Environmental Impact Assessment and Environmental Permit Processes.
- Ministry of Environment Regulation No. 16 of 2012 regarding Guidelines for Preparing Environmental Document.
- Ministry of Environment Regulation No. 07 of 2010 concerning Competencies Certification of AMDAL Documents Preparation and Requirements of Training Institute for Competencies of AMDAL Documents Compiler.
- Ministry of Environment Regulation No. 8 of 2013 regarding Procedures for Environmental Document Analysis and Review and Environmental Permit Issuance.
- Ministry of Environment Decree No. 45 of 2005 regarding Guidelines for Preparation of an Environmental Management Plan (RKL) and Environmental Monitoring Plan (RPL) Reports.

3.2.3 Atmosphere

Regulations related to the protection of the atmosphere are as follows:

- GoI Regulation PP No. 41 of 1999 regarding Air Pollution Control
- Ministry of Environment Regulation PerMenLH No. 21 of 2008 regarding Stationary Emission Standard for Thermal Power Generation Business and/or Activity.
- Ministry of Environment Decree KepMenLH No. KEP-48/MENLH/11/1996 regarding Noise Level Standard
- Ministry of Environment Decree KepMenLHNo. KEP-49/MENLH/11/1996 regarding Vibration Level Standard
- Ministry of Environment Decree KepMenLH No. 50/MENLH/11/1996 regarding Ambient Odor

3.2.4 Hydrosphere

- GoI Regulation PP No. 82 of 2001 regarding Water Quality Management and Waste Pollution Control
- South Sumatra Governor Decree No. 16 of 2005 regarding Water Quality Criteria

- Ministry of Health Regulation PerMenKes No. 492 of 2010 regarding Drinking Water Quality Standard
- Ministry of Health Regulation PerMenKes No. 528 of 1982 regarding Groundwater Quality Related to Health
- Ministry of Public Works and Settlements PerMenPUPR No. 50 of 2015 regarding Water Resources Utilization Permit
- Ministry of Environment Regulation PerMenLH No. 13 of 2007 regarding Requirements of Wastewater Injections for Oil and Gas as well as Geothermal Business and/or Activity
- Ministry of Environment Regulation PerMenLH No. 8 of 2009 regarding Wastewater Quality Standards for Geothermal Power plant Business and/or Activity
- Ministry of Environment Regulation PerMenLH No. 19 of 2010 regarding Wastewater Quality Standards for Oil and Gas as well as Geothermal Business and/or Activity

3.2.5 Biosphere

- Ministry Forestry Regulation PerMenHut No. 4 of 2011 regarding Guidelines on Forest Reclamation
- Ministry Forestry Regulation PerMenHut No. P.12/Menhut-II/2009 regarding Forest Fire Control
- Ministry of Environment and Forestry No. P.50/Menlhk/2016 regarding Guidelines on Borrow-Use of Forest Area

3.2.6 Waste Management

- GoI Regulation No. 81 of 2012 regarding Management of Domestic Waste and Similar Type to Domestic Waste
- Ministry of Internal Affairs Regulation No. 33 of 2010 regarding Guidelines for Waste Management.

3.2.7 Hazardous Waste and Material

- Head of BAPEDAL Decree KEP-02/BAPEDAL/09/1995 regarding Guidelines to Prepare Hazardous Waste Documents
- Ministry of Environment and Forestry Regulation PerMenLHK No. 101 of 2014 regarding Hazardous and Toxic Waste Management
- Head of BAPEDAL Decree KEP-01/BAPEDAL/09/1995 regarding Procedure and Technical Requirement for Hazardous Waste Storage and Collection
- Ministry of Environment Regulation PerMenLH No. 14 of 2013 regarding Symbols and Labeling of Hazardous and Toxic Waste
- Head of BAPEDAL Decree KEP-03/BAPEDAL/09/1995 regarding technical requirements for processing hazardous waste
- Ministry of Environment Regulation PerMenLH No. 18 of 2009 on Obtaining Permits for Storage, Treatment and Disposal of Hazardous Waste
- Head of BAPEDAL Decree No. KEP-255/BAPEDAL/08/1996 regarding Lubricating Oil Collection and Storage Procedure

- Ministry of Environment Regulation PerMenLH No. 2 of 2008 concerning Hazardous Waste Utilization
- GoI Regulation PP No. 74 of 2001 regarding Hazardous Material Management
- Ministry of Environment Regulation PerMenLH No. 3 of 2008 regarding Procedure of Providing Symbol and Label for Hazardous and Toxic Materials
- Ministry of Manpower Regulation PerMenNaKer No. 3 of 1985 regarding Occupational Health and Safety on Asbestos Use
- Head of National Police Regulation No. 2 of 2008 regarding Supervision, Control, and Safety of Commercial Explosive

3.2.8 Social Sphere – Labor

- GoI Regulation No. 78 of 2015 on Payment
- GoI Regulation PP No. 45 of 2015 regarding Implementation of Pension Insurance Program
- GoI Regulation PP No. 46 of 2015 and No. 60 of 2015 regarding Implementation of Pension Plan Program
- GoI Regulation PP No. 44 of 2015 regarding Implementation of Occupational Accident and Life Insurance Programs

3.2.9 Social Sphere – Occupational Health and Safety

- GoI Regulation PP No. 50 of 2012 regarding Implementation of Safety and Occupational Health Management System
- Ministry of Mining and Energy Decree KepMenTamben No. 555K of 1995 regarding Occupational Safety and Health for General Mining
- Ministry of Health Decree KepMenKes No. 1405 of 2002 concerning Occupation Health Requirement at Office Work and Industry
- Director General of Manpower and Maintenance Decree No. 40 of 1978 regarding Construction of Installation at Work Place
- Ministry of Manpower and Transmigration Regulation PerMenNaKerTrans No. 13 of 2011 regarding Physical and Chemical Factors Threshold at Workplace
- Ministry of Health Regulation PerMenKes No. 28 of 2014 regarding National Health Insurance Program Implementation Guidelines
- Ministry of Health Regulation PerMenKes No. 28 of 2011 regarding Clinic Requirements
- Ministry of Mining and Energy PP No. 2 of 1990 regarding Operational Safety During the Exploration and Exploitation of Geothermal Resources
- Ministry of Mining and Energy Regulation PerMenTambEn No. 6 of 1991 regarding Inspection of Occupational Safety on Installation, Equipment and Techniques Utilized in Oil and Gas Mining and Exertion of Geothermal Resources.
- Ministry of Manpower Regulation PerMenNaKer No. 12 of 2015 regarding Electrical Safety and Health
- Ministry of Manpower and Transmigration Regulation PerMenNaKerTrans No. PER-02/MEN/1980 regarding Worker Medical Check-Up in Work Safety Implementation

3.2.10 Social Sphere – Land acquisition

- National Land Head Agency Regulation No. 5 of 2012 and No. 06 of 2015 regarding Technical Guidelines for Land Procurement
- Presidential Decrees PerPres No. 71 of 2012; No. 40 of 2014; No. 99 of 2014; No. 30 of 2015; and No. 148 of 2015 regarding Implementation of Land Procurement for Development in Public Interest
- GoI Regulation PP No. 24 of 2010; No. 61 of 2012; and No. 105 of 2015 regarding Utilization of Forest Area

3.2.11 International Conventions and Treaties

International environmental conventions or agreement or treaties that have been ratified by Indonesia become incorporated as part of Indonesian laws. Key relevant International conventions or agreement or treaties on the environmental, health and safety aspects are listed in the following Table.

Table 8 International Treaties and Conventions

International Convention/Treaty	Ratification by Indonesian Laws and Regulations
Air and Atmosphere	
United Nations Framework Convention on Climate Change	Law No. 6 of 1994
Kyoto Protocol to the United Nations Framework Convention on Climate Change	Presidential Decree PP No. 92 of 1998
Biodiversity	
International Plan Protection Convention	Presidential Decree PP No. 2 of 1977
Convention on International Trade in Endangered Species of Wild Fauna and Flora	Presidential Decree PP No. 43 of 1978
ASEAN Agreement on the Conservation of Nature and Natural Resources	Presidential Decree PP No. 26 of 1986
Amendment 1979 to Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973	Presidential Decree PP No. 1 of 1987
Convention concerning the Protection of the World Cultural and Natural Heritage	Presidential Decree PP No. 17 of 1989
Cartagena Protocol on Biosafety to the Convention on Biological Diversity	Law No. 21 of 2004
Ramsar Convention on Wetlands	Presidential Decree PP No. 48 of 1991
Forestry	
International Tropical Timber Agreement	Presidential Decree PP No. 4 of 1995
Labor	
ILO Conventions	Law No.19 of 1999, Law No.20 of 1999, Law No. 21 of 1999

3.2.12 Good International Industry Practice (GIIP)

The project is designed to comply with relevant IFC guidance documents:

- ADB Safeguard Policy Statements (SPS) 2009;
- IFC Environmental and Social Performance Standards (IFC PS) 2012; and

- General and sector-specific International Finance Corporation (IFC) Environment, Health and Safety (EHS) Guidelines of 2007 (IFC EHS Guidelines) as main GIIP reference.
- Engie Health and Safety Policy

3.3 Numerical Standards

The project is designed to comply with the applicable numerical standards set forth in GoI and GIIP standards and regulations indicated in section 3.2.

3.3.1 Ambient Air and Air Emission

Table 9~~Table 9~~ presents the GoI and GIIP numerical standards for ambient air and emission quality.

Table 9 Air Quality and Emission Standards

Parameter	Ambient Air Quality		Emission Quality	
	PP No. 41 of 1999 and South Sumatra Governor Regulation No. 17 of 2005 (µg/Nm³)	IFC (µg/Nm³)	PerMenLH No. 21 of 2008 (mg/Nm³)	IFC (µγ/Nm³)
Gases				
Sulfur Dioxide (SO_2)	900 (1 hr) 365 (24 hr) 60 (1 yr)	20 guideline (24 hr)	NR	NR
Carbon Monoxide (CO)	30,000 (1 hr) 10,000 (24 hr)	NR	NR	NR
Nitrogen Dioxide (NO_2)	400 (1 hr) 150 (24 hr) 100 (1 yr)	200 guideline (1 hr) 40 guideline (1 yr)	NR	NR
Oxidant / Ozone (O_3)	235 (1 hr) 50 (1 yr)	100 (8 hr daily maximum)	NR	NR
Hydrocarbon (HC)	160 (3 hr)	NR	NR	NR
Hydrogen Sulfide (H_2S)	NR	NR	35	NR
Ammonia (NH_3)	NR	NR	0.5	NR
Dust				
Particulate Matter < 10 µm (PM_{10})	150 (24 hr)	50 guideline (24 hr) 20 guideline (1 yr)	NR	NR
Particulate Matter < 2.5 µm ($PM_{2.5}$)	65 (24 hr) 15 (1 yr)	25 guideline (24 hr) 10 guideline (1 yr)	NR	NR
Total Suspended Solid (TSP)	230 (24 hr) 90 (1 yr)	NR	NR	25,000 (1 yr)
Lead (Pb)	2 (24 hr) 1 (1 yr)	NR	NR	NR

Parameter	Ambient Air Quality		Emission Quality	
	PP No. 41 of 1999 and South Sumatra Governor Regulation No. 17 of 2005 (μg/Nm³)	IFC (μg/Nm³)	PerMenLH No. 21 of 2008 (mg/Nm³)	IFC (μγ/Nm³)
Dustfall	10 ton/km³/mo (residential area) 20 ton/km³/mo (industrial area)	NR	NR	NR
Total Fluoride (as F)	3 (24 hr) 0.5 (90 day)	NR	NR	NR
Fluor Index	40 (30 day)	NR	NR	NR
Chlorine & Chlorine Dioxide	150 (24 hr)	NR	NR	NR
Sulphate Index	1 mg SO/100 cm³ of Lead Peroxide	NR	NR	NR

NR = Not Regulated

Nm^3 = Normal cubic meter (1 atmosphere, 25°C)

3.3.2 Odor

Table 10~~Table 10~~ presents the GoI and GIIP numerical standards for ambient air of odor and emission quality of odor.

Table 10 Standards for Unpleasant Odor Levels

Parameter	Ambient Air Quality of Odor			Emission Quality of Odor	
	KepMenLH No. 50 of 1996 (ppm)	PerMenNaKer No. 13 of 2011 (ppm)	IFC	PerMenLH No. 21 of 2008 (mg/Nm³)	IFC
Ammonia (NH_3)	2.0	NR	NR	0.5	NR
Methyl Mercaptan (CH_3SH)	0.002	NR	NR	NR	NR
Hydrogen Sulphide (H_2S)	0.02(28 μg/m³) (24 hr)	1	7 (0.5 h) (WHO) (odor) 0.1 ppm (WHO) (public health)	35	NR
Methyl Sulphide ($(CH_3)_2S$)	0.01	NR	NR	NR	NR
Styrene ($C_6H_8CHCH_2$)	0.1	NR	NR	NR	NR

NR = Not Regulated

3.3.3 Noise and Vibration

Table 11~~Table 11~~ presents the GoI and GIIP numerical standards for noise level.

Table 11 Noise Levels

Area	Maximum Noise Level dB(A)	
	Indonesia	IFC
Housing and residence	55	45 night time (22.00 to 07.00) 55 day time (07.00 – 22.00)
Trade and service	70	70 (commercial)

Area	Maximum Noise Level dB(A)	
	Indonesia	IFC
Office and trade	65	70 (commercial)
Green open space	50	Background + 3 dB
Industry	70	70
Government and public space	60	Background + 3 dB
Recreation	70	Background + 3 dB
Specific - cultural heritage	60	Background + 3 dB
Hospital, school, and religious building	55	45 night time (22.00 to 07.00) 55 day time (07.00 – 22.00)

The IFC Environmental, Health and Safety General Guidelines, referenced in the Equator Principles, stipulate that noise impacts, as measured in 8-hour LAeq and LAmax "fast" should not exceed the levels presented in the table below (Table 12~~Table 12~~) or result in a maximum increase in background levels of 3dB at the nearest receptor locations. (LAmax "fast" is averaged over 0.125 second.)

Table 12 Noise Levels for Various Working Environments

Location / Activity	Equivalent Level LAeq 8h dB(A)	Maximum LAmax "fast" dB(A)
Heavy industry (No demand for oral communication)	85	110
Light industry (limited demand for oral communication)	50 - 65	110
Open offices, control rooms, service counters or similar	45 - 50	NR
Individual offices (No disturbing noise)	40 - 45	NR
Classroom, lecture halls	35 - 40	NR
Hospitals	30 - 35	40

NR = Not Regulated

The vibration limitations applicable to the project are set forth in Ministry for Environment Decree KepMenLH No. KEP-49/MENLH/11/1996 on Vibration Levels.

3.3.4 Water Discharge

Table 13~~Table 13~~ presents the GoI and GIIP numerical standards for wastewater effluent standards.

Table 13 Effluent Standards for Surface Water and Drainage Water

Source	Unit	Maximum Value		
		PerMenLH No. 8 of 2009	PerMenLH No. 19 of 2010	IFC
Surface Runoff				

Source	Unit	Maximum Value		
		PerMenLH No. 8 of 2009	PerMenLH No. 19 of 2010	IFC
TSS	mg/L	100	NR	NR
Drainage Water				
Oil and Grease	mg/L	NR	15	NR
TOC	mg/L	NR	110	NR

NR = Not Regulated

PerMenLH = Regulation of Ministry for Environment

Table 14~~Table 14~~ presents the GoI numerical standards for receiving water body by class.

Table 14 Quality Standards for Receiving Water Body Based by Class

Parameter	Unit	PP No. 82 of 2001	Governor of South Sumatra Decree No. 16 of 2005 [1]	PerMenKes No. 492 of 2010*	Remarks
		Class II	Class I		
Physical					
Temperature	˚C	Dev. 3	Dev. 3	Dev. 3	Deviation of temperature from its natural conditions
Dissolved Residue	mg/L	1,000	1,000	500	
Suspended Residue	mg/L	50	50	NR	For conventional drinking water processing, suspended residues < 5,000 mg/L
Odor		NR	NR [1]	Odorless	
Color		NR	NR [1]	Colorless	
Turbidity	NTU	NR	NR [1]	5	
Taste		NR	NR [1]	Tasteless	
Hardness	mg/L	NR	NR [1]	500	
Inorganic Chemicals					
pH		6 - 9	6 - 9	6.5 - 8.5	If naturally outside this range, determined based on its natural condition
BOD	mg/L	3	2	NR	
COD	mg/L	25	10	NR	
DO	mg/L	4	6	NR	Minimum limit values
Total Phosphate as P	mg/L	0.2	0.2	NR	
NO_3 as N	mg/L	10	10	50	
NH_3 - N	mg/L	NR	0.5	1.5	For fisheries, free ammonia contents for sensitive fish ≤ 0.02 mg/L as NH_3
Arsenic	mg/L	1	0.05	0.01	
Cobalt	mg/L	0.2	0.2	NR	

Parameter	Unit	PP No. 82 of 2001	Governor of South Sumatra Decree No. 16 of 2005 [1]	PerMenKes No. 492 of 2010*	Remarks
		Class II	Class I		
Barium	mg/L	NR	1	0.07	
Boron	mg/L	1	1	0.5	
Selenium	mg/L	0.05	0.01	0.01	
Cadmium	mg/L	0.01	0.1	0.003	
Chrome (VI)	mg/L	0.05	0.05	0.05	
Copper	mg/L	0.02	0.02	2	For conventional drinking water processing, Cu ≤ 1 mg/L
Iron	mg/L	NR	0.3	0.3	For conventional drinking water processing, Fe ≤ 5 mg/L
Lead	mg/L	0.03	0.3	0.01	For conventional drinking water processing, Pb ≤ 0.1 mg/L
Manganese	mg/L	NR	0.1	0.4	
Mercury	mg/L	0.002	0.001	0.001	
Zinc	mg/L	0.05	0.05	3	For conventional drinking water processing, Zn ≤ 5 mg/L
Chloride	mg/L	NR	600	250	
Cyanide	mg/L	0.02	0.02	0.07	
Fluoride	mg/L	1.5	0.5	1.5	
Nitrite as N	mg/L	0.06	0.06	3	For conventional drinking water processing, NO_2 - N ≤ 1 mg/L
Sulphate (SO_4)	mg/L	NR	400	250	
Free Chlorine	mg/L	0.03	0.03	5 (as free chlorine)	For conventional drinking water, not specified
Sulfur as H_2S	mg/L	0.002	0.002	NR	For conventional drinking water processing, S as H_2S < 5 mg/L
Aluminum	mg/L	NR	NR [1]	0.2	
Antimony	mg/L	NR	NR [1]	0.02	
Molybdenum	mg/L	NR	NR [1]	0.07	
Nickel	mg/L	NR	NR [1]	0.07	
Sodium	mg/L	NR	NR [1]	200	
Organic content $KMnO_4$	mg/L	NR	NR [1]	10	
Microbiology					
Fecal Coliforms	Nos./ 100 mL	1,000	100	0	For conventional drinking water processing, fecal coliform ≤ 2,000 Nos./100 mL and Total Coliform ≤
Total Coliforms	Nos./	5,000	1000	0	

Parameter	Unit	PP No. 82 of 2001	Governor of South Sumatra Decree No. 16 of 2005 [1]	PerMenKes No. 492 of 2010*	Remarks
		Class II	Class I		
	100 mL				10,000 Nos./100 mL.
Radioactivity					
Gross - A	Bq/L	0.1	NR [1]	0.1	
Gross - B	Bq/L	1	NR [1]	1	
Uranium	mg/L	1	NR [1]	0.015	
Organic Chemicals					
Oil and Grease	µg/L	1,000	1,000	NR	
Detergents as MBAS	µg/L	200	200	50	
Phenolic compounds as Phenols	µg/L	1	1	9 (as PCP)	
BHC	µg/L	210	NR [1]	NR	
Aldrin / Dieldrin	µg/L	NR	NR [1]	0.03	
Chlordane	µg/L	NR	NR [1]	0.2	
DDT	µg/L	2	NR [1]	NR	
Heptachlor and heptachlor oxides	µg/L	NR	NR [1]	NR	
Lindane	µg/L	NR	NR [1]	NR	
Methoxychlor	µg/L	NR	NR [1]	20	
Endrin	µg/L	4	NR [1]	NR	
Toxaphene	µg/L	NR	NR [1]	NR	

NR = Not Regulated

NR [1] = Not regulated under Governor of South Sumatra Decree No. 16 of 2005

*= see Appendix of PerMenKes No. 492/ MenKes/Per/IV/2010 for complete parameters

4 PROJECT DESCRIPTION

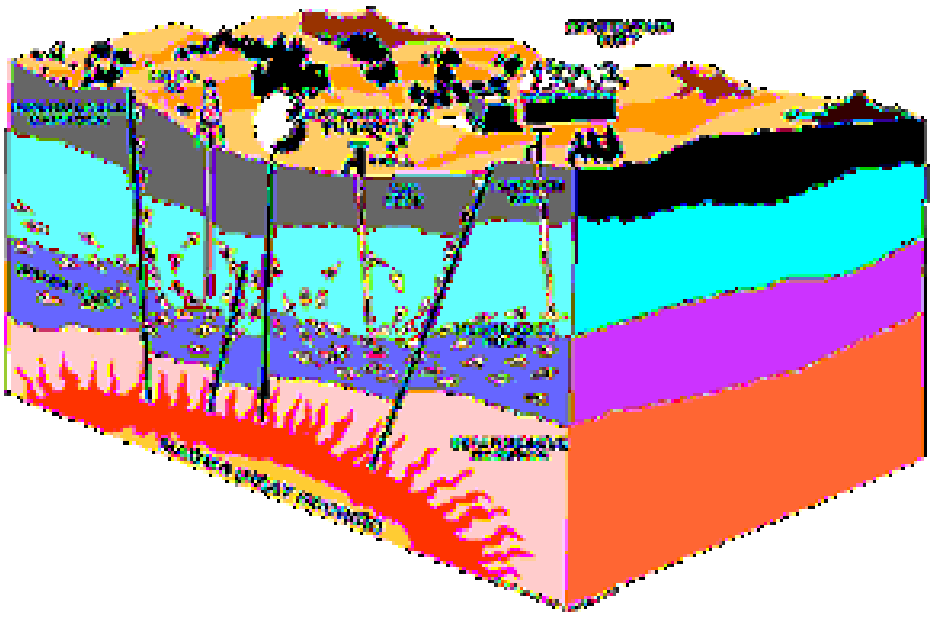
Geothermal power plants, like most power plants (e.g., hydro and wind power), convert energy to electricity through the use of turbines that drive electric generators. Energy is contained in the heat present in geothermal reservoirs, commonly located about two thousand meters below ground level. There are two main exploitable sources of geothermal energy.

- Hydrothermal systems use naturally occurring hot water or steam trapped in or circulating through permeable rock, to drive steam powered electricity generators;
- Another technology extracts heat from hot rock by artificially circulating water through the rock to produce hot water or steam to drive the generators.

Once wells are drilled to tap into sources of geothermal energy there are two ways of converting thermal energy into electricity:

- Utilize the hot water emerging from the production wells to heat the water in a vat to produce steam, which is then directed to the turbine; and
- Steam from production wells is typically separated from brine in a separator, then scrubbed to remove any particle or solid that can damage the turbine and then directed to the turbine;

Geothermal energy is considered to be clean and renewable energy. Environmental and social impacts are commonly limited to the construction phase: once in operation there are few if any environmental impacts.



Source: Energy Information Administration, Geothermal Energy in the Western United States and Hawaii: Resources and Projected Electricity Generation Supplies, DOE/EIA-0544, Washington DC, 1991

Figure 4 Illustration of Geothermal Energy Production.

4.1 Technology

The PT SERD project has the following technical design criteria:

1. Capacity: The initial proposed power plant has a total capacity of 250MW. Based on the exploration results and modeling of the reservoir, the Phase 1 power plant capacity is 92MW. The largest part of the total capacity, based on the feasibility study (FS) will come from high pressure (HP) steam with 79.3MW and 31.2MW from low pressure (LP) steam. Capacity will be increased as additional wells come online and additional exploration/step-out wells demonstrate sufficient resource capacity.

2. Steam Supply: Steam will be supplied from 2 existing and 2 future wells from Wellpad-I; 5 future wells from Wellpad-L; 4 future wells from Wellpad-M; and 2 existing wells and 1 future well from Wellpad-C. At the power plant, a separator station separates steam and brine.

3. Brine Reinjection: Brine is reinjected into the geothermal reservoir returning the water to the formation. There will be up to 4 reinjection wells for the entire project.

4. Dual Flash Steam Cycle: The selected technology based on the FS depends on the most efficient heat conversion and its variation of produced geothermal fluid (steam and brine) and well production capacities. Other factors can also influence technology selection, such as topography and land availability, availability of equipment and economic considerations (e.g. capital and operating expenses).

5. With results obtained from the initial exploration activities, a dual flash steam cycle was selected. HP fluids are supplied from wells located at Wellpads I, L and M and separated into steam and brine at a pressure of 7.0 bara. The separated steam is supplied to the high pressure portion of the steam turbine at a pressure of 6.2 bara. The separated brine is flashed to a lower pressure and combined with the two phase fluid supplied from wells located on Wellpad C. In the LP separators operating at a pressure of 2.6 bara LP steam is produced and supplied to the LP portion of the steam turbine at a pressure of 2.0 bara. The separated brine leaving the LP separators is at a temperature of around 128°C and reinjected. Excess plant condensate at a temperature of around 36°C is also reinjected. The generator will be directly driven by the steam turbine at 3,000 rpm with a generating voltage of 11kV, typical for 46 MW size generators. A brushless rotating type exciter with permanent magnet generator will be used for the generator excitation system. The generator output will be controlled by the turbine-generator control module of the DCS in conjunction with the automatic voltage regulator (Figure 5~~Figure 5~~).

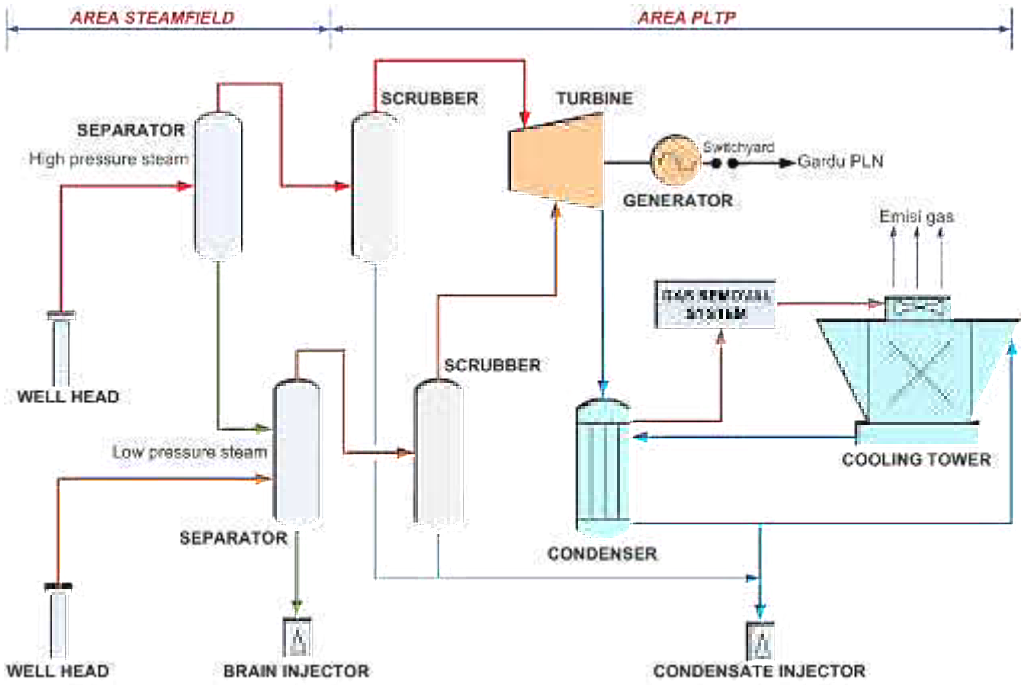


Figure 5 Illustration of Basic Design Dual Flash Power Plant of PT SERD

Table 15 Main Parameters for Dual Flash Power Plant

Parameter	*Value*	*Unit*
High Pressure (HP) steam entering separator	7.0	bara
Low Pressure (LP) steam entering separator	2.6	bara
Gas Content in Steam	0.1 to 3	% by weight
Flow rate of HP steam (including gas)	119	kg/s (including gas)
Flow rate of LP steam (including gas)	62	kg/s (including gas)
Condenser pressure	0.07	bara
Generator gross power	92	MW
Net electricity supply of Geothermal Power Station (PLTP)	86.5	MW
Electrical load during operation	5-6	MW
Steam rate (HP + LP)	1.5-2.0	kg/s/MW gross

Source: PT SERD Feasibility, 2016

4.2 Main Project Components

4.2.1 Access Roads

The main access roads (totaling 42.5 km) are:

- Access road between Lahat and Kota Agung, an existing road improvement in previously non-forest area;
- Access road between Kota Agung and Tunggul Bute, an existing road improvement (14.2 km in total) in previously non-forest areas;
- Tunggul Bute to Rantau Dedap Road which was a new road construction (7.8 km).
- Rantau Dedap Road - facilities area which was a new road construction (4.0 km).

During construction, the project plans to upgrade and realign some of the roads including some of the existing bridges to allow for equipment mobilization and construction and operation activities. Few roads will be built for new access at the green field to the new locations of Wellpads L, M, N and X. Table 16~~Table 16~~ lists the access roads and changes.

Table 16 Overview of Access Roads to Project and Planned Changes

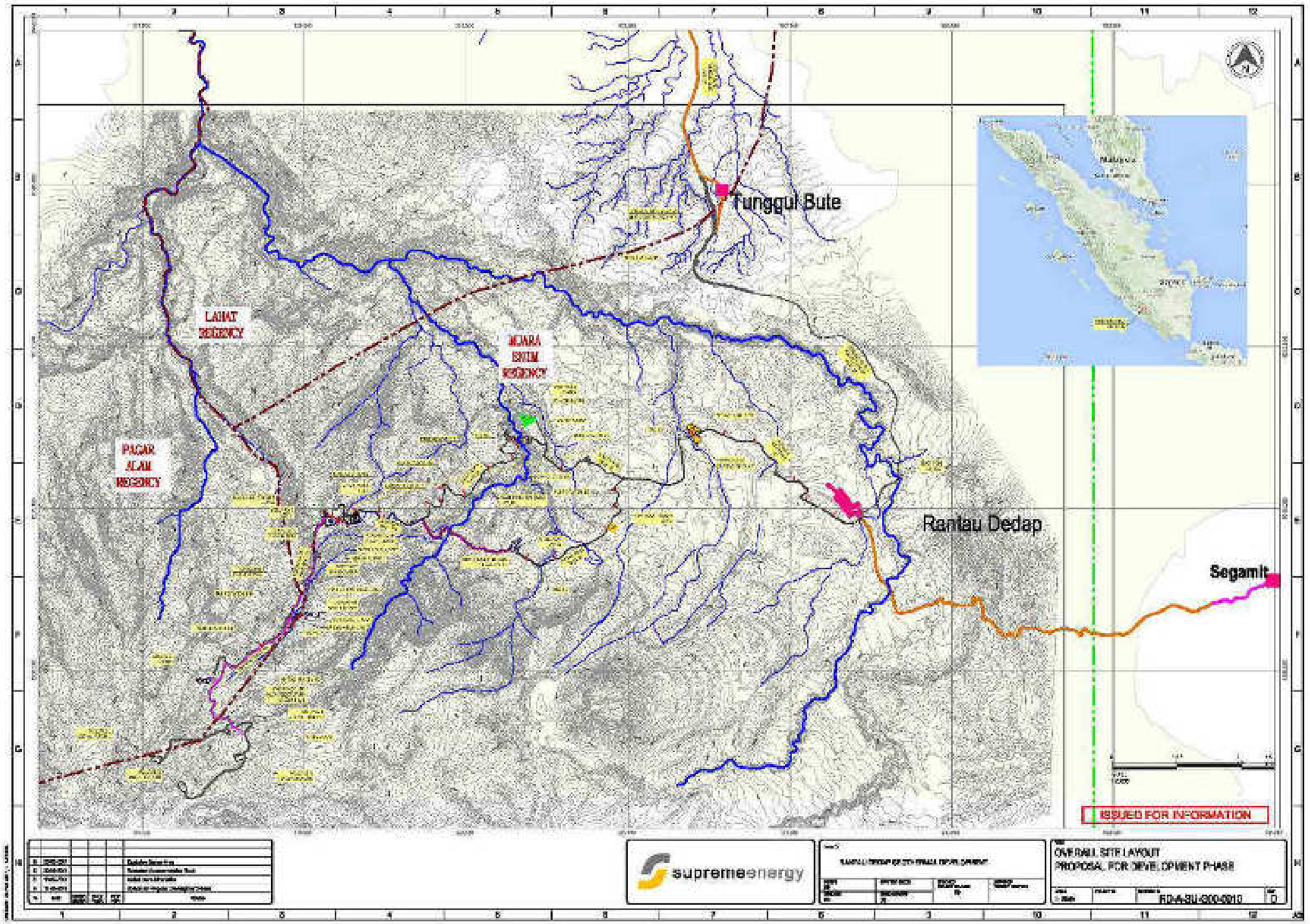
Location	Road Length Plan (meter)	Road Length Option-1 (meter)	Road Length (meter)	Remarks
Kota Agung - Tunggul Bute	12,270	12,270	12,270	Road Improvement
Tunggul Bute - Rantau Dedap	7,890	7,890	6,850	New Road - Remains 1,040 m at Tunggul Bute bypass
Jl. Arabika to Facility Area	3,900	3,900	3,900	New Road
Jl. Anoa to Junction to Jl. Badak	1,600	1,600	1,600	New Road
Jl. Badak to Wellpad B	2,731	2,731	2,731	New Road
Jl. Anoa to Wellpad A	2,054	2,054	2,054	New Road
Jl. Endikat	3,810		400	Deleted but this length already developed
Short Cut		1,500	1,500	New Road
Jl. Gajah	5,590	2,795	2,795	New Road
Jl. Elang to Wellpad E	2,485	2,485	2,485	New Road
Jl. Cendrawasih to Wellpad C	2,331	2,331	2,331	New Road
Jl. Domba to Wellpad D	2,760		-	Deleted
Jl. Ibis to Wellpad I		1,950	1,950	New Road
Total Road Realignments			**12,270**	
Total New Road Construction			**28,596**	

Source: PT SERD, 2016

4.2.2 Production Wells, Injection Wells and Wellpads

It is estimated that about 48 production wells are required for operation of the full capacity 250MW geothermal power plant (PLTP). The 92MW Phase 1 dual flash power plant requires 16 production wells and 4 reinjection wells, situated on 4 to 6 wellpads. Reinjection wells are required to return brine and condensate back to the reservoir formation. The reinjection wells will be located downhill, at the existing Wellpad B and Wellpad E.

The geothermal drilling process will use water-base mud (WBM) to prevent boreholes from collapsing during drilling and also to protect the environment. Water required for drilling is estimated to be up to 30 – 100 l/sec and it will be drawn from surface water and/or collected runoff water. A permit was obtained to source the surface water from the Cawang Tengah / Kiri Rivers. This water will be extracted in such way that it will not impact the environment. It is also noteworthy that there are no communities located downstream of the main water intake .



Map 6 Project Layout Plan

4.2.3 Water Supply and Water Distribution System

The water supply and water distribution system is designed following these Project assumptions:

- River water is the primary water source for use during drilling. The main water source is from the Cawang Tengah River which has an estimated flow of 981 l/s and smaller water supplies are also available near Wellpad B (water intake #1) and Wellpad C (water intake #2) .
- The maximum surface water usage is about 41.1 l/s for Stage 1 Development and EPC Construction which will abstracted at water intake #3 in Cawang Tengah/Kiri River. This is 4.1% of the total discharge flow of the river (Reference: SERD-PRD-MEM-009 dated 19 Sept 2016). PT SERD has a permit to consume up to 100 l/s.
- The water distribution system to be developed shall also be capable of conveying hot brine from one well pad to another at a nominal flow of around 80 l/s and a temperature of 80-90 degrees C.
- Movable, skid mounted, diesel-driven pumps will be used to transfer water and brine between well pads.

Water is mainly used for drilling. Water for drilling is obtained from near Wellpad B (water intake #1), near Wellpad C (water intake #2) and from Shortcut area (water intake #3). Discharge of water from the main water intake is around the 981 liters/sec or 3,532 m^3/h while the smaller ones have discharge rate of 80 – 90 liters/sec or 288 – 324 m^3/h. Water from water intakes will be stored in a water pond and a mud pond will be used for drilling fluid. Sufficient quantities of water will be stored in the ponds to be available for loss circulation or to control the well in case of a well leak. The initial drilling program showed an estimated peak water requirement of 53.68 liters/sec (193.2 m^3/h) during the drilling of the reservoir.

In normal operations, water is used as drilling fluid to bring drilling cuttings in the wellbore to the surface. The mixture of mud and drilling cuttings from the well is then separated in shakers where water (mud) is then sent to mud tanks to be recycled as drilling fluid whereas drilling cuttings are sent to a drilling cutting storage area.

4.2.4 Water and Mud Ponds

Upon completion of drilling, water will be kept in the ponds or optionally transferred to ponds at other wellpads for use in their drilling activity, minimizing freshwater use. Upon completion of the drilling program, the water will be injected into the reservoir. Brine water is also temporarily collected in ponds before channeling it back into the reservoir, thus there will be no discharge to surface water.

The size and design of the ponds have taken into consideration the maximum water supply from the intake, as well as additional rainfall. Capacities of the water ponds are 3,825m^3 and mud ponds are 2,750m^3 each. By design, water runoff from the surrounding area will not enter the ponds. Ponds are made of compacted soil covered with an impermeable HDPE liner.

4.2.5 Pipelines

The project will have an above-ground Steam Gathering System (pipeline network) for 2 phase-flow dry steam, wet steam, brine and condensate, as well as the fresh water supply (FWS). The production piping system will consist of two-phase fluid pipes from wellheads to the separator and three different single-phase fluid pipes: steam, brine and condensate. The steam pipes will divert steam

from the separator stations to the power plant, the brine will be routed to injection wells and the condensate will be routed from the power plant condenser to the injection well. The pipeline route will follow existing roads or dedicated corridors to facilitate easier and lower-impact construction and maintenance. Cut and fill is necessary in some pipeline sections to stabilize slopes and ensure safe operating conditions. Drainage channels parallel to the pipelines and structures to cross roads, rivers, or other features are to be built. Where possible, pipeline routes are selected to facilitate gravity flow for brine and condensate (between power plant and reinjection wells). Based on exploration results, both HP and LP steam will be produced from the production wells. The piping system is schematically depicted in Figure 6.

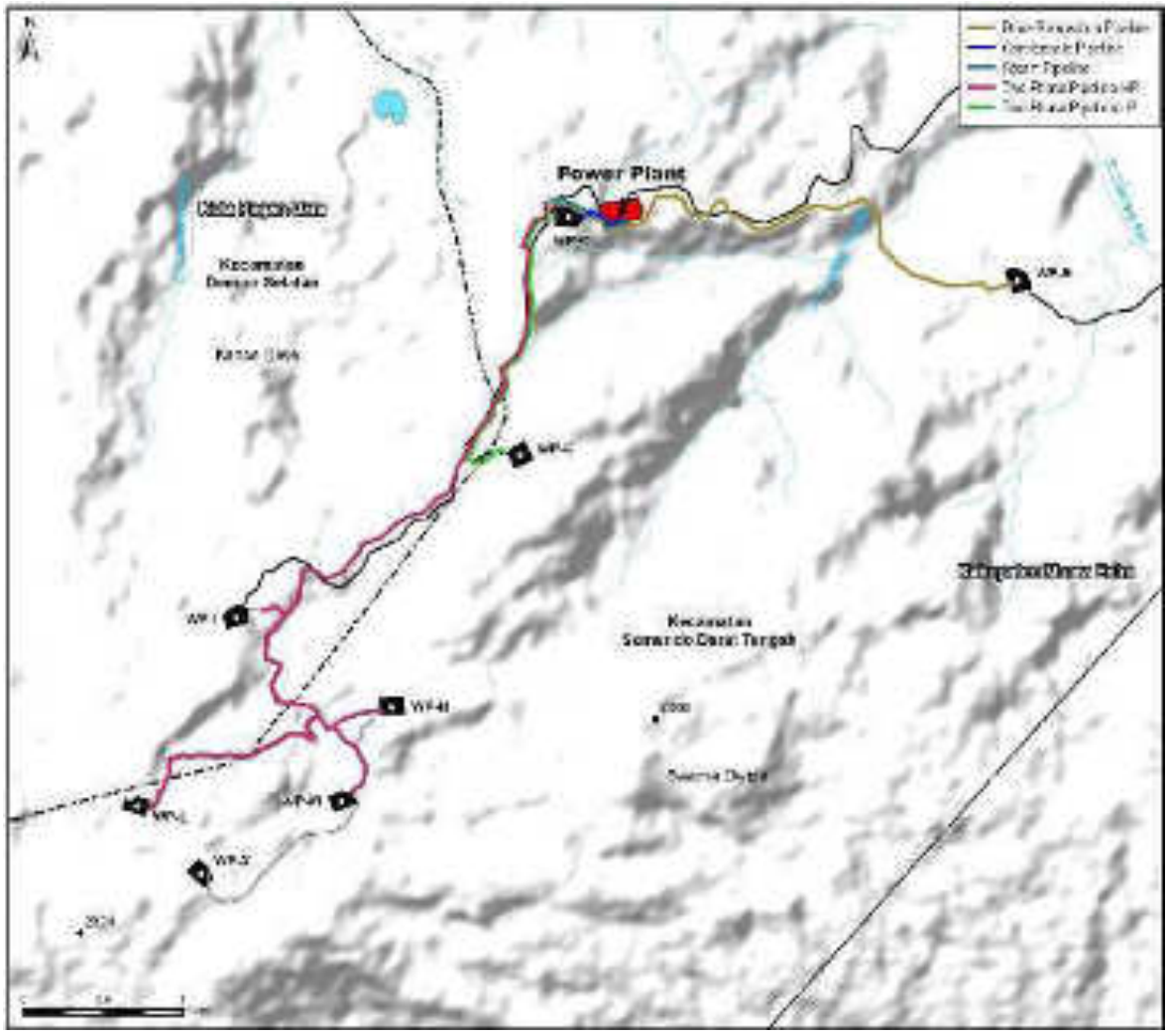


Figure 6a Pipeline System

A significant portion of the brine reinjection pipeline will deviate from the road side alignment and traverse a shorter route to Wellpad B. Although there are no communities or houses that will need to be relocated along this route, the construction of this pipeline corridor might potentially fragment and isolate habitat areas surrounded by this pipeline and access roads. Wildlife movement across pipeline can be facilitated by either above-pipeline crossings, or under-pipeline crossings. Under-pipeline crossings are preferred. All opportunities for under-pipeline crossings shall be incorporated into the pipeline design. The placement of pipeline crossing shall consider wildlife habitat corridors and attempt to maintain movement corridor for the full of diversity of species expected to occur. Data sources such as wildlife monitoring and vegetation/topographical maps may inform these decisions and influence crossing location.

4.2.6 Atmospheric Flash Tank and Steam Muffler

During well testing, steam is released through an Atmospheric Flash Tank (AFT). In case of unscheduled operational events within the power plant system, steam can be released through steam rock mufflers.

4.2.7 Separator Station

Steam and brine are separated from the flow coming from a well in the separator station. Brine exiting the separator has a temperature of about 144°C and contains naturally occurring trace elements that will be channeled back into the reservoir through reinjection wells at a depth range of 1,500 to 3,000 meters. The reinjected brine is reheated in the geothermal reservoir into superheated water and steam.

4.2.8 Scrubber

A scrubber purifies steam from impurities, such as silica. By applying a scrubber line, steam is separated from remaining liquid water. Steam from the scrubber line is routed to the turbine.

4.2.9 Turbine

In the turbine, the pressurized hot steam spins the turbine blades that in turn rotate the generator shaft.

4.2.10 Generator

The generator converts mechanical energy from the turbine into 11kV electricity.

4.2.11 Switchyard and Transmission System

The 11kV electricity from the generator terminal is then run through a step-up transformer unit to increase the voltage from 11kV to 150kV and then channeled to the GIS substation located within the power plant area. The PT SERD substation/switchyard allows space for connection of future generating units and includes a power meter.

The interface between PT SERD and PLN is at the high voltage gantry of the substation/switchyard; from that point, the electricity is connected to the PLN transmission system. The construction of the transmission line is a separate project and will be undertaken in accordance with national permitting requirements. The development of the transmission line is not included as part of the activities for which PT SERD are seeking finance. It is recognized that part of the transmission line will be an associated facility however this is still under conceptual study by PLN.

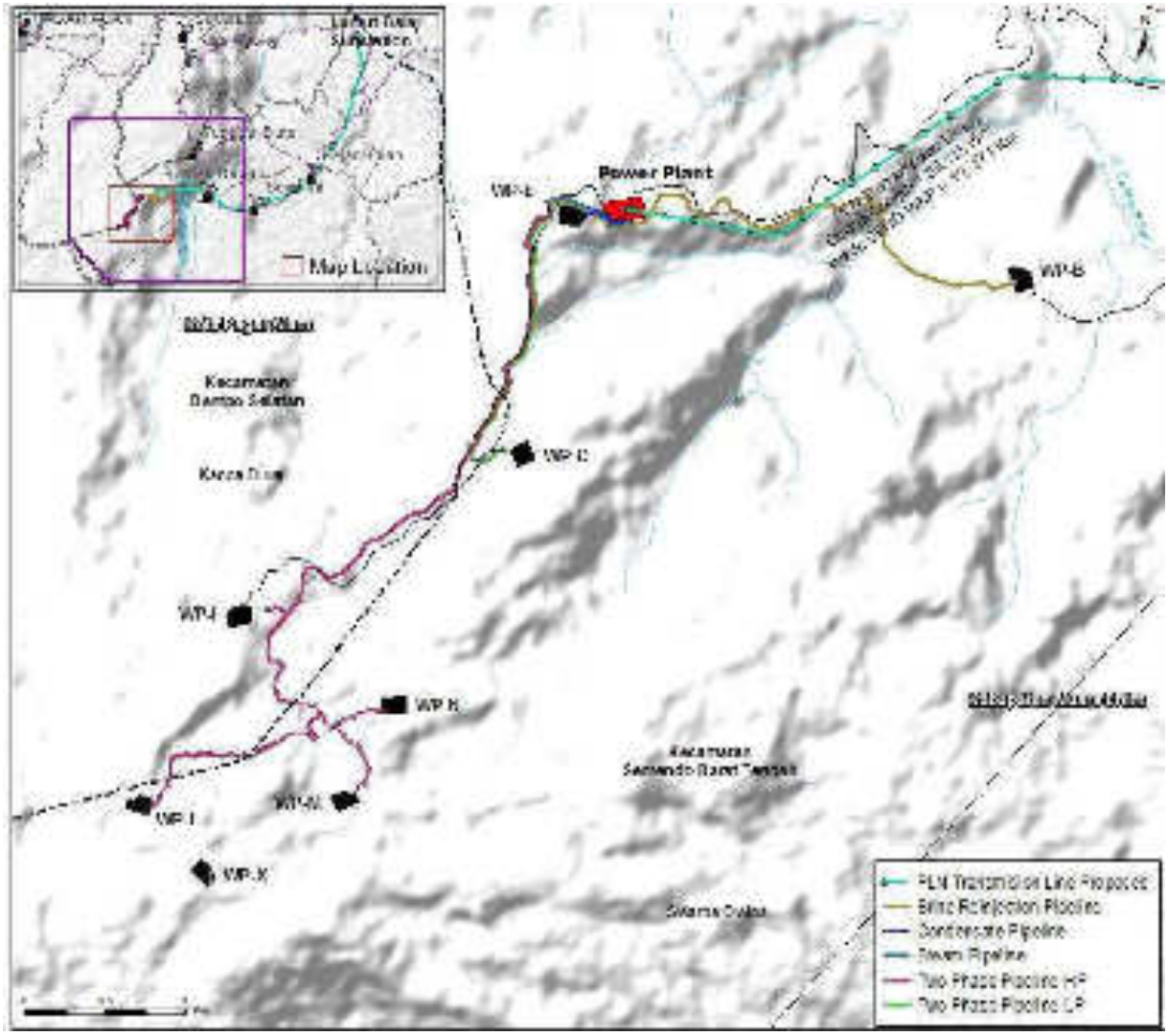


Figure 6b Proposed Alignment of the Transmission Line to Substation in Lumut Balai.

4.2.12 Condenser

After passing through the turbine blades, steam is directed to the condenser, in which cooling water is injected from a spray nozzle to condense steam into water condensate. From the condenser, cooling water is continuously pumped back to the cooling tower to reduce its temperature so it can be reused as a closed cooling water system.

4.2.13 Non-Condensable Gas (NCG) Removal System

Geothermal fluids contain non-condensable gases (NCGs) in various amounts. NCG flows to a conventional geothermal power plant with the steam and are withdrawn from the condenser by the Gas Removal System to prevent increased condenser pressure and consequently decreased power generation. NCG concentration measured at the exploration wells ranges NCGs are separated from the steam fraction in the Steam Ejector, an instrument used for creating vacuum pressure in the Condenser via the Venturi effect (converging inlet nozzle / diverging outlet diffuser). Separated NCGs are released to the atmosphere through the Cooling Tower stacks.

4.2.14 Cooling Tower

Further cooling of water is accomplished in the cooling tower, reducing water temperature from about 40°C to about 28°C. Some water from the cooling tower ("condensate water") is used for circulation in the condenser as water that is sprayed through nozzles in the condenser; additional water is used in the Gas Removal System. Excess water from the cooling tower (“blowdown”) is piped to the condensate injection wells.

4.2.15 Soil Disposal Areas

There are 2 soil disposal areas located in the new wellpad areas to store the excess excavated soil which is expected only in the construction of the new roads to wellpad L and M. Other earthworks are planned in equally cut and fill balances.

4.2.16 Explosive Bunker

Explosives Bunker will be located at the access road to the Wellpad B and store the explosives to be used for drilling purpose. The bunker will be fenced and secured from any unauthorized entry.

4.2.17 Workers Accommodations Facilities

Accommodation block for PT SERD will be constructed consisting of staff accommodations and recreational block. Separate accommodation complex will be developed for EPC workers.

4.2.18 Other Support Facilities

The project also plans to build facilities for domestic water supply and treatment, waste water treatment, chemical storage, workshop, firefighting system, emergency power supply, concrete batching plant, warehouse, laydown/open storage area (for pipe racks, etc.) and project administration building. The location of the concrete batching plant is not yet determined at this time as it will be under the discretion of the EPC contractor.

4.2.19 Associated Facilities

Although PLN is responsible in the development and operations of the 40 km long transmission line and the Lumut Balai Substation, the transmission line between PT SERD’s Switchyard and PLN’s Lumut Balai Substation is considered as associated facilities of the project in accordance with IFC Performance Standard 1. Thus the potential impact of these components and management of such impacts and risks are included in this ESIAMP.

4.3 Decommissioning

The project planning purposes the project life is assumed to be 30 years, but can be longer. PT SERD will prepare a decommissioning plan 5 years before the end of the project life to restore the area to its pre-development state or to an agreed (with the consent of the local community) new land use recognizing that regional development is likely to change the local conditions. This plan will be based on operational experience and the social and environmental outcomes of this ESIAMP. Decommissioning impacts are addressed in the ANDAL (Sections 1.2.4), as well as sections 10 and 11 below.

5 RESOURCE EFFICIENCY AND POLLUTION PREVENTION

Geothermal energy in the form of heat from the earth is universally considered to be clean and sustainable. In addition, PT SERD proposes using proven technology, in line with internationally accepted technologies and practices. The project is designed to comply with GoI and GIIP standards and requirements. The Environmental Design Criteria (Section 3) present numeric environmental standards adopted for this Project. When Indonesian regulations differ from GIIP, the project will adopt the more stringent level and/or measure.

PT SERD will consider additional strategies and adopt measures that avoid or reduce negative effects. These strategies include, but are not limited to, evaluation of project location alternatives, use of a pollution abatement technology, and emissions offsets.

5.1 Resource Efficiency

By design, the geothermal project as proposed by PT SERD excels in resource efficiency in areas considered core business, that is - geothermal energy, the main project input, is at least on a human time scale unlimited and renewable. The proposed dual flash power plant technology is widely used and desirable because it maximizes electric energy recovery from geothermal energy. Brine and condensate water are reinjected into the geothermal reservoir. As such, with the notable exception of NCG (largely H_2S and CO_2) the project is a zero emission project.

5.2 Greenhouse Gases

It is widely recognized that geothermal developments contribute to the abatement of GHG emissions by reducing the need to develop fossil-fueled power plants. For example, it is estimated that Wayang Windu Unit 2, a 110 MW geothermal project in Java, contributes an emission reduction over period of 7 years of 750,000 tCO_2-e. The Sarulla Geothermal Project, a 200 MW geothermal project in North Sumatra, will contribute a potential emission reduction of 14.5 million tCO_2-e over 21 years. The project addresses concerns over current and projected atmospheric concentration of greenhouse gases (GHG), especially related to changes in climate:

- GHG emissions are reduced, since developing geothermal energy replaces the need for developing fossil-fueled power plants;
- Geothermal energy, at least on a human time scale, is unlimited and renewable;
- Environmental and social impacts are largely confined to the construction phase, and are few in numbers;
- Once in operation, the geothermal project will provide local and national benefits with negligible if any environmental and social impacts.

It is important to note that the project will emit GHG during construction and exploration (mobile equipment and drilling) and to a smaller extent during operation (CO_2 and CH_4 contained in steam). GHG emissions are estimated to be about 41,475 tons of CO_2-equivalent annually during operations. From the standpoint of displacement of alternative fossil fuel power systems, the project results in a net reduction of GHG emissions of about 452,268 tCO_2-e/year (compared to the South Sumatra grid power mix).

5.3 Other Gaseous Emissions

The air pollution and ambient allowable odor level legislations are set forth in Section 3.2 and Table 7~~Table 7~~ and Table 8~~Table 8~~.

PP No. 41 of 1999 on Ambient Air Pollution Control is the key regulation governing air pollution control in Indonesia, defining ambient air quality standards based on the effects of criteria pollutants on the sensitive receptors. Indonesian ambient air standards are comparable to major international standards. Of note is, however, that the Indonesian ambient air quality standard for H_2S is well below--more rigorous than--the relevant IFC guidance.

During exploration drilling, it was found that NCG gases that are present with a low range. In the operating facility, condensate will be piped to injection wells and NCGs collected in a gas removal system and released to the atmosphere above the cooling tower fans, to be immediately diluted and dispersed.

Modeling result indicated that permanent accommodation facilities (sensitive receptor R90) are located more than 1.5 km to the east of the power plant (emission source) and outside of the 28 $\mu g/m^3$ odor concentration contour. The predicted maximum concentration at this location is 22 $\mu g/m^3$.

Modeling also shows that H_2S emissions from one of the sampling locations, R54 (coffee farmer hut, 1.5 km east of power plant) exceed the 28 $\mu g/m^3$ odor standard only one time in a three-years period. The exceedance at R54 is only 0.1% of the time. Most of the time (>85%) the H_2S concentration at this receptor is ranging from 0 to 7 $\mu g/m^3$. Thus the exceedance frequency can be considered insignificant. Note also this is the standard for odor which is significantly lower than the toxic level of H_2S.

The quality of the input data, the advanced CALPUFF modeling software used, and the good modeling results demonstrate that the project will operate safely within the Indonesian threshold limits.

The project is thus expected to comply with National Standards, both in emissions as well as ambient air quality. Gaseous emissions are minor and it can be reasonably concluded that gaseous emission will not impose adverse project impacts on existing ambient conditions, considering both future land use and the potential for cumulative impacts. Furthermore, it is worth noting, that the project is located in a sparsely populated remote area, with a largely unpolluted air shed.

Odor standards for the project are based on MoEF Decree KEP-50/MENLH/11/1996. The key odorant of concern is Hydrogen Sulfide, limited to 28 $\mu g/m^3$. Extremely toxic, H_2S is more than an odor problem; H_2S detectors that activate alarms will be installed throughout the facility.

5.4 Water Consumption

Since the project is a potentially significant consumer of water, in addition to applying the resource efficiency requirements of Performance Standard 3, PT SERD will adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others.

During the project development phase, water is required for well drilling. PT SERD has already obtained a Water Use Permit (WUP) or *Surat Izin Pengambilan dan Pemanfaatan Air* (SIPPAIR) under South Sumatra Governor Decree No. 193/PTSP-BP3MD/IX/2015. PT SERD is allowed to extract water

at the amount of 467 m^3/day from Cawang Kiri and Asahan Rivers. Drilling, and as such water abstraction, will be scheduled so that it does not interfere with surface and groundwater conditions and the needs of downstream communities.

During project operation, the river water extraction is limited, predominantly for domestic use.

5.5 Wastewater Management

PT SERD will in general avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release. This applies to the release of pollutants to air, water, and land due to routine, non-routine, and accidental circumstances with the potential for local, regional, and trans-boundary impacts. Project design has considered the results of a geotechnical survey of subsurface conditions. A weather station is installed at the site to learn site-specific weather conditions—wind speed and direction, temperature, rainfall, humidity--required for developing site-specific design criteria.

The project will produce water in the form of pH neutral brine and condensate with the TDS values ranging from 2,535 to 4,142 ppm (equivalent to 2,550 to 5,800 mg/L) for condensate and approximately 4,142 ppm (equivalent to 5,800 mg/L) for brine, those are naturally occurring minerals such as Boron (B), Arsenic (As), Lithium (Li), and Silica (SiO_2). It is standard industry practice to reinject geothermal produced water back to the reservoir through the injection wells. Brine and condensate are temporarily stored in a pond returned to the wellpad at a depth of 1.800 to 2.000 mMD, eliminating the potential for impacting fresh groundwater resources. The requirement and standard of practice are not to release contaminated effluents to surface water.

To support exploration drilling and to prepare for the exploitation phase, PT SERD will develop drilling cutting area to temporarily store drilling cutting waste before further use. Land structure where shallow groundwater is existed will be avoided and 30” steel surface conductor casings were and will be installed in all wells to protect groundwater. Drainage systems were engineered at wellpads to control runoff water to the water ponds. Geothermal brine from the wells is returned to the formation through injection wells. Requirements for the injection shall be in adherence to Per/MenLH No. 13 of 2007. In future operations, steam and brine will be enclosed within pipes or vessels. No wastewater will be discharged to the water body, except the surface runoff.

To ensure that this commitment of minimizing any discharges to the environment is translated into best industry practice, water at ponds and gaseous emissions from drilling during exploration were regularly sampled and analyzed in accordance to the provisions of the Environmental Monitoring Plan in the RPL (*Rencana Pemantauan Lingkungan Hidup*). The results were included in the compliance reports submitted to the authorities.

In accordance to the approved RKL and RPL the project is required to submit 6-monthly implementation reports to the MoEF (KLHK), South Sumatra Province Environmental Office (BLHD), Muara Enim Regency Environmental Office (BLHD), Lahat Regency Environmental Office (BLHD), and Kota Pagar Alam Environmental Office, detailing the management actions carried out and monitoring done. These reports address surface water, fresh groundwater, soil, flora, fauna, social issues, air emissions, noise, and odor.

Effluent quality regulations applicable to the project are Ministry of Environment (MoE) Decree PerMenLH No. 8 of 2009 on Quality Standards for Wastewater from Thermal Power Plants and MoE Decree PerMenLH No. 19 of 2010 on Quality Standards for Effluents from Oil, Gas, and Geothermal Industries. The effluent quality standards are only applicable for surface water runoff and drainage.

Domestic wastewater is to be treated in a wastewater treatment system to meet water quality standards, while 'black' wastewater (sewage) is discharged to a septic tank. In the operating plant, all sewage will be treated in a package sanitary sewage treatment system to applicable Indonesia standards. The package sanitary sewage treatment system will be located in accommodation complex, warehouse, and power plant office area which each of capacity system is about 20 m^3/day. No sewage (domestic) effluents standard are applied since there is no domestic effluent will be discharged out of project.

5.6 Waste Management

The project will as much as possible avoid the generation of hazardous and non-hazardous solid wastes. Where waste generation cannot be avoided, PT SERD aims at reducing the generation of waste, and recovering and reusing waste in a manner that is safe for human health and the environment. Where waste cannot be recovered or reused, PT SERD will treat, destroy, or dispose of it in an environmentally sound manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste material.

The project is required to develop a '3R' (Reduce, Reuse, and Recycle) plan that specifically addresses:

- Non-hazardous waste;
- Empty chemical containers;
- Process and laboratory chemicals;
- Oil products;
- Oil contaminated materials;
- Degreasing and cleaning solvents;
- Cutting fluids;
- Scrap metal;
- Scrap wood;
- Fluorescent lighting;
- Lead-acid batteries;
- Clinical waste;
- Hazardous sludge i.e. from cooling tower
- Sewage sludge.

5.6.1 Solid Non Hazardous Waste

Domestic solid wastes are collected in the Temporary Disposal Site (*Tempat Pembuangan Sementara* or TPS) at the project site before transported to a Final Disposal Station (*Tempat Pembuangan Akhir* or TPA) prescribed by the Government of Lahat Regency for permanent disposal.

Residual construction materials (i.e. scrap wood and metal) will be collected and reused or handed over to a third party for reuse or disposal.

The use of water based drilling mud is one example of adopting reduced hazards in material that can become hazardous waste. Overall, there are very low heavy metals and mercury concentrations in

drilling cuttings (solids). Drilling cuttings are settled in an engineered Temporary Disposal Storage (TPS) and will be reused as backfill material or construction material. Drilling mud and cuttings are no longer considered as hazardous waste per GoI regulation PP No. 101 of 2014.

The project is subject to numerous laws and regulations on waste management; the most important are Law UU No. 18 of 2008 on Waste Management.

5.6.2 Hazardous Waste

Hazardous wastes i.e. used oil, hazardous contaminated materials, hazardous sludge, and empty chemical container will be stored in the licensed temporary hazardous waste storage. PT SERD has obtained the Temporary Hazardous Waste Storage Permit or *Izin Penyimpanan Sementara Limbah Bahan Berbahaya dan Beracun,* under South Sumatra Decree No. 941/KPTS/BLH/2014 valid until November 2019.

Hazardous wastes will be transported with licensed transporter to a licensed hazardous waste treatment and disposal facility.

PT SERD's requirements for the management of hazardous waste are detailed in its Waste Management SHE Standard. The standard includes controls for the appropriate aspects of hazardous waste management, including;

- Identification;
- Handling and storage;
- Transportation;
- Treatment and disposal;
- Training;
- Emergency response;
- Reporting and records; and
- Audits and review.

The project is subject to numerous laws and regulations on waste management; the most important is PP No. 101 of 2014 on Management of Toxic and Hazardous Wastes.

5.7 Hazardous Materials Management

Hazardous materials are used as input materials or produced as waste products by the project. PT SERD will avoid or, when avoidance is not possible, minimize and control the release of hazardous materials. In this context, the production, transportation, handling, storage, and use of hazardous materials for Project activities is assessed in a continuous improvement approach. PT SERD will consider less hazardous substitutes where hazardous materials are intended to be used in site operations, and avoid the use of chemicals and hazardous materials subject to international bans or phase-outs due to their high toxicity to living organisms, environmental persistence, potential for bioaccumulation, or potential for depletion of the ozone layer. The key regulatory instrument for hazardous materials is PP No. 74 of 2001 on Hazardous Materials Management.

Chemicals will be accompanied with Material Safety Data Sheets (MSDS). Most of the chemicals are categorized as non-hazardous materials. Storage and handling of a chemical as well as its residues will be carried out in accordance with the MSDS.

Small amounts of explosives will be used during drilling. The explosives warehouse shall have a permit from the State Police Headquarters (MABES POLRI) and will be monitored regularly by relevant agencies, among others, by the Provincial Police (POLDA) and the Department of Energy and Mineral Resources. Any use of explosives will be informed to the local police and reported regularly to relevant agencies.

5.8 Pesticide Use and Management

The project will not use pesticides, and thus this requirement is not applicable. Should pesticides and or herbicides be found necessary for the project operations (as in fogging residential and workplace areas for mosquitoes), procedures for procuring, storing, and applying these will be added to the Environmental Management Plan and System.

6 LABOR AND WORKING CONDITIONS

The GoI (GoI) has adopted all core ILO Conventions, and relevant UN Conventions (Table 17). The GoI also requires all companies to prepare a comprehensive Employees Manual, to be approved by the GoI, detailing rights and obligations of workers directly engaged by PT SERD (*Peraturan Perusahaan* (PP) or Company Employee Handbook (Law No. 13/2003 regarding Labor)). Notably, Indonesian law prohibits harmful child labor and forced labor. It also requires equal employment opportunity and includes articles against workplace harassment.

Table 17 International Labor Related Conventions

	Ratified by GoI
ILO Four Core Conventions	
ILO Convention 87 on Freedom of Association and Protection of the Right to Organize ILO Convention 98 on the Right to Organize and Collective Bargaining	In Force since 09 Jun 1998 In Force since 15 Jul 1957
ILO Convention 29 on Forced Labor ILO Convention 105 on the Abolition of Forced Labor	In Force since 12 Jun 1950 UU-19-1999 (Law No. 19/1999)
ILO Convention 138 on Minimum Age (of Employment) ILO Convention 182 on the Worst Forms of Child Labor	UU-20-1999 (Law No. 20/1999) UU-01-2000 (Law No. 1/2000)
ILO Convention 100 on Equal Remuneration ILO Convention 111 on Discrimination (Employment and Occupation)	UU-80-1957 (Law No. 80/1957) UU-21-1999 (Law No. 21/1999)
Other ILO Conventions	
ILO Convention 155 on Occupational Safety and Health	
ILO Protocol 155 of 2002 to the Occupational Safety and Health Convention	
ILO Convention 162 on Asbestos	
ILO Convention 174 on Prevention of Major Industrial Accidents	
ILO Declaration of Fundamental Principles and Rights at Work	
ILO 2006 Tripartite Declaration of Principles Concerning Multinational Enterprises and Social Policy	
ILO Convention No. 81 Concerning Labor Inspection In Industry And Commerce	UU- 21-2003 (Law No. 21/2003)
ILO Convention No.106 regarding Weekly Rest	UU-03-1961 (Law No. 3/1961)
UN Conventions	
Convention Against Torture and other Cruel, Inhuman, or Degrading Treatment or Punishment	UU-05-1998 (Law No. 5/1998)
UN Universal Declaration of Human Rights	
UN International Covenant on Economic, Social, and Cultural Right	
UN Convention on the Rights of the Child	Keppres-36-1990
UN Convention on the Elimination of All Forms of Racial Discrimination	UU-29-1999 (Law No. 29/1999)
UN Convention on the Elimination of All Forms of Discrimination against Women	UU-07-1984 (Law No. 7/1984)

	Ratified by GoI
UN Convention on the Rights of Persons with Disabilities	UU-19-2011 (Law No. 19/2011)
UN Optional Protocol to the Convention on the Rights of Persons with Disabilities	

6.1 Human Resources Policies and Procedures

PT SERD's Human Resources Policies and Procedures (HRPP) comply with local laws and regulations. It is a legal document approved by the GoI that outlines the relationship between PT SERD management and employees, including workers' rights under national labor and employment law, including hours of work, wages, overtime, compensation and benefits (Table 18). The HRPP is freely distributed to all workers directly engaged by PT SERD and is available on the intranet. The document is renewed every two years to reflect changes in labor laws, and inputs of workers. All PT SERD workers have a contract which describes the employment relationship.

Table 18 PT SERD Employee Handbook (PP) Table of Contents

Chapters	Description
Chapter I	Definitions
Chapter II	Employment, Classification, and Families of Employees
Chapter III	Wage, Insurance, and Assistance
Chapter IV	Working Hours, Rest Breaks, and Overtime
Chapter V	Official Holiday
Chapter VI	Annual Leave
Chapter VII	Permission to Leave Work
Chapter VIII	Worker Protection
Chapter IX	Healthcare and Treatment
Chapter X	Business Travel
Chapter XI	Education and Training
Chapter XII	Discipline and Disciplinary Action
Chapter XIII	Suspension
Chapter XIV	Termination of Employment
Chapter XV	Grievance Procedure
Chapter XVI	Terms of Part-Time Worker

PT SERD is obliged by law to make contributions to pension funds, or *Jaminan Sosial Tenaga Kerja* (*Jamsostek*).

6.2 Working Conditions and Management of Worker Relationship

PT SERD provides reasonable working conditions and terms of employment, as detailed on Pages 9 to 10 of the PP, and in conformance to working conditions established by National law. Indonesian law requires equal employment opportunity. That said, PT SERD will give preference to the recruitment of qualified skilled and unskilled local villagers. Migrant workers will likely be engaged by the EPC contractor during construction. PT SERD will contractually require the EPC Contractor to engage migrant workers on substantially equivalent terms and conditions to local workers carrying out similar construction work.

Given the remote location, PT SERD will develop permanent accommodations for part of its workforce. During construction, temporary accommodations will be constructed by the EPC contractor. Temporary and permanent accommodation facilities will meet minimum standards, as outlined in Workers' Accommodation and Standards - A Guidance Note by IFC and the EBRD, 2009. The Framework of Temporary Worker Accommodation Management Plan is contained in Appendix 7. Accommodation services will be provided in a manner consistent with the principles of non-discrimination and equal opportunity. Accommodation services provided by PT SERD will comply with national and international standards for quality, security, safety, and professional competency. Workers will not be forced to use any of the services provided by PT SERD.

6.3 Protecting the Workforce

6.3.1 Child Labor

In conformance with Indonesian law (UU-20-1999 and UU-01-2000, see also Table 1) PT SERD will not employ under-aged workers (appreciating that for purposes of IFC PS 2, a child is a person under age 18). PT SERD may from time to time offer certain types of work to children (such as internship or training), but only when carried out in a manner that is both legal and safe. Any such employment will be reviewed by and approved by a qualified HR personal. Under no circumstances will children perform work that is 1) economically exploitative; or 2) likely to be hazardous or to interfere with the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development; or 3) illegal, even if such practices are considered socially or culturally acceptable in the host region.

6.3.2 Forced Labor

Indonesian law prohibits forced labor and PT SERD complies with Indonesian law.

6.4 Occupational Health and Safety (OHS)

The SE SHE Policy and Manual (Appendix 12) contains OHS requirements and procedures that apply to employees and contractors, including subcontractors. To protect the safety of workers, PT SERD provides safety equipment with reference to the provisions of Indonesian Law No. 1 of 1970 on Occupational Safety. PT SERD is obligated to report on its occupational health and safety conditions to the Department of Energy and Mineral Resources quarterly.

6.5 Workers Engaged by Third Parties

PT SERD outsources some activities, such as much of the construction and drilling activities. Contracted workers are bound by employment agreements that provide terms of employment and the rights and obligations of both parties, except in matters such as: annual leave, annual leave cost assistance, and severance pay.

6.6 Supply Chain

PT SERD will inquire about and address child labor and forced labor in its supply chain, through a combination of the following:

- Policies and procedures that control the supply chain;
- Mapping suppliers and sub-contractors, with risk assessment;

- Supplier labor standards commitment letter;
- Labor standards clause in contracts with suppliers, including disclosure of subcontractors; and
- Audit reports on suppliers.

7 ENVIRONMENTAL AND SOCIAL PROJECT SETTING

7.1 Data Sources

The baseline contains information pertinent to the development of the PT SERD 250MW Geothermal Power Plant. The environmental baseline used primary data from the following:

- KA ANDAL August 2016
- ANDAL draft December 2016)
- Initial Environmental Examination (IEE) of PT SERD May 2014 (ADB)
- Several phases of UKL/UPL monitoring programs of the PT SERD Exploration UKL/UPL on 2014 (4 monitoring sequences) to 2015 (2 monitoring sequences)

Secondary data were also drawn from credible information published by the following:

Dataset	Year	Source
Global Biodiversity Hotspots	2011	IBAT
WWF Terrestrial Ecosystems	2015	WWF
RAMSAR Wetlands	2015	IBAT
UNESCO MAB	2015	UNESCO
World Heritage Sites	2015	UNESCO
Key Biodiversity Areas	2015	IBAT
Endemic Bird Areas	2015	IBAT
World Database of Protected Areas	2015	IBAT
IUCN Threatened Species Grid	2014	IBAT download
IUCN Red list of threatened species	2015	IUCN Red List
Global Biodiversity Information Facility (GBIF)	2015	GBIF
Bird database	2016	Cornell University
Land cover	2011	Ministry of Environment and Forestry

Climate data were obtained from the following sources:

- Pagar Alam Rain Station (monthly average rainfall data). The Pagar Alam Rain Station is located approximately 30 km from the project. The BMKG Bengkulu has more complete climate data; it is located about 125 km from the project.
- Meteorology, Climatology and Geophysical Bureau (*Badan Meteorologi, Klimatologi dan Geofisika*/BMKG) of Bengkulu, based on the Class II Meteorology Station of Fatmawati Sukarno (temperature, relative humidity, wind speed and wind direction data).

The social baseline study was compiled primarily from published reports:

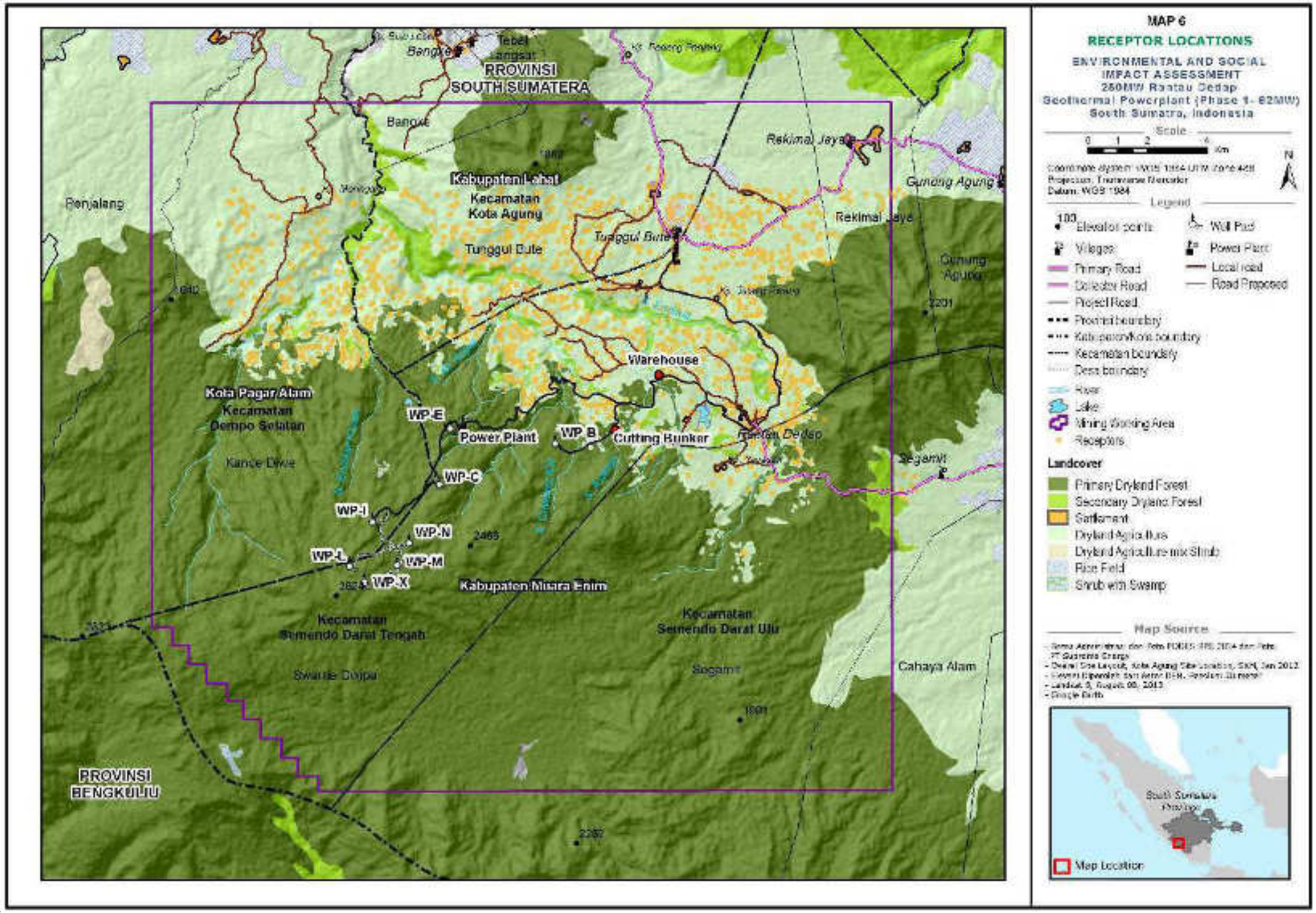
- PT SERD AMDAL Study (KA ANDAL August 2016)
- PT SERD Initial Poverty and Social Analysis (ADB, June 2014)
- PT SERD Social Safeguards Compliance Audit Report (ADB, June 2014)
- PT SERD Final Report Integrated Social Development Program (ISDP) (IHS, 2015)

Demographic, livelihood, health and education data were obtained from published GoI data:

- Statistical Bureau (Biro Pusat Statistik/BPS)
- Regional Planning and Development Bureau (Badan Perencanaan Pembangunan Daerah/BAPPEDA)
- Community Development Bureau (Lembaga Pemberdayaan Masyarakat/LPM)
- Public Health Office / District Office / Sub-district Office / Village Office
- Community Health Center (Pusat Kesehatan Masyarakat/Puskesmas)

Social-economic, socio-cultural and community health data were obtained from direct interviews using structured questionnaires and field observations. Primary data were collected through characteristic random sampling of 10-20% of the total population.

Map 7~~Map 7~~ shows the sensitive receptor locations.



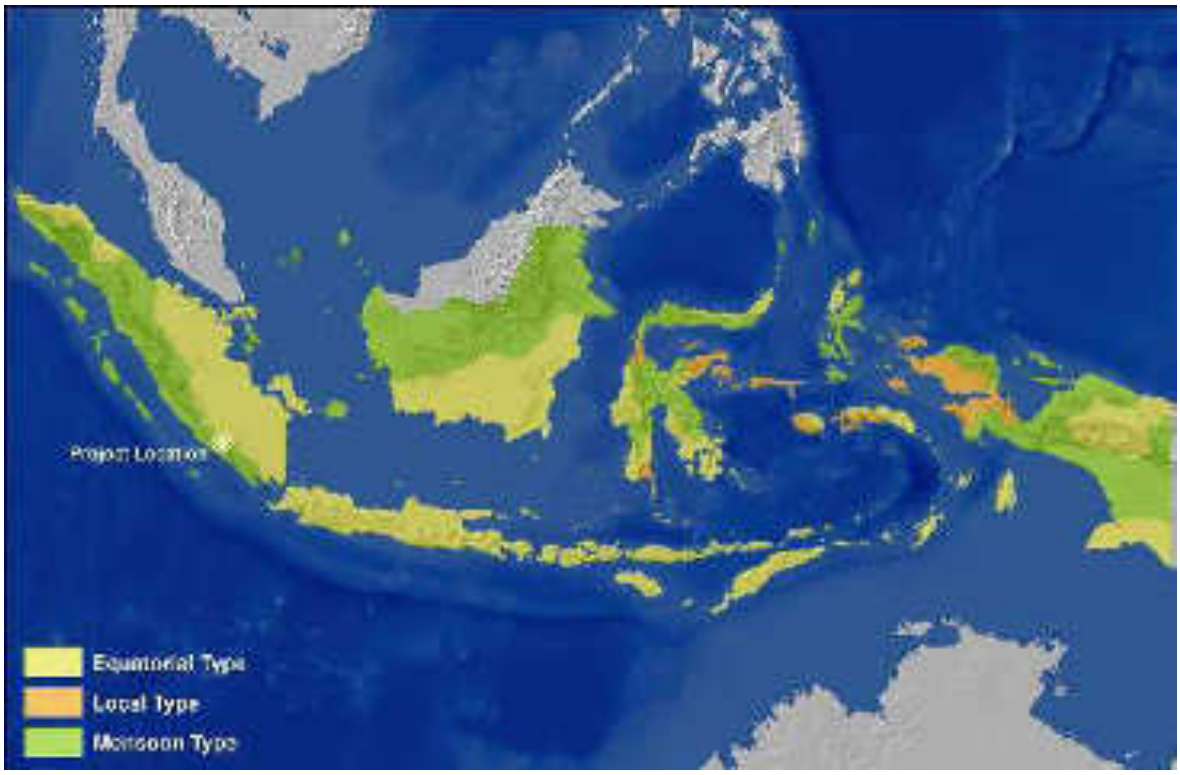
Map 7 Map of Receptor Locations

7.2 Atmosphere

The Rantau Dedap field is located in Muara Enim Regency, Lahat Regency and Kota Pagar Alam, South Sumatera Province. Based on the climate type in South Sumatera in general and around study area especially is classified as tropical climate. Tropical climate is described by a number of experts by several terms such as follows: 1) Afa Climate (tropical rain climate), by Koppen; 2) A Climate (very wet area), by Schmidt-Ferguson 1950; and 3) B1 climate (region, which spans 7 to 9 wet months and 2 dry months, by Oldeman 1979.

Generally ambient air quality in the project area is good.

7.2.1 Climate



Seasons		Temperature
Dry season: May to October Wet season: December to March Transition period: April and November		Annual average: 27.1°C Range of monthly average temperatures: 26.5 to 27.8°C
Rainfall	**Relative Humidity**	**Wind Pattern**
Annual average: 225 mm/month Highest monthly average: 666 mm Lowest monthly average: 23 mm	Annual average: 81% Highest monthly average: 85% December Lowest monthly average: 76% September	Semi-annual reversal wind Wind direction: SW, 13.5% and NE, 11.9% probabilities Average observation wind speed: 2.23 m/s

7.2.1.1 Rainfall

The Pagar Alam Rain Station is the nearest rain station from the Rantau Dedap and is located approximately 30km from the Project Area. While BMKG Bengkulu is considered to have more complete climate data it is located further away (approximately 125km) from the Project Area.

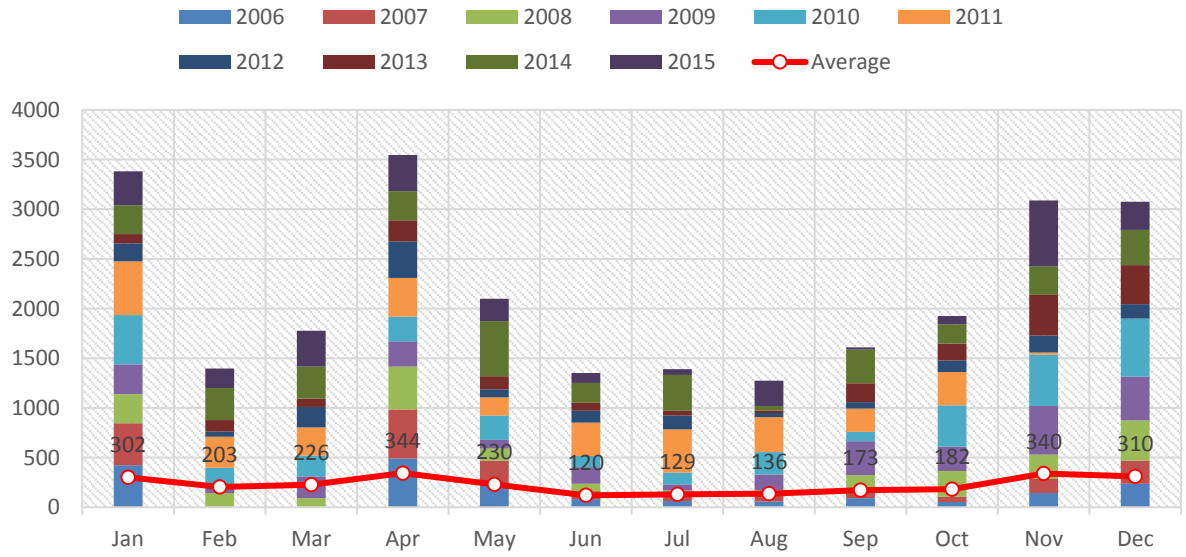
According to Schmidth and Ferguson (1951), the project area is categorized as type A (Very Wet), which is reflected in the data contained in Table 19 showing monthly average rainfall data from 2006 to 2015 (that compares the total average dry months and the total average wet months).

Table 19 Recorded Monthly Average Rainfall Data (2006-2015)

Year	Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2006	422	N/A	N/A	492	234	81	63	58	93	52	143	235	1,873
2007	422	N/A	N/A	492	234	81	63	58	93	52	143	235	1,873
2008	294	144	92	431	122	73	44	57	136	261	245	405	2,304
2009	299	55	218	257	89	170	61	156	342	246	487	441	2,821
2010	497	198	211	247	245	111	118	225	95	415	518	583	3,463
2011	179	542	313	284	388	183	335	435	353	234	334	23	3,603
2012	180	52	204	368	79	120	140	43	66	118	169	146	1,685
2013	93	117	84	213	133	82	47	25	190	170	410	391	1,955
2014	291	322	322	294	553	197	360	43	337	193	285	356	3,553
2015	341	197	362	364	227	102	58	255	23	83	666	284	2,962
Average	302	203	226	344	230	120	129	136	173	182	340	310	**2,609**

Source: Pagar Alam Rain Station, Kota Pagar Alam, 2016
Not : N/A : Data not available

Figure 8 shows trends and monthly average rainfall from 2006 to 2015. The highest annual rainfall recorded was in 2011 (3,603mm/year) and the lowest occurred in 2012 (1,685mm/year). The two wettest months are April and November and the two driest months are June and July.



Source: Pagar Alam Rain Station, Kota Pagar Alam, 2016

Figure 7 Monthly Average Rainfall (2006-2015)

2015 rain day events are shown in Table 20. 2015 had a total of 159 rain days and averaged 13.25 rain days per month. March had the most rain day events (23), while September and October had the least (2).

Table 20 Recorded Monthly Average Rainfall Data (2015)

Number of Rain Day Event											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
14	17	23	21	13	16	4	8	2	2	22	17

Source: Pagar Alam Rain Station, Kota Pagar Alam, 2016

7.2.1.2 Temperature and Humidity

The recent recorded temperature and relative humidity data for 2015 shows the average temperature was 27.1°C with an average humidity of 81%. The lowest recorded average temperature was 26.5°C in January while the highest average temperature was 27.8°C in May. The average monthly humidity ranged from 76% to 85%. The highest air humidity occurred in the December-January period.

Table 21 Recorded Monthly Average Temperature and Relative Humidity Data (2015)

Component	Month												Average
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Temperature (°C)	26.5	26.6	27.4	27	27.8	27.5	27.1	27.3	26.6	27.7	26.9	26.7	27.1
Relative Humidity %	83	83	80	85	81	80	77	79	76	79	84	85	81

Source: Meteorology, Climatology and Geophysical Bureau of Bengkulu, the Class II Meteorology Station of Fatmawati Sukarno

7.2.1.3 Wind Speed and Direction

PT SERD commisioned a meteorology Station in the study area in 2012. The station has recorded Hourly meteorological observation data since February 2012. The measured parameters are wind direction and speed, temperature, relative humidity, barometer pressure, rainfall, and evaporation. As some of the data recorded was incomplete, meteorological forecast data was used to calculated wind speed and direction as well as for the dispersion modeling.

Meteorology data forecast data for the period of 1 January 2013 until 31 December 2015 (three years) with one hour interval was obtained from Lakes Environmental, a company from Canada which provides meteorology modeling data for dispersion modeling requirement over the world. The company uses WRF Model (Weather Research Forecasting) from NCAR (National Center for Atmospheric Research) which is an atmospheric research and development agency in the United States.

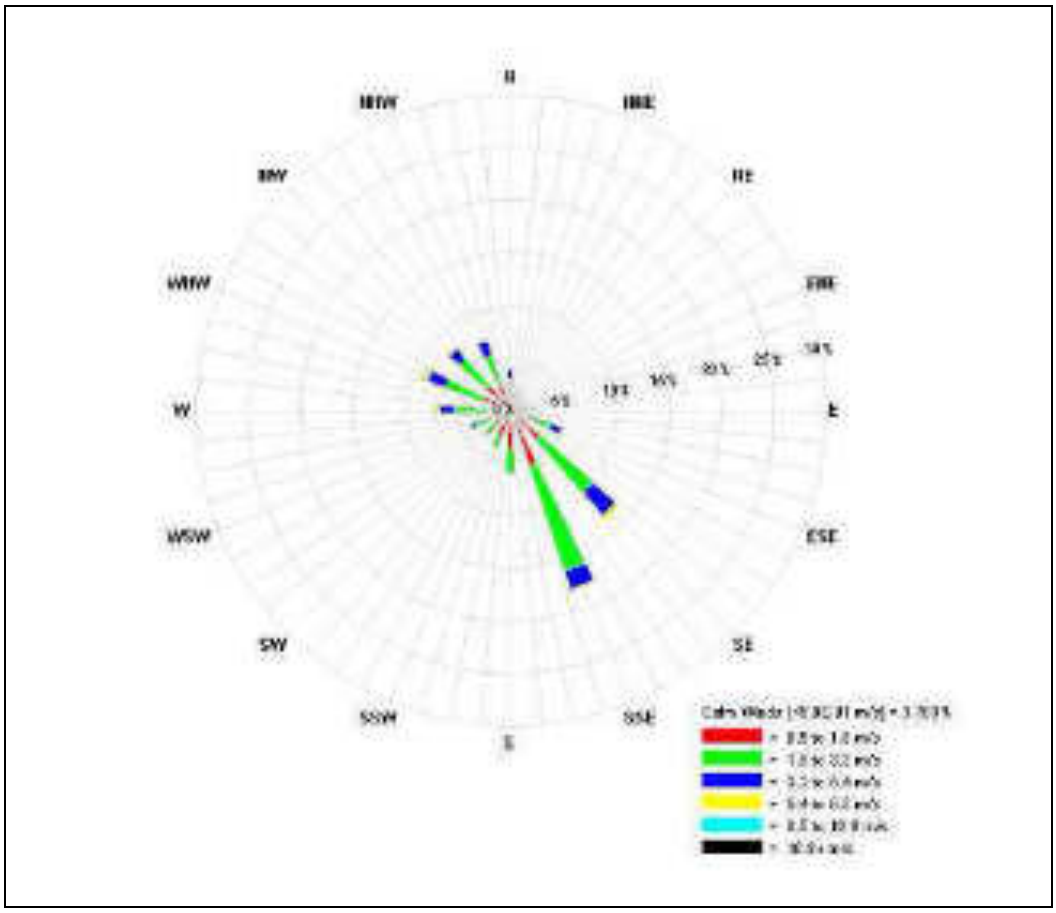


Figure 8 Wind-rose with wind direction distribution based on PT SERD Observation (Period of 2013-2016) Source: AECOM, 2016

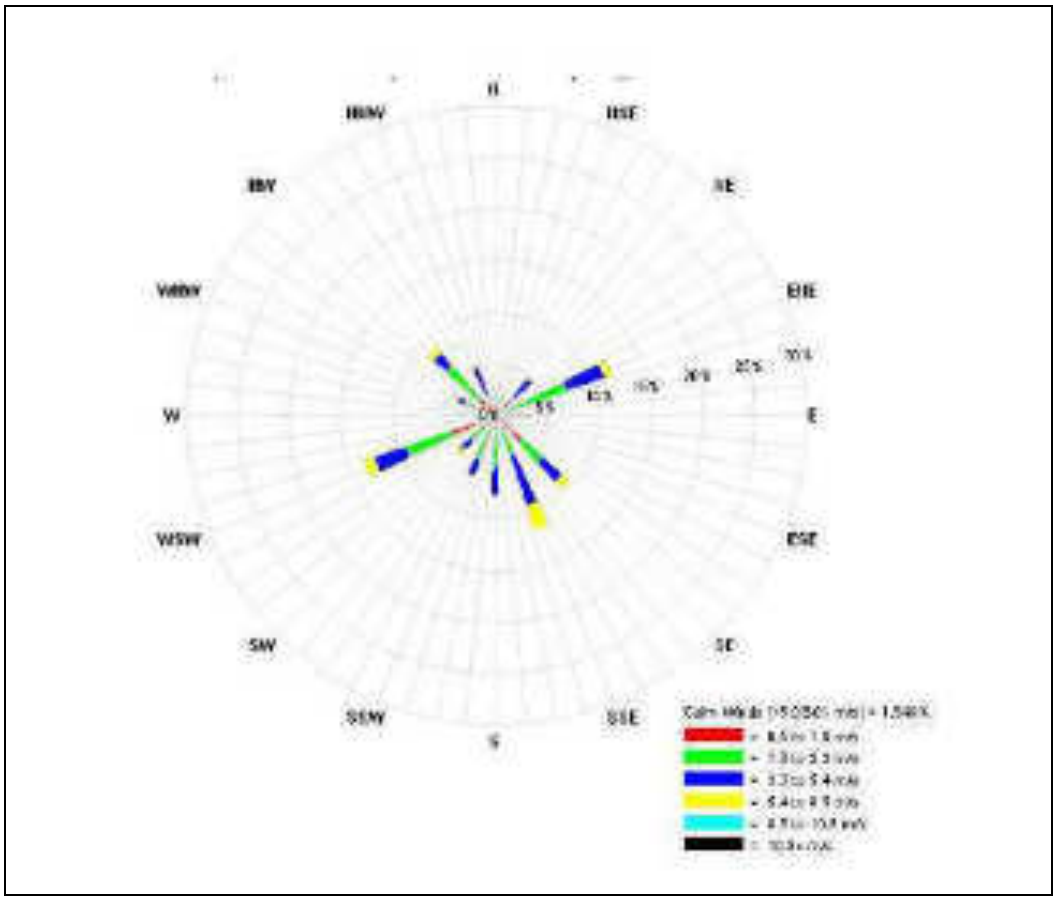


Figure 9 Wind-rose with wind direction distribution based on CALMET simulation (Period of 2013-2016) Source: AECOM, 2016

Figure 1 and Figure 2 present the wind roses from SERD observation and Calmet simulation for three year period respectively. Compared with the observations, it is shown that the predicted wind rose is not close to the observed. However, the Calmet simulation does a reasonable job in capturing the distribution of wind directions.

The Lakes Environmental dataset shows that wind direction in the project area is highly dispersed. This indicates that wind direction is strongly influenced by terrain conditions. In general, the west-southwest wind direction dominates with a frequency of 13.5%. However, the frequency of winds from the other directions (east-northeast) differs only by 2% of 11.9%. The third dominant wind direction was from the south-southeast at a frequency of 11.5%. The wind was calm only at a frequency of 1.5%.

The dataset has already been preprocessed using CALMET which is then used for CALPUFF. As can be seen in Table 21, the predicted parameter values are very close to those observed especially for wind direction and temperature. Only the predicted wind speeds are higher 32% to 38% than those observed, but these can be still considered acceptable. It can be seen that the agreement between the measurements and predictions are satisfactory.

From the observation data, prevailing winds in the study area are primarily from the SSE. The Calmet simulation tends to under-predict the frequency of winds from this direction and over- predict the frequency of winds from WSW and ENE. The average wind speeds for the observed and predicted were about 2.4 m/s and 3.3 m/s, respectively. Simulation-predicted wind speeds are slightly higher than the observed values.

Table 22 Comparison of Wind Speed and Wind Direction from PT SERD Observation vs. CALMET Simulation

Year	PT SERD Observation		CALMET Simulation		Comparison	
	Wind Direction (°)	Wind Speed (m/s)	Wind Direction (°)	Wind Speed (m/s)	Wind Direction (°)	Wind Speed (m/s)
2013	201	2.1	202.2	2.9	0.6	38.1
2014	205	2.2	188.3	2.9	-8.1	31.8
2015	197	2.4	172.6	3.3	-12.4	37.5

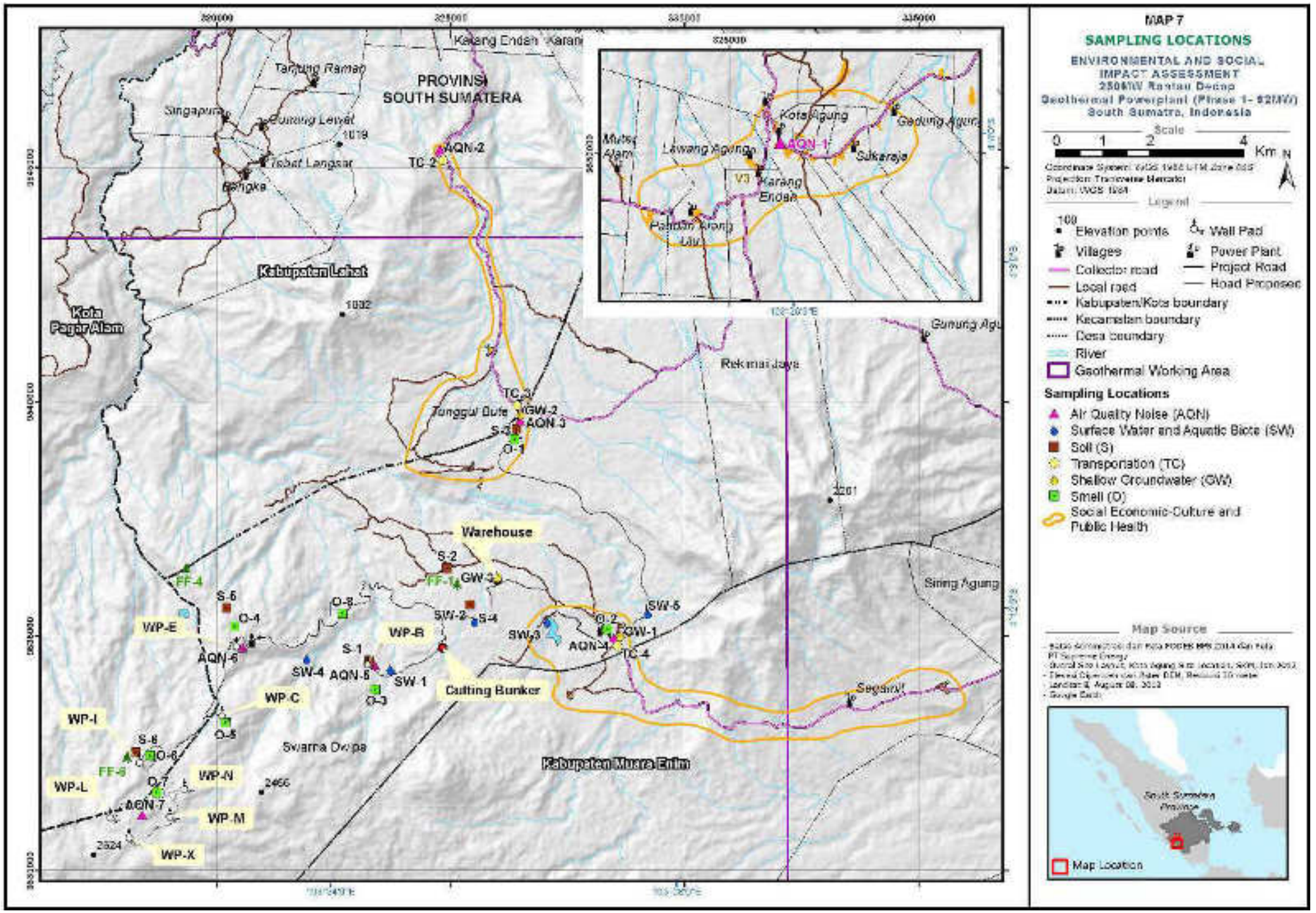
Source: AECOM, 2016

7.2.2 Air Quality and Noise

7.2.2.1 Ambient Air Quality

Ambient air quality data were obtained through direct sampling in 7 sampling locations (Map 8~~Map 8~~) across the project area.

Air aspects measured include SO_2, CO, NO_2, O_3, HC, TSP, Pb, PM_{10} and $PM_{2.5}$, in accordance with GoI and local government requirements. Table 23 presents the ambient air quality analysis.



Map 8 Sampling Location

Table 23 Ambient Air Quality Analysis Result (2014, 2015 & 2016)

Parameter	Unit	Result											Threshold Value*	Sampling Period
		AQN-1	AQN-2	AQN-3	AQN-4	AQN-5			AQN-6			AQN-7		
		1	1	1	1	1	4	5	1	2	3	1		
SO_2	µg/Nm^3	46	29	30	41	28	59	54	26	17	17	26	900	1 hour
CO	µg/Nm^3	2,635	1,833	1,948	2,520	1,604	<1,116	<1,145	1,146	2,589	2,795	1,260	30,000	1 hour
NO_2	µg/Nm^3	32	20	24	30	22	23	26	17	14	15	21	400	1 hour
O3	µg/Nm^3	40	26	29	38	23	12	13	20	24	12	24	235	1 hour
HC	µg/Nm^3	94	87	88	90	85	<49	<53	80	79	85	83	160	3 hours
TSP	µg/Nm^3	78	60	67	70	45	72	76	31	21	26	40	230	24 hours
Pb	µg/Nm^3	< 0.08	< 0.08	< 0.08	< 0.08	< 0.08	N/A	N/A	< 0.08	<0.02	<0.02	< 0.08	2	24 hours
PM_{10}	µg/Nm^3	17	14	15	18	10	N/A	N/A	8	9	13	9	150	24 hours
$PM_{2.5}$	µg/Nm^3	5	3	3	5	2	N/A	N/A	2	5	7	2	65	24 hours

Source:

1. PT SERD ANDAL August 2016
2. PT SERD UKL/UPL Monitoring 2nd Semester of 2015
3. PT SERD UKL/UPL Monitoring 1st Semester of 2015
4. PT SERD UKL/UPL Monitoring 2nd Semester of 2014
5. PT SERD UKL/UPL Monitoring 1st Semester of 2014

Note: * Government Regulation No. 41 year 1999, Sumatra Selatan Governor Regulation No. 17 Year 2005; N/A: Not Analyzed

Generally ambient air quality in the project area of Influence was good based on the data from the PT SERD ANDAL August 2016. It can be seen that all of the measured parameters are below threshold standards for ambient air quality based on two threshold standard regulations; Government Regulation No. 41 Year 1999 and Sumatra Selatan Governor Regulation No. 17 Year 2005.

7.2.2.2 Odor

Odor data were obtained through direct sampling in the eight sampling locations across the project area of Influence. Map 8~~Map 8~~ describes the eight sampling location used during PT SERD AMDAL studies (August 2016).

Parameters measured for the odor were H_2S and NH_3 in accordance with the requirements of Ministry of Environment Regulation No. 50 Year 1996; Table 24 contains an analysis of the results.

Table 24 Odor Level Analysis Result

Parameter	Unit	Result								Threshold Value*
		O-1	O-2	O-3	O-4	O-5	O-6	O-7	O-8	
H_2S	µg/Nm^3	< 0.0016	< 0.0016	0.004	< 0.0016	0.005	0.006	< 0.0016	< 0.0016	0.02
NH_3	µg/Nm^3	< 0.03	< 0.03	0.05	< 0.03	0.06	0.07	< 0.03	< 0.03	2

Source: PT SERD AMDAL 2016

Note: * Ministry of Environment Regulation No. 50 Year 1996 regarding the Odor

Odor levels are below the threshold standards and laboratory limit based on the threshold standards Ministry of Environment Regulation No. 50 Year 1996 regarding Odor.

7.2.2.3 Noise

Noise data were directly sampled at 7 sites across the project area of influence (using same air sampling locations). Noise sampling was conducted in accordance with Ministry of Environment Decree No. 48 Year 1996. The threshold values applicable in this regulation are industrial (70dBA) and settlement (55dBA) areas. Results of the noise level analysis are presented in the following Table.

Table 25 Noise Level Analysis Result

Location	Unit	Sampling Period	Noise Level (dBA)	Threshold Value*
Settlement Area	AQN-1	1	49	55dBA
	AQN-2	1	45	
	AQN-3	1	48	
	AQN-4	1	47	
Industrial Area	AQN-5	1	46	70dBA
		4	50.2	
		5	53.2	
	AQN-6	1	46	
		2	38	
		3	58	
	AQN-7	1	46	

Source:
PT SERD ANDAL August 2016
PT SERD UKL/UPL Monitoring 2nd Semester of 2015
PT SERD UKL/UPL Monitoring 1st Semester of 2015

PT SERD UKL/UPL Monitoring 2nd Semester of 2014 PT SERD UKL/UPL Monitoring 1st Semester of 2014 Note: * Ministry of Environment Decree No. 48 Year 1996

As shown by the PT SERD ANDAL (August 2016), noise levels in the Project area were below the threshold standards of the Ministry of Environment Decree No. 48 Year 1996 for both industrial and settlement areas. Additionally, the time series data from the previous UKL/UPL monitoring studies on 2014 and 2015 also shows compliance with the applicable threshold regulations, though there were fluctuations in detection levels. Table 18 describes lithosphere of the project area (PT SERD AMDAL Study on August 2016).

7.3 Lithosphere

The Project Area is situated in the highland area of the South Sumatera region, at elevation ranges between 1,500m to 2,600m. This unit is characterized by hilly terrain with the geomorphological form mostly classified as undulating land and volcanic peaks (which may have high slope angles).

Physiography and geology in the Project region is characterized by the fault zone associated with the line of active volcanoes along the Great Sumatera Fault System or Semangko Fault, which extends 1,650 km along the axis of Sumatera Island. Geology is dominated by pyroclastic (volcanic) units to 1,400m depths.

Even with high sand contents, soil fertility ranges from moderate to high. Erosion hazards on undisturbed highland soils within the geothermal concession are generally rated very low to moderate.

7.3.1 Topography and Geomorphology

According to the Pre-feasibility Study of PT SERD, the geomorphology of the proposed Rantau Dedap Geothermal Power Plant Area is predominantly a volcanic mountainous area. The identified volcanic mountainous area is comprised of the Bukit Besar Complex, Bukit Mutung Complex and Anak Gunung Complex with several lakes identified by LANDSAT (2013).

Generally, the study area is comprised of three morphological terrains as follows:

Steep Hills Morphology: This area is formed by the underlying volcanic breccia and hard rock formations carved by river flows in the sloping areas. The water flows into the rift valley which previously formed along horizontal faults zones in the past. Generally, those rivers flow to the northern direction and the valleys form a V formation. The elevation of this morphological zone ranges from 1,200 to 2,200 m above sea level. The steep hills morphological zone accounts for approximately 70% of the Project Area. The steep and mountainous hills are located in the Southwestern, Southern and Northern portion of Rantau Dedap. Regionally, the drainage pattern follows a dendritic pattern and locally can follow a trellis pattern. The slopes range from 25 to 40% and the top of the mountain includes the peak of Anak, Bukit Mutung and Bukit Besar Mountain.

Sloping Hills Morphology: This area is formed of sloping hills with the slope range from 15 to 25%. The rock composition is comprised of volcanic breccia, lava and tuff. The sloping hills are located on the top of the mountainous cone such as in the Northern and Southeastern portions of Bukit Besar. River flows were not identified in this structure and the elevation of the sloping hills were in the range from 2,000 to 2,200 m above sea level.

Flatland Morphology: This morphological structure is relatively flat with low level undulations. Slope values range from 0 to 8% and is mostly comprised of volcanic sediments. The proposed project

footprint will be located in the middle of this morphology as it is considered to having stable slopes. River flows are comprised of trellis patterns and the main river flows circularly following geological structures in this area; these comprise of perpendicular faults caused by tectonic activity during eruption events.

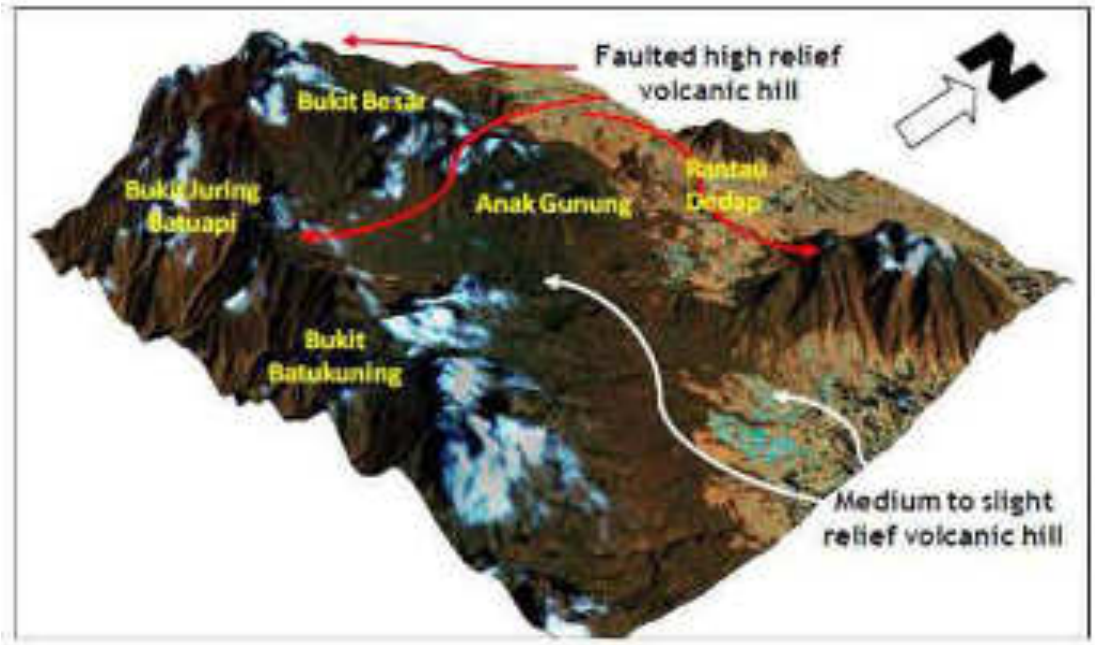


Figure 10 Geomorphology of the Proposed Rantau Dedap Geothermal Project Area

7.3.2 Geology

Rantau Dedap Geothermal Field is located at the eastern fringe of Sumatera Fault System, at a distance of 15 kilometers (Figure 11~~Figure 11~~). The Field is situated on a NE-SW volcanic ridge, which is relatively perpendicular to the Sumatera Fault System. This NE-SW ridge is composed of Bt. Besar at its SW-end, where the Rantau Dedap Field is placed, and Bt. Padupuan at its NE-end. In between those two volcanoes are some smaller volcanoes, such as Bt. Mutung and Bt. Pandan which formed curvilinear ridges facing each-other. These curvilinear volcanic chains suggest a prevailing extensional tectonic regime, and a slight offset.

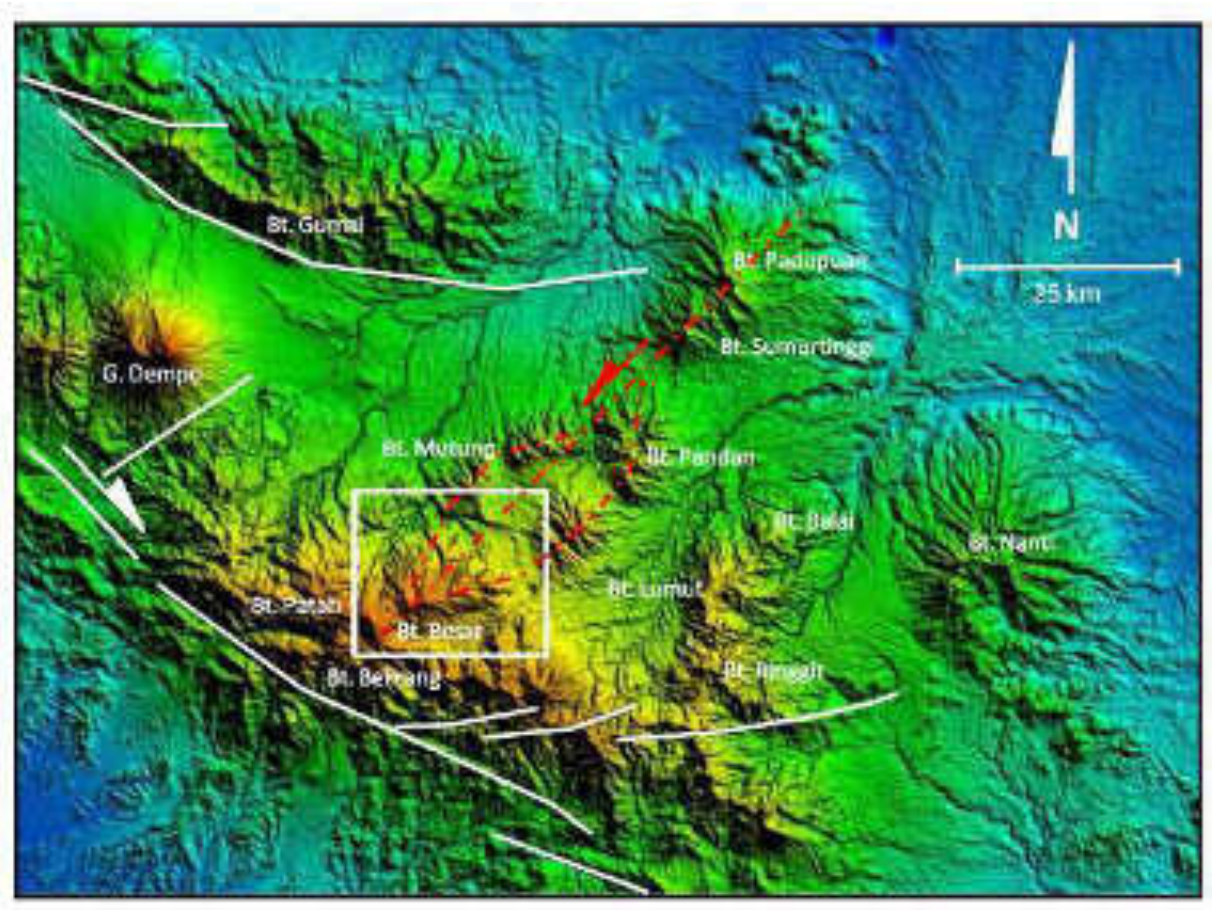


Figure 11 Sumatra Fault System and Location of Rantau Dedap Geothermal Field

Lithologies found within the Project Area include breccias, minor lava, combinations of lava & tuff, and rhyolitic volcanic rocks. There are several volcanic stratigraphy units in the Project Area, the most dominant being eruptive material from the volcanic activities of Bukit Besar Volcano (Bukit Besar Unit) which is mainly composed of pyroclastic rock (tuff, volcanic breccia) and lava flow (basalt-adesite), and some more recent volcanic material from Anak Gunung.

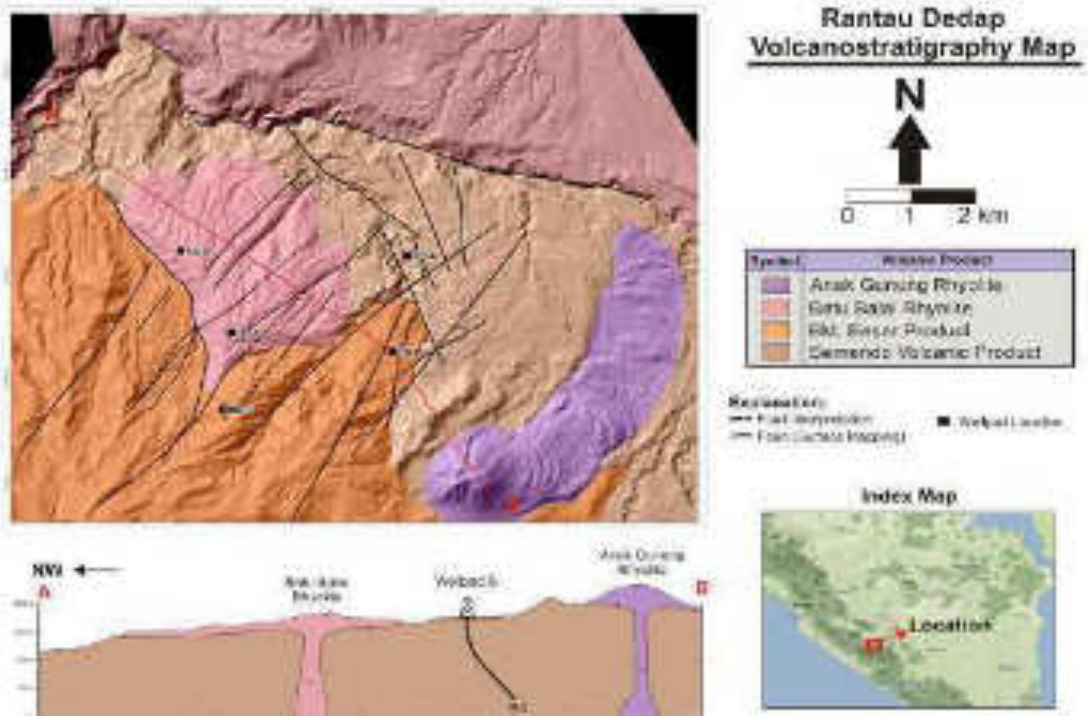
The primary data taken from the drilling activities during the PT SERD AMDAL Study on August 2016 shows the lithological description within the Project Area as presented in the following Table.

Table 26 Lithological Description

Elevation (m below ground surface)	Volcanic Facies	Lithological Description
Surface level to 600	Proximal- Medial	Comprised of andesite lava flows until ballistic and pyroclastic rock which mostly consist of tuff breccias and minor tuff associated with volcanics of the Patah Sembilan Mountain.
600 to 1,000	Medial	Comprised of pyroclastic rock from the volcanic breccia and tuff associated with volcanic eruptions of the Patah Sembilan Mountain.
1,100 to 1,400	Medial– Proximal	Comprised of pyroclastic rock (dominated by volcanic breccias) and low flow of basalt and andesite. The distribution of rock in these layers is associated with

		volcanic eruptions of Patah Sembilan Mountain.
1,400 to *Well Depth*	Medial	Mostly comprised of pyroclastic rocks: breccia volcanic and tuff associated with the oldest volcanic eruptions of Patah Sembilan Mountain.

Source: PT SERD AMDAL August 2016; Original Source: PT SERD Sub-surface Department, 2012



Source: PT SERD ANDAL Study August 2016

Figure 12 Volcanic Stratigraphy of the Proposed Rantau Dedap Geothermal Project Area

7.3.3 Soil

Volcanoes within the immediate vicinity of the site are extinct, while the closest active aged volcano is 35 km northwest of the site. The materials that formed the top layer comprise of either weathered Diorite, soils weathered from Diorite, bedded volcanic Airfall Tephra (ash), generally weathered, debris flow materials (exposed materials are sourced from weathered diorite and ash; organic soils and in some areas hydrothermally altered Diorite and debris flow material.

As part of the AMDAL (2016), soil samples were taken at 6 locations (Map 8~~Map 8~~). Based on the soil analysis, it was found that:

- Soil texture is clay sandy clay, hydrothermally altered diorite
- Average soil pH ranged from 4.12 to 4.87 (acidic).
- Organic content is low, ranging from 2.64 to 6.8.
- Organic content was correlating with the nitrogen content in the soil. Analysis also shows the total nitrogen is in the low level, ranging from 0.06 to 0.14.

Complete results of the soil quality analysis are presented in Table 27~~Table 27~~.

Table 27 Soil Quality Analysis Result (2014, 2015 & 2016)

Parameter	Unit	Sampling Location									
		S1			S2	S3	S4	S5			S6
		1	3	4	1	1	1	1	2	3	1
Texture											
Sandy clay	%	44.46	N/A	39.43	88.99	43.49	56.34	43.56	69.4	37.82	42.95
Dust	%	32.76	N/A	24.43	8.88	43.59	25.75	36.52	30.33	56.27	37.97
Clay	%	22.78	N/A	36.14	2.13	12.92	17.91	19.92	0.27	5.91	19.08
pH											
H_2O	-	4.21	4.33	5.83	4.42	4.46	4.87	4.66	5	5	4.12
KCl	-	4.17	4.28	4.85	4.36	4.31	4.51	4.6	N/A	N/A	3.96
Organic Compound											
C	%	0.54	15.45	2.12	0.34	0.75	0.2	0.62	9	2.32	0.37
N	%	0.09	0.57	0.58	0.07	0.11	0.06	0.14	0.2	0.02	0.14
C/N	-	6	27	4	4.8	6.8	3.3	4.4	45	116	2.64
HCl 25%											
P_2O_5	mg / 100 g	7.89	6.57	5.06	10.25	10.33	2.5	14.31	0	5	4.85
K_2O	mg / 100 g	5.42	0.51	0.3	7.3	9.68	3.12	7.74	N/A	N/A	5.1
Available											
P_2O_5	mg / kg	5.66	N/A	N/A	7.1	4.72	0.76	9.85	N/A	N/A	1.19
Exch. NH_4OAc pH 7											
K	me / 100 g	3.78	0.06	0.3	5.79	15.22	2.01	8.66	0.1	2	7.42
Na	me / 100 g	0.1	0.11	0.55	0.97	1.62	0.66	0.22	0.2	4	3.03
Ca	me / 100 g	12.61	0.55	0.4	10.02	3.6	2.14	6.15	2	11	5.36
Mg	me / 100 g	3.06	0.18	0.11	0.52	0.75	0.34	0.65	1	2	1.1
KTK	me / 100 g	53.16	30.45	16.27	25.31	39.71	27.8	52.5	5	550	41.28
Extract KCl.N											
Al	me / 100 g	1.26	1.28	0.74	4.75	2.4	0.8	3.07	0.4	3	0.55
H	me / 100 g	0.8	0.16	0.39	2.6	1.85	0.67	2.18	0	-	0.3

Source:

1. PT SERD ANDAL August 2016
2. PT SERD UKL/UPL Monitoring 2nd Semester of 2015
3. PT SERD UKL/UPL Monitoring 1st Semester of 2015
4. PT SERD UKL/UPL Monitoring 2nd Semester of 2014
5. PT SERD UKL/UPL Monitoring 1st Semester of 2014

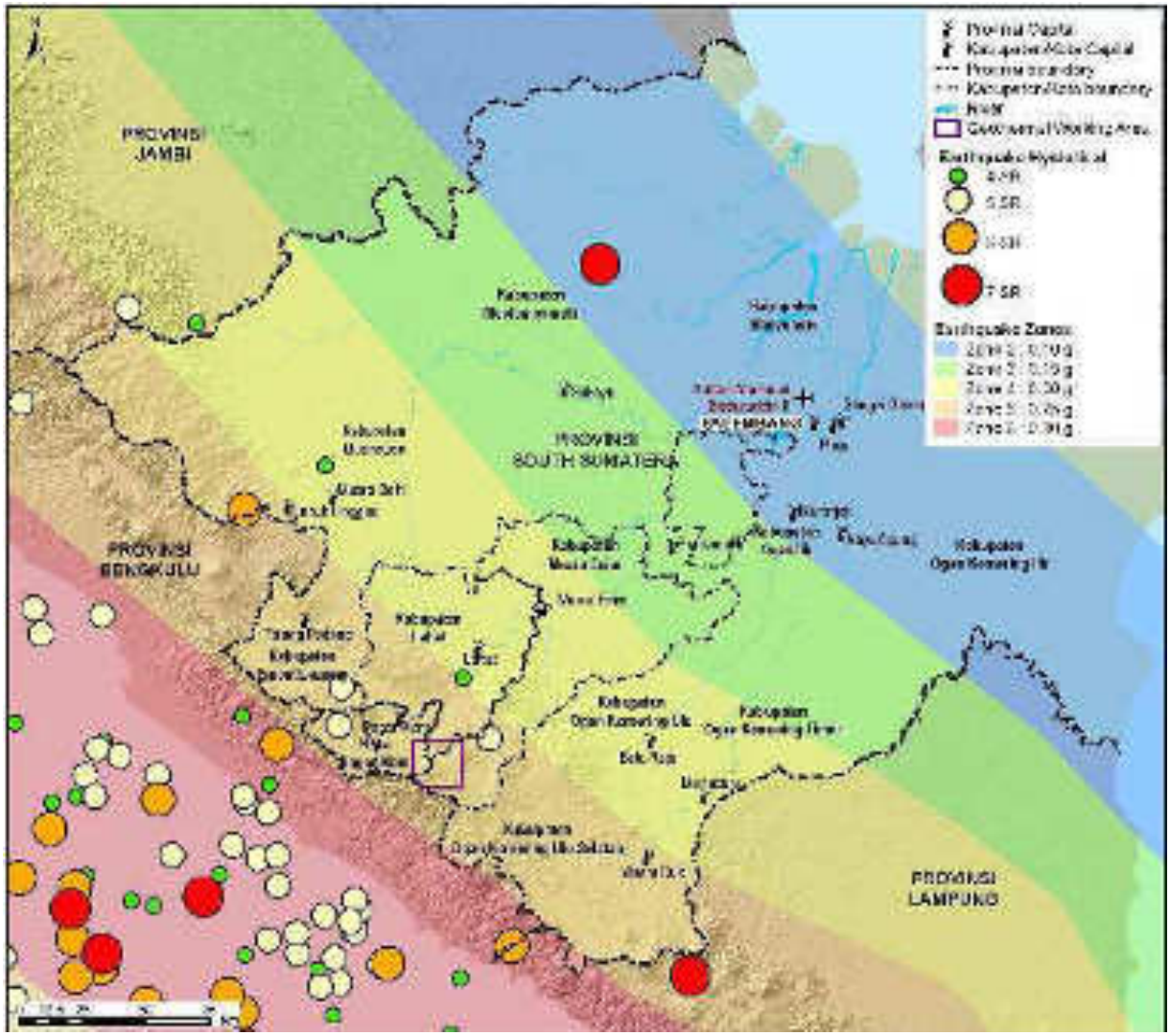
Note: N/A: Not Analyzed

7.3.4 Seismicity

This area is considered to be located in a relatively tectonically stable region; however, as with much of Indonesia seismic activity is common, and the project area is located within the Sumatra Fault Zone.

The geotechnical evaluation from Golder Associates (2009) indicates the potential of geological hazards within the proposed Project Area are of low to medium possibility, comprising debris flows, landslides, surface soil cracking due to the fault zone, seismic vibration and rock falls.

Map 9~~Map 9~~shows the record of seismicity within the Rantau Dedap Area and surrounds.



Map 9 Seismicity Recorded from 2004 to 2013

7.4 Hydrosphere

7.4.1 Hydrology

The Project Area contains several rivers including the Cawang, Asahan and Endikat. Information from the PT SERD IEE Report stated that those rivers are used for drinking water and household purposes by the local community. The rives are all tributaries of the Lematang Rive which is approximately 97.5km length and the Lematang Watershed is approximately 7,380km^2. It has approximately 3,000L/s discharge. The drainage follows the dendritic pattern for the most part, but part of the area follows the trellis pattern. The Lematang Watershed includes coal mining, coral and sand mining, oil palm plantation and agriculture activities.

Table 28 Catchment Areas within the Project Area Footprint

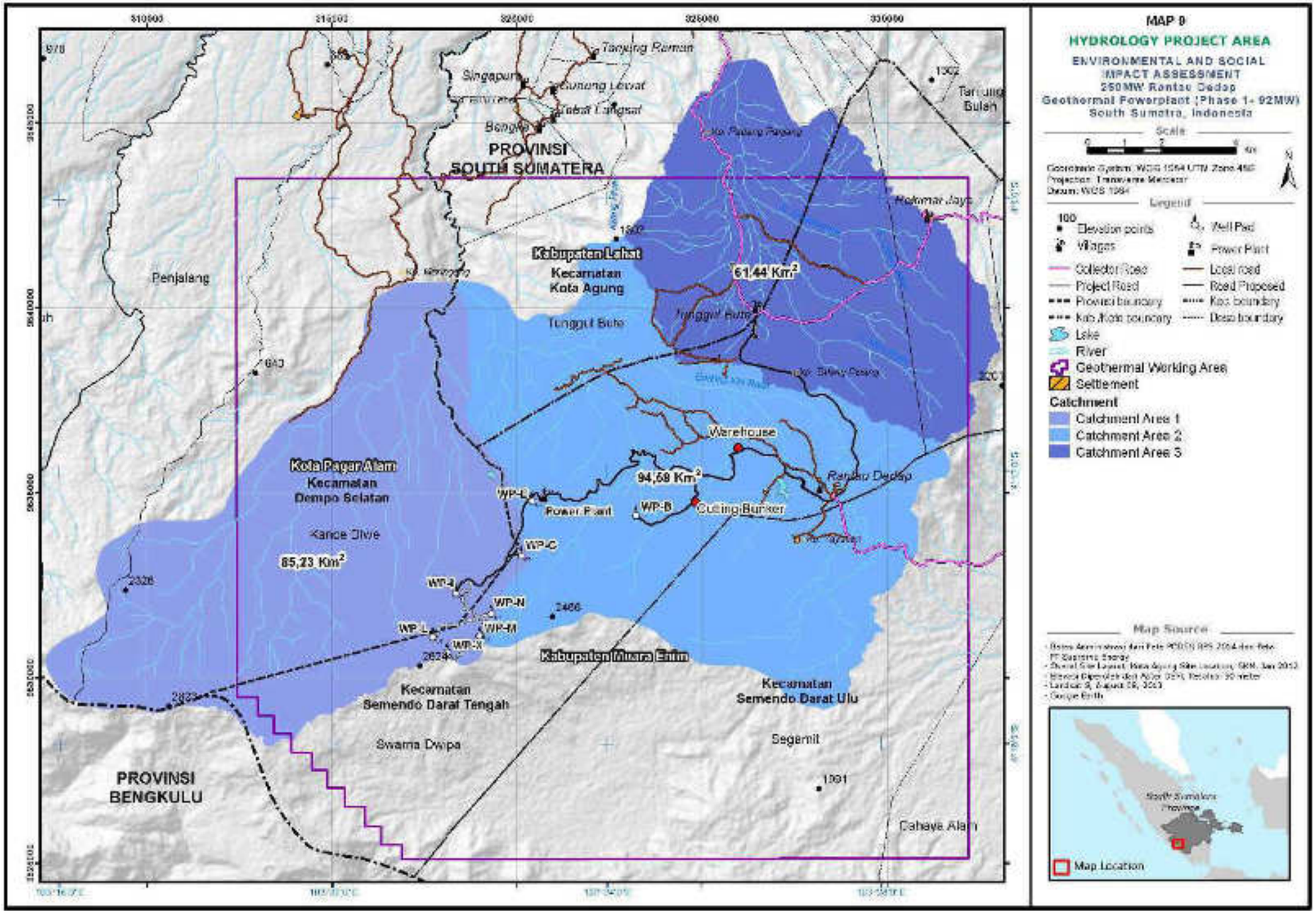
Catchment Areas	Total Area (ha)
Catchment Area 1	8,523
Catchment Area 2	9,457
Catchment Area 3	6,144

Source: PT SERD ANDAL August 2016

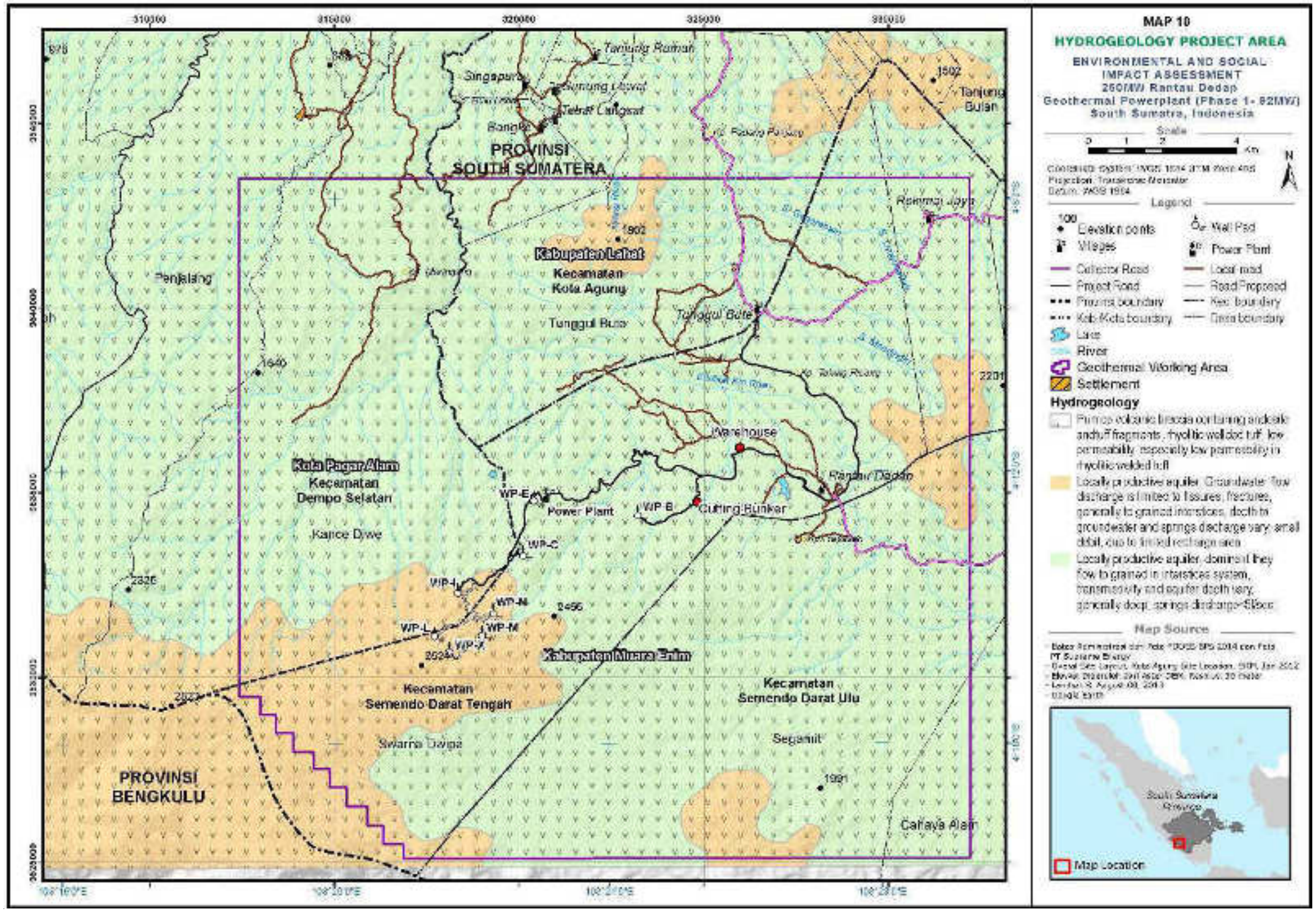
Catchment Area 1 consists of the Endikat Kanan River and the tributaries. The Catchment Area 2 consists of the Endikat Kiri River and the tributaries, such as Bebasan River, Dedapan River and Asahan River. Catchment Area 2 includes the following villages: Sumber Rejeki Village, Yayasan village and Rantau Dedap Village. Catchment Area 3 consists of Gegareman River and tributaries, such as the Mendingin River and Limaubadak River. Catchment 3 includes the following villages: Talang Pisang, Tunggul Bute, Patal and Padang Panjang. Lakes are also present in the catchment areas (Map 10~~Map 10~~).

7.4.2 Hydrogeology

Groundwater within the project Area can be classified as shallow and deep groundwater (Map 11~~Map 11~~). Shallow groundwater flows out of the breccia and tuff layer. Deep groundwater can be observed at the surface through groundwater springs, which flow from aquifers. The presence of fumaroles and hot springs indicate geothermal resources are in the area.



Map 10 Hydrology at Muara Enim Regency, Lahat Regency and Kota Pagar Alam



Map 11 Hydrogeology of Rantau Dedap Geothermal Project Area

7.4.3 Surface Water Quality

Sampling at 5 locations was used to obtain surface water quality data for the PT SERD AMDAL studies in August 2016. Map 8~~Map 8~~ shows the 5 sampling locations.

Parameters measured for the surface water quality are physical, chemical and microbiology, based on the requirement of Government Regulation No. 82 Year 2001 and Sumatra Selatan Governor Regulation No. 16 Year 2005 (threshold standard for water class I) considering the local threshold standard applicable at the Protected Forest area. Table 29 presents the results of the surface water quality analysis.

Surface Water Quality – Physical Parameters

All of the physical parameters (temperature, TDS and TSS) show compliance with both of the applicable threshold standards of Government Regulation No. 82 Year 2001 and Sumatera Selatan Governor Regulation No. 16 Year 2005. Additionally, recorded data from the last three years also show compliance with all of the physical parameters.

Surface Water Quality – Chemical Parameters

Generally, most of the chemical parameters including the pH, nutrients and metals were in compliance with the applicable threshold standards within the last three years. However, most of the parameters such as DO, BOD_5 and COD were not showing compliance on the applicable threshold standards within the last three years trend series data. Based on the direct observation in the Project Area, actually there were no industrial and/or domestic activities occurring within the Project Area and surroundings. It can be determined that the low level of DO and high level of BOD_5 and COD were caused by the natural condition within the Project Area and surroundings and were not impacted by industrial and domestic activities. The relatively calm stream flow within the Project Area and lack of observed turbulent water flow may account for the relatively low oxygen diffusion/concentration in the water.

Surface Water Quality – Microbiology

The microbiology condition (total coliform and fecal coliform) of surface water within the Project Area exceeded the applicable threshold standards. Based on direct observation within the Project Area, the high concentration of fecal coliform may be caused by wild animal and also the decomposition of organic compounds from the upstream areas flowing into the downstream areas. This is consistent with the high level of detected BOD_5 and COD within those surveyed rivers. Analysis obtained based on this condition indicated the dissolved oxygen levels in the water may be utilized by micro-organisms to degrade the organic discharge. Additionally, the organic discharge may react with the dissolved oxygen causing a decrease of dissolved oxygen.

Table 29 Surface Water Quality Analysis Result (2014, 2015 & 2016)

Parameter	Unit	Threshold[1]	Threshold[2]	SW-1					SW-2					SW-3			SW-4	SW-5				
				1	2	3	4	5	1	2	3	4	5	1	2	3	1	1	2	3	4	5
Physic																						
Temperature (insitu) **)	^{0}C	Ambient Air ± 3	Ambient Air ± 3	20.2	N/A	N/A	26	25	20.5	N/A	N/A	26.1	23	20.3	N/A	N/A	21.2	19.2	N/A	N/A	26	24
Total Dissolved Solid (TDS)	mg/l	1,000	1,000	44	42	37	60	12	28	53	27	43	10	36	32	115	34	48	59	45	57	9
Total Suspended Solid (TSS) **)	mg/l	50	50	5	<2	2	25.2	4.14	14	<2	7	21.6	4.4	4	4	6	3	7.92	4	<2	23.3	3.38
Chemical																						
pH (insitu) 26°C **)	-	6 — 9	6 — 9	7.4	7	7.34	6.63	6.2	7.99	7	7.8	6.58	6.1	7.59	7	7.36	7.36	7.79	7	8	6.74	6.8
Ammonia (NH_3-N) **)	mg/L	-	0.5	0.08	0.05	0.05	0.02	0.112	0.02	0.05	0.04	0.03	0.1	0.05	0.05	0.04	0.04	0.09	0.05	0.04	0.06	0.107
Mercury (Hg)	mg/L	0.002	0.001	< 0.0005	<0.0005	<0.0005	<0.0001	N/A	< 0.0005	<0.0005	<0.0005	<0.0001	N/A	< 0.0005	<0.0005	<0.0005	< 0.0005	< 0.0005	<0.0005	<0.0005	<0.0001	N/A
Arsenic (As)	mg/L	1	0.05	< 0.005	<0.005	<0.005	<0.0009	<0.1	< 0.005	<0.005	<0.005	<0.0009	<0.1	< 0.005	<0.005	<0.005	< 0.005	< 0.005	<0.005	<0.005	<0.0009	<0.1
Barium (Ba)	mg/L	-	1	< 0.2	<0.004	<0.004	N/A	N/A	< 0.2	<0.004	<0.004	N/A	N/A	< 0.2	<0.004	<0.004	< 0.2	< 0.2	<0.004	<0.004	N/A	N/A
Boron (B)	mg/L	1	1	< 0.01	<0.01	<0.01	N/A	N/A	< 0.01	<0.001	<0.01	N/A	N/A	< 0.01	<0.01	0.5	< 0.01	< 0.01	<0.01	<0.01	N/A	N/A
Iron (Fe) **)	mg/L	-	0.3	N/A	<0.003	<0.003	0.02	0.018	N/A	0.11	<0.003	0.03	0.012	N/A	0.1	<0.003	N/A	N/A	0.1	<0.003	0.02	0.01
Dissolved Oxygen (DO) (insitu)	mg/L	4	6	3.9	5	4	4.19	5.9	3.7	6	4	4.21	5.8	3.6	5	4	3.2	3,0	5.6	4	4.26	6
Fluoride (F) **)	mg/L	1.5	0.5	< 0,01	<0.01	0.3	0.007	<0.001	< 0.01	0.4	0.2	0.012	<0.001	< 0.01	0.1	0.4	< 0.01	< 0.01	<0.01	<0.01	0.009	<0.001
Phenol	mg/L	0.001	0.001	< 0,001	<0.001	<1	N/A	N/A	< 0.001	<0.001	<1	N/A	N/A	< 0.001	<0.001	<1	< 0.001	< 0.001	<0.001	<1	N/A	N/A
Total Phosphate (PO_4—P) **)	mg/L	0.2	0.2	0.06	0.1	0.02	0.05	0.67	0.02	0.05	0.02	0.11	0.07	0.04	0.02	0.05	0.03	0.08	0.04	0.04	0.05	0.59
Cadmium (Cd)	mg/L	0.01	0.1	< 0,003	<0.002	<0.002	<0.0015	0.004	< 0.003	<0.002	<0.002	<0.0015	0.005	< 0.003	<0.002	<0.002	< 0.003	< 0.003	<0.002	<0.002	<0.0015	0.004
Chloride (Cl) **)	mg/L	-	600	5	2	2	5	19.7	3	5	2	8.7	21.7	4	2	14	4	6	3	2	7	15.7
Chromium VI (Cr^{6+})	mg/L	0.05	0.05	< 0.01	<0.01	<0.01	N/A	<0.01	< 0.01	<0.01	<0.01	N/A	<0.01	< 0.01	<0.01	<0.01	< 0.01	< 0.01	<0.01	<0.01	N/A	<0.01
Cobalt (Co)	mg/L	0.2	0.2	< 0.02	<0.004	<0.004	0.01	N/A	< 0.02	<0.004	<0.004	0.01	N/A	< 0.02	<0.004	<0.004	< 0.02	< 0.02	<0.004	<0.004	0.01	N/A
Free Chlorin (Cl_2)	mg/L	0.03	0.03	< 0.01	0.02	<0.01	N/A	<0.001	< 0.01	0.02	<0.01	N/A	<0.001	< 0.01	0.01	<0.01	< 0.01	< 0.01	0.02	<0.01	N/A	<0.001
Manganese (Mn) **)	mg/L	-	0.1	N/A	<0.003	<0.003	0.01	0.0032	N/A	<0.003	<0.003	0.02	0.0041	N/A	<0.003	<0.003	N/A	N/A	<0.003	<0.003	0.03	0.0032
Oil & Grease	mg/L	1	1	< 0.2	<200	<200	0.098	0.2	< 0.2	<200	<200	0.101	<0.2	< 0.2	<200	<200	< 0.2	< 0.2	<200	<200	0.076	<0.2
Nitrate (NO_3-N) **)	mg/L	10	10	0.6	<0.1	0.1	0.03	N/A	0.3	<0.1	0.1	0.05	N/A	0.4	<0.1	0.2	0.4	0.8	<0.1	0.1	0.07	N/A
Nitrite (NO_2-N) **)	mg/L	0.06	0.06	0.01	<0.002	0.01	0.017	0.01	0.006	<0.002	<0.002	0.011	0.02	0.009	<0.002	0.01	0.008	0.02	<0.002	<0.002	0.024	0.017
Selenium (Se)	mg/L	0.05	0.01	< 0,002	<0.002	<0.002	<0.0012	N/A	< 0.002	<0.002	<0.002	<0.0012	N/A	< 0.002	<0.002	<0.002	< 0.002	< 0.002	<0.002	<0.002	<0.0012	N/A
Zync (Zn)	mg/L	0.05	0.05	0.02	<0.008	<0.008	0.01	0.002	< 0.01	<0.008	<0.008	0.02	0.0041	< 0.01	<0.008	<0.008	< 0.01	< 0.01	<0.008	<0.008	0.02	0.003
Cyanide (CN)	mg/L	0.02	0.02	< 0.005	<0.005	<0.005	0.005	0.046	< 0.005	<0.005	<0.005	0.006	0.003	< 0.005	<0.005	<0.005	< 0.005	< 0.005	<0.005	<0.005	0.005	0.034
Sulphate (SO_4)	mg/L	-	400	4	1	1	12.6	6	2	1	1	8.9	6	3	7	5	3	5	9	1	9.4	5
Sulfide (H_2S)	mg/L	0.002	0.002	< 0.002	<0.002	<0.002	ND	0.046	< 0.002	<0.002	<0.002	ND	0.029	< 0.002	<0.002	<0.002	< 0.002	< 0.002	<0.002	<0.002	ND	0.032
Surfactant (MBAS)	mg/L	0.2	0.2	0.04	0.03	20	N/A	N/A	0.06	0.03	20	N/A	N/A	0.03	0.02	20	0.03	0.04	0.02	20	N/A	N/A
Copper (Cu)	mg/L	0.02	0.02	< 0.013	<0.009	<0.009	<0.003	<0.018	< 0.013	<0.009	<0.009	<0.003	<0.018	< 0.013	<0.009	<0.009	< 0.013	< 0.013	<0.009	<0.009	<0.003	<0.018
Lead (Pb)	mg/L	0.03	0.3	< 0.01	<0.004	<0.004	<0.003	0.019	< 0.01	<0.004	<0.004	0.01	0.017	< 0.01	<0.004	<0.004	< 0.01	< 0.01	<0.004	<0.004	<0.003	0.023
BOD_5	mg/L	3	2	5	4	7	1.8	1.03	6	3	9	1.8	1.21	4	4	7	4	6	7	8	1.85	1.36
COD	mg/L	25	10	12	16	22	2	9.25	17	12	29	6	9.47	10	18	23	11	16	3	26	8	9.68

Parameter	Unit	Threshold[1]	Threshold[2]	SW-1					SW-2					SW-3			SW-4	SW-5				
				1	2	3	4	5	1	2	3	4	5	1	2	3	1	1	2	3	4	5
MICROBIOLOGY																						
Fecal Coliform	MPN/ 100ml	1,000	100	7	930	2,400	ND	ND	15	930	750	ND	100	15	750	930	4	43	750	750	ND	100
Total Coliform	MPN/ 100ml	5,000	1,000	11	1,500	4,600	ND	6,100	21	1,500	1,200	ND	4,800	21	1,200	2,100	9	93	1,200	1,200	ND	4,200

Source:

1. *PT SERD ANDAL August 2016*
2. *PT SERD UKL/UPL Monitoring 2nd Semester of 2015*
3. *PT SERD UKL/UPL Monitoring 1st Semester of 2015*
4. *PT SERD UKL/UPL Monitoring 2nd Semester of 2014*
5. *PT SERD UKL/UPL Monitoring 1st Semester of 2014*

Note: Threshold 1: Government Regulation No. 82 Year 2001 (threshold standard for water class II); Threshold2: Sumatra Selatan Governor Regulation No. 16 Year 2005 (threshold standard for water class I); N/A: Not Analyzed; ND: Not Detected

7.4.4 Groundwater Quality

Groundwater quality data were obtained for the PT SERD AMDAL studies (August 2016) through direct sampling at 3 locations. Map 8~~Map 8~~shows the sampling locations.

Parameters measured for the groundwater quality are based on the requirement of Ministry of Health Regulation No. 492 Year 1990 regarding the Requirements and Monitoring of Water Quality (Appendix II). Results of the groundwater quality analysis are presented in Table 30.

Table 30 Groundwater Quality Analysis Result

Parameter	Unit	Threshold	GW-1	GW-2	GW-3
Physical					
Temperature (insitu)	°C	Ambient Air ± 3	21.2	20.8	20.1
Total Dissolved Solid (TDS)	mg/l	1,500	51	42	46
Turbidity	NTU	25	1	1	1
Odor (insitu)	-	Odorless	Odorless	Odorless	Odorless
Color	Pt-Co	50	2	2	2
Taste	-	Tasteless	Tasteless	Tasteless	Tasteless
Chemical					
Mercury (Hg)	mg/L	0.001	< 0.0005	< 0.0005	< 0.0005
Arsenic (As)	mg/L	0.05	< 0.005	< 0.005	< 0.005
Iron (Fe)	mg/L	1	< 0.02	< 0.02	< 0.02
Fluoride (F)	mg/L	1.5	< 0.01	< 0.01	< 0.01
Cadmium (Cd)	mg/L	0.005	< 0.003	< 0.003	< 0.003
Total Hardness (CaCO3)	mg/L	500	45	36	49
Chloride (Cl)	mg/L	600	36	29	31
Chromium VI (Cr 6+)	mg/L	0.05	< 0.01	< 0.01	< 0.01
Manganeese (Mn)	mg/L	0.5	< 0.02	< 0.02	< 0.02
Nitrate (NO3-N)	mg/L	10	2	0.5	1
Nitrite (NO2-N)	mg/L	1	< 0.006	< 0.006	< 0.006
pH (insitu)	-	6.5 – 9	6.87	6.91	6.72
Selenium (Se)	mg/L	0,01	< 0.002	< 0.002	< 0.002
Zync (Zn)	mg/L	15	< 0.01	< 0.01	0.02
Cyanide (CN)	mg/L	0.1	< 0.005	< 0.005	< 0.005
Surfactant (MBAS)	mg/L	0.5	0.03	0.03	0.04
Lead (Pb)	mg/L	0.05	< 0.01	< 0.01	< 0.01
Sulfate (SO4)	mg/L	400	8	3	4
Permanganate (KmnO4)	mg/L	10	1	2	1
Microbiology					
Total Coliform	MPN/ 100ml	50	3	9	9

Source: PT SERD ANDAL August 2016; Threshold: Ministry of Health Regulation No. 492 Year 1990 Appendix II

7.5 Biosphere

7.5.1 Vegetation Cover

7.5.1.1 Result from the Baseline Study of the Biodiversity Action Plan 2016

Map 12~~Map 12~~shows the flora study sampling locations and ecosystem types. The project area can be categorized into two ecosystem types: lower montane and montane. The project area has similar vegetation types (depending on elevation).

Wellpad B (1,700 masl)

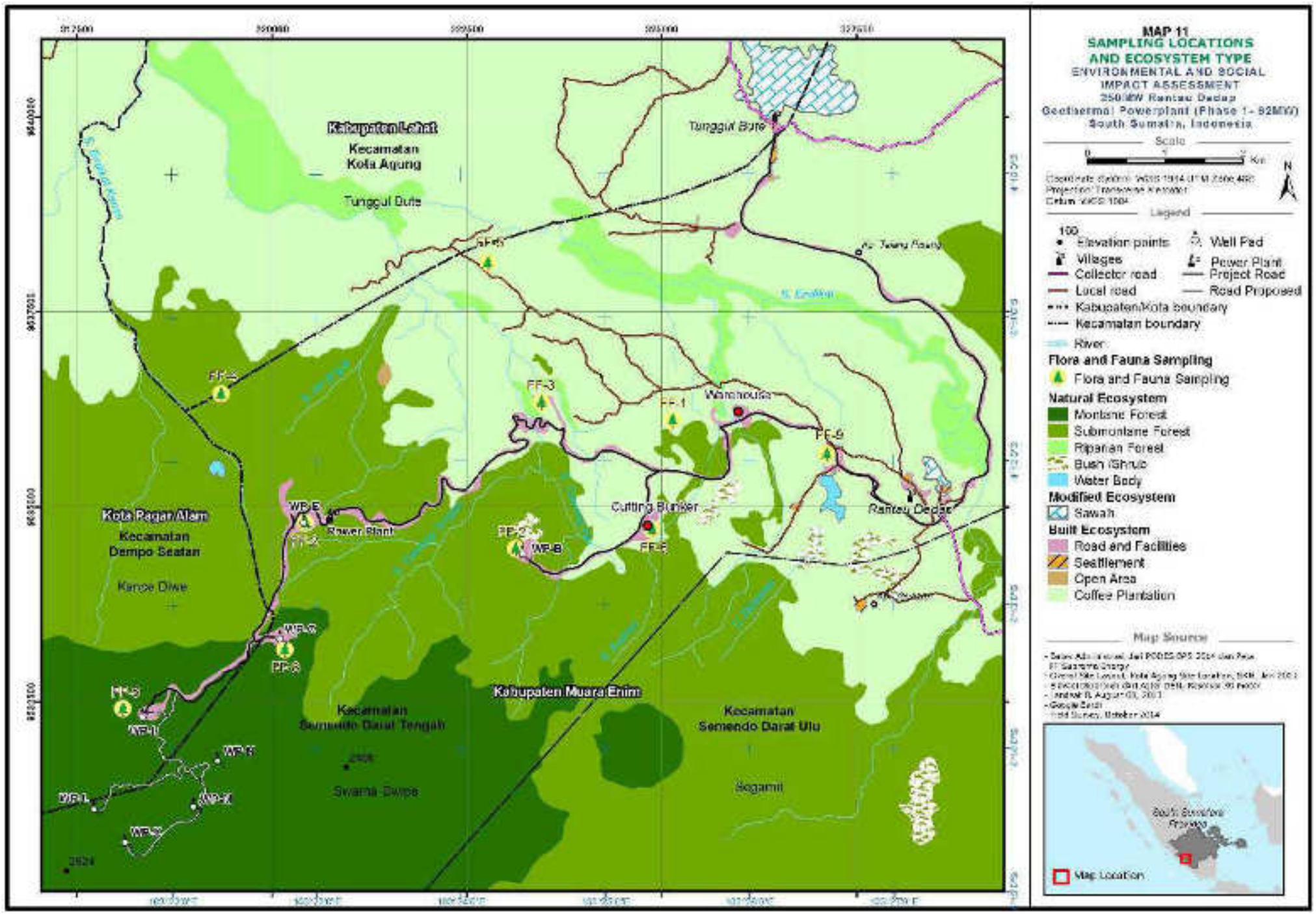
Wellpad B is in a sub-montane forest ecosystem. Observations identified trees over 60 cm in diameter, consisting of Puspa (*Schima wallichii*), Pasang (*Quercus* sp.), Medang (*Litsea* sp.), and Kebe elang (*Aglaia* sp.). Undergrowth plants were primarily Kelat groups (*Syzygium* sp.), Baso (*Caryota mitis*) and Kekawi (*Lasianthus* sp.) Species found on the forest floor were *Begonia isoptera*, *Begonia muricata*, and *Begonia multangular,* as well as *Balanophora* sp. (a parasitic plant that roots on trees of *Quercus* sp.). Some pioneer plants were also found, including Sepat (*Ficus* sp.) and Jelatang (*Laportea stimulant*). A secondary mountain plant species found to be quite dominant is Maleuleu (*Litsea cubeba*). Edelweiss (*Anaphalis longifolia*) is also found.

Wellpad E (2,000 masl)

Wellpad E is in a sub-montane forest ecosystem. Observations identified the following dominant species Lengkedai (*Dacrycarpus imbricatus*) and Lengkedai daun (*Taxus sumatranus*). Both are commonly used for building material by local communities. Lengkedai daun is abundant in the hilly areas. Less common species are *Syzygium* sp., Medang, Cihu (*Schima wallichii*) and *Litsea cubeba*. The second canopy layer has the following dominant species: *Syzygium lineatum*, *Neolitsea* sp., *Evodia latifolia*, and *Litsea* sp. Domonant forest floor species that were identified are *Sarcandra glabra*, *Argostemma montanum*, *Begonia muricata*; *Sonerilla* sp., *Medinilla speciosa*, *Polygonum* sp., and *Ficus* sp are also found.

Wellpad I (2,200 masl)

Wellpad I is in the montane forest ecosystem. Forest composition is dominated by *Taxus sumatrana* and *Dacrycarpus imbricatus* and common species are *Weinmania* sp., *Liquidambar* sp. *Cinnamomum* sp., *Syzygium* sp., and Cihu (*Schima wallichii*). The lower forest canopy has *Lasianthus* sp., *Litsea* sp, *Acer laurinum*, *Symplocos* sp., and Proteaceae family species. Liana plants are rare, except *Rubus* sp. and *Lasianthus* sp., indicating the forest is in good condition. The forest floor has *Sonnerila* sp., *Elatostemma* sp., *Impatiens* sp.



Map 12 Sampling Locations and Ecosystem Types

7.5.1.2 Result from the Baseline Study of the ANDAL Study 2016

Baseline data for the AMDAL studies were derived from three sampling locations:

- FF1: Lowland Montane Forest and Coffee Plantation
- FF4: Lowland Montane Forest
- FF6: Highland Montane Forest

Source: PT SERD ANDAL Study August 2016

Result from the PT SERD ANDAL Study stated that the flora diversity in the Project Area is categorized as moderate to high with the level ranged from 2.01 to 3.34. Forest and trees covers were relatively show the highest diversity index in each plot which considered as the old secondary forest (Molles 2005). While the result of Importance Value Index (Indeks Nilai Penting/INP) shows the dominant trees species at FF1 sampling point are dominated by tree *Actinodaphne* sp. (INP = 27,87%), stake/pole *Cyathea* sp. (INP = 58,89%), sapling *Anisophylla disticha* (INP = 46,93%) and seedling *Lycopodium* sp1 (INP = 21,60%). While the FF4 sampling point are dominated by tree *Barringtonia* sp. (INP = 55,35%), stake/pole *Michelia alba* (INP = 63,71%), sapling *Acronychia porteri* (INP = 66,45%) and seedling *Begonia* sp1 (INP = 94,39%) and FF6 sampling point are dominated by tree *Cryptocarya* sp. (INP = 56,62%), stake/pole *Cryptocarya* sp. (INP = 58,89%), sapling *Acronychia porteri* (INP = 66,45%) and seedling *Dryopteris* sp. (INP = 24,40%).

Table 31 List of Terrestrial Flora Species at FF1 Sampling Point

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Tree								
Cyathaceae	*Cyathea* sp.				1,47	2,08	1,91	5,47
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing		CR	2,94	2,08	0,49	5,52
Fabaceae	*Caesalpinia* sp.				2,94	2,08	0,69	5,71
Fagaceae	*Lithocarpus* sp2				1,47	4,17	1,80	7,43
Fagaceae	*Lithocarpus* sp3				5,88	6,25	1,61	13,74
Fagaceae	*Quercus subsericea*	Kecing batu			1,47	2,08	1,38	4,93
Gymnospermae	*Gymnospermae* sp.				11,76	10,42	0,45	22,63
Lauraceae	*Actinodaphne borneensis*				1,47	2,08	0,97	4,53
Lauraceae	***Actinodaphne* sp.**				**1,47**	**2,08**	**24,31**	**27,87**
Lauraceae	*Alseodaphne* sp2				1,47	2,08	2,51	6,06
Lauraceae	*Cinnamomun parthenoxylon*	Selasihan			1,47	2,08	2,00	5,55
Lauraceae	*Criptocarya griffithiana*	Medang buaya			5,88	4,17	2,04	12,08
Lauraceae	*Cryptocarya* sp.				14,71	10,42	0,48	25,60
Lauraceae	*Litsea* sp2				1,47	2,08	3,36	6,91

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Lecythidaceae	*Barringtonia* sp.	Kancil			7,35	4,17	3,05	14,57
Magnoliaceae	*Michelia alba*	Cempaka putih			2,94	2,08	14,16	19,19
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			1,47	2,08	0,69	4,24
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			1,47	2,08	3,08	6,64
Myrtaceae	*Syzygium* sp4	Jambu-jambuan			2,94	4,17	6,96	14,06
Myrtaceae	*Syzygium* sp5				1,47	2,08	0,66	4,21
Myrtaceae	*Syzygium tetraquetra*				4,41	2,08	1,86	8,35
Pentaphylacaceae	*Adinandra dumosa*	Api-api			1,47	2,08	0,69	4,24
Phyllanthaceae	*Antidesma* sp1				1,47	2,08	5,90	9,45
Phyllanthaceae	*Antidesma* sp2				1,47	2,08	0,53	4,09
Primulaceae	*Ardisia* sp.				4,41	6,25	2,08	12,74
Sterculiaceae	*Scaphium macropodum*	Kembang semangkok		LC	8,82	8,33	2,21	19,37
	sp4				1,47	2,08	10,42	13,98
	sp5				1,47	2,08	1,34	4,90
	sp6				1,47	2,08	2,37	5,92
Stake/pole								
Anisophylleaceae	*Anisophyllea disticha*				9,52	5,88	8,46	23,86
Cyathaceae	***Cyathea* sp.**				**19,05**	**23,53**	**16,31**	**58,89**
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing		CR	4,76	5,88	5,78	16,43
Fabaceae	*Caesalpinia* sp.				4,76	5,88	3,91	14,55
Fagaceae	*Lithocarpus* sp2				4,76	5,88	7,14	17,79
Lauraceae	*Actinodaphne* sp.				14,29	11,76	16,30	42,35
Lauraceae	*Cryptocarya* sp.				9,52	11,76	10,28	31,57
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			4,76	5,88	4,34	14,99
Myrtaceae	*Syzygium tetraquetra*	Jambu-jambuan			14,29	5,88	15,83	36,00
Primulaceae	*Ardisia* sp.				4,76	5,88	5,04	15,68
Sterculiaceae	*Scaphium macropodum*	Kembang semangkok		LC	4,76	5,88	3,30	13,95
	sp4				4,76	5,88	3,30	13,95
Sapling								
Anisophylleaceae	***Anisophylla disticha***				**21,43**	**11,76**	**13,73**	**46,93**
Cyathaceae	*Cyathea* sp.				3,57	5,88	16,14	25,59
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing		CR	7,14	5,88	7,56	20,58
Fagaceae	*Lithocarpus* sp3				3,57	5,88	3,90	13,35

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Lauraceae	*Actinodaphne glomerata*	Huru dapung			3,57	5,88	0,59	10,04
Lauraceae	*Cryptocarya* sp.				7,14	5,88	7,03	20,05
Lecythidaceae	*Barringtonia* sp.	Kancil			3,57	5,88	0,97	10,43
Magnoliaceae	*Michelia alba*	Cempaka putih			3,57	5,88	4,81	14,27
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			10,71	5,88	23,42	40,02
Myrtaceae	*Syzygium tetraquetra*	Jambu-jambuan			17,86	11,76	10,43	40,06
Phyllantaceae	*Glochidion superbum*	Dalok			3,57	5,88	4,81	14,27
Phyllanthaceae	*Antidesma* sp1				10,71	17,65	5,14	33,50
Polygalaceae	*Xanthophyllum* sp.				3,57	5,88	1,46	10,91
Seedling								
Apocynaceae	*Hoya* sp.					0,48	1,54	2,02
Araceae	*Philodendron* sp.					0,24	1,54	1,78
Arecaceae	*Calamus* sp.					0,24	1,54	1,78
Aspleniaceae	*Asplenium* sp1					1,44	3,08	4,51
Aspleniaceae	*Asplenium* sp2					0,24	1,54	1,78
Athyriaceae	*Diplazium* sp.	Paku sayur				7,18	1,54	8,72
Begoniaceae	*Begonia* sp.	Begonia				3,59	4,62	8,20
Cyatheaceae	*Syathea* sp.					0,24	1,54	1,78
Cyperaceae	*Cyperus* sp.					0,48	1,54	2,02
Hydrocharitaceae	*Hydrilla* sp.					2,39	1,54	3,93
Hymenophyllaceae	*Trichomanes javanicum*	Pakis kartam				1,91	4,62	6,53
Lauraceae	*Cinnamomum* sp.					1,91	3,08	4,99
Lauraceae	*Litsea* sp.					0,24	1,54	1,78
Lycopodiaceae	*Lycopodium serratum*					0,48	1,54	2,02
Lycopodiaceae	***Lycopodium* sp1**					**16,99**	**4,62**	**21,60**
Lycopodiaceae	*Lycopodium squarossum*					1,91	1,54	3,45
Melastomataceae	*Pternandra cordata*					0,48	1,54	2,02
Myrtaceae	*Syzygium* sp1	Jambu-jambuan				6,22	4,62	10,84
Myrtaceae	*Syzygium* sp2	Jambu-jambuan				1,44	3,08	4,51
Myrtaceae	*Syzygium* sp3	Jambu-jambuan				0,24	1,54	1,78
Nephrolepidaceae	*Nephrolephis* sp.					0,24	1,54	1,78
Pentaphylacaceae	*Adinandra* sp1					1,44	1,54	2,97

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Pentaphylacaceae	*Adinandra* sp2					0,24	1,54	1,78
Phyllanthaceae	*Aporosa* sp1					0,48	1,54	2,02
Phyllanthaceae	*Aporosa* sp2					1,20	1,54	2,73
Piperaceae	*Piper* sp.					0,48	1,54	2,02
Proteaceae	*Helicia* sp.					1,44	3,08	4,51
Pteridaceae	*Adiantum caudatum*	Suplir				12,92	6,15	19,07
Rubiacae	*Adina* sp1					0,72	1,54	2,26
Rubiacae	*Adina* sp2					0,24	1,54	1,78
Rubiaceae	*Lasianthus* sp1					1,20	1,54	2,73
Rubiaceae	*Lasianthus* sp2					0,48	1,54	2,02
Rubiaceae	*Rubiaceae*					1,20	1,54	2,73
Selaginellaceae	*Selaginella* sp2					14,11	6,15	20,27
	Sp2					5,26	3,08	8,34
	Sp3					1,20	3,08	4,27
	Sp4					0,48	1,54	2,02
	Sp5					6,94	6,15	13,09
	Sp6					0,48	1,54	2,02
	Sp7					0,24	1,54	1,78
	Sp8					0,24	1,54	1,78
	Sp9					0,48	1,54	2,02

Source: PT SERD ANDAL Study August 2016

Table 32 List of Terrestrial Flora Species at FF4 Sampling Point

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Tree								
Anisophylleaceae	*Anisophylla disticha*				1,49	1,96	0,48	3,94
Euphorbiaceae	*Macaranga tanarium*	Mara			5,97	5,88	3,13	14,98
Fagaceae	*Lithocarpus* sp1				4,48	5,88	2,11	12,47
Fagaceae	*Lithocarpus* sp2				8,96	7,84	14,36	31,16
Fagaceae	*Quercus subsericea*	Kecing batu			4,48	3,92	7,05	15,45
Faraceae	*Lithocarpus* sp3				4,48	5,88	2,40	12,76
Lauraceae	*Actinodaphne borneensis*				1,49	1,96	10,57	14,02
Lauraceae	*Actinodaphne* sp.				2,99	3,92	1,82	8,73
Lauraceae	*Alseodaphne* sp.				2,99	3,92	2,54	9,45
Lauraceae	*Criptocarya griffithiana*	Medang buaya			1,49	1,96	1,40	4,85
Lauraceae	*Cryptocarya* sp.				1,49	1,96	0,54	3,99
Lauraceae	Lauraceae 3				2,99	1,96	1,63	6,58
Lauraceae	Lauraceae 4				1,49	1,96	0,66	4,12

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Lauraceae	Lauraceae 5				2,99	3,92	1,36	8,27
Lauraceae	*Litsea* sp1				2,99	3,92	5,98	12,89
Lecythidaceae	***Barringtonia* sp.**	**Kancil**			**20,90**	**9,80**	**24,65**	**55,35**
Magnoliaceae	*Michelia alba*	Cempaka putih			4,48	5,88	3,40	13,76
Moraceae	*Ficus* sp.				2,99	1,96	1,94	6,89
Myrtaceae	*Syzygium* sp1	Jambu-jambuan			2,99	3,92	2,03	8,94
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			2,99	3,92	2,24	9,15
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			2,99	3,92	3,09	10,00
Pentaphylacaceae	*Adinandra dumosa*	Api-api			1,49	1,96	0,99	4,44
Phyllanthaceae	*Antidesma* sp1				1,49	1,96	1,88	5,34
Polygalaceae	*Xanthophyllum* sp.				1,49	1,96	0,46	3,91
Rutaceae	*Acronychia porteri*	Melaman	LC		4,48	3,92	2,06	10,46
	sp4				1,49	1,96	0,50	3,95
	sp5				1,49	1,96	0,70	4,15
Stake/pole								
Anisophylleaceae	*Anisophylla disticha*				17,86	17,39	15,86	51,11
Cyathaceae	*Cyathea* sp.				10,71	8,70	6,65	26,06
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing	CR		3,57	4,35	1,74	9,66
Euphorbiaceae	*Macaranga tanarius*	Mara			3,57	4,35	3,91	11,83
Fabaceae	*Albizia* sp.				3,57	4,35	3,91	11,83
Fagaceae	*Quercus* sp.				3,57	4,35	5,24	13,16
Lauraceae	*Actinodaphne* sp.				3,57	4,35	14,48	22,40
Lauraceae	*Actinodaphne glomerata*	Kuru dapang			3,57	4,35	1,74	9,66
Lauraceae	*Cryptocarya* sp.				7,14	8,70	7,86	23,69
Magnoliaceae	***Michelia alba***	**Cempaka putih**			**25,00**	**17,39**	**21,32**	**63,71**
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			7,14	8,70	5,98	21,81
Rutaceae	*Acronychia porteri*		LC		3,57	4,35	2,06	9,98
	sp3				3,57	4,35	3,47	11,39
	sp4				3,57	4,35	5,79	13,70
Sapling								
Anisophylleaceae	*Anisophylla disticha*				9,09	10,00	12,34	31,43
Lauraceae	*Actinodaphne borneensis*				9,09	10,00	12,09	31,18
Lauraceae	*Cryptocarya* sp.				9,09	10,00	0,81	19,90
Lauraceae	*Criptocarya griffithiana*	Medang buaya			18,18	20,00	10,56	48,75
Lauraceae	*Litsea* sp2				9,09	10,00	0,81	19,90
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			9,09	10,00	2,01	21,10
Myrtaceae	*Syzygium tetraquetra*				9,09	10,00	3,22	22,31
Phyllanthaceae	*Antidesma* sp1				18,18	10,00	10,80	38,98

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Rutaceae	***Acronychia porteri***				**9,09**	**10,00**	**47,36**	**66,45**
Seedling								
Arecaceae	*Calamus* sp.				4,15	8,06		12,21
Arecaceae	*Licuala* sp.				1,04	1,61		2,65
Aspleniaceae	*Asplenium nidus*	Paku sarang burung			0,52	1,61		2,13
Athyriaceae	*Diplazium* sp.	Paku sayur			11,92	8,06		19,98
Begoniaceae	***Begonia sp1***	**Begonia**			**28,50**	**8,06**		**36,56**
Begoniaceae	*Begonia* sp2	Begonia			2,59	3,23		5,82
Calophyllaceae	*Calophyllum* sp.				1,04	1,61		2,65
Cecropiaceae	*Myrianthus* sp.				0,52	1,61		2,13
Euphorbiaceae	*Macaranga tanarium*	Mara			1,55	3,23		4,78
Gesneriaceae	*Aeschynanthus radicans*	Tanaman lipstik			2,07	3,23		5,30
Gesneriaceae	*Gesneriaceae*				1,04	3,23		4,26
Lamiaceae	*Vitex trifolia*	Legundi			0,52	1,61		2,13
Lauraceae	*Alseodaphne* sp.				0,52	1,61		2,13
Lauraceae	*Cryptocarya ferrea*	Huru kayu			0,52	1,61		2,13
Lauraceae	*Litsea* sp.				0,52	1,61		2,13
Lomariopsidaceae	*Nephrolepis* sp.	Paku pedang			0,52	1,61		2,13
Melastomataceae	*Pternandra* sp.				0,52	1,61		2,13
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			0,52	1,61		2,13
Orchidaceae	*Anoectochilus* sp.	Anggrek permata		II	0,52	1,61		2,13
Orchidaceae	*Bulbophyllum macranthum*	Anggrek dupa	LC	II	1,04	3,23		4,26
Orchidaceae	*Bulbophylum uniflorum*			II	0,52	1,61		2,13
Orchidaceae	*Calanthe triplicata*			II	0,52	1,61		2,13
Orchidaceae	Orchidaceae (sp2)			II	0,52	1,61		2,13
Phyllanthaceae	*Aporosa* sp1				5,70	8,06		13,76
Primulaceae	*Ardisia* sp.				0,52	1,61		2,13
Pteridaceae	*Adiantum* sp.	Suplir			17,62	8,06		25,68
Rosaceae	*Rubus rosifolius*	Rubus			0,52	1,61		2,13
Rubiacae	*Adina* sp.				1,04	1,61		2,65
Rubiacae	*Psychotria* sp.				2,07	4,84		6,91
Sapotaceae	*Payena* sp.				0,52	1,61		2,13
Selaginellaceae	*Selaginella* sp2	Paku rane			6,22	3,23		9,44
Theaceae	*Camellia* sp.				0,52	1,61		2,13
Vitaceae	*Leea indica*	Girang merah			1,04	1,61		2,65
Zingiberaceae	Zingiberaceae				2,59	1,61		4,20

Source: PT SERD ANDAL Study August 2016

Table 33 List of Terrestrial Flora Species at FF6 Sampling Point

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Tree								
Anisophylleaceae	*Anisophyllea disticha*		LC		10.81	12.5	6.64	29.95
Cyatheaceae	*Cyathea* sp.				6.76	7.5	2.82	17.08
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing	CR		4.05	5	1.82	10.87
Fabaceae	*Caesalpinia* sp.				2.7	5	11.88	19.58
Fagaceae	*Lithocarpus* sp.				1.35	2.5	1.13	4.98
Lauraceae	*Actinodaphne* sp.				4.05	5	1.34	10.39
Lauraceae	***Cryptocarya sp.***				**25.68**	**12.5**	**18.44**	**56.62**
Lauraceae	Lauraceae 1				8.11	10	22.09	40.19
Lauraceae	Lauraceae 2				2.7	2.5	2.8	8
Lauraceae	*Cinnamomun parthenoxylon*	Selasihan			1.35	2.5	2.94	6.79
Lauraceae	*Alseodaphne* sp.				1.35	2.5	0.5	4.35
Lauraceae	Lauraceae 3				2.7	2.5	3.06	8.26
Lecythidaceae	*Barringtonia* sp.	Kancil			16.22	12.5	19.25	47.96
Myrtaceae	*Syzygium* sp1	Jambu-jambuan			4.05	5	1.32	10.38
Primulaceae	*Ardisia* sp.				2.7	5	1.47	9.17
Sterculiaceae	*Scaphium macropodum*	Kembang semangkok	LC		5.41	7.5	2.5	15.4
Stake/pole								
Anisophylleaceae	*Anisophyllea disticha*				10,34	9,09	10,56	30,00
Cyathaceae	*Cyathea* sp.				3,45	9,09	12,09	24,63
Lauraceae	*Actinodaphne* sp.				3,45	9,09	2,01	14,55

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Lauraceae	***Cryptocarya* sp.**				**37,93**	**9,09**	**47,36**	**94,39**
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			10,34	9,09	12,34	31,77
Myrtaceae	*Eugenia* sp.				10,34	18,18	3,22	31,74
Polygalaceae	*Xanthophyllum* sp.				3,45	9,09	0,81	13,35
Rubiaceae	*Adina* sp.				17,24	9,09	10,80	37,13
Rubiaceae	*Randia* sp.				3,45	18,18	0,81	22,44
Sapling								
Anisophylleaceae	*Anisophyllea disticha*				9,09	10,00	12,34	31,43
Lauraceae	*Actinodaphne borneensis*				9,09	10,00	12,09	31,18
Lauraceae	*Cryptocarya* sp.				9,09	10,00	0,81	19,90
Lauraceae	*Criptocarya griffithiana*	Medang buaya			18,18	20,00	10,56	48,75
Lauraceae	*Litsea* sp2				9,09	10,00	0,81	19,90
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			9,09	10,00	2,01	21,10
Myrtaceae	*Syzygium tetraquetra*	Jambu-jambuan			9,09	10,00	3,22	22,31
Phyllanthaceae	*Antidesma* sp1				18,18	10,00	10,80	38,98
Rutaceae	***Acronychia porteri***	**Ketiak**			**9,09**	**10,00**	**47,36**	**66,45**
Seedling								
Araceae	*Arisaema* sp	Kiacung			0,99	2,70		3,69
Aspleniaceae	*Asplenium* sp1	Paku-pakuan			6,93	5,41		12,34
Balsaminaceae	*Impatiens* sp				1,98	5,41		7,39
Begoniaceae	*Begonia* sp1	Begonia			14,85	5,41		20,26
Begoniaceae	*Begonia* sp2	Begonia			3,96	5,41		9,37
Cyathaceae	*Cyathea* sp.				8,91	5,41		14,32

Family	Scientific Name	Local Name	Conservation Status		KR (%)	FR (%)	DR(%)	*INP*
			IUCN	CITES				
Drypoteridaceae	***Dryopteris* sp.**	**Paku-pakuan**			**10,89**	**13,51**		**24,40**
Gesneriaceae	*Aeschynanthus radicans*	Tanaman lipstik			3,96	5,41		9,37
Lamiaceae	*Lamiaceae* sp1				2,97	5,41		8,38
Lomariopsidaceae	*Nephrolepis hirsutula*	Paku kinca			8,91	5,41		14,32
Lycopodiaceae	*Lycopodium* sp1	Paku kawat			9,90	8,11		18,01
Lycopodiaceae	*Lycopodium* sp2	Paku kawat			0,99	2,70		3,69
Myrtaceae	*Syzygium* sp1	Jambu-jambuan			0,99	2,70		3,69
Orchidaceae	*Bulbophyllum macranthum*	Anggrek dupa	LC	II	2,97	5,41		8,38
Orchidaceae	Orchidaceae (sp1)			II	0,99	2,70		3,69
Piperaceae	Piperaceae sp1				1,98	2,70		4,68
Rubiaceae	Rubiaceae sp1				1,98	2,70		4,68
Selaginellaceae	*Selaginella* sp1	Paku rane			11,88	2,70		14,58
Theaceae	*Camellia* sp.				1,98	5,41		7,39
Vitaceae	*Cissus* sp.				0,99	2,70		3,69
	Sp1 (not identified)				0,99	2,70		3,69

Source: PT SERD ANDAL Study August 2016

7.5.2 Fauna

7.5.2.1 Result from the Baseline Study of the Biodiversity Action Plan 2016

Birds

Seven birds were detected in the project area.

Table 34 List of Birds in the Study and Project Area

Name		Status		Endemic?
English	Scientific name	GOI	IUCN	
Oriental pied hornbill	*Anthracoceros convexus*	P	LC	
Orange-bellied flowerpecker	*Dicaeum trigonostigma*		LC	
Greater green leafbird	*Chloropsis sonnerati*		LC	
Snowy-browed flycatcher	*Ficedula hyperythra sumatrana*		LC	
Wedge-tailed green pigeon	*Treron sphenurus korthalsi*		LC	
Pygmy wren-babbler	*Pnoepyga pusilla penida*		LC	
Shiny whistling thrush	*Myophonus melanurus*		LC	

Note: IUCN: EN = Endangered, CR = Critical Endangered, GOI = Indonesia law under PP 7/1999: P = Protected

Source: PT SERD Biodiversity Action Plan 2016

Mammals

A total of 21 mammals were detected in the project area. Mammals were identified through footprints, camera traps, and sounds.

Table 35 List of Mammals in the Study and Project Area

Name		Status		Endemic?
English	Scientific name	GOI	IUCN	
Siamang	*Hylobates syndactylus*	P	EN	
Sumatran surili	*Presbytis melalophos*	P	EN	E
Sunda pangolin	*Manis javanica*	P	CR	
Dhole	*Cuon alpinus*	P	EN	
Sumatran tiger	*Panthera tigris sumatrae*	P	CR	E
Wild boar	*Sus scrofa*		LC	
Red muntjac	*Muntiacus muntjak*	P	LC	
Sumatran serow	*Capricornis sumatraensis*	P	VU	E
Malayan tapir	*Tapirus indicus*	P	EN	
Malayan sun bear	*Helarctos malayanus*	P	VU	
Sambar deer	*Cervus unicolor*	P	VU	
Leopard cat	*Prionailurus bengalensis*		LC	
Common palm civet	*Paradoxurus hermaphroditus*		LC	
Marbled cat	*Pardofelis marmorata*		VU	
Masked palm civet	*Paguma larvata*		LC	
Asian golden cat	*Catopuma temminckii*		NT	
Banded linsang	*Prionodon linsang*	P	LC	
Large treeshrew	*Tupaia tana*		LC	

Name		Status		Endemic?
English	Scientific name	GOI	IUCN	
Yellow throated marten	*Martes flavigula*		LC	
Malayan porcupine	*Hystrix brachyura*	P	LC	

Note: IUCN: EN = Endangered, CR = Critical Endangered, GOI = Indonesia law under PP 7/1999: P = Protected

Source: PT SERD Biodiversity Action Plan 2016

Herpetofauna

Table 36 List of Herpetofauna in the Study and Project Area

Name		Status		Endemic?
English	Scientific name	GOI	IUCN	
Banded krait	*Bungarus fasciatus*		LC	

Source: PT SERD Biodiversity Action Plan 2016

7.5.2.2 Result from the Baseline Study of the ANDAL Study 2016

Result from the PT SERD ANDAL Study shows the highest fauna occurence were observed in Wellpad B which indicated the lowland montane forest is ideally considered for the terrestrial fauna diversity. The overall list of the terretrial fauna found within the project area are presented in the following Table.

Table 37 List of Terrestrial Fauna Observed in the Study and Project Area

Local Name	Scientific Name	Conservation Status			Endemic	Location							
		PP 7/1999	IUCN	CITES		Wellpad B	Wellpad E	Wellpad I	Plantation	Wellpad C	Wellpad D	Puyang Lake	Wellpad L, M, N, X
Mammalia													
Siamang	*Symphalangus syndactylus*		EN			D, V			T, D		D, V	D	
Surili	*Presbytis melalophos*	L	EN			D			V			D	
Tapir	*Tapirus indicus*	L	`	I		K	K	K		K		K, CT	F, K
Kijang kuning	*Muntiacus muntjak*	L	LC			K, CT	K	CT					K
Kambing hutan Sumatra	*Capricornis sumatrensis*	L	VU	I		K							
Babi hutan	*Sus scrofa*		LC			K						K	
Landak	*Hystrix brachyura*	L	LC						CT				
Rusa sambar	*Cervus unicolor*		VU					K					K
Beruang madu	*Helarctos malayanus*	L	VU	I		K, CT	K	K	CT	K	K, CT		
Kucing emas Asia	*Catopuma temminckii*		NT	I					CT				
Kucing batu	*Pardofelix marmorata*		VU	I		CT		CT					CT
Ajag	*Cuan alpinus*		EN			CT			CT		CT		
Linsang	*Prionodon linsang*		LC	II									
Musang bulan	*Paguma larvata*		LC			CT			CT		CT		
Trenggiling	*Manis javanica*	L	CR	II							CT		

Local Name	Scientific Name	Conservation Status			Endemic	Location							
		PP 7/1999	IUCN	CITES		Wellpad B	Wellpad E	Wellpad I	Plantation	Wellpad C	Wellpad D	Puyang Lake	Wellpad L, M, N, X
Musang leher kuning	*Martes flavigula*		LC							CT			
Tupai	Tupaiidae							CT					
Tupai tanah	*Tupaia tana*		LC						CT				
Harimau Sumatra	*Panthera tigris sumatrae*	L	EN	I		K					K		F
Kucing kuwuk	*Prionailurus bengalensis*	L	LC	II			K						
Luwak	*Paradoxurus hermaphroditus*		LC				CT						
Bird													
Kangkareng perut putih	*Anthracoceros convexus*	L	LC	II									D
Kolibri ninja	*Dicaeum trigonostigma*		LC										D
Cucak hijau	*Chloropsis sonnerati*		LC										D
Sambar kening putih	*Ficedula hyperythra sumatrana*		LC										D
Punai gagak	*Treron sphenurus korthalsi*		LC										D
Berencet kerdil	*Pnoepyga pusilla penida*		LC										D
Ciung-batu Sumatra	*Myophonus melanurus*		LC										D

Local Name	Scientific Name	Conservation Status			Endemic	Location							
		PP 7/1999	IUCN	CITES		Wellpad B	Wellpad E	Wellpad I	Plantation	Wellpad C	Wellpad D	Puyang Lake	Wellpad L, M, N, X
Herpetofauna													
Welang	*Bungarus fasciatus*		LC										D

Source: PT SERD ANDAL Study August 2016

7.5.3 Aquatic Biota

7.5.3.1 Phytoplankton

Result analysis of the phytoplankton taken in the same location of surface water quality samples were presented in the following Table.

Table 38 Phytoplankton Species at the Surface Water

Species Name	Total individual/m^3				
	SW1	SW2	SW3	SW4	SW5
Cyanophyta					
Oscillatoria sp.		714			
Spirulina sp.			714		
Chrysophyta					
Cymbella sp1				1,428	1,428
Cymbella sp2				714	
Fragillaria sp.	1,428	2,142	2,142	1,428	2,856
Gomphonema sp.		714		714	
Gyrosigma sp.	714				
Navicula sp1	714	1,428	714	714	714
Navicula sp2	1,428				
Nitzchia sp.		714		714	714
Pinnularia sp.				714	
Surirella robusta			714		714
Tabellaria sp.	2,856		2,856	1,428	2,142
Chrysophyta (sp)	714		714		
Chlorophyta					
Actinastrum sp.				714	
Pediastrum sp.				3,570	1,428
Spirogyra sp.				714	
Euglenophyta					
Euglena sp.				714	
Trachelomonas sp.				714	
Total individual per m^3	7,854	5,712	7,854	14,280	9,996
Abundance	6	5	6	13	7
Biodiversity Index	2.3685	2.1556	2.2999	3.4414	2.6106
Uniformity Index	0.4637	0.9284	0.8897	0.93	0.9299

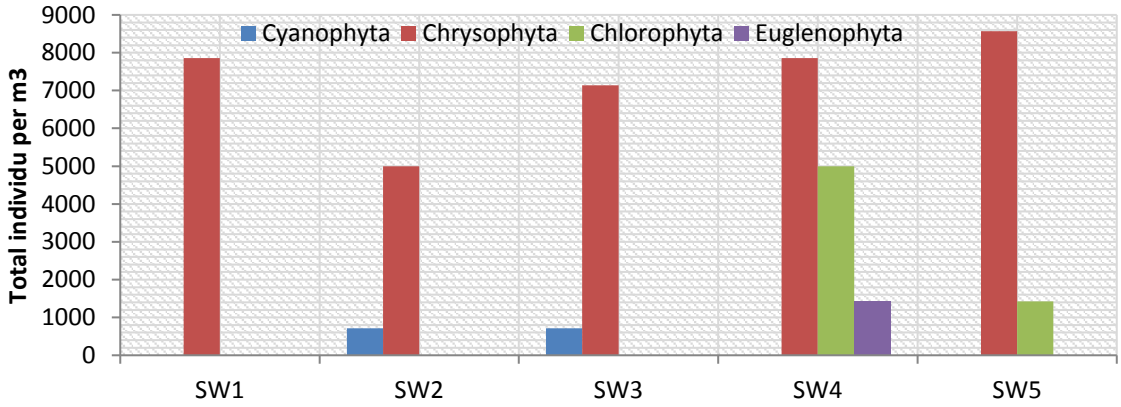
Source: PT SERD ANDAL Study August 2016

The SW-4 sampling point (Deduruk Lake) have the highest number of total individual, taxa and biodiversity index compares to the other sampling points. It shows the Deduruk Lake have the ideal ecosystems condition within the Project Area.

Chrysophyta were found as the taxa which have highest population within the project area. It can be determined that the availability of chrysophyta together with the chlorophyta reflect the low

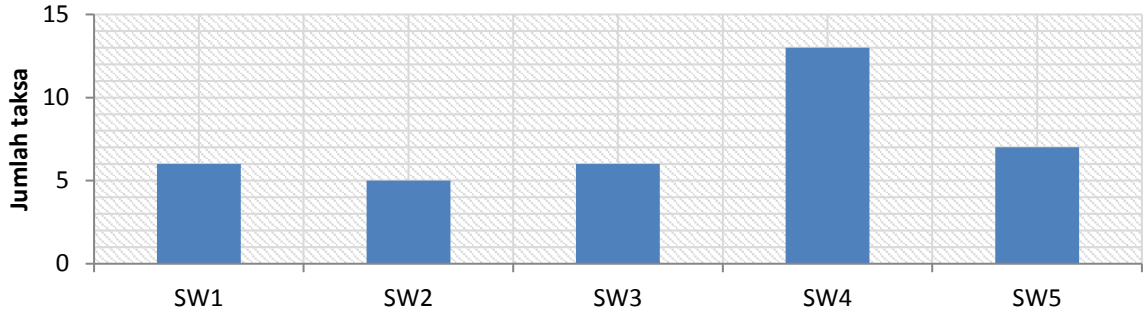
light/sun penetration in the ecosystems. Chrysophyta were also considered as the heterotrophic facultative species or can be survive from organic compound as long as there were supporting ecosystems. This is also supported by the high level of organic compound in the project area which presented by the high level of COD which were higher than the applicable threshold standard.

Generally the phytoplankton level in the project area shows the water body was in the moderate to high level condition.



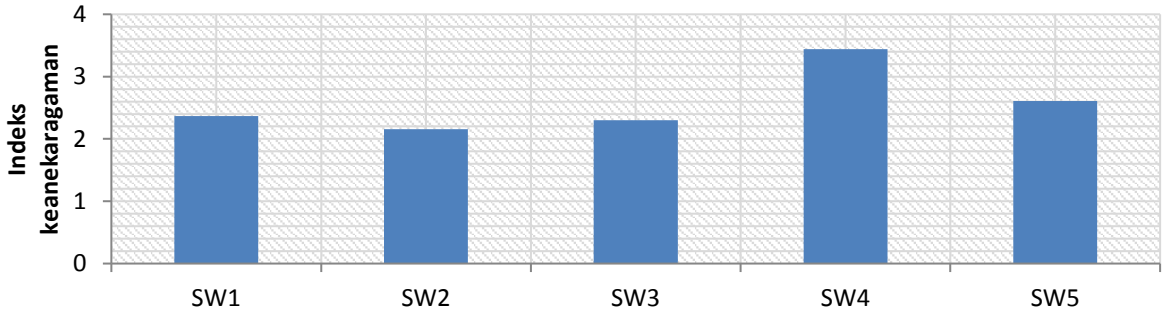
Source: PT SERD ANDAL Study August 2016

Figure 13 The Number of Phytoplankton Individual per m^3 in Each Sampling Point



Source: PT SERD ANDAL Study August 2016

Figure 14 Number of Phytoplankton Species in Each Sampling Location



Source: PT SERD ANDAL Study August 2016

Figure 15 Shannon-Wiener Diversity Index of Phytoplankton in the Sampling Area

7.5.3.2 Zooplankton

Just like the phytoplankton samples, the zooplankton samples were also taken in the same location with the surface water quality sampling points. The result analysis of zooplankton is presented in the following Table.

Table 39 Zooplankton Species at the Surface Water

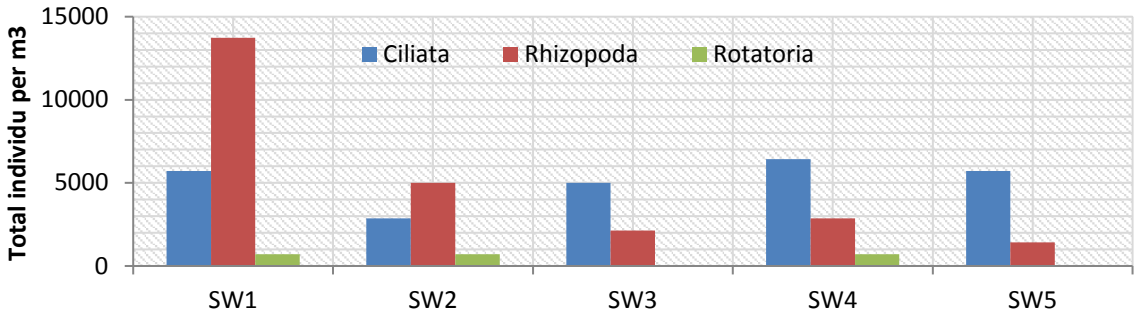
Species name	Total individual/m^3				
	SW1	SW2	SW3	SW4	SW5
Protozoa					
Ciliata					
Colpoda sp.				2,142	1,428
Didinium sp.	4,998	1,428	2,856	2,856	3,570
Glaucoma sp.			1,428	714	
Ciliata (sp)	714	1,428	714	714	714
Rhizopoda					
Arcella discoides	9,448	3,570	1,428	1,428	714
Centropyxis acuriata	2,142	714		714	
Euglypa sp 1	2,142	714		714	
Euglypa sp 2			714		714
Trochelminthes					
Rotatoria					
Monostyla sp		714		714	
Rotatoria (sp)	714				
Total individual per m^3	19,992	8,568	7,140	9,996	7,140
Abundance	6	6	5	8	5
Biodiversity Index	2.0478	2.2842	2.1219	2.7534	1.961
Uniformity Index	*0.7922*	*0.8836*	*0.9139*	*0.9178*	*0.8445*

Source: PT SERD ANDAL Study August 2016

The Cawang Tengah River (SW-3) has the highest zooplankton population or approximately 19,992 individual per m^3. In this location, rhizopoda group has a significant dominant population. The high level of Rhizopoda population generally indicates high level of organic compound in the ecosystems. However, it is not observed a significant COD value differences within the project area which may be caused by the limited availability of niches in the ecosystem.

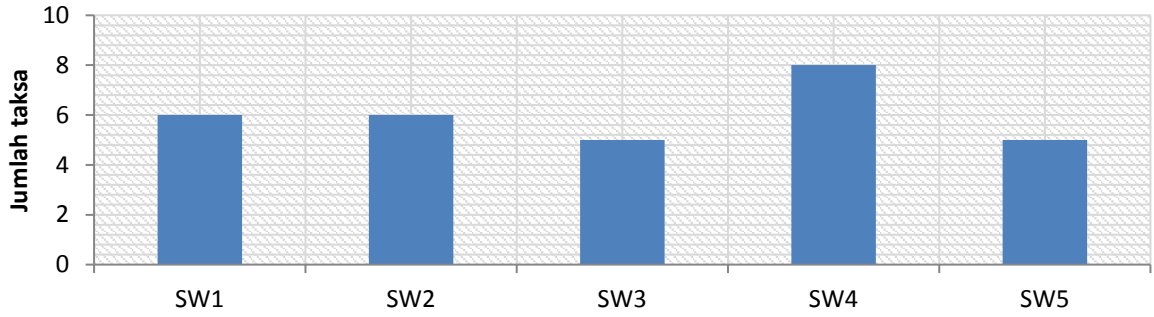
Similarly with the case on phytoplankton, the Deduruk Lake have the highest number of taxa and diversity index within the project area which shows the Deduruk Lake have the most ideal ecosystems compares to the other area within the project area.

Generally the zooplankton level in the surface water was in the moderate to high level condition.



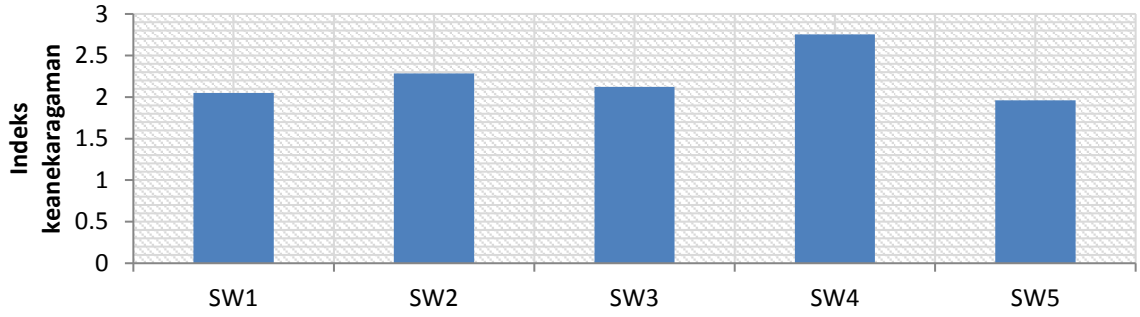
Source: PT SERD ANDAL Study August 2016

Figure 16 The Number of Zooplankton Individual per m^3 in Each Sampling Point



Source: PT SERD ANDAL Study August 2016

Figure 17 Number of Zooplankton Species in Each Sampling Location



Source: PT SERD ANDAL Study August 2016

Figure 18 Shannon-Wiener Diversity Index of Zooplankton in the Sampling Area

7.5.3.3 Benthos

Similar with the phytoplankton and zooplankton sampling areas, the benthos samples were also taken at the same sampling points with the surface water quality. The result analysis of benthos is presented in the following Table.

Table 40 Benthos Species at the Surface Water

Species name	Total individual/m^3				
	SW1	SW2	SW3	SW4	SW5
Arthropoda					
Insecta					
Diptera					
Chironomidae sp.		17		17	
Diptera (sp1 pupa)	34	17	17		17
Diptera (sp2 pupa)				17	
Coleoptera					
Coleoptera (sp1 pupa)	17	17	34	17	
Coleoptera (sp2 pupa)	17				17
Annelida					
Olygochaeta					
Olygochaeta (sp)				68	17
Nemathelminthes					
Nematoda					
Nematoda (sp)		34		85	34
Total individual per m^3	68	85	51	204	85
Abundance	3	4	2	5	4
Biodiversity Index	1.5	1.9219	0.9183	1.9508	1.9219
Uniformity Index	0.9464	0.961	0.9183	0.8402	0.961

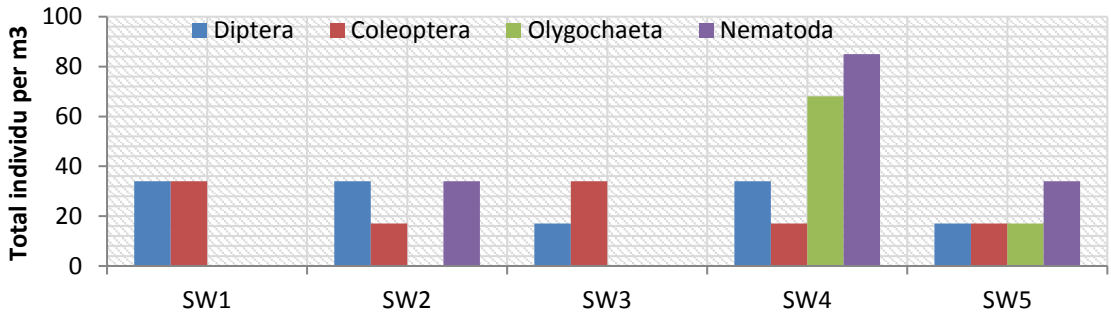
Source: PT SERD ANDAL Study August 2016

The Deduruk Lake (SW-4) have the highest number of benthos within the project areas (204 individual/m^3) which mostly comprise of *olygochaeta* and *nematoda*. It is representing the high level of organic compound in the surface water.

The Deduruk Lake also has the highest number of taxa (5groups) which represent the number of plankton taxa as the food source. The high number of taxa can be used as the indicator of the ecological niches variations.

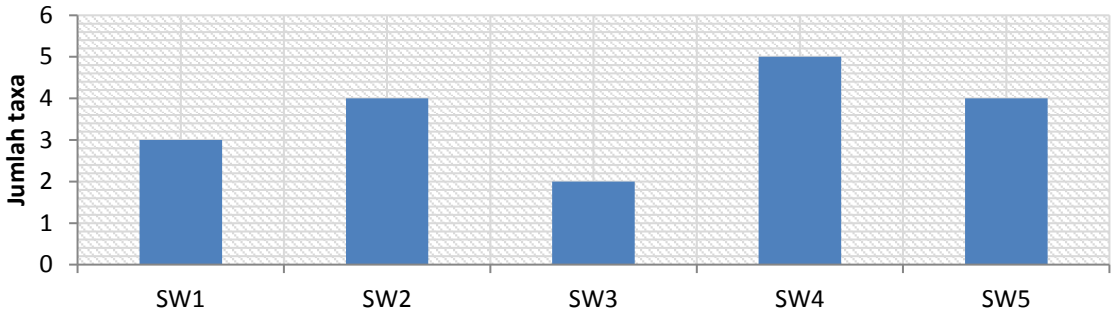
The diversity index at all of the project area were relatively shows the uniform level despite the Asahan River (SW-2). The low benthos community structure can be used as an indicator of the pollutant availability. Benthos is considered as the sensitive bioindicator for pollutant in the surface water sediments.

Generally, the benthos condition in the project area shows the moderate to low benthos level.



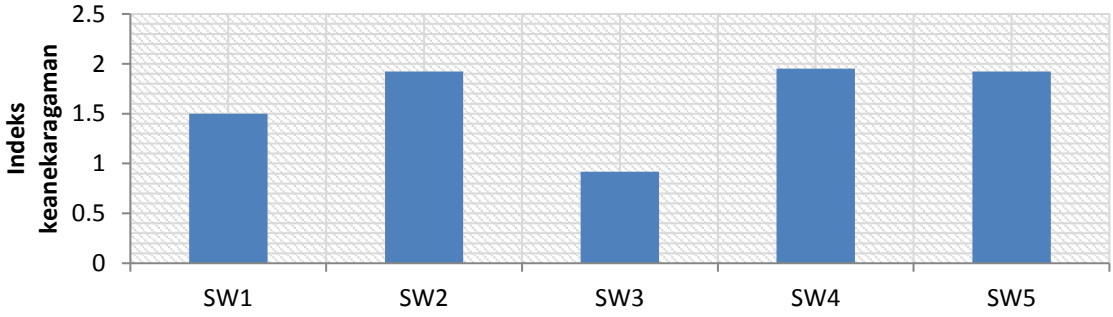
Source: PT SERD ANDAL Study August 2016

Figure 19 The Number of Benthos Individual per m^3 in Each Sampling Point



Source: PT SERD ANDAL Study August 2016

Figure 20 Number of Benthos Species in Each Sampling Location



Source: PT SERD ANDAL Study August 2016

Figure 21 Shannon-Wiener Diversity Index of Benthos in the Sampling Area

7.5.4 Biodiversity Hotspot and Eco-Region

7.5.4.1 Sundaland

Biological diversity in Sundaland is exceptionally high, with the Sundaland Hotspot covering the western half of the Indo-Malayan archipelago, an arc of some 17,000 equatorial islands; moreover, this biodiversity hotspot is dominated by two of the largest islands in the world: Borneo (725,000 km^2) and Sumatra (427,300 km^2).

Lowland rainforests are dominated by the towering trees of the family Dipterocarpaceae. Sandy and rocky coastlines harbor stands of beach forest, while muddy shores are lined with mangrove forests, replaced inland by large peat swamp forests. In some places, ancient uplifted coral reefs support specialized forests tolerant of the high levels of calcium and magnesium in these soils. Infertile tertiary sandstone ridges support heath forest. Higher elevations boast montane forests thick with moss, lichens, and orchids, while further up, scrubby subalpine forests are dominated by rhododendrons. At the very tops of the highest mountain peaks, the land is mostly rocky and without much vegetation.

Sundaland is one of the biologically richest hotspots on Earth, holding about 25,000 species of vascular plants, 15,000 (60%) of which are found nowhere else. One plant family, the Scyphostegiaceae, is confined to the hotspots and is represented by a single tree species, *Scyphostegia borneensis* from Borneo. There are at least 117 endemic plant genera in the hotspot; 59 of these endemic genera are found in Borneo, 17 in Sumatra, and 41 on the Malay Peninsula.

Borneo has about 3,000 species of trees, including more than 265 species of dipterocarps; no less than 155 of these are endemic to the island. Borneo also has more than 2,000 species of orchids.

Notable plants in the hotspot include members of the genus *Rafflesia*, represented by 16 species with very large flowers. One of these, *Rafflesia arnoldii*, has the largest flowers in the world, measuring up to one meter in diameter.

Birds - Of the approximately 770 bird species that regularly occur in Sundaland, nearly 150 are endemic; around 40 of these endemic species are threatened. Borneo alone supports nearly 30 endemic species, most of which are montane species. As such, the Bornean Mountains, with 20 species confined to this EBA, are considered one of five Endemic Bird Areas (EBAs) recognized by BirdLife International in this hotspot.

Mammals - Of Sundaland's more than 380 mammal species, over 170 are endemic to the hotspot. In addition, 17 of 136 genera are endemic. Borneo boasts the most endemic mammal species of any island in the hotspot, with over 25 species found nowhere else.

Of all of Sundaland's diverse and threatened species, the best symbols of the vital need for conservation in the hotspot are its large mammals. The best known of these are the orangutans, represented by two species: the Bornean (*Pongo pygmaeus*, EN), and the Sumatran (Pongo abelii, CR), the latter of which had an estimated 3500 individuals surviving in the wild in Sumatra at the end of 2002. Orang-utans, which mature slowly and have a low reproductive rate, are threatened by habitat loss due to logging, fires, and agricultural conversion. Once reduced, their populations can take many years to recover.

Other famous flagships include the Proboscis monkey (*Nasalis larvatus*, EN), found only on Borneo.

Reptiles - Reptile endemism is impressive in Sundaland. There are over 450 species of reptiles, roughly 250 of which are endemic, including 24 genera. There are also three endemic reptile families: two snake families, Anomochilidae and Xenophidiidae, and the monotypic Lanthanotidae, represented by the very rare and little known Bornean earless monitor lizard (*Lanthanotus borneensis*), a remnant of ancient fauna in the region. One of the most distinctive reptiles in the hotspot is the endemic false gharial (*Tomistoma schlegelii*, EN), a freshwater crocodilian species that can grow up to 4.7 meters in length and is found mostly in Sumatra and Borneo. Other threatened reptiles include two species of large river terrapins: the mangrove terrapin (Batagur baska, CR) and

the painted terrapin (*Callagur borneoensis*, CR). Both species inhabit creeks and estuaries and have been extirpated from large portions of their range. The hotspot is also home to several Endangered and Vulnerable species of tortoises and freshwater turtles.

Amphibians - The Sundaland hotspot is home to more than 240 species of amphibians, nearly 200 of which are endemic. Seven genera are endemic, including the slender toads (Leptophryne, comprising two species), and three with single species: Pseudobufo, Phrynella, and Gastrophrynoides. The amphibian fauna of Sundaland remains extremely poorly known, and Sumatra, in particular, represents a very high research priority.

Freshwater fishes - Nearly 200 species of fish have been discovered in the rivers, lakes and swamps of Sundaland in just the last decade. There are currently about 1000 known species of freshwater fish in the hotspots (out of a projected 1400), more than a quarter of which are restricted to one or more of the main islands. Once again, Borneo tops the list, with about 430 species, more than 160 of which are endemic. One of the best known fish species in the hotspot is the dramatic Asian bony tongue or golden arowana (*Scleropages formosus*, EN), a highly prized aquarium fish that can sell for thousands of dollars per animal.

7.5.4.2 Sumatran Montane Rain Forest

Project boundary of PT SERD spans over one eco-region, the Sumatran montane rain forests.

This ecoregion represents the montane forests (>1,000 m) along the Barisan Mountain Range of Sumatra. This region is located in the western part of the island of Sumatra, and rows of active mountains, ranging from Aceh to Lampung Province.

Climate: Based on the Köppen climate zone system, Sumatra falls in the tropical wet climate zone (National Geographic Society 1999). The montane rain forests of the Barisan Range receive more rainfall on their western slopes than their eastern slopes, which are in a rain shadow. However, most of Sumatra experiences less than three consecutive months of dry weather (less than 100 mm rainfall/month), and rainfall in the montane rain forests averages more than 2,500 mm/year (Whitten *et al*. 2000).

Sumatra's montane rain forests can be separated into three major forest zones: lower montane forest, upper montane forest, and sub-alpine forest. Temperature and cloud level are the major factors determining these forest zones. The lower montane zone forests are similar to lowland rain forests but begin to get smaller. The canopy height typically is no more than 35 m high. Emergents may extend to 45 m, but buttresses are rare. Lianas usually are absent, and epiphytes such as orchid begin to increase in abundance. The upper montane zone sharply changes from lowland rain forests. The canopy becomes even and rarely exceeds 20 m. Emergents may extend to 25 m, but buttresses usually are absent. Trees rarely have compound leaves or lianas. Orchids and other epiphytes such as moss, lichen, and liverworts are very common. Beyond this forest lies the sub-alpine forest, a complex of grass, heath, and bog areas. Small, stunted trees may reach 10 m high, orchids become very rare, but moss, lichen, and liverworts are very abundant (Whitten *et al*. 2000).

Vegetation: The montane flora of Sumatra originates from two sources: local sources (autochthonous) and areas that have a center of origin outside of Sumatra (allochthonous). The local source can be divided into two categories: species that are characteristic of lowland rain forest, such as Dipterocarpaceae, Bombacaceae, and the genus Ficus (figs), and those that have a large global latitudinal distribution such as pines, Cruciferae (e.g., mustard), Theaceae (e.g., tea), and tree ferns.

The allochthonous flora belongs to genera whose species are found only in cold climates, not near equatorial rain forests. These species in the tropics are never found below 1,000 m and usually dominate the sub-alpine flora. Genera include Rhododendron, the pretty herbs Gentiana, and grass Deschampsia. Most of these species dispersed from Asia or Australia during cooler glacial periods when the Sunda region was a single landmass. Forest zones were all 350-400 m lower than their present height, providing numerous stepping stones (Steenis 1950).

The characteristic vegetation in lower montane forests changes from Dipterocarpaceae, the dominant lowland family, to Fagaceae (oaks) and Lauraceae (laurels). Lithocarpus, Quercus, and Castanea are common genera in the Fagaceae family, and Cinnamomum burmansea, Persea americana, and Litsea spp. are common Lauraceae species. Other families common to the lower montane region include Cunoniaceae, Monimiaceae, Magnoliaceae, and Hamamelidaceae (FAO 1981; Whitten *et al*. 2000). Tree ferns in the genus Cyathea are also common in the lower montane forests. The upper montane forest is characterized by conifers (pines and related trees), particularly by the Ericaceae (Rhododendron, Vaccinium) and Myrtaceae (Eucalyptus, Melaleuca) families. Dacrycarpus imbricatus and Leptospermum flavescens are also abundant in these forests, which because of their smaller stature are called elfin forests. Lichens are common to the drier parts of this zone, whereas mosses and liverworts are common in the moister parts of this zone that coincide with where clouds form and are commonly called cloud or moss forests. The sub-alpine zone is characterized by smaller specimens of the montane forest. There is also an increased abundance of grasses (Agrostis and Festuca), rushes and sedges (Juncus, Carex, Scirpus, and Cyperus), and small, colorful herbs (Whitten *et al*. 2000).

Five of the sixteen species of the parasitic Rafflesia plant are found in Sumatra and have been recorded as high as 1,800 m on Mt. Lembuh, Aceh province. *Rafflesia arnoldi*i, which produces the largest flower in the world, is found in this ecoregion. Its large brown-orange and white flowers can reach 1 m in diameter. Rafflesia have no leaves, instead deriving all their energy from the tissues of its host, the ground vine Tetrastigma. Large buds emerge from the vine and have five large, flowery petals surrounding spikes, which smell like rotting meat and attract pollinating insects (Whitten *et al*. 2000; MacKinnon 1986).

Steep slope montane rain forest ecosystem

Shrub on accessed area

Vegetation types on top of the hill

Source: PT SERD Biodiversity Action Plan 2016

Figure 22 Montane Rain Forests in Project area

7.5.5 Bukit Barisan Selatan National Park (BBSNP)

BBSNP is located within the vicinity of the project location by 27.3 km. This national park is not only licensed as a conservation area by the Indonesian government, but also listed as a World Heritage Site, IUCN Protected Area Categories II, Key Biodiversity Area, and Important Bird Area (IBA).

Bukit Barisan Selatan area was declared as Wildlife Sanctuary in 1935, and become a National Park in 1982. Initially the size of the park was 356,800 hectares. But actual current park area calculated using GIS is approximately 324,000 Ha.

BBSNP is located on the tip of the south-west region of Sumatra. Seventy percent of the park (249,552 hectares) falls under the administration Lampung Barat and Tanggamus Regencies, both are part of Lampung Province. The rest of the park covers 74,822 hectares (23% of total park area) is in the Kaur District of the Bengkulu province. Sumatra Selatan is also important for the park borders overlaps with province's border.

BBSNP contains some of Sumatra's last protected lowland forests. It is extremely rich in biodiversity and is home to three of the world's most endangered species: the Sumatran elephant (fewer than 2000 survive today), the Sumatran rhino (total global population: 300 animals and declining rapidly), and the Sumatran tiger (total global population around 400 animals).

7.5.6 Tropical Rainforest Heritage of Sumatra

The 2.5 million hectares Tropical Rainforest Heritage of Sumatra site comprises three national parks: Gunung Leuser National Park, Kerinci Seblat National Park, and Bukit Barisan Selatan National Park. The site is located at the edge of KSNP on the Bukit Barisan range and holds the greatest potential for long-term conservation of the diverse biota of Sumatra, including many endangered species.

7.5.7 Endemic Bird Area (EBA)

The Sumatra and Peninsular Malaysia area is a notable EBA within the Southeast Asia region. EBA includes mountains on the Indonesian island of Sumatra (in the provinces of Aceh, Sumatra Utara, Sumatra Barat, Jambi, Bengkulu, Sumatra Selatan and Lampung) and in Peninsular Malaysia. The Barisan range runs the entire length of western Sumatra, and has several peaks of over 3,000.

The mountains of Sumatra and Peninsular Malaysia are defined as comprising a single EBA because they share more restricted-range species than are endemic to the mountains of Peninsular Malaysia alone. Of the 20 species confined to this EBA, 14 are endemic to Sumatra and two to Peninsular Malaysia, and four are shared, including the monotypic endemic genus Psilopogon. This EBA has affinities with the other Greater Sunda montane EBAs, sharing 12 restricted-range species with the Javan and Bali forests (EBA 160), and five with the Bornean Mountains (EBA 157).

The mountains of Peninsular Malaysia are relatively well known ornithologically (e.g. Medway and Wells 1976, Yatim 1993), but those of Sumatra are less well studied (see van Marle and Voous 1988, Holmes 1996) and much remains to be learned about the habitat requirements and distributions of that island's restricted-range species. All are primarily forest birds, but there is some variation in their altitudinal distribution. Several species appear to be particularly associated with hill dipterocarp and lower montane forest, notably *Rheinardia ocellata* (restricted within this EBA to hill dipterocarp forest in Peninsular Malaysia), *Treron oxyura, Carpococcyx viridis, Batrachostomus poliolophus, Pitta venusta, Pycnonotus leucogrammicus, P. tympanistrigus, P. nieuwenhuisii* (considered to be a lowland-forest-slope specialist by Wells 1985), *Chloropsis venusta, Garrulax lugubris, Napothera marmorata* and *Dicrurus sumatranus*.

Several species appear to be localized in their distribution on Sumatra, including *Lophura hoogerwerfi*, which is known only from the northern Barisan range, and *L. inornata* and *Carpococcyx viridis*, which have only been recorded in the southern Barisan range.

7.5.8 Important Bird Area (IBA)

BBSNP is important habitat for Sumatran mountain species birds. Eight species of bird became the trigger species for this Important Bird Area as presented in the following Table.

Table 41 Populations of IBA Trigger Species

Species	Season	Period	Population Estimate	IBA Criteria	IUCN Category
Asarcornis scutulata White-winged duck	resident	2004	present	A1	Endangered
Mycteria cinerea Milky stork	resident	2004	present	A1	Endangered
Leptoptilos javanicus Lesser adjutant	resident	2004	present	A1	Vulnerable
Nisaetus nanus	resident	2004	present	A1	Vulnerable

Species	Season	Period	Population Estimate	IBA Criteria	IUCN Category
Wallace's hawk eagle					
Treron capellei Large green pigeon	resident	2004	present	A1	Vulnerable
Apalharpactes reinwardtii Javan trogon	resident	2004	present	A1	Vulnerable
Alcedo euryzona	resident	2004	present	A1	Not recognized
Pitta venusta Graceful pitta	resident	2004	present	A1	Vulnerable

Sources: www.birdlife.org

An IBA criteria A1 site is known or thought regularly to hold significant numbers of a globally threatened species, or other species of global conservation concern. A site qualifies if it is known, estimated or thought to hold a population of a species categorized by the IUCN Red List as Critically Endangered, Endangered, or Vulnerable. In general, the regular presence of a Critical or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection. Thresholds are set regionally, often on a species by species basis. The site may also qualify if holds more than threshold numbers of other species of global conservation concern in the Near Threatened, Data Deficient and, formerly, in the no-longer recognized Conservation Dependent categories. Again, thresholds are set regionally.

7.6 Social and Cultural Sphere

7.6.1 Project Affected People and Communities

While the project footprint crosses two regencies (Lahat, Muara Enim) and one city district (Kota Pagar Alam); the nearby communities affected by the project are located in Lahat and Muara Enim Regencies only while the Kota Pagar Alam part of the project footprint lies within Protection Forest area that is not used by any of the communities.

The communities and people affected by the project can be summarized as living mainly in four different locations (Table 42~~Table 42~~, Map 13~~Map 13~~):

1. At project location and reaching to the east of the project: Village Segamit and its hamlets, administratively part of Kecamatan Semende Darat Ulu.

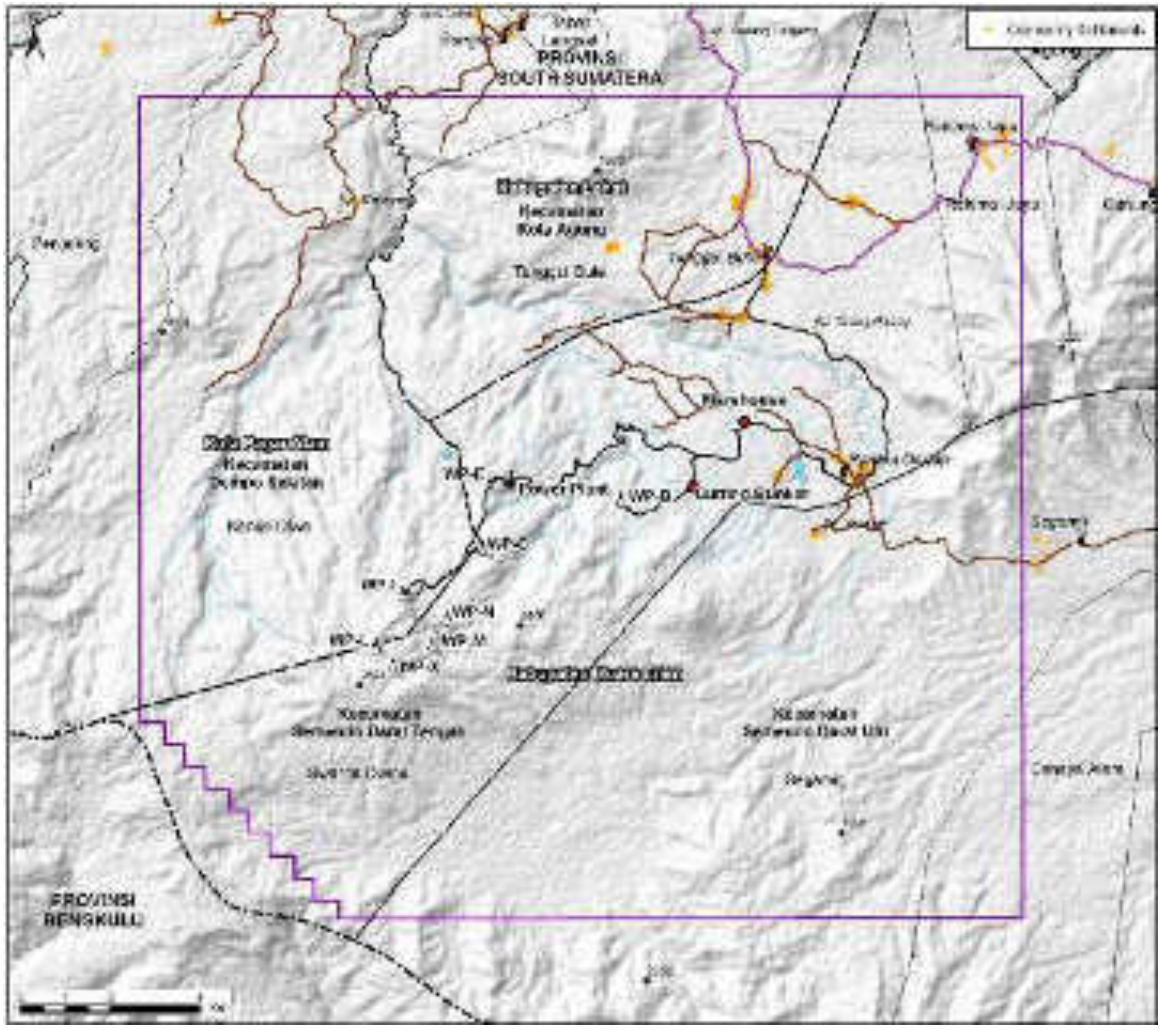
2. To the immediate north of the project location on the main road towards Kota Agung: Tunggul Bute and its hamlets/sub-village, administratively part of Kecamatan Kota Agung.

3. Further to the north, towards the town of Kota Agung: the villages Karang Endah, Lawang Agung and Sukarame, which belong administratively to Kecamatan Kota Agung.

4. To the southwest, the project area lies on the village administration of Penjalang, and its hamlet Meringang Lama.

Table 42 Project Affected Communities

Location No	(Desa/Dusun)	Affected Dusun (sub-villages)	Kecamatan	Kabupaten/Kota
1	Segamit Village	Yayasan (aka Rantau Dedap)* Segamit Talang Jawa Gunung Gajah	Semende Darat Ulu (SDU)	Muara Enim
2	Tunggul Bute Village	Tunggul Bute Padang Panjang Talang Pisang Selepah	Kota Agung	Lahat
3	Karang Endah Village Lawang Agung Village Sukarame Village (or Suka Rame)		Kota Agung	Lahat
4	Penjalang Village	Meringang Lama	Dempo Selatan	Pagar Alam



Map 13 Location of Affected Communities

The following section describes the social data for these communities to gain a better understanding of the baseline conditions.

7.6.2 Population Size, Growth and Distribution, Age Groups and Gender

Population, gender and density in the 5 affected villages are presented in Table 43 and Table 44**.** Both regencies are relatively sparsely populated and so are the kecamatan. Tunggul Bute on the other hand appears to be the most densely populated of all the affected villages (similar to the township of Kota Agung), followed by Sukarame and Segamit. Gender Ratios as generally slightly higher than 100, meaning there are more men than women, in particular in Karang Endah which may be an indication of the mining activities in the region. In total the 5 affected villages have a population of 6,512 people. Penjalang and Segamit Villages have the biggest area with 47km^2 and 26km^2 respectively, while the area of each other project affected village is less than 10 km^2.

Table 43 Population, Gender Ratio and Density in the 5 Affected Villages with Regional Level and nearby Town

No	Village/Kecamatan /Kabupaten	Population (People)			Gender Ratio	Area (km^2)	Density (People/km^2)
		Male	Female	Total			
1	Tunggul Bute	792	793	1,585	100	4.74	334
2	Karang Endah	197	178	375	111	7.47	50
3	Lawang Agung	297	274	571	108	7.30	78
4	Suka Rame	483	473	956	102	6.43	149
	Kota Agung	1,035	950	1,985	109	5.88	338
	Kecamatan Kota Agung	6,609	6,146	12,755	108	166	77
	Kabupaten Lahat	**200,689**	**187,442**	**393,235**	**107**	**4,361**	**91**
5	Segamit	1,513	1,512	3,025	100	26	117
	Kecamatan Semende Ulu Darat	8,190	8,213	16,403	99	427	38
	Kabupaten Muara Enim	**300,519**	**290,456**	**590,975**	**103**	**7,483**	**79**
6	Penjalang			2,384		47	50
	Kecamatan Dempo Selatan			11,378		218	
	Kota Pagar Alam						
	Total Project Affected Population			**8,791**			

Source: Kota Agung in Figures 2016, Muara Enim in Figure (BPS Kabupaten Muara Enim, 2016), Lahat in Figure (BPS Kabupaten Lahat, 2016), ISDP report, 2015.

Table 44 Population and Area Distribution of the 5 Projected Affected Villages

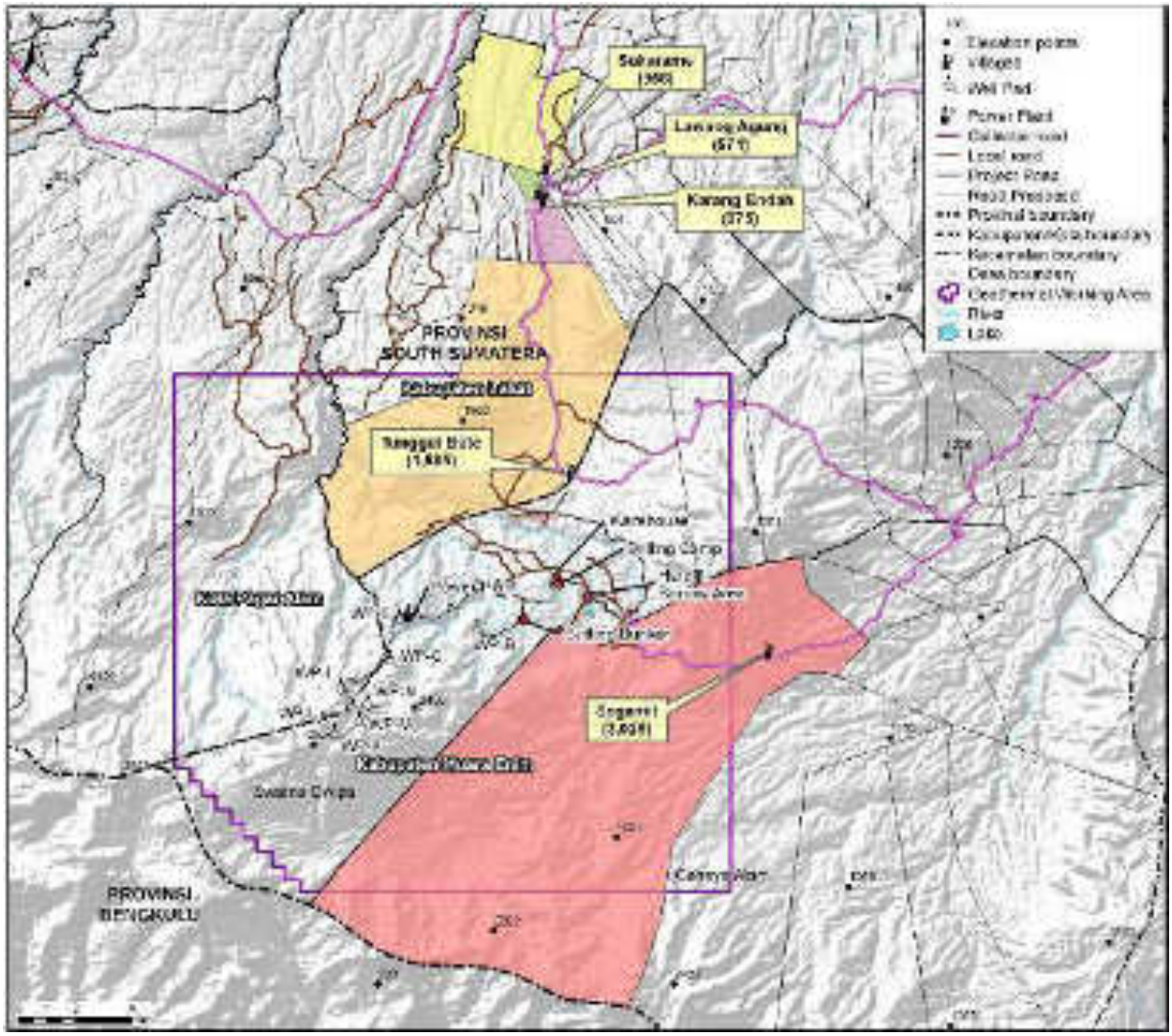
No	Village/Kec. /Kab.	Total Population	Area (km^2)	Distribution (%Area of Total) Kecamatan Level	Distribution (%Pop of Total) Kecamatan Level	Distribution (%Area of Total) Kabupaten Level	Distribution (%Pop of Total) Kabupaten Level
1	Tunggul Bute	1,585	4.74	3%	12%	0.1%	0.4%
2	Karang Endah	375	7.47	5%	3%	0.2%	0.1%

No	Village/Kec. /Kab.	Total Population	Area (km^2)	Distribution (%Area of Total) Kecamatan Level	Distribution (%Pop of Total) Kecamatan Level	Distribution (%Area of Total) Kabupaten Level	Distribution (%Pop of Total) Kabupaten Level
3	Lawang Agung	571	7.3	4%	4%	0.2%	0.1%
4	Suka Rame	956	6.43	4%	7%	0.1%	0.2%
	Kota Agung	*1,985*	*5.88*	*4%*	*16%*	*0.1%*	*0.5%*
	Kec. Kota Agung	*12,755*	*166*	*100%*	*100%*	*3.8%*	*3.2%*
	Lahat	***393,235***	***4,361***	*na*	*na*	*100%*	*100%*
5	Segamit	3,025	26	6%	18%	0.3%	0.5%
	Kec. SDU	*16,403*	*427*	*100%*	*100%*	*5.7%*	*2.8%*
	Muara Enim	***590,975***	***7,483***	*na*	*na*	*100%*	*100%*
6	Penjalang						
	Kecamatan Dempo Selatan						
	Kota Pagar Alam						

Source: Kota Agung in Figures 2016, Muara Enim in Figure (BPS Kabupaten Muara Enim, 2016), Lahat in Figure (BPS Kabupaten Lahat, 2016)

Comparison to total population at Kecamatan Level and Kabupaten Level shows, that the respective villages occupy an area below 10% while population in Tunggul Bute represents 12% of total Kecamatan population, similar to that of Kota Agung Town (Map 14~~Map 14~~).

Population growth numbers are only available at the regional level and for Lahat only total population was available (Figure 24). The Lahat population has grown quite rapidly by on average 6% while the Muara Enim population has grown more slowly at an average of 1.6% over the three years.



Map 14 Population Distribution of the Area and location of the 5 project affected villages

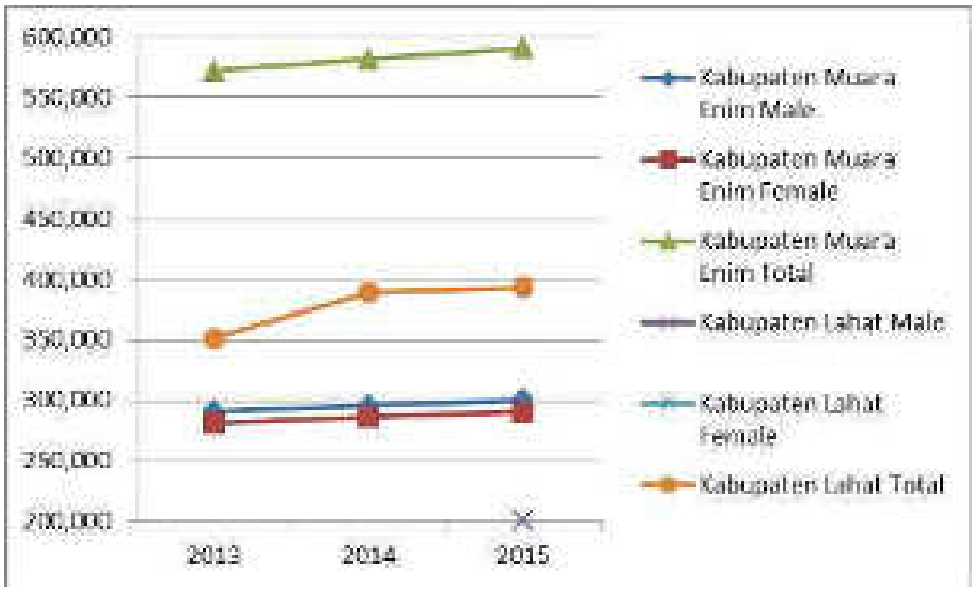


Figure 23 Population Growth, Kabupaten Muara Enim and Lahat, 2012-2014

The following tables show age group and gender composition as well as dependency ratios for each kecamatan. The working age group is quite large in Semende Darat Ulu, the youth an average of around a quarter to a third of the total population, while the old make up less than 5%. In total, dependency in Semende Darat Ulu is quite low at 37%, while that of the Kota Agung population is higher with a total of 54%.

Table 45 Population Composition according to Age Group and Gender, Kecamatan Semende Darat Ulu and Kota Agung, 2015

Age Group	Semende Darat Ulu			Kota Agung		
	Male	Female	Total	Male	Female	Total
0-4	508	493	1,001	645	592	1,237
5-9	672	649	1,320	607	624	1,231
10-14	696	682	1,378	652	576	1,228
15-19	762	756	1,517	522	423	945
20-24	835	854	1,690	467	359	826
25-29	893	904	1,796	554	486	1,040
30-34	786	797	1,583	574	523	1,097
35-39	680	690	1,370	547	472	1,019
40-44	573	575	1,148	403	432	835
45-49	491	501	992	397	359	756
50-54	410	411	820	361	363	724
55-59	311	304	615	277	268	545
60-64	221	214	435	203	197	400
65-69	123	131	254	139	146	285
70-74	106	115	221	86	103	189
75+	123	140	262	103	158	261
Total	***8,190***	***8,214***	***16,403***	**6,537**	**6,081**	**12,618**

Source: Semende Darat Ulu in Figures, 2016; Kota Agung in Figures, 2016

Table 46 Percentage Age Group Composition and Dependency Ratio, Kecamatan Semende Darat Ulu and Kota Agung, 2015

Age Group/ % Composition	Semende Darat Ulu			Kota Agung		
	Male	Female	Total	Male	Female	Total
Youth	23%	22%	23%	29%	29%	29%
Working Age	73%	73%	73%	66%	64%	65%
Old	4%	5%	4%	5%	7%	6%
Total	100%	100%	100%	100%	100%	100%
Dependency Ratio	37%	37%	37%	52%	57%	54%

The population pyramids of both kecamatan (Figure 25) still show population growth with a relatively larger young population than the older, although in Semende Darat Ulu that trend is clearly declining for the under 25 years old and in Kota Agung, the shape indicates a slower population growth.

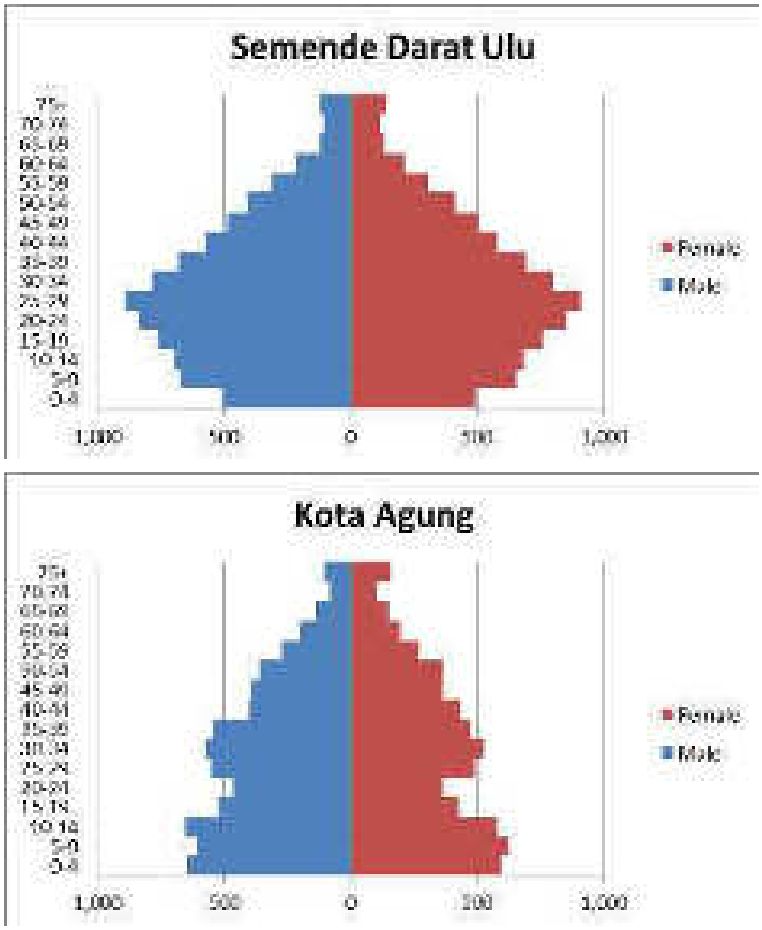


Figure 24 Population Pyramids, Semende Darat Ulu and Kota Agung, 2015

7.6.3 Economic Profile

The economy of the area is primarily based on the mining and extraction and agricultural sectors (Table 47 and Table 48**)**. In Muara Enim the mining an extraction sector makes up more than half of the total economy while in Lahat its share is around a third. All sectors have been more or less constant in terms of share they contribute to the local economy in the last couple of years. The electricity and gas sector are an insignificant contributor to both local economies with less than 1%. The per capita share in Muara Enim is around double that of Lahat and about the same as the average for Indonesia (IDR 45 million in 2015).

Table 47 Lahat Economy by Sector (constant, in billions IDR)

Activities/business Sector	2013	2014	2015	2015 (%)
Agriculture, Forestry and Fisheries	2,331	2,424	2,509	24%
Mining and Extraction	3,783	3,827	3,814	36%
Processing Industry	378	399	420	4.0%
Electricity and Gas Services	25	28	28	0.27%
Water, Waste and Recycle Services	3	3	3	0.03%
Construction	825	859	860	8.2%
Trading	1,027	1,094	1,111	11%
Transportation	91	97	106	1.0%
Accommodation and Restaurant Services	86	91	99	0.94%

Activities/business Sector	2013	2014	2015	2015 (%)
Information and Communication	89	96	103	1.0%
Financial Services	165	172	177	1.7%
Real Estate	233	249	264	2.5%
Company Services	4	4	5	0.05%
Governmental Administration	519	550	592	5.6%
Education Services	256	294	312	3.0%
Health and Social Services	72	78	83	0.79%
Other Services	50	52	53	0.50%
Total	**9,937**	**10,318**	**10,538**	100%
Per Capita GDP (in million IDR)	***28.3***	***26.5***	***26.8***	

Source: Lahat in Figures 2016

Table 48 Muara Enim Economy by Sector (constant, in billions IDR)

Activities/business Sector	2012	2013	2014	2014 (%)
Agriculture, Forestry and Fisheries	3,472	3,615	3,766	13%
Mining and Extraction	14,892	16,337	16,724	57%
Processing Industry	3,414	3,622	3,598	12%
Electricity and Gas Services	22	25	27	0.09%
Water, Waste and Recycle Services	6	6	6	0.02%
Construction	1,366	1,495	1,504	5.2%
Trading	1,278	1,394	1,504	5.2%
Transportation		258	278	0.95%
Accommodation and Restaurant Services	102	112	119	0.41%
Information and Communication	173	191	207	0.71%
Financial Services	163	183	191	0.65%
Real Estate	-	225	248	0.85%
Company Services	3	4	4	0.01%
Governmental Administration	497	443	459	1.6%
Education Services	322	355	434	1.5%
Health and Social Services	100	113	123	0.42%
Total	**25,810**	**28,378**	**29,192**	100%
Per Capita GDP (in million IDR)	***45.1***	***48.8***	***49.4***	

Source: Muara Enim in Figures 2016

7.6.4 Employment

The workforce is defined as the population group that is 15-64 years old that can produce goods and services. However, not all are participating in the local economy and earning a living. According to regency statistics, workforce participation in Muara Enim and Lahat is around 70%, with the male workforce slight higher than the female as one would expect. Unemployment levels are in both regencies around 5% (Table 49**)**.

The available workforce in Kota Agung in 2015 is 8,187 people (or 65% from the total Population). In SDU, the available workforce is 11,966 people (or 73% of the total population). Details on employment were not available at the time of investigation.

Table 49 Workforce Employment and Unemployment in Muara Enim and Lahat District, 2015

Main Activities	Muara Enim			Lahat		
	Male	Female	Total	Male	Female	Total
Laborforce	-	-	371,248	123,350	83,024	206,374
Working	-	-	350,439	118,372	79,219	197,591
Unemployment	-	-	20,809	4,978	3,805	8,783
Nor-laborforce	-	-	158,658	19,986	54,763	74,749
Attend School/college	-	-	51,641	-	-	-
House keeper	-	-	73,979	-	-	-
Other	-	-	33,038	-	-	-
TOTAL	-	-	529,906	143,336	137,787	281,123
Workforce Participation	-	-	70.1%	86.1%	60.3%	73.4%
Unemployment Level	-	-	5.9%	4.2%	4.8%	4.4%

Source: Muara Enim in Figures 2016; Lahat in Figures 2016

7.6.5 Livelihoods

There are a wide range of livelihoods in the project area as shown in Table 50. Farming is however by far the main occupation, mainly focused on agricultural crops, plantations, livestock and fisheries. Coffee has become a dominant plantation crop. Rubber, coconut, pepper, clove, oil palm, candlenut and cacao are also common crops. Average area that a farmer cultivates ranges between 0.5 to 3 hectares.

The main income also comes from coffee plantations. Main harvesting season for coffee is the month of August, when all other activities become secondary. Coffee prices in July 2016 ranged between IDR 16,000 and 20,000 per kg based on the quality of the coffee beans. Manually harvested coffee in general got better prices than the machine-harvested ones.

Table 50 Type of Livelihood Activities, Kecamatan Semende Darat Ulu, 2015

Type of Activities	Population	Population (%)
Farming	6,951	93.4%
Trader	223	3.0%
Civil Worker/Army/Police	136	1.8%
Private Company Employee	51	0.7%
Retired	34	0.5%
Entrepreneur	39	0.5%
Paramedic	7	0.1%
Total	**7,441**	**100%**

Source: SDU in Figure 2016

The ISDP report, a study undertaken by Inti Hexa Semesta in 2015, found that in the project affected villages, livelihoods are similar (Table 51). Of the 122 people interviewed in five of the six project affected villages, 85% are farmers who work in their own plantation or as farm workers on another plantation. The remaining people were working as traders or in the services sector.

The main income also comes from coffee plantations. Coffee is more promising according to the farmers compared to rice. Prices for coffee sold wet was around IDR 9,000, while the price for dry coffee ranged between IDR 16,000 and 20,000 per kg based on the quality of the coffee beans. Manually harvested coffee in general got better prices than the machine-harvested ones. Main harvesting season for coffee is the month of August, when all other activities become secondary. In all of the villages, a potential for diversification of agricultural production was identified. Training related to agricultural activities, such as coffee and other crops was perceived as most preferred, in particular cultivation techniques and marketing of coffee (SDP report, 2015). Other trainings that communities were interested in were fish farming and animal husbandry.

Table 51 Main livelihood in Project Affected Villages

Village	Farmers %, main crop cultivated	Traders/Employees %	Work for PT SERD
Segamit	90% coffee	10%	40 people (2014)
Tunggul Bute	90%, coffee	10%	
Karang Endah	70%, rice and coffee	30%	5 people (2014)
Lawang Agung	90%, rice and coffee	10%	5 people (2014)
Sukarame	70%, coffee farmers	30%	5 people (2014)
Penjalang	n/a		

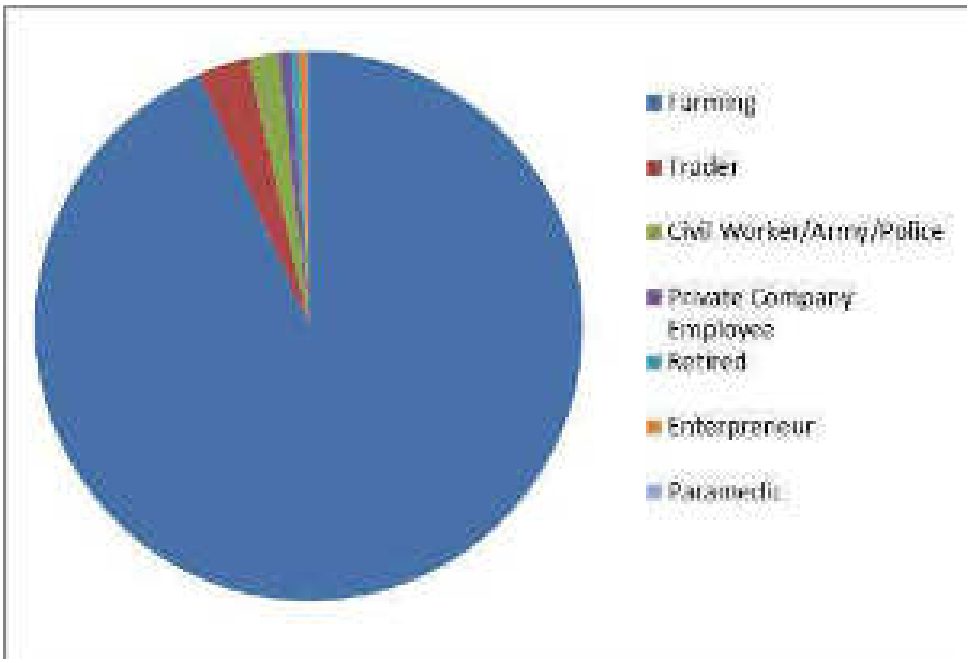


Figure 25 Livelihoods of Communities in Semende Darat Ulu, 2011

Most farmers have other work or a business going next to farming. The types of businesses recorded in Table 51 give an indication as to what type of other livelihood activities they engage in. The majority of the listed businesses in Kecamatan Kota Agung are small shops/stalls or warung. The smaller part consists of diners, groceries stores, and the craft, wood, apparel and food and beverages industries.

Table 52 Type of Business recorded in Kecamatan Kota Agung, 2015

Type of Business/Activities	Total Number
Warung	194
Diner/Restaurant	10
Groceries Stores	10
Workshop	9
Craft Industries	4
Wood Industries	4
Food & Beverages Industries	4
Apparel Industries	2
Total	**237**

Source: Kota Agung in Figures 2016

Income levels ranges between less than Rp 750,000 per month or more than Rp 2 million, though most people either earn less than Rp 750,000 or between Rp 1.5 to Rp 1.75 million per month as a field study in 2015 with 50 respondents (Figure 27). These income levels are similar to those recorded in the ISDP study. The ISDP report also notes that income from farming is low and that with little money to put aside for savings and investment and relatively low education level there is little capacity for economic growth.

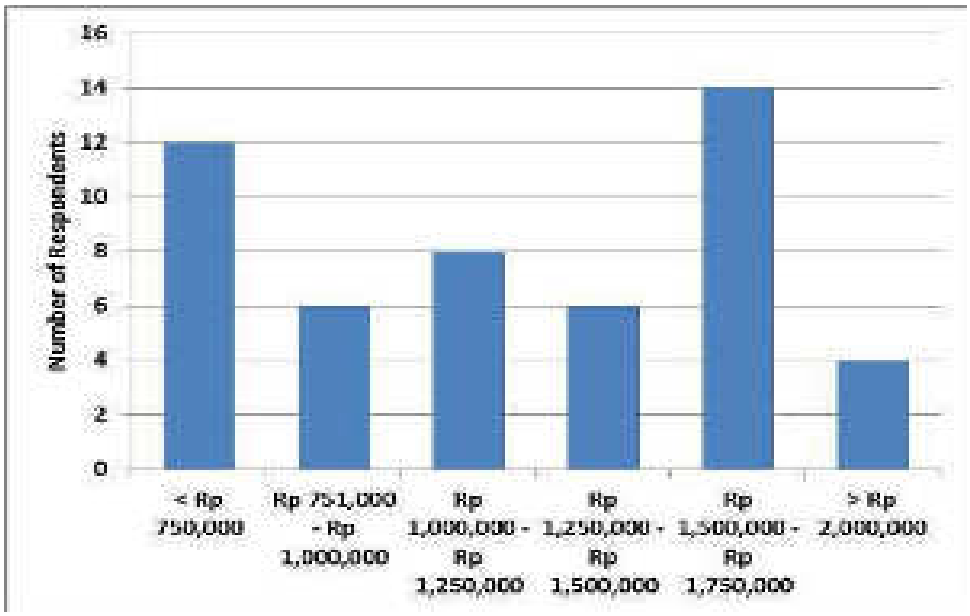
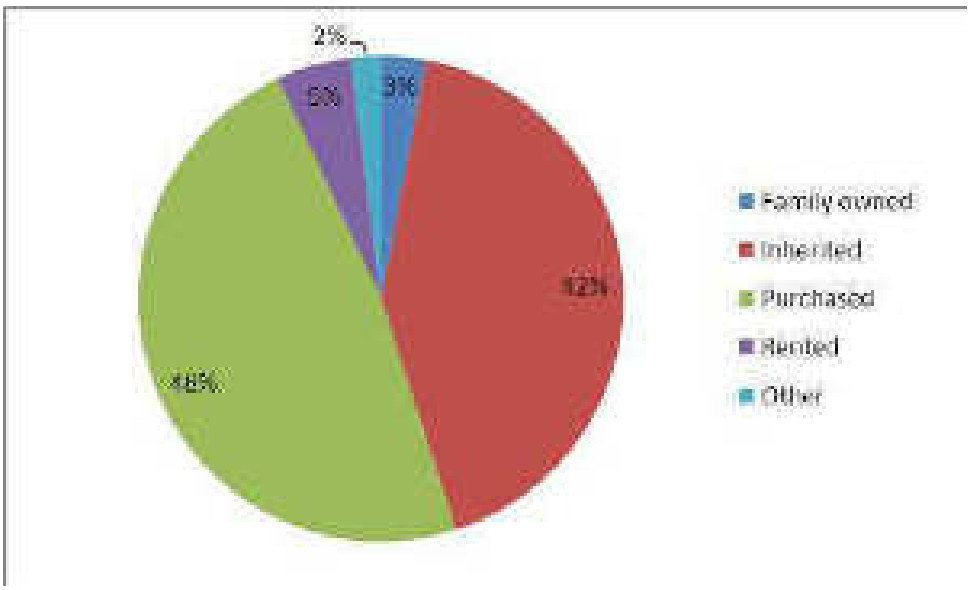


Figure 26 Range of Income in Affected Villages

The economic burden is also reflected in the number of dependents per household, which was ranging between 1 to 12 persons per household (ISDP report, 2015). About half of the surveyed households have 3 to 5 dependents, while about a third have beteen 6 to 12 dependents.

7.6.6 Land Ownership

The ISDP report records that most of the surveyed households own property in the vicinity of the project. Only 7% don't own any land, while 5% rent land and 2% work on land that belongs to the village (Figure 27). Since most of the respondents have been living in the area for more than 10 years, these figures are possible. Typical land sizes owned by those surveyed range between 0.5 to more than 2.5 ha, though the majority has land of a size between 0.5 to 1.5 ha and only a few have an area larger than 2.5ha.

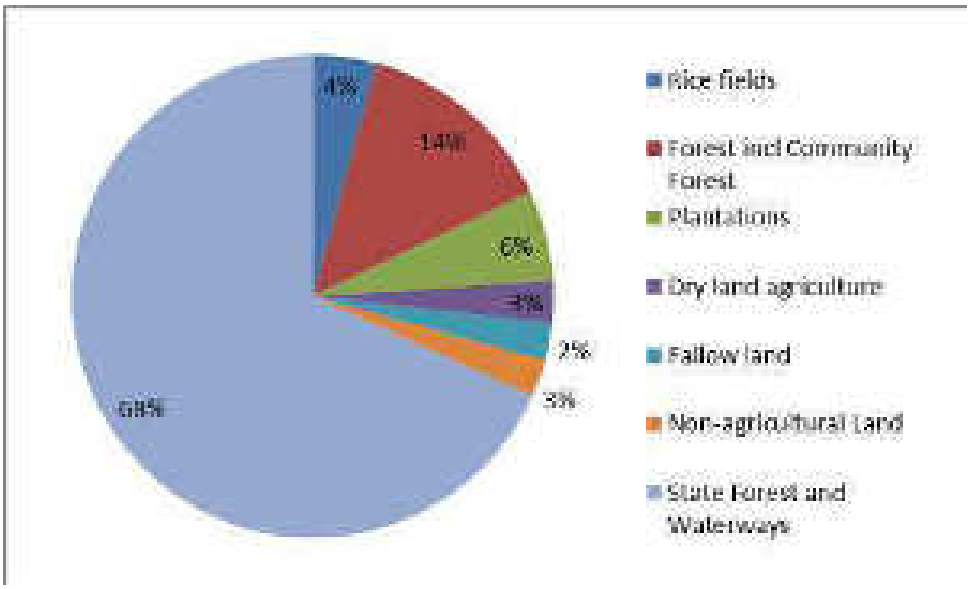


Source: ISDP Report, 2015

Figure 27 Type of Landownership, 2015

7.6.7 Land Use

More than three quarters of all land in Semende Darat Ulu is covered by Bukit Jambul Gunung Patah Protection Forest including waterways. The largest share of the community use land is community forest land, followed by plantations (the majority of which is coffee) and rice fields which however make up a much smaller part of the total land use (Figure 28).



Source: Semende Darat Ulu in Figures, 2016

Figure 28 Land Use, Semende Darat Ulu, 2015

All the land of Semende Darat Ulu lies at an altitude of between 700 to 2,000 meters above sea level, which is a suitable climate for coffee plantation. Coffee planting was already known in this area during the Dutch colonial times.

In Kecamatan Kota Agung the protection forest occupies a much smaller area (29%) while the plantation area is much larger with 24% followed by Community managed forest (16%), rice fields (14%), fallow land (10%) and dry land agriculture (6%) (Figure 29).

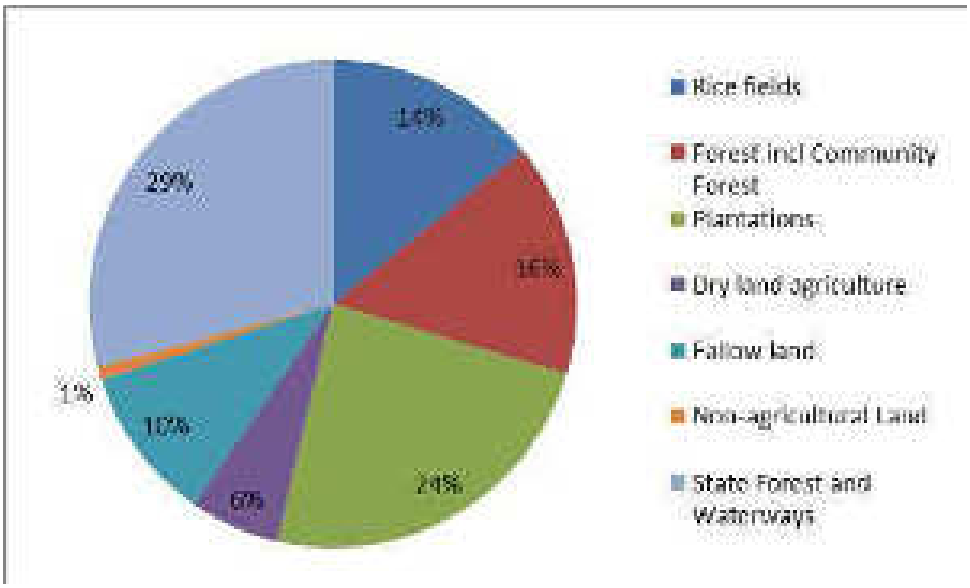


Figure 29 Land Use, Kecamatan Kota Agung, 2015

7.6.8 Ethnicity and Socio-Culture

The Semendo and Besemah ethnic groups are the original inhabitants of the project area. They have become integrated into Indonesian culture and systems. The project does not have Indigenous Peoples. Table 52 lists percentage ethnic composition of the 5 project affected villages.

Table 52 Ethnicity of the 5 Project Affected Villages (Percentage Composition)

No	Village	Besemah	Semendo	Others (Java, Padang, Sunda, Lampung, Bengkulu)
1	Tunggul Bute	>95%		
2	Karang Endah	70%		
3	Lawang Agung	70%		
4	Suka Rame	70%		
5	Segamit		80%	20%
	- Dusun Yayasan		30%	70% Java

7.6.8.1 Semendo Ethnic Group

The Semendo can be found mostly in Kabupaten Muara Enim, in particular in the kecamatan of Semende Laut Darat, Semende Darat Ulu and Semende Darat. Their total population is estimated at around 250,000 and their language is similar to Besemah and that of Palembang and part of the Malay language family. Some historians link the Semendo to the Banten ethnic group who have migrated to Sumatra from Java several centuries ago. The majority have been rice and coffee farmers for generations. Their culture is strongly influenced by Islam as many other ethnic groups are in Sumatra yet other religions are tolerated and no religious conflict has occurred in this area.

The Semendo kinship system is matrilineal. One custom linked to this inheritance pattern is the 'Tunggu Tubang', a type of totem that is kept in the kitchen, identified as the home of a family and handed down from oldest daughter to oldest daughter and with it all inheritances is also given to the

oldest daughter. The inheritance usually comes in the form of a rice field and housing. Although this right is not absolute, but allows her to tend, cultivate and harvest. The inherited land and housing can never be sold. Many young Semendo men opt to travel to other regions to find work and success.

Gotong Royong or communal work is still common. For instance at the time of a death in a family, others will come and bring food and money to help with the burial. Communal work can also be seen at the time of Islamic religious festivities.

7.6.8.2 Besemah Ethnic Group

The Besemah (or Pasemah) are found across South Sumatra, but particularly in Kabupaten Lahat and Kota Pagar Alam. They are the dominant ethnicity of Kecamatan Kota Agung. As with the Semendo people, the Besemah culture is firmly based on Islam. They depend mostly on subsistence agriculture, such as wet and dry land rice farming and coffee plantations. In addition to rice and coffee, they are also known to cultivate rubber. Their total population is estimated at 450,000 people.

One particular tradition that is upheld is called 'Lampik Empat, Merdike Due', a form of democratic approach to community life. The village leaders in the study area are most revered as are the traditional heads and the elders. They play a key role in resolving any social conflict that may occur.

7.6.9 Socio-cultural Activities

In the 5 villages, socio-cultural activities are smiliar, such as youth group activities, Qur'an recitals and ceremonial events such as marriage and circumcision celebrations or charitable events.

7.6.10 Education

Most people in Muara Enim and Lahat attained senior highschool (80% and 66% respectively) (Table 55), while around 15% in Muara Enim and 21% in Lahat have a higher degree, either diploma or bachelor.

Table 53 Education Attainment, Kabupaten Lahat and Muara Enim, 2015

Education Level	Muara Enim District	Lahat District
Elementary School	17	20
Junior High School	65	36
Senior High School / Vocational School	1,196	384
Higher Degree (Diploma or Bachelor)	226	121
Bachelor Degree	107	72
Total	**1,504**	**581**

Source : SDU and Kota Agung in Figures 2016

Table 54 Available School Facilities in the Project Vicinity, 2015

School Location	Segamit	Tunggul Bute	Karang Endah
Kindergarden	1	1	1
Elementary School (Total)	4	4	1
Public	2	2	
Islamic	2	2	

School Location	Segamit	Tunggul Bute	Karang Endah
Junior High School	2	1	

Source : SDU and Kota Agung in Figures 2016, ISDP report 2015.

Education facilities in the area are limited to up to the Junior High School level only. For higher and tertiary education, people have to go to schools in Kota Agung, Lahat or to Muara Enim. For Tunggul Bute and Segamit communities, the highest educational attainment is junior high school level, while for Karang Endah, Lawang Agung, and Sukarame it is at senior high school level.

7.6.11 Public Health

7.6.11.1 Diseases

Table 57 shows the disease patterns within the project area in 2015. These include dyspepsia/gastric pains, hypertension, acute respiratory tract infection, skin infections and diarrhea. Antalghia is also a common disease within the communities, it is possibly caused by the poor ergonomic working condition at the plantation.

Table 55 Disease Types Recorded within Project Affected Areas

Type of Diseases	Semende Darat Ulu		Kota Agung	
	Total	Rank	Total	Rank
Dyspepsia	978	1	796	1
Antalghia	972	2	431	4
Acute Respiratory Tract Infection	804	3	458	3
Hypertension	768	4	517	2
Diarrhea	668	5	385	6
Skin Infection	552	6	425	5
Skin Allergy	432	7	345	7
Skin Fungi	312	8	216	9
Eye	288	9	223	8
Accident	164	10	148	10

Source: SDU and Kota Agung Public Health 2016.

More specifically, in the 5 surveyed villages, hypertension and rheumatic are the most commonly reported diseases (Table 56). Rheumatic diseases generally affect joints and mucles, and are either due to wear and tear or relate to the immune system and nutrition. Hypertension or high blood pressure is a non-communicable disease (not caused by infection but by lifestyle related factors) which is on the rise across Indonesia. Main risk factors are salt rich diets, overweight, smoking and not enough exercise, however genetic factors can also contribute.

Table 56 Main diseases reported and sanitation in Project Affected Villages

Village	Main diseases and accidents	Toilet, Bathing, Washing	Drinking Water
Segamit	Rheumatic, hypertension, snake bites	Public facilities, ponds	Well water, bottled water
Tunggul Bute	Rheumatic and hypertension, snake bites	Public facilities, ponds	Bottled water

Village	Main diseases and accidents	Toilet, Bathing, Washing	Drinking Water
Karang Endah	Hypertension, rheumatic	PDAM, ponds, public faciltiies	Bottled water
Lawang Agung	Rheumatic, hypertension, gastric diseases	PDAM, ponds, public faciltiies	Bottled water
Sukarame	Cold, coughs, fever, rheumatic and hypertension	Own toilets, PDAM	PDAM, well water, bottled water
Penjalang	n/a		

In many of the villages, communities still prefer public toilet facilties over toilets at home which can pose a higher risk of gastric related diseases, although that seems not to be an issue here. All but one village buy their drinking water. Also most households are connected to the public water facilities.

7.6.11.2 Health Services

As in most parts of Indonesia, communities within the project area visit the kecamatan community health center (Pusat Kesehatan Masyarakat/Puskesmas) for treatment. These health centers have limited capacity however (Figure 30) . Communities purchase commercial drugs at shops. Table 58 presents the available health services within the Project area. The ratio indicates the number of patients per health facility or personnel there could be given a total population over Segamit and Tunggul Bute Villages of 4,610. There is only one hospital in each Kabupaten Muara Enim and Lahat, located in the capital cities.

According to community interviewed in Segamit Village, before the arrival of a midwife, there were several cases of women who died in child birth, one of the reasons being that access to health facilities is low and the hospital is located far away.

Figure 30 Puskesmas Desa Tunggul Bute

Table 57 Health Services and Personnel in the Project Area

Location	Public Health Facilities					Public Health Personnel			
	Hos-pital	Health Center	Poly-clinic	Health Post	Phar-macy	Doctor	Mid-wife	Nurse	Healer
Kecamatan SDU	-	5	-	8	-	1	10	4	6
Segamit Village	-	1	-	1	-	-	1	1	1
Kecamatan Kota Agung	-	3	-	10	1	1	15	20	14
Tunggul Bute Village	-	-	-	1	-	-	1	-	-
Total	-	9	-	20	1	2	27	25	21
Total Population to Health facility & personnel Ratio *	0	512	0	231	4,610	2,305	171	184	220

* Total Population of Tunggul Bute and Segamit Villages together amounts to 4,610 people.

7.6.11.3 Community Health and Sanitation

Houses are generally equipped with corrugated iron roofs and the walls are made of woden planks and some of bricks (ISDP report, 2015) (Figure 31). Lack of clean water and domestic sewage systems as key issues in the projects area. Water is generally sourced from rivers and wells and routed to houses though piping/hose systems. Almost all households have toilets (approximately 95%), but the sewage treatment is lacking, especially in the dry season.

Figure 31 Typical house found in Tunggul Bute

7.6.12 Transportation

The project area can be accessed by road from Palembang City in 8-10 hours depending on traffic conditions. From Palembang to the Project Area, the road passes through Muara Enim City the capital of Kabupaten Muara Enim, then through Pajar Bulan and Segamit Villages (in Kecamatan Semende Darat Ulu) before reaching the project area. Road traffic to the Project Area can be very congested during the afternoon and night primarily due to coal transportation. Road quality is generally poor, with some areas unpaved.

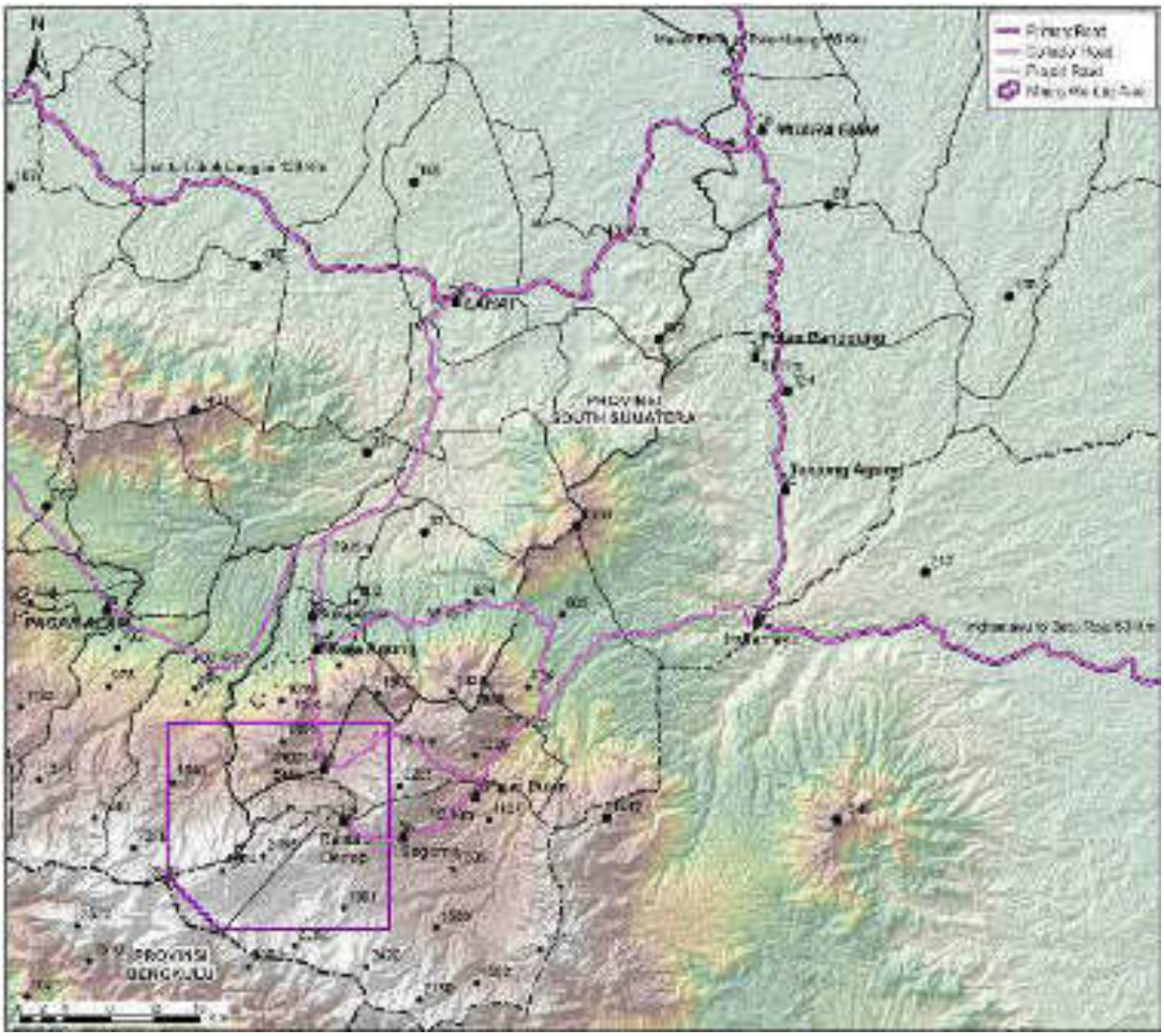
Source: PT SERD ANDAL Study August 2016

Figure 33 Road Conditions at the Tunggul Bute Village

An alternative route to the Project Area is via Lahat City (the capital of Kabupaten Lahat) to Pagar Alam City, on to Sukarame, Lawang Agung, Karang Agung and Tunggul Bute Villages. The road is generally paved.

The distance from the intersection at Kota Agung to the project location is roughly 22km, the road is a gravel road. This road is being regularly maintained by the project proponent and is being therefore well used by the local communities.

Map 15 presents the alternative routes.



Map 15 Primary Routes to Rantau Dedap including Distance

7.6.13 Community Perception

The PT SERD ANDAL Study August 2016 indicates that the community is aware of the project and the project is generally welcome. Approximately 76% of the people support PT SERD's project. The people expect a company program to support the communities, such as employment recruitment/training, agricultural improvement and associated small business development as well as home industries development. They are most worried about the increase in dust, noise and traffic during materials and equipment mobilization, in particular near settlements.

8 SCOPING OF ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS

8.1 Area of Influence

The area of influence is the 124.5 ha project area that will contain the project components specified in section 4.2 as well as transportation routes to/from the project location. The baseline environmental and social setting (Section 7) describes the area of influence, including receptors.

8.2 Scoping Methodology

An ESIA requires primary and secondary data. Primary data are obtained from direct observations and field measurements, laboratory analyses, questionnaires and in-depth interviews. Secondary data (e.g. spatial management map, administration map, topographical map, land use map, statistical data, or rainfall data) are obtained from a variety of sources such as published environmental studies, government institutions and the internet. Collected data, which is mainly baseline information, enables the analysis of interactions between the project and host environment as illustrated in Figure 31.

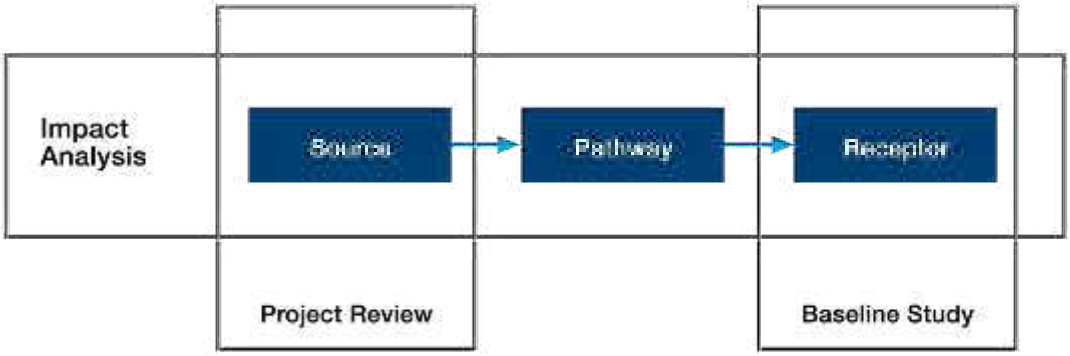


Figure 31 Interactions between the project and Host Environment

Screening occurs is in three stages:

Stage 1: Identifying Potential Impacts. The outcome of this stage is a listing of all potential environmental and social impacts associated with the project;

Stage 2: Evaluating Potential Impacts. The outcome of this stage is a screening and prioritization of impacts as significant and non-significant; and

Stage 3: Detailed Evaluation Hypothetical Significant Impacts. This requires in-depth assessment which is conducted in the subsequent impact assessment.

8.3 Method for Impact Identification and Evaluation

The project was screened against various aspects of the following parameters, for the exploration, construction, operations and decommissioning stages:

- Natural Resources (air, water, land, biodiversity)
- Waste (hazardous and nonhazardous)
- Natural Hazards
- Noise and Light

- Demography, Economy and Social and Cultural Resources (including livelihoods, customs, housing, welfare)
- Public Health (including facilities, medical staff, sanitation)
- Public Services (transportation, public infrastructure, utilities and services)
- Aesthetics and Reputation
- When assessing direct and indirect impacts, the following are considered:
- Number of people affected from planned activities;
- Area affected;
- Intensity and duration of impact;
- Other environmental components affected;
- Nature of cumulative impacts;
- Reversibility of impacts; and
- Other criteria in accordance with sciences and technology.

While a proposed development may have a large impact in terms of magnitude, the effects may not significantly affect the environment as a whole. A variety of methods help determine whether a project activity produces significant impacts or non-significant impacts. This process involves input and analysis from environmental and social experts from inside and outside of PT SERD, as well as engineers and others that understand the technical aspects of the project. The team considers detailed project activities, consultations with people directly or indirectly affected by the project as well experience and lessons learned from similar projects.

The outcome of impact evaluation in Stage 2 also results in a refined set of important impacts, i.e. the Hypothetical Significant Impacts. During the impact assessment, these impacts are evaluated and studied.

Figure 32 Methods and Tools for Identifying and Evaluating Impacts

The following approaches can be tailored and scaled for use in any step in the impact evaluation, though the more complex and costly methods are used only in step 3 (impact assessment).

Mathematical Modeling: Standard mathematical models, either analytical or numerical, are used to predict the magnitude of impacts: Gaussian Models to predict dispersion of dust and gaseous pollutants in the ambient air; Mixing Zone Models for water quality parameters; mathematic formulas to determine Importance Value Index (IVI), diversity index, similarity index for terrestrial and aquatic biota; as well as mathematical models to predict socioeconomic and transportation aspects.

Overlay Mapping: Overlay mapping, preferably done by Geographic Information Systems (GIS), assists in identifying the geographic extent of impacts and can assist in identifying where cumulative impacts and impact interactions may occur. Overlay mapping is best suited for identifying physical/chemical impacts and their geographical extent. Overlay mapping involves preparing maps or layers of information which are then superimposed on one another. Overlay mapping can provide a composite picture of the baseline environment, identifying sensitive areas or resources. Overlay mapping helps to illustrate the influences of past, present and future activities on a project or receiving environment.

Threshold Analysis: The boundary of significant impact distribution can be determined using threshold analysis. Threshold analysis is based on the assumption that thresholds exist in most ecological systems, specifying limits in an environmental medium (predominantly but not to limited to air and water) that must not be exceeded, or levels of environmental quality that must be maintained. Thresholds may be expressed in terms of goals or targets, standards and guidelines, carrying capacity, or limits of acceptable change, each term reflecting different combinations of scientific data and societal values.

A threshold can be a maximum concentration of a certain pollutant beyond which health may be adversely affected, a maximum number of hectares of land cleared from its existing natural state before visual impacts become unacceptable, or a maximum number or proportion of animals lost from a habitat before the viability of the population is threatened.

Prime examples of environmental threshold limits are ambient environmental standards set by the GoI defining the degree of environmental quality that must be maintained in an environmental resource to support its continued beneficial human use. Emission standards represent yet another group of threshold limits defining the maximum acceptable quantity and/or concentration of pollutants that may be discharged into the environment.

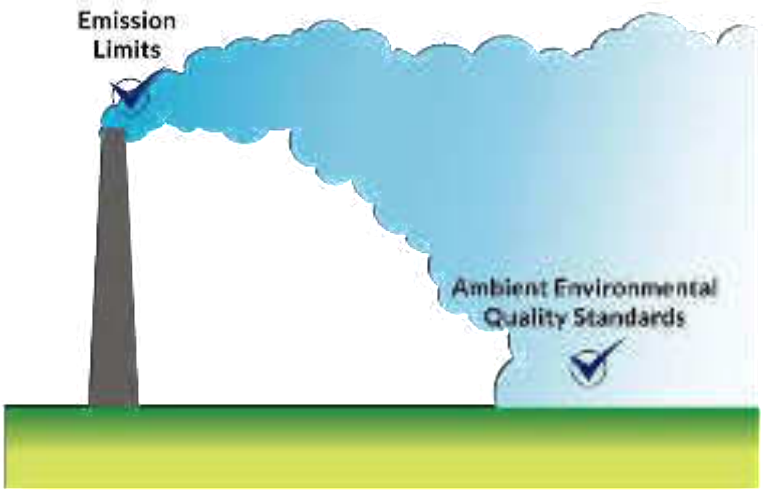


Figure 33 Combination of emission controls and ambient environmental quality standards to protect environment illustrated

Analogy Method: Prediction by analogy is where environmental impacts are predicted by direct comparison or extrapolation from similar activities at existing industries. Conclusions may be adjusted to accommodate different conditions at the site of the proposed activity. The analogy between an existing activity and a new project depends on the extent to which both activities and both sites are similar. Predictions based on comparable experiences are always preferred to estimates with no basis of direct observations. Impact prediction, of course, is made easier if the proposed development is an expansion of an existing operation: For example, the environmental impact assessment of the Indonesian Copper Smelter will benefit from 2 decades of successful operation of PT Smelting Gresik and the wealth of environmentally relevant knowledge and data generated over this time.

Professional Judgment: Professional judgment always forms an intrinsic part of environmental assessment. No matter what method is applied for identifying and evaluating impacts, it is not possible to conduct an environmental assessment without relying on expert opinions. Many impacts cannot be adequately predicted by numerical methods or by analogy. Such impacts can be judged by experienced professionals who have been involved in similar studies.

8.4 Method for Determining Significance of Impacts

Assessment of the level of significance requires consideration of the likelihood and magnitude of the environmental effect; its geographical scale and duration in relation to the sensitivity of the key receptors and resources are also considered. Criteria for assessing the significance of impacts stem from the following key elements:

The magnitude (including nature, scale and duration) of the change to the natural environment (for example, loss or damage to habitats or an increase in noise), which is expressed in quantitative terms wherever practicable.

The nature of the impact receptor, which may be physical, biological, or human. Where the receptor is physical (for example a water body) its quality, sensitivity to change and importance are considered. Where the receptor is biological, its importance (for example its local, regional, national or international importance) and its sensitivity to impact are considered. For a human receptor, the sensitivity of the community or wider societal group is considered along with its ability to adapt to and manage the effects of the impact.

The likelihood (probability) that the identified impact will occur is estimated based upon experience and/or evidence that such an outcome has previously occurred.

The significance of impacts is then devised from a combination of the sensitivity of the receptor, the magnitude of impact and the likelihood of occurrence.

8.5 Impact Mitigation Hierarchy

In impact assessment, avoidance of impacts is the preferred option. The next best options in order of preference are: minimization, restore/remediate and compensation or offset. Where identified risks and impacts cannot be avoided, a management plan is prepared containing mitigation measures to ensure the project will operate in compliance with applicable laws and regulations and meet the requirements of Performance Standards 1 through 8 contained the ESMS. Figure 34 describes the impact mitigation hierarchy.

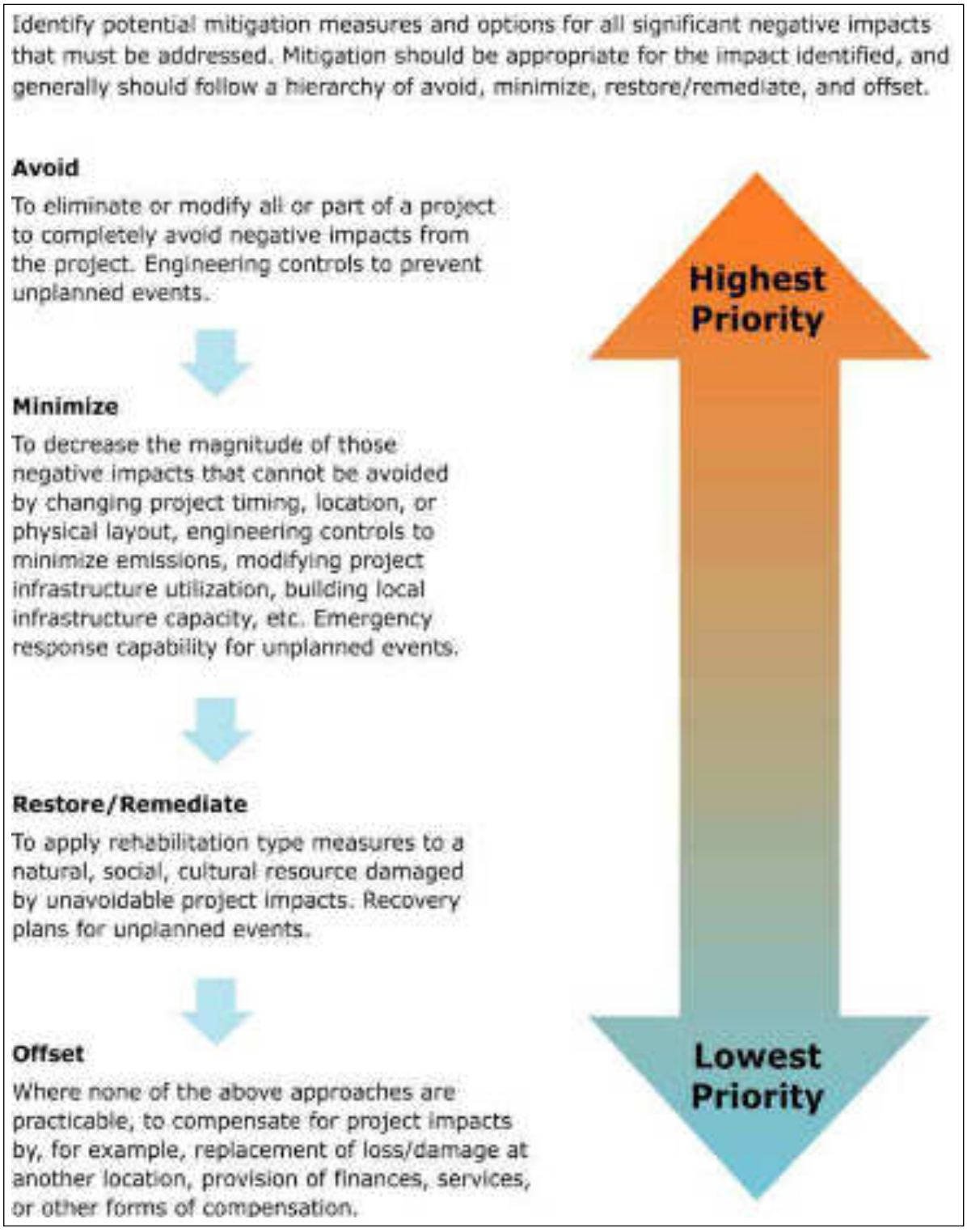


Figure 34 Impact Mitigation Hierarchy

8.6 Identified Significant Impacts of Project Activities

In the ESIA screening and scoping, the following significant impacts were identified, based on the ANDAL, a Social Compliance Audit Report and Initial Poverty and Social Analysis (2014) and further assessment undertaken in this ESIA to meet GIIP (e.g. IFC, ADB), see Table 59. The identified hypothetical impacts are described and analyzed in Section 10.

Table 58 Summary of Potentially Significant Impacts

Environmental & Social Impacts	Activity Stage							
	Exploration	Construction			Operations			Decom-mission-ing
	Well Drilling	Land Preparation/ Mobilization	Well Drilling/ Plant Facilities	Transmission/ Pipeline/ Road	Well Drilling	Power Generation	Transmission/ Pipeline/ Road	
Physical-Chemical								
H2S Emissions	-		-		-	-		
GHG						-		
Mercury Emissions (and sludge)	-		-		-			
Dust		-	-	-			-	-
Noise		-	-		-	-		-
Erosion and Sedimentation- water quality, increased run-off rate	-	-	-	-	-			-
Water- Surface water usage		-	-		-	-		
Solid and Liquid Waste		-	-	-	-	-		-
Hazardous Waste		-	-	-				-
Biodiversity								
Fauna	-	-	-	-	-	-	-	-
Flora	-	-	-	-	-	-	-	-
Invasive Species	-	-	-	-	-	-	-	-
Mgt of Ecosystem Services	-	-	-	-	-	-	-	-
Social & Cultural								
Employment Opportunities	+	+	+	+	+	+	+	+
Workforce impacts on communities- disease, cultural, drain on local resources, etc.		-	-	-				-
Business Opportunities	+	+	+	+	+	+	+	+
Cultural Heritage		-	-	-	-	-	-	-
Land Acquisition/ Economic Displacement	-	-						
Community Concern	+/-	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Community impacts from landslides and flooding		-	-	-				
Indigenous Peoples	-	-	-	-	-	-	-	-
Community Health, Safety and Security- H_2S			-	-	-	-	-	-
Traffic and Transportation		-	-	-				-
Workforce								
OSH	-	-	-	-	-	-	-	-
Compliance with Labor Legislation	-	-	-	-	-	-	-	-

Environmental & Social Impacts	Activity Stage							
	Exploration	Construction			Operations			Decom-mission-ing
	Well Drilling	Land Preparation/ Mobilization	Well Drilling/ Plant Facilities	Transmission/ Pipeline/ Road	Well Drilling	Power Generation	Transmission/ Pipeline/ Road	
General								
Cumulative and Transboundary Impacts- Influx		-	-	-	-	-	-	-
Loss of Opportunity (Business, Employment)- construction and decommissioning		-	-	-				-

Note:
- Negative Impact
+ Positive Impact

9 INFORMATION DISCLOSURE, CONSULTATION, AND PARTICIPATION

9.1 Stakeholder Analysis and Engagement

The project's Stakeholder Engagement Procedure provides a structured, disciplined and integrated process for systematically meeting the engagement objectives above. External Relations is responsible for the execution and resourcing of the procedure, specifically to:

1. Prepare for stakeholder engagement by preparing a Stakeholder Engagement Plan (SEP): Identify stakeholders, consider their issues, assess their influence and interest and document in a Stakeholder Engagement Plan. This exercise is updated continually, based on changing project conditions and external stakeholder perceptions. Appropriate functions are engaged to conduct stakeholder engagement, including Health, Environment and Safety, Security, Legal, Supply Chain and Operations.
2. Conduct Stakeholder Engagement, following the SEP.
3. Analyze Stakeholder Results
    a. After engaging stakeholders, analyze stakeholder results and appropriately incorporate stakeholder feedback into project planning and operations.
    b. Provide feedback to the stakeholders on how their views and concerns have been addressed (for example, stakeholder input is considered but not necessarily adopted). The feedback is transparent and timely and stakeholders' responses to the feedback received are monitored and documented.
4. Review the SEP and update as necessary, to improve the effectiveness of engagement.

The scope of the SEP encompasses the operational footprint (i.e. zone of influence, both direct and indirect), including the facility and region. Stakeholders are broadly defined as individuals or groups who can affect, or are affected by, or have a legitimate interest in the company's performance. Table 60 presents the stakeholders that were identified as relevant to PT SERD's project activities, recognizing that stakeholders will change over the life of the project. The project's SEP is contained in Appendix 1.

Table 59 SERD Stakeholders

Project Affected Communities
Tunggul Bute Village
Segamit Village
Karang Endah Village
Lawang Agung Village
Sukarame Village
Government/Regulatory Authorities
National level government bodies
Ministry of Energy and Mineral Resources
Ministry of Environment and Forestry (MoEF)
Ministry of Finance
Ministry of Public Works
Police (POLRI)
National Land Body (Badan Pertanahan Nasional or BPN)

PT PLN (Persero) Other related government institutions such as Investment Coordinating Board (BKPM) , and Disaster Mitigation office Regional level Governor of South Sumatra Regents of Muara Enim and Lahat City of Pagar Alam Provincial Police (POLDA) and Resort (Regency) Police (POLRES) Local Environment & Forestry Office Mining and Energy Office Local Investment Coordinating Body Local Level Head of Sub-District (Camat) Sub-district Military Command (Koramil) Sector Police (Polsek) Head of the Villages (Kepala Desa) Head of the Hamlets
Non-Governmental and Civil-Based Organizations (NGOs)
Wahana Lingkungan Hidup Indonesia (WALHI) World Wildlife Fund (WWF) Institute for Essential Services Reform (IESR) Yayasan Rantau Dedap
Women and other vulnerable Groups
PKK of Muara Enim and Lahat Regency as well as Pagar Alam City Beneficiaries of PT SERD's livelihood Opportunity and Skill Development Programs
Private Businesses
Private businesses stakeholders are those outside contractors, suppliers, distributors, and customers. Besides private businesses, business associations and local chamber of commerce are considered stakeholders to the Project.
Mass Media and Other Stakeholders
Sriwijaya Post & Online (Local) Antaranews Sumsel, Radar Indonesia (local) Kompas, Tempo , Republika (National Newspaper) Energy today, Kontan, Petromindo (National -Online) TVONE, MetroTV, TVRI (National TV) National Geographic (International) BBC (International)
Educational Institutions
Sriwijaya University Bandung Technology Institute Gadjah Mada University, etc.

9.2 Disclosure of Information

The following project information has been prepared and made available to stakeholders:

- Brochures, posters or flyers prepared to visually explain the project;
- Press releases and media kits

- Announcements, published in local newspapers as well as on the information boards in the affected villages;
- Supreme Energy Website (http://www.supreme-energy.com/company/se-rantau-dedap/)

9.3 Consultation and Participation

The SEP drives PT SERD's public consultation and participation. Table 61 summarizes engagement activities that PT SERD undertook to inform and consult with project stakeholders.

Table 60 Summary of Past Engagement Activities

No	Date of consultation	Location	Theme	Participants (Number of Participants)	Information Disseminated	Key Issues Raised
1	13 Mar 2008	Dusun IV Yayasan / Rantau Dedap	Project Information	Project affected communities	Information on planned project activities (exploration)	Purpose of the project Benefits of the project Employment opportunities Electricity black-out and shortage Land procurement
2	18 Oct 2010	Muara Enim Regency Office	Project information	Regent of Muara Enim Regency and his team	Project activity dissemination as shown in Project Work plan; the contribution of the Project to sustainable development.	Employment opportunities Electricity black-out and shortage in Muara Enim Boundary of the project with other Regency Regency non tax revenue sharing
3	22 July 2011	Pondok Pesantren Darul Ikhlas, Semende Darat Ulu District, Muara Enim Regency, South Sumatera Province.	Stakeholder consultation meeting	The attendees for the stakeholder consultation meeting were invited by invitation letter. The attendance list of the stakeholder consultation meeting recorded 89 attendees of the meeting	Socialize the project activity. Clean Development Mechanism.	Question was raised concerning the possibility of accident that would be happened same as in Lapindo The possibility of profit sharing for the Semende Darat Ulu District Expectation of road repair in the Semende Darat Ulu District. Possibility of land damaged by construction of Rantau Dedap Geothermal Power Plant. An expectation that the project activity would give benefits for local community: Scholarship, mosque renovation, builds schools. The possibility of cultural shift in society, such as a change from agrarian to industrial community due to the existence of this project.
4	27 Jan 2012	Kota Agung -	Geothermal	Head of Lahat Regency,	Public consultation with respect	Expectation of road repair

No	Date of consultation	Location	Theme	Participants (Number of Participants)	Information Disseminated	Key Issues Raised
		Lahat	Project Socialization	Head of Police Resort, Head of sub district, Sub district police, sub-district army, local government apparatus, 5 Village community, public figures (Tokoh Masyarakat), youth groups, Community, and Journalists (more than 100 participants)	to planned project activities i.e.: Who is Supreme Energy What is Geothermal Project Benefits and contribution Project legal frame The construction.	Question was raised concerning the possibility of accident that would be happened same as in Lapindo An expectation that the project activity would give benefits for local community
5	02 Feb 2012	Desa Segamit – SDU Muara Enim.	Project information	Head of sub district, Sub district police, sub-district army, local government apparatus, community patron (Tokoh Masyarakat), youth groups, and project affected communities.	Public consultation with respect to planned project activities i.e.: Who is Supreme Energy What is Geothermal Project Benefits and contribution Project legal frame The construction.	The possibility of profit sharing for the Semende Darat Ulu District Expectation of road repair in the Semende Darat Ulu District. An expectation that the project activity would give benefits for local community: Scholarship, mosque renovation, builds schools.
6	24 dan 27 Feb 2013	Kota Agung & SDU	Form the Villages Forum	Key stakeholders and affected community members	Villages Forum will bridge the company and community interest, as well as serves as the front liner on the dissemination process.	
7	22 Jul 2012 - 15 Sep 2012	Kota Agung Sub district – Lahat Regency	Land acquisition and compensation process dissemination	Land owners, local government/ regency & sub district level	Project background, land requirements, procedure for land acquisition, negotiations, grievance mechanism, potential benefits to the communities including employment	Welcomed the project activities, and expressed support for the project and Company. Clarity on negotiation process and fair compensation for land and crops lost Concern from coffee planters within the

No	Date of consultation	Location	Theme	Participants (Number of Participants)	Information Disseminated	Key Issues Raised
8	28 Jul 2012 s/d 02 Sep 2013	Desa Segamit Kecamatan Semende Darat Ulu (SDU) Muara Enim		Affected persons, village head, community representatives	opportunities	protection area, whether they will be compensated for crops since the land does not belong to them Tentative timing and schedule of the project Concerns with respect to land measurement (land owner not in agreement with the size measured by the topographic surveys), age of crops (compensation of coffee is based on age, the decree rates for 20 year old coffee plants is low) Potential for employment in the project stage, priority of local labor over outside labor Impacts during construction and operation, dust, noise, and outside labor conflicts Clarity on what the process for registering any complaints, grievances regarding the project activities Need for better infrastructure in the project area, roads and other infrastructure, improvement of school buildings and facilities in schools, improvement to the mosques
9	15 Sep 2012 s/d 17 Mar 2013	Desa Tunggul Bute, Kecamatan Kota Agung - Lahat		Affected persons, village head, community representatives		
10	02 Apr 2013	Kota Agung - Lahat	Public Announcement	Project affected communities and wider audience	Public announcement was published	
11	17 December 2013	Serbaguna Hospital, Muara Enim	Public Consultation Meeting for ANDAL	Government officials, community representatives, community leaders, women and youth	Information on the project and plans for exploration and exploitation	Land acquisition and compensation, expectations for employment, air quality in terms of dust and noise during construction/exploration phase, land clearing of vegetation, and impact on flora and fauna.

No	Date of consultation	Location	Theme	Participants (Number of Participants)	Information Disseminated	Key Issues Raised
				group representatives and NGOs.		
12	02 Feb 2014 03 Feb 2014	Muara Enim Rantau Dedap	Media Gathering Spud in Rtd – B1	All media in West Sumatra (newspapers & electronics), local government's public relation, 35 participants were involved	Project disclosed information, company policy & procedure, and question & answer.	Purpose of the project Benefits of the project Employment opportunities Electricity black-out and shortage Forestry permit & land procurement The possibility of accident that would be happened same as in "Lapindo mud"
13	08 Feb 2014	Kota Agung dan SDU	ADB Lender Site Visit	Local villagers visiting the local market	Questions were asked by the ADB Lender about the knowledge of the local community and government officials about the project and the consultation so far as well as land acquisition and compensation process.	Public awareness Information disclosure Social compliance Land Acquisition & crops compensation process
14	23 Mar 2014	Rantau Dedap - Segamit	Grievance Mechanism (GM) Dissemination	Project affected communities, local government and traditional leaders	GM dissemination including the GM procedure, contact detail and discuss other project issues.	
15	02 – 03 Jul 2014	Kota Agung dan SDU	Lender's Consultant Site Visits	Local villagers visiting the local market	Questions were asked by Lender's Consultants about the knowledge of the local community and government officials about the project and the consultation so far as well as land acquisition and compensation process.	Environment and social compliance Land Acquisition & crops compensation process BAP & CHA
16	10 October 2015	Talang Pisang -Rantau	CSR Stakeholder Meeting	Kades Tunggul Bute Dan Segamit	Socialization of four pillars and program synchronization with	Need for better infrastructure in the project area, roads and other infrastructure,

No	Date of consultation	Location	Theme	Participants (Number of Participants)	Information Disseminated	Key Issues Raised
		Dedap			the results of the kecamatan Development Planning Consultative Meeting (MUSRENBANG--Musyawarah Perencanaan Pembangunan) accommodating proposed CSR Program.	improvement of school buildings and facilities in schools, improvement to the mosques
17	2015	6 villages	Community Capacity Building (Needs Analysis)	Total of 122 survey respondents	Survey on social data and training needs	Improving life skills, in particular farming, farm animal raising and fishing
18	3 February 2016	Segamit Village	Training Coffee and Vegetable Cultivation (Workshop)	40	Training/Extension Services on farming	Farmers interested to learn more about proper cultivation of coffee
19	3 February 2016	Rantau Dedap Hamlet	Training Coffee and Vegetable Cultivation (Workshop)	40	Training/Extension Services on farming	Farmers have insufficient knowledge of fertilizer application and face pest problems
20	4 February 2016	Tunggul Bute Village	Training Coffee and Vegetable Cultivation (Workshop)	60	Training/Extension Services on farming	Farmers obtain information on how to manage coffee and vegetable plantations better including how to manage pests.
21	5-8 March 2016	Tunggul Bute Village, Rantau Dedap Hamlet and Segamit Village	Training in the field (biopore preparation, fertilizing of coffee)	21 participants (Rantau Dedap/Segamit) 20 (Tunggul Bute)	Training/Extension Services on farming	Farmers learn in the field how to do biopore and fertilizer coffee.
22	2 May 2016		KA ANDAL presentation			

9.4 Ongoing Community Feedback

As indicated in the Stakeholder Engagement Plan, information about the project and activities, especially during construction, will be provided to affected stakeholders. Consultation (including feedback also occurred during the AMDAL. During construction and operations, as issues arise (either through the GM, SEP or other community feedback) they will be addressed and communicated.

9.5 Grievance Mechanism

The GM and SEP are related and complementary. The GM is reactive, while the SEP is proactive. They apply to the exploration, construction, operation, and post-operation phases. The Project aims to expeditiously resolve grievances and a resolution hierarchy has been developed as follows:

1. Direct resolution at the individual or group level;
2. Community-level resolution through public meetings;
3. Resolution through a stakeholder group comprising Project representatives, government representatives, religious and village leaders, and the complainants; and finally
4. Recourse to legal counsel if the grievance cannot be resolved.

To build awareness of the Grievance Mechanism, PT SERD is undertaking the following:

1. Develop the role and function of the community working group as the front liner on the dissemination process. The Group would facilitate a regular gathering between PT SERD's representative and the community, among others to introduce and maintain the awareness on the Grievance Mechanism.
2. Regular update to the Head of the Village, as the arm of the Grievance Contact, in understanding the community knowledge on the Grievance Mechanism.
3. Distribute the printed materials (newsletter) on the Grievance Mechanism to the community.
4. Provide signage and other media to inform the contact details of the Grievance mechanism and its committee to the affected community.

9.5.1 Grievance Resolution Step by Step

The step-by-step GM procedure is presented in (Figure 35) and each step is explained below. The full Grievance Mechanism is in Appendices 1 and 2.

Step 1: Complaints may be expressed verbally or in writing to the Field Representative PT Supreme Energy in Rantau Dedap. Contact detail for the Representative is disclosed to the Affected Community through signage, flyers, and other media. Complaints received by other Project personnel will be forwarded to the Field Representative.

Step 2: Site Support Manager will be responsible for documenting verbal and written complaints. Complaints will be written onto a complaints log and action form (see attached). The complaints log and action form records (a) who reports the complaint; (b) the date the complaint was received and recorded; (c) the nature of the complaint; (d) information of proposed corrective action; (e) date of response (verbal and written) provided to the complainant; (f) corrective actions taken by whom and when, and (g) the date the complaint was closed out.

"Minor" complaints will be then directed to the Site GRC within 1 (one) day period, which could include the Relation Response Team, Community Committee, and/ or Contractor Representatives

depending on the particular cases for necessary actions and immediate tactical with limited adverse impact to the community and PT SERD. This will be followed by the action plan provision and implementation no longer than 2 (two) working days. And it goes to Step 8.

As for “Major” complaints, the cases which have high adverse impact to the community and PT SERD will be directed to the Step 3.

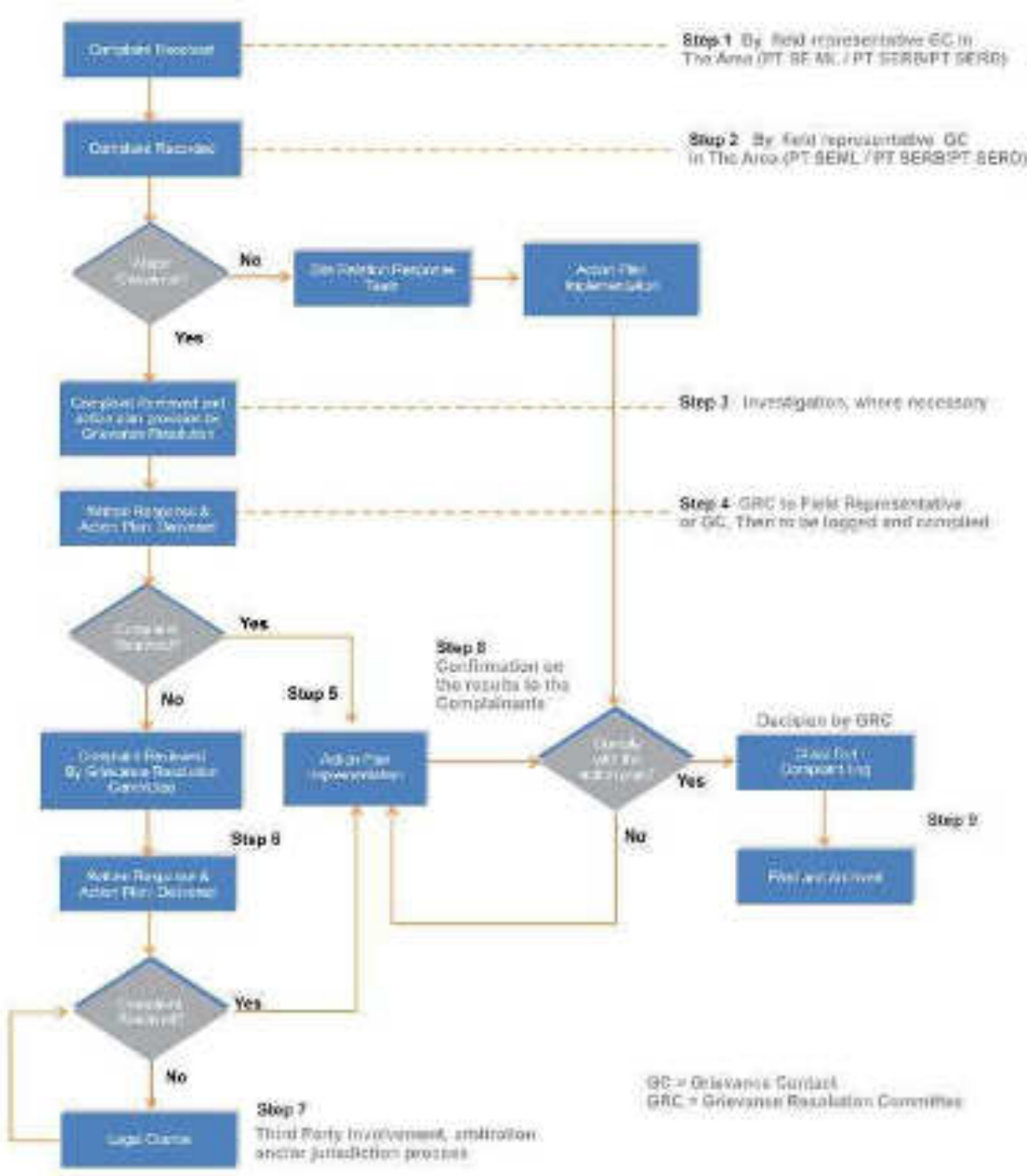


Figure 35 Grievance Mechanism

Step 3: All complaints log and action forms will be forwarded to the management team. Appropriate actions to close out the complaint will be determined and written onto the form. Where necessary the Relation, Project, Security and/ or SHE team will investigate complaints from the community and an investigation report will be developed. All the process should be finalized within 1 (one) week at most, depend on the cases.

Step 4: A written response for every grievance will be prepared within 14 (fourteen) days at most. The response will be delivered verbally before the written copy is provided to the complainant. The complainant will be asked to sign and date the complaints log and action form to confirm receipt of the project written response and Action Plan.

Step 5: Action Plan implementation. The management PT Supreme Energy recognizes that eventually timelines for possible actions will be determined by the nature of the grievance as stipulated in the agreed action form. If more time is required to implement appropriate actions, the Relations and/ or Security team will inform the complainant. Relation and/ or Security Team, however, will assume responsibility for ensuring all actions are implemented to close out the complaint.

In most cases the written response and agreed actions may be sufficient to resolve the complaint; otherwise more actions will be taken. When the actions are completed the process will be continued by confirming to the Complainants on the compliancy of the results with the agreed action plan.

If unresolved,

Step 6: the complainant will be referred to the Grievance Resolution Committee. The Committee will comprise department of Relations, Security, and Site Support. Other sections or department i.e., SHE, Legal, Project, Subsurface, Drilling, Supply Chain Management, Contract, Accounting, HRD, etc. will be included on a needs basis. The Grievance Resolution Committee aims to resolve complaints within 21 days. Again, depending on the nature of the complaint, a longer timeline may be agreed upon with the complainant. If an agreeable solution is reached, the complainant will be asked to sign on the log book, date, complaints and the agreements to confirm receipt of agreement with the project written response.

When it is resolved the process will be continued by action plan implementation (Step 5) and confirming the results to the Complainants.

Step 7: Should all the steps above be insufficient in resolving the issue, the final resolution is found by legal counsel. The Indonesian law jurisdiction shall apply. The timeline will follow the applicable law and regulations.

When it is resolved the process will be continued by the action plan implementation and confirming the results to the Complainants.

Step 8: The confirmation on the results from the Complainants should be submitted within 7 (seven) days after the results confirmation log is given from the PT SERD, otherwise the complaint log will be deemed as closed. Should both parties be satisfied with the results; both parties will sign and date the agreement form. Otherwise, the process will be given back to the Grievance Resolution Committee for the action plan re-implementation.

Step 9: The agreement on the results will become the log closing and will be recorded and archived as a formal document for filing and evaluation purposes.

10 ASSESSMENT OF ANTICIPATED ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS

10.1 Project Benefits

The potential benefits from the project include:

Improved socioeconomic conditions from direct and indirect employment and business creation, for the largely rural inhabitants of the area as well as other parts of Indonesia.

Tax benefits to the local and national government.

Additional electricity supply that helps the GoI meet its power production targets under the Electricity Acceleration Program.

Contribute to GoI priority of reducing the country's dependence on fossil fuels through the development of renewable energy source.

10.2 Summary of Significant Impact Assessment in AMDAL

The ANDAL Term of Reference (ToR) was approved in August 2016. Scoping for PT SERD impact assessment is in adherence to PerMenLH No. 16 of 2012, and went through 3-stage process consisting of potential impacts identification, potential impacts evaluation, and hypothetical significant impacts listing.

Significant impacts are further assessed and determined in the ANDAL document through mathematical calculation, analogy with other similar activities and professional judgment, as well as updating baseline information and environmental modeling.

The AMDAL document has been approved and Environmental Permit has been obtained from MoEF on 15 March 2017. Approval of the AMDAL and issuance of an Environmental Permit indicates that GoI environmental and consultation requirements are met.

10.3 Land Acquisition and Economic Displacement

Like other geothermal developments, the project requires a comparatively small footprint. Generally, an entire geothermal field uses 1-8 acres per megawatt (MW) versus 5-10 acres per MW for nuclear operations and 19 acres per MW for coal power plants. Fossil fuel power plants also require significant acreages for mining their fuel.

The project caused economic displacement mostly of farmers growing crops on the forest area. The project will require a total of 124.5 ha of land located in the districts of Kabupaten Muara Enim and Lahat Regencies, as well as in Kota Pagar Alam. The Project has acquired 9.5 ha private lands and 115 ha lands within Bukit Jambul Gunung Patah Protection forest area during exploration activity[2]. Table 62 summarizes the project land requirements.

[2] This land acquisition figure is different from the information in the SCAR, 2014, i.e. private land 19.4 ha, forest land 89.1 ha. Total 108.5 ha. The number of private land indicated in the SCAR is total land acquired by SERD while the information presented in this document is only the actual land used for the Project. Since 2014 SERD acquired more forest land for additional well pads.

Table 61 Project Land Requirements

Land use	Area (hectares)	
	Non Forest	Forest
Acquired Land		
Access Road	4.6	53.1
Wellpads	-	10.6
Other Facilities	4.9	5.7
Sub-Total	**9.5**	**69.4**
Land To Be Acquired		
Access Road and Pipelines	-	6.3
Wellpads	-	8.0
Other Facilities	-	14.1
Contingency	-	17.2
Sub-Total	**0**	**45.6**
Total Non-Forest and Forest Area	**9.5**	**115.0**
Total Land Acquired	**124.5**	

The project engaged with the project affected households (PAH) to disclose relevant project information, obtain stakeholder feedback and describe the compensation process with landowners. Stakeholders included individual households, village elders, heads of villages and hamlets and the local government. Within this acquired land area, a total of 153 households were affected, which includes 57 PAHs whose private lands and/or crops were affected and 96 PAHs within the protected forest whose coffee plantations were affected and who were eligible for crop compensation. None of the 153 households required physical displacement of housing and commercial assets. The project employed a negotiated settlement process to acquire the land, which started in February 2011 and was completed in January 2014. The 91 hectares of lands belonging to MoEF were assigned to PT SERD through Borrow-use permit (*Hak Pinjam Pakai*) permit for exploration dated 20 November 2012. This permit was extended on 19 March 2015 through the decree letter of Investment Coordinating Board Chairman No. 1/1/IPPKH-PB/PMA/2015.

Most of the land that has been acquired by PT SERD from individual land owners was small, that is less than 0.5ha per owner and most of this land was considered to be non-productive. Compensation paid to those affected ranged between IDR 5 million to more than IDR 50 million depending on the size of land and on the standing crops on the land.

The lands within the protection forest required for the development of wellpads and access roads have been cultivated by 96 households for coffee plantations since the 1980s by Semendo people, who shifted from the nearby Segamit village. The 19.4 ha private land belonging to 57 households are required to accommodate the access road improvements, soil disposal locations and the construction camp site. 100% of the land required has been obtained by PT SERD through negotiations with the landowners and cultivators. A grievance mechanism was made available to the affected stakeholders that allows them to submit specific concerns about compensation. No major grievances occurred in relation to the land acquisition and crop compensation process. Few grievances recorded in the registry were closed out in few days.

The remaining land to be acquired for the project is located mainly inside the protection forest and no cultivators and/or crop farmers were found. For using this area the project will have to obtain the Forestry Area Borrow Use Permit from MoEF through the Investment Coordinating Board. No compensation to individual households will be required.

Key applicable regulations include:

a. Presidential Regulation No. 65 of 2006 amending Presidential Regulation No. 36 of 2005 on the Procurement of Land for Realizing Development for Public Interest.
b. The 2012 Land Acquisition Act implemented by Presidential Regulation No. 71 of 2012 on Land Procurement Process for the Public Interest, amended by Presidential Decree No. 30 of 2015: much more detailed and aligned with international standards.
c. Minister of Environment & Forestry Regulation No. P. 50 of 2016 concerning the Forestry Area Borrow-Use Permit Guidelines.

Table 62~~Table 62~~ describes the compensation process. Further details on the process, affected people, land area and crops compensated and actual compensation amount are documented in detail (Appendix 3).

Table 62 PT SERD's Land Compensation Process

Step 1: Socialization ▪ Pre-acquisition socioeconomic baseline study and census (Appendix 8) ▪ Files are compiled containing results of identification of plants, buildings, and land for each cultivator ▪ Provide explanation of the land acquisition process and framework for determination of compensation value of plants, buildings and land
Step 2: Compile negotiation records consisting of ▪ Results of determination of plants, buildings, and land ▪ Calculation of compensation value to be offered for plants, buildings, and land ▪ Statement of person working the land expressing approval of compensation offered
Step 3: Signing of Land Acquisition and Compensation Agreement for Notarization ▪ Agreed compensation payments for plants, buildings, and land ▪ Transfer of rights for plants and buildings
Step 4: Setting up accounts at Bank BRI to transfer payments from PT SERD to each Cultivator
Step 5: Payment of Compensation ▪ Transfer of money to each Cultivator's bank account corresponding to the compensation value ▪ The sooner the signing, the sooner the payment is made

A Socioeconomic Baseline Study and Census (Appendix 8) was prepared before the acquisition. It contains socioeconomic baseline data, identifies landowners affected by the project, assesses the use and quality of the land and specifies who is eligible for compensation and assistance. A cut-off date for determination of eligibility was established to discourage opportunism. Information regarding the cut-off date was well documented and disseminated throughout the project area. A 2014 Environmental and Social Safeguard Audit confirmed that:

- The land acquisition process was transparent with active involvement of the affected persons.
- Compensation for land and assets was at replacement costs or higher.
- Expropriation of landowners/cultivators unwilling to part with lands did not occur; PT SERD identified alternate sites if needed.
- Affected landowners were informed of the project, acquisition process, compensation rates and are aware of the grievance mechanism.
- Consultations were carried out at various stages of the project planning and design with the affected communities, in a culturally appropriate manner (using both Bahasa Indonesia and the Semendo dialect) with facilitators from Semendo community.

Prior to the presence of PT SERD in the area, Segamit and Tunggul Bute were isolated villages with poor access of transportation to the area. Villagers used traditional mode of transportation such as horses to transport their produce and agricultural products such as coffee to the market. Previously, middlemen who came to the area determined the price of villager's agricultural products without the villagers' ability to negotiate the price. With the opening of road access by PT SERD, villagers can now use the road for their daily activities including the transport of their produce. They become more mobile by using modern mode of transportation such as motorcycles and cars. Currently, some of the villagers around the Project area sell their produce directly to the market. The development of Information Technology (IT) in the area also contribute to the improvement of community economy. Villagers are able to access real price information of their produce in the market, which makes them able to negotiate the price. Another notable development is the increase of land value in the project affected villages which previously was considered very low to 'no value'.

The development of community around the Project area is further strengthened with implementation of PT SERD's Corporate Social Responsibility (CSR) program. The CSR program is carried out based on 4 pillars as follows:

1. Health and Education - provides a wider and better health education opportunity for local communities, such as mass circumcision, improvement of school buildings, and scholarship.
2. Infrastructure - provides resources to address community needs in the form of better infrastructures such as better road access for the community, clean water facility, and electricity.
3. Economic empowerment - enchance community capacity/income and self sustaining capabilities, for example provision of trainings on coffee roasting and agriculture in collaboration with Sriwijaya University, and provision of plant seeds such as mangosteen and potato.
4. Community relations - enhance company and community relationship through participation and contribution on local values/wisdom such as supporting community public events like religious events and celebration of national independence anniversary.

PT SERD considers 5 aspects in designing and implementing the CSR program, 1) Local resources based; 2) Community based; 3) Economic empowerment; 4) Sustainable program; and 5) Participatory program. The external relations of PT SERD assisted the process of community participation to come up with good CSR activities that is sustainable. The mechanism of CSR program is designed in such a way that the program does not overlap with government development programs through stakeholders meeting which is carried out in October every year. PT SERD's CSR pillars and consideration aspects are in line with local government's plan to improve the condition of communities in Segamit and surrounding areas which were previously isolated thus had minimum level of development.

In conclusion, despite the magnitude of the economic displacement impact of the project (affecting 153 households) with 100% likelihood of happening, the Company was able to mitigate this impact through the implementation of an acceptable and successful land acquisition process that resulted in 100% acquisition of privately owned land needed. In addition, the impacts of the economic displacement was cushioned by the Company's CSR programs. The receptors of the impact were saticfactorily compensated (for value of land and crops) thus it could be argued that the duration of this impact has lapsed and therefore it is no longer a significant issue. The residual impact is PT SERD's security from future disputes on land ownership issue.

10.4 H_2S Emissions

H_2S contained in the non-condensable gas (NCG) could be a significant impact during drilling (well testing) at both construction and operation phases. GoI and GIIP emission standards are specified in Section 3.

Emission Inventory and Model Input

For the purpose of estimating the emission, a steady-state condition was assumed. The H_2S will be emitted together with other NCG from vents located above the mechanical evaporative cooling towers. The emissions concentration of the H_2S from the power plant was predicted by CALPUFF, which need to be calculated in units of grams per second (g/s) at the point of emission.

The PT SERD geothermal power plant will have two identical units of cooling tower. Each cooling tower will have five fan cells arranged in a straight line. The dimension of each tower is 80m long and 16m wide, with a height of 15m above base level. Summary of the source parameters for individual cells of PT SERD's Cooling Tower is provided below:

Table 63 Source Parameters for Individual Cells of Cooling Tower

Specification	Unit	Value
Stack height	m	15
Stack outlet diameter	m	10
Stack volumetric flowrate	m^3/s	580
Stack exit velocity	Mm	7.4
Flue gas temperature	°C	32

For the purpose of modeling, high gas case is used for the calculation. Summary of the calculated emission and other selected parameters are presented in Table 65.

Table 64 Calculated H_2S Emission Rate and Other Selected Parameters

Item	Unit	Value
NCG content in HP steam	% weight	1.60
NCG content in LP steam	% weight	1.15
H_2S content in NCG of HP and LP Steam	% weight	5.00
Temperature of exit airflow	K	305.15
Pressure of exit airflow	bar	0.80
Specific volume of exit airflow	m^3/kg	1.14
Mass flowrate of exit air	kg/s	507.50
Volume of exit airflow at normal condition (25°C)	m^3/s	449.00
H_2S concentration at normal condition	mg/m^3	30.00
H_2S mass flowrate	g/s	13.25

Note: All calculations represent one cooling tower cell (i.e. one fan)

The calculations by Aecom show that the PT SERD's H_2S emission concentration (30mg/m^3) meets the requirement of the Indonesian Emission Standard of 35mg/m^3 at normal condition.

Dispersion Modeling

Dispersion modeling is developed using the advanced 3D CALPUFF Modeling System. CALPUFF is a modeling system that is capable of modeling and analyzing air quality in a non-steady-state meteorological condition, in project areas with complex terrain. The CALPUFF modeling system was approved for air quality assessment by the US Environmental Protection Agency, from its Guideline on Air Quality Models.

Dispersion modeling uses a range of hourly-meteorological data, including temperature, humidity wind speed, wind direction and rainfall. The data are based on two sources; meteorological observation data from the PT SERD project site climate station, and CALMET meteorological forecast data. Comparison between these two data sets was done to validate the data before it is processed into a meteorological model for use in the dispersion model. This analysis showed that the similarity of the observation data and the forecasted data is very close indicating that the forecasted data is compatible for later usage in developing the dispersion model.

Modeling Domain and Representative Receptor Network

For this study, dispersion is modeled over 12km x 12km domain with the power plant cooling tower at the Centre. This domain is considered to have covered all settlements closest to the project area.

For the purpose of input into CALPUFF, receptor points are modeled in the form of representative receptor networks. The distribution of concentrations will be calculated based on this receptor network. In this model, the representative receptor is modeled as an arbitrary polar network with power plant cooling tower as its Centre point. In this network, the receptor points are placed at 500 m x 500 m grid. This generated 576 representative receptor points.

Sensitive Receptors

The impact of air emissions on sensitive members of the population is of particular concern. Sensitive receptors include residences, schools, mosques, churches, market places and clinics. They are selected by identifying rooftops from Google Earth Satellite Imagery. Using this approach, 81 sensitive receptors were selected. For assessing health impact of H_2S to the workers, eight random locations representing workers inside the plant were added to the sensitive receptors.

Modeling Result

24-Hour Average Incremental Hydrogen Sulphide

Map 16shows the predicted 24-hour average hydrogen sulphide concentration within 12km x 12km domain for the expected total hydrogen sulphide emission rate of 133g/s. Table 66 shows the predicted concentrations within smaller domain (3km x 3km). These figures were made based on spatial interpolation of predicted concentrations at gridded receptors.

Based on CALPUFF calculations at discrete receptors (at this case the identified sensitive receptors), the exceedance of the 24-hour incremental concentrations only occurs at one coffee farmer hut i.e. R54 located approximately 1.5 km to the east of the power plant. The predicted maximum concentration at this receptor is 30µg/m^3. The maximum incremental concentrations predicted at the other sensitive receptors are in the range of 5-28µg/m^3, or less than or equal to the odor standard.

Table 66 shows frequency distribution of predicted 24-hour average hydrogen sulphide concentrations at R54 within three years period of modeling.

Table 65 Frequency Distribution of 24-hour Average H_2S Concentrations at R54

Concentration Range* (µg/m3)	Frequency (days)	Percentage (%)
0-7	932	85.
8-14	119	10.9
15-21	42	3.8
22-28	1	0.1
>28	1	0.1

* Concentrations are rounded to one significant value

The hydrogen sulphide emissions from the proposed power plant are predicted to cause the R54 to exceed the 28 µg/m^3 odor standard only once in three years. The exceedance at R54 is only 0.1% of the time. Most of the time (>85%) the H_2S concentrations at this receptor will range from 0 to 7 µg/m^3. Thus the exceedance frequency or likelihood can be considered insignificant.

In addition, the predicted concentrations are well below the WHO guideline of 150 µg/m^3 and will not result in any adverse health effects.

8-Hour Average Incremental Hydrogen Sulphide

The 8-hour predictions have been undertaken to assess the potential health related effects as opposed to the safety standard, in addition to the potential odor nuisance effects. Table 67 shows the predicted maximum 8-hour average hydrogen sulphide concentrations at eight representative worker receptors resulting from emissions from the proposed power plant.

Table 66 Maximum 8-Hr Average H_2S Concentrations (µg/m^3) at Representative Worker Receptors (Sorted by The Highest)

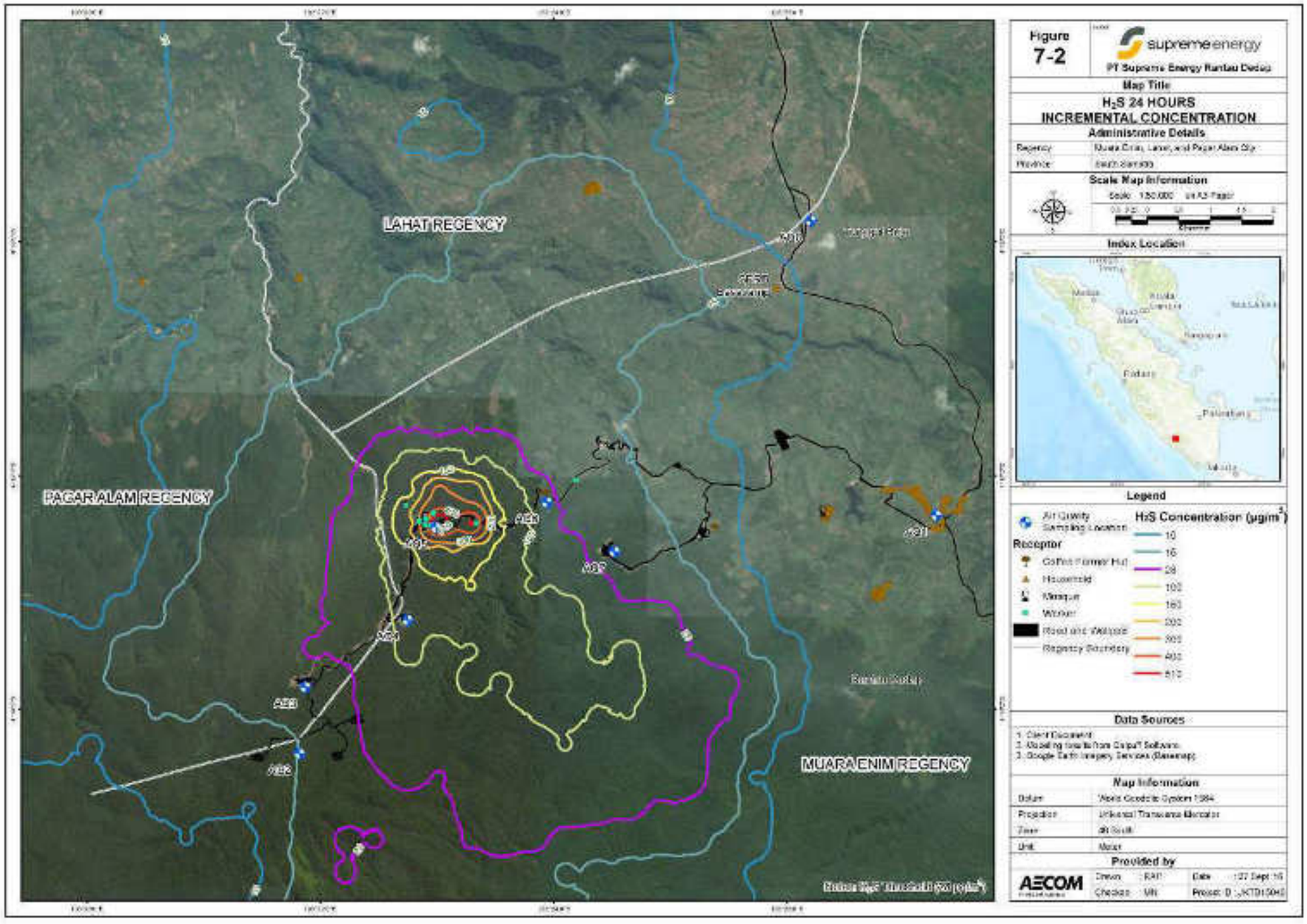
Receptor Number	MaximumConcentration * (µg/m3)
86	1,051
75	696
88	689
85	589
87	536
83	498
84	462
56	267

* Concentrations are rounded to one significant value

Map 18~~Map 18~~ shows the predicted 8-hour average hydrogen sulphide concentration contributions for the proposed power plant. There is no exceedance of the 8-hour incremental concentrations at representative worker receptors. The highest predicted 8-hr concentration is at receptor number 86 which is 1,051 µg/m^3, or 75% of the 1,400 µg/m^3 threshold value in the working environment as stipulated in Ministry of Manpower PP PER.13/MEN/X/2011. This receptor is located less than 100

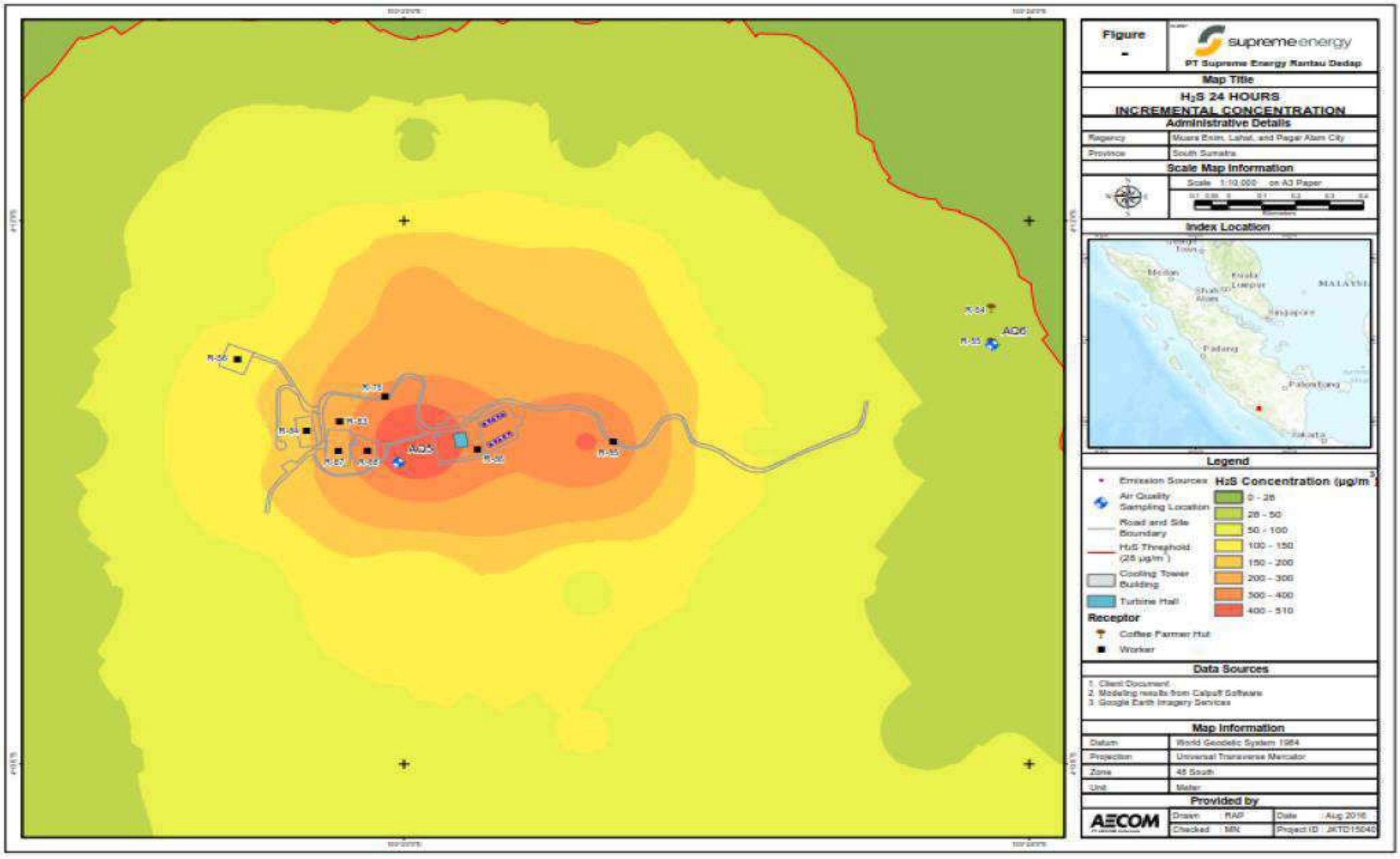
meter from the cooling tower. The incremental concentrations predicted at the other worker receptors are in the range 267-696 µg/m^3, or 19-50% of the threshold value.

In conclusion, based on the low magnitude of the calculated and modelled concentrations of H_2S (both below the applicable standards), almost negligible likelihood of exceeding the standards (<1% for receptors outside the plant and non-exceedance for worker receptors), and very low frequency of occurrence (once every 3 years), H_2S emissions will not have significant impacts on worker's health and safety and to surrounding communities (including farms). For surrounding communities, odor may sometimes be noticeable however, though this is a nuisance, it is not toxic and therefore not a significant impact. That said, H_2S emission of the power plant will not have any residual impacts.



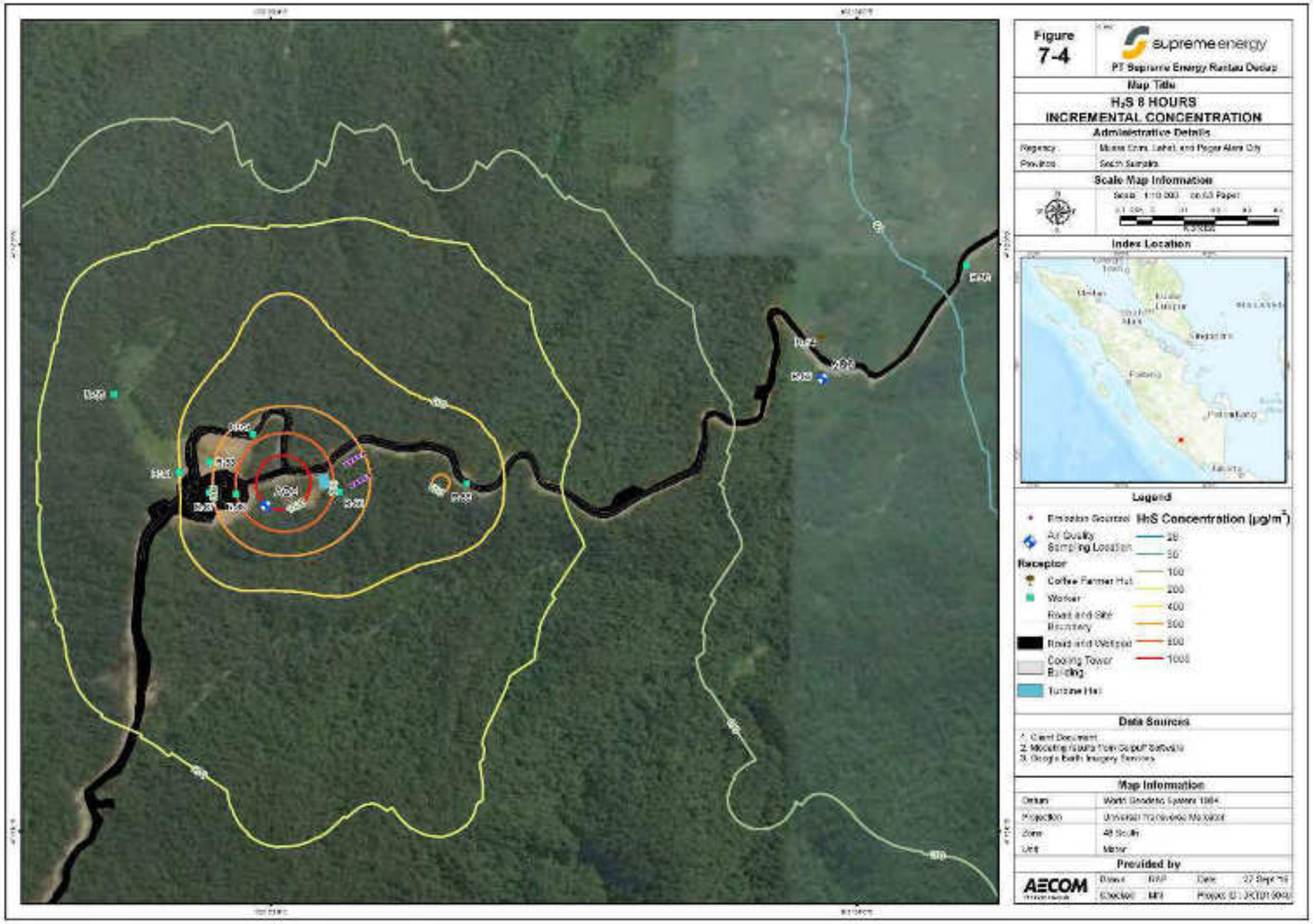
Map 16 Predicted Incremental 24-hour Concentrations of H2S (µg/m³) within 12km x 12km Domain

Source: Air Dispersion Modeling Results Report, 2016



Map 17 Predicted Incremental 24-hour Concentrations of H_2S (µg/m^3) within 3km x 3km Domain

Source: Air Dispersion Modeling Results Report, 2016



Source: Air Dispersion Modeling Results Report, 2016

Map 18 Predicted Incremental 8-hour Concentrations of H_2S (µg/m^3) within 3km x 3km Domain

10.5 GHG Emissions

10.5.1 Geothermal Compared to Typical Baseline Alternative

To meet growing power demand, new power systems must be developed. Geothermal is a low-GHG emission option that is renewable. Though coal, gas and diesel tend to be the most commercially viable in Indonesia, geothermal energy is widely available in Indonesia and represents an especially large-scale clean renewable energy option-- especially in comparison to solar and wind. Compared to hydro, geothermal has a much smaller footprint as it does not have the typically negative land use impacts of hydro (utilization of large land area for water impoundment, impacted rivers, resettlement, etc.).

The Rantau Dedap project was originally developed as a Clean Development Mechanism (CDM) project under the UN Framework Convention on Climate Change. Under the CDM, the comparison of the project emissions to a defensible baseline constitutes the emission reduction (e.g. carbon credits). In South Sumatra the grid was determined to be a blend of hydro, diesel, coal and natural gas. Greenhouse Gas emissions from geothermal projects are primarily from CH_4 and CO_2 in the NCG. The original CDM project was based on a 250MW development, not the current 92MW phase, that produces 156,018tCO_2-equivalents annually resulting to a reduction of 1,099,745tCO_2-e per year from baseline.

The GHG emission generated annually from the 92MW project is about 41,475 tCO_2-e per year or a reduction of 452,268 tCO_2-e/year from baseline (South Sumatra grid) and over a 30-year project life the total emissions is calculated to be 1.24 million tCO_2-e resulting to a total reduction of 13.57 million tCO_2-e.

Based on the magnitude of the potential GHG emission reductions and the certainty that this will occur if the project is implemented, this impact should be considered as a significant positive contribution to the environment and climate change. The expected residual impact is prevention of substantial GHG emission compared to other types power generating projects that could have been implemented to meet the increasing power demand of the region.

10.6 Mercury

Mercury content is low in drilling cutting (< 0.05 mg/L, measured in 2014) and steam (0.0027 - 0.0064 mg/kg, measured in 2015). Mercury maybe contained in the NCG but it will be in a very small amount. Based on this very small magnitude, this impacts is considered insignificant and therefore has no residual impact.

10.7 Dust

Dust will be generated from the road by vehicles from equipment and material mobilization during construction affecting residential areas of Kota Agung and partially at Tunggul Bute Village.

The dust concentration measured as part of the ANDAL baseline study ranges between 31 and 78 µg/Nm^3 which are still below the national daily standard of 243 µg/Nm^3 as stipulated in the regulation (PP 41/1999). This data was collected during the dry season which may represent the maximum possible dust concentration in the area. In the rainy season, this number may drop due to the dust being watered down by the rain.

Using the baseline data in the dry season, dust line source modeling result predicted dust intensity will reach a concentration of up to 341.7 µg/m^3 at 25m. The total concentration of dust during construction is estimated to reach 457.7 µg/m^3 at most, which exceeds the standard of 90 µg/m^3 (Figure 36).

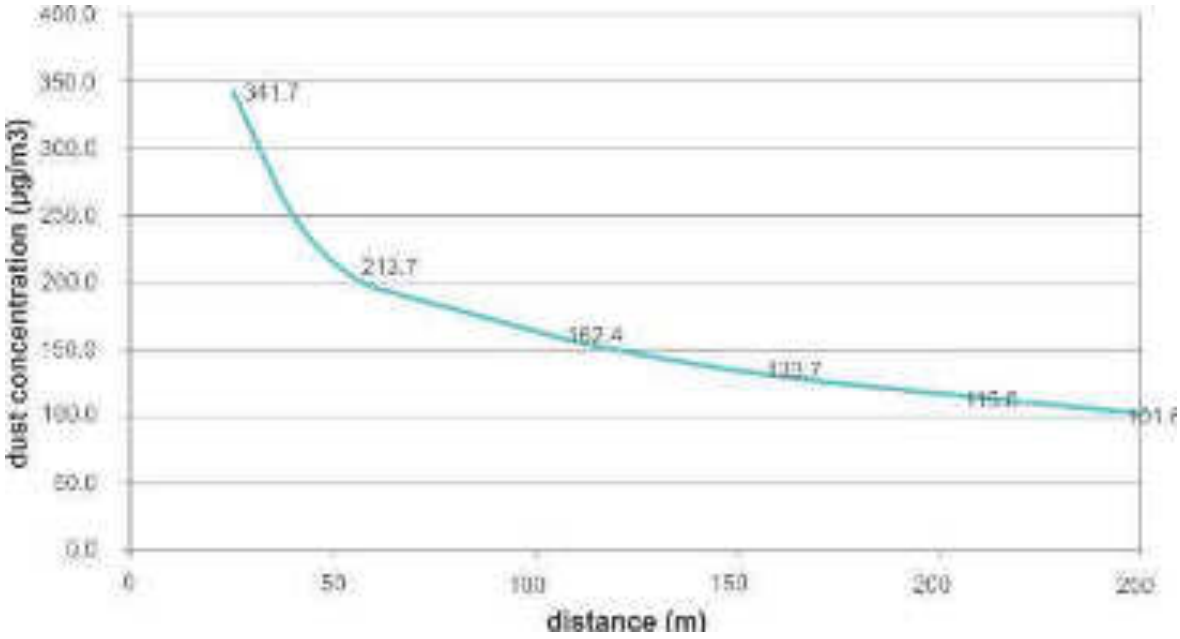


Figure 36 Predicted Dust Concentration, ANDAL baseline study, 2016

During construction stage of Phase 1 development, water trucks will be used for watering the road and vehicle speed will be limited in residential areas. The additional wellpads (Wellpad L, M, N and X) and the Power Plant are far from residential areas, hence their development will not affect the generation of dust in these areas.

The dust measurement and modeling undertaken during the ANDAL baseline study shows that the magnitude of dust has the potential to rise by as much as 3.5 times the standard (at 25m from source), hence this should be considered as significant impact even if receptors are far. Although the occurrence and duration is limited only during the construction stage, mitigating measures should be developed and implemented during the time of occurrence.

No residual impact is expected as dust propagation is limited only during construction period and can be effectively suppressed with appropriate mitigating measures.

10.8 Noise

Noise will be mainly generated during construction (drilling, production testing, equipment mobilization). Baseline study in the ANDAL measured that the noise level ranges from 41 – 59 dBA. Vehicle speed will be limited in residential areas to reduce dust as well as noise generation. The location of the power plant construction, drilling and production testing will be more than 7 km away from the nearest communities.

Bi-annual monitoring undertaken as part of the explorations phase UKL-UPL indicated that noise levels at industrial and residential locations complies with the Indonesian standards (i.e. 55 dB for residential and 70 dB for industrial areas).

The ANDAL baseline study showed that noise level at residential areas may exceed the Indonesian standard. The magnitude is not substantial and the frequency is low (i.e only during the passing of vehicles), hence this impact is deemed insignificant. The proponent plans to undertake the hauling of equipment and supplies during mobilization at night time to avoid congestion, accidents and minimize disturbance at the residential areas. The noise to be generated may exceed the standard for residential areas at night time which is 45 dB based on the outcome of the noise survey. To ensure that strict implementation of slowing down in residential zones will be observed, traffic marshals shall be provided at all times.

The power plant which is located very far from the receptors will not create noise disturbance to the communities. However the well drilling activities may disturb and confuse nearby wildlife. To minimize this impact, gradual raming up of drilling intensity will be practiced to allow nearby animals sufficient time for dispersion.

The limited mitigation (i.e. slowing down of passing vehicles, scheduling of the mobilization trips) may be adequate to reduce the noise nussaince. No residual impact is expected.

10.9 Water Use and Quality

Water usage has been estimated by PT SERD using empirical method based on actual recorded water consumption of drilling during exploration phase, other recognized usage values and water usage calculated by the Engineering department. The maximum water consumption for the Stage 1 development and EPC construction that includes provision for drilling of two wells is estimated to be 3,551.48 m^3/day or 41.1 liters/sec. This will be abstracted at the main water intake #3 located at Cawang Tengah/Kiri River which has a discharge rate of 981 liters/sec. From there water will be pumped via the Service Water System to the well pads and construction sites. The analysis showed that the maximum water requirement of the development and construction is only 4.2% of the total discharge flow of Cawang Tengah/Kiri River (Ref: SERD-PRD-MEM-0009 dated 19 September 2016).

During construction phase, fresh water will be predominantly used for the concrete batching plant and cleaning and domestic use at the EPC contractor's camps and drilling operations of two geothermal wells at a time.

In the operation phase, water consumption will be much lesser at 8.65 m^3/day or 0.1 liters/sec. This will be taken at water intake #2 which is 0.5% of the total discharge flow.

Significant amount of water will be used for cooling water at 600 m^3, however the cooling water will be recycled in a closed cooling system, hence consumption due to system losses (e.g. leaks, evaporation) will be very low.

PT SERD will extract limited amounts of river water from Cawang Kiri and Cawang Tengah Rivers for domestic consumption, drilling activity, construction, and process cooling water. These 2 water intakes are designed and constructed to have a limited impact on the water courses.

Water Use Permit (WUP) or *Surat Izin Pengambilan dan Pemanfaatan Air* (SIPPA) was obtained under South Sumatra Governor Decree No. 193/PTSP-BP3MD/IX/2015. This permit has been secured from the previous exploration activity and restricting PT SERD to extract at 467 m^3/day volume of water.

PT SERD may apply for additional WUP but since the peak consumption will happen only during development and construction stage more particularly during the drilling of the geothermal reservoir that last about 19 days, scheduling and water impounding pond may be resorted to ensure adequate amount of water will be available at the time of peak consumption. In addition, portion of the water requirement of drilling will also be supplied by recycled water from the mud ponds which is a general industry practice.

PT SERD installed water meters and water valves to measure the monthly water usage which is included in the monthly monitoring report. The frequency of measurement and reporting will be revised if the water usage approaches the allowable limit.

Drilling, including water usage, will be scheduled so that it does not interfere with surface water conditions and the needs of downstream communities.

The impact from surface water usage is not significant considering the very low magnitude of the water demand of the project (4.2% of the river discharge rate during development and construction and 0.5% of the source discharge rate during operations).

10.9.1 Erosion and Sedimentation - water quality, increased run-off rate

Earthwork activities for land clearing of well pads, access roads, the power plant and associated facilities as well as cut and fill activity may change surface run-off patterns and cause localized erosion and sedimentation.

Erosion rate may increase, as a result of land cover change from forest to open area. As erosion rate increases, so does sedimentation. The existing facilities included the construction of the bridges at Endikat River, access to Wellpad B (Cawang Kiri River), shortcut road (Cawang Tengah River) and Asahan River. Modeling in the ANDAL uses Sungai Endikat as a scenario for calculating TSS increase. TSS baseline at Endikat River is 7.92 mg/L and as a result of erosion, it will increase to 10.9 mg/L. This calculation has taken into consideration that surface runoff management is implemented that runoff will be <100 mg/L before entering waterbody.

The location of the new wellpads is far away from a stream or river, and hence erosion is not expected to reduce water quality of waterways. Figure 37~~Figure 37~~ shows potential erosion points and erosion rate per year.

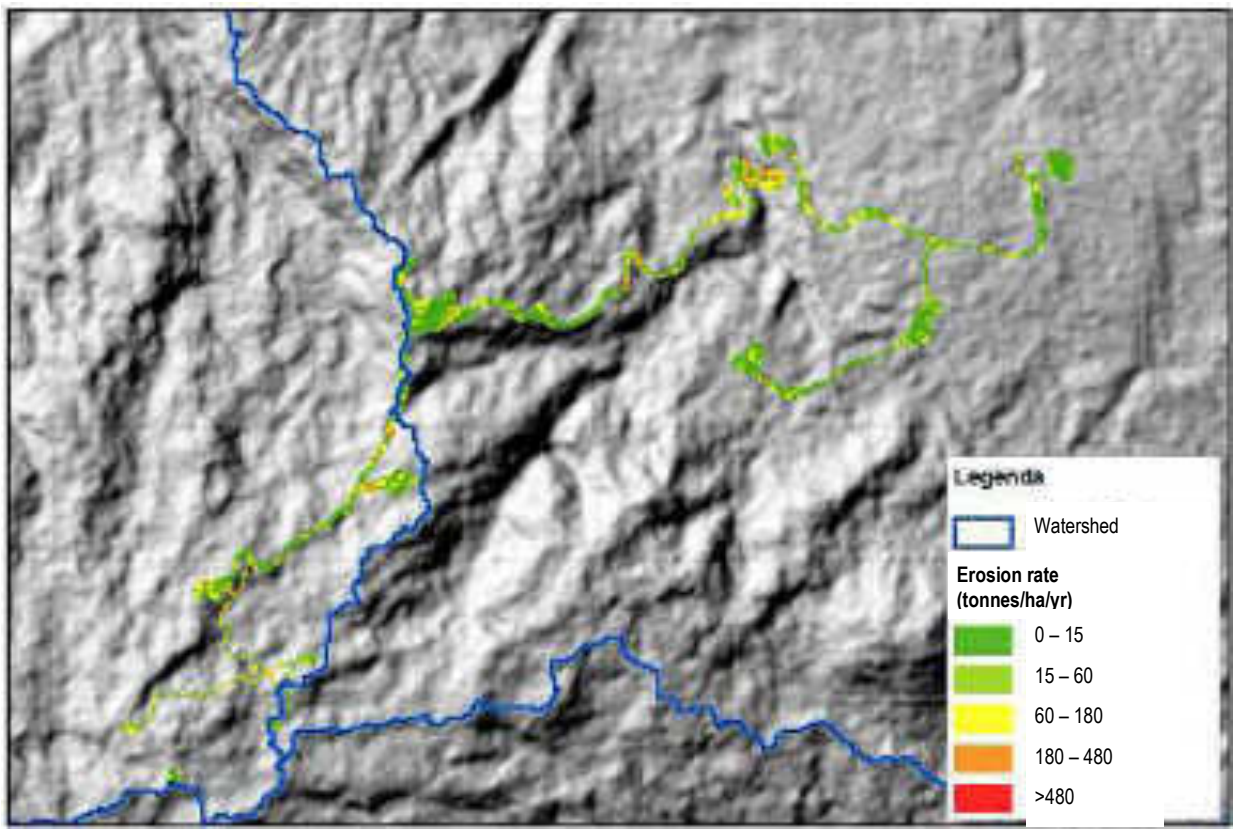


Figure 37 Potential Erosion Points and Predicted Erosion Rate/Year

Erosion and sedimentation are considered insignificant impacts as the magnitude is very small and occurrence is limited during constructions stage. In addition, open areas that maybe potential sources of erosion such as wellpad are very far from the receptors (i.e. water courses).

10.9.2 Erosion and siltation – Soil Disposal Area

To store the excess excavated soil expected only in the construction of the new access roads to new Wellpads L and M, two soil disposal areas shall be located in the new well pad areas. Soils are loose materials that are susceptible to erosion that may result to siltation. To avert this unwanted consequences, it is a common practice that storage areas are designed generaly flat but slightly sloping is a single direction so that surface water will flow to a common area where catchment canal with series of silt traps are constructed. These measure effectively control erosion and transportation of the soil stockpile.

To prevent the runoff from surrounding areas from flowing into the soil disposal area, diversion ditches or berms are constructed at the perimeter of the upper portion of the disposal site. In this way the amount of water that will be potentially contaminated by soil will be reduced.

With the availability of good practices in preventing soil erosion and siltation such as those mentioned, these impacts can be easily prevented and managed, thus making them insignificant.

10.10 Geohazards – Flood and Landslides

Geohazards in the form of flooding and landslides are insignificant risk to the project due to the low likelihood of happening. The project area is well drained and most of the structures like the pipelines are designed to be constructed well above ground to avoid the impact of flash flooding during

exceptionally high rainfall events. Moreover there are no steep open slopes that maybe susceptible to landslides.

10.10.1 Flood Risk

PT SERD has adopted a staged approach to assess flood risks:

- Stage 1 Flood risk identification to identify whether there may be any flooding or surface water management issues related to project development that may warrant further investigation;
- Stage 2 Initial flood risk assessment to confirm sources of flooding that may affect a specific project component (e.g. pipeline), to appraise the adequacy of existing information and to scope the extent of the risk of flooding; and
- Stage 3 Detailed flood risk assessment to assess flood risk issues in sufficient detail and provide a quantitative appraisal of potential flood risk to the project (or any part of it), of its potential impact, and of the effectiveness of any proposed mitigation measures.

The principle actions in flood risk management planning are to (see also Figure 38~~Figure 38~~ below):

- Identify potential flood risk early in the planning process;
- Select development locations with little or no flood hazard thereby avoiding or minimizing the risk;
- Commit to a location at risk of flooding only when there are no alternative, reasonable sites available in areas at lower risk that also meet the project objectives;
- Design project with careful consideration of flood risk and design appropriate mitigation measures; and to
- Ensure appropriate emergency planning measures are in place.

Figure 38 Flood Risk Management Hierarchy

The Rantau Dedap project has a small footprint relative to the catchment area, has avoided obvious flood risks in project siting and design and does not produce impacts that will increase flooding (e.g. earthworks, road construction, facility siting, etc.). Additionally, it is important to note that an ESIA is

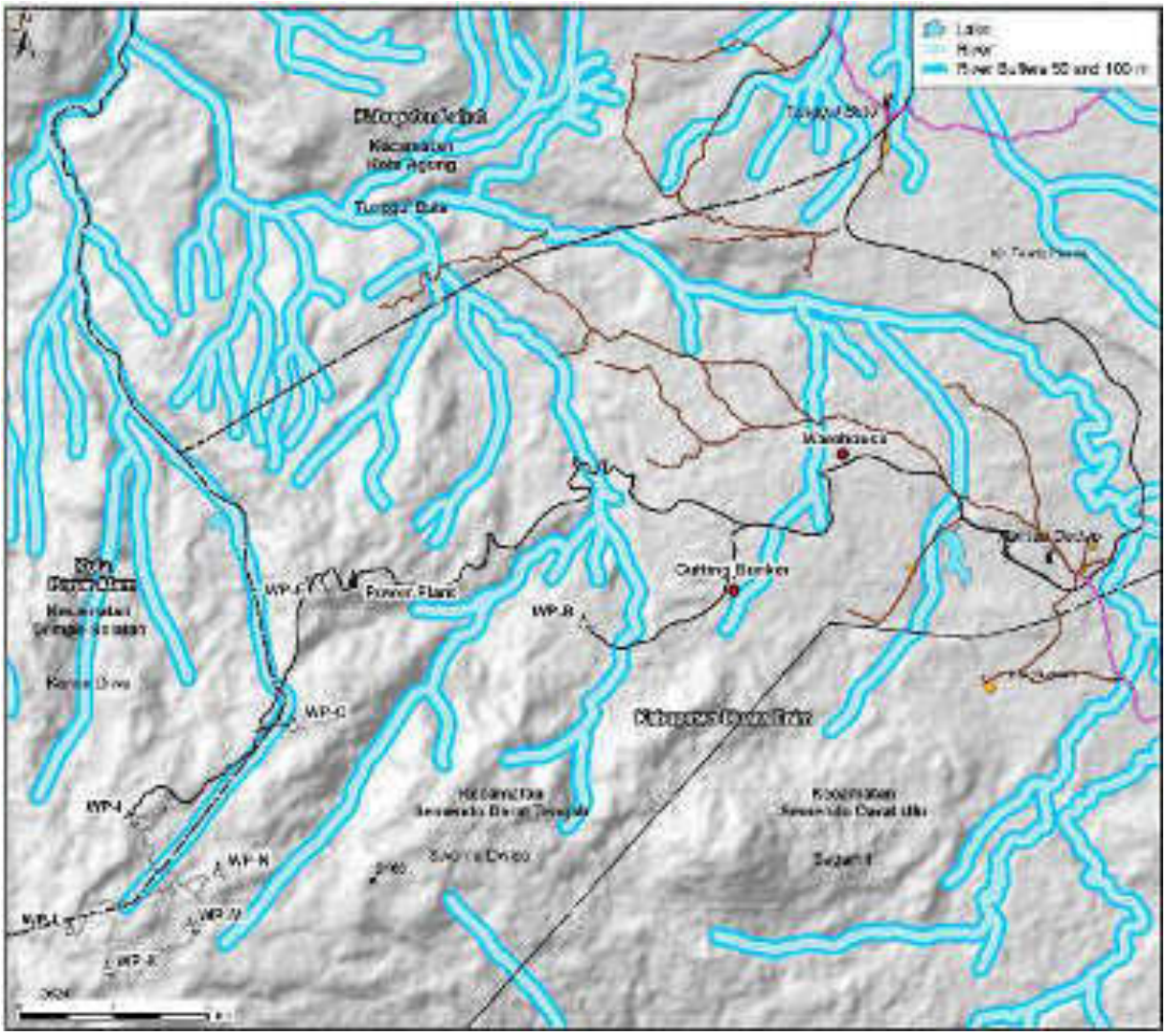
not the sole or primary mechanism for a capital project to address flood risk. The siting, design and layout and construction methods of the project all seek to minimize such risks for budget, engineering and schedule reasons. As such, project engineering and construction play key roles in addressing such risks, including analyses and decisions that predate the ESIA. That said, the Rantau Dedap project ESIA screens potential flooding and helps gain a better appreciation of the significance of peak water flows (Stages 1 and 2 above) and further inform project decision-making.

10.10.1.1 Stage 1 Flood Risk Identification

Flash floods in creeks and rivers in the project area are likely to occur given that the project is located in an area of high rainfall and steep topography. Flash/peak flows are largely affected by the level of precipitation and its abstractions, and the size of the catchment area:

- The importance of the size of catchment areas for estimating peak flow is obvious: Firstly, peak flow (as well as base flow) increases with catchment area size. Secondly, surface water discharge responds more rapidly to rainfall as the size of catchment areas decreases. The periods of rising, peak and falling water represent the flood curve. Small streams respond very rapidly to local rainfall and their flood curves are very spiky / flashy.
- Abstractions of precipitation in its evolution into run-off are numerous, and are influenced by factors such as topography, land use and land surface, vegetation, soil type, flow diversions, and channelization. Abstraction factors are often readily estimated using field and published research data. As for catchment area, the importance of topography is also clear: flood flow responds more rapidly to rainfall if the terrain is steep.
- In the project area, sub-catchment areas are relatively small (Map 19~~Map 19~~) and are located in steep mountainous terrain. It is reasonable to assume that the main Endikat River and its tributaries will respond rapidly to rainfall, and floods will be in form of flash floods, depending on rainfall intensity. In plain terms, the area is well drained that occurrence of flash flood aside from creeks and rivers is very unlikely.

As illustrated in Map 19~~Map 19~~the proposed power plant site and well pads are not located close to water courses and are therefore not considered at risk of flooding. In some cases, however, the pipeline route will need to cross water courses increasing the risk of pipeline damage due to flooding and/or collision with boulders carried downstream by floodwater.



Map 19 Site Hydrology Illustrated

10.10.1.2 Stage 2 Initial Flood Risk Assessment

Screening for flood risks is based on elaborating on three main components of site hydrology: intensity, duration, and frequency of rain fall events; estimates for peak flood events; and location of project structure/component. More specifically screening for flood risks is by

- Estimating intensity, duration, and frequency (IDF) of rain fall events;
- Determine catchment areas and drainage system;
- Analytical analysis of run-off using the Rational Method to estimate peak flows, and to test variation in input data; and
- Estimate flood risk based for key facilities based on location within the catchment areas.

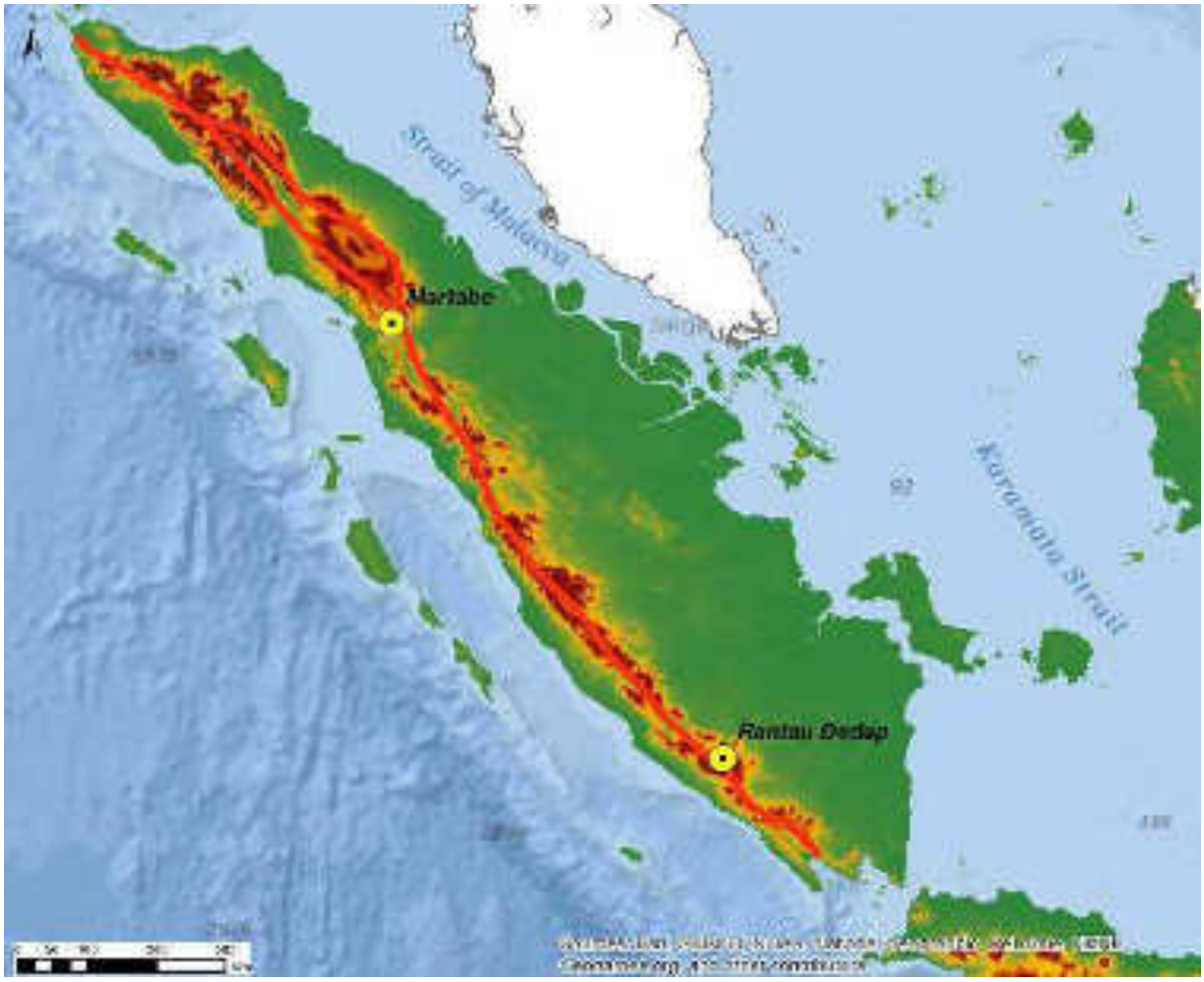
Estimation of Intensity, Duration, and Frequency of Rainfall Events

The importance of precipitation (or rainfall) is also obvious, the higher the rainfall the higher the run-off. However, it is much harder to define what constitutes a high or low rainfall, because rainfall is measured as rainfall intensity. The intensity of rainfall is a measure of the amount of rain that falls over time measured in the height of the water layer covering the ground in a period of time, say 30

mm of rain per day or 20 mm in two hours (one mm of water equals one liter of water on a square meter). Rainfall intensity is the single most important factor in estimating peak flow. High intensity of rainfall on steep slopes, as it is the case in the project area, may lead to flash floods.

Rainfall is commonly expressed in terms of intensity (I), duration (D) and frequency (F), summarized in form of IDF curves. Establishing a reliable IDF curve to estimate flood events requires long-term continuous rainfall monitoring records. For example, a 2 or 3 years' data record is insufficient to extrapolate IDF data over 50 years or more.

Continuous rainfall monitoring data at the Project site over a long period are not available to derive IDF curves required to estimate design floods. For screening purposes reference is made to continuous rainfall monitoring data from the Martabe Gold Project about 800 km north east of the project site which has recorded rainfall continuously for close to two decades. However, both sites differ in relation to the mountain range (Map 20~~Map 20~~): The Martabe Gold Project is located on the western side of the range facing the Indian Ocean, while the PT SERD project site is located on the eastern side of the range. It is reasonable to assume that the Martabe site is wetter on average.



Map 20 Location of Project area and Martabe Gold Mine Illustrated

At Martabe records of daily rainfall indicate an average annual rainfall of 3,880 mm/year. Monthly rainfall tends to be highest in October to November and lowest in June. While the rainfall pattern compares favorably to estimated rainfall pattern at the project site (see Chapter 7), the annual average of about 2,609 mm at the Project site is well below the measured values at Martabe.

Figure 39~~Figure 39~~illustrates approximate IDF curves developed for Martabe Gold Project. Note that given that the annual average at the Project site is well below the annual rainfall average at Martabe, IDF curves at the project site will also be well below the Martabe estimates.

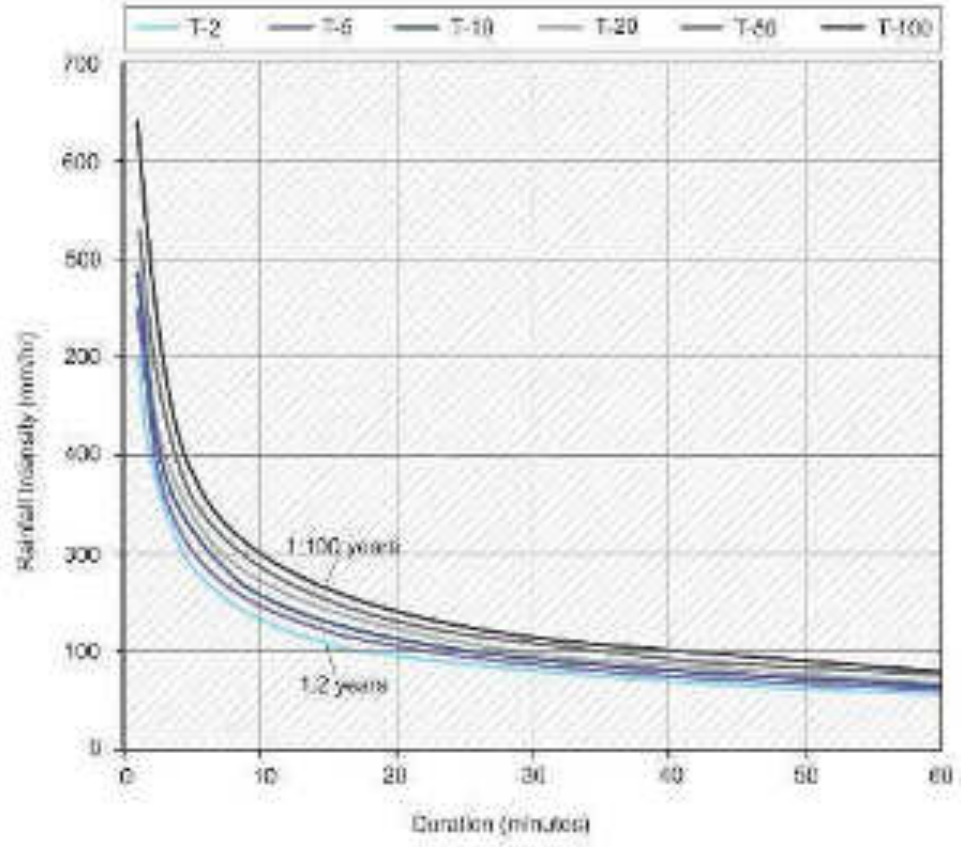


Figure 39 IDF Curves based on Rainfall Intensity at Martabe Weather Station

The Intensity-Duration-Frequency (IDF) analysis illustrates the probability that a given average rainfall intensity will occur. Multiple curves are plotted on the same graph with each line representing the average frequency between occurrences for a given rainfall. For example, the 30-minute rainfall intensity with 1 in 100-year occurrence likelihood is estimated at 130 mm, the equivalent 15-minute rainfall intensity is 180 mm (Martabe site).

Catchment Areas and Drainage System

The Project is located in a highland valley surrounded by steep mountain ridges and on ridge flanks and crests. The overall catchment area is bordered by mountain ridges to the southwest and northeast. In the upper catchment area there are numerous sub-catchment areas, all of them feeding into the main Endikat River to the north.

These upper catchments of the Endikat River are really small (~200 ha) and mostly located to the northeast of the wellpads and power plant location, which are situated on local ridge tops.

Topography, soil type and vegetation cover in all sub-catchment areas are similar: terrain is mountainous with steep slopes, covered by highland rainforest. As catchment areas are similar to each other, this flood screening exercise assumes that runoff from each sub-catchment area in response to a given rainfall event will likely differ proportionally to the size of the catchment area.

Given the characteristics of these sub-catchment areas runoff will respond very rapidly to local rainfall so that runoff hydrographs are spiky. Water flow in streams will peak rapidly after rainfall with high intensity, subsiding to normal base flow shortly after.

Analytical Analysis of Run-Off Using the Rational Method

For catchment areas less than 100 to 200 ha with generally uniform surface cover and topography the Rational Method, using an empirical linear equation, allows peak runoff rate to be estimated from a selected period of uniform rainfall intensity as a function of drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time of concentration (the time required for water to flow from the most remote point of the basin to the location being analyzed). The Rational Method is expressed as follows:

DISCHARGE = AREA X RUN-OFF COEFFICIENT X RAINFALL INTENSITY

Application of the Rational Method involves the selection of a coefficient that is appropriate for topography, soil, and land cover/use. The run-off coefficient can range between 0 (entire rainfall evaporates/infiltrates) and 1 (entire rainfall reports as run-off). While the assignment of the runoff coefficient is somewhat subjective, its range can be quantified using well-established estimates in the literature for different land cover and slopes, etc. In this study an average runoff coefficient of 0.5 is derived from consideration of topography, soil type and vegetation cover.

This flood risk screening uses concentration time of 30 min based on average catchment size and topography, suggesting an intensity of around 130 mm/hr from the derived IDF curve (1 in 100 flood).

The Rational Method suggests a 1 in 100 peak flow up to 80 m^3/s at the river close to the drilling camp and warehouse considering an upper catchment area of about 400 ha. Actual flow will be likely less given that the IDF Curve developed for Martabe are likely above the curves for the project site, and the Rational Method is applied to a larger area. The 1 in 100 peak flow at the outflow of the sub-catchment area is estimated at around 40 m^3/s.

Water depths related to peak flood are not estimated in this screen exercise. Water depth will depend on geometry, slope, and roughness of the drainage channel under consideration. For the purpose of this flood risk screening it is assumed the flooding could affect an area to 50 m to 100m to both sides of the surface drainage channel (as illustrated in Figure 39). Note that in steep terrain, water flow will be concentrated in narrow channels given high flow velocities. The opposite applies in flat terrain.

Estimate Flood Risk Based for Key Facilities

The following table summarizes the outcome of flood risk screening considering location, topography, and peak flows.

Table 67 Flood Risk Screening Result

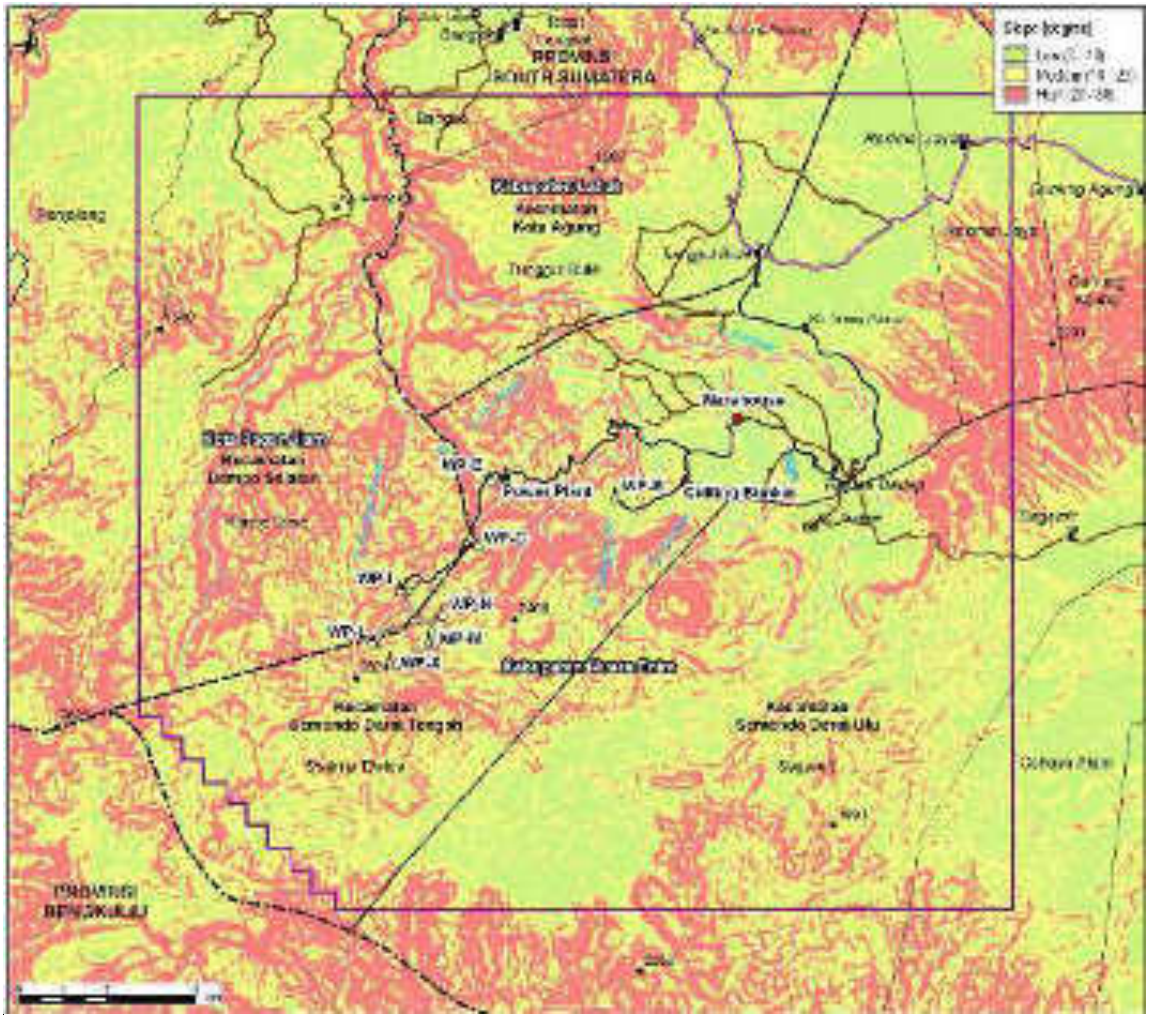
Structure	Location	Risk
Power plant	The proposed power plant is located about 100 m distance from the nearest surface water drainage channel on elevated ground. The location sits upstream of the beginning of the catchment	low
Wellpad WP-B	Wellpad WP-B is on an elevated ridge over 500m and well above the nearest surface water drainage channels.	low

Structure	Location	Risk
Wellpad WP-C	Wellpad WP-C is located some 600m uphill on a ridge above the nearest surface water drainage channel.	low
Wellpad WP-E	Wellpad WP-E is near the Power plant, some 200m uphill on a ridge above the nearest surface water drainage channel.	low
Wellpad WP-I	Wellpad WP-I located on top of the hill, some kilometers distal from the nearest surface water drainage channel.	low
Wellpad WP-L	Wellpad WP-L located on top of the hill, some kilometers distal from the nearest surface water drainage channel.	low
Wellpad WP-M	Wellpad WP-M located on top of the hill, some kilometers distal from the nearest surface water drainage channel.	low
Wellpad WP-N	Wellpad WP-N located on top of the hill, some kilometers distal from the nearest surface water drainage channel.	low
Wellpad WP-X	Wellpad WP-X located on top of the hill, some kilometers distal from the nearest surface water drainage channel.	low
Access Roads	From the power plant site to all other infrastructure sites except the wells there are over 10 river channel crossings. These locations have a greater catchment area than Wellpads and Power plant. Significant peak flow at the bridges/crossings may cause flood damage.	medium
Drilling Camp/ Warehouse	The Drilling Yard and adjacent Warehouse are situated on slightly elevated ground some 100m or so from the nearest surface water drainage channel.	low
Cutting Bunker	The Cutting Bunker is located on an elevated ridgeline some 200m and uphill from the nearest surface water drainage channel.	low

10.10.2 Landslide Risk

This ESIA provides an initial landslide risk screening to identify areas that could potentially be susceptible to land slide hazards risk, with subsequent risks to community safety. The detailed geotechnical study and landslide risk assessment is mainly the concern and responsibility of engineering and design (FEED, EPC contractor).

As can be seen on the Slope Map (Map 21~~Map 21~~), villages and individual houses within the project area are located on relatively flat areas that are suitable for housing and farming distal to steeper upper portion of the catchment areas. Similarly, most of the wellpads, power plant and support facilities including the access roads are also located on areas with relatively low sloping areas. Many wellpads are adjacent to steep terrain, but tend to be uphill on ridge tops, so any triggered landslides would tend to move away from these locations. As a whole, settlements and agricultural land within the project area are not exposed to landslide risk potentially triggered by project activities.



Map 21 Slope Conditions within the PT SERD Project Area

10.11 Waste Management

(Extract from ANDAL Section 1.2.3.4)

The project will seek to avoid the generation of waste; where it cannot be avoided, the project will reduce, recover or reuse waste in a manner that is safe for human health and the environment. Where waste is produced, PT SERD will treat, destroy or dispose of it in an environmentally sound manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste. Residual construction materials will be collected and reused or handed over to a third party for reuse or disposal.

Wastes can be categorized into:

- Solid Non Hazardous Waste
- Hazardous Waste
- Wastewater

10.11.1 Solid Non Hazardous Waste

Drilling mud and cuttings are wastes generated during drilling activity. Water based mud is used for well drilling, containing calcium (Ca) and barium (Ba). The waste is classified as non-hazardous waste. Drilling cuttings are also classified as non-hazardous waste as it consists of fragments of the natural subsurface rock formations which were collected during the drilling operations. Drill cuttings can be reused as construction materials, filling materials or stored in a lined storage area.

Other non-hazardous wastes are generated from camps and offices such as papers, cardboards, plastics, and aluminum cans, as well as sewage sludge. The volume of non-hazardous wastes will be at peak during construction phase but will be much lesser in operation phase.

List of complete non-hazardous waste is described in PT SERD Waste Management Plan contained in the list of SOPs (Appendix 12).

Solid non-hazardous waste impact is considered insignificant mainly due to very small amount generated and can be easily managed through an effective Waste Management Plan.

10.11.2 Hazardous Waste

Hazardous wastes will be generated from numerous activities:

- Maintenance workshop i.e. used oil, oily rags, oil in oily water separator and batteries;
- Power plant i.e. Build up sludge from the cooling water and transformer coolant;
- Office i.e. printer toner, fluorescent light, and batteries.

Except during the construction, the project will not require substantial fleet of heavy equipment, thus the amount of work that will be undertaken at the workshop will be very limited. Hence the expected amount of hazardous waste is not significantly large that it cannot be properly managed. The magnitude of this impact is therefore insignificant.

10.11.3 Wastewater

Brine and condensate are the main wastewater in the project. Brine is water-associated-steam containing high saline of approximately 5,800 mg/L. Brine will be produced during production test from AFT and from separator station during operation. Condensate is wastewater forming due to condensation of steam in the condenser. Condensate contains TDS of 3,550 – 5,800 mg/L. These wastewaters are reinjected to the reservoir through brine and condensate reinjection wells. Figure 41 below presents the water mass balance of brine and condensate.

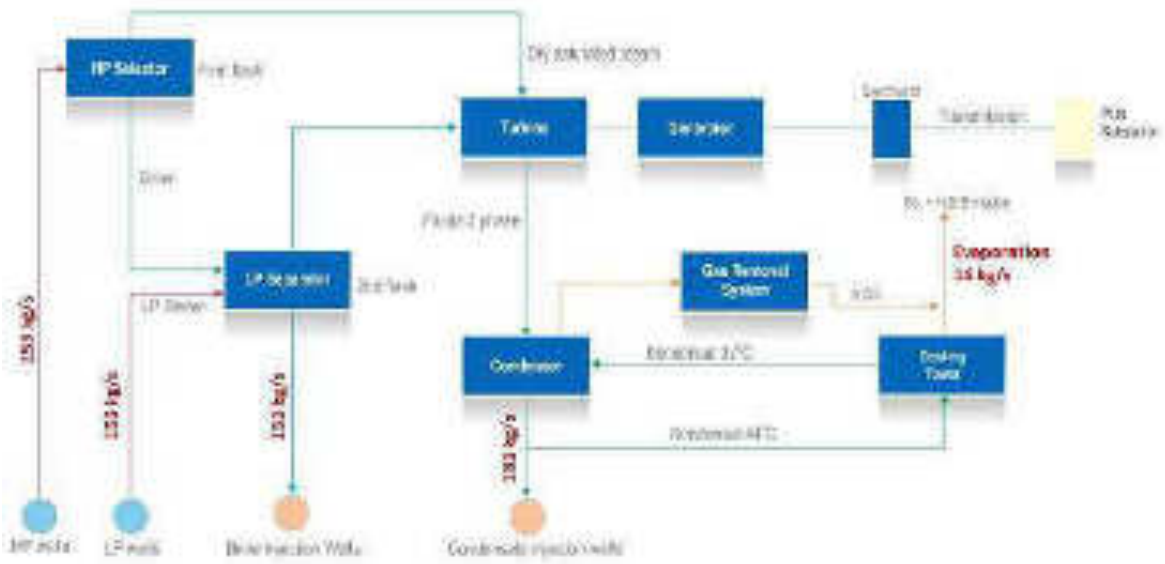


Figure 40 Brine and Condensate Balance

Acidizing activity using acidizing agent HCl and HF may be applied to prevent or remove silica scales inside a pipe. The wastewater will be reinjected to reservoir and will be neutralized naturally when it comes in contact with the subsurface rock.

During construction, basecamps and office will consume about 100 m^3/day and will produce almost the same volume of domestic wastewater. These wastewater will be directed to septic tanks and other water treatment facility. At the construction site, water usage will be 200 m^3/day for the batching plant and another 200 m^3/day for cleaning, washing, and flushing of pipes (Ref: SERD-PRD-MEM-0009, 19 Sept2016). Thus at least 200 m^3/day wastewater is expected to be generated. This type of wastewater is contaminated mainly by mixture of cement and sand, mud and to a lesser degree oil and grease from the pipe coatings. The management of this type of wastewater will be a combination of proper drainage that will collect the effluents and direct them to oil-water separators and sediment settling pit or ponds. Clean water overflow can either be reused (e. g. watering of plants, spraying of roads, and other dust suppression measures) or released into a water course.

During operations, wastewater will be produced from housing complex, warehouse and power plant office at an estimated volume of 9 m^3/day. These effluents will be directed to sewer and water treatment facilities.

As previously discussed, ponds will be used to collect and hold brine and condensate before reinjection. These structures will be designed to also accommodate stormwater runoff specially those that flow over process areas.

As a whole, the impacts of wastewater generation is insignificant since most of the chemically contaminated effluents (i.e. brine, condensate, and drilling mud) will be reinjected into the formation. The other types of wastewater produced (i.e. domestic wastewater) is small in quantity that it can be it processed in a wastewater treatment system. Overall, the impact of wastewater generation is insignificant with no expected residual effects.

10.12 Biodiversity

10.12.1 Exploration/Construction Phase

a. Loss of Terrestrial Habitat

As described in Section 0 of CHA document there are a number of landcover types that will be cleared to facilitate construction of the required project infrastructure and to undertake the exploration phase. The natural habitat areas in particular provide habitat values for a variety of native flora and fauna species, including species listed on the IUCN Red list of threatened species. Albeit modified, the modified habitat areas also provide value to native species, in particular those adapted to disturbed environments and human settlement areas.

b. Changes to aquatic habitat

The geothermal drilling process will use water-base mud to prevent boreholes from collapsing during drilling and also to protect the environment. Water demand for drilling is matched by surface water and/or collected runoff water, amounting to up to 30 – 100 l/sec. This water will be sourced from the Cawang Tengah/Kiri Rivers.

Water extraction has the potential to change the amount of aquatic habitat available in the waterways where water will be sourced. Intensive aquatic biota sampling has not been undertaken as part of the baseline assessment however impacts to aquatic environmental are identified. If extracted at sufficient volume aquatic habitat can be reduced to an extent that fish and other biota communities are unviable. In addition a reduction in flow volume has potential to reduce quality of downstream habitat and interrupt fish migration triggers and pathways. Based on the Project description the volume of water to be extracted is well within the current reported river discharge. The water intake is designed to prevent ingress of fish into the water pipe system.

c. Disturbance and displacement of resident species

The disturbance and displacement of resident fauna species within the 46 has footprint will primarily be caused by light, noise and vibration impacts.

Noise, light and vibration disturbances have the potential to influence breeding, roosting or foraging behaviour of fauna. During the exploration/construction phase temporary impacts from the Project are expected. Noise will be the primary disturbance of this nature due to vegetation clearing, excavation, movement of materials, drilling and general construction activities. These activities will introduce noise sources to areas not currently exposed to these disturbances. In addition there may be vibration associated with drilling activities and the movement of any heavy vehicles/machinery.

The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations. For example if breeding and communication is inhibited influencing lifecycle, or, if individuals are displaced from noisy areas and home ranges are reduced. Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species.

The duration of construction activities (not already undertaken) is expected to short-term. Similarly, it should be noted that the noise, light and vibration disturbances will not be continuous for the construction period, or focused on any one specific location for the total time.

Noise light and vibration disturbances will occur throughout the Project Area during construction for the Project components identified, and the impact will include occurring in natural habitat areas where threatened species are known to occur (Sensitivity High).

Although temporary, the construction schedule is expected to be relatively short and not to span multiple breeding seasons. Noise, light and vibration disturbance are unlikely to occur at all locations simultaneously and will be localized.

d. Barrier to Terrestrial Fauna Movement

Construction activities relating to linear infrastructure have potential to create a barrier to fauna movement (for some fauna groups). This includes construction of the access roads, the transmission line and water pipeline infrastructure. Most other Project components are discrete areas that may be navigated around by fauna that may be moving through the area. The construction of access roads and pipelines will introduce gaps in the forest where some fauna may not readily cross given potential vulnerability to predation and/or mortality. This will be a permanent impact.

The linear infrastructure for the Project will not be fenced, which then would not restrict movement; however the break in the forest has potential to generate a barrier. Linear infrastructure traversing natural habitat areas represent higher risk areas for impact as a result of barrier to movement. There is approximately 12km of access road that intersects natural habitat.

e. Fragmentation and Edge Effects

Edge effects are an indirect impact of land clearing during construction and throughout operation. Where vegetation clearing occurs, adjacent vegetation and habitats can be exposed to changes in noise, light (natural or artificial), dust, humidity and temperature factors as well as increased competition from predators and invasive species. The impact of edge effects to habitat value and forest composition has been widely recognized as a contributor to forest degradation and impacts to biodiversity. In extreme cases the effects have potential to alter the habitat characteristics of the ecotone and influence suitable habitat for native flora and fauna (including threatened species). Clearing of vegetation for the Project will create ‘new’ edges in areas that have not previously been disturbed.

Vegetation responses to edge creation are site specific (Harper et al. 2005) and as such there are challenges in defining the magnitude of edge influence for the Project area. A variety of studies have been undertaken that have assessed a ‘distance of edge influence (DEI) using field collected data to measure the distance at which structure or composition is different from undisturbed areas and/or when abiotic factors (e.g. humidity, temperature) are different. Literature review of studies targeted to tropical forest (keywords tropical forest, tropical rainforest, lowland rainforest) types identified a range of DEI values:

- Microclimate effects reported up to 40m from forest edge in tropical rainforest (Turner, 1996);
- Canopy cover effects up to 10m, snag abundance up to 13m, understory density up to 13m in tropical forest (Harper et al. 2005);

- Effects in light, temperature, humidity, gaps, weeds and pioneer species of up to 50-100m for linear clearings (no forest type defined)(Laurance et al. 2009);
- Altered floristic composition and disturbance indicators up to 20-45m in tropical rainforest (Goosen and Jago, no date);
- Edge effects to woody seedling density up to 10m and temperature and vapor pressure effects up to 50m in lowland tropical forest (Sizer and Tanner 1999); and
- Microclimate effects in tropical forest up to 20m (Ewers and Banks-Leite 2013).

The indirect impact area is dominated by the primary and secondary forest land classes. These forest types are largely considered to be natural habitat and are known to support a variety of native and conservation significant species. It is not anticipated that these impacts will cause significant impacts; however dust impacts may occur on areas adjacent to roads, smothering vegetation. It is likely that this impact will be limited to the dry season as rainfall will wash dust from vegetation during the wet season.

Fragmentation of habitats can occur where currently linked habitats are disconnected through the construction of Project components. Fragmentation reduces the continuity of habitat and hence the ability for fauna to move within and between habitat patches. The resulting impact can cause reductions in foraging and breeding habitats. Species with limited home ranges may have a reduction in available area, leading to conflict over resources or negative interactions over territories. Fragmentation of existing habitats is not considered to be a significant impact as the infrastructure design does not lead to isolation of habitat patches.

f. Degradation of Habitats

A range of Project activities have the potential to lead to degradation of native flora and fauna habitats including excavation, construction, land clearing, spoil disposal, movement of vehicles, drilling, refueling, hazardous materials storage and maintenance. In general the impacts will cause: dust; runoff; release of potential contaminants; and invasive species. Construction activities have been assessed for these impact types, including: construction of the access roads, cement plant, transmission line and water pipeline.

Dust

During construction, land preparation has the potential to generate dust which may settle on vegetation adjacent to the construction area (including access roads). Excessive dust deposition on flora may act to suppress growth through limiting photosynthesis and the dusted foliage may also become unpalatable to foraging fauna. The construction activities will be temporary and dust generation is likely to be localised to active work areas. Rainfall will generally remove dust from foliage and this impact has been assessed for significance as part of the Edge Effects impact in CHA document.

Runoff

Land preparation will expose earth areas to be vulnerable to erosion (wind and/or runoff) until infrastructure construction or replanting is completed to stabilise the surface. The Project Area experience varied topography including steep slopes. Erosive processes transport sediment downstream depositing mobilized sediment downstream/downslope of habitats (both aquatic and terrestrial). This indirect impact has potential to degrade downstream habitat areas or change habitat

characteristics, and as such influencing suitability for native flora and fauna communities. Runoff may flow into the local river systems which may provide habitat for conservation significant and commercially utilised fish species.

Release of Contaminants

Accidental release or spill of these materials can be toxic to flora and fauna locally and downstream if substances are released into the aquatic environment. Runoff from construction sites has potential to carry contaminants substantial distance downstream. Construction activities such as refueling, storage and other activities that require oil and hazardous substances to be used are undertaken at risk of accidental release.

g. Fauna Mortality

Vehicle/Machinery Strike

Fauna mortality can occur during most construction activities (e.g. vegetation clearing, excavation, vehicle movement) in the event individuals are struck by vehicles and machinery. Animals that are unable to disperse during clearing activities are vulnerable to being injured or destroyed through interaction with machinery or falling debris.

It is likely that most individuals will disperse from construction activity locations into adjacent habitats as a result of noise and other disturbance however some less mobile species may experience a localised reduction in abundance during this period, such as amphibians, reptiles and small mammals.

Hunting and Poaching

With greater human activity in the region and increased access points to the forest there is a risk of increased hunting and poaching activities leading to fauna mortality from workers and also local people who may have access to habitats that were previously restricted or difficult to access. Hunting of wildlife, including conservation significant species is known to occur in Sumatra. Through the installation of new roads, i.e. increased ease of access hunting and poaching may increase. Species located within the Project Area include the Sunda Pangolin (Manis javanica) that have been listed as Critically Endangered, primarily due to poaching and wildlife trafficking.

10.12.2 Operation Phase

a. Loss of Habitat – Induced Clearing

There will be no additional clearing of habitat as part of operation of the Project however the issue of induced clearing must be considered. Induced clearing has potential to occur locally when Project infrastructure is established and there is increased access to the forest areas and a larger number of people residing in the area for the purposes of employment.

b. **Disturbance and displacement of resident species**

Disturbance and displacement of species during operation will be primarily caused by light and noise generated during operation and maintenance of the facilities. Light and noise impacts will have the same type of impacts to resident fauna as described in the impact assessment for the exploration / construction phase (as outlined above). Impacts will relate to both natural and modified habitats

surrounding the Project infrastructure. Given the Project does not involve high noise generating activities (such as blasting) this impact is not expected to be substantial.

c. Fragmentation and Edge Effects

Impacts from fragmentation and edge effects on resident species are likely to be similar to those described in the construction impact assessment (as discussed above). No new edges will be created as part of operational activities.

d. Degradation of Habitats

Impacts relating to habitat degradation are likely to be similar to those described in the exploration / construction impact assessment (as discussed above). No new risk activities will be undertaken as part of operational activities.

e. Fauna Mortality

Impacts relating to fauna mortality are those described in the exploration / construction impact assessment (as discussed above). No new risk activities will be undertaken as part of operational activities.

f. Species Impacts

Species of conservation significance identified to occur or potentially occur within the Project Area have been assessed below based on the likely impact during construction and operation.

10.12.3 Protected Areas

The Rantau Dedap Project footprint mostly falls within the Hutan Lindung Protection Forest.

Despite the limited area directly impacted (i.e. small project footprint), the scattered arrangement of the project infrastructures, such as facilities, roads, pipelines and wellpads, can have a larger impact in the form of habitat fragmentation. A clear example of the potential impacts of habitat fragmentation is the construction of the brine reinjection pipeline from the Separator Station to Wellpad B that closes a complete loop with the access road isolating the forest habitat inside the loop. Therefore the project has potential significant adverse impacts on biodiversity of flora and fauna.

10.13 Invasive Species

Invasive species (flora and fauna) have the potential to be introduced or spread throughout the Project Area through increased movement of people, vehicles, machinery, vegetation and soil. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some native flora and fauna, including conservation significant species. Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native vegetation communities to re-establish. Invasive animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation.

10.14 Management of Ecosystem Services

The following results apply the assessment criteria for the priority ecosystem service values identified from the screening assessment.

a. Food: cultivated crops

Local people clear forested areas for the creation of fields to cultivate crops. This practice is undertaken on a rotational seasonal basis. The Project has restricted clearing activities within the AoI since 2013 to reduce impacts on biodiversity values. This subsequently reduced land available for clearing by local people. Whilst this reduction in access will have biodiversity benefits, local people will have a reduction in area available to clear and use for cultivated crops.

b. Freshwater

Local people are reported to use freshwater from local waterways for irrigation, potable and non-potable uses. Water extraction is proposed to occur that will reduce the amount of water available all year. The resource loss will be predominately in the dry season each year. The amount of water extraction is estimated to be small.

10.15 Income Opportunities

10.15.1 Employment Opportunities

The project will generate skilled and unskilled employment opportunities throughout the project life—from construction to operations to decommissioning. Priority will be given on sourcing labor requirements locally. In cases that skilled workers are not locally unavailable, they are recruited from other parts of Indonesia. The labor requirements of the different stages vary, creating a cycle of recruitment and termination. Aside from the income generation resulting from employment, those who will be given the opportunity to work for the project will also benefit in terms of gaining experience and training. The enhanced qualification will empower them to get other jobs if terminated or recruited by other companies. Their acquired skill and earnings from their income may also be useful in setting up their own business or services. Those employed by the project and those who are gainfully earning from businesses induced by the operations of the project will be in a better position to send their children to school. Undoubtedly, this project impact can be considered significant, positive, long term, cumulative and irreversible as people's lives are changed for the better. The residual impact is the upliftment of the quality of life of the project beneficiaries.

Section 1.6 outlines the workforce requirements of the different phases.

10.15.2 Business Opportunities

Business opportunities are created during the construction and operation of PT SERD for products and services such as basic building materials, construction equipment, laundry, clothing, food services, cleaning services, excavation, construction material supply, etc. Indirect economic impacts will also occur from increased demand for products and services due to the increased workforce in the area. Business opportunities are greatest during construction and will continue though at a reduced rate during operations. Business opportunities are a positive impact to host communities which has a has multiplier effect. Other members of the households that are engaged in lucrative businesses also benefit from the income generated. It is significant since it affects a wider portion of the local population and has long term benefits such as when children and dependents get

education. The residual impact is likewise better quality of life for those who will take advantage of this opportunity and be successful.

10.15.3 Loss of Income Opportunities (Business, Employment)

At the end of construction and the project itself (decommissioning) some of the employees will experience loss of income when their employment is terminated. Likewise there will reduction of business activity when demand for goods and services of the operations ceased.

At the end of construction (and the commencement of operations), workforce requirements will be reduced to a level that is about 10% that of the construction workforce (section 1.7). Similarly, businesses that are dependent on the construction activities of the project such as contractors and suppliers will be adversely affected.

The project planning and evaluation purposes, the operating life of the plant is assumed to be 30 years after which it may be decommissioned (or may continue on). Should there be compelling reasons to shut down the plant, the infrastructures that may have alternative uses, such as buildings and roads, will be turned over to the host communities and local government for common use. The power plant and associated facilities which do not have alternative uses will be dismantled and disposed of at a licensed facility. It is probable that the impacts of the loss of employment and business opportunities will be partly cushioned by the available opportunities brought about by the induced economic development in the region. Those who were employed will be better qualified to other job opportunities due to gained experience and trainings. As a whole, this impact may be moderately significant at first but may diminish through time.

10.16 Workforce Impacts on Communities - Disease, Cultural, Drain on Local Resources, etc.

The workforce during construction represents a sudden significant increase in the local population. A portion of the workforce may come from outside the region. There is a risk that the workforce will:

- Bring a different culture;
- Increase use of local resources, such as utilities (water, electricity), public services (such as police, health and other government services) and food; and
- Increase the spread of diseases (for example mosquito borne diseases).

Community exposure to disease could increase during the construction phase and should be addressed through specific measures to be incorporated into the project's community safety, health and environmental plan (SHE plan). These impacts however are not totally negative as enhanced demand for goods and service may stimulate more business activities and economic development.

Sudden increase in local population due to workforce requirements during construction impacts on capacity of local health facilties in the short-term, in particular during construction phase. The total population in the affected villages is currently 8,791. Expected workforce during construction is around 2,100, which signifies a maximun increase in population of 24%, however part of the workforce will be local, so this percentage will be in actual fact smaller. During operation the additional workforce expected is 200, some of which again will be local, therefore impact on health facilities will be minimal.

The potential negative impacts can be easily mitigated with proper (SHE and HR) management plans and allocated budget to temporarily increase available health and other facilities. It can be concluded that these impacts will not cause serious and certain risks and therefore can be considered as insignificant.

10.17 Cultural Heritage

No cultural heritage exists in the Project area. PT SERD has endeavored to design and locate the Project so that significant adverse impacts to cultural heritage are avoided. The impacts identification process has determined that it is unlikely that cultural heritage will be encountered during construction phase. In case archaeological sites or cultural heritage relics are found during the excavation for the construction of the Power Plant, roads, and other structures, a 'chance finds' procedure was developed for PT SERD. The Chance Finds Procedure is in Appendix 10. Based on the outcome of the assessment, this potential impact is insignificant due to the low likelihood of occurrence.

10.18 Host Community Concern

Consultations have been undertaken per AMDAL requirements. Additional engagement has occurred as part of land acquisition and ongoing exploration activities. There is stakeholder concern over the construction and operation of a geothermal power plant in the area. A Stakeholder Engagement Plan and Grievance Mechanism were prepared to manage stakeholder perceptions and build relationships. The SEP includes contact details, issues of concern and a summary of engagement results/ status. The grievance mechanism is widely known by stakeholders in the region. The results of these community engagements and absence of unresolved grievence show that the project has general public support and there is no significant adverse impacts on this aspect.

10.19 Indigenous Peoples

The social baseline chapter contains details on the ethnic groups in the area. While subsistence farming and traditional lifestyles characterize the project area of influence, the ethnic groups are integrated into the Indonesian culture and mainstream economic and political systems.

10.19.1 The Semendo Ethnic Group

The Semendo ethnic group is the dominant ethnicity in Semendo Darat Ulu Sub-district. Migrants from Java, Padang and Aceh are also present. No evidence of ethnic conflict exists. The population of Segamit, one of the 5 project affected villages, reflects that pattern too, 80% are Semendo and 20% are from other areas, except for the Dusun of Yayasan, where 70% of the people are Javanese and only 30% are Semendo.

In fact, however, the Semendo have also migrated into the project area for economic reasons, around 30 years ago. None of the land has any traditional rights or ancestral attachment. Ever since they have moved to the area they have been involved in the coffee growing business, including processing and trading. In addition, they have taken up other professions, including paid employment in the private and public sector and can therefore be considered as mainstream. Although they have their own language, everyone also speaks Bahasa, and follows Islamic religion and practices and therefore can be considered also socio-culturally as mainstream.

Table 68~~Table 68~~applies ADB Indigenous Peoples criteria to the Semendo people, showing that they are not Indigenous Peoples.

Table 68 Indigenous Peoples Criteria Applied to Semendo Ethnic Group

Criteria	Applicable	Remarks
Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others.	√	Though part of the Malay culture of the region, the Semendo people are a distinct ethnic group with its own language and culture. The Basemah are considered to be integrated into the mainstream economy and culture, though they are recognized as the historic ethnic group of the area.
Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.	X	Semendo people have moved into the project area some 30 years ago and have established settlements throughout the area. The Semendo do have traditionally rights or ancestral attachments to land, but not in the project area. The Semendo people's livelihoods are based primarily on agriculture, such as rice and coffee cultivation. Semendo farming methods are traditional and basic. They are integrated into the regional economy and have entered other professions, including salaried employment in private and public sector.
Customary, cultural, economic, social, or political institutions that are separate from those of the dominant society and culture.	X	Semendo customs and culture reflect general Indonesian culture found throughout western Indonesia-- Muslim Malay. Mosques, mushalla and Islamic shools (pesantren) are common throughout the area. They have a distinctive traditional house design. They also have a distinct martial arts style called Kuntau. A unique Semendo custom is "Tunggu Tubang" whereby family inheritance is governed by the oldest female child. Inheritance primarily consists of farmland and houses. Given this custom, males typically migrate from the area.
Distinct language, often different from the official language of the country or region.	X	Like much of Indonesia, the Semendo are at least bilingual. They have their own language derived from the Malay language family (with some similarities to the Palembang language) and are conversant with the national language.

10.19.1 The Besemah Ethnic group

Table 69~~Table 69~~applies ADB Indigenous Peoples criteria to the Besemah ethnic group, showing that the Indigenous Peoples Safeguard does not apply.

Table 69 Indigenous Peoples Criteria Applied to Besemah Ethnic Group

Criteria	Applicable	Remarks
Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others.	√	Though part of the Malay culture of the region, the Besemah people are a distinct ethnic group with its own language and culture. The Basemah are considered to be integrated into the mainstream economy and culture
Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories.	X	Besemah are historically from the area. The Besemah have traditional rights or ancestral attachment to land in the area, but not in the vicinity of the project. They also are integrated into the regional culture and governmental system. Like the Semendo, livelihoods are based primarily on agriculture, such as rice, coffee and rubber cultivation. They are integrated into the regional economy and have entered other professions, including salaried employment in private and public sector. The Besemah are considered more advanced than the Semendo.
Customary, cultural, economic, social, or political institutions that are separate from those of the dominant society and culture.	X	Besemah customs and culture reflect general Indonesian culture found throughout western Indonesia-- Muslim Malay. Mosques, musholla and Islamic schools (pesantren) are common throughout the area.
Distinct language, often different from the official language of the country or region.	X	Like much of Indonesia, the Besemah are at least bilingual. They have their own language derived from the Malay language family and are conversant with the national language.

10.20 Community Health, Safety and Security - H_2S

H_2S emissions can be a hazard that could affect community health and safety if present in high concentration for a long period of time, that is when there is a risk of prolonged exposure at unacceptable levels. The project was designed and located to minimize H_2S risks to communities. Detailed calculations and dispersion modeling showed that such risk is almost nil (<1% chance of occurring). Inspite of this, PT SERD has developed community safety, health and enviornmental (SHE) policies and procedures, to further mitigate such potential H_2S risks to communities. Responsibilities are also passed down to contractors. This issue is therefore considered as insignificant.

10.21 Traffic and Transportation

Potential significant transportation impacts (e.g. traffic) may be caused by mobilization of heavy equipment and other project supplies, primarily during construction and drilling activities. Land transportation will utilize trucks, trailers and personnel transport vehicles. Transported equipment consists of dozers, loaders, dump trucks, excavators and cranes as well as drilling rigs, casing pipes and cementing equipment, diesel generators, pumps, mechanical construction equipment (welding machine, cutting equipment), materials and equipment for building (lumber, structural steel, concrete, pipes), turbines, transformers and other items. Though significant, traffic and transportation impacts are considered short term and reversible impact which can be mitigated through an appropriate traffic management program.

10.22 Compliance with Labor Legislation

Non-compliance with labor standards (company HR policy, national laws and regulations, and international conventions) by contractors and subcontractors is a potentially significant impact. Aggrieved workers may take actions (such as plotting strikes) that may hamper the project implementation. When blown out of proportion, the impact may hurt the company's reputation and diminish community support. This significant impact deserves serious attention and mitigation.

10.22.1 Occupational Health and Safety

PT SERD's Safety, Health and Environmental Manual, including Standard Operating Procedures (SOPs), is comprehensive and personnel are provided with training on health and safety issues at a level appropriate to the specific risks associated with their job description. Though job related accidents may still happen, the policies and SOP's in place will effectively reduce the risks and occurrence.

10.22.2 Labor Grievances

Contractors and subcontractors are expected to conduct their operations compliant with applicable national and international labor laws, including making a labor Grievance Mechanism available to the workforce. The Company established a centralized grievance log and tracking system. This database is utilized to allow all registered grievances to be tracked and recalled as necessary. The Project's performance in managing and closing out grievances is reviewed as part of internal and external monitoring.

10.23 Cumulative and Transboundary Impacts

This ESIAMP is supplemented by a Rapid Cumulative Impact Assessment (RCIA) following the procedure recommended in IFC Good Practice Handbook (GPH) - Cumulative Impact Assessment and Management (2013) to properly determine the potential cumulative impacts of the project in relation to other proposed or existing projects, associated facilities and natural and social stressors.

Cumulative impact are defined as those impacts that result from successive, incremental and or combinedeffcts of developments when added to other eisting, planned and or reasonlyb anticipated futures ones. Ideally the assessment of cumulative impacts (CIA) is undertaken at the regional level by the relevant government agencies to be able to consider all possible developments in one region. RCIA are a simplified version of CIA limited to identficiation and assessment of those impacts that are recognized as most important based on scientific concern and concerns from affected communities. This RCIA considers PT SERD geothermal power plant development, the PT PLN Trasmission line corridor from the PT SERD switchyard to the PLN power substations and the Pertamina geothermal power plant development at Lumut Bali (units 1, 2, 3 and 4) (Table 70).

Table 70 Overview of Pertamina Geothermal Power Plant Developments in Vicinity of PT SERD

Pertamina Development	Total Capacity	Location	Status
Lumut Balai Unit 1 and 2	2x55 MW	Lumut Balai, Semende Darat Laut, Muara Enim, South Sumatera Province	Unit 1 is at EPCC stage, commercial operation planned in 2016 Unit 2 is at infrastructure and drilling preparation stage, commercial operation planned in 2018.

Lumut Balai Unit 3 and 4.	2x55 MW	Lumut Balai, Semende Darat Laut, Muara Enim, South Sumatera Province	Development process Commercial operation planned in 2022

The GPH proposes a six step process as applied below.

10.23.1 Step 1 - Scoping Phase I – VECs, Spatial and Temporal Boundaries

As elucidated in the GPH, the initial step is the identification of the potential Valued Environmental and Social Components (VECs) and definition of the Spatial and Temporal boundaries beyond which it is reasonable to predict that there will be no more appreciable impacts on VECs.

Valued Environmental and Social Component of the Project

VECs are environmental and social attributes that are considered to be important in assessing risks, they are referred to as sensitive or values receptors of impacts. Taking into consideration the impacts assessment of this ESIAMP, the following VECs were identified to have potentially cumulative impacts:

1. The forest landscape as the locus of habitats of several species and harbor of biodiversity; The viability and sustainability of this VEC is determined in the BAP and CHA. Loss or degradation of natural and critical habitat – which is an inevitable result when portions of the protected and natural forest are converted into alternative land use permanently or for long period of time. Aside from the direct impacts of the project which will use 115 hectares of forestry land for wellpads and facilities, other factors such as induced development and other projects may contribute to the cumulative impacts. The indicators of the cumulative impacts are (a) total area of lost habitat, (b) change in the rate of habitat loss, and (c) measures of habitat fragmentation.

2. Economic condition of the communities; farm-based livelihoods with low potential for economic growth: the thresholds of the economic condition are two ways and would be the communities falling below the poverty level on the one hand, or increasing and diversifying their economic condition to a more varied and hence less prone livelihood at the other end. Additional employment opportunities due to the project and other developments in the area can be considered as potential cumulative impacts. An indicator for this can be the number, size and skills of the regional labor force that developed through time.

Geographic Boundaries

The spatial boundaries can be reckoned as the direct area of influence (DAI) of this project plus the DAI of other projects that may overlap with the latter. In this case, the spatial coverage of the potential cumulative impacts is the region consisting of the geothermal concession of PT SERD (35,440 hectares) plus the PT PLN Transmission line corridor from PT SERD power plant switchyard to the PLN power substations (40 km) in Lumut Balai, the five directly affected villages with a population of about 6,500 within Muara Enim, Lahat Regency and Kota Pagar Alam in South Sumatra, the geothermal concession of Pertamina at Lumut Balai (Units 1, 2, 3 and 4), the protected forest in between the PT SERD and Pertamina projects. At this time, the exact concession area of Pertamina is undetermined as some of the projects of Pertamina is still in permitting stage. The exact boundaries can be determined when all the necessary data (e.g. geothermal concessions of Pertamina and their DAI) are available.

Temporal Boundary

The temporal boundary can be based on the project life cycle of the two major projects: PT SERD and Pertamina geothermal power plants. PT SERD started exploration in 2013 and the power plant is expected to operated for 30 years from 2020 to 2050. The start of commercial operation of Pertamina's geothermal power plants are 2016 for Unit 1, 2018 for Unit 2 and 2022 for Units 3 and 4. Assuming a similar operating life with PT SERD, the last power plant will be operational until 2052. The time that Pertamina started exploration is unknown at the moment. Initially the temporal boundary can be set at 2010 (prior to the start of exploration) to 2055, few years after the assumed operating life of the last plant to operate.

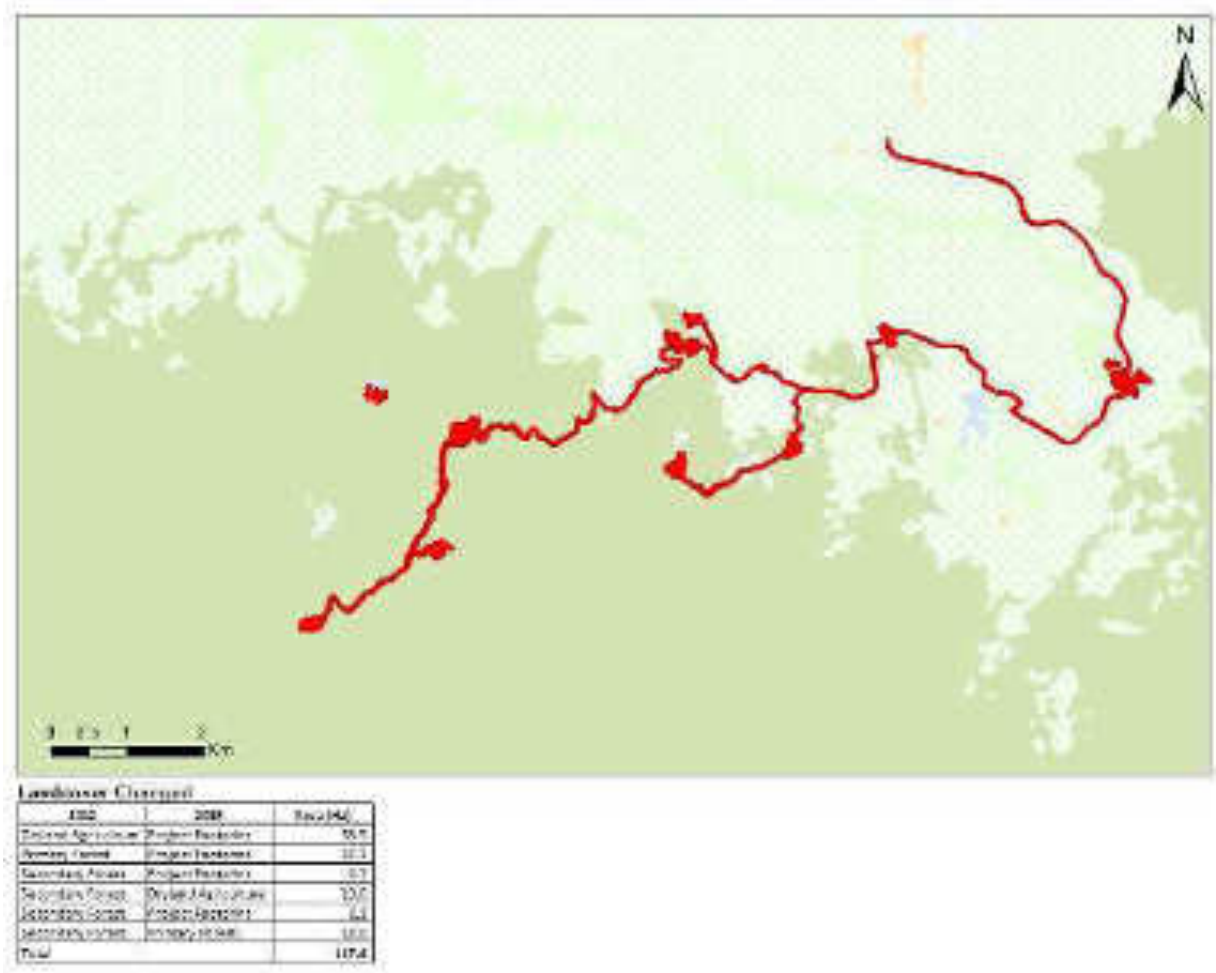
10.23.2 Step 2 - Scoping Phase II – Other Activites and Environmental Drivers

The planned activities within the geographic boundaries are the PT SERD geothermal power plant, the power transmission line of PT PLN from PT SERD power plant switchyard to the substation in Lumut Balai, and Pertamina's four geothermal power plant projects in Lumut Balai.

The natural and social external influence and stressors are the forest poaching and increased pressure on forest resources by the expanding population on the one hand, and as the population expands a more diversified livelihood due to expanding employment and business opportunities.

10.23.3 Step 3 – Baseline Status of the VECs

The natural and critical habitat can be aptly represented by the protection forest cover. Based on the satellite imagery taken in 2012 and 2015 as shown in Map 22. Comparing these Imageries, the total change in forest is 117.4 ha. It is worthy to note that aside from the project footprint, the community encroachment (i.e. conversion into agricultural land) occurred in secondary forest at rate of 10 ha over the 3 years period. The average annual loss of (secondary) forest cover is about 3.3 ha.



Map 22 Comparison of land cover between 2012 and 2015 imagery

Population growth at the regional level has been rapid, in particular in Lahat, with 6% over the last couple of years, while in Muara Enim, growth was at 1.6%. Further growth can be expected with the geothermal project developments.

With regard to regional employment condition, the baseline study for the AMDAL showed that in 2015, Lahat Regency has a labor force of 206,374 persons, of which 197,591 are employed. Unemployment rate is 4.4%. The labor force is 73.4% of the workforce which is defined as the productive component of the population aged between 15 and 64 years old. In Muara Enim Regency, the labor force is 371,248 person and the employed is 350,439. The unemployment rate is 5.9%. Workforce participation rate is 70.1%. The total labor force of the two Regencies is 577,622 individuals.

Farming is by far the main occupation (93.4%), mainly focused on agricultural crops, plantations, livestock and fisheries. Coffee has become a dominant plantation crop. Rubber, coconut, pepper, clove, oil palm, candlenut and cacao are also common crops. Average area that a farmer cultivates ranges between 0.5 to 3 hectares.

The other sources of income of the population in decreasing significance are trading (3%), civil worker/army/police (1.8%), private company employment (0.7%), retired (0.5%), entrepreneur (0.5%), and paramedic (0.1%).

The livelihoods and employment situation in the project affected villages reflects the statistics on the regional level.

10.23.4 Step 4 – Assessment of Cumulative Impacts on VECs

The cumulative impacts on the loss of natural and critical habitat can be estimated from the combined project footprints and projected land conversion arising from forest poaching within the temporal and spatial boundaries. The PT SERD Geothermal Power Plant - Phase 1 (92MW) will use 124.5 hectares of which 115 hectares are in Protection Forest. This will be increased when Phase 2 is implemented to increase the installed capacity to 250MW.

Based on its website, Pertamina plans to install a total of 220MW power plant in Lumut Balai. This will bring the total geothermal power generating capacity in the region to 470MW.

Footprint of geothermal power projects has been estimated to range from 10.4 ha to 3.2 ha per MW. For PT SERD Phase 1 project, the average land usage is 1.35 ha per MW. Some portion of these will be on protected forest and some on privately-owned lands.

Associated to PT SERD project is the 40 km transmission line to the Lumut Balai substation of PT PLN. At this stage, there is insufficient data on final alignment of the transmission line and width of the corridor, hence the total area of the forest land that will be affect is unknown. If the corridor width is assumed at 20m, the footprint of the transmission line is around 80 ha.

Comparison of satellite maps taken on 2012 and 2015 revealed that the annual change in forest cover due to community poaching is 3.3 ha within the PT SERD Geothermal Concession area.

The cumulative impact after 30 years cannot be estimated at this time due to lack of data in other areas outside PT SERD geothermal concession.

With regard to employment opportunities that will be generated by the project, 2,110 skilled and semi-skilled laborers will be needed during construction, and only 200 will be required to support the commercial operations.

The manpower demand of the other geothermal project is unknown at this time hence a good estimate is very difficult. The range can be predicted by using this project as the benchmark. Projecting the 200 workers needed for the 92MW project, it is possible that the combined 470MW geothermal Power plants will employ around 1,000 workers. Compared to the total labor force of the two Regencies which stands at 577,622 persons in 2015, the cumulative impact on long term employment is 0.17% only, a rather insignificant value on a regional scale. For short term employment, that is during the construction period, the employment rate maybe 10 times as predicted for the PT SERD project.

Considering the multiplier effect that these developments will have on the other hand will create a cumulative impact on employee demand in the vicinity of the project as well as within the region. With the increase in power generating capacity and the growing population combined, there is a valid prospect for a continued increase in manpower demand.

The absence of data on other projects practically makes the cumulative impact prediction difficult at this stage. The RCIA can be amended later when the needed data becomes available.

10.23.5 Step 5 – Assessment of the Significance of Predicted Cumulative Impacts

The loss of natural and critical habitat can be minimized through project design and monitoring program to impede possible poaching. Given the small footprints of all the geothermal power projects relative to the total area of the protection forest and the potential to control the communities encroachment into the forest, the cumulative impacts on the loss of habitat can be considered insignificant.

In relation to the employment opportunities, all of the project will have significant impacts on the lives of their hired employees. The multiplier effect due to influx of workers, general population growth and the increased availability of power to the community will create new employment opportunities. In order for the project affected communities to partake in these develompents skills development will be key to increase their competitiveness against those coming from outside.

10.23.6 Step 6 – Management of Cumulative Impacts – Design and Implementation

The impacts on the potential loss of natural and critical habitat due to land conversion and fragmentation at project level is best addressed through the Biodiversity Action Plan (BAP). However, noting that the cumulative impacts is insignificant, broader mitigation plan that will involve multi-stakeholders of all the projects in the region may not be necessary at this time.

For employment generation, the manpower need of the geothermal projects is limited. At best, they can give priority in hiring local workers. The companies may also implement their CSR projects that focus on developing alternative income generating projects as a way of giving opportunities to people that will not be hired by the operations. Considering the multiplier effect that these developments combined can have, it is relevant that local communities are given opportunities to develop their skills to be competitive with the influx of outsiders to the region. PT SERD has already started implementing such skills development training.

11 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Mitigation and monitoring measures for potentially significant impacts are detailed in the ESMP. The ESMP designates responsible authorities and identifies relevant project documents that support execution of the ESMP. The ESMP is comprised of the following tables: Table 70 for exploration, Table 71 for construction and Table 72 for operations. Decommissioning is addressed in the final section, 11.1.

Mitigation and monitoring for biodiversity component is detailed in the BAP document in Appendices 6a and 6b.

Table 71 Exploration

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
Land Acquisition	▪ Land owners and occupants of project areas ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Carry out land acquisition and compensation that is compliant with laws and regulations and acceptable to the affected parties. Take into account the aspirations of land owners and government ▪ Disseminate land acquisition plans with reference to GoI laws and regulation ▪ Make land owners aware of PT SERD Grievance Mechanism and execute Grievance Mechanism	▪ Three-months after acquisition, confirm: ○ Land acquisition and compensation was compliant with GoI laws and regulations ○ Dissemination of acquisition plans, per Stakeholder Engagement Plan ○ Awareness-raising of Grievance Mechanism, per Stakeholder Engagement Plan ▪ Annually review Grievance Mechanism log to assess whether past land owners have filed grievances and, if so, confirm that they were closed out	▪ External Relations Manager ▪ Project Manager	Internal staff costs only	Has not caused conflicts in the community	▪ Land Acquisition Process (and records) ▪ Stakeholder Engagement Plan ▪ Grievance Mechanism
Economic Displacement	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	MPTo comply with ADB SR2 [and SR3] requirements, the PT SERD project: ▪ Established a socioeconomic profile of the affected persons, including income sources, secondary sources of income, educational levels of the household, skill development requirements etc., to assess the vulnerability of the affected households and identify specific livelihood restoration and training measures. ▪ Develop the integrated social development (ISDP) plan through developing effective CSR programs including the skill development and livelihood improvement program. This shall be developed based on the skills profile and training needs assessment by the community/skill development consultant. ▪ As part of Stakeholder Engagement Plan, documenting and recording consultations. PT SERD has been engaged in active consultations with the stakeholders in the project area, since the initiation of project activities (2012). Records include the date and timing of consultation, location, number of participants, profile of participants, information disseminated to the participants, key issues raised and suggestions from the participants, and the response by PT SERD, and the follow-up actions required to be taken up by PT SERD. ▪ Prepared and implements a Grievance Mechanism that includes logs of the grievance received and the actions taken to address the grievances. The audit noted that the requirements are not followed fully on ground, and training of relations team staff to maintain better grievance records and log is recommended. ▪ As part of recruitment strategy, prioritized employment and	▪ If Livelihood Restoration Plan prepared, annually confirm (for 3-years) successful implementation of plan per outcome from ISDP, Stakeholder Engagement Plan, Grievance Mechanism and other sources (starting one-year after implementation of the plan)	▪ External Relations Manager	Internal staff costs only	No valid complaints from the host communities	▪ Livelihood Impact Monitoring Report (Format) ▪ Stakeholder Engagement Plan ▪ Grievance Mechanism

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		appropriate business opportunities to affected persons, especially vulnerable households. ▪ Complies with monitoring requirements of the ESMP. In addition to internal monitoring by SERD, an external monitoring expert to monitor the progress and effectiveness of the skill development/livelihood improvement measures is engaged bi-annually to assess progress and identify gaps. ▪ As part of the ADB SR2, the project Stakeholder Engagement Plan, Grievance Mechanism and Community Development are subject to annual training (at a minimum) and audits to assess effectiveness					
H_2S Emission	▪ Workers ▪ Visitors ▪ Fauna ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ H_2S emission in compliance with applicable standards. H2S monitoring at each well, power plant and various points on pipeline network is undertaken to ensure the H2S exposure limit is not exceeded. ▪ Comply with SE SHE Policy and Manual, including training and applicable procedures related to H2S concentrations , such as use of personal H2S monitors. ▪ Select the optimum well location that minimizes and avoids adverse impacts and establish safe exclusion zone according to the SOP ▪ Install alarm system which will set off at concentration >20ppm ▪ Caustic soda injection to capture H_2S inside the production pipe.	▪ Regular H_2S monitoring at each well and other points within the facility to ensure the H2S exposure limit is not exceeded. ▪ Conduct ambient air monitoring at residential area adjacent to access road every 6 months during exploration ▪ Conduct ambient air monitoring at 500 – 1000m radius inside wellpads vicinity every 6 months during exploration ▪ Conduct H_2S monitoring at each well and other points within the facility to ensure the H_2S exposure limit is not exceeded ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Annual review of training records of occupational SHE procedures and incident records to assess pattern and make improvement	▪ SHE Manager ▪ Welltest Manager ▪ Drilling Manager ▪ Contractors	US$ 50,000 annually. Project cost	Air quality meets the standards (H_2S < 35mg/Nm^3; odor level <28 µg/Nm^3)	▪ Monthly NCG chemical properties report ▪ H_2S MSDS ▪ H_2S Management and Emergency Procedure ▪ UKL-UPL document
Noise	▪ Workers ▪ Visitors ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Inform affected communities of current project activities (that produce noise) ▪ Establish safe exclusion zone for high noise level prior to any activity ▪ Noise generated equipment i.e. electricity generator shall be covered with casing or place inside noise-proof room ▪ Install silencer on noise sources ▪ Wear proper hearing protection equipment (i.e. ear plug, ear muff) for workers work near noise sources ▪ Implement gradual ramping up of drilling intensity to allow	▪ Conduct noise monitoring every 6 months at wellpads during exploration ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Regular equipment maintenance	▪ SHE Manager ▪ Construction Manager ▪ Drilling Contractors	$15,000 per well. Project cost	Noise level meets the standard (at residential areas <55dBA (Day) <45dBA (Night); at industrial areas <70 dBA; at working areas <85dBA)	▪ Schedule of Environmental Compliance Norms ▪ UKL-UPL document

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		for anilam dispersion.					
Surface Water Usage	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Comply the requirements set forth in the water extraction permit issued by South Sumatra Governor ▪ Install flow meter to record daily intake ▪ Intake volume not exceeding allowable limit	▪ Prepare implementation report to relevant agencies ▪ Regularly monitor the implementation of permit requirements	▪ SHE Manager ▪ External Relations Manager ▪ Project Manager ▪ Drilling Manager ▪ Drilling Contractors	$500 per location Project cost	No complaints from the community regarding water availability and quality	▪ Water Use Permit ▪ UKL-UPL document
Water Quality	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts ▪ Surface Water	▪ Comply with the ambient surface water applicable regulation (PP 82 of 2001) ▪ No land clearing will be conducted beyond the approved plan ▪ Control surface water runoff by employing engineered drainage systems ▪ Construct trenches to divert storm water and build catch trap at the downstream before entering water body ▪ Remove sediment in regular interval to the trenches and catch trap ▪ Compact the open area and spread gravel to reduce erosion ▪ Planting trees perpendicular to water flow or parallel to the contour and/or in open areas that are prone to erosion ▪ Revegetation of wellpad areas and other exposed surfaces follows Restoration Plan. ▪ During drilling, use high density polyethylene (HDPE) lined mud ponds to protect shallow groundwater ▪ Install steel surface casing pipe in all wells to protect groundwater ▪ Reinject of drilling water and brine instead of discharge to the environment	▪ Ambient surface water monitoring at Asahan Endikat, Shortcut Cawang Tengah, and Cawang Kiri Rivers every 6 months during exploration ▪ Inspection to the erosion and sedimentation control ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Revegetation schedule in accordance with Project Plan	▪ SHE Manager ▪ Project Manager ▪ Drilling Manager ▪ EPC and Drilling Contractor ▪ SSM	$500 per location Project cost	No complaints from the community regarding water availability and quality	▪ Water Management Plan ▪ Schedule of Environmental Compliance Norms (Standards for surface water quality) ▪ UKL-UPL document ▪ Revegetation Plan
Solid Non-Hazardous Waste (drilling mud and cuttings, domestic)	▪ Soil ▪ Surface water ▪ Groundwater t	▪ Follow Waste Management Plan ▪ Conduct waste management training to relevant workers ▪ Implement 3Rs initiative ▪ Segregate waste to its characteristic and provide ▪ Send recyclable waste to recycling facility ▪ Reuse drilling mud as much as possible. Dispose excess mud in the mud disposal ▪ Drilling cuttings are collected in temporary drilling cutting storage or, once dried and reuse such as for construction and road material or disposed in drilling cutting disposal ▪ Dispose solid non-hazardous waste to Temporary Solid Waste Storage (TPS)	▪ Inspection to waste management facility ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Annual review training records to confirm those handling waste are receiving requisite training	▪ SHE Manager	Internal staff cost only	Complied with waste management policy of the company	▪ Waste Management Plan ▪ UKL-UPL document
Hazardous Waste	▪ Soil ▪ Surface water ▪ Groundwater	▪ Hazardous waste management is in compliance with government regulation no. 101 of 2014 and its derivative regulations ▪ Follow Waste Management Plan	▪ Prepare hazardous waste manifest ▪ Prepare routine and submit it to relevant agencies ▪ 6-monthly review of management	▪ SHE Manager	Internal Staff Cost only	Complied with regularions on hazardous waste management	▪ Waste Management Plan ▪ UKL UPL document

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		▪ Segregate hazardous waste to its compatibility ▪ Prohibit the use of PCBs, asbestos, ODS (ozone depleting substances), and other materials as stated in regulations ▪ Conduct awareness training to relevant workers ▪ Store used lead acid batteries safely in the temporary hazardous storage ▪ Collectand store used oil in drums in the temporary hazardous storage ▪ Install secondary containment around flammable and dangerous waste materials storage as needed ▪ Conduct training for workers in handling hazardous waste ▪ Store in temporary hazardous waste storage using proper labels. ▪ Transport hazardous wastes with licensed transporter to licensed hazardous waste treatment and disposal facility	measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Annual review training records to confirm those handling waste are receiving requisite training				
Wastewater	▪ Surface water ▪ Groundwater ▪	▪ Wastewater is reinjected to the well ▪ Build collection pond for water and mud lined with impermeable HDPE material ▪ Reuse wastewater from drilling activity as much as possible, and/or reinjected to the injection well ▪ Produced water (i.e. brine) is temporarily collected in the pond and reinjected to injection well ▪ Domestic sewage will be treated with septic tank	▪ Integrity inspection to the ponds ▪ Wastewater monitoring at the water and mud pond every 6 months ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	▪ SHE Manager	Internal staff cost only	Wastewater quality meets the standards.	▪ UKL UPL document
Invasive Species	▪ Flora	▪ Revegetation using local species only ▪ Monitor and respond to invasive alien species on Project site and vicinity	▪ 5-year review of revegetation plans and practices, including monitor the presence of invasive species	▪ SHE Manager ▪ Project Manager	Internal Staff cost only	No invasive species encountered during routine monitoring	▪ Biodiversity Action Plan
Income Opportunities	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Actively and transparently disclose employment opportunities publicly, including qualification requirements and the selection process ▪ Focus recruitment on local skilled and unskilled; where qualified local workers cannot be found, the project will recruit regionally and nationally ▪ To facilitate local employment, provide targeted job skills training and education opportunities to existing and potential workers. For the general population seeking employment opportunities, the Community Development Plan has local employment as a strategic objective. For existing workers that want to increase responsibilities and contributions to SERD, professional development is offered ▪ Enhance local business development through supply chain development and the Community Development Plan.	▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	▪ External Relations Manager	Internal Staff cost only	Number and proportion of local workers hired	▪ Community Development Plan
Workforce Impacts on Communities-Disease, Cultural, Drain on Local Resources, etc.	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Implement Public Health Awareness Raising Plan to address malaria prevention, hygiene and sanitation and other community health issues. ▪ Conduct cultural awareness training for workforce, including contractors.	▪	▪	Internal Staff cost only	No negative perception of the company; No valid grievance recorded.	▪ Public Health Awareness Raising Plan

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		▪ Monitor local resource impacts; address gaps and problems as needed.					
Host Community Concerns	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	Execution of the following: ▪ Stakeholder Engagement Plan ▪ Community Development/CSR Plan ▪ Grievance Mechanism	▪ 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary. ▪ Monthly review of Grievance Mechanism log to determine if there are legitimate issues that should be given priority in resolving.	▪ External Relations Manager	Internal Staff cost only	No negative perception of the company; No valid grievance recorded.	▪ Stakeholder Engagement Plan ▪ Community Development Plan ▪ Grievance Mechanism
Community Health, Safety and Security	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Implement SERD Safety, Health and Environment (SHE) policies and procedures, including security. ▪ Carry out site management practices such as the provision of fencing around mud ponds and road signage to drive SHE objectives. ▪ Implement Public Health Awareness Raising Plan to address malaria prevention, hygiene and sanitation, safe sex practices and other community health issues. ▪ Implement ERP, ensuring that it includes contact names and phone numbers and community aspects such as communication routes in the event of an emergency—including disclosure to local government to ensure the implementation is a coordinated effort. ▪ Socialization to community related to H2S hazard communication and emergency procedure ▪ Increase public awareness of safety, health and environmental issues by providing information directly and indirectly through campaign.	▪ 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary.	▪ SHE Manager ▪ External Relations Manager	Internal Staff Costs only	No increases in diseases, no change in disease pattern	▪ SERD SHE policies and procedures ▪ Public Health Awareness Raising Plan ▪ Emergency Response Plan (EPR)
Encroachment	▪ Flora ▪ Fauna ▪ Host communities	▪ Leverage Biodiversity Action Plan to help prevent encroachment ▪ Develop, maintain and improve the Community Development Plan. ▪ Implement the Stakeholder Engagement Plan and Grievance Mechanism.	▪ Monitor the perimeter area at least annually to gauge encroachment and settlement trends. If negative trends are deemed to have been caused by the project, SERD will take remedial action. ▪ 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary.	▪ SHE Manager ▪ External Relations Manager	Internal Staff Costs only	All encroachment attempts prevented.	▪ Biodiversity Action Plan (BAP) ▪ Stakeholder Engagement Plan ▪ Community Development/CSR Plan

Table 72 Construction

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
Economic Displacement	▪ Land owners	MPTo comply with ADB SR2 [and SR3] requirements, the PT SERD project: ▪ Implementation of skill development and livelihood	▪ 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary.	▪ External Relations Manager	Internal Staff Costs only	No valid complaints from the host communities	▪ Land Acquisition Process (and records) ▪ Land Acquisition and

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		improvement program. This shall be developed based on the skills profile and training needs assessment by the community/skill development consultant. ▪ As part of Stakeholder Engagement Plan, documenting and recording consultations. PT SERD has been engaged in active consultations with the stakeholders in the project area, since the initiation of project activities (2012). Records include the date and timing of consultation, location, number of participants, profile of participants, information disseminated to the participants, key issues raised and suggestions from the participants, and the response by PT SERD, and the follow-up actions required to be taken up by PT SERD. ▪ Prepared and implements a Grievance Mechanism that includes logs of the grievance received and the actions taken to address the grievances. The audit noted that the requirements are not followed fully on ground, and training of relations team staff to maintain better grievance records and log is recommended. ▪ As part of recruitment strategy, prioritized employment opportunities to affected persons, especially vulnerable households. ▪ Complies with monitoring requirements of the ESMP. In addition to internal monitoring by SERD, an external monitoring expert to monitor the progress and effectiveness of the implementation of the resettlement process and the skill development/livelihood improvement measures is engaged bi-annually to assess progress and identify gaps. ▪ As part of the ADB SR2, the project Stakeholder Engagement Plan, Grievance Mechanism and Community Development are subject to annual training (at a minimum) and audits to assess effectiveness. ▪ Prepare annual Livelihood Impact Monitoring Report.					Livelihood Impact Monitoring Report (Format) ▪ Stakeholder Engagement Plan ▪ Grievance Mechanism
H_2S Emission	▪ Workers ▪ Visitors ▪ Fauna ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ H_2S emission in compliance with applicable standards. H_2S monitoring at each well, power plant and various points on pipeline network is undertaken to ensure the H_2S exposure limit is not exceeded. ▪ Comply with SE SHE Policy and Manual, including training and applicable procedures related to H_2S concentrations , such as use of personal H_2S monitors. ▪ Select the optimum well location that minimizes and avoids adverse impacts and establish safe exclusion zone according to the SOP ▪ Install alarm system which will set off at concentration >20ppm ▪ Caustic soda injection to capture H_2S inside the production pipe.	▪ Regular H_2S monitoring at each well and other points within the facility to ensure the H_2S exposure limit is not exceeded ▪ Conduct ambient air monitoring at residential area adjacent to access road every 6 months during exploration ▪ Inspection for potential sources H_2S gas perform in regular basis ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness 6-monthly review management measures to ensure	▪ SHE Manager ▪ EPC Contractor	▪ Review measures internal staff only. ▪ AQ monitoring (including H2S & Dust) $60,000 annually	Air quality meets the standards (H_2S < 35mg/Nm^3; odor level <28 µg/Nm^3)	▪ H_2S measurement records ▪ EPC Contract

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
			they are being effectively executed; undertake continual improvement if necessary ▪ Annual review of training records of occupational SHE procedures and incident records to assess pattern and make improvement				
Dust	▪ Workers ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Dust concentration is in compliance with applicable regulation ▪ Converting roads to hard surfaces and frequently watering dirt roads during dry season ▪ Water road during dry season ▪ Limit the speed of vehicles (maximum speed of 20 km/hour) ▪ Regular vehicle maintenance ▪ Install signs for Safety, Occupational Health, and Environment in accordance with the SOP ▪ Provide dust masker for workers	▪ Inspecting construction activities to confirm use of water to minimize dust. ▪ Ambient air quality monitoring for TSP concentrations at residential area adjacent to access road ▪ Inspection of roads to determine effectiveness of dust controls and undertake improvements. ▪ Spot checking vehicle speeds6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary.	▪ SHE Manager ▪ Project Manager	Review measures internal staff only. AQ monitoring (including H2S & Dust) $60,000 annually	Air quality meets the standards (TSP < 230µg/Nm^3)	▪ RKL RPL document ▪ SERD SOP
Noise	▪ Workers ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Noise level at residential area adjacent to access road shall be in compliance with applicable regulation of ≤ 55 dBA ▪ Inform affected communities of current project activities (that produce noise) ▪ Use Atmospheric Flash Tanks (AFTs), which reduce noise as dry steam is diverted to and released through the AFT. ▪ Establish safe exclusion zone for high noise level prior to any activity ▪ Wear proper hearing protection equipment (i.e. ear plug, ear muff) for workers work near noise sources ▪ Schedule major mobilization activities at night time to minimize congestion and disturbance at residential areas ▪ Restrict vehicle speed limit at 20 km/hour. ▪ Provide traffic marshalls during mobilization to ensure compliance to noise standards at night time (45 dB). ▪ Establish vehicle safe distance on roads ▪ Regular vehicle maintenance ▪ Noise generated equipment i.e. electricity generator shall be covered with casing or place inside noise-proof room ▪ Install silencer on noise sources ▪ Regular equipment maintenance	▪ Ambient air quality monitoring for noise level at residential area adjacent to access road ▪ Conduct noise monitoring every 6 months at wellpads during exploration ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Periodic inspection/ audit to confirm use of AFTs and hearing protection are in compliant ▪ Spot checking on vehicle speeds on roads	▪ SHE Manager ▪ Construction Manager	▪ Management review measures internal staff costs only. ▪ Noise survey, internal staff costs only.	Noise level meets the standard: ▪ at residential areas <55dBA (day) <45dBA (night) ▪ at industrial areas <70 dBA ▪ at working areas <85dBA)	▪ RKL RPL document ▪ SERD SOP ▪ Schedule of Environmental Compliance Norms (Standards for Noise) ▪ Occupational Safety, Health and Environmental Plan ▪ Stakeholder Engagement Plan ▪ Grievance Mechanism

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		▪ Implement gradual ramping up of drilling intensity to allow for animal dispersion.					
Surface Water Usage	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Comply the requirements set forth in the water extraction permit issued by South Sumatra Governor ▪ Install flow meter to record daily intake ▪ Intake volume not exceeding allowable limit ▪ Provide water storage structure (e.g. lined pond) so that there will be ample supply during peak demand (i.e. Drilling operations) ▪ Collect and reuse drilling water to reduce consumption of fresh water ▪ Developed a detailed Water Balance for the Construction Phase and Operation Phase ▪ Install water catchment pond within the natural drainage system which will serve as impoundment of rainwater and silt traps.	▪ Prepare implementation report to relevant agencies ▪ Regularly monitor the implementation of permit requirements	▪ SHE Manager ▪ External Relations Manager ▪ Project Manager ▪ EPC Contractors	Compliance monitoring and WQ testing $20,000 annually	▪ No complaints from the community regarding water availability and quality ▪ No violation of Water Extraction Permit	▪ Water Use Permit ▪ RKL RPL document
Water Quality	▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts ▪ Surface water	▪ Surface runoff shall be in compliance with TSS >100 mg/L and ambient surface water quality (PP 82 of 2001) ▪ Comply with the ambient surface water applicable regulation (PP 82 of 2001) ▪ No land clearing conducted beyond the approved plan ▪ Control surface water runoff by employing engineered drainage systems ▪ Construct trenches to divert storm water and build catch trap at the downstream before entering water body ▪ Pave access road with gravel ▪ Compact the open area and spread gravel to reduce erosion ▪ Remove sediment in regular interval to the trenches and catch trap ▪ Erosion control by growing bamboo species ▪ Planting trees perpendicular to water flow or parallel to the contour and/or in open areas that are prone to erosion ▪ Revegetation of wellpad areas and other exposed surfaces follows Rehabilitation Plan.Compact the open area and spread gravel to reduce erosion ▪ As much as possible, earthwork activity conducted during dry season ▪ Build biopores at some appropriate locations ▪ Establish Buffer zone adjacent to the water body	▪ Ambient surface water (TSS) at estuaries (outfall), 20m upstream, 100m downstream and 200 downstream ▪ Ambient surface water monitoring at Asahan Endikat, Shortcut Cawang Tengah, and Cawang Kiri Rivers every 6 months during exploration ▪ Inspection to the erosion and sedimentation control ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Routine monitoring of pond water levels ▪ Revegetation schedule in accordance with Project Plan	▪ SHE Manager ▪ Project Manager ▪ EPC Contractor ▪ SSM	Compliance monitoring and WQ testing $20,000 annually	▪ No complaints from the community regarding water availability and quality ▪ No violation of Water Quality Standard	● RKL RPL document ● SERD SOP ● Revegetation Plan
Erosion and Siltation	▪ Water courses	▪ Design soil disposal area such that runoff will flow in a common direct and be collected through a series of drains, silt traps and imponding pond for settlement of suspended solids. ▪ At the upper perimeter of the soil disposal site construct structures (diversion canals or berms) to prevent runoff from surrounding areas to enter the soil stockpile.	Include in routine weekly monitoring		Internal Staff Cost only.	No discharge of water that violates the Water Quality Standards	RKL/RPL document

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
Solid Waste (drilling cuttings, domestic)	• Workers • Affected villages in Kota Agung and Semende Darat Ulu sub-districts	• Follow Waste Management Plan • Conduct waste management training to relevant workers • Implement 3Rs initiative • Segregate waste to its characteristic • Send recyclable waste to recycling facility • Reuse drilling mud as much as possible • Drilling cuttings are collected in the mud ponds or, once dried and reuse such as for construction and road material, and revegetation • Waste will be segregated to its characteristic • Dispose solid waste to Temporary Solid Waste Storage (TPS), transported to TPA Lahat	• Annual review training records to confirm those handling waste are receiving requisite training. • 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness • Inspection to waste management facility	• SHE Manager • Project Manager • EPC Contractor	Internal Staff Cost only.	Complied with waste management policy of the company	• RKL RPL document • Drilling SOP • Waste Management Plan
Hazardous Wastes	• Workers • Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Hazardous waste management is in compliance with government regulation no. 101 of 2014 and its derivative regulations. ▪ Implement Waste Management Plan ▪ Conduct waste management training to relevant workers ▪ Segregate and store hazardous waste to its compatibility using proper labeling. ▪ Prohibit the use of PCBs, asbestos, ODS (ozone depleting substances), and other materials as stated in regulations ▪ Neutralizing battery acid and store used lead acid batteries safely ▪ Collecting used oil in drums ▪ Installing secondary containment around flammable and dangerous waste materials storage as needed ▪ Temporarily store hazardous waste in a licensed temporary hazardous waste storage ▪ Transport hazardous waste with the licensed transporters to a licensed hazardous waste treatment and disposal facility	▪ Prepare hazardous waste manifest ▪ Prepare periodic report and submit it to relevant agencies ▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Annual review training records to confirm those handling waste are receiving requisite training.	▪ SHE Manager ▪ Project Manager ▪ EPC Contractor	Internal staff cost only	Complied with regularions on hazardous waste management	▪ RKL RPL Document ▪ MSDS ▪ Waste Management Plan
Wastewater	Surface water Groundwater	▪ Build collection pond for water and mud lined with impermeable HDPE material ▪ Reuse wastewater as much as possible, and/or reinjected to the injection well ▪ Produced water (i.e. brine) is temporarily collected in the pond and reinjected to injection well ▪ Domestic sewage will be treated with septic tank ▪ Provide proper drainage where water is frequently used (e.g.wash areas, batching plant) to collect waterwater flow into a system of drain, sitl traps and impoundment. Clean processed water can then be reused (e.g spraying dusty road, watering plants).	Wastewater monitoring at the water and mud pond every 6 months	SHE Manager	Internal staff cost only	▪ No unprocess wastewater released into the environment ▪ Wastewater quality meets the standards. ▪ Water consumption within budget	▪ RKL RPL document ▪ SERD SOP
Biodiversity	Fauna Flora	▪ For pipelines, use thermally insulated pipelines and install above-ground to allow terrestrial animals to pass. Undertake erosion prevention and soil stabilization to maintain stability of the pipeline. ▪ Collaboration with stakeholders to protect the landscape, especially NGO that concern with Tiger Conservation—Collaborative management ▪ Socialization with the community on protected species	▪ 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness ▪ Monitor threatened species and the presence of endangered species on	▪ SHE Manager ▪ Project Manager ▪ External Relations Manager ▪ Security Manager	▪ Management, training, consultations US$ 20,000 annually. ▪ Habitat restoration US$500/ha	▪ Land clearing in accordance with the project's requirement ▪ All land area, that is approx 14 ha of temporarily clear land to be	▪ Critical Habitat Assessment ▪ Biodiversity Action Plan ▪ Environmental Management and Monitoring Plans that are part of the

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		awareness ▪ Minimize open land areas without vegetation; ▪ Open new land areas in stages and in accordance with approved project schedule and activity planning ▪ Relocate and conserve protected flora found around the project site; ▪ Revegetate using local plants that adjust local soil types and climatic conditions on bare areas; ▪ Revegetate using plant species that are a source of food for animals; ▪ Prohibit hunting and poaching of wildlife and removal of protected flora; ▪ Install banners informing the prohibitions of hunting/poaching and removal of protected flora; ▪ Build nursery for revegetation and rehabilitation;	project site (at least every 3 years)			restored at the end of construction; ▪ MoU with local government and relevant institutions for environmental management ▪ No of employees and workers reached in awareness training program ▪ Established Community Conservation Management Plan and implemented	AMDAL
Fragmentation and isolation of Natural Habitat (due to the construction of the reinjection pipeline)	Terrestrial Fauna and Wildlife	▪ Wildlife movement across pipeline can be facilitated by either above-pipeline crossings, or under-pipeline crossings. Under-pipeline crossings are preferred. All opportunities for under-pipeline crossings must be incorporated into the pipeline design. The placement of pipeline crossing shall consider wildlife habitat corridors and attempt to maintain movement corridor for the full of diversity of species expected to occur. Data sources such as wildlife monitoring, vegetation/topographical maps, and LIDAR may inform these decisions and influence crossing location. Discussions among industry, consultants, Badan Lingkungan Hidup Daerah (BLHD) or Regional Environmental Authority/Badan Konservasi Sumber Daya Alam (BKSDA) or government institution for nature resources conservation are necessary prior to finalization of the pipeline design. Crossings Design ▪ Under-pipe crossing is the preferred type and is defined as any crossing that has a minimum clearance of 180 cm at apex between ground and bottom of the pipe. A minimum clearance of 175 cm above ground must be maintained for at least 20 m (clearance height is measured from the soil surface to the lowest obstruction). Under- pipe permeability is encouraged, even where minimum extent above 175 cm does not approach the 20 m minimum for a crossing due to topographical constraints. Under-pipe crossing must account for at least 65% of crossing opportunities within an In-situ development. In situation where more than 35% of crossing opportunities are provided by over-pipe crossings, operator must pursue further dialogue with BLHD/BKSDA. ▪ Over-pipe crossings are engineered structures whose intended function is exclusively for wildlife movement over the pipeline.	▪ PT SERD shall ensure that the reinjection pipeline design is fully compliant with the requirements. ▪ PT SERD shall closely supervise the construction of the pipeline from start to finish.	Project Manager	Internal staff cost only	100% compliance with pipeline design	▪ PT SERD Doc. RD-DDI01-RFI-0109

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		Over-pipe crossings will be a minimum of 8 m wide at the surface of the crossing (exclude side slopes) and an approach and egrees with a slope of 1:6 (unless adjacent natural gradient is steeper or additional clearing of habitat would be required to facilitate a slope of 1:6). Slopes of over-pipe crossings cannot exceed 1:3 under any circumstances. ▪ Over-pipe crossings shall only be used when under-pipe crossings are not feasible or logistically possible. Ancillary use of over-pipe crossings for vehicle is prohibited. ▪ To both encourage wildlife movement and discourage vehicle traffic, natural materials such as rocks, boulders, coarse woody material, earth berms, and live vegetation planting among others material should be deployed. All over-pipe crossings are to be vegetated with species consistent with adjacent native plant communities. Over-pipe crossings must take into account the natural surroundings and potential wildlife use of the crossing (e.g. maintain line of sight across the right-of-way). Wildlife crossings must not be located in areas wildlife are likely to avoid (e.g. beside parking lot). Note: If safety rails are installed along the sides of the crossing then the minimum width of such crossings shall be 9 m. ▪ The minimum number of crossing per segment of pipelines must be achieved, both inside and outside large wildlife ranges. In example, crossing opportunities are required at a rate of 3 crossings per 1000 m of continuous above-ground pipeline outside of wild buffalo or large boar range. While in wild buffalo or large boar range, crossing opportunities are required at a rate of 4 crossings per 1000 m of continuous above- ground pipeline. Pipeline extending less than 250 m from the power plant block do not require a crossing opportunity. ▪ A continuous segment is defined as any mainline pipeline extending from the boundary of power plant block to a junction with lateral pipeline, or boundary of multi-well pad; or any lateral pipeline extending from the boundary of a pad to the boundary of another pad. ▪ Where local environmental conditions constrain number of wildlife crossing possible, operators may to provide an equivalent extent of crossing opportunity for each above-ground pipeline segment, provided that minimum crossing widths and maximum intervals between crossings are met. Equivalent extent of crossing opportunity is equal to 8% of total length of above-ground pipeline within large wildlife habitat, and 6% of above-ground pipeline length elsewhere. ▪ For continuous segments requiring more than 1 crossing opportunity, the distance between crossings within that segment shall be 100 m minimum and 500 m maximum.					

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
Invasive Species	Fauna	▪ Revegetation using only local species ▪ Monitor and respond to invasive alien species on Project site and vicinity	5-year review of revegetation plans and practices, including monitor the presence of invasive species	▪ SHE Manager ▪ Project Manager ▪ EPC Contractor	▪ Internal staff costs. ▪ External review US$15,000	No invasive species encountered during routine monitoring	Biodiversity Action Plan
Income Opportunities	Workforce Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Actively and transparently disclose employment opportunities publicly, including qualification requirements and the selection process. ▪ Focus recruitment on local skilled and unskilled; where qualified local workers cannot be found, the project will recruit regionally and nationally. ▪ To facilitate local employment, provide targeted job skills training and education opportunities to existing and potential workers. For the general population seeking employment opportunities, the Community Development Plan has local employment as a strategic objective. For existing workers that want to increase responsibilities and contributions to PT SERD, professional development is offered. ▪ Enhance local business development through supply chain development and the Community Development Plan. PT SERD commits to sourcing products and services from the local area (though more complex and unique geothermal-related goods and services will likely need to be sourced from other parts of Indonesia (or abroad)). ▪ One-year before construction ends, focus efforts on helping employees, contractors and businesses transition from the reduction in project activity.	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	▪ External Relations Manager ▪ Field Supply Chain Manager	Internal Staff Costs only.	Number and proportion of local workers hired	▪ Community Development Plan ▪ Supply Chain Strategy
Workforce Impacts on Communities- Disease, Cultural, Drain on Local Resources, etc.	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Implement Public Health Awareness Raising Plan to address malaria prevention, hygiene and sanitation and other community health issues. ▪ Conduct cultural awareness training for construction workforce. ▪ Monitor local resource impacts; address gaps and problems as needed.			Internal Staff Costs only.	▪ No complaint from the communities ▪ No spread of new diseases	Public Health Awareness Raising Plan
Compliance with labor legislation	Workforce	▪ Commit to compliance with PT SERD policy, Indonesian labor laws and relevant related international conventions. ▪ An Employee Grievance Mechanism is available to employees; new employees are made aware of this Mechanism when hired and all employees are kept aware of the availability of the Mechanism. The grievance mechanism for workers (and their organizations) provides a mechanism to raise reasonable workplace concerns. The Mechanism has senior management sponsorship and addresses concerns promptly, using an understandable and transparent process that provides feedback to claimants, without any retribution. The mechanism does not impede access to other judicial or administrative remedies available under law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements	Annual review of the Employee Grievance Mechanism log and HR-related audits to assess whether workers have submitted any grievances related to labor legislation compliance, including forced and child labor.	▪ Admin Manager ▪ Human Resources Manager ▪ EPC Contractor	Internal Staff Costs only.	No valid labor related compaints/ no reported violation of labor laws	▪ Employee Grievance Mechanism ▪ PT SERD HR policies

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		▪ Contractor and subcontractor compliance, including with forced and child labor restrictions, are monitored through PT SERD's audit system.					
Occupational Health and Safety	Workforce	• Develop relevant health and safety (H&S) SOPs and implement the approved SOPs • Provide training on H&S related matters at a level appropriate to the specific risks associated with their job description. • Take into consideration engineering approach in reducing H&S risks at the workplace • Provide safety protection to all workers appropriate to their job risks	• Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness • Annual review training records to confirm those handling waste are receiving requisite training.	SHE Manager	• Internal Staff Costs. • External OHS audit US$9,000	No increases in diseases, no change in disease pattern	• SHE Policy and Manual • Construction Workers Accommodation Management Plan
Cultural Heritage	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	There are no known cultural heritage impacts. However, in consideration of the sensitivity of cultural heritage, PT SERD is committed to comply with applicable national law and UN convention obligations to protect cultural heritage during design, construction and operations and ensure that internationally recognized cultural heritage practices for protection, study and documentation are implemented, namely: • When necessary, competent professional assistance will be used assess cultural heritage in the project area. • Avoidance of possible cultural heritage impacts as the preferred option • Adoption of a Chance Finds Procedure that documents steps to be undertaken if cultural objects are found over the course of the project. • Informed Consultation and Participation (ICP) is undertaken with communities on the subject of cultural heritage. • If ultimately a cultural heritage is found, community access is granted in accordance with company health, safety and security considerations. In case tangible cultural heritage that is replicable and non-critical is found, PT SERD will favor avoidance or if not feasible, o minimize adverse impacts and implement restoration measure in situ; or o where restoration is not possible in situ, move the cultural heritage to another site including restoring its functionality, carried out according to principles of paragraph 6 and 7; or o compensate for loss only where minimization and restoration are not feasible and cultural heritage is used for long-standing cultural purposes by affected communities. • In case Non-replicable cultural heritage is found, it is not to be removed from its place unless no feasible alternatives are found and overall benefits of the project outweigh the anticipated cultural heritage loss from removal. • In case critical cultural heritage is found, such as internationally recognized heritage used by communities for long-standing	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	• External Relations Manager • Project Manager • SHE Manager	Internal Staff Costs only.	Full compliance with the policy on chance find of any relic that may have cultural significance	Chance Finds Procedure

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document

		cultural purposes or legally protected heritage areas, it is not to be removed, significantly altered or damaged unless exceptional circumstances apply where impacts are unavoidable. PT SERD will use a process of ICP with affected communities and assistance of external experts is required. In the case of legally protected cultural heritage sites, additional requirements apply.
		• In case project use of cultural heritage is required, PT SERD will inform the communities of
		  ○ their rights,
		  ○ scope and nature of project uses, and
		  ○ potential consequences. A process of ICP will be applied fairly, resulting in a documented outcome that provides for fair and equitable sharing of any benefits.					

Host Community Concerns	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	Execution of the following: • Stakeholder Engagement Plan • Community Development/CSR Plan • Grievance Mechanism	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	External Relations Manager	Internal Staff Costs only.	No negative perception of the company; No valid grievance recorded.	• Stakeholder Engagement Plan • Community Development Plan • Grievance Mechanism
Community Health, Safety and Security	Workers and residents of Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Implement PT SERD Safety, Health and Environment (SHE) policies and procedures, including security. ▪ Carry out site management practices such as the provision of fencing around mud ponds and road signage to drive SHE objectives. ▪ Implement Public Health Awareness Raising Plan to address malaria prevention, hygiene and sanitation and other community health issues. ▪ Implement ERP, ensuring that it includes contact names and phone numbers and community aspects such as communication routes in the event of an emergency—including disclosure to local government to ensure the implementation is a coordinated effort. ▪ Socialization to community related to H2S hazard communication and emergency procedure ▪ Increase public awareness of safety, health and environmental issues by providing information directly and indirectly through campaign. ▪ To minimize the pressure on local health facilities due to sudden influx of workers during constrauction stage, EPCM shall be required as part of its obligation to provide satellite clinic at the job site. The same requirement shall be imposed on sub-contractors employing more than 50 persons.	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	SHE Manager	Internal Staff Costs. External OHS audit US$9,000	No increases in diseases, no change in disease pattern	• PT SERD SHE policies and procedures • Public Health Awareness Raising Plan • Emergency Response Plan • EPCM Contract
Traffic and Transportation	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Mobilization of equipment and materials will occur at night (between 9pm to 6am) using up to 6 convoys. Operating transportation impacts are not significant. Where contractors are used, this requirement is to be written into the contract. ▪ A detailed Traffic and Transportation Plan is contained in the list of SOP (Appendix 12)	▪ Observation of equipment mobilization to assure that it occurs within specified hours.	▪ EPC Contractor ▪ Project Manager	Internal Staff Costs only.	No valid traffic-related complaint/ no traffic accident	▪ Traffic and Transportation Plan

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
Encroachment	Flora Fauna Host communities	▪ Leverage Biodiversity Action Plan to help prevent encroachment ▪ Develop, maintain and improve the Community Development Plan. ▪ Implement the Stakeholder Engagement Plan and Grievance Mechanism.	▪ Monitor the perimeter area at least annually to gauge encroachment and settlement trends. If negative trends are deemed to have been caused by the project, PT SERD will take remedial action. ▪ 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary.	▪ SHE Manager ▪ External Relations Manager	Internal Staff Costs only.	All encroachment attempts prevented.	▪ Biodiversity Action Plan (BAP) ▪ Stakeholder Engagement Plan ▪ Community Development Plan

Table 73 Operations

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
H_2S Emission	• Humans • Fauna	• H_2S emission in compliance with applicable standards. H_2S monitoring at each well, power plant and various points on pipeline network is undertaken to ensure the H2S exposure limit is not exceeded. • Comply with SE SHE Policy and Manual, including training and applicable procedures related to H_2S concentrations , such as use of personal H_2S monitors. • Select the optimum well location that minimizes and avoids adverse impacts and establish safe exclusion zone according to the SOP • Install alarm system which will set off at concentration >20ppm • Caustic soda injection to capture H_2S inside the production pipe • community Health, Safety and Security: Socialization to community related to H_2S communication and emergency procedure (odor).	• Routine H_2S monitoring at each well and other points within the facility to ensure the H2S exposure limit is not exceeded. • Conduct ambient air monitoring at 500 – 1000m radius inside wellpads vicinity every 6 months • 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness 6-monthly review management measures to ensure they are being effectively executed; undertake continual improvement if necessary. • Annual review of training records of occupational SHE procedures and incident records to assess pattern and make improvement	SHE Manager	• Review measures internal staff only. • AQ monitoring $60,000 annually	Air quality meets the standards (H_2S < 35mg/Nm^3; odor level <28 µg/Nm^3)	• RKL RPL Document • H_2S measurement records • H_2S SOP
GHG Emissions	Climate Change	Based on steam production and analysis of NCG, carry out GHG inventory and post results on the Supreme PT SERD project website	Annual GHG inventory records	SHE Manager	Included in costs above for H2S Emissions	Air quality meets the standards	GHG Inventory
Noise	• Workers • Affected villages in Kota Agung and Semende Darat Ulu sub-districts	• Noise level at residential area adjacent to access road shall be in compliance with applicable regulation of ≤ 55 dBA • Inform affected communities of current project activities (that produce noise) • Atmospheric Flash Tanks (AFTs), which reduce noise as dry steam is diverted to and released through the AFT • Provide hearing protection for workers • Establish safety exclusion zone at noise sources • Restrict vehicle speed limit at 20 km/hour • Establish heavy vehicle safe distance on roads • Regular vehicle maintenance	• Ambient air quality monitoring for noise level at residential area adjacent to access road • 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness • Monthly inspection/audit to confirm use of AFTs and hearing protection are in compliant • Spot checking on vehicle speeds on roads	SHE Manager	• Review measures internal staff only. • Noise Monitoring US$10,000	Noise level meets the standard: (at residential areas <55dBA; at industrial areas <70 dBA; at working areas <85dBA)	• RKL RPL Document • SERD SOP • Schedule of Environmental Compliance Norms (Standards for Noise) • Occupational Safety, Health and Environmental Plan • Stakeholder Engagement Plan • Grievance

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
							Mechanism
Surface Water Usage	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	• Comply the requirements set forth in the water extraction permit issued by South Sumatra Governor • Install flow meter to record daily intake • Intake volume not exceeding allowable limit	• Prepare implementation report to relevant agencies • Regularly monitor the implementation of permit requirements	• SHE Manager • External Relations Manager	Compliance monitoring and WQ testing $20,000 annually	No complaints from the community regarding water availability and quality	• Water Use Permit • RKL RPL document
Solid Waste (drilling cuttings, domestic)	• Workers • Affected villages in Kota Agung and Semende Darat Ulu sub-districts	• Follow Waste Management Plan • Conduct waste management training to relevant workers • Implement 3Rs initiative • Segregate waste to its characteristic • Send recyclable waste to recycling facility • Reuse drilling mud as much as possible • Drilling cuttings are collected in the temporary drilling cutting storage, or, once dried and reuse such as for construction and road material, dsipose drilling cutting to disposal • Waste will be segregated to its characteristic • Dispose solid waste to Temporary Solid Waste Storage (TPS)	• Annual review training records to confirm those handling waste are receiving requisite training. • 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness • Inspection to waste management facility	SHE Manager	Internal Staff Costs Only.	Complied with waste management policy of the company	• AMDAL • SERD SOP • Waste Management Program
Hazardous Wastes	• Workers • Affected villages in Kota Agung and Semende Darat Ulu sub-districts	• Hazardous waste management is in compliance with government regulation no. 101 of 2014 and its derivative regulations. • Implement Waste Management Plan • Conduct waste management training to relevant workers • Segregate and store hazardous waste to its compatibility using properly labeled containers. • Prohibit the use of PCBs, asbestos, ODS (ozone depleting substances), and other materials as stated in regulations • Neutralizing battery acid and store used lead acid batteries safely • Collecting used oil in drums • Installing secondary containment around flammable and dangerous waste materials storage as needed • Temporarily store hazardous waste in a licensed temporary hazardous waste storage • Transport hazardous waste with the licensed transporters to a licensed hazardous waste treatment and disposal facility	• Prepare hazardous waste manifest • Prepare 3-monthly report and submit it to relevant agencies • 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness • Annual review training records to confirm those handling waste are receiving requisite training. • Hazardous waste management facility inspection conducted in regular basis	SHE Manager	Internal Staff Costs Only.	Complied with regularions on hazardous waste management	• RKL RPL document • MSDS • Waste Management Plan
Wastewater	• Surface water • Groundwater • Workers • Affected villages in Kota Agung and Semende Darat Ulu sub-districts	• Implement the requirements set forth in the wastewater injection permit • At the separator station, produced water (brine) is separated from steam. Brine is collected temporarily in an impermeable pond and reinjected back to reservoir through dedicated brine injection well • Condensate from the condenser unit is temporarily collected in an impermeable pond and reinjected back to reservoir through dedicated condensate injection well • No discharge of brine and condensate to surface water • Wastewater from production and injection wells acid treatment is injected to reservoir through injection wells • Supernatant water from the oily water separator in the	• Integrity inspection to the facility • Wastewater monitoring at the water and mud pond every 6 months • 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	SHE Manager	Internal Staff Costs Only.	Wastewater quality meets the standards.	• SERD SOP • RKL RPL document

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		maintenance workshop will be collected in the pond and injected to the reservoir through injection well • Domestic sewage will be treated with septic tank					
Biodiversity	• Fauna • Flora	• Collaboration with stakeholders to protect the landscape, especially NGO that concern with Tiger Conservation—Collaborative management • Socialization with the community on protected species awareness • Minimize open land areas without vegetation; • Open new land areas in stages and in accordance with approved project schedule and activity planning • Relocate and conserve protected flora found around the project site; • Revegetate using local plants that adjust local soil types and climatic conditions on bare areas; • Revegetate using plant species that are a source of food for animals; • Prohibit hunting and poaching of wildlife and removal of protected flora; • Install banners informing the prohibitions of hunting/poaching and removal of protected flora; • Build nursery for revegetation and rehabilitation;	• 6-monthly review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness • Monitor threatened species and the presence of endangered species on project site (at least every 3 years)	• SHE Manager • Project Manager • External Relations Manager • Security Manager	Management, training/awareness, monitoring US$ 20,000 annually.	• Land clearing in accordance with the project's requirement; No incidence of hunting or poaching of wildlife. • Flora: presence of protected species, pioneer species, and invasive species either native or alien. • Fauna: presence, abundance and distribution of species with important conservation status and endemic species as a basis for habitat and population management. • No of employees and workers reached in awareness training program	• Critical Habitat Assessment • Biodiversity Action Plan • Environmental Management and Monitoring Plans that are part of the AMDAL
Invasive Species	Flora	• Revegetation using only local species • Monitor and respond to invasive alien species on Project site and vicinity—No alien species have been recorded at the project site and surrounding areas to date. This may not always be the case, however, and adaptive management principles need to incorporate the ability to recognize and identify invasive alien species should this occur in future. The linear nature of the structures in the project and their spatial arrangement raises the risk that invasion can occur and a risk assessment and mechanism for initiating an appropriate response needs to be addressed in the Biodiversity Action Plan.	5-year review of revegetation plans and practices, including presence of invasive species	SHE Manager	Internal staff costs. External review US$15,000	No invasive species encountered dutring routine monitoring	RKL RPL document
Workforce Impacts on Communities-Disease, Cultural, Drain on Local	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Implement Public Health Awareness Raising Plan to address malaria prevention, hygiene and sanitation, safe sex practices and other community health issues. ▪ Conduct cultural awareness training for new hires. ▪ Monitor local resource impacts; address gaps and problems as needed.		• SHE Manager • Project Manager • External Relations	Internal Staff Costs only.	No increases in diseases, no change in disease pattern	Public Health Awareness Raising Plan

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
Resources, etc.				• Manager • Security Manager			
Income Opportunities	▪ Workforce ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Prepare Annual Land Acquisition and Livelihood Impact Monitoring Report (see Appendix 9: Land Acquisition and Livelihood Impact Monitoring Report (Format)). ▪ Actively and transparently disclose employment opportunities publicly, including qualification requirements and the selection process. ▪ Focus recruitment on local skilled and unskilled; where qualified local workers cannot be found, the project will recruit regionally and nationally. ▪ Facilitate local employment, provide targeted job skills training and education opportunities to existing and potential workers. For the general population seeking employment opportunities, the Community Development Plan has local employment as a strategic objective. For existing workers that want to increase responsibilities and contributions to PT SERD, professional development is offered. ▪ Enhance local business development through supply chain development and the Community Development Plan. Source products and services from the local area (though more complex and unique geothermal-related goods and services will likely need to be sourced from other parts of Indonesia (or abroad)).	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	• External Relations Manager • Field Supply Chain Manager	Internal Staff Costs only.	No labor complaint	• Community Development Plan • Supply Chain Strategy
Compliance with labor legislation	Workforce	• Commit to compliance with PT SERD policy, Indonesian labor laws and relevant related international conventions. • An Employee Grievance Mechanism is available to employees; new employees are made aware of this Mechanism when hired and all employees are kept aware of the availability of the Mechanism. The grievance mechanism for workers (and their organizations) provides a mechanism to raise reasonable workplace concerns. The Mechanism has senior management sponsorship and addresses concerns promptly, using an understandable and transparent process that provides feedback to claimants, without any retribution. The mechanism does not impede access to other judicial or administrative remedies available under law or through existing arbitration procedures, or substitute for grievance mechanisms provided through collective agreements • Contractor and subcontractor compliance, including with forced and child labor restrictions, are monitored through PT SERD's audit system. • Capacity development and training of workforce	• Annual review of the Employee Grievance Mechanism log and HR-related audits to assess whether workers have submitted any grievances related to labor legislation compliance, including forced and child labor. • Six monthly training and capacity building of employees in accordance with needs and requirements related to managing and monitoring of environmental and social impacts.	• Admin Manager • Human Resources Manager • SHE Manager	Internal Staff Costs only.	• No labor complaint • No violations of Labor Laws • Number of training	• Employee Grievance Mechanism • PT SERD HR policies • PT SERD SHE Policies • Annual List of ESMPorgani related trainings
Cultural Heritage	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	There are no known cultural heritage impacts. However, in consideration of the sensitivity of cultural heritage, PT SERD is committed to comply with applicable national law and UN convention obligations to protect cultural heritage during design, construction and operations and ensure that internationally	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	• External Relations Manager • Project Manager	Internal Staff Costs Only.	Full compliance with the policy on chance find of any relic that may have cultural significance	Chance Finds Procedure

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document

		recognized cultural heritage practices for protection, study and documentation are implemented, namely:
		• When necessary, competent professional assistance will be used assess cultural heritage in the project area.
		• Avoidance of possible cultural heritage impacts as the preferred option
		• Adoption of a Chance Finds Procedure that documents steps to be undertaken if cultural objects are found over the course of the project.
		• Informed Consultation and Participation (ICP) is undertaken with communities on the subject of cultural heritage.
		• If ultimately a cultural heritage is found, community access is granted in accordance with company health, safety and security considerations.
		• In case tangible cultural heritage that is replicable and non-critical is found, PT SERD will favor avoidance or if not feasible,
		  ○ minimize adverse impacts and implement restoration measure in situ; or
		  ○ where restoration is not possible in situ, move the cultural heritage to another site including restoring its functionality, carried out according to principles of paragraph 6 and 7; or
		  ○ compensate for loss only where minimization and restoration are not feasible and cultural heritage is used for long-standing cultural purposes by affected communities.
		• In case Non-replicable cultural heritage is found, it is not to be removed from its place unless no feasible alternatives are found and overall benefits of the project outweigh the anticipated cultural heritage loss from removal.
		• In case critical cultural heritage is found, such as internationally recognized heritage used by communities for long-standing cultural purposes or legally protected heritage areas, it is not to be removed, significantly altered or damaged unless exceptional circumstances apply where impacts are unavoidable. PT SERD will use a process of ICP with affected communities and assistance of external experts is required. In the case of legally protected cultural heritage sites, additional requirements apply.
		• In case project use of cultural heritage is required, PT SERD will inform the communities of
		  ○ their rights,
		  ○ scope and nature of project uses, and potential consequences. A process of ICP will be applied fairly, resulting in a documented outcome that provides for fair and equitable sharing of any benefits.
				SHE Manager			

Host Community Concerns	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	Execution of the following: • Stakeholder Engagement Plan • Community Development/CSR Plan • Grievance Mechanism	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	External Relations Manager	Internal Staff Costs only.	No negative perception of the company; No valid grievance recorded.	• Stakeholder Engagement Plan • Community Development Plan • Grievance

Impact	Potential Receptors	Mitigating Measures	Monitoring Measures and Frequency	Responsible Authority	Cost Estimate/ Fund Sources	Performance Indicators	Relevant project Document
		• Project ESMP					Mechanism
Community Health, Safety and Security	Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Implement PT SERD Safety, Health and Environment (SHE) policies and procedures, including security. ▪ Carry out site management practices such as the provision of fencing around mud ponds and road signage to drive SHE objectives. ▪ Implement Public Health Awareness Raising Plan to address malaria prevention, hygiene and sanitation and other community health issues. ▪ Implement ERP, ensuring that it includes contact names and phone numbers and community aspects such as communication routes in the event of an emergency—including disclosure to local government to ensure the implementation is a coordinated effort. ▪ Socialization to community related to H2S hazard communication and emergency procedure ▪ Increase public awareness of safety, health and environmental issues by providing information directly and indirectly through campaign.	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	SHE Manager	Internal Staff Costs only.	No increases in diseases, no change in disease pattern	• PT SERD policies and procedures • Community Health and Safety (CCHS) Plan (to be prepared by EPC contractor). • Emergency Response Plan
Encroachment and other cumulative and Trans boundary Impacts	▪ Fauna ▪ Flora ▪ Affected villages in Kota Agung and Semende Darat Ulu sub-districts	▪ Monitor the perimeter area around the PT SERD site at least annually to gauge encroachment and settlement trends. If negative trends are deemed to have been caused by the project, PT SERD will take remedial action. ▪ Assess whether project is causing transboundary impacts at least every 5-year; address identified impacts. ▪ Leverage Biodiversity Action Plan and Community Development Plan to prevent encroachment ▪ Implement Stakeholder Engagement Plan and Grievance Mechanism; document feedback.	Annual review of management measures to confirm their successful implementation and, where necessary, make continual improvement to improve effectiveness	▪ External Relations Manager ▪ SHE Manager	Internal Staff Costs Only.	All encroachment attempts prevented.	▪ Biodiversity Action Plan ▪ Stakeholder Engagement Plan ▪ Community Development Plan

11.1 Decommissioning

Decommissioning is expected to be 30-years after operation begins; however, the project may continue beyond that timeframe if commercial and resource conditions permit. Therefore, this impact is to be addressed in detail toward the end of the project's operational life.

Based on ANDAL documents, the management strategies to address expected impacts are:

- Proactively socialize the decommissioning to build awareness and encourage employees, the supply chain and other beneficiaries of the project to prepare and diversify.
- Preparation of a retrenchment plan for the workers that includes appropriate compensation. Some workers will likely be redeployed to other Supreme Energy projects.
- Undertake revegetation and minor earthworks to restore surface drainage and minimize sedimentation and soil erosion.
- Where possible, develop beneficial uses of project infrastructure.
- For infrastructure that is dismantled, seek beneficial use of the materials inside or outside the project area; where this is not possible, dispose the materials in lined landfills.

12 CONCLUSION

The development of the project will expand the economic activities nationally and regionally. The benefits to the nation as follows:

1. Bolster energy security through the use of domestic renewable resource;
2. Limit exposures to fossil fuel market volatility by diversifying the Indonesian power generation profile and reducing reliance on diesel / fuel oil;
3. Support government effort of producing clean energy.

The benefits for regional economy and industry as follows:

1. Providing multiplier effect to local economy, which is expected to be sustained;
2. An increase in regional incomes at provincial and regency level, through tax and non-tax income;
3. Creating job opportunities for local communities, according to Company's requirements and conditions;
4. Reduces critical energy shortages in Sumatra Interconnection System caused by very low reserve margins.

The project is in South Sumatra at an elevation ranging from 1,500 to 2,600 meters and characterized by undulating terrain with mainly moderate slopes. The project area affects 124.5 hectares of forest, including protected forest (115 hectares), and 9.5 hectares of private land. Protection forest is a MoEF categorization in which development activities may be carried out provided that overall catchment integrity is maintained in accordance with the forestry permit, which has been given for this project. In addition, a Forest Management Plan (FMP) has been approved by the Forestry office.

The project's approach to environmental risk mitigations comprises an Environmental and Social Policy, an Environmental and Social Management System and specific mitigations detailed in the Environmental and Social Management Plan (ESMP). While the project is located in a forest area, significant adverse environmental impacts that are irreversible, diverse or unprecedented are unlikely. Further, Indonesia's Ministry Environment and Forestry required that exploration impacts be remediated at the conclusion of the exploration phase.

The project is categorized as an ADB Category A project for environment, and an Indonesian environmental impact assessment (EIA) as well as this ESIA were prepared. The EIA and ESIA process concluded that there are no 'High' level residual risks associated with the exploration, construction and operations phases of the project development, following the implementation of mitigation measures detailed in the ESMP. Most impacts identified would be considered a "Low' residual risk following mitigation, especially considering that geothermal energy generation is a well-established practice in Indonesia, and government authorities and Project Proponent can refer to a substantial body of in-country knowledge and expertise. PT Supreme Energy Rantau Dedap also has experience developing such projects.

The project is committed to following GIIP by adopting ADB and IFC safeguard policies. This commitment can be achieved by implementing the ESMP, ensuring that the project will achieve good industry practice compared to similar geothermal projects operating in Indonesia and around the world.

Construction of access roads, facilities, and wellpads present the primary environmental hazards. The facilities have been constructed in already disturbed farmland areas. In accordance with the FMP, (i) all trees removed must be counted and a compensation fee paid to MoEF; (ii) disturbed areas must be rehabilitated and revegetated at the completion of the exploration phase; and (iii) the borrower must implement various management activities such as training, prevention of illegal forestry and poaching activities, and monitoring and reporting. The project area includes four rivers that are traversed by access roads in several locations. Roads are constructed to ensure maintenance of river flows, and minimization of erosion and sediment impacts.

Operation of the drilling rig presents relatively minor and temporary environmental hazards. Noise and air impacts from drilling rig operations and vehicles are not significant because the well pads are in areas remote from human settlement. A comprehensive safety, health, and environmental management system and environmental management, monitoring, and mitigation measures are in place.

The project is designed to minimize water use and avoid the generation of wastewater from drilling. Drilling mud and drilling cuttings from the exploration wells are separated for reuse, with wastes stored for later off-site disposal or utilized as construction material. Water is ponded and can be pumped between well pads; remaining ponded water will be reinjected and not released to the environment.

A targeted species survey program is established to ensure habitat values are protected and, should potential environmentally sensitive areas be identified, project activities will be modified to minimize impacts. Baseline environmental and social conditions have been analyzed and are documented.

APPENDICES

List of Appendices