Geothermal Power Plant Project Ijen Bondowoso

Environmental and Social Impact Assessment (ESIA) Study

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Acronyms and Abbreviations

Name	Description
µg	Micrograms
^{o}C	Degree Celsius
ALARP	as low as reasonably practicable
APHA	American Public Health Association
AQI	Air Quality Index
As	Arsenic
ASEAN	Association of Southeast Asian Nations
B	Boron
Ba	Barium
BGI	Bare Ground Index
BOD5	Five-Day Biochemical Oxygen Demand
$CaCO_3$	Calcium Carbonate
Cd	Cadmium
CH	Critical Habitat
CH4	Methane
Cl	Chlorine
Cl-	Chloride
cm	Centimetre
CO	Carbon monoxide
COC	Chain of Custody
COD	Chemical Oxygen Demand
Cr	Chromium
CR	Critically Endangered
CSOs	Civil Society Organizations
Cu	Copper
dB	Decibel
dB(A)	A-weighted Decibel
DD	Data Deficient
EAAA	Ecologically Appropriate Area of Analysis
EBA	Endemic Bird Area
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EN	Endangered
EPA	United States Environmental Protection Agency
EPAS	Environmental Perimeter Air Station
ERM	ERM-Siam Company Limited
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan

Name	Description
ESMS	Environmental and Social Management System
F-	Fluoride
Fe	Iron
FFI	Foreign Financial Institution
FGDs	Focus Group Discussions
FIs	Financial Institutions
FPIC	Free, Prior, and Informed Consent
ft	Feet
GEMSS®	Generalized Environmental Modelling System for Surface Waters
GIFT	Generalized Integrated Fate and Transport
GIS	Gas Insulated Switchyard
GHG	Greenhouse Gas
GN	Guidance Note
GPS	Global Positioning System
h	Hour
ha	Hectare
H&S	Health and Safety
Hg	Mercury
IA	Impact Assessment
IBA	Important Bird Areas
IBAT	Integrated Biodiversity Assessment Tool
IFC	International Finance Corporation
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
KBAs	Key Biodiversity Areas
kg	Kilogram
km^2	Square Kilometre
km	Kilometre
KPIs	Key Performance Indicators
L	Litre
LAeq	A-weighted equivalent continuous sound level in decibels
LC	Least Concern
m	Meter
m^2	m^2
m^3	Cubic Metre
MD	Measured depth
mg	Milligrams
mL	Millilitre
MLD	Millions of Litres Per Day

Name	Description
mm	Millimetre
Mn	Manganese
ND	Not Detected
NGOs	Non-Governmental Organizations
NH_3	Ammonia
NHMH	Natural Habitat and Modified Habitat
nm	Nautical Miles
NO_x	Nitric Oxide
NO_2	Nitrogen Dioxide
NO3-N	Nitrate
O_3	Ozone
PA	Protected Area
PACs	Potentially Affected Communities
PAoI	Project Area of Influence
PAPs	Potentially Affected Persons
PAs	Protected Areas
Pb	Lead
PM2.5	Particulate Matter <2.5 micrometres
PM10	Particulate Matter <10 micrometres
PRA	Participatory Rural Appraisal
PSs	Performance Standards
Pt	Platinum
RO	Reverse Osmosis
s	Second
Se	Selenium
SEP	Stakeholder Engagement Plan
SO_2	Sulphur dioxide
SO_4	Sulphate
$SO_4$2-	Sulphate
sq	Square
TD	Total Depth
TDS	Total Dissolved Solid
TOC	Total Organic Carbon
ToR	Terms of Reference
TSS	Total Suspended Solid
UKAS	United Kingdom Accreditation Service
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

Name	Description
VU	Vulnerable
WCS	Wildlife Conservation Society
WEF	Water Environment Federation
WHO	World Health Organization
Zn	Zinc

0 EXECUTIVE SUMMARY

0.1 Introduction

PT ERM Indonesia ("ERM") has been appointed to undertake an Environmental and Social Impact Assessment (ESIA) for a 34 megawatt (MW) geothermal project ("the Project") located at Blawan Ijen, Bondowoso East Java by MEDCO CAHAYA GEOTHERMAL ("MCG"), which is a subsidiary of Medco Power Indonesia.

The project needs to develop an Environmental and Social Impact Assessment (ESIA) that that documents conformance with international standards as part of the project financing process for lenders. This report is the ESIA for the Project covering the Project area (well pads, geothermal power plant, logistics yard, base camp, access roads, and the transmission line to the Banyuwangi sub-station. passing

0.2 Policy and Regulatory Framework

The Project is being funded by international lenders and as such, this ESIA has been prepared in accordance with the local laws and International Finance Corporation Performance Standards (IFC PSs). The regulatory framework for this ESIA includes:

- Indonesia Administrative Framework;
- Indonesian Regulatory Legislation;
- International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012);
- Word Bank Group Environmental, Health and Safety (WBG EHS) guidelines, General EHS Guidelines (2007);
- WBG, EHS Guidelines for Geothermal Power Generation (2007);
- Equator Principles 4;
- International conventions signed by Indonesia; and
- Environmental Standards – National vs. International Standards.

0.3 Project Description and Alternatives

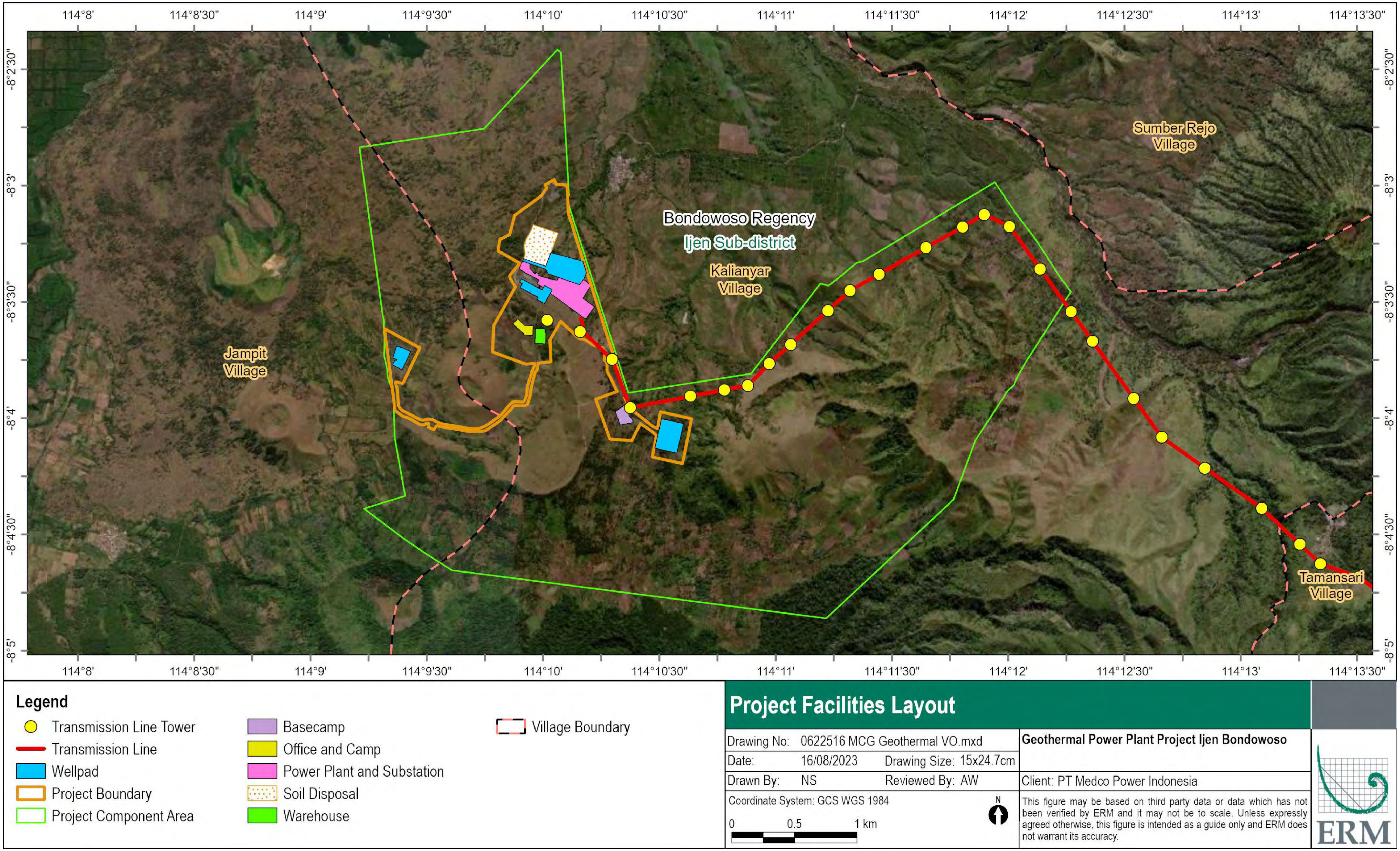
MCG proposes to develop a 110 MW geothermal project located at Blawan Ijen, Bondowoso East Java. This Project will be developed in stages, referred to herein as units. Unit 1 will include production and injection wells, and associated ancillary facilities, to support a 34 MW powerhouse. The Project plans to expand to 110 MW capacity with a future Unit 2. At this time, however, the Project is only seeking financing for Unit 1. The key components of Unit 1 include the following, as shown in ***Figure 0-1:***

- Exploitation facilities including power plant, separator and brine pump, vent station (rock muffler), base camp, office, and car park;
- Drilling and exploration facilities including four well pad areas, including 6 production wells, 2 injection wells, and one backup injection well), logistics yard, and explosives bunker;
- Access Roads (within the Project Site); and
- 150 kV Transmission line and 83 towers (approximately 28.3 km).
- The site has already been cleared at the well drilling pads. MCG have previously conducted drilling campaigns within this Project Site:
    - o Two deep slim-holes exploration drilling in 2016-2017: IJN 01 and IJN 02; and

- Three deep big-holes exploration drilling in 2020, discovered well with 300 deg: IJN 6-1 ST, IJN 5-1, and IJN 6-2.

The Project is located on Bondowoso and Banyuwangi regencies, East Java province, Indonesia and is approximately 270 km southeast of Surabaya.

Figure 0-1: Project Site Location



The Project (Unit 1) will be undertaken in phases as shown in ***Table 0-1***

Table 0-1: Project Phases

Activities	Details	Schedule
Drilling Activities	■ Drilling Rig ■ Exploration wells ■ Production well and Well pads ■ Drilling Fluids and cuttings	24 months
Construction Phase	■ Power plant and Transmission line, construction for Unit 1 is estimated to be 21 months; ■ Access road.	21 months
Commissioning Phase	■ Preliminary test consists of individual tests for systems, sub systems, equipment and installation. ■ Performance test is meant to test the whole system of Power Plant and shall be performed uninterrupted for 72 hours.	n/a
Operational Phase	Operation will include the following: ■ Plant Automation; ■ Electrical Output; ■ Operation Range; ■ Concept Design; and ■ Design Life and Availability.	30 years
Decommissioning	■ Pre-decommissioning activities: includes the detailed planning, development and approval procedures; ■ Decommissioning activities: removal of plant machinery & equipment and demolition, decommissioning of facilities, infrastructure, decontaminated land assessment and rehabilitation; and ■ Post-decommissioning activities: site survey, close-out report and field monitoring as necessary.	n/a

Resource Requirements

Water supply will be sourced from local streams in the Project Area. It is estimated that a total of 1,200 gallons per minute will be required for the construction and drilling activities. A local permit for water abstraction has been obtained.

Power supply or electricity is needed to pump the water for the power station, as well as for other operational needs. This electricity will come diesel powered engines at site. Power will be supplied from the national grid for during operation.

Large equipment and heavy cargo shall be transported via sea and unloaded on the Jetty either in Banyuwangi Seaport around 150 km from the site or Probolinggo Seaport, around 170 km from the Site.

The overall anticipated workforce during construction estimated to be 450 workers. During operation, as the power plant will be automated, there will only be around 69 workers.

Emissions and Discharges and Control Measures

The following section outlines the emissions and discharges and control measures for the Project. The Project will generate the following emissions, discharges, and wastes**:**

- Drilling Fluids and Cutting;
- Wastewater;
- Run-off water;

- Soil;
- Air Emission;
- Noise Emission; and
- Solid and Hazardous waste.

Project alternatives

Alternatives considered include the no project alternative, location alternatives (e.g. power plant, access roads, transmission line), and water and mud discharge alternatives (e.g. reinject or discharge to brine collection ponds and infiltration).

0.4 Description of the Environment

The Study Area covers the Project footprint in Blawan Ijen, Bondowoso East Java and the transmission line, which extends 28.3 km from the Project to the existing Banyuwangi sub-station. The Project Area of Influence (AoI) extends for 5 km from the main works area and transmission line route to encompass any sensitive environmental and social receptors.

- Environmental AoI (air, noise, soil, water) – dust fall is typically up to 200 m from construction activities and noise from construction is likely to impact an area within 500 m. Given the extent of Project activities; the Environmental AoI is likely to be within 500 m of the Project Area.
- Biodiversity AoI - the direct footprint of the project comprising the project site, and the areas immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence and project related activities (e.g., sourcing of fill materials, transportation). This kind of disturbance has been estimated to occur within the project footprint and surrounding areas (approximately 5 km from the activity areas).
- Social AoI – social impacts can be experienced from the Project in local villages and towns involving both direct impacts within the project footprint) and indirect impacts (i.e., disturbance to services such as traffic).

The environmental setting of the site is presented in ***Table 0-2***.

Table 0-2: Summary of Environmental and Social Baseline Conditions

Receptor	Description
Climate and Meteorology	■ The Project is located in East Java, there is a lot of rainfall in the wet season between November and April with an average annual rainfall is 1,900 mm and 100 days of rain. January is the wettest month, whereas May through October typically dry in which August is the driest month. ■ The average temperature is between 19-34 degrees Celsius. The warmest month in East Java is October with an average maximum temperature of 22°C[1].
Ambient Air and Climate	■ Air quality sampling conducted for the ESIA demonstrates that at parameters measured were in line with the Indonesia national air quality standards for all parameters. ■ All parameters from Air monitoring data from 2017 to 2021 were below the local regulatory limits (compared to Ambient Quality Standard: Gub Jatim No 10/2009).
Ambient Noise	■ Noise sampling conducted for the ESIA demonstrates that day time measurements at all locations were in line the Indonesia and WBG standards except at some villages along the transmission line route during the night-time. ■ The results of the monitoring data are indicate that existing noise level is below the regulatory limit in all instances except in 2021. Area IJN 06 was exceeded 70 db.

[1] World Bank Group (2021), Climate change knowledge portal. Available from:
https://climateknowledgeportal.worldbank.org/country/indonesia/climate-data-historical
https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15504-Indonesia%20Country%20Profile-WEB_0.pdf

Receptor	Description
Land Use and Land Cover	■ The proposed main development area is located within an area of production forest that has been permitted for use for the Project from the local government. ■ The transmission line runs through production forest and protected forest areas. The proposed transmission line route is along the current access road to the sub-station. This does not overlap with the legally protected Kawah Ijen Nature Reserve. ■ The transmission line route extends for 28.3 km (to avoid residential areas) within a 10 m wide right-of-way (ROW), and includes 83 towers, each with a footprint ranging from 225 to 625 square meters (m^2) determined by geotechnical conditions. ■ The Project will only acquire land within the tower footprints, and not the full ROW, although there will be land use and height restrictions within the ROW for safety purposes.
Geology	■ The geological review of Bondowoso Regency indicates that its stratigraphy is composed of volcanic deposits from older Quaternary volcanoes (21.6%) and younger Quaternary volcanoes (62.8%). ■ Based on the Geological Map of the Ijen Caldera Complex, East Java (Sitorus et al., 1988), the project site is located within the Kendeng Caldera, which erupted approximately 294,000 years ago. ■ Ijen was designated as a UNESCO Global Geopark on 24 May 2023.
Soil	■ The soils in the Project Area are classified medium (SD) to hard soil (SC) according to SNI-1726-2019 (Design Standard for Earthquake Resistance for Building and Non building Structure.
Surface and Ground Water Resources	■ The majority of river water in Java is polluted or heavily polluted by untreated domestic sewage, solid waste disposal, and industrial effluents. ■ The surface water quality for SW1 and SW4 mostly meet the threshold according to Government Regulation (except for biological oxygen demand (BOD), while there are several parameters in SW2 and SW3 that exceed the thresholds. ■ SW2 and SW3 are located near the Ijen Crater and impacted by the high sulphur content. SW1 and SW4 are located in a stream closer to the Project rea. ■ Surface water monitoring was conducted at a stream within the Project Area at upstream and downstream locations from the Project between 2017 and 2021. The results of the surface water monitoring show that the majority of parameters tested are within the Surface Water Quality Standards (PP RI No 82/2001). ■ Groundwater samples conducted for the ESIA recorded high levels of total coliform bacteria that is likely due to poor water hygiene practises. ■ Groundwater monitoring was conducted at a stream within the Project Area at upstream and downstream locations from the Project between 2017 and 2021. The results showed that Total Coliform exceed standards, which may be due to the lack of wastewater treatment in neighbouring communities and human and animal faeces/waste.
Natural Hazards	■ Indonesia is located within the Pacific Ring of Fire. The country is vulnerable to natural disasters such as earthquakes, volcanic eruptions, tsunamis, floods, landslides, droughts, and forest fires. ■ Yogyakarta and Central Java are experiences frequent earthquakes events in 2006 at 6.2 magnitude and affected >5,700 fatalities. ■ The active volcanoes distributed in Sumatra Island, Java Island, Bali, Nusa Tenggara, North Sulawesi and the Mollucas Island constitute 13% of the world active volcano distribution. ■ Indonesia experienced an earthquake and subsequent tsunami off the coast of Sumatra, killing over 167,000 people in Indonesia and resulted in the displacement of more than half a million of people as thousands of homes were destroyed. ■ In 2020, Bondowoso (East Java Province) was hit by flash flood where more than 200 houses flooded and 856 peopled were displaced as recorded by the Indonesian National Board for Disaster Management (BNPB). ■ In 2021, landslide in East Java triggered by moderate to high-intensity rainfalls killed at least nine people. ■ Regions Indonesia that are prone to forest and land fires include Sumatra and Kalimantan Islands that have large areas of plantation and large scale farming as

Receptor	Description
	well as several districts/cities in Sulawesi, East Nusa Tenggara, and Java Island (in which the Project is located).
Ecological Background	According to East Java Natural Resources Conservation Centre[2] the general ecosystem in Ijen Crater Nature Reserve consisted as: ■ Montane Rain Forest, this area distributed between 1,000 and 2,500 m above sea level. The vegetation found is a combination of Mountain Rain Forest and Sub Alpine Rain Forest dominated by Compositae (Eidelweiss) and Ericaceae (Vaccinium). ■ Sub Alpine Rain Forest, this area distributed between 2,500 and 4,000 m above sea. The vegetation is dominated by shrubs and shrubs, given the unfavourable environmental conditions and the increasing influence of sulphur compounds. ■ There are two KBAs, both Important Bird Areas (IBA), located within 1 km of the Project: Gunung Raung to the north and Gunung Ijen to the south-west. A trigger species of these KBAs is the Javan Hawk-eagle (Nisaetus bartelsi) listed as Endangered on the IUCN Red List.
Species of Concerns	■ Secondary data gathered from Integrated Biodiversity Assessment Tool (IBAT) listed seven species that can be considered as species of concerns potentially present around the proposed Project area. The species are consisted of one insect species, one mammal species (a bat), and five bird species.
Biodiversity Baseline data collection	■ The wet season biodiversity study conducted between 15 – 28 February with the focus of study including Terrestrial biodiversity, Aquatic biodiversity, and Vantage survey for Birds. ■ ERM performed data comparison analyses of the recorded species against the IUCN Red list data, list of regional endemic species, invasive species list. The analyses results to be utilize to understand the potential presence of critical habitat within and surrounding the project site.
Natural Habitat and Modified Habitat	■ Habitats around the Project are dominated by natural habitats including water bodies, forest areas, and natural features (craters). There are some modified habitats such as Kalianyar village (within 300 m of the closest well pad) and plantations.
Terrestrial Flora and Fauna Baseline	■ A total of 532 species were observed present within and surrounding the project site, these species consisted of 345 flora, 77 birds, 16 mammals, 19 herpeto-fauna and 75 insect species. ■ Referring to the IUCN red list data base, ERM identified most of the encountered species were listed LC (122 species) and none of them listed as CE, however there are one EN and two VU species found. ■ In terms of endemic and migratory species, ERM identified 22 endemic species and three migratory species within and surrounding the project site.
Aquatic Biodiversity Field Survey	■ 3 fish and 18 aquatic macroinvertebrates identified. ■ The species richness of fish is very low with only 3 species found throughout all sampling locations. ■ The fish were only caught at station A1 and A4. ■ There were no fish or other aquatic biota at station A2, A2A, and A3 since the river in those stations contain high concentrations of sulfur from the Ijen crater.
Species of conservation concerns	■ Based on the criteria of Indonesian Law, global policy, migratory, and endemicity, one flora and 32 fauna are considered species with conservation significance, including 24 birds, three mammals, one herpetofauna, and four insects species.
Critical Habitat Screening	■ This critical habitat screening finds that the EAAA potentially qualifies as critical habitat under IFC PS6 criteria 1, 2 and 4. A total of seven species (one insect species, one mammal species, and five bird species) have been identified as potentially critical habitat-qualifying biodiversity features. The forest ecosystem present in the EAAA is recognised as a high priority for conservation at the national level, and is also likely to qualify the area as critical habitat.

[2] East Java Natural Resources Conservation Centre website: Kawah Ijen Nature Reserve. Available from: https://bbksdajatim.org/cagar-alam-kawah-ijen-merapi-ungup-ungup-2

Receptor	Description
Administrative and Demographics	■ Most communities in the surrounding Project area are Muslim, however, other religions include Protestant, Roman Catholic, Hinduism and Buddhism. Bondowoso and Banyuwangi are known for its strong Islamic tradition, following Nahdlatul Ulama (NU), one of the biggest islamic organizations in Indonesia. In Bondowoso and Banyuwangi Regency have a diverse range of ethnic groups. Madurese is the largest ethnic group in Bondowoso, followed by Javanese.
Economic Profile and Livelihoods	■ The majority of communities in Ijen Sub-district work as labourers in state-owned plantations (PTPN XII) with daily wages of IDR 35,000.00 to IDR 50,000.00. ■ The main crops cultivated by the communities are mostly vegetables and fruits, given the geographical characteristic of the area. The vegetables are varied, ranging from potatoes, cabbage, tomatoes to chilies. While the fruits include avocado, banana, dragon fruit, etc. Some are also raising cattle, goat, and chicken. ■ Additionally, local communities are currently developing tourism sector in their respected village, particularly nature tourism.
Education	■ Level of education is illustrated through three main indicators, namely literacy rate, mean years of schooling, and school participate rate. Literacy rate indicates the proportion of people ages 15 and above who can read and write. Mean years of schooling suggests the average number of completed years of education of a country's population aged 15 years and older, excluding years spent repeating individual grades. ■ School enrolment rate measured the ratio between the number of students of a particular age group enrolled in all levels of education by the size of the population of that age group.
Health	■ Health facilities in the Study Area include hospital, maternity hospital, clinic, community health centre (with and without inpatient care facility), individual doctor practice and pharmacy. These facilities are available in project AOI.
Tourism	■ The Project is located within the Kawah Warang (Wurung) Park which is a tourism hiking area known for scenic views and a number of crater features such as Kawah Wurung and Kawah Ilalang which are adjacent to the access road and transmission line respectively. ■ Kawah Ijen is a composite volcano located at the easternmost part of Java Island in Indonesia and hosts the largest natural acidic lake in the world3. This crater is a popular tourism site as is located within the Kawah Ijen Crater Park. At its closest point, this tourism site is located 300 m from the transmission line route and around 2.5 km from the main construction area. ■ The existing tourism destinations in Kalianyar village are managed by Tourism, Youth, and Sport Agency of Bondowoso Regency. The village office does not obtain any direct revenue. However, the village is currently planning to develop the tourism potential and the community expectations are for the Project to support this initiative (from ESIA engagement).
Traffic Infrastructure	■ The road connecting the villages in the sub-district has been paved, except in Sumber Rejo Village, which is still a gravel/stone road. Street lights are evident across the sub-district road, yet they are not sourced from the government. ■ Communication access in the sub-district is rather poor; only a couple of telecommunication providers are working properly.
Vulnerable Groups	■ The local communities who are categorised as vulnerable groups may be more sensitive to the Project's negative impacts. Hence, special attention shall be paid to these community members or groups.
Cultural Heritage and Indigenous Peoples	■ The Indonesian government classifies the Osing People as Indigenous. 18 TT PAHs impacted by land acquisition for the power plant identified as Osing, as a result Indigenous People are directly affected by the Project. Stakeholder engagement and site surveys undertaken for this Project did not identify any physical displacement, which includes cultural heritage and collective attachment. None of the Osing

[3] USGS website, 2015: Kawah Ijen volcanic activity: A review. Available from: [Kawah Ijen volcanic activity: A review | U.S. Geological Survey (usgs.gov)]

Receptor	Description
	households which are impacted by the land acquisition for the transmission line towers are significantly impacted, based on the census data collected by MCG. ■ Osing households impacted by land acquisition will be benefit from the overall livelihood restoration programs outlined in the Livelihood Restoration Plan (LRP). The Project has ensured that the Project will not produce significant changes to livelihoods of the Osing people. In addition, as evidenced by the census data, and meeting notes, MCG has free, prior and informed consent from the affected households. ■ There are three mosques located within 1 km of the transmission line route. No areas of intangible cultural heritage were identified in the Study Area.

0.5 Stakeholder Engagement

MCG has conducted multiple consultations and held several stages of negotiation since 2018. Based on MCG's stakeholder engagement database, consultations were conducted with various different groups of stakeholders including local authorities, community leaders, affected community members, youth groups, women's groups, Osing representatives and community groups. As of 14 July 2023, MCG had conducted 172 consultations with various stakeholders (in addition to the household surveys conducted with affected households). Community concerns were primarily related to land acquisition. In addition, communities also raised issues related to infrastructure, health, environment, safety, security, economy and education. Concerns and comments from the community were listed in MCG's stakeholder engagement database and in the meeting notes. Follow up actions were also outlined for each concern. As a result of the consultations, several towers were moved based on community members' inputs.

During site visits, consultation meetings were held with various relevant stakeholders at Regency and district levels. The purpose of the consultations was to present information regarding the Project, gather information on potentially affected people, and identify potential data gaps. ESIA consultations involved face-to-face meetings with a range of stakeholders including local government representatives and community representatives in the Project Area, such as the heads of districts, village heads, informal leaders, religious leaders, youth, representatives of women's groups, youth representatives, and other key relevant stakeholders.

Community perceptions, expectations, and concerns were collected as part of the above processes. ***Table 0-3*** summarises the key stakeholders engaged and their key concerns and expectations.

Table 0-3: Stakeholder Engagement Activities Conducted for the ESIA

Date	Location	Stakeholder Involved	Key Message for ESIA
02/03/2022	Kalianyar Village, Bondowoso	■ Head of Kalianyar Village ([redacted]) ■ Religious leader of Kalianyar Village ([redacted]) ■ Youth representative of Kalianyar Village ([redacted])	■ Project is expected to continue the CSR program, particularly in conducting local hiring. Besides, Project is expected to accept local vocational high school graduates to work on the Project. ■ Project is expected to continue the existing community development program, especially in providing assistance to renovate worship facility (mosques) and conducting local hiring for unskilled workforce.
03/03/2022	Power plant area, Kalianyar Village, Bondowoso	Local farmers in Power plant area	■ Farmers are aware that the land is formally owned by Perhutani and currently used and borrowed by MCG

Date	Location	Stakeholder Involved	Key Message for ESIA
	Curah Macan hamlet in Kalianyar, Bondowoso	Head of LMDH / Forest village community [redacted]	■ Community supports the project and has no concerns on the existence of MCG's project located near the hamlet other than the steam kick happened in 2020.[4]
	Kalibendo, Kampung Anyar Village, Banyuwangi	One of owners of the Kalibendo plantation [redacted]	■ Engagement for the transmission line done by MCG team and the team will continue to communicate with the plantation owner for any project development. ■ Compensation should be fair, transparent and benefiting the affected communities
04/03/2022	Kalibendo, Kampung Anyar Village, Banyuwangi	Osing people (youth)	■ Osing cultural norms and values are not practised by young people anymore
	Kopendugu Hamlet, Grogol Village, Banyuwangi	Grogol Village Secretary ([redacted]	■ The village secretary received inquiries/ concerns from the community related to Compensation ■ Compensation should be transparent, fair and benefiting the affected people
05/03/2022	Bulupayung Hamplet, Bulusari, Banyuwangi	Bulupayung head of hamlet, Bulusari Village [redacted]	■ Engagement for the transmission line was conducted by MCG team ■ There are no current issues related to the Project. However, affected landowners are waiting for further information related to the next step of the acquisition process
06/03/2022	Sempol Village, Banyuwangi	■ Wife of the Sempol Village head ([redacted] ■ Head of Perhutani Forest Management in Sempol Area ([redacted] ■ PTPN XII Supervisor ([redacted]	■ There are few concerns related to access road and traffic due to MCG's mobilizations of equipment ■ Vehicle noise create disturbance/ inconvenience during night-time in community residential area ■ All six (6) LMDHs have established contract agreement with Perhutani indicating legitimate partnership ■ Cooperative models involving PTPN XII and communities utilizing PTPN's land are two things; rent price per hectare determined by harvest revenue and selling price of the crop, and daily labour wage for farmers that are engaged indirectly through renters especially in harvest seasons

[4] This steam kick incident occurred while drilling IJN 6-1. The drilling penetrated a shallow depth high temperature steam reservoir at 630 m. This incident can occur during geothermal drilling and was mitigated with the installation of a BOP (Blow Out Preventer). During the incident, the BOP functioned properly, however due to the increase of pressure and temperature of the well, the steam flowed to the surface. No harmful gases were detected that could harm the local community, and the situation was properly controlled. MCG managed the steam kick and stabilized the well by pumping heavy drilling mud. The incident was reported to relevant government bodies and communicated to local authorities and communities.

Date	Location	Stakeholder Involved	Key Message for ESIA
			■ Fresh water for drinking, eating and other household use for community in Sempol is sourced from Taman spring water located nearby in Sempol area.
07/03/2022	Bulusari Village, Banyuwangi	Bulusari Office Staff members	■ General socioeconomic condition in Bulusari village: main livelihood activity is farming, 85% of the people are Madurans, 10% -15% are Osing people, water resources are from Patemon water spring in Kalibendo plantation area as well as water spring in Meranti mountain.
	Kalipuro District Office, Banyuwangi	Bulusari Village head [redacted]) and Village secretary ([redacted])	■ Initially identified landowners inquire about the realization of the project and negotiation process for land acquisition ■ Proactive communication with MCG to inform affected landowners the current progress and the tentative timeline for negotiation is required ■ Local communities would like to gain better information on the development of transmission line, safety aspects of it and the likely impacts during construction and operation
	Giri Village (Urban Village), Banyuwangi	Giri Village Head ([redacted] and Village Secretary ([redacted])	■ Limited socializations may lead to negative perception and risk of social unrest ■ Inclusive and continuous socializations targeted for directly and indirectly affected people the surrounding communities and other related stakeholders are essential
08/03/2022	Jampit Village, Bondowoso	Community and Religious Leader ([redacted])	■ Community is welcomed and supportive towards the project ■ The steam kick incident was not affecting people in Jampit area ■ Donations to Jampit community are done few times by MCG

Stakeholder consultation undertaken to date confirmed that potential impacts from Project activities will be small in scale and of limited extent. MCG will provide an activity update in the notice to local communities prior to the start of the Project. A grievance mechanism will be in place during operation, in line with international good practices.

0.6 Environmental and Social Impact Assessment

Impact identification and assessment starts with scoping and continues through the remainder of the ESIA Process covering all phases of the Project. Once the prediction of potential impacts is complete, each potential impact is described in terms of its various relevant characteristics (e.g., type, scale, duration, frequency, extent). The next step in the impact assessment phase is to assign each potential impact a ‘magnitude’ and receptor ‘sensitivity’.

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the potential impact. The magnitude designations are: Positive; Negligible; Small; Medium; and Large. In the case of a potential positive impact, no magnitude designation (aside from 'positive') is assigned. In the case of potential impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised. However, the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterising the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/importance of the impacted resource/receptor. The sensitivity/vulnerability/importance designations used are: Low; Medium; and High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in ***Table 0-4***. Whereas for unplanned events, impact significance is designated with a different matrix, shown in ***Table 0-5***.

Table 0-4: Impact Significance

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Table 0-5: Impact Significance for Unplanned Events

		Likelihood of Occurrence				
		Incidental	**Minor**	**Moderate**	**Major**	**Severe**
Consequence	**Incidental**	Negligible	Negligible	Negligible	Negligible	Negligible
	Minor	Negligible	Minor	Minor	Minor	Moderate
	Moderate	Minor	Minor	Moderate	Moderate	Major
	Major	Moderate	Moderate	Major	Major	Major
	Severe	Major	Major	Major	Major	Major

This ESIA report has been prepared based on the technical report provided by PT Medco Cahaya Geothermal, Results in scoping matrix and reports relevant to the Project, site visits, environmental and social baseline data collection and the stakeholder engagement.

Table 0-6 includes a summary of residual impact significance. All impacts have been mitigated to **moderate** at worst case, and have a range of mitigation, management and monitoring measures to ensure no significant impacts to the environment or people.

Table 0-6: Summary of Residual Impact Significance

Impact Type	Residual Impact Significance	
	Construction	Operation
Physical Environment Impact Assessment		
Impacts on Ambient Air Quality	**Minor**	**Not scoped into assessment**
Impacts on Ambient Noise	**Minor**	**Not scoped into assessment**
Impacts on Surface water and Groundwater Quality	**Minor**	**Minor**
Impacts on Soil Environmental	**Minor**	**Not scoped into assessment**
Impacts on Topography and Landscape	**Moderate**	**Moderate**
Biological Environment Impact Assessment		
Impact on Biodiversity	**Negligible to Moderate**	**Negligible to Minor**
Social Impact Assessment		
Impact on Livelihoods and land Acquisition	**Minor**	**Not scoped into assessment**
Impact on Cultural Heritage	**Minor**	**Not scoped into assessment**
Impact on Tourism	**Moderate**	**Moderate**
Impact on Infrastructure and Services (including Traffic and Transport)	**Minor**	**Not scoped into assessment**
Impact to Community Health and Safety	**Minor**	**Minor**
Impact to Occupational Health and Safety	**Minor**	**Minor**
Unplanned Events		
Leakage and spill incidents	**Minor**	**Minor**
Traffic accidents	**Minor**	**Minor**
Fire and explosion	**Minor**	**Minor**
Well blow out	**Moderate**	**Moderate**
Natural hazards	**Moderate**	**Moderate**
Cumulative Impacts		
Topography and landscape	**Moderate**	
Biodiversity	**Moderate**	
Land and Livelihoods	**Minor**	
Tourism	**Moderate**	
Community health and safety	**Minor**	

0.7 Environmental and Social Management Plan

For all the impacts identified in the study, mitigation, management, and monitoring measures have been proposed and included in the Environmental and Social Management (ESMP) in this ESIA Report, including the schedule for monitoring.

The purpose of the Environmental and Social Management Plan (ESMP) is to specify the standards and controls required to manage and monitor environmental and social impacts during construction and operation phase. The ESMP (in ***Section 8***) will be part of the future construction and operational activities, and as the future construction and operational plans are prepared, these are expected to confirm how these commitments will be incorporated into the Project's Environmental and Social Management System. This implementation will be under the responsibility of the EPC (Engineering Procurement and Construction) Contractor and MCG.

The ESMP covers all in built controls and additional mitigation measures proposed to reduce the impacts as well as a list of all required management plans. Monitoring will be required for the Project to ensure compliance. This will include regular auditing of the Project during construction and operation as detailed in ***Section 8.5*** including air, noise, and surface water monitoring and auditing of mitigation measures.

Standalone management plans will be required for the Project. These will include:

- Air Quality Management Plan (Construction and Drilling Phase);
- Noise and Vibration Management Plan (Construction and Drilling Phase);
- Soil Erosion and Sediment Control Plan (Construction and Drilling Phase);
- Waste Management Plan (Construction, Drilling, and Operation);
- Biodiversity Action Plan (Pre-Construction Phase);
- Water Quality Protection and Management Plan for Surface Water and Groundwater (Construction, Drilling, and Operation);
- Traffic Management Plan (Construction, Drilling, and Operation);
- Occupational Health and Safety Plan (Construction, Drilling, and Operation);
- Hazardous Material Management Plan (Construction, Drilling, and Operation);
- Biodiversity and Pest Control Management Plan (Pre-Construction Phase);
- Cultural Heritage Management Plan (Pre-Construction Phase); and
- Land Acquisition and Resettlement Action Plan (Pre-Construction Phase);

1 INTRODUCTION

1.1 Project Background and Overview

PT ERM Indonesia ("ERM") has been appointed to undertake an Environmental and Social Impact Assessment (ESIA) for a 110 MW geothermal project ("the Project") located at Blawan Ijen, Bondowoso East Java by MEDCO CAHAYA GEOTHERMAL ("MCG"), which is a subsidiary of Medco Power Indonesia.

As part of the process to obtain the environmental approval, the Project was required to develop the AMDAL for national permitting. The AMDAL process for the 110 MW power plant has been completed, but the AMDAL for the transmission line is ongoing as the time of writing this report. Details on the AMDAL process and approval status are outlined in ***Section 1.1.1***.

This Project will be developed in multiple units. Unit 1 will include the production and injection wells, and associated ancillary facilities, needed to support a 34 MW powerhouse. The Project plans to expand to 110 MW capacity with a future Unit 2. At this time, however, MCG is only seeking financing for Unit 1 (hereafter referred to as the "Project"), so this ESIA is focused on those impacts associated with Unit 1. This Report serves as the ESIA Study for the Project covering the Project area (well pads, geothermal power plant, logistics yard) and associated facilities including worker base camp, access roads, and the transmission line to the Banyuwangi sub-station.

Further Project details are provided in ***Table 1-1***.

Table 1-1: Key Project Details

Key Highlights	Description
Company	PT Medco Cahaya Geothermal
Project location	Bondowoso, Banyuwangi, and Situbondo Regency, East Java Province, Indonesia
Exploration Permit	Effective until Sep 2022
Power Purchase Agreement (PPA) Capacity	Unit 1: Up to 34 MW Unit 2: Up to 110 MW
Minimum Capacity under PPA	34 MW
Estimated Commercial Operation Date (COD)	Phase-1: 2024 Phase-2: 2026
PPA Term	30 years from COD Phase-2
Base Tariff	8.58 cent/kWh
PPA escalation	35% linked to US PPI
Transmission Reimbursement Component PPA	Additional 0.3 cent/kWh
PLN TOP (local power) Obligation	90%
Power Distribution	Transmission line of 28.3 km to Banyuwangi Substation

1.1.1 AMDAL Process and Approval Status

The Government Regulation No. 22 of 2021 on Implementation of Environmental Protection and Management states that businesses and/or activities shall obtain an Environmental Approval through either the preparation and feasibility assessment of Environmental Impact Assessment document

(AMDAL) or the preparation and verification of an Environmental Management and Monitoring Effort form (UKL-UPL). With the issuance of the Government Regulation in lieu of Law No. 2 of 2022 on Job Creation, the Environmental Approval will now be part of the issuance of the Business License.

Through the Minister of Environment and Forestry (MoEF) Regulation No. 4 of 2021, the types of businesses and/or activities that are required to prepare an AMDAL, UKL-UPL, or Capability Statement for Environmental Management and Monitoring (SPPL) have been defined. Based on technical considerations and potential significant impacts, the Project falls within the category of business and/or activity which is required to prepare an AMDAL. The AMDAL consists of two documents: (1) a Terms of Reference (KA); and (2) an Environmental Impact Assessment (Andal) and Environmental Management and Monitoring Plan (RKL-RPL). The AMDAL document review and approval will be an Environmental Approval in the form of an Environmental Feasibility Letter.

Additionally, referring to the Government Regulation No. 5 of 2021 regarding the Implementation of Risk-Based Business Licensing, electricity and power distribution projects (such as this Project), are classified as high-risk businesses and/or activities. Thus, the Project is required to develop an AMDAL.

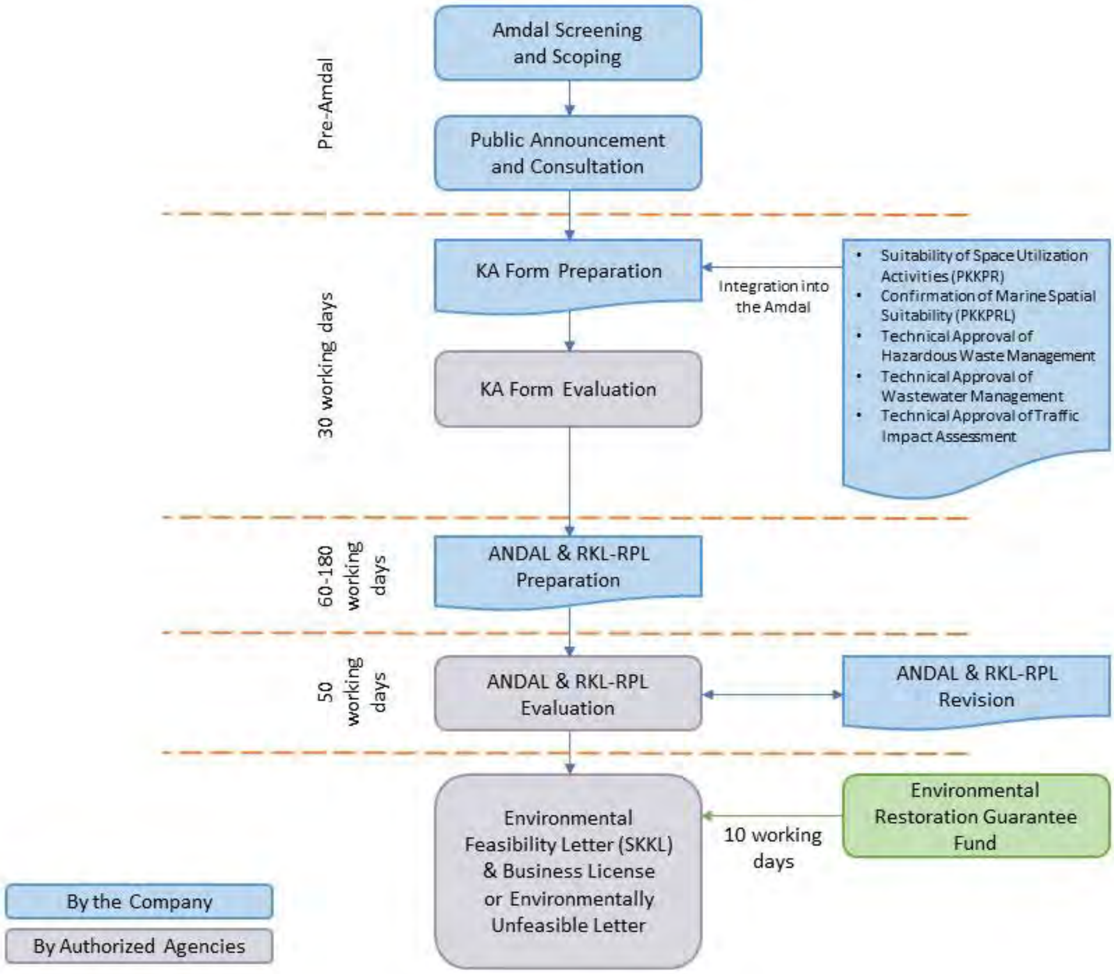
Prior to the development of the AMDAL, the Project must process and acquire the applicable Technical Approval (locally known as *Persetujuan Teknis* or *pertek*) for the Project. The Project shall carry out an internal screening and seek official recommendation from the authorized government agency to determine which *pertek* is applicable for the Project, and how comprehensive the document would be (i.e., in the form of a technical analysis or technical standard). Generally, *pertek* is required for:

- Suitability with spatial plans;
- Fulfilment of emission standards;
- Fulfilment of wastewater standards;
- Hazardous waste management; and/or
- Traffic impact assessment.

Following the issuance of the Technical Approval, the relevant government's agency will evaluate if the design and commitment in the Technical Approval document has been met such that they can issue an Operationally Feasible Letter (*Surat Layak Operasi* or SLO). If not, improvements will be expected to be carried out at the installed facility or on the equipment to meet the design and commitment in the Technical Approval.

The overall process of obtaining an Environmental Approval through the preparation of AMDAL and *pertek* is shown in ***Figure 1-1***.

Figure 1-1: Environmental Approval Issuance Process



At the time of writing this Report, the Project has developed and is in the process of developing several environmental documents. The Project has also obtained several environmental related permits and approvals. This information is presented in ***Table 1-2*** below.

Table 1-2: Project's Environmental Documents, Permits and Approvals

No	Document	Document Number	Date
Environmental Documents			
1.	KA for the Planned 110 MW Geothermal Exploitation and Development of Geothermal Power Plant	N/A	May 2022
2.	Andal and RKL-RPL for the Planned 110 MW Geothermal Exploitation and Development of Geothermal Power Plant	N/A	May 2022
3.	Draft Addendum Andal and RKL-RPL	N/A	Still in preparation
4.	Draft KA for the Development of 150 kV Transmission Line	N/A	Still in preparation

Permits and Approvals			
5.	Approval for the use of forest areas for the development of geothermal power plant	SK.8/MENLHK/SETJEN/PLA.0/1/2023	11 January 2023
6.	Environmental Feasibility Letter for the planned geothermal exploitation and development of geothermal power plant	SK.1231/MENLHK/SETJEN/PLA.4/12/2022 issued by the MoEF	13 December 2022
7.	Technical Approval for the fulfillment of wastewater quality standards	S.173/PDKL/PPA/PKL.2/4/2022 issued by the Directorate General of Pollution Control and Environmental Damage, MoEF	22 April 2022
8.	Technical Approval for the fulfilment of emission standards through technical analysis	S.158/PDKL/PNU/PKL.3/4/2022 issued by the Directorate General of Pollution Control and Environmental Damage, MoEF	14 April 2022
9.	Traffic Impact Assessment Approval for the planned geothermal exploitation, development and operation of geothermal power plant and transmission line	188.45/005/ANDALALIN/430.9.6/ 2021 issued by the Head of Environmental and Transportation Agency of Bondowoso Regency	27 December 2021
10.	Surface water abstraction and utilization permit	26/05.02/02/IX/2021 issued by the One Stop Integrated and Investment Agency of East Java	1 July 2021, valid up to 30 June 2024
11.	Operational permit for hazardous waste management	N/A Permit issued by the Regent of Bondowoso Regency	26 March 2020
12.	Temporary storage permit for hazardous waste	660.1/236/430.9.6/2020 issued by the Environmental and Transportation Agency of Bondowoso Regency	March 2020

1.2 Purpose and Objective of this ESIA Report

The specific objectives of this ESIA report are as follows:

- Facilitate an understanding of the elements of the existing baseline conditions that are relevant to resources/receptors that could be potentially impacted by the Project;
- Identify the aspects of the Project that could potentially result in significant environmental and social impacts on resources/receptors;
- Document how stakeholders have been engaged during the ESIA Process, and how stakeholder
- feedback has been considered in the ESIA study;
- Predict and evaluate the significance of the potential environmental and social impacts of the Project;
- Identify the aspects of the Project that need to be managed, and recommend appropriate and

  justified mitigation and enhancement measures;
- Determine the significance of residual impacts, taking into account the implementation of mitigation measures; and

- Generate plans for the management and monitoring of impacts, including plans for ongoing stakeholder engagement.

1.3 Structure of this ESIA Report

The remainder of this ESIA Report is presented as follows:

- **Chapter 2** presents an overview of the environmental and social policy, legal and institutional framework related to the proposed Project;
- **Chapter 3** provides details on the Project description and alternatives considered;
- **Chapter 4** provides a description of the existing biophysical and socioeconomic environment;
- **Chapter 5** highlights the stakeholder identification, stakeholder engagement activities, including Project disclosure and results from stakeholder engagement meetings; and
- **Chapter 6** presents the impact assessment methodology, the key potential environmental and social impacts, and potential mitigation measures;
- **Chapter 7** presents the Cumulative Impact Assessment (CIA);
- **Chapter 8** provides the Environmental and Social Management Plan (ESMP);
- **Chapter 9** provides conclusions and recommendations.

The supporting documents are inserted as Appendices, as follows:

- Appendix A: Environmental Baseline Results
- Appendix B: Species Summary from Baseline Survey
- Appendix C: Integrated Biodiversity Assessment Tool (IBAT) Report
- Appendix D: Vantage Point Surveys
- Appendix E: Social Engagement Records
- Appendix F: Stakeholder Engagement Plan
- Appendix G: Grievance Redress Mechanism
- Appendix H: Emergency Management Plan
- Appendix I: Landscape and Visual Impact Assessment
- Appendix J: Climate Change Risk Assessment
- Appendix K: Biodiversity Action Plan
- Appendix L: Land Acquisition Framework
- Appendix M: Livelihood Restoration Plan
- Appendix N: Air Quality Impact Assessment
- Appendix O: Noise Impact Assessment

2 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 Administrative Framework

Indonesia has four levels administrative structures, as listed below:

- **Province** (*provinsi*): administratively, Indonesia consists of 34 provinces, five of which have special status, including a special capital region. Each of these provinces or regional governments has its own political legislature and is headed by a governor;
- **Regency** (*kabupaten*) and **City** (*kota*); depending on the area and population;
- **District** (*kecamatan* or *distrik* in Papua and West Papua). The District level is administratively stratified into two levels: *kecamatan* (sub-district) and *kelurahan* for urban areas and *desa* or village for rural areas;
- **Administrative Village** (either *desa, kelurahan, kampung, nagari* in West Sumatra, or *gampong* in Aceh): village is the lowest level of government administration in Indonesia. Furthermore, a village is divided into several community groups (Rukun-Warga (RW)) which are further divided into neighbourhood groups (Rukun-Tetangga (RT)). In Java the desa (village) is divided further into smaller units called dusun or dukuh (hamlets), these units are the same as Rukun-Warga.

Each level is headed by a regional head: the governor for the province, the *bupati* for the regency and the *walikota* for the municipality, the *camat* for the *kecamatan*, and the *lurah* for the *kelurahan* and the *kepala desa* for the village. Previously, all governor, *bupati* and *walikota* were also made representatives of the central government in the regions. They were appointed and accountable to the central government.

2.2 Indonesian Regulatory Legislation

The national policy frameworks governing the project are listed below:

1. Government Regulation No. 79 of 2014 regarding National Energy Policy

The national energy policy is valid from 2014 to 2050. It aims to give direction for energy management in order to create independency and security in energy field. For example, the Indonesian government is required to decrease oil and gas export, increase renewables consumption and power plant development, determine progressive electricity tariff and feed in tariff for renewable energies, and also formulate subsidies mechanism for low class society.

2. President Regulation No. 22 of 2017 regarding National Energy General Planning

This regulation acts as the reference for central and regional development preparation. Besides, it also acts as the reference for national budget planning and regional budget planning. Strategies and frameworks for energy planning are described here.

The following Indonesian regulatory standards are applicable to the Project:

- Act No. 1 of 1970 regarding Occupational Health and Safety;
- Act No. 11 of 2010 regarding Cultural Preservation;
- Act No. 13 of 2003 regarding Employment and its amending regulations;
- Act No. 17 of 2019 regarding Water Resources and its amending regulations;
- Act No. 18 of 2008 regarding Waste Management;
- Act No. 19 of 2004 regarding Stipulation of Government Regulation;
- Act No. 2 of 2012 regarding Land Procurement for Development for Public Interest and its amending regulations;

- Act No. 21 of 2014 regarding Geothermal and its amending regulations;
- Act No. 30 of 2009 regarding Electricity and its amending regulations;
- Act No. 32 of 2009 regarding Protection and Management of the Environment and its amending regulations;
- Act No. 36 of 2009 regarding Health;
- Act No. 37 of 2014 regarding Land and Water Conservation;
- Act No. 41 of 1999 regarding Forestry;
- Act No. 5 of 1990 regarding Biodiversity and Ecosystem Conservation;
- Constitutional Court Decision No. 85/PUU-XI/2013 regarding the Evaluation of Act No. 7 of 2004 regarding Water Resources;Government Regulation in lieu of Law No. 2 of 2022 regarding Job Creation;
- Government Regulation No. 23 of 2021 regarding Forestry Implementation;
- Government Regulation No. 23 of 2014 regarding the Amendment to Government Regulation No. 14 of 2012 regarding Electricity Supply Business;
- Government Regulation No. 5 of 2021 regarding the Implementation of Risk-Based Business Licensing;
- Government Regulation No. 19 of 2021 regarding Land Acquisition for Development in Public Interest;
- Government Regulation No. 22 of 2021 regarding Implementation of Environmental Protection and Management;
- Government Regulation No. 82 of 2019 regarding the Amendment to Government Regulation No. 44 of 2015 regarding Work Accident Security and Death Security Programs Implementation;
- Government Regulation No. 47 of 2012 regarding Corporate Social Responsibility;
- Government Regulation No. 79 of 2014 regarding National Energy Policy;
- Government Regulation No. 7 of 1999 regarding the Preservation of Flora and Fauna Species;
- Government Regulation No. 43 of 2008 regarding Groundwater;
- Minister of Agrarian and Spatial Arrangement/Head of National Land Agency (BPN) Regulation No. 17 of 2019 regarding Location Permit;
- Minister of Energy and Mineral Resources Regulation No. 13 of 2021 regarding Minimum Free Space and Free Distance for Electric Power Transmission Line and Compensation for Land, Building and/or Plants under the Transmission Line Free Space Area;
- Minister of Energy and Mineral Resources Regulation No. 36 of 2014 regarding Enactment of Indonesian National Standard (SNI) 0225:2011 and the amendment of General Requirements for Electricity Installation as the Mandatory Standards;
- Minister of Energy and Mineral Resources Regulation No. 4 of 2020 regarding the Second Amendment to the Minister of Energy and Mineral Resources Regulation No. 50 of 2017 regarding Renewable Energy Sources Utilisation for Electricity Supply;
- Minister of Environment and Forestry Regulation No. P.68/Menlhk/Setjen/Kum.1/8/2016 regarding Domestic Wastewater Quality Standards;
- Minister of Environment and Forestry Regulation No. P.106/Menlhk/Setjen/Kum.1/12/2018 regarding Second Amendment to the Minister of Environment and Forestry Regulation Number P.20/Menlhk/Setjen/Kum.1/6/2018 Concerning Protected Animals and Plants Species;

- Minister of Environment and Forestry Regulation No. P.94/Menlhk/Setjen/Kum.1/12/2016 regarding Invasive Species;
- Minister of Environment Decree No. KEP-48/MENLH/11/1996 regarding Noise Level Quality Standards;
- Minister of Environment Decree No. KEP-49/MENLH/11/1996 regarding Vibration Level Standards;
- Minister of Environment Regulation No. 02 of 2013 regarding Guideline for Administrative Sanctions Implementation in the Environmental Protection and Management;
- Minister of Industry Regulation No. 05/M-IND/PER/2/2017 regarding amendment of No. 54/M-IND/PER/3/2012 regarding Guideline for Local Product Usage in Electricity Infrastructures Development;
- Minister of Manpower Regulation No. 5 of 2018 regarding Occupational Health and Safety at Working Environment;
- Minister of Health Regulation No. 2 of 2023 regarding Implementing Regulation for the Government Regulation No. 66 of 2014 regarding Environmental Health;
- President Regulation No. 14 of 2017 regarding the Amendment to President Regulation No. 4 of 2016 regarding Acceleration on Electricity Infrastructure Development;
- President Regulation No. 1 of 2023 regarding Mainstreaming of Biodiversity Conservation in Sustainable Development; and
- President Regulation No. 64 of 2020 regarding the Second Amendment to President Regulation No. 82 of 2018 regarding Health Insurance.

3. **Regional Regulation of Regional Spatial Plan of East Java No.5 to develop a 150 kV transmission**

The site plan for the construction of the transmission line MCG has obtained Approval for Conformity of Spatial Utilization Activities (PKKPR) from the Ministry of Agrarian and Spatial Planning/National Land Agency. Based on the Approval of Conformity of Space Utilization Activities for National Strategic Activities Number PF.01/820 – 200/X/2022 dated October 17, 2022. The following regulations are fully approved with the consideration:

Regional Regulation of East Java Province Number 5 of 2012 Regulation of the Minister of Agrarian Affairs and Spatial Planning/Head of the National Land Agency Number 13 of 2021

2.3 International Standards and Guidelines

2.3.1 International Finance Corporation Performance Standards

In addition to national legislation, the Project will be undertaken to, as much as possible, comply with the IFC Performance Standards. These standards are set to complement and reinforce national legislation and ensure the Project is conducted under best practices in a way that minimizes risks, impacts and ensures compliance and fair practices.

The IFC Performance Standards provide guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities. The IFC Performance Standards represent the ’policy framework’ for the ESIA and sustainable social and environmental management for the Project.

The complete list of IFC Performance Standards, along with a brief description of each, are listed in ***Table 2-1***. Not all of these are applicable to the Project, but they are presented here for completeness.

Table 2-1: IFC Performance Standards

Performance Standard	Description	Objectives
Performance Standard 1 – Assessment and Management of Environmental and Social Risks and Impacts	Underscores the importance of managing social and environmental performance throughout the life of a project (any business activity that is subject to assessment and management).	■ Impact identification and assessment. To identify and assess social and environmental impacts, both adverse and beneficial, in the project's area of influence. ■ To avoid, or where avoidance is not possible, minimise, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment. ■ Stakeholder engagement. ■ To ensure that affected communities are appropriately engaged on issues that could potentially affect them. ■ Effective management. ■ To promote improved social and environment performance of companies through the effective use of management systems.
Performance Standard 2 – Labour and Working Conditions	Recognises that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers.	■ To promote fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws. ■ To establish, maintain and improve the worker management relationship. ■ To promote compliance with national employment and labour laws. ■ To protect the workforce by addressing child labour and forced labour. ■ To promote safe and healthy working conditions, and to protect and promote the health of workers.
Performance Standard 3 – Resource Efficiency and Pollution Prevention	Recognises that increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level.	■ To avoid or minimise adverse impacts on human health and the environment by avoiding or minimising pollution from project activities. ■ To promote more sustainable use of resources, including energy and water. ■ To reduce project–related GHG emissions.
Performance Standard 4 – Community Health, Safety and Security	Recognises that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development.	■ To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. ■ To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimises risks to the Affected Communities.
Performance Standard 5 – Land Acquisition and Involuntary Resettlement	Outlines that involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition	■ To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. ■ To avoid forced eviction. ■ To anticipate and avoid, or where avoidance is not possible, minimise adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of

Performance Standard	Description	Objectives
		information, consultation and the informed participation of those affected. ■ To improve, or restore, the livelihoods and standards of living of displaced persons. ■ To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.
Performance Standard 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources	Recognises that protecting and conserving biodiversity—the variety of life in all its forms, including genetic, species and ecosystem diversity—and its ability to change and evolve, is fundamental to sustainable development	■ To protect and conserve biodiversity. ■ To maintain the benefits from ecosystem services. ■ To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.
Performance Standard 7 – Indigenous People	Recognises that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population.	■ To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. ■ To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. ■ To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. ■ To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project life-cycle. ■ To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in the Performance Standard are present. ■ To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.
Performance Standard 8 – Cultural Heritage	Recognises the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage in the course of their project activities.	■ To protect cultural heritage from the adverse impacts of project activities and support its preservation. ■ To promote the equitable sharing of benefits from the use of cultural heritage.

Source: IFC, 2012

2.3.2 Good International Industry Practise Guidelines

In addition to national legislation, a range of international standards, including IFC Performance Standards (IFC PS) and the World Bank Group (WBG) Guidelines will be considered for the Project. These standards are set to complement national legislation and ensure the Project is conducted under best practices in a way that minimises risks, impacts and ensures compliance and fair practices.

The following international guidelines and standards have been considered for the ESIA Study of the Project:

- IFC PS (2012): The IFC PS represent the 'policy framework' for the EIA and sustainable environmental management for the Project, whereas the World Bank Group's EHS Guidelines provide guidance on general and industry best practice as well as recommended numerical limits for emissions to the atmosphere, noise, liquid and solid wastes, hazardous wastes, health and safety, and other aspects of industrial facilities and other types of development projects;
- World Bank Group (WBG) Environmental Health and Safety (EHS) General Guidelines (2007): The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs;
- WBG, EHS Guidelines for Geothermal Power Generation (2007): This specific guideline includes information relevant to environmental, health, and safety aspects of geothermal power plant facilities;
- WBG, EHS Guidelines for Environmental, Health, and Safety Guidelines for Electrical Power Transmission and Distribution (2007): This specific guideline includes information relevant to power transmission between generation facility and a substation located within an electricity grid.

2.3.3 International Conventions

Relevant international conventions to which Indonesia is a signatory include those related to pollution prevention, waste management, biodiversity conservation, and labour conventions. The key international conventions of relevance to the Project are included in ***Table 2-2***.

Table 2-2: International Conventions Relevant to the Project

Conventions	Year (Ratified/Accepted)
Environmental	
Vienna Convention for the Protection of the Ozone Layer, Vienna 1985	1992
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal 1987	1992
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London 1990	1992
United Nations Framework Convention on Climate Change (UNFCCC), New York 1992	1994
Convention on Biological Diversity, Rio de Janeiro 1992	1994
The Convention Concerning the Protection of the World Cultural and Natural Heritage, Paris 1972	1989
The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1992	1993
Social	
Relevant ILO Conventions in force in Indonesia ■ C029 - Forced Labour Convention, 1930 (No. 29) ■ C087 - Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87) ■ C098 - Right to Organise and Collective Bargaining Convention, 1949 (No. 98)	In force

Conventions	Year (Ratified/Accepted)
■ C100 - Equal Remuneration Convention, 1951 (No. 100) ■ C105 - Abolition of Forced Labour Convention, 1957 (No. 105) ■ C111 - Discrimination (Employment and Occupation) Convention, 1958 (No. 111) ■ C138 - Minimum Age Convention, 1973 (No. 138) ■ Minimum age specified: 15 years ■ C182 - Worst Forms of Child Labour Convention, 1999 (No. 182) ■ C081 - Labour Inspection Convention, 1947 (No. 81) ■ C144 - Tripartite Consultation (International Labour Standards) Convention, 1976 (No. 144) ■ C019 - Equality of Treatment (Accident Compensation) Convention, 1925 (No. 19) ■ C088 - Employment Service Convention, 1948 (No. 88) ■ C106 - Weekly Rest (Commerce and Offices) Convention, 1957 (No. 106) ■ C120 - Hygiene (Commerce and Offices) Convention, 1964 (No. 120)	

2.4 Project Environmental Standards – National vs. International Standards

Indonesia has national environmental quality standards. In addition to the local Environmental Quality standards, the World Bank Group EHS Guidelines apply their own set of standards for specific effluents, emissions and discharges. Application of these guidelines requires that when host country regulations differ from the levels and measures presented in the World Bank Group EHS Guidelines, projects are required to achieve whichever is the more stringent. If less stringent levels or measures than those provided in the EHS Guidelines are appropriate in view of specific project circumstances, a full and detailed justification must be provided for any proposed alternatives through the environmental and social risks and impacts identification and assessment process. This justification must demonstrate that the choice for any alternate performance levels is consistent with the objectives of WB ESS 1 and 3.

In comparison of Indonesian and World Bank Group standards, the most stringent standard will be applied for ease of reference for ESIA assessment. The following section lists the standards as defined by local and WBG EHS guidelines.

2.4.1 Air Quality and Management of Air Pollution

Under Indonesian regulations, air quality is regulated by Government Regulation No. 22 of 2021 regarding Implementation of Environmental Protection and Management (GR 22/2021). The World Bank Group EHS Guidelines for ambient air quality state that to protect ambient air quality nationally legislated ambient air quality standards should be selected or in their absence for emitted compounds standards from the World Health Organisation (WHO) or other internationally recognised standards are applicable. Where standards exist under PP41/1999, these effectively become the World Bank Group EHS guideline. The detailed description of ambient air quality standards is presented in ***Table 2-3***. The most stringent standards (adopted for the Project) are highlighted.

Table 2-3: Applicable Ambient Air Quality Standards

Parameter	Period of Measurement	Unit	GR 22/2021	WB Group EHS Guideline
Sulphur dioxide (SO_2)	10 minute	µg/m^3	-	500
	1 hour	µg/m^3	150	-
	24 hour	µg/m^3	75	125 (Interim target-1) 50 (Interim target-2) 40 (guideline)
	1 year	µg/m^3	45	-
Carbon monoxide (CO)	1 hour	µg/m^3	10,000	-
	24 hour	µg/m^3	-	7 (Interim target-1) 4 (guideline)
Nitrogen dioxide (NO_2)	1 hour	µg/m^3	200	200
	24 hour	µg/m^3	65	120 (Interim target-1) 50 (Interim target-2) 25 (guideline)
	1 year	µg/m^3	50	40 (Interim target-1) 30 (Interim target-2) 20 (Interim target-3) 10 (guideline)
O_3 (Oxidant)	1 hour	µg/m^3	150	-
	8 hour	µg/m^3	100	-
	1 year	µg/m^3	35	-
Ozone	8-hour daily maximum	µg/m^3	-	160 (Interim target-1) 100 (guideline)
HC	3 hour	µg/m^3	160	-
PM_{10}	24 hour	µg/m^3	75	150 (Interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (Interim target-4) 45 (guideline)
	1 year	µg/m^3	40	70 (Interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (Interim target-4) 15 (guideline)
$PM_{2.5}$	24 hour	µg/m^3	55	75 (Interim target-1) 50 (Interim target-2) 37.5 (Interim target-3) 25 (guideline)
	1 year	µg/m^3	15	35 (Interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
Dust (TSP)	24 hour	µg/m^3	230	-

Parameter	Period of Measurement	Unit	GR 22/2021	WB Group EHS Guideline
Pb	24 hour	μg/m^3	2	-

Source: Government Regulation No. 22 of 2021 regarding Implementation of Environmental Protection and Management Appendix VII and WBG EHS Guidelines, 2007

The ambient air quality standards applied for the Project are presented in ***Table 2-4***, based on the most stringent standards between GR 22/2021 and WB Group EHS Guideline.

Table 2-4: Project Ambient Air Quality Standards

Parameter	Period of Measurement	Unit	Project Quality Standards
Sulphur dioxide (SO_2)	10 minute	μg/m^3	500
	1 hour	μg/m^3	150
	24 hour	μg/m^3	75
	1 year	μg/m^3	45
Carbon monoxide (CO)	1 hour	μg/m^3	10,000
	8 hour	μg/m^3	7 (Interim target-1) 4 (guideline)
Nitrogen dioxide (NO_2)	1 hour	μg/m^3	200
	24 hour	μg/m^3	65
	1 year	μg/m^3	40 (Interim target-1) 30 (Interim target-2) 20 (Interim target-3) 10 (guideline)
O_3 (Oxidant)	1 hour	μg/m^3	150
	8 hour	μg/m^3	100
	1 year	μg/m^3	35
Ozone	8-hour daily maximum	μg/m^3	160 (Interim target-1) 100 (guideline)
HC	3 hour	μg/m^3	160
PM_{10}	24 hour	μg/m^3	75
	1 year	μg/m^3	40
$PM_{2.5}$	24 hour	μg/m^3	55
	1 year	μg/m^3	15
Dust (TSP)	24 hour	μg/m^3	230
Pb	24 hour	μg/m^3	2

2.4.2 Noise Levels

Under Indonesian standards, noise level is regulated in Decree of Environmental Ministry No. 48/1996 on Noise level Quality Standard. Noise health and safety limits are established under the Ministry of Manpower and Transmigration Decree No 51 of 1999.

Table 2-5 provides the applicable noise level standards per Indonesian regulation and WB EHS group guidelines. The most stringent standard will be adopted for the Project (highlighted). According to the

WB EHS guidelines, noise impacts should not exceed the levels presented in the table, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 2-5: Noise Standards (dBA)

Site	MoE Dec. #48/1996	Ministry of Manpower and Transmigration Decree No. PER.13/MEN/X/2011	WB Group EHS Guidelines* One Hour LAeq (dBA)	
	Noise Level dB(A)	Exposure Limit/Day (dBA)	Daytime (07:00 - 22:00)	Night-time (22:00 - 07:00)
Residential; Institutional; educational	55	-	55	45
Industrial; commercial	70	-	70	70
Occupational Health & Safety (exposure limits)		85 (8 hours)	LAeq, 8h (dB(A))	Max LAmax, fast (dB(A))
		88 (4 hours)	85 (heavy industry)	110 (heavy industry)
		91 (2 hours)	50-65 (light industry)	110 (light industry)
		94 (1 hours)	45-50 (open offices)	
		97 (30 minutes)	40-45 (closed offices)	

Source: Ministry of Environment Decree #48, 1996; Ministry of Manpower Decree 51, 1999; The WB Group General EHS Guidelines, 2007, page 53

The noise standards applied for the Project are presented in ***Table 2-6***, based on the most stringent standards between Ministry of Environment Decree 48/1996, Ministry of Manpower Decree 51/1999, and WB Group EHS Guideline***.***

Table 2-6: Project Noise Standards

Site	Project Quality Standards One Hour LAeq (dBA)	
	Daytime (07:00 - 22:00)	Night-time (22:00 - 07:00)
Residential; Institutional; educational	55	45
Industrial; commercial	70	70
Occupational Health & Safety (exposure limits)	85 (heavy industry)	110 (heavy industry)
	50-65 (light industry)	110 (light industry)

	45-50 (open offices)	
	40-45 (closed offices)	

2.4.3 Domestic Wastewater Standards

Domestic wastewater standards are regulated under Ministry of Environment and Forestry P.68/Menlhk/Setjen/Kum.1/8/2016 regarding Domestic Wastewater Threshold. The WB Group EHS guidelines also provide standards for domestic wastewater quality. ***Table 2-7*** provides the applicable standards according to MoEF Regulation and the WB Group EHS Guidelines. The most stringent standard will be applied (highlighted).

Table 2-7: Domestic Wastewater Quality Standards

Parameter	Unit	MoEF Regulation N. P.68/Menlhk/Setjen/ Kum.1/8/2016*	WB Group EHS Guidelines Indicative Values for Treated Sanitary Sewage Discharges
pH	pH	6 – 9	6 – 9
BOD	mg/L	30	30
COD	mg/L	100	125
TSS	mg/L	30	50
Total nitrogen	mg/L	-	10
Total phosphorus	mg/L	-	2
Oil and grease	mg/L	5	10
Ammonia	mg/L	10	-
Total Coliform	MPN/100mL	3000	-
Total coliform bacteria	MPN/100 ml	-	400
Total Suspended Solids	mg/L	-	50
Flowrate	L/person/day	100	-

Notes:

**Ministry of Environment and Forestry Regulation No. P.68/Menlhk/Setjen/Kum.1/8/2016 regarding Domestic Wastewater Threshold*

WB Group EHS Guidelines: Not applicable to centralized, municipal, wastewater treatment systems which are included in EHS guidelines for water and sanitation

MPN = Most Probable Number

The domestic wastewater quality standards applied for the Project are presented in ***Table 2-8***, based on the most stringent standards between MoEF Regulation N. P.68/Menlhk/Setjen/ Kum.1/8/2016 and WB Group EHS Guideline.

Table 2-8: Project Domestic Wastewater Quality Standards

Parameter	Unit	Project Quality Standards
pH	pH	6 – 9
BOD	mg/L	30

Parameter	Unit	Project Quality Standards
COD	mg/L	100
TSS	mg/L	30
Total nitrogen	mg/L	10
Total phosphorus	mg/L	2
Oil and grease	mg/L	5
Ammonia	mg/L	10
Total Coliform	MPN/100mL	3000
Total coliform bacteria	MPN/100 ml	400
Total Suspended Solids	mg/L	50
Flowrate	L/person/day	100

2.4.4 Vibration

The IFC does not establish standards for vibration, vibration standards will refer to Minister of Environment Decree establishes Indonesian standards No. KEP-49/MENLH/II/1996 regarding Threshold for Vibration. The vibration level threshold based according to Minister of Environment Decree are shown in ***Table 2-9***.

Table 2-9: Vibration Level Threshold*

Frequency (Hz)	Vibration level, in micron (10-6 metre)			
	Not Disturbing	Disturbing	Not Comfortable	Hurt
4	<100	100-500	>500-1000	>1000
5	<80	80-350	>350-1000	>1000
6.3	<70	70-275	>275-1000	>1000
8	<50	50-160	>160-500	>500
10	<37	37-120	>120-300	>300
12.5	<32	32-90	>90-220	>220
16	<25	25-60	>60-120	>120
20	<20	20-40	>40-85	>85
25	<17	17-30	>30-50	>50
31.5	<12	12-20	>20-30	>30
40	<9	9-15	>15-20	>20
50	<8	8-12	>12-15	>15
63	<6	6-9	>9-12	>12

Source: Minister of Environment Decree No. KEP-49/MENLH/II/1996 regarding Threshold for Vibration
**Conversion: Acceleration= (2πf) 2 x deviation, Velocity = 2πf x deviation, π = 3.14*

2.4.5 Transmission Line

The WBG EHS exposure limits for general public exposure to electric and magnetic fields published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) is provided in ***Table 2-10***.

Table 2-10: Electric and Magnetic Fields – Electric Power Transmission and Distribution

Frequency	Electric Field (V/m[a])	Magnetic Field (µT[b])
50 Hz[c]	5000	100
60 Hz	4150	83

[a] Volts per meter; [b] Micro tesla; [c] Hertz

3 PROJECT DESCRIPTION AND ALTERNATIVES SELECTION

This section provides and overview of the Project description including the construction and operation as well as alternative assessment of the Project.

3.1 Project Overview and Key Components

MCG proposes to develop a 34 MW geothermal project located at Blawan Ijen, Bondowoso East Java. The Project will be carried out in two stages. The first stage, referred to as Unit-1, will have a capacity of 34 MW and the second or final stage referred to as Unit-2 will reach the full capacity at 110 MW. This ESIA Report covers only Unit-1 of the proposed Project. The key components of the Project include the following, as shown in ***Figure 3-1***

- Exploitation facilities including power plant, separator and brine pump, vent station (rock muffler), base camp, office, and car park;
- Drilling and exploration facilities including well pad areas, logistics yard, and explosives bunker;
- Access Roads (within the Project Site); and
- 150 kV Transmission line and towers 28.3 km.

The well pads and wells for Unit-1 and Unit-2 are shown in ***Table 3-1***.

Table 3-1: Well Pads and Wells

Wellpad	EXISTING (Exploration) Wells	EXPANSION (Exploitation) Wells for Unit-1	Total well for Unit-1	Unit-2 and beyond
IJN-1	1 slim hole	0	0 (exclude slim hole)	4 injection wells (TBC)
IJN-2	1 slim hole	2 injection wells	2 injection wells (exclude slim hole)	2 injection wells (TBC)
IJN-5	1 injection well	0	1 injection well (backup)	0
IJN-6	2 production wells	2 production wells	4 production wells	2 production wells (TBC)
IJN-7	0	0	0	4 production wells (TBC)
IJN-8	0	2 production wells	2 production wells	2 production wells (TBC)
IJN-9	0	0	0	4 production wells (TBC)

3.1.1 Project Location

The Project is located on Bondowoso and Banyuwangi regencies, East Java province, Indonesia and is approximately 270 km southeast of Surabaya. The Project location is shown in ***Figure 3-2***.

The prospect is situated in a big rim caldera structure with diameter of +16-20 km at an altitude of +1,500 m above sea level. Young volcanic activity has occurred along the southern part of the caldera which includes Gunung (Mount) Merapi. The main construction area is located in Kalianyar Village, Ijen Sub-District, Bondowoso East Java. The transmission line will traverse the administrative areas as shown in ***Table 3-2***.

Table 3-2: Administrative Areas of the Project

Regency	Sub-District	Village
Bondowoso	Ijen	Kalianyar
		Sempol
		Jampit
Banyuwangi	Licin	Tamansari
	Kalipuro	Pesucen
		Bulusari
	Glagah	Anyar Village
	Giri	Grogol
		Giri

Figure 3-1: Overview of Project Facilities (Main Construction Area)

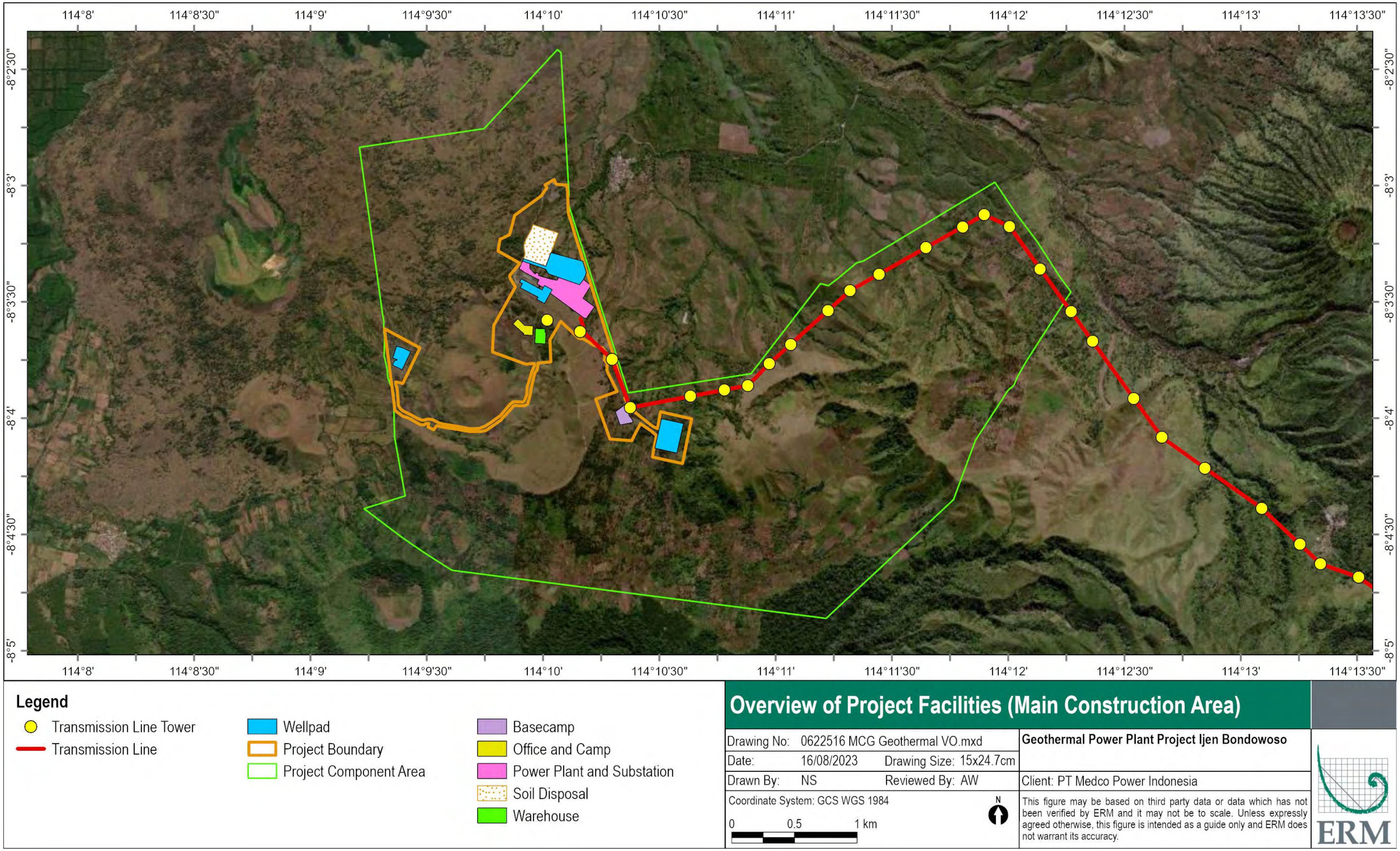
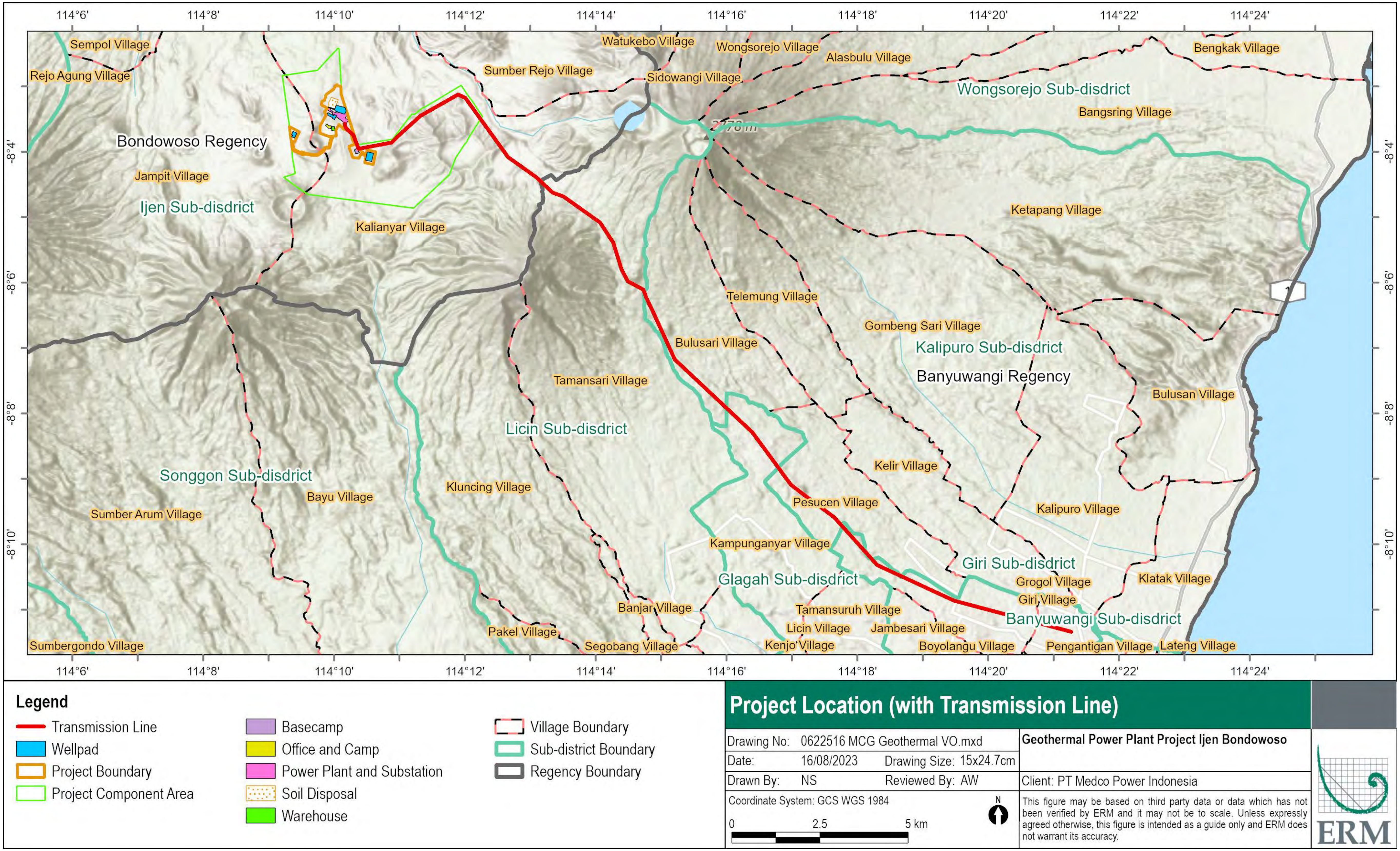


Figure 3-2: Project Location (with Transmission Line)



3.1.2 Land Use and Land Acquisition

Based on MCG's PPKH for the geothermal power plant - KLHK Decree No. 8 of 2023, MCG was granted approval to occupy/manage and conduct geothermal power plant development activities, and utilize the results of the activities up until 2046 (Article 13). This approval can be extended based on Article 12. For obligations and restrictions, please refer to KLHK Decree No. 8 Articles 7 and 8.

As outlined in ***Table 3-3***Error! Reference source not found.Error! Reference source not found., the power plant will have permanent infrastructure within the Project Area, representing about 40.9452 hectares (ha), and temporary infrastructure on 0.2523 ha of the total footprint. For the transmission line, excluding the ROW, there will be acquisition of 2,780.5 ha for the transmission towers and no temporary area. The approximate permanent land required for the ROW is 24.2 ha. The worker accommodation for the construction phase is covered by the temporary power plant facility, which is owned by MCG. The total land required for the Project is 2822.2 ha.

The land required for the accommodation and power plant (the Project site) was acquired by MCG in accordance with government regulation through PPKH (Forest Area Utilization Approval) permit which is issued by MoEF. The land use for the Power Plant and Worker Accommodation is Production Forest, which under IFC standards does not automatically negate existing land tenure rights, customary land use, or collective attachment by local communities. Stakeholder engagement and site surveys undertaken for this Project did not identify any physical displacement, which includes cultural heritage and collective attachment. There is also no economic displacement within the power plant site, but there is economic displacement as a result of the transmission line. It was noted from Key Informant Interviews (KIIs) and field visits that farmers from nearby villages – Jampit Village – cultivate potatoes in proximity to the Project Area but not located within the Project permit boundary. The land inside the concession area (Project Site) is owned by MCG is shown in ***Figure 3-3***.

Table 3-3 Land Requirements

Project Component	Previous Land use	Rationale for Land Requirement	Land Requirement (m2)	Affected Groups
Power Plant	Production Forrest	The total area of power plant and supporting facilities is 41.1975 ha, of which permanent buildings/facilities is 40.9452 ha and temporary buildings/facilities is 0.2523 ha.	Permanent: 40.9452 ha Temporary: 0.2523 ha **Total**: 41.1975 ha	0 PAHs 0 PAPs
Transmission Line (not including Right of Way)	Production Forest Protected Forest Plantation	Transmission line is 28.3 km, consisting of 83 towers. For the 36 towers outside forest area, land has been acquired (1,143.5 ha). For the 47 towers inside forest area, land acquisition is an ongoing process through the PPKH permit (1,637 ha).	Permanent: 2,781 ha Temporary: 0 ha **Total**: 2,781 ha	31 PAHs 110 PAPs
Right of Way	Production Forest Protected Forest Plantation	The 28.3 km ROW consists of 12.1 km with HGU - Cultivation Rights Title (Kalibendo area) and SHM - Certificate of Ownership. The remaining 16.2 km is for Production Forest and Protected Forest land areas. With a planned width of 20 m x 12100 m, the land area that will be compensated is 24.2 ha (outside forestry area).	Permanent: 24.2 ha Temporary: ha **Total**: 24.2 ha	250 PAHs (Approx) 1,055 PAPs (Approx)[5]
Worker accommodation	Production Forest	The worker accommodation covers an area of 0.0905 ha, including: camp/worker building, recreation hall, mess hall, kitchen, laundry & iron building, and garbage disposal site.	Permanent: 0 ha Temporary: 0.0905 ha **Total**: 0.0905 ha	0 PAHs 0 PAPs

[5] Based on an average household size of 4.22 for East Java (Global Data Lab, 2023) https://globaldatalab.org/areadata/table/hhsize/IDN/

During the stakeholder consultations, no informal land users were identified as utilising the power plant site. In addition, no community members were identified as being non-timber forest product collectors during the AMDAL or the ESIA data collection process. There were also no Taliasi payments paid which signifies the lack of informal users. Taliasi is the cash compensation which is provided to informal users/non-title holders in Indonesia. If any informal users are identified in future stakeholder consultations, MCG will ensure the individuals are adequately compensated as per international lender's requirements and the procedures outlined in the Livelihood Restoration Plan and Land Acquisition Framework.

A total of 31 PAHs have been identified for the TL, of which 11 PAHs have been identified as legal title holders with permanent loss of land and 19 PAHs are informal occupants/land users without legal title but are affected by permanent loss of land. In addition, there is one business owner that has been identified as affected by the TL. The LRP provides a discussion of the livelihood impacts based on the socio-economic household survey conducted by MCG third parties.

Approximately 250 households have been identified as impacted land and/or crop owners located in the Blawan-Ijen[6] PLTP (Pembangkit Listrik Tenaga Panas)[7] Transmission Line (T42 to T76) ROW. Based on initial identification, there are around 250 land parcels and MCG assumes there are a maximum of 250 landowners who will receive land compensation for plants, trees, land, and buildings in the ROW in accordance with the Energy and Mineral Resources Ministerial Regulation No.13 of 2021. Based on the results of the HS there may be additional land users that will be entitled to compensation.

Land access and land ownership systems need to be considered given the Project will acquire a large amount of land to develop the Project, particularly for the transmission line. Each tower requires between 225 m² and 625 m² of land and the distance between towers is 200m to 500 m spread along the 28.3 km path. ***Table 3-4*** presents the potential TL area, which is mostly located in Banyuwangi Regency. The characteristics of land use in the potential TL area varies from rural to urban area.

Table 3-4: Transmission Line Area

Regency	District	Village	Land Use Characteristic	Land Use
Bondowoso	Ijen	Kalianyar	Rural	Forestry Area
Banyuwangi	Licin	Tamansari	Rural	Forestry Area
	Kalipuro	Bulusari	Rural	Paddy field/ garden
		Pesucen	Rural	Paddy field/ garden
	Glagah	Kampung Anyar	Rural	Forestry Area and private coffee plantation
	Giri	Grogol	Rural	Paddy field/ garden
		Giri	Urban	Garden

Source: MCG, 2021

The land acquisition process for the TL will involve various landowners, namely state company (Perhutani), private plantation (Kalibendo), and project affected communities in several villages in Banyuwangi Regency. Therefore, various methods are expected to take place, depending on the landowners. The land acquisition process is detailed in the LAF which serves as a standalone document to the ESIA.

The land use conditions along the proposed TL route can be described as a mix of forestry and agriculture areas, with the nearest residential area and public facilities approximately 100 m away.

[6] Ijen refers to a volcano complex located in East Java. Blawan is an small area within this complex.

[7] Pembangkit Listrik Tenaga Panas Bumi is Indonesian for Geothermal Power Plant.

According to MCG documentation dated August 2021, the agriculture areas cover paddy field, coffee, coconut, avocado, banana, papaya, cassava, taro, bamboo, chillies, mahogany, teak tree and various seasonal fruit trees (mangosteen, mango, durian, and rambutan).

Figure 3-3: Land Use in the Main Project Site

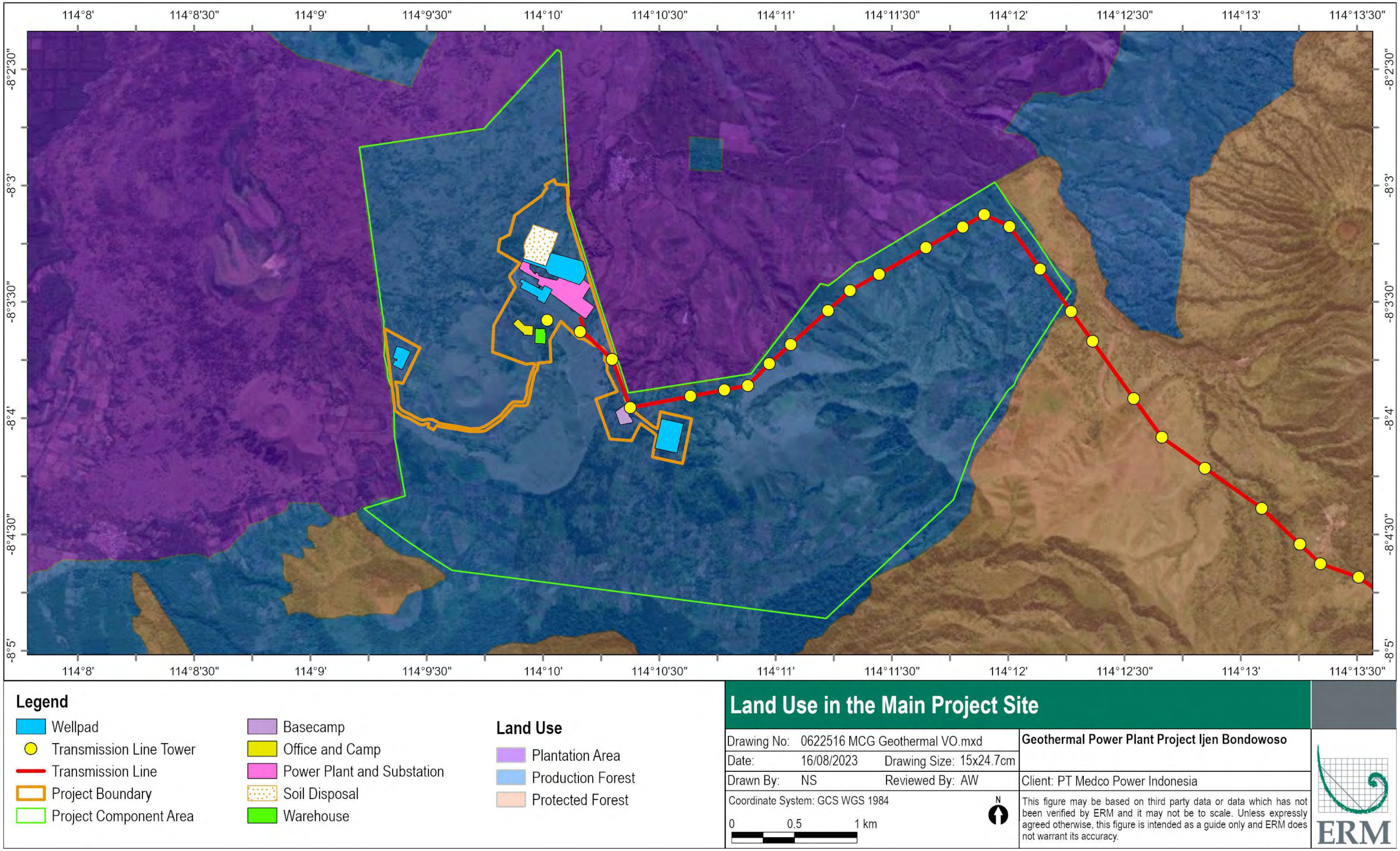
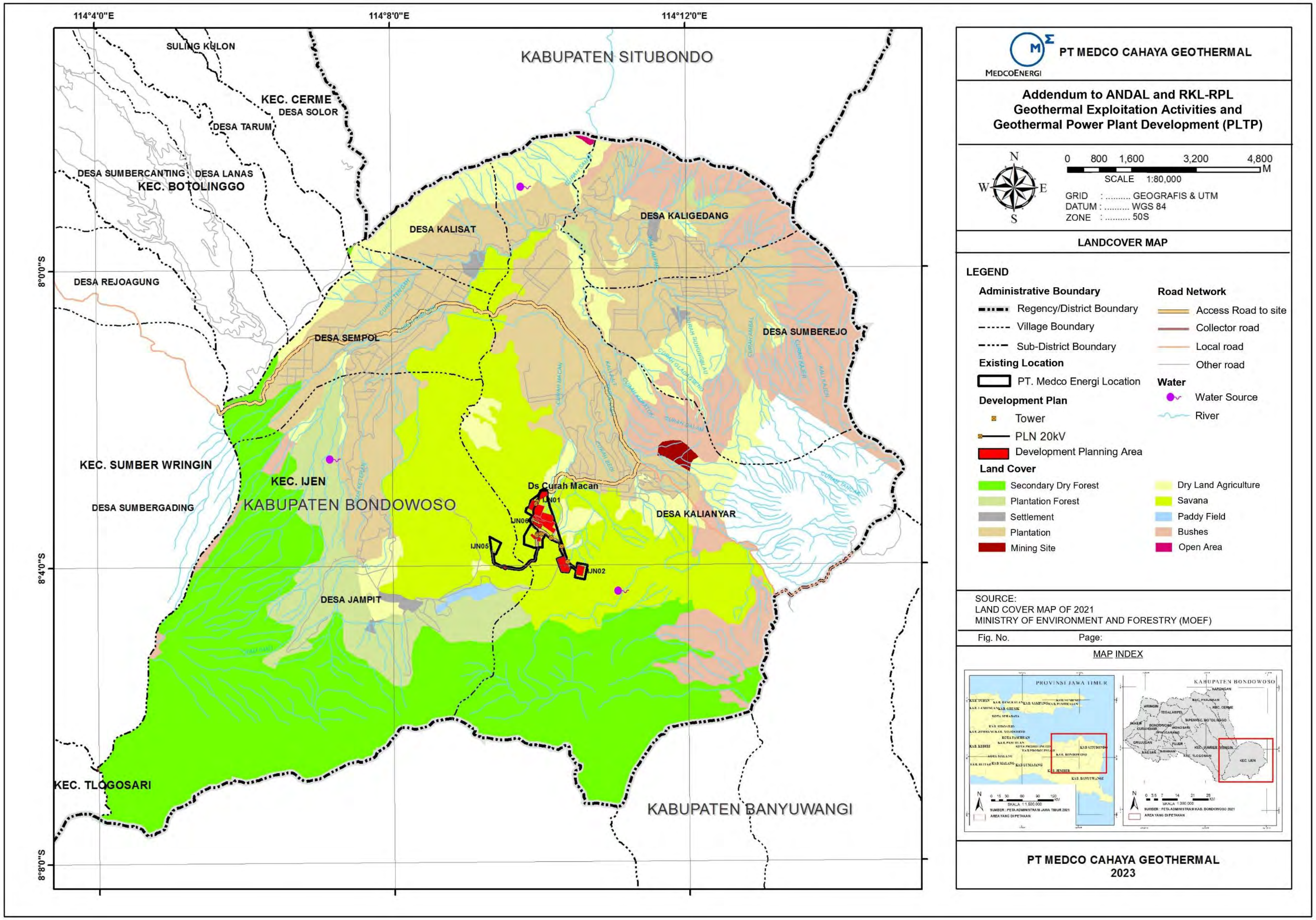


Figure 3-4: Land Cover in the Main Project Site



The total length of the transmission line to be installed is 28.3 km with the total of 83 towers. The Right of Way (RoW) will be around 10 m from each side of the line. The transmission line is split into 4 segments based on the type of ecosystem or land traversed, including:

- Segment 1 : Production Forest
- Segment 2 : Protected Forest
- Segment 3 : Plantation and Agriculture
- Segment 4 : Settlement

Table 3-5: Land Conditions / Functions in Each Segmentation

Segment	Segment Type	Tower Number	Sum (Tower)	Current Land Cover
1	Production Forest	■ T 01 – T12 ■ T 36 – T 41	23	■ Savanna ■ Forest ■ Plantation
2	Protected Forest	■ T 13 – T 35	24	■ Forest ■ Shrubs
3	Plantation and Agriculture	■ T 42 – T 57	17	■ Plantation
4	Settlement	■ T 58 – T76	19	■ Plantation ■ Paddy

Source: Tower List / Tower Schedule, 2022

3.1.3 Current Status of Site

The site has already been cleared at the well drilling pads. MCG have previously conducted drilling campaigns within this Project Site:

- Two deep slim-holes exploration drilling in 2016-2017: IJN 01 and IJN 02; and
- Three deep big-holes exploration drilling in 2020, discovered well with 300 deg: IJN 6-1 ST, IJN 5-1, and IJN 6-2 ST-2.

Previous activities are summarised in ***Table 3-6***.

Table 3-6 Current Site Status

Facility	Status
Site Preparation	■ Drilling Infrastructure Construction Completed ■ 4 Well Pads (Pad 6, 5, 2, and 1), base camp, log yard, bunker ■ Water Supply System (pipeline, pump stations, and water intake) ■ Access Road
Drilling Well IJN 6-1	■ Spud In Well IJN 6-1 on 30 March 2020 ■ Completed drilling on 25 June 2020 (*87 days since Spud In*), with Total Depth 2,300 m mD
Drilling Well IJN 5-1	■ Spud In Well IJN 5-1 on 20 July 2020 ■ Completed drilling on 31 August 2020 (*42 days since Spud In*), with Total Depth 2,700 m MD
Drilling Well IJN 6-2	■ Spud In Well IJN 6-2 on 03 November 2020 ■ Completed drilling on 25 December 2020 (*53 days since Spud In*), with Total Depth 2,644 m MD

3.1.4 Project Components

The key components of the Project and dimensions are included in ***Table 3-7***.

Table 3-7: Project Key Components

DESCRIPTION	VOLUME		REMARKS
	VALUE	UNITS	
Access Road			
Regency Road (existing road)	47,631.5	Meters	■ Belong to Bondowoso Regency, from Tapen's (Bondowoso) Laydown to Rural Road Junction
Local Road (existing road)	1,900	Meters	■ Belong to PTPN XII, made of Concrete Road (built by Bondowoso Regency)
Hauling Road	6,197	Meters	■ MCG will upgrade the access road from Regency road junction to all facilities with a total length of 8.6 km with asphalt.
Drilling & Exploration Facilities			
Well Pad IJN-6	18,462	Square Meters	■ 4 production wells
Well Pad IJN-6 Water Pond and Mud Pond	4,160	Square Meters	■ Water Pond and Mud Pond
Well Pad IJN-5 Platform	15,094	Square Meters	■ 1 injection well (backup)
Well Pad IJN-5 Water Pond and Mud Pond	4,160	Square Meters	■ Water Pond and Mud Pond
Well Pad IJN-2	14,753	Square Meters	■ 2 injection wells
Well Pad IJN-2 Water Pond and Mud Pond	4,160	Square Meters	■ Water Pond and Mud Pond
Well Pad IJN-8 including Water Pond and Mud Pond	36,617 m2	Square Meters	■ 2 production wells, Water Pond and Mud Pond
Logistic Yard (Basecamp)	12,948	Square Meters	■ Indoor warehouse is included
Explosive Bunker	702	Square Meters	
Exploitation Facilities Plan			
Power Plant and Substation	54,676	Square Meters	
Separator Station	3,403	Square Meters	■ Brine pumps included
Security Post, Parking, and Other Supporting Facilities	2,300	Square Meters	
Transmission Line			
Length	28.3	Kilometre	■ 150 kV from Power Plant to Banyuwangi Substation (The RoW will be around 10 m from each side of the line).

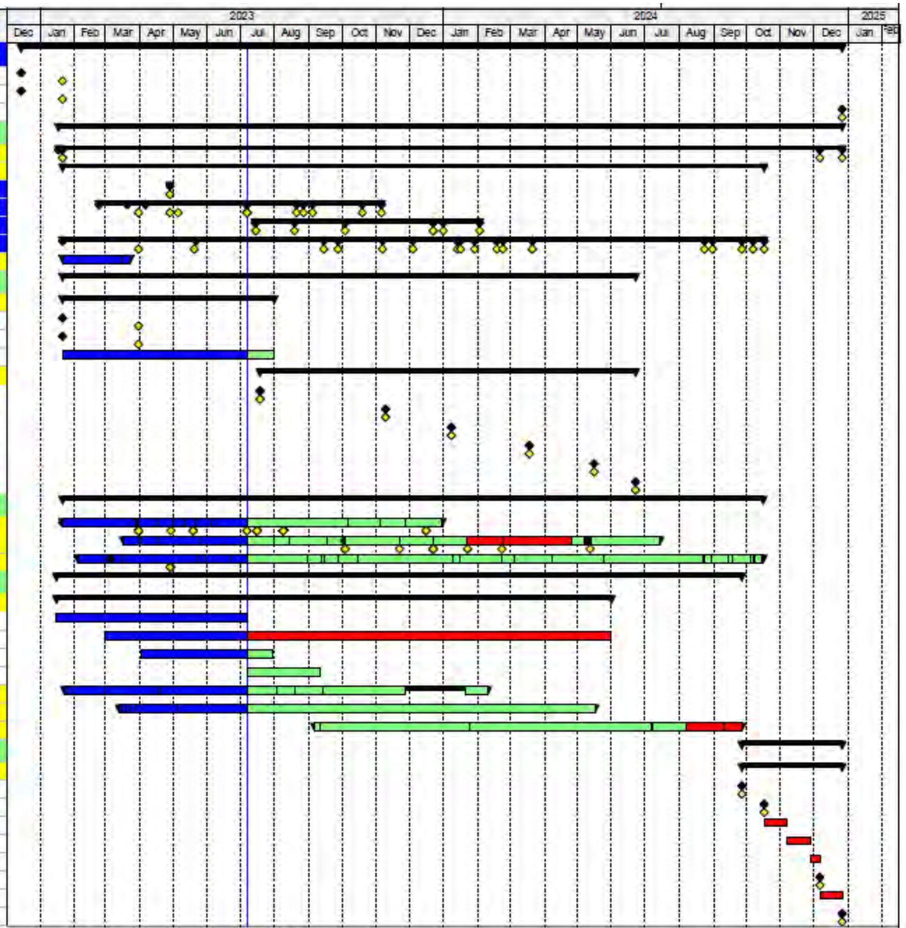
DESCRIPTION	VOLUME		REMARKS
	VALUE	UNITS	
Tower	83	Points	

3.1.5 Project Schedule

The proposed Project schedule is provided in ***Figure 3-5***. For the power plant and transmission line, construction for Unit 1 is estimated to be 21 months.

Figure 3-5: Proposed Project Schedule

Activity Name	Duration	Activity % Complete	Start	Finish
Blawan Ijen PP Rev 1 (PB+BOP+TLS)	708		15-Dec-22 A	26-Dec-24
Limited Notice to Proceed (LNTP)	0	100%	15-Dec-22 A	
Project Start	0	100%	15-Dec-22 A	
Project Finish	0	0%		26-Dec-24*
Common	706		18-Jan-23 A	26-Dec-24
Contract Milestone	706		18-Jan-23 A	26-Dec-24
Project Milestone	568		21-Jan-23 A	16-Oct-24
Project Management	0		28-Apr-23 A	28-Apr-23 A
Engineering	220		23-Feb-23 A	05-Nov-23
Procurement	203		14-Jul-23	02-Feb-24
Construction	568		21-Jan-23 A	16-Oct-24
Project Management	30		21-Jan-23 A	24-Mar-23 A
MCG	450		21-Jan-23 A	22-Jun-24
Permitting	146		21-Jan-23 A	31-Jul-23
AMDAL (PP + SAGS)	0	100%		21-Jan-23 A
PPKH (PP + SAGS)	0	100%		21-Jan-23 A
AMDAL (Revision)	146	83%	21-Jan-23 A	31-Jul-23
Hand over to Contractor	340		18-Jul-23	22-Jun-24
Well 2-1 Handover to EPC	0	0%		18-Jul-23*
Well 6-3 Handover to EPC	0	0%		09-Nov-23*
Well 6-4 Handover to EPC	0	0%		08-Jan-24*
Well 8-1 Handover to EPC	0	0%		18-Mar-24*
Well 8-2 Handover to EPC	0	0%		15-May-24*
Well 2-2 Handover to EPC	0	0%		22-Jun-24*
Power Plant, BOP & SAGS Area	565		21-Jan-23 A	15-Oct-24
Engineering	275		21-Jan-23 A	30-Dec-23
Procurement	465		17-Mar-23 A	14-Jul-24
Construction & Precommissioning	565		04-Feb-23 A	15-Oct-24
Transmission Line System	476		16-Jan-23 A	26-Sep-24
Permit	390		16-Jan-23 A	31-May-24
Amdal TLS	90	100%	16-Jan-23 A	07-Jul-23
ROW Compensation	390	15.42%	01-Mar-23 A	31-May-24
Akta Pelepasan Tanah (Tapak Tower)	343	93%	03-Apr-23 A	30-Jul-23
PPKH TLS and PBG TLS	66	0%	07-Jul-23	10-Sep-23
Engineering	246		23-Jan-23 A	09-Feb-24
Procurement	90		14-Mar-23 A	16-May-24
Construction and Precommissioning	387		06-Sep-23	26-Sep-24
Commissioning & Start-up	91		26-Sep-24	26-Dec-24
General	91		26-Sep-24	26-Dec-24
Back Feeding Start	0	0%	26-Sep-24	
Mechanical Completion (MC)	0	0%		16-Oct-24
Offline Test	21	0%	17-Oct-24	06-Nov-24
Online Test	21	0%	07-Nov-24	27-Nov-24
Performance Test, Reliability Run	9	0%	28-Nov-24	06-Dec-24
PAD	0	0%		06-Dec-24
SLO	20	0%	07-Dec-24	26-Dec-24
COD	0	0%		26-Dec-24



Actual Work
Remaining Work
Critical Remaining Work
Baseline Milestone
Milestone
Summary

Data Date : 07-Jul-23

3.1.6 Design Information

The estimated resources for the Project are summarised in ***Table 3-8***.

Table 3-8: Well Production Specifications

Parameter	Value
Net Output for phase 1	■ 34 MW
Initial enthalpy	■ 1300 kJ/kg to 1600 kJ/kg
Average well output	■ Total of 6 (six) production wells to produce minimum 180 kg/s and maximum 270 kg/s mass flow rate, consist at least 44 kg/s steam and 136 kg/s brine to get 30 MWe output
Average injection well capacity	■ Upper limit of 105 kg/s of hot water (93.7 degC) with minimum injection pressure 10 barA from each injection well ■ Total injection capacity will be 178.3 kg/s from two injection wells ■ Note: considering providing re-injection pump
Non condensable gas	■ 2.5% based on IJN6.2 ■ 1.45% based on IJN6.1-ST
Production well pads	■ In first stage's 34 MW Power Development, well pad 6 consisting of 4 (four) production wells and well pad 8 consisting of 2 (two) production wells
Injection well pads	■ Well pad 2 will be main injection well pad consisting of 2 (two) injection wells, and well pad 5 shall be a supplementary injection well pad consisting of 1 (one) injection well
Brine pumping pressure	■ For Brine Transfer from well pad 8 to Power Plant at least 24.3 Bar A discharge pressure ■ For Brine Transfer from well pad 6 to Power Plant at least 14.8 Bar A discharge pressure ■ Note: consider the required separation pressure 14 bar G
pH Adjustment	■ Providing in brine flow line prior entering Power Unit ■ The target pH is between 4.5 – 5.15

3.2 Project Activities

Key activities to be conducted over the life of the Project are outlined in the following sections.

3.2.1 Land Preparation

The location for geothermal exploitation activities and the construction of a geothermal power plan will be carried out on a 117.81 ha site (excluding the transmission line RoW). Land preparation is the activity of preparing land (including land clearing) for wellpad, pipelines, drilling water facilities, disposal areas, and other supporting facilities.

3.2.2 Drilling Activities

3.2.2.1 Drilling Rig

The general specification of the drilling rig is provided below and shown in ***Figure 3-6***.

- 1,500 HP Minimum Draw-work Capacity; 750,000 lbs Minimum Hoisting Capacity on 12 Lines, and 500 T Travelling Block Capacity;
- 148 ft Mast Height; 750,000 lbs minimum hook weight; 9.40 m of substructure minimum clearance below rotary beam, including pony/skid-sub; and 500.000 lbs simultaneous set-back + 750,000 lbs rotary capacity;

- Skid system with 12 m minimum length of skid beams;
- OEM Certified AC-VFD Electric 500 Ton rating Top Drive System;
- 21-1/4” 2K Blow Out Preventer (BOP) & 13-5/8” 5K BOP Package or 20-3/4” 3K BOP with 3 Rams and high temperature elastomer up to 350 deg F;
- 3 mud pumps with 1600 HP & 1 optional independent pump;
- SCR / VFD system, diesel powered main rig engine to give 4000 HP minimum continuous operating output;
- Mud tanks and solid control with 2,000 bbls minimum total tank capacity, complete with cooling tower of 800 gpm capacity;
- Tubes and pipes include:
  - 2500 m minimum of 5”, 19.5 ppg, G-105 drill pipe & 1500 m of 5”, S-135, premium drill pipe
  - 1000 m of 3-1/2”, 13.3 ppf, G-105 premium drill pipe
  - 9-1/2”, 8”, 6-3/4” & 4-3/4” drill collars & 5”, 3-1/2” HWDP

Figure 3-6: Potential Drilling Rig

3.2.2.2 Exploration Wells

The exploration of the Project is in progress. The status of the exploration is as follows:

- ISH-01 is a slim-hole well drilled by Pertamina in 1989 at the south flank of Kawah Wurung (630 m);
- Two slim-hole wells drilled by MCG in 2016, IJN-01 (2,000 m) and IJN-02 (depth: 778 m);
- Four big-hole exploration wells drilling with 2+1+1 drilling strategy, drilled by MCG on partnership with Ormat. A summary of the wells drilled to date is provided in ***Table 3-9***;
- Three wells drilled in 2020, IJN 6-1 ST1, IJN 5-1 and IJN 6-2, found neutral reservoir with steam cap (270-280^{o}C) on top of brine reservoir with max. T > 300^{o}C;
- After developing a Numerical Model (based on the three wells results), a 4th well was drilled to confirm productivity in the main reservoir; and
- IJN 6-1 ST2, 4th Well, drilled by side-tracking IJN 6-1 ST1 from around 505 m measured depth (MD).

Table 3-9: Exploration Wells Drilled to Date

No	Well Name	Spud-in Date	Total Depth (TD) Date	Final Depth	Production Test Date
1	IJN 6-1 ST1	March 30th, 2020	June 25th, 2020	2,300 m MD	Aug 9th, 2020 - Sept 12th, 2020
2	IJN 5-1	July 20th, 2020	August 21st, 2020	2,700 m MD	Not conducted (negative WHP)
3	IJN 6-2	Nov 3rd, 2020	Des 25th, 2020	2,644 m MD	Jan 19th, 2021 – April 3rd, 2021
4	IJN 6-1 ST2	Sept 17th, 2021	Nov 5th, 2021	2,770 m MD	Nov 23rd, 2021 – Jan 22nd, 2022

3.2.2.3 Production Wells and Well Pads

Production field development involves drilling steam or hot water production wells and reinjection wells and processing of the reservoir output for use in the power plant. Generally, the drilling process includes site and pit preparation, erection of drilling towers, mud pond, and reservoir testing and laying of the transmission pipes respectively.

34 MW start-up production would need six (6) production wells (2 wells from exploration and 4 wells will be drilled in the development), two (2) injection wells (will be drilled in the development), and one (1) injection well as a backup (from exploration).

The proposed steam field layout will include four production wells from Pad 6, two production wells from Pad 8, two injector wells will be drilled from Pad 2. One injection well will be a backup from Pad 5. For 30 years production of 34 MW capacity, it is estimated to have approximately 1 to 3 make-up wells, depending on the support from the injector wells and deeper reservoir. The make-up wells could be drilled from Pad 8, Pad 6, or new Pad to the east or south of Pad 6 (within the Project Area).

The casing configuration for development wells drilling is shown in ***Figure 3-7*** and the estimated specifications for the production and injection wells is provided below:

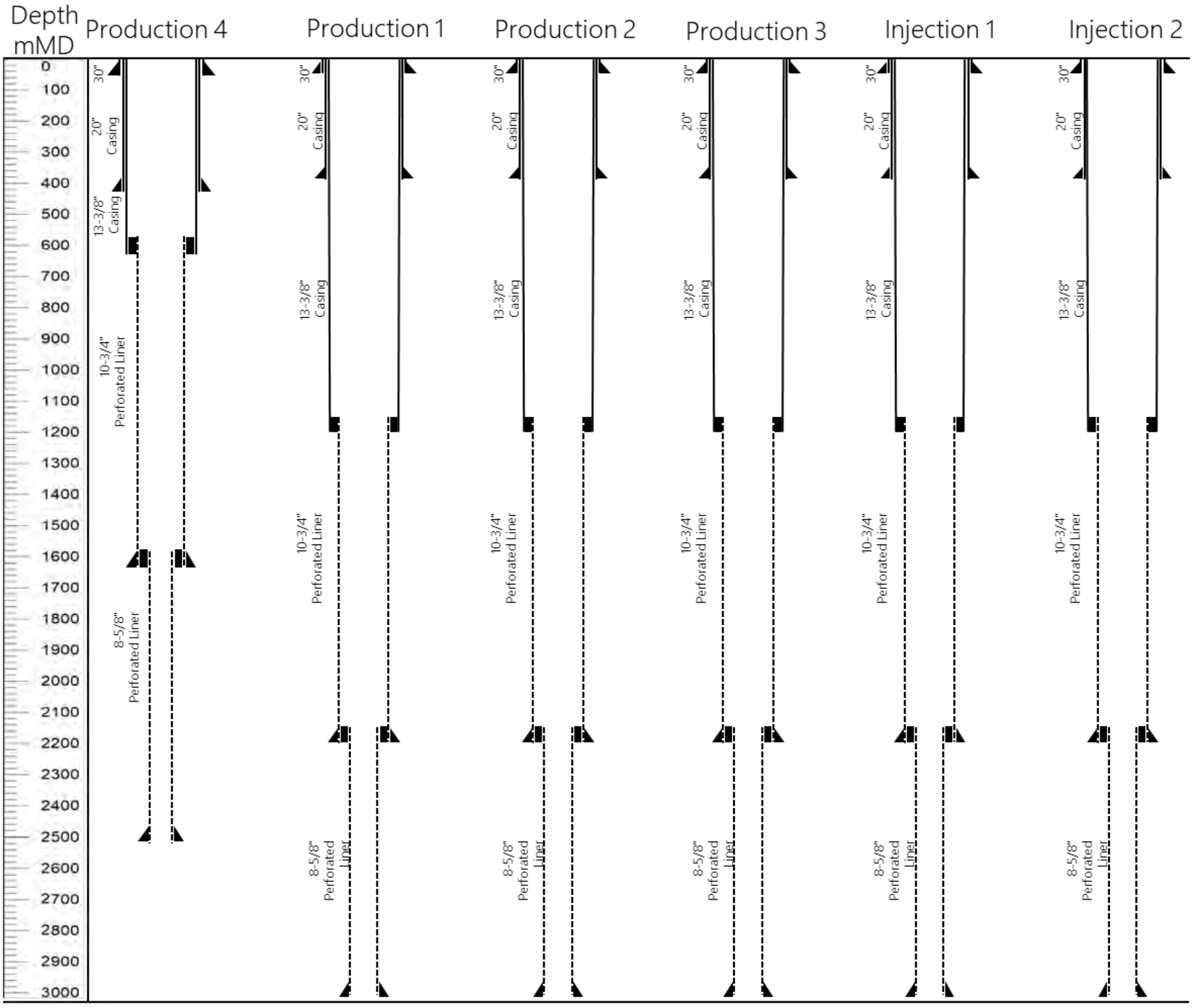
Production 4

- Well Target: 500m
- ~1000 m of 12-1/4" HS and perforated 10-3/4" Casings, ~900 m of 9-7/8" HS and perforated 8-5/8" Casings

Production 1, 2, 3 and Injection 1, 2

- Well Target TD 3,000 m
- ~1000 m of 12-1/4" HS and perforated 10-3/4" Casings, ~800 m of 9-7/8" HS and perforated 8-5/8" Casings

Figure 3-7: Potential Casing Configuration for Development Wells Drilling



Drilling will continue throughout the life of the project, as production and injection wells need to be periodically updated to support power generation requirements.

3.2.2.4 Drilling Fluids and Cuttings

In normal operations, drilling fluid is used 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 ponds to be recycled as drilling fluid, whereas drilling cuttings are sent to a drilling cutting storage area.

The drilling mud will consist of the following:

- Barite
- Bentonite
- Caustic Soda
- Defoamer
- KCL
- Soda Ash
- Soaltex
- Lignite
- Polymer

3.2.3 Power Plant

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

Power plant construction activities include construction of the power plant facility and associated infrastructure, including air-cooled condenser, pipelines, and facilities for treatment and reinjection of wastewaters and gases.The preparation, construction and operation of the power station will include:

- Earthworks and foundation construction
- Location of Power station
- Power station construction
- Pipeline construction for steam and water
- Geothermal steam turbine installation
- Cooling system installation
- Chemical analysis laboratory and hydrogen sulphide (H_2S) detection and protection system installation
- Service water supply, water storage tank, filters, pump, pipes from inlet installation (service water is to be used for initial fill of cooling water system and for fire-fighting system)
- Electrical works and connection to power grid
- Discharge systems (water, drilling mud, gas, etc.) installation
- The power plant construction will include:
- Tree Cutting and Land Clearing;
- Earthworks (Site Preparation), Slope Protection (Stability) and Drainage (Lined);
- Concrete piling works
- Foundation (Excavation and concrete);
- Power Block Installation;
- Building Construction (Control Room, Workshop, etc.);
- Switch Yard Installation; and
- Commissioning.

The land required for the power plant will be approximately 60,000 m^2.

Construction materials will be sourced locally and the power block (Turbine and Generator) will be sourced from ORMAT (imported from Israel).

3.2.4 Construction of Geothermal Pipeline Installation

The geothermal pipeline (pipeline network) will typically follow existing road construction to facilitate the construction process. Pipelines have certain slope, security, and safety requirements, thus the pipeline is required to adjust the slope and flow using gravity. The diameter of the pipe to be used is expected to be 12". Geothermal pipelines will be laid on the ground, and pipelines that cross with roads must be particularly constructed in accordance with the Decree of the Minister of Mining and Energy No. 300.K/38/M.PE/1997 on the Safety of Oil and Gas Pipelines. In this situation, a pedestrian bridge will be built over the pipeline where it crosses the road. The geothermal pipeline consists of the steam pipelines from the production wells to the geothermal power plant and brine and condensate pipelines from the power plant to the injection wells, as follows:

- Steam pipeline from the production well to geothermal power plant:
  - Length of pipeline from IJN 06 to the power plant is ±300 m;
  - Length of pipeline from IJN 08 to the power plant is ±450 m;
- Brine and condensate pipeline to injection well:
  - Length of the pipeline from the power plant to IJN 02 is ±2.000 m;
  - Length of the pipeline from the power plant to IJN 05 is ±3.000 m (contingency plan)

Pipe welding will be powered by 3 units of 100 kVA generators that will move (mobile) along the pipeline.

3.2.5 Access Roads

Access to the Project site is already established by a neighbouring coffee plantation. The site can be accessed by car and is approximately a two-hour drive from Banyuwangi. MCG will upgrade (widen and asphalt) the access road from Regency road junction to all facilities with a total length of 8.6 km.

3.2.6 Transmission line

The energy produced by the Project will be connected to the national grid through 150 kV transmission line between the Project Area and Banyuwangi Substation.

The transmission line construction will include:

- Tree Cutting and Land Clearing;
- Foundation (Excavation and concrete);
- Tower Erection and Isolator/Accessories Installation;
- Stringing (Conductor Installation); and
- Commissioning.

The total length of transmission line to be installed is 28.3 km with the total of 83 towers. Details of the transmission line and towers are described in ***Table 3-10***.

Table 3-10: Details on the Transmission Line and Towers

Parameters	Details
Normal voltage	150 kV
Maximum voltage	170 kV
Tower	
Basic span	350 m
Wind span: ■ Normal ■ Broken	■ 500 m ■ 400 m
Weight span: ■ Normal ■ Broken	■ 700 m ■ 400 m
Maximum working tension	2,400 kg
Normal ground clearance	90m
Seismic code	SNI 03-1726-2002
Wind pressure ■ Conductor ■ Steel tower ■ Insulator	■ 40 kg/m ■ 120 kg/m ■ 60 kg/m
Clearance Vertical clearance ■ Above normal ground, open and agricultural land ■ Above pedestrian access ■ Above tree ■ At power circuit crossing ■ At telephone line crossing ■ Urban/inhabited area	■ 9 m ■ 12 m ■ 5.5 m ■ 5 m ■ 5 m ■ 12 m

The Right of Way (RoW) will be around 10 m from each side of the line. All human settlements will need to be cleared in order to be compliant with magnetic and electric field limits. It is currently estimated that around 83 transmission towers will be built. This is equivalent to around 0.3 km spacing between towers. The tower spacing is dictated to some extent by transmission line vertical clearance safety requirements indicated in ***Table 3-10***.

For the foundation design of the 150 kV towers, individual footing foundation is recommended for firm ground and the cast-in-situ pile foundation type is recommended for marshy, weak ground, river crossing, and other crossings. However, this will be optimized based on soil investigation and geo-technical survey findings.

3.2.7 Commissioning

3.2.7.1 Preliminary Test

Preliminary test consists of individual tests for systems, sub systems, equipment and installation. The equipment shall run individual tests operated at constant rating long enough to minimize fluctuations in operating characteristics, such as pressures and temperatures. The rating shall be held constant during the individual tests period. The duration of every individual tests period shall be the minimum required for obtaining representative data, but shall not exceed four hours for each test run, except sub system tests to demonstrate capacity and capability which shall not exceed twenty- four hours.

3.2.7.2 Performance Test

Performance test is meant to test the whole system of Power Plant and shall be performed uninterrupted for 72 hours. It shall be conducted after the completion of the Preliminary Tests.

3.2.7.3 Notification of Test, Standards and Government Regulations

Apart from the various standards used in the whole plant, the following codes specifically apply for testing and measurement:

- ASME PTC 6, Turbine Generators Performance Test Code;
- ISO 5167 – 1980, Measurement Code of Fluid Flow by Means of Orifice Plates, Nozzles and Venture Tubes;
- ASTM D-2186, Test Methods for Deposit Forming Impurities in Steam;
- ASTM D-1066, Standard Method of Sampling Steam;
- ASTM D-3370, Standard Practice for Sampling Water; and
- CTI-ATS-105, Acceptance Test Code for Closed Circuit Cooling Towers.

3.2.8 Operation and Maintenance

3.2.8.1 Plant Automation

The Plant shall be designed to run fully automatically, with minimum operator intervention. The whole Plant shall finally be controlled from one control room, which will usually be manned continuously.

The control system of the plant will be designed by the Power Block's Supplier and done according to the Power Block's Supplier standard with ability to run the plant in fully automatic and safety way.

On behalf of the control of the whole Geothermal Power Plant, a multi-level architecture and advanced integrated plant control system shall be utilized. This process control system shall support all platforms, applications and services, which are required for modern future proof plant automation.

The plant control system shall have an open system architecture providing platforms for process, safety, management and maintenance applications. This means that all processes are integrated in one single database platform with one central database.

The process automation of the Geothermal Power Plant shall be based on a modern Distributed Control System (DCS) with central operation from Video Display Units (VDU) based on standard technologies.

3.2.8.2 Electrical Output

The Geothermal Power Plant shall be designed to generate a minimum 34 MW net electric power at design conditions, measured at Step up transformer 150 kV side.

3.2.8.3 Operation Range

The new Turbine Generator shall be capable of stable, sustained operation between 100% and 30% maximum continuous rating (MCR). It shall be possible to shut down the plant in a safe way from every operating point. This requirement applies to both normal and abnormal operating conditions. The new Turbine Generator shall be capable of stable, sustained operation between the operation parameters as showing in ***Table 3-11***.

Table 3-11: Minimum and Maximum Turbine Generator Parameters

Parameter	Value	
	Min	Max
Brine flow rate at inlet	425.6 t/h	562.9 t/h
Brine temperature at inlet	185 °C	205 °C
Vapor (steam + NCG) flow rate at inlet	134.7 t/h	182.2 t/h
Steam pressure at inlet	11.9 bara	16.1 bara
NCG flow rate	2.7 t/h	3.6 t/h
Ambient air temperature	10°C	35°C

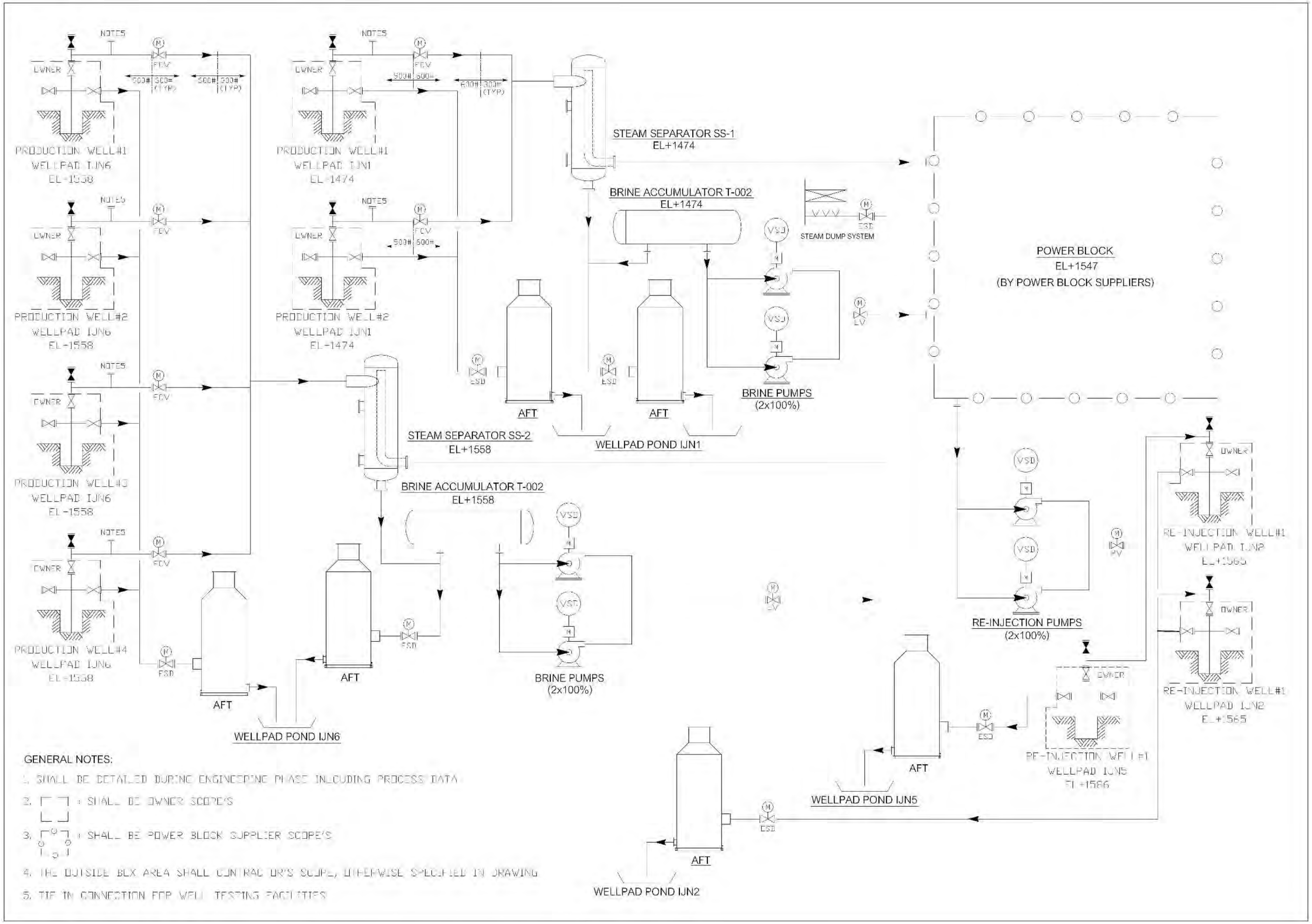
The Final Acceptance Tests will comprise the Trip Test, the Performance Test and the Capacity Test. The Capacity Test will be conducted over a four (4) hour period. The Performance Test will be conducted over a period of up to three (3) day (72 hours). During the Final Acceptance Test the Geothermal Fluid conditions, the ambient air temperature and the gross and net electrical power output will be measured and recorded every thirty (30) minutes.

3.2.8.4 Concept Design

The geothermal fluid from wells will be separated into Steam and Brine in the Separator. The brine will be fed to Preheater to increase the motive fluid's temperature and steam will be fed into the vaporizer to vaporize the motive fluid and then introduced to new organic turbine to produce electricity.

The flowrate and temperature of exhaust gas to be used as design basis is provided in ***Section 3.1.6*** and typical preliminary Process flow diagram of Binary System Power Plant can be found in ***Figure 3-8***.

Figure 3-8: Process Flow Chart



3.2.8.5 Design Life and Availability

3.2.8.5.1 Design Life

The Plant shall be designed for a Design Life of 30 years.

3.2.8.5.2 Availability

The power plant shall be designed to run for at least 8,322 equivalent full-load hours per annum, throughout its lifetime. This equates to an availability of 95%.

3.2.8.5.3 Reliability

The Plant shall be designed in such a way that forced outages will be limited as far as practically possible. In general, outage of one component shall not lead to a total shutdown of the plant. Critical equipment, such as pumps, and some specific High Speed Turbo Machineries and High Pressure and Temperatures shall be redundant.

3.2.9 Decommissioning

Decommissioning is the term used to describe all the stages involved in the closure and rehabilitation of the geothermal site. The process can generally be categorized into three (3) key phases as follows:

- Pre-decommissioning activities :includes the detailed planning) development of the decommissioning plan) and approval procedures;
- Decommissioning activitiesincludes :removal of plant machinery & equipment and demolition, production and injection well plug and abandonment, decommissioning of other facilities and infrastructure, workforce demobilization, decontaminated land assessment and rehabilitation; and
- Post-decommissioning activities;includessite survey, close-out report and field monitoring as necessary.

The project is designed for 30 years operation. If decommissioned, all components including foundations and internal roads of the Project will be removed and the site will be restored to its pre-construction state.

Workforce Demobilization

Workforce demobilzation shall be carried out in compliance with the employment contract between MCG and the relevant workforce.

Land Rehabilitation

Land rehabilitation will be carried out with well closure procedures and demolition of main infrastructure, geothermal network installations, geothermal power plant units, and supporting facilities and environmental management.

Most of the equipment will be sold to third parties and some will be disposed of in designated disposal sites. Afterwards, revegetation will be carried out by planting plants with species that match the baseline data of flora and fauna at the activity site. This activity is expected to be carried out for at least three years after the date the Project is decommissioned.

3.2.9.1 Plug and Abandonment

Before the Plug and Abandonment (P&A) activities, the appropriate government body (Directorate General of New Renewable Energy and Energy Conservation EBTKE) shall be notified. The borehole shall be cleared of obstructions before implementation of plugging and abandonment. This might involve fishing lost equipment and other obstacles out of the borehole or squeezing cement across suspected casing holes.

To avoid damage to the well casing, the well will be gradually cooled down by quenching with cold water in a controlled manner before performing P&A activities. Mechanical barrier shall be set as a retainer, as deep as possible above the production interval where the well is fully filled with fluid or air. The well will then be filled with an un-cemented pre-perforated liner, and then the cement plug will be placed above the mechanical barrier to isolate the reservoir from the upper wellbore.

The following P&A steps are provided by MCG:

- Set bridge plug inside the 13-3/8" production casing, right above the 10-3/4" top of liner.
- Set cement plug by using 15.8 ppg cement slurry with minimum total cement linear length of 60 m (approx. 200 ft), then waiting on cement to set.
- Test cement plug by placing minimum pipe weight of 15,000 pounds on top of its surface and perform pressure test to surface pressure of a minimum of 1,000 psi.
- To isolate across tie-back setting depth, a cement plug shall be laid down across the liner lap of any cement liner, even if the liner has been tied back to surface.
- Pumping high viscosity mud on top of the first cement plug to be used as a cushion for second cement plug.
- Setting a cement plug by using 15.8 pounds per gallon (ppg) cement slurry with minimum total cement linear length of 60 m (approx. 200 ft) and waiting for cement to set.
- Testing cement plug by placing minimum pipe weight of 15,000 pounds on top of its surface. And perform pressure test to surface pressure of slightly above the Maximum Anticipated Surface Pressure (MASP) or minimum 1,000 psi.
- Isolate the well top/ surface section.
- Pumping high viscosity mud on top of the previous cement plug to be used as cushion for the surface cement plug.
- Setting a cement plug by using 15.8 ppg cement slurry with minimum total cement linear length of 60 m (approx. 200 ft) from the surface and waiting for cement to set.
- Testing cement plug by placing minimum pipe weight of 15,000 pounds on top of its surface.

After every well section has been isolated, master valve, wellhead and wellhead valve will be removed from the location. All casing and conductor will be cut to a depth of at least 1 m underground and welded plate over the casings and conductor. The abandonment will be complete when the well has been marked with their permanent name plate together with P&A date.

3.3 Resource Requirements

The following section provides the resource requirements for the Project during all phases.

3.3.1 Water

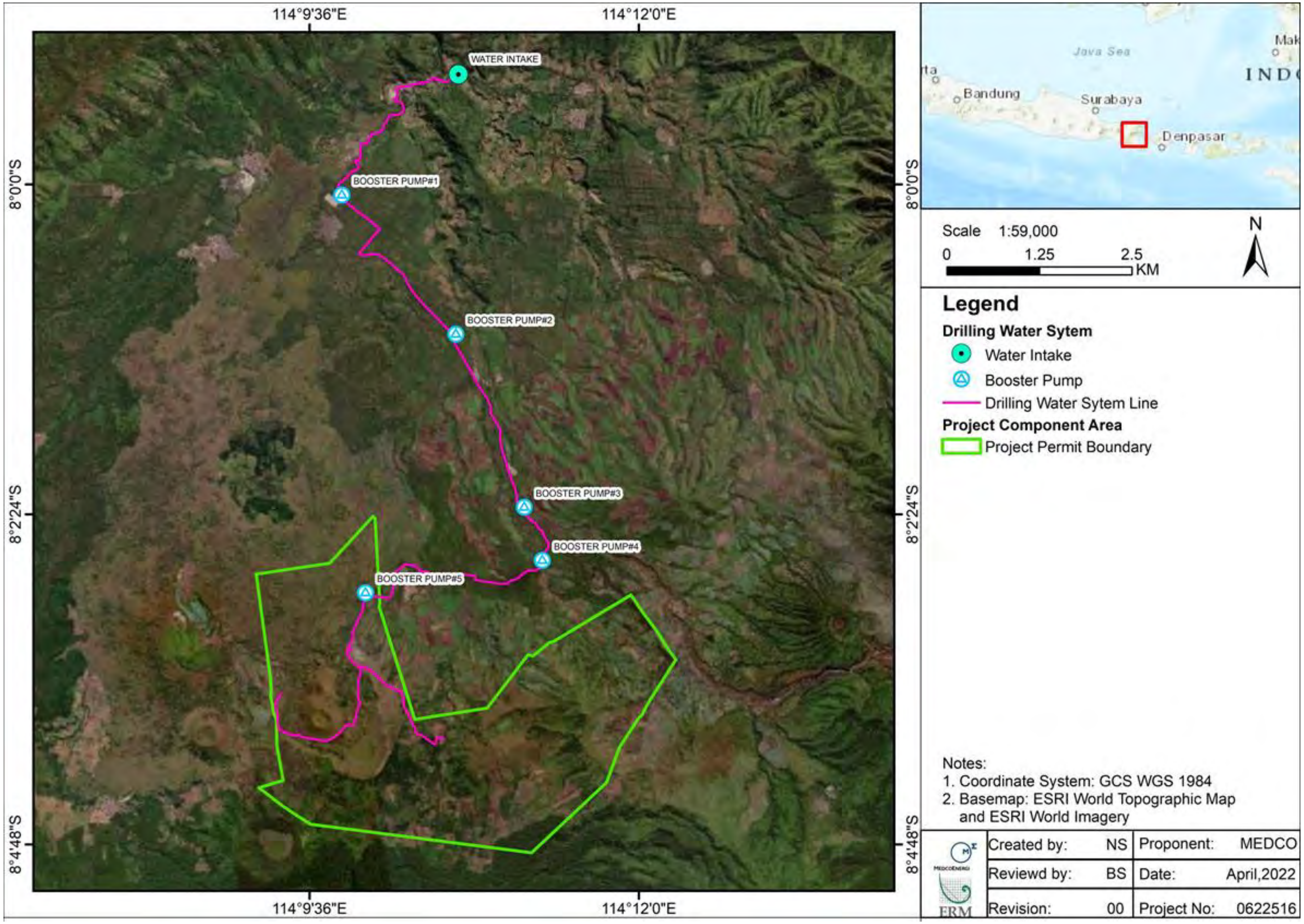
The water required for the Project will be sourced from the Ampar River via intake pump. The total water requirements will be 1,200 gallons per minute (GPM) and will be transferred via existing pipelines (6" x 2 lines).

Water will be collected in 20-ft storage tank and then will be pumped again to Booster Pump 2 to 5 until reaching the Project well pads water pond. The operator will standby at the pump house for 24-hour pump operation in 2 (two) working shift during water supply. The water pipeline and pump locations are shown in Figure 3.8.

Currently, the existing site has 3 (three) well pads with each water pond already constructed with a capacity of 6,150 m^3 (1,600,000 US Gallons). MCG has a water abstraction permit (SIPAP NOMOR:

26/05.02/02/IX/2021 (Surat Izin Penggunaan Air Pernukaan) owned by PT MCG, which allows for pumping up to 5,400 GPM.

Figure 3-9: Location of Water Pumping Stations



3.3.2 Power Supply

Electricity is needed to pump the water for the power station, as well as for other operational needs. This electricity will come diesel powered engines (i.e., gensets) at site. The power requirements during construction are shown in ***Table 3-12***. During operation, power will be supplied from the national grid.

Table 3-12: Power Requirements during Construction

No	Description	Quantity	Unit
1	Total Genset Capacity (Installed Capacity)	5540	kW
2	Actual Maximum Power (Actual Reading)	2067	kW

3.3.3 Transportation of Equipment and Workers

Large equipment and heavy cargo shall be transported via sea and unloaded on the Jetty either in Banyuwangi Seaport, around 150 km from the site, or Probolinggo Seaport, around 170 km from the Site. Transport and personnel access to the site is via the existing roads as provided in ***Table 3-7***.

3.3.4 Equipment List

The equipment required for the construction and drilling phases is provided in ***Table 3-13***.

Table 3-13: Construction Equipment List

No	Equipment	Equipment Description
1	Drilling Rig	Hoisting equipment
2		Electric motor
3		Rig Mast
4		Crown Block
5		Substructure
6		Drilling Line
7		Travelling Block
8		Rotary Table
9		Top Drive System
10		Water Tank
11		Mud Tanks
12		Mud Pump
13		Shale Shaker
14		Desander
15		Desilter
16		Degasser
17		Centrifugal Pump
18		Blow Out Preventer
19		Choke Manifold
20		Accumulator

No	Equipment	Equipment Description
21		Genset
22		SCR (power control room)
23		Air Compressor
24		Fuel Tanks
25		Bug Blowers
26		Mud Lab
27		Drill Pipe
28		Drill Collar
29		Heavy Weight Drill Pipe
30		Tubular Handling Equipment
31		Safety Equipment
32		Heavy Duty Equipment
33		Light Vehicles
34		Office and Camps
35		Solid Control Equipment
36	Mud Logging Unit	Various Sensor
37		Laboratory Equipment
38		Office cabin
39	Wireline	Wireline unit
40		Wireline cable
41	Aerated Drilling	Compressor
42		Booster
43		Fuel Tanks
44		Office
45		Flow line and separator
46		Rotating Control Head
47	Cementing	Cementing pumping unit set
48		Cement surge tank set
49		batch mixer
50		dry bulk storage
51		twin cutting bottle
52		water tank
53		air compressor
54	Drilling Instruments	Mud motor
55		Measurement-While-Drilling tools
56		Stabilizers
57		Cabin unit
58	Drilling mud services	Mud lab equipment

No	Equipment	Equipment Description
59	Drilling Bit	Drilling Bit

3.3.5 Labour

The overall anticipated workforce during construction is estimated to be 450 workers. During operation, as the power plant will be automated, there will only be around 69 workers.

MCG is committed to hiring local workers, especially from the Ijen District area. For the construction phase, MCG will source 77% of its workforce as per the labour requirements.

This has been done by MCG for the already completed geothermal well exploration activities. However, for jobs that require skills and competencies, MCG must recruit workers who have the required competencies.

3.4 Emissions and Discharges and Control Measures

The following section outlines the emissions and discharges and control measures for the Project.

3.4.1 Drilling Fluids and Cuttings

It is estimated that the total volume of waste drilling mud per well is around 500 m^3 (3,000 m^3 for six wells. The waste drill cuttings ±300 m^3 per well, will be transferred via trucks and either sent to local manufacturing companies (for concrete bricks) or for materials for civil works. All drill cuttings will be managed in accordance with national regulation (ESDM) No 21 year 2017 regarding waste mud and drill cutting management for geothermal activities.

3.4.2 Wastewater

Wastewater shall be treated and discharged. The only discharge into the surface waters will be treated water.

The liquid effluents generated during the construction phase will include domestic sewage from the temporary site office and worker accommodation. The sewage generated from the site office and worker accommodation will be treated through sewage treatment system. The standards, as per local and IFC guidelines, for this discharge water are provided in ***Section 2.4***.

During construction, it is anticipated that the maximum number of workers will peak at approximately 450. The quantities of sanitary wastewater can be estimated as an average of 50 litres/person/day. Considering the expected amount of sanitary wastewater produced is approximately 80% of the total water consumption per person (for non-continuous use), this equates to a predicted 22,500 litres of sanitary wastewater per day at peak construction periods. The Engineering, Procurement, and Construction (EPC) contractor will establish a management system for sanitary wastewater before construction.

The operational phase will include wastewater from the power plant and office, which will be treated through sewage treatment system prior to discharge to surface waters.

3.4.3 Run-off water

Run-off from the paved areas will pass through and discharge into a storm sewer system and existing water collection pond. Any excess will be discharged into the surface waters. This discharge will be tested to ensure it aligned with the standards in ***Section 2.4***.

3.4.4 Soil

The Project shall be designed in such a way that no pollutants will be released into the soil. The floors for transfer, storage and processing of fuels, oils and chemicals shall be impermeable. Storage arrangements shall be in compliance with the latest applicable standards. The facilities for delivery and storage of other materials shall also be constructed in such a way as to prevent soil pollution.

3.4.5 Air Emissions

During construction, the primary sources of emissions will be fugitive dust and vehicle emissions. Fugitive dust emissions generated from various activities, e.g .piling, use of construction machinery, and vehicular movement on unpaved roads)vehicular emissions generated from increased traffic volume from transportation of material .Fugitive dust emissions from construction activities should be minimized through relevant mitigation, e.g .

- Sprinkling along the site boundary twice a day at least;
- Asphalting the construction road at worksite after construction and prior COD;
- Maintaining speed limit at worksite to 20 km/h; and
- Truck wheel shall be washed at wheel wash.

Under normal operations, there will be no gaseous emissions from the Project site .However, there is a potential emission from worker vehicle and chemical transportation .

3.4.6 Noise Emission

Noise emission will be generated from drilling activities, movement of vehicles, and other construction machinery using for land clearing activities, levelling and excavation work, e.g., excavator, backhoe, crane, generator.

The average sound pressure level measured at a distance of 1 meter from the outer surface of equipment/enclosure at 1.5 m height above ground shall not exceed 85 dB(A). Such limitation shall not exceed when the equipment is running in operational with dedicated working condition. In the case of package equipment unit, measurement shall not be made in individual item.

In the standard operation, explosives may be used however only for pipe recovery activity (due to stuck pipe) such as severing or back off activity. The management of explosives is conducted under PT Dahana[8] and all standard operating procedures for explosive management will be provided by PT Dahana.

3.4.7 Solid and Hazardous Waste

During construction phase, solid waste is generated from construction camp, excess excavated materials and for hazardous waste from oil, grease, and fuel. The Contractor will be required to prepare, educate workers, and implement a waste management plan as part of the Waste Management Plan (WMP) Waste will be disposed of by licensed waste handling facilities.

The estimated non-hazardous and hazardous waste during geothermal exploration activity and the construction of the power plant is provided in ***Table 3-14*** and ***Table 3-15***, respectively.

[8] PT. Dahana is an Indonesian State-Owned company in the field of strategic industry offering integrated explosives services, widely used in O&G & Geothermal drilling activity

Table 3-14: Estimated Non-Hazardous Waste Generation from Project

No.	Activity Component	Non-Hazardous Waste Production Estimation
1.	Basecamp Operations	122,5 kg/day
2.	Construction of major building infrastructure	12 m^3
3.	Development of supporting facilities infrastructure and environmental management	452.4 m^3
4.	Geothermal exploitation drilling	130-150 kg/day
5.	Power Plant unit construction	31.68 m^3
6.	Labour operations	24.15 kg/day

Table 3-15: Estimated Hazardous Waste Generation from the Project

No.	Activity	Hazardous Waste	Hazardous Wastes Produced
Pre Construction Phase			
1	Geoscientific surveys (geoscience, geology, geochemistry)	None	n/a
2	Planning study	None	n/a
3	Licensing	None	n/a
4	Land use cooperation process	None	n/a
5	Exploration well test	None	n/a
6	Exploration well maintenance	None	Used lubricants Used gloves/majun Used absorbent and/or filter
7	Activity socialization	None	n/a
Construction Phase			
1	Mobilization of construction workforce	None	n/a
2	Basecamp Operations	Yes	Used lubricants Used hazardous material packaging Used gloves/rags Used battery Used lamp Used battery Used absorbent and/or filter Contaminated waste by hazardous material Sand/husk contaminated with hazardous waste
3	Mobilization of heavy equipment and materials	None	n/a
4	Dredging, backfilling and compaction of land	None	n/a
5	Construction of major building infrastructure	Yes	Used hazardous material packaging

No.	Activity	Hazardous Waste	Hazardous Wastes Produced
			Used gloves/rags Sand/husk contaminated with hazardous waste
6	Development of supporting facilities infrastructure and environmental management	Yes	Used hazardous material packaging Used gloves/rags Sand/husk contaminated with hazardous waste Medical waste containing hazardous material
7	Geothermal exploitation drilling and geothermal well installation	Yes	Used lubricants Used hazardous material packaging Used gloves/rags Used absorbent and/or filter Used battery Sand/husk contaminated with hazardous waste
8	Construction of geothermal well network installation	Yes	Used lubricants Used gloves/rags Sand/husk contaminated with hazardous waste
9	The power plant unit construction	Yes	Used lubricants Used hazardous material packaging Used gloves/rags Used absorbent and/or filter Used battery Sand/husk contaminated with hazardous waste
10	Production test of geothermal wells and the power plant units	None	n/a
11	Heavy equipment demobilization	None	n/a
Operation Phase			
1	Labour mobilization	None	n/a
2	Labour operations	Yes	Used hazardous material packaging Electronic waste including cathode ray tube (CRT), printed circuit board (PCB) and metal wire Used TL lamp Used battery

No.	Activity	Hazardous Waste	Hazardous Wastes Produced
3	Operation and maintenance of geothermal production wells	Yes	Used lubricants Used hazardous material packaging Used gloves/rags Used absorbent and/or filter Used battery Sand/husk contaminated with hazardous waste
4	Operation and maintenance of geothermal well network installation		Used lubricants Used gloves/rags
5	The power plant operation and maintenance	Yes	Used lubricants Used hazardous material packaging Used gloves/rags Used absorbent and/or filter Used battery Sand/husk contaminated with hazardous waste
6	Operation and maintenance of supporting facilities and environmental management	Yes	Used hazardous material packaging Electronic waste including cathode ray tube (CRT), printed circuit board (PCB) and metal wire
Post Operation Phase			
1	Labour release	None	n/a
2	Land rehabilitation/revegetation	None	n/a

3.5 Future Expansion Plans

Following the completion of the first stage (Unit 1), the Project will continue onto the second stage to reach its full capacity of 110 MW. During the writing of this ESIA Report, it is understood that the second stage will involve the development of 2 additional well pads, namely IJN-7 and IJN-9. Details on the number and type of wells proposed are shown in ***Table 3-16***. These future expansions plan are not included as part of this Project for purposes of current financing and will be the subject of a future ESIA supplement. It should be noted that this future expansion stage was included in the approved ANDAL.

Table 3-16: Well Pads and Wells Proposed for Second Stage

Well pad	Wells
IJN-1	4 injection wells
IJN-2	2 injection wells
IJN-6	2 production wells
IJN-7	4 production wells
IJN-8	2 production wells
IJN-9	4 production wells

3.6 Project Alternatives

This section provides an overview of the alternatives considered for the Project.

3.6.1 No Project Alternatives

The 'no project alternative' considers the consequences in case a decision not to proceed with the Project is made. In this scenario, the possible positive and negative impacts of the proposed activities on the receiving environment and social receptors would not occur.

Specific benefits of the no project alternative are considered to be the following:

- The constructing of the Project, including the construction of associated facilities (e.g., transmission lines and internal roads), which will have an adverse impact on the environment (e.g., dust emission, contamination of soil and surface water, and to biodiversity habitats e.g., permanent and temporary loss of habitats, and increased mortality of resident species) would not occur;
- The possible social disruption and health impacts arising from the construction and operational activities; e.g., impacts to health and safety of community, unplanned events, loss of land and structure, loss of ecosystem services which they depend on, and change of landscape, would be avoided;

The land at the proposed sites would be unaltered and remain available for alternative use.

In case that the Project is not developed (No Project Scenario) there would be no impacts to local communities within the Project Area of influence e.g. loss of land and structure, loss of ecosystem services which they depend on, change of landscape, etc.

Conversely, the disadvantages of the no project alternative are as follows:

- Limited available electricity supply, and power importation would have to continue at higher tariff and intensive load management interventions required.

- Development of local socio-economics and its positive benefits would not be realized e.g. increase in employment rate, and increased access to electricity, improved roads, improved facilities such as schools, healthcare facilities, and clean water systems.
- Not developing this Project may result in the need to establish alternative plants using other energy and fuel sources e.g., hydroelectric, gas-fired, or coal-fired. These alternatives would have greater adverse impacts on the physical and social environment from an increased greenhouse gas emission, and larger impact due to land acquisition (including physical and economic displacement) and biodiversity habitat loss.

3.6.2 Location Alternatives

The Project must be located where the geothermal resource is present. As the Project site has already been developed for exploration activities, and since the predicted impacts are not considered significant, there was not a compelling need to consider other alternative locations within the immediate areas. However, the selection of the specific location of facilities within the Project Site was conducted based on technological needs and environmental and social considerations. The proposed location of the project facilities in the main concession area are shown in ***Figure 3-10***.

3.6.2.1 Power Plant

The power plant has been located over 1 km from the nearest village at the furthest possible distance from social receptors to reduce any potential impacts. The boundary of the Project site has been defined to avoid plantation areas where possible, which limits potential impacts to livelihoods associated with these areas.

3.6.2.2 Well Locations

The new well pads for the production and injection wells are located around 600 m from the nearest village. The wells have been located at the furthest possible distance from receptors to reduce the impacts from drilling noise and air emissions.

3.6.2.3 Access Roads

The access roads are existing on the site. These roads will be upgraded and paved with asphalt during the Project prior to COD. The access road does not pass through any nearby villages to reduce impacts from vehicle movements in the communities.

3.6.2.4 Transmission Line

The route of the transmission line has been defined based on analysis of the topography and to avoid any biodiversity sensitive areas as well as local villages. The transmission line route (as shown in ***Figure 3-11***) has been aligned along the route of an existing access road and to avoid the Kawah Ijen Nature Reserve.

Figure 3-10: Project Facilities Layout

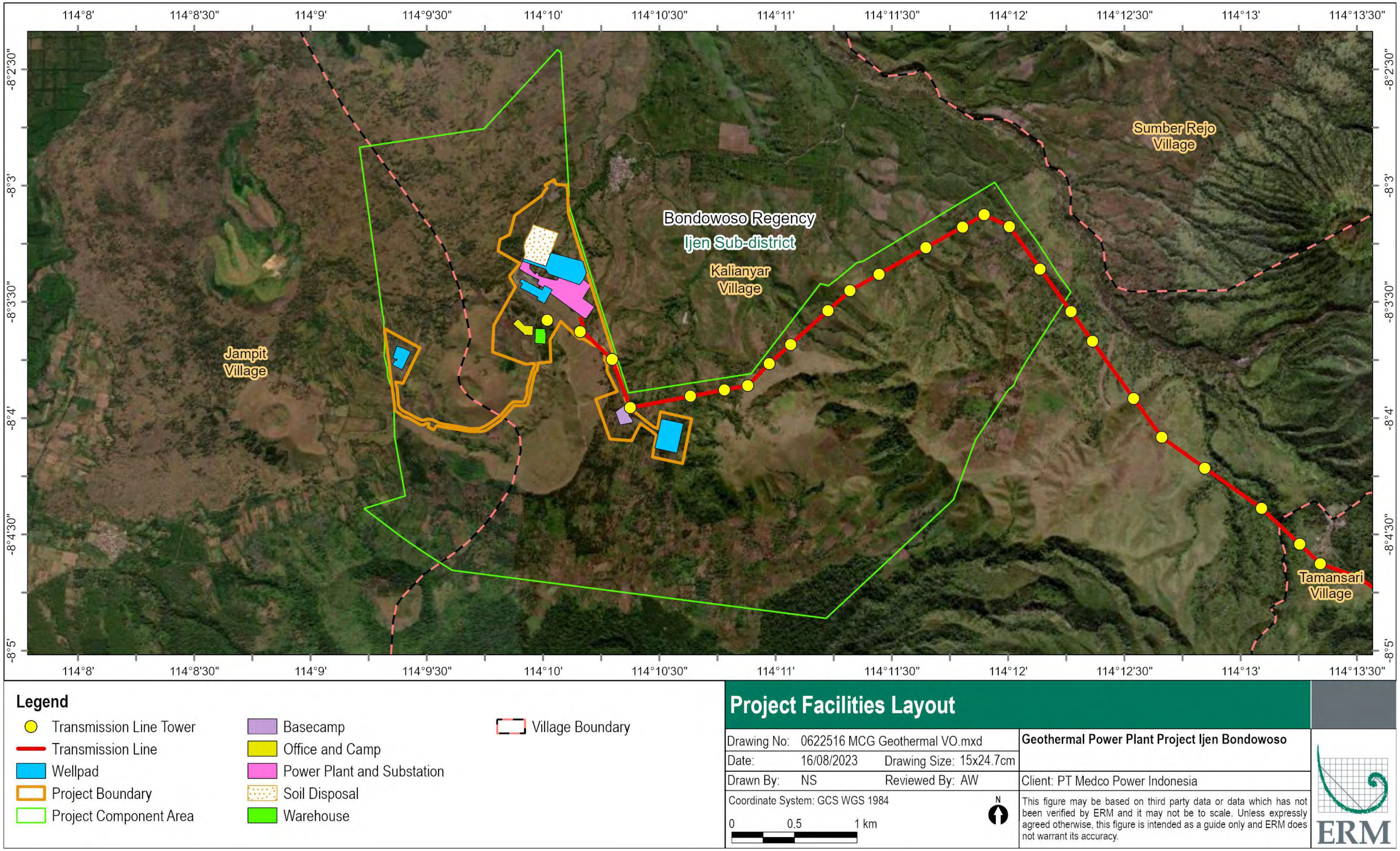
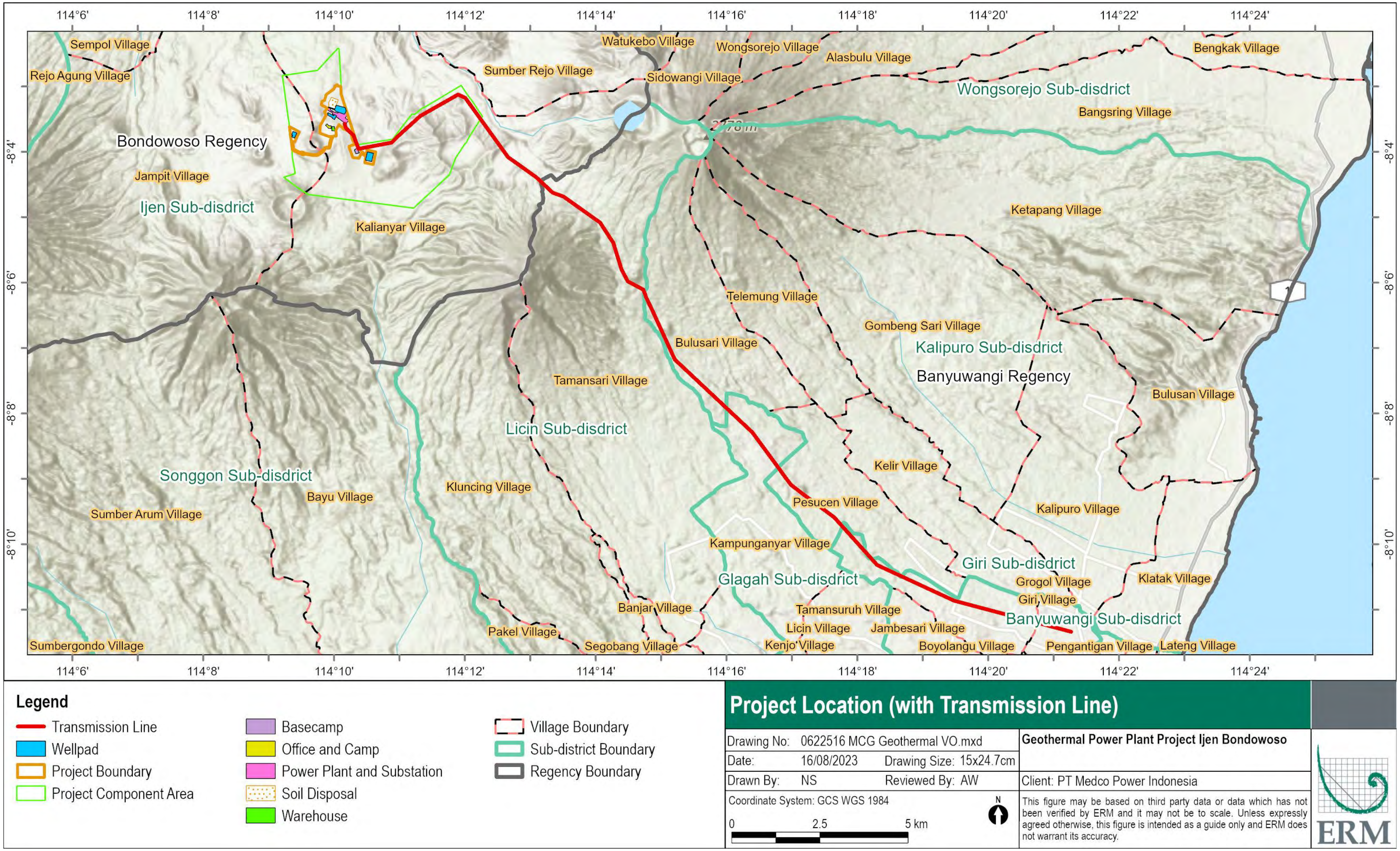


Figure 3-11: Transmission Line Route



3.6.3 Alternatives for Discharge of Water

Alternatives for the handling of discharge water and mud include:

- Reinjection to the injection well.
- Discharge to brine collection ponds.

3.6.3.1 Reinjection

By monitoring and using reinjection along with extraction from the geothermal resource, a certain degree of sustainability will be reached:

- Fluid extracted from the resource is reinjected back.
- Heat energy left in the fluid is also returned to the reservoir.
- Reinjection can damp down subsistence by reducing pressure drop which can accompany extraction from the reservoir.

Reinjection however requires equipment, pipelines and reinjection wells. The reinjection pipelines will follow the routes of the existing road network in the Project Site to avoid additional impacts to the terrestrial environment.

3.6.3.2 Collection Ponds

Ponds are used for collecting brine from tested wells and from the power station. The fate of effluent water or brine collected in a pond would be evaporation. The pond also acts to delimit the area affected by the discharge. The size of a brine collection pond would depend on the steam/water ratio from each well. The pond itself is constructed with Polyethylene liner - HDPE which will avoid any impacts to the environment from any infiltration. The ponds would result in greater land disturbance, represent a potential hazard for wildlife, and evaporation would likely be limited during the wet season.

3.6.3.3 Selected Alternative

MCG have elected to utilise 2-phase Organic Rankine Cycle (ORC) binary plant with a 100% geothermal fluid reinjected back to the reservoir/injection wells. This avoids any potential impacts to the groundwater table.

4 DESCRIPTION OF THE SURROUNDING ENVIRONMENT

4.1 Overview

This section presents the environmental, ecological and socio-economic baseline of the Project AoI. Baseline refers to the physical, biological, social and cultural conditions that currently exist within the Project Area of Influence.

4.1.1 Defining the Study Limits

The **Project Area** covers the main construction area (well site) as well as the transmission line route. The **Study Area** covers the Project footprint in Blawan Ijen, Bondowoso East Java and the transmission line route equalling approximately 28.3 km from the Project site. This is to encompass any sensitive environmental and social receptors in the area.

The **Project Area of Influence (AoI)** covers the Project Area out to around 5 km from the main works area and 500 m around the transmission line route. This is conservatively estimated based on potential impacts (specifically to bird species).

The AoI with respect to the environmental and social receptors are defined further in the Impact Assessment (***Section 6***) and summarised here:

- Environmental AoI (air, noise, soil, water) – dust fall is typically up to 200 m from construction activities and noise from construction is likely to impact an area within 500 m. Given the extent of Project activities; the Environmental AoI is likely to be within 500 m of the Project Area.
- Biodiversity AoI - the direct footprint of the project comprising the project site, and the areas immediately adjacent to the project footprint within which a zone of ecological disturbance is created through increased dust, human presence and project related activities (e.g., sourcing of fill materials, transportation). This kind of disturbance has been estimated to occur within the project footprint and surrounding areas (approximately 5 km from the activity areas).
- Social AoI – social impacts can be experienced from the Project in local villages and towns involving both direct impacts within the project footprint) and indirect impacts (i.e., disturbance to services such as traffic).

4.1.2 Methodology and Objectives

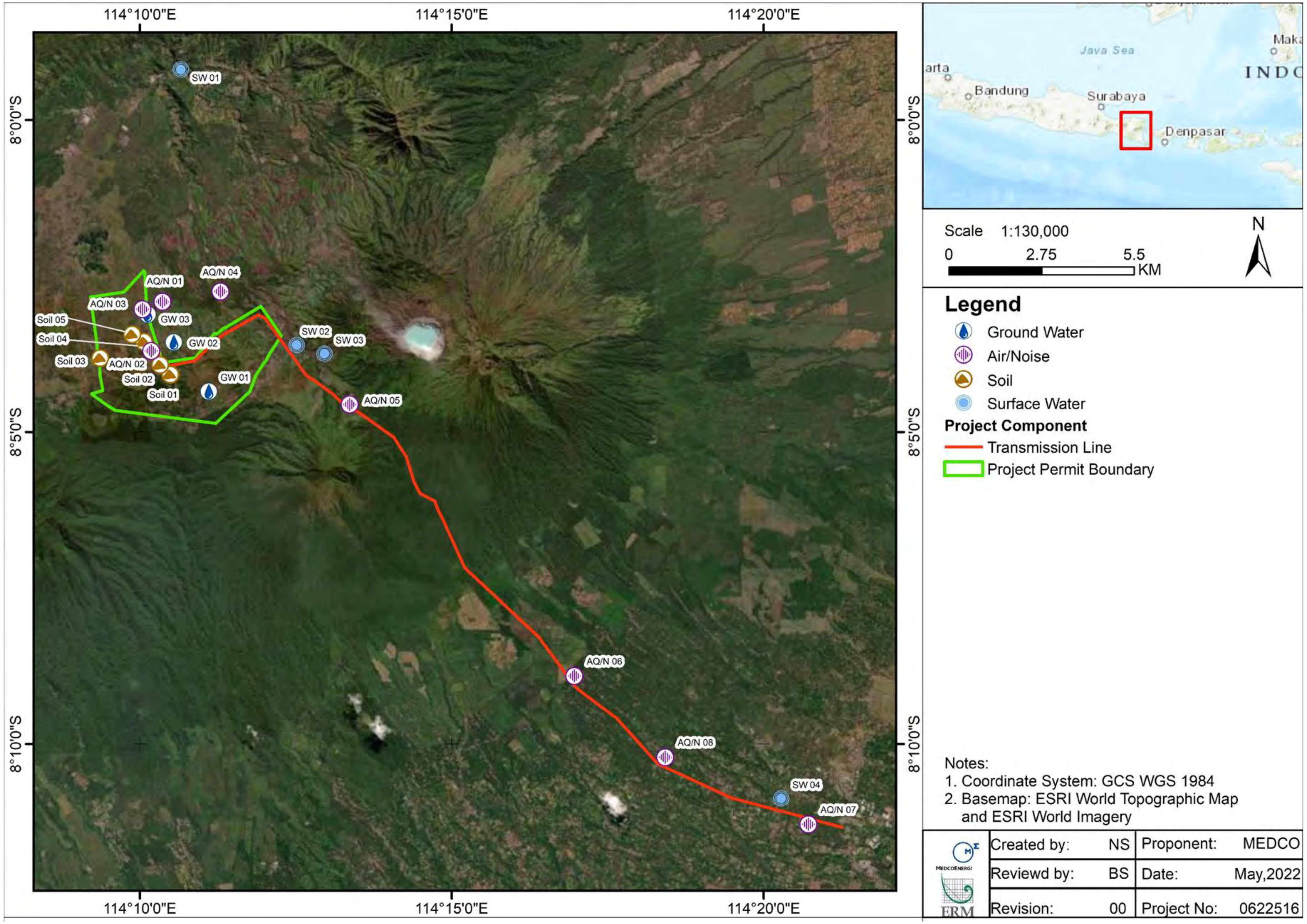
The key sources of information presented in describing the baseline of the Study Area are primary data collection, supplemented with data provided by the Project developer and secondary data such as a review of published and publicly available information. Primary environmental information was collected during February-March 2022, and the methodologies are provided in the relevant sections. Engagement with local communities (as outlined in ***Chapter 5***) was conducted to gather socio-economic data.

4.2 Physical Environmental Baseline

An environmental baseline within the Project AoI was determined based on a review of secondary sources and primary data collection. A desktop review of resources from government institutions and peer reviewed literature was conducted to obtain secondary data for environmental aspects including soil, geology, hydrology, drainage, and ecology. Primary data was collected though site observations and baseline sampling for land use, air quality, noise and surface water quality. The locations of the air, noise, water, and soil sampling are shown in ***Figure 4-1***.

A description of the baseline physical environment within the Project AoI is detailed in the sections below.

Figure 4-1: Physical Baseline Sampling Locations



4.2.1 Climate and Meteorology

The climate of Indonesia is determined mostly by its island structure and position astride the Equator. According to World Bank Group, Indonesia has almost entirely a tropical climate. The country's climate is hot and humid, with rainfall covering mostly in low-lying areas and mountainous regions experiencing cooler temperatures. Indonesia faces drier condition during El Nino events and wetter conditions during La Nina events. As Indonesia lies across the range of the Inter-Tropical Convergence Zone (ITCZ), heavy rainfall, severed local thunderstorms with variable intensities, strong ascending motion, overcast skies, and strong squalls are characteristics of this zone (World Bank Group, 2021).

In East Java, where the Project is located, there is a lot of rainfall in the wet season between November to April with an average annual rainfall is 1,900 mm and 100 days of rain. January is the wettest month, whereas May through October typically dry in which August is the driest month. The average temperature is between 19-34 degrees Celsius. The warmest month in East Java is October with an average maximum temperature of 22°C[1].

Monitoring data has been collected from various locations within the Project Area between in 2017 and 2021. This data includes temperature, humidity, wind speed, and wind direction. Data from 2021 is summarised in ***Table 4-1*** and provided in full in ***Appendix A***.

Table 4-1: Meteorological Monitoring Data (2021)

Stations	Sample results				Unit
	Area Well Testing (Area IJN 06)* (S:08°03'26.85" E:114°09'55.99")	Area Kawah Wurung* (S:08°03'40.35" E:114°10'13.05")	Area Dusun Curah Macan* (S:08°02'56.83" E:114°10'19.53")	Cluster IJEN 06** (S:08°03'25.79" E:114°09'54.44")	
	Jan – Jun 2021			Jul - Dec 2021	
Temperature	21.8	20.9	21.9	27.5	°C
Relative Humidity	80.2	68.2	67.8	47.7	%
Wind Direction (to)	140	90	210	South	°
Wind Speed	1.0-3.0	0.5-2.0	0.3-1.5	1.2	m/s
Weather	Cloudy	Cloudy	Cloudy	-	-
Air Pressure	757	757	757	840.5	mmHg

Source: Environmental Management and Monitoring Reports during 2017-2021

4.2.2 Ambient Air Quality

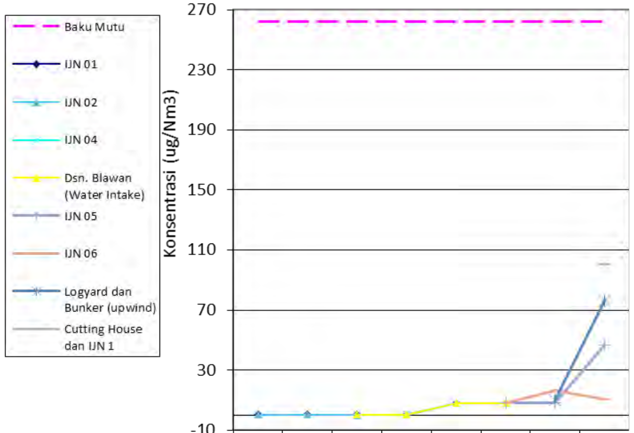
Air monitoring data has been collected in the Project Area from 2017 to 2021. The parameters sampled at each station include Sulphur Dioxide (SO_2), Carbon Monoxide (CO), Nitrogen Dioxide (NO_2), Ozone (O_3), Dust, Lead (Pb) Hydrogen Sulphide (H_2S), Ammonia (NH_3), and Hydrocarbon (HC).

[1] World Bank Group (2021), Climate change knowledge portal. Available from :
https://climateknowledgeportal.worldbank.org/country/indonesia/climate-data-historical
https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15504-Indonesia%20Country%20Profile-WEB_0.pdf

The results of the monitoring data are presented in the ***Appendix A*** in full and summarised in ***Figure 4-2*** and ***Figure 4-3***. All parameters were below the local regulatory limits (compared to Ambient Quality Standard: Gub Jatim No 10/2009).

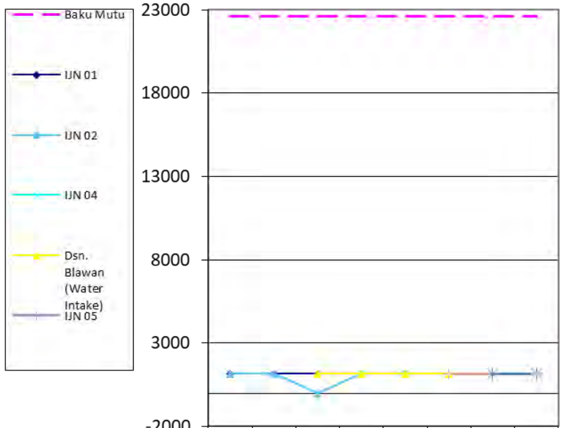
Figure 4-2: Measurements of SO2, CO, and HC (2017 to 2021)

Parameter SO2



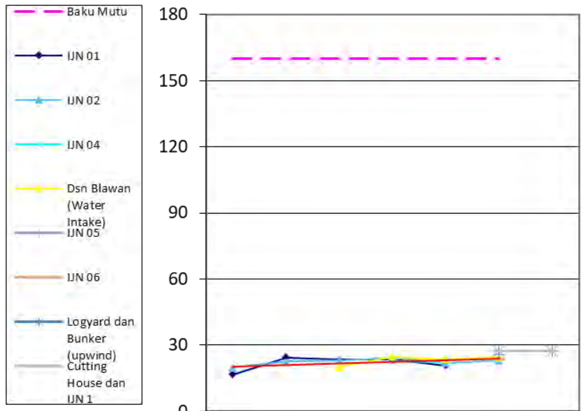
	S 1 '17	S 2 '17	S 1 '18	S 2 '18	S 1'19	S 2 '19	S 1 '20	S 2 '20
Baku Mutu	262	262	262	262	262	262	262	262
IJN 01	0.4	0.4	0.4	0.4	8.28			
IJN 02	0.4	0.4	0	0.4	8.28	8.28		
IJN 04				0.4	8.28			
Dsn. Blawan (Water Intake)			0.4	0.4	8.28	8.28		
IJN 05						8.28	8.28	46.5
IJN 06						8.28	16.6	10.6
Logyard dan Bunker (upwind)							9.82	76.1
Cutting House dan IJN 1								100.3

Parameter CO



	S 1 '17	S 2 '17	S 1 '18	S 2 '18	S 1'19	S 2 '19	S 1 '20	S 2 '20
Baku Mutu	22600	22600	22600	22600	22600	22600	22600	22600
IJN 01	1150	1150	1150	1150	1150			
IJN 02	1150	1150	0	1150	1150	1150		
IJN 04				1150	1150			
Dsn. Blawan (Water Intake)			1150	1150	1150	1150		
IJN 05						1150	1150	1150
IJN 06						1150	1150	1150
Logyard dan bunker (Upwind)							1150	1150
Cutting House dan IJN 1								1150

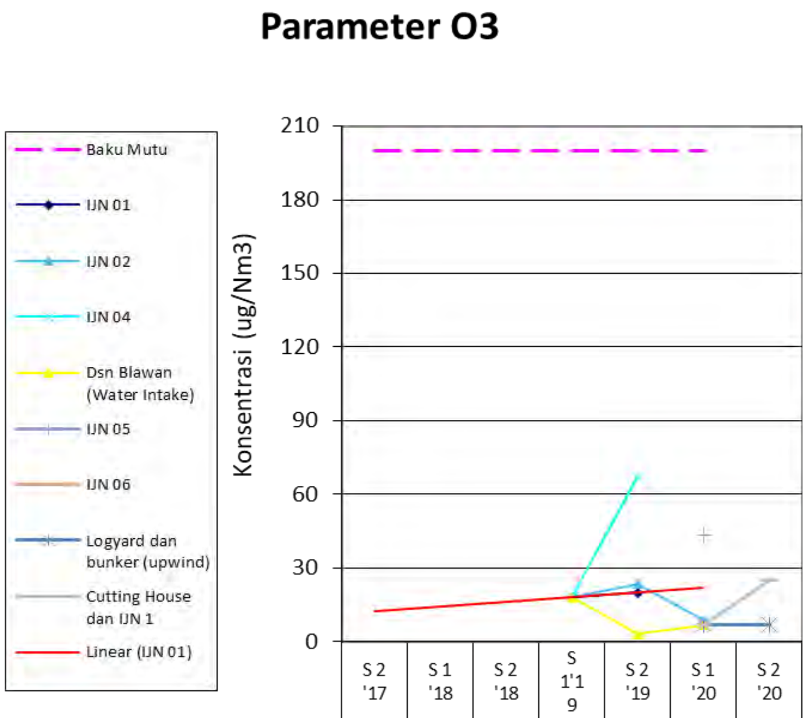
Parameter Hidrocarbon (HC)



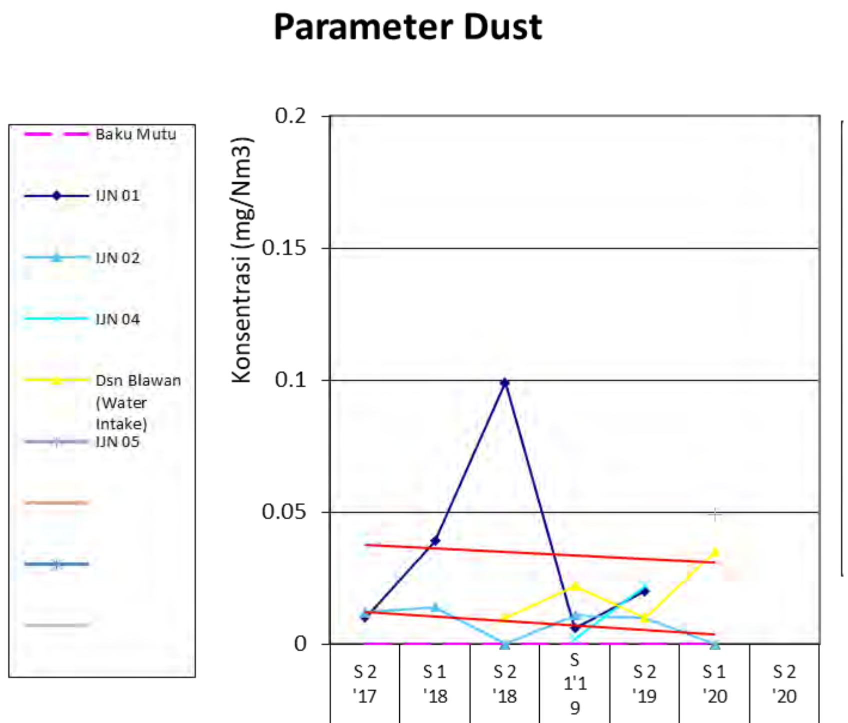
	S 2 '17	S 1 '18	S 2 '18	S 1'19	S 2 '19	S 1 '20	S 2 '20
Baku Mutu	160	160	160	160	160	160	
IJN 01	16.6	24.3	23.3	23.3	20.8		
IJN 02	19.7	22.6	23.2	24.3	21.9	22.9	
IJN 04				22.6	22.5		
Dsn Blawan (Water Intake)			20.2	24.7	23.5	24.6	
IJN 05						25.8	
IJN 06						23.6	
Logyard dan Bunker (upwind)						27.3	27.3
Cutting House dan IJN 1						27.3	27.3

Source: Environmental Management and monitoring reports during 2017-2021. The regulatory limit is shown in pink

Figure 4-3: Measurements of O3 and Dust (2017 to 2021)



	S 2 '17	S 1 '18	S 2 '18	S 1'19	S 2 '19	S 1 '20	S 2 '20
Baku Mutu	200	200	200	200	200	200	
IJN 01				18	19.9		
IJN 02				18	23.6	8.87	
IJN 04				18	66.9		
Dsn Blawan (Water Intake)				18	3.1	6.8	
IJN 05						43.5	
IJN 06						6.8	
Logyard dan bunker (upwind)						6.8	6.8
Cutting House dan IJN 1						6.8	25.1



	S 2 '17	S 1 '18	S 2 '18	S 1'19	S 2 '19	S 1 '20	S 2 '20
Baku Mutu	0	0	0	0	0	0	
IJN 01	0.01	0.039	0.099	0.006	0.02		
IJN 02	0.012	0.014	0	0.011	0.01	5E-06	
IJN 04				0.002	0.022		
Dsn Blawan (Water Intake)			0.0099	0.022	0.01	0.035	
IJN 05						0.049	

Source: Environmental Management and monitoring reports during 2017-2021. The regulatory limit is shown in pink

4.2.2.1 Updated Primary Air Quality Baseline Data Collection Methodology - 2022

Updated ambient air quality monitoring was carried out to determine the present baseline air quality condition in the vicinity of the project area location and within the project area of influence. The sample locations were chosen with the consideration of adjacent sensitive receptors within the Study Area to represent the background concentrations of the most sensitive conditions within the project area and project area of influence.

Ambient air quality sampling was carried out at eight (8) locations, including four (4) locations within 2.5 km of the Project Area for 72 hours continuously and four (4) locations along the transmission line area for 48 hours continuously. ERM engaged PT Karsa Buana Lestari (KBL), a nationally authorized local laboratory, to collect field data and analyze samples for air quality from 18 – 28 February 2022. The overview of sampling locations and measured substances are presented in ***Table 4-2*** and shown in ***Table 4-1***.

Table 4-2: Ambient Air Sampling Locations and Data Collection

Sample ID	Remarks	Sampling Location		Measurement Time	Measured Substances
		South	East		
AN-01	Nearest settlement to development area	08°02'54,60"	114°10'21,92"	72 hours continuous monitoring	Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Oxidant (O_3), particle <10 µm (PM_{10}), particle <2.5µm ($PM_{2.5}$)
AN-02	Intersect area between tourist area and development area	08°03'42,03"	114°10'11,12"		
AN-03	Well pad	08°03'02,01"	114°10'02,66"		
AN-04	Near community plantation area and Site main entrance	08°02'44,80"	114°11'17,78"		
AN-05	Main tourist entrance area to Ijen Crater near the transmission line	08°04'33,58"	114°13'21,92"	48 hours of continuous monitoring	
AN-06	Village near the transmission line	08°08'54,58"	114°16'58,10"		
AN-07	Village near the transmission line	08°11'17,14"	114°20'43,05"		
AN-08	Village near the transmission line	08°10'12,66"	114°18'25,52"		

Source: PT KBL Laboratory, Field Survey, February 2022

4.2.2.2 Primary Air Quality Baseline Data Collection Results

The result of the ambient air quality is presented in ***Table 4-3***. Ambient air quality sampling results were compared to the standard outlined in Government Regulation No. 22 of 2021 (GR 22/02021), Attachment VII (Ambient Air Quality Standard) and the WBG EHS Guidelines (as per ***Section 2.4***). The results of ambient air quality show that there were no parameters that exceeded the threshold levels based on WBG EHS or GR 22/2021. All parameters examined are present in low concentrations, thus indicating that the condition of ambient air quality is deemed to be relatively good (unpolluted).

Table 4-3: Ambient Air Quality Analytical Result

Parameter	Unit	Regulation Limit	WBG EHS (general)	Result							
				AN-01	AN-02	AN-03	AN-04	AN-05	AN-06	AN-07	AN-08
SO_2	μg/Nm³	75	125 (Interim target-1) 50 (Interim target-2) 20	40	44	32	54	57	44	44	45
NO_2	μg/Nm³	65	65	15	11	13	21	9	14	20	19
O_3	μg/Nm³	100	150	51	45	42	35	41	39	42	51
PM_{10}	μg/Nm³	75	50	13	15	14	14	14	17	27	26
$PM_{2.5}$	μg/Nm³	55	25	9	7	5	7	7	10	13	14

Source: PT KBL Laboratory, analysis results, March 2022

Note: Regulation limit based on Government Regulation No. 22 of 2021 (GR 22/2021), Attachment VII (Ambient Air Quality Standard)

The Project Area is located within an open land and plantation area which has good ambient air quality. The potential sources of existing air pollution are mainly derived from community activities (vehicle emissions) and dust particles from gravel-surface roads. Air quality contaminants (i.e., CO, NOx, and SO2) are generated from the burning of fossil fuels (gasoline and diesel) especially for transportation activities.

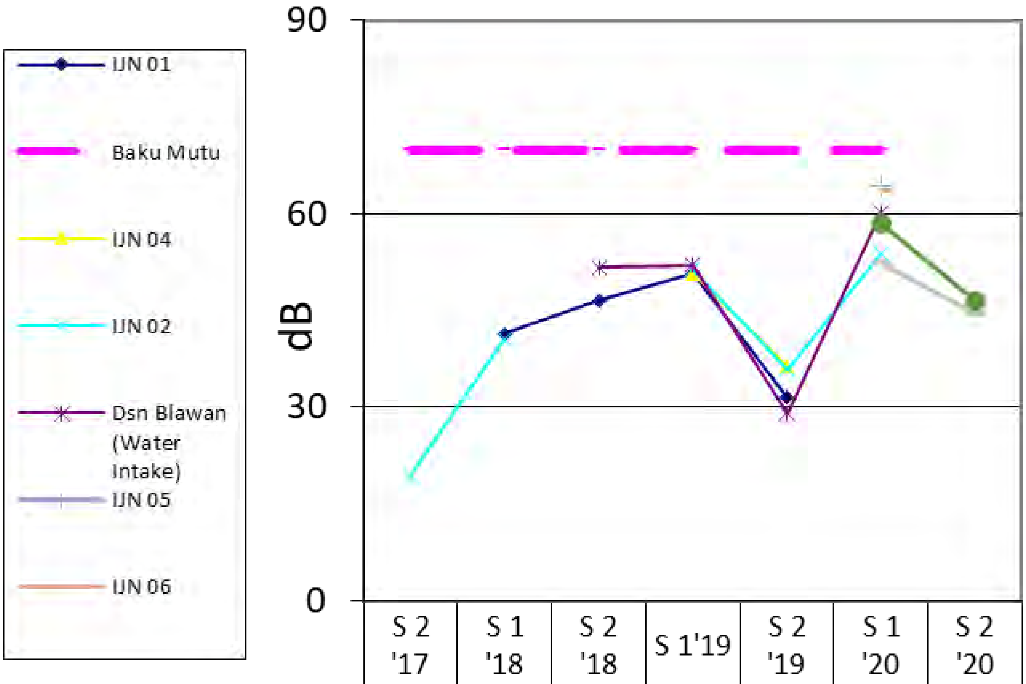
4.2.3 Ambient Noise

Management and monitoring Report of the Geothermal Exploration Wells Drilling Execution in Sempol Sub District in 2017 – 2021 by measuring several stations for noise level around the Project Area.

The results of the monitoring data are presented in the ***Appendix A*** and indicate that existing noise level is below the regulatory limit in all instances except in 2021, where noise at Area Well Testing (Area IJN 06) (S: 08°03’26.85" E: 114°09’55.99’’) exceeded 70 db.

Measurements of noise between 2017 and 2021 at the various Project locations are summarised in ***Figure 4-4***.

Figure 4-4: Measurements of Noise (2017 to 2021)



	S 2 '17	S 1 '18	S 2 '18	S 1'19	S 2 '19	S 1 '20	S 2 '20
IJN 01		41.5	46.6	50.7	31.5		
Baku Mutu	70	70	70	70	70	70	
IJN 04				50.7	36.4		
IJN 02	19.7	40.6		51.4	35.9	53.8	
Dsn Blawan (Water Intake)			51.7	52.1	29.1	60.2	
IJN 05						64.5	
IJN 06						63.7	
Logyard dan Bunker (upwind)						58.6	46.6
Cutting House dan IJN 1						52.4	44.6

Source: Environmental Management and monitoring reports during 2017-2021. The regulatory limit is shown in pink

4.2.3.1 Updated Primary Ambient Noise Baseline Data Collection Methodology - 2022

Noise sampling was conducted to determine the background noise condition around the Project Area as well as within the Project Area of Influence. The Project's activity has the potential to increase the surrounding noise level. Noise level measurement was conducted simultaneously with ambient air quality sampling i.e from 18 – 28 February 2022. Noise levels were measured for daytime and nighttime at selected locations. Noise sampling locations was carried out at eight (8) location for 48 hours continuously where the location was the same as the location of ambient air quality sampling (***Table 4-4***).

Table 4-4: 2022 Noise Level Result

Sample ID	Remarks	Measurement Time	Noise Level dB (A)		Noise Level Standard dB(A)[1]	WBG EHS Standards
			1st Day	2nd Day		
AN-01	Nearest residential development area	LAeq, daytime	63	55	55	55
		LAeq, nighttime	44	44		45
		Total LAeq	61	54		
AN-02	Intersect area between tourist area and development area	LAeq, daytime	44	46	70	55
		LAeq, nighttime	48	49		45
		Total LAeq	49	50		
AN-03	Well pad	LAeq, daytime	41	45	70	70
		LAeq, nighttime	46	44		70
		Total LAeq	47	47		
AN-04	Near plantation area and Medco main entrance	LAeq, daytime	58	59	50	55
		LAeq, nighttime	50	51		45
		Total LAeq	57	58		
AN-05	Main tourist entrance area to Ijen Crater near the transmission line	LAeq, daytime	47	53	70	55
		LAeq, nighttime	42	42		45
		Total LAeq	47	52		
AN-06	Village near the transmission line	LAeq, daytime	52	46	55	55
		LAeq, nighttime	44	50		45
		Total LAeq	52	51		
AN-07	Village near the transmission line	LAeq, daytime	57	49	55	55
		LAeq, nighttime	51	57		45
		Total LAeq	57	58		
AN-08	Village near the transmission line	LAeq, daytime	53	52	55	55
		LAeq, nighttime	50	50		45
		Total LAeq	54	54		

Source: PT KBL Laboratory, laboratory analytical report, March 2022

Note: [1] Noise Level Standard based on the Decree of the Minister of Environment (MoE) No.48 of 1996, Noise limit to regional allocations for: Settlement area : 55 dB(A), Industry: 70 dB(A), Tourist/Recreation area: 70 dB(A), Green area: 50 dB(A)

Documentation of sampling activities is presented in ***Figure 4-5***, while the sampling points are presented in ***Figure 4-1***.

Figure 4-5: Documentation of Ambient Air and Noise Sampling

Source: PT KBL Laboratory, Field survey, February 2022

4.2.3.2 Primary Ambient Noise Baseline Data Collection Results

Noise level results were compared to the standard outlined in the Decree of the Minister of Environment (MoE) No. 48 of 1996 and WBG EHS (as per ***Section 2.4***). The average one hour LAeq for daytime equivalent noise level was determined for the duration from 07.00 AM to 10.00 PM. Similarly, the mean nighttime noise level was recorded from 10.00 PM to 07.00 AM.

According to the noise level results in ***Table 4-4***, the noise at several noise sampling locations are still below the quality standard according to Kep.MENLH No. Kep.50/MENLH/11/1996 concerning Noise Level Standards. At points AN-01, AN-04 and AN-07 the noise level exceeds the noise level quality standard. The noise level in AN-01, the daytime noise level is 63 dB(A) on the 1st day of sampling, the noise level in AN-04 and AN-07 the total LAeq (daytime and nighttime) on the 1st and 2nd-day, noise levels are higher compared with the noise level limits to regional allocation for settlements. Villages along the transmission line (AN-06 to AN-08) all showed exceedances of noise level standards during night-time.

The acoustic environment of the areas crossed by the Project can be described as being typical of natural and rural areas. The existing sources of noise mostly came from community activities and transportation.

4.2.4 Land Use and Land Cover

The proposed main development area is located within an area of production forest that has been permitted for use for the Project from the local government.

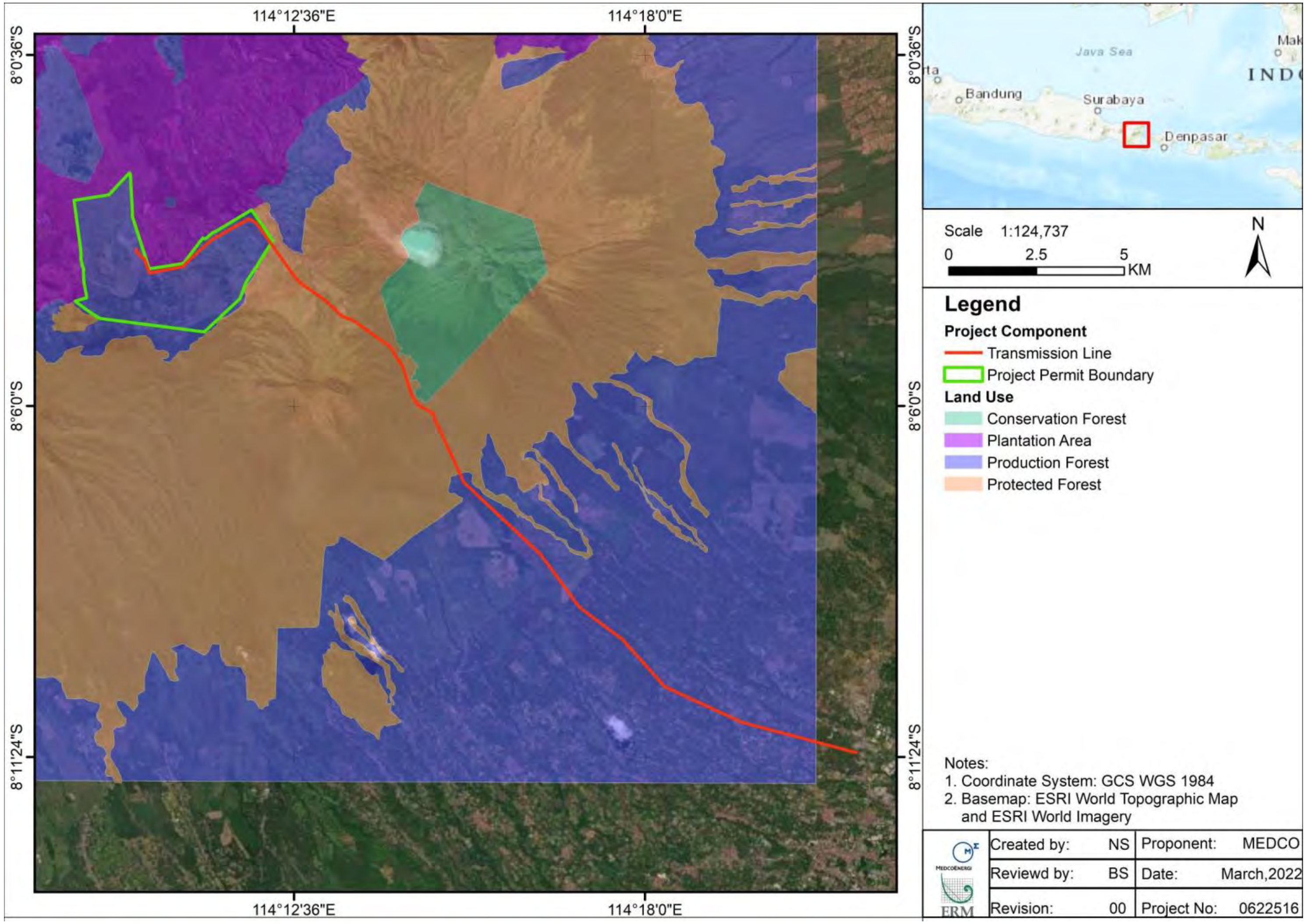
The transmission line runs through production forest and protection forest areas (***Figure 4-6***). It should be noted that Protection Forest under the Indonesian Forestry Law (No. 40/1999) is not classified as an IUCN management classification. Further details on the land use of the transmission line route are provided in ***Table 4-5***.

Table 4-5: Land Use of Transmission Line Route

Regency	Location	Tower	Length (km)	Remarks
Bondowoso	Forestry	23	7.9	
Banyuwangi	Forestry	24	8.2	
	Private Estate	7	2.3	Kalibendo Plantation
	Public/Local Land	29	9.8	Community Property
Total		**83**	**28.2**	

The proposed transmission line route is along the current access road to the sub-station. This does not overlap with the legally protected Kawah Ijen Nature Reserve.

Figure 4-6: Land Use and Land Cover with the Project AoI



4.2.5 Geology

According to the AMDAL document, the geological review of Bondowoso Regency indicates that its stratigraphy is composed of volcanic deposits from older Quaternary volcanoes (21.6%) and younger Quaternary volcanoes (62.8%). These deposits consist mainly of leucite, tuff, and sandstone (5.6%), alluvium (8.5%), and Mio-Pliocene sediment facies (1.5%) dominated by clay, silt, sandy silt, and fine sand (approximately 96.9%), and coarse sand, gravel, cobbles, and boulders (approximately 3.1%). The region is part of the Quartary volcanic mountain zone categorized within the Ringgit - Buser Mountain Complex, dominated by the deposits of younger Quaternary volcanic activities and intermountain sedimentation (Recent Volcanic Formation). The majority of Bondowoso Regency has Regosol soil covering 78,286 hectares in 23 sub-districts, while Andosol soil covers 32,859 hectares in 10 sub-districts, with the largest area found in Sempol sub-district

Based on the Geological Map of the Ijen Caldera Complex, East Java (Sitorus et al., 1988), the project site is located within the Kendeng Caldera, which erupted approximately 294,000 years ago. The Ijen area consists of the Pre-Caldera, Syn-Caldera, and Post-Caldera formations. The Pre-Caldera includes lava flows known as the Old Ijen Formation, the Syn-Caldera consists of ignimbrites, which are deposits of fallen or collapsed material from the stratovolcano, and the Post-Caldera represents the final volcanic phase formed by the activities of young volcanoes after the collapse of the stratovolcano that created the large caldera.

Ijen was designated as a UNESCO Global Geopark on 24 May 2023, at the 216th Executive Council meeting of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in Paris, France. A UNESCO Global Geopark must contain geology of international significance. It is independently evaluated by scientific professionals in the relevant discipline of Earth Science. UNESCO Global Geoparks are living, working landscapes where science and local communities engage in a mutually beneficial way. UNESCO Global Geoparks, within UNESCO’s International Geoscience and Geoparks Programme (IGGP), encourage international cooperation between areas with geological heritage of international value, through a bottom-up approach to conservation, local community support, promotion of heritage and sustainable development of the area. UNESCO Global Geoparks are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development. UNESCO Global Geoparks use geological heritage, in connection with all other aspects of that area’s natural and cultural heritage, to enhance awareness and understanding of key issues facing society in the context of the dynamic planet we all live on.

4.2.6 Soil

Data on soils has been collected for the Project. This confirms that the soil in the Project Area is classified medium (SD) to hard soil (SC) according to SNI-1726-2019 (Design Standard for Earthquake Resistance for Building and Non building Structure.

4.2.6.1 Primary Soil Baseline Data Collection Methodology

A soil quality survey was conducted to examine the current soil conditions in the Project area. The purpose of soil quality sampling is to determine soil fertility levels from the nutrient factors, organic parameters, and contamination level from the heavy metals contents in the soil quality. Soil samples for primary data has been collected in February 2022 within the study area boundary from five (5) locations mainly in the area of well pads as shown in ***Table 4-6*** and ***Figure 4-1***.

Soil samples were taken from low layers or rooting layers using a Belgian soil drill (auger) at depths of 0-20 cm. Prior to sampling, the soil surface is cleaned from remnants of litter or organic materials. Soil samples were stored into plastic bags and labelled with sampling codes, sample numbers, sample origins and sampling date. The soil samples were then delivered to an accredited environmental laboratory to be analysed for its soil physical, chemical and organic properties.

Table 4-6: Soil Sampling Locations

No	Planned coordinate of the Location Sampling		Rationale
	East	South	
Soil -01	E: 114°10'29,59"	S: 08°04'04,79"	Well pad area
Soil -02	E: 114°10'19,89"	S: 08°03'55,48"	Well pad area
Soil -03	E: 114°09'22,08"	S: 08°03'48,94"	Well pad area
Soil -04	E: 114°10'04,26"	S: 08°03'33,36"	Well pad area
Soil- 05	E: 114°09'53,02"	S: 08°03'26,11"	Well pad area

4.2.6.2 Primary Soil Baseline Data Collection Results

The analysis results for the soil samples were compared to the standard quality referring to the United State of Environmental Protection Agency (U.S. EPA), since there is no national regulation applied for these matters. The parameters analysed and results are shown in ***Table 4-7***.

Table 4-7: Soil Quality

No.	Parameter	Unit	S 01	S 02	S 03	S 04	S 05	Threshold*
Metals								
1	Total Chromium (Cr)	mg/L	1	1	1	1	1	50
2	Cadmium (Cd)	mg/L	1	1	1	1	1	34
3	Arsenic (As)	mg/L	2	4	2	2	1	10
4	Lead (Pb)	mg/L	1	3	1	1	1	400
5	Mercury (Hg)	mg/L	5	1	1	1	1	610
6	Copper (Cu)	mg/L	17	26	15	15	22	2500
7	Iron (Fe)	mg/L	7.81	9.61	7.50	9.43	10.61	-
8	Manganese (Mn)	mg/L	246	197	246	229	325	-
Other								
9	VCOs (s)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-
10	Semi-volatile Organic Compounds (SVOCs) (s)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-
11	BTEX (s)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	-
12	Phenol	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	2500
13	Total Petroleum Hydrocarbons (TPHs)	mg/L	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	-
14	Poly-Aromatic Hydrocarbons (PAHs)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-
15	Polychlorinated biphenyl (PCBs)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	1
16	Organochlorine (s)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-
17	OrganoPhosphate (s)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	-
18	Pesticide (s)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-

Source : KBL Laboratory Analysis Results
**) United State of Environmental Protection Agency (U.S. EPA), 1993, BTEX = benzene, toluene, ethylbenzene and xylene*

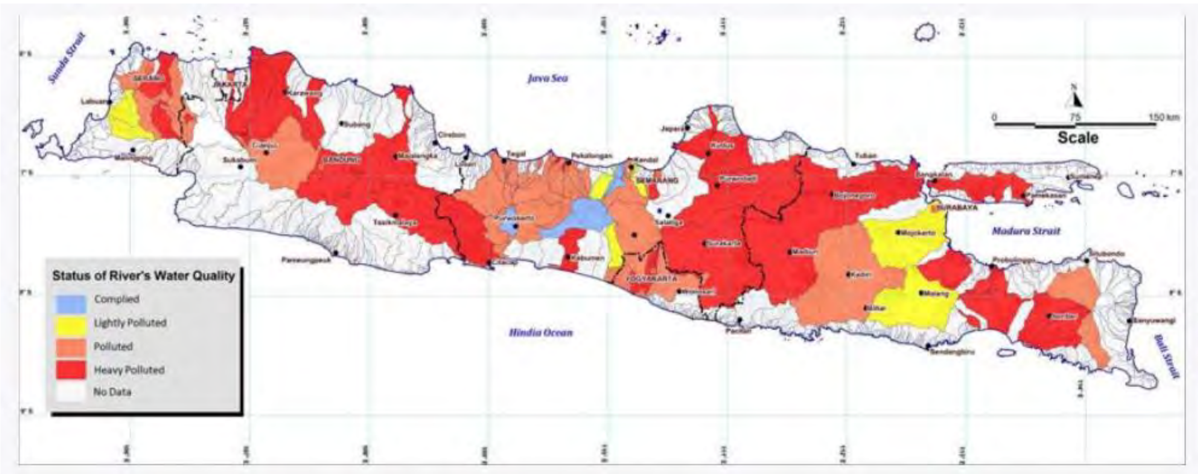
Heavy metal contamination of soil is one of the most important environmental problems. The ability of heavy metals to accumulate and cause toxicity in biological systems – humans, animals, microorganisms and plants has been reported. As chemical hazards, heavy metals are non-biodegradable and can remain almost indefinitely in the soil environment. The adequate protection and restoration of the soil ecosystems, therefore, require the characterization and remediation of soils that are contaminated with heavy metals (Wuana et al. 2010).

The sampling locations for all five samples are located in the existing and future well pad area in the within project site. All metals, pesticides, PCB, and Total Petroleum Hydrocarbon contained in the soil are under the regulation limit and present in low concentrations suggesting limited soil contamination in the Project Area.

4.2.7 Surface Water

According to AoI, the status of water quality is shown as no data in that area. However, the surface water in most parts of Java Island is evaluated as “highly polluted” with most remaining islands being evaluated as “lightly polluted” (***Figure 4-7***) (Statistical Year Book of Indonesia, 2020).

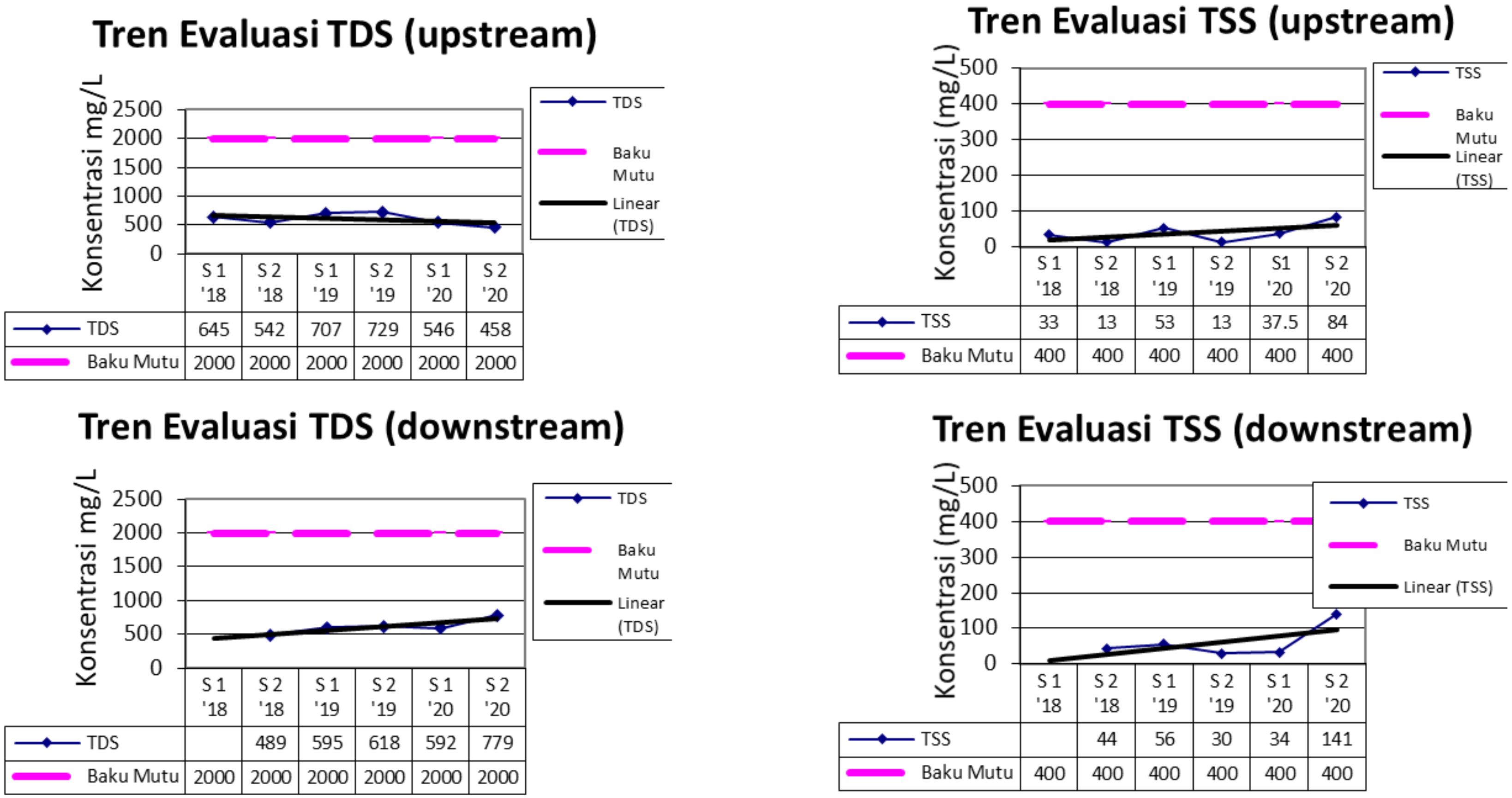
Figure 4-7: Java River Water Quality Status



Source: Ministry of Environment. Status Lingkungan Hidup (State of the Environment) Indonesia 2012

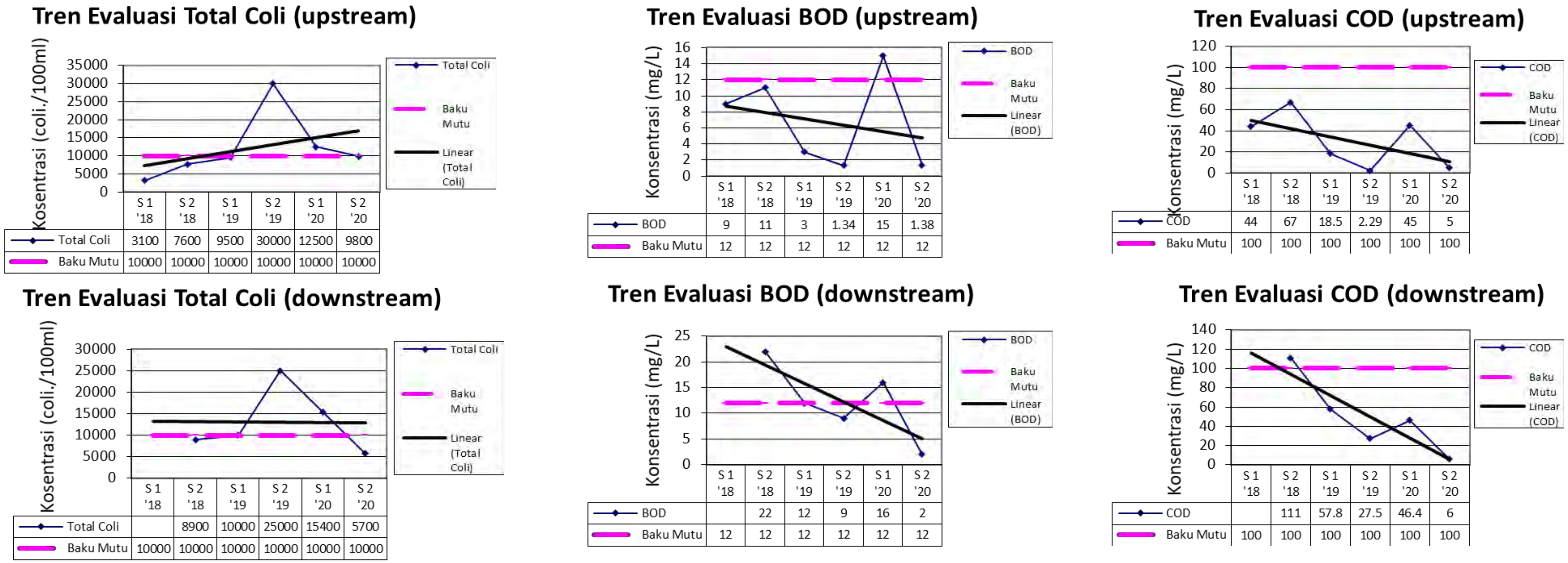
Surface water monitoring was conducted at a stream within the Project Area at upstream and downstream locations from the Project between 2017 and 2021. The results of the surface water monitoring show that the majority of parameters tested are within the Surface Water Quality Standards (PP RI No 82/2001). Elevated levels of chemical oxygen demand (COD) and biological oxygen demand (BOD) were reported which may be due to traditional farm and local agricultural practises (such as pesticide residue, etc.). Measurements of surface water between 2017 and 2021 at the various Project locations are summarised in ***Figure 4-8*** and ***Figure 4-9***. Full results are provided in ***Appendix A***.

Figure 4-8: Surface Water Quality Monitoring for Total Dissolved Solids and Total Suspended Solids (2017 to 2021)



Source: Environmental Management and monitoring reports during 2017-2021. The regulatory limit is shown in pink

Figure 4-9: Surface Water Quality Monitoring for E Coli, BOD, COD (2017 to 2021)



Tren Evaluasi Total Coli (upstream)

	S 1 '18	S 2 '18	S 1 '19	S 2 '19	S 1 '20	S 2 '20
Total Coli	3100	7600	9500	30000	12500	9800
Baku Mutu	10000	10000	10000	10000	10000	10000

Tren Evaluasi BOD (upstream)

	S 1 '18	S 2 '18	S 1 '19	S 2 '19	S 1 '20	S 2 '20
BOD	9	11	3	1.34	15	1.38
Baku Mutu	12	12	12	12	12	12

Tren Evaluasi COD (upstream)

	S 1 '18	S 2 '18	S 1 '19	S 2 '19	S 1 '20	S 2 '20
COD	44	67	18.5	2.29	45	5
Baku Mutu	100	100	100	100	100	100

Tren Evaluasi Total Coli (downstream)

	S 1 '18	S 2 '18	S 1 '19	S 2 '19	S 1 '20	S 2 '20
Total Coli		8900	10000	25000	15400	5700
Baku Mutu	10000	10000	10000	10000	10000	10000

Tren Evaluasi BOD (downstream)

	S 1 '18	S 2 '18	S 1 '19	S 2 '19	S 1 '20	S 2 '20
BOD		22	12	9	16	2
Baku Mutu	12	12	12	12	12	12

Tren Evaluasi COD (downstream)

	S 1 '18	S 2 '18	S 1 '19	S 2 '19	S 1 '20	S 2 '20
COD		111	57.8	27.5	46.4	6
Baku Mutu	100	100	100	100	100	100

Source: Environmental Management and monitoring reports during 2017-2021. The regulatory limit is shown in pink

4.2.7.1 Updated Primary Surface Water Baseline Data Collection Methodology - 2022

Surface water quality is a critical component of the biological and physical environment, hence a change in surface water quality could adversely affect other valued ecosystem components (VECs) such as fish and fish habitat, aquatic resources, wildlife and wildlife habitat, groundwater quality, and human health.

Sampling was conducted in February 2022 at 4 (four) near the Project area, representing the upstream and downstream of Kalipait River (SW2, SW3), Kelomprit River (SW1), and Sengon River (SW4). The sampling points are presented in ***Table 4-8*** and shown in ***Figure 4-1***.

Table 4-8: Sampling Location of Surface Water Quality

No	Coordinates of the Sample Locations		Rationale
	East	South	
SW1	E: 114°10'39,56"	S: 07°59'11,30"	To measure baseline condition of water intake for project operations (Sengon river)
SW2	E: 114°12'31,11"	S: 08°03'36,32"	To measure baseline condition on the downstream of Kalipait, the direct crater flow of Mount Ijen
SW3	E: 114°12'57,78"	S: 08°03'44,59"	To measure baseline condition on the upstream of Kalipait, the direct crater flow of Mount Ijen
SW4	E: 114°20'16,95"	S: 08°10'52,26"	To measure baseline condition of surface water near the proposed transmission line (Kelomprit river)

Surface water samples from each location were tested for parameters including physical parameters, chemical, and microbiology. The sampling water was analysed by an accredited laboratory (KBL Laboratory) with the results compared to the parameters contained in surface water quality standards. These standards refer to Government Regulation No. 22 of 2021 on Environmental Protection and Management.

4.2.7.2 Updated Primary Surface Water Baseline Data Collection Results

The surface water quality for SW1 and SW4 mostly meet the threshold according to Government Regulation (except for biological oxygen demand (BOD), while there are a number of parameters in SW2 and SW3 that exceed the thresholds. ***Table 4-9*** presents the results of measurements of surface water quality and more information on the results is provided in the following sections.

Table 4-9: Surface Water Quality Results

Parameter	Unit	Result				Threshold*)
		SW1	SW2	SW3	SW4	
Physical properties						
Temperature	°C	22.5	20.5	20.0	25.0	Deviation 3
Total Dissolved Solid (TDS)	mg/L	530	52.12	52.32	122	1,000
Total Suspended Solid (TSS)	mg/L	38	116	170	18	50
Colour	Pt-Co Unit	< 2	23	27	< 2	50

Parameter	Unit	Result				Threshold*)
		SW1	SW2	SW3	SW4	
Chemical properties						
pH	-	8.0	< 0.01	< 0.01	7.1	6 - 9
BOD (5 Day 20°C)	mg/L	11	858	1,093	9	3
COD	mg/L	27	1,785	2,332	20	25
DO	mg/L	4.0	2.2	2.2	4.1	4
Sulphate (SO42-)	mg/L	112	614	330	68	300
Chloride (Cl-)	mg/L	89	10,998	10,998	5	300
Nitrate as N (NO3-N)	mg/L	3	0.04	0.1	1	10
Nitrite as N (NO2-N)	mg/L	0.04	0.01	0.01	0.01	0.06
Ammonia (NH3-N)	mg/L	0.3	2.8	1.4	0.2	0.2
Total Phosphate as P	mg/L	0.3	0.01	0.01	0.01	0.2
Fluoride (F-)		0.8	0.9	1.1	0.8	1.5
Barium (Ba)	mg/L	0.02	0.04	0.04	0.01	-
Boron (B)	mg/L	0.3	16	18	0.05	1.0
Arsenic (As)	mg/L	< 0.004	1	1	< 0.004	0.05
Selenium (Se)	mg/L	< 0.003	0.03	0.05	< 0.003	0.05
Iron (Fe)	mg/L	0.03	0.3	0.3	0.3	-
Cadmium (Cd)	mg/L	< 0.001	0.1	0.1	< 0.001	0.01
Cobalt (Co)	mg/L	< 0.004	0.3	0.3	< 0.004	0.2
Manganese (Mn)	mg/L	0.03	15	17	0.1	-
Nickel (Ni)	mg/L	< 0.011	0.1	0.1	< 0.011	0.05
Zinc (Zn)	mg/L	< 0.003	2	2	0.02	0.05
Copper (Cu)	mg/L	0.004	0.4	0.5	0.004	0.02
Chromium Hexavalent (Cr6+)	mg/L	< 0.016	0.04	0.1	0.01	0.05
Nitrogen Total (s)	mg/L	3,6	2.9	3.4	3.6	15
Sulphur, as H2S **	mg/L	0.005	0.004	< 0.002	0.006	0.002
Cyanide (CN-) **	mg/L	0.004	< 0.002	< 0.002	< 0.002	0.02
Free Chlorine (Cl2) **	mg/L	0.03	< 0.02	< 0.02	0.02	0.03
Mercury (Hg) **	mg/L	< 0.0001	0.01	0.01	< 0.0001	0.002
Lead (Pb) **	mg/L	< 0.009	1	1	< 0.009	0.03
Oil and Grease **	mg/L	1	4	4	1	1
Surfactant Anionic (MBAS) **	mg/L	< 0.013	3.1	3.2	0.1	0.2
Phenol **	mg/L	< 0.002	0.009	0.011	< 0.002	0.005
Aldrin/ Dieldrin (s)	μg/L	< 0.01	< 0.01	< 0.01	< 0.01	-
BHC (s)	μg/L	7,6	8,8	8,1	7,5	210
Chlordane (s)	μg/L	< 0.01	< 0.01	< 0.01	< 0.01	-

Parameter	Unit	Result				Threshold*)
		SW1	SW2	SW3	SW4	
DDT (s)	µg/L	< 0.02	< 0.02	< 0.02	< 0.02	2
Endrin (s)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	4
Heptachlor (s)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	-
Lindane (s)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	-
Methocychlor (s)	µg/L	< 0.02	< 0.02	< 0.02	< 0.02	-
Toxaphane (s)	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	-
Microbiology						
Faecal coliform	MPN/100 mL	39,980	14,775	18,450	38,790	1000
Total Coliform	MPN/100 mL	86,220	32,340	40,400	84,500	5000

*Notes: *) Government Regulation No. 22 of 2021 (Attachment VI.I, Class II)*

The parameters tested were differentiated based on the following categories:

Category 1: Physical Parameters (including dissolved metals)

Four physical parameters analysed in surface water samples included Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Turbidity, and Temperature. Temperature was measured in-situ whereas TSS, TDS and Turbidity were sent to the KBL laboratory for analysis. Based on the laboratory results, TSS and TDS in sampling points SW2 and SW3 were found to exceed the standards. The increase in turbidity is most likely caused by rains that occurred several hours before sampling. TSS parameters at other sample points were in accordance with the quality standards.

In the natural condition, TSS can include a wide variety of materials, such as silt, decaying plants and animal matter. High concentrations of suspended solids can cause many problems for stream health and aquatic life, such as the abrasion of gills that can be severe (Shah *et al* 2015).

The presence of suspended particles greatly influences the dissolved oxygen (DO) present in the water. The sunlight absorbed by the suspended particles, increases the water temperature. This in turn reduces the oxygen holding capacity of the warm water and disturbs the cold-water species. This may explain the low DO parameter in SW2 and SW3, as high concentrations of TSS were detected in these sampling points.

There were 13 parameters of dissolved metals in surface water tested in the laboratory; Chromium Hexavalent, Arsenic (As), Barium (Ba), Boron (B), Cadmium (Cd), Cobalt (Co), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Selenium (Se), Zinc (Zn), and Mercury (Hg). Of the thirteen parameters, seven parameters exceeded the quality standard, namely the Boron, Arsenic, Cadmium, Cobalt, Nickel, Zinc, and Copper at point SW 2 and SW 3 (Kalipait River). This high concentration of dissolved metals in these two-sampling location might be because of the natural volcanic activity in Kawah Ijen which might produce metals as the product, as this river is a direct crater flow from Kawah Ijen.

Category 2: Chemical (Anions, Organics, Nutrients, Pesticides)

The six chemical-anions that were analysed in surface water samples included pH, residual chlorine, fluoride, chloride, sulphate, and unionize sulphide. pH and residual chlorine was measured in-situ whereas the remaining parameters were sent to KBL laboratory for analysis.

Test results indicate that almost all chemical-anions parameters in surface water in SW2 and SW3 exceeded the quality standards. Sulphate and Chloride at SW2 and SW3 exceeded the quality standard for surface water. This high parameters confirm that the Kawah Ijen crater flow have the characteristic of water to be acidic (as shown in results with a highlight acidic pH value). SW1 and SW4 were within the pH standards.

A pH of 7 is considered to be neutral and as acidity increases the pH value decreases (with alkalinity increasing the pH value). The pH of water affects the solubility of many toxic and nutritive chemicals; therefore, the availability of these substances to aquatic organisms is affected. As acidity increases, most metals become more water soluble and more toxic. Toxicity of cyanides and sulphides also increases with a decrease in pH (increase in acidity). Ammonia, however, becomes more toxic with only a slight increase in pH.

Nutrients are an important indicator of surface water quality because inorganic nitrogen (nitrate and ammonia) and phosphorus control the growth of aquatic plants. Excessive growth of aquatic plants can cause dissolved oxygen concentrations in streams to decrease during the night to levels that may not sustain certain species of fish. Excess nitrates in drinking water can also cause adverse effects in human and animal health.

Nutrient parameters analysed in surface water samples included Ammonia, Nitrate, Nitrite, and Total Phosphate. Cyanide parameters analysed included Cyanide (Total) in surface water samples. Most all nutrient and cyanide parameters in wet season were below quality standards as compared to the environmental quality standards, except for high Ammonia in SW 2 and SW3.

There are six (6) organic parameters measured in the surface water samples. These are Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen, Oil and Grease, Surfactant, and Total Phenol. In the wet season, all four BOD water sample points, two COD in SW2 and SW3, two oil and grease, surfactant, and phenol in SW2 and SW3 water sample point exceeded the quality standard. The quality standard for BOD is 3 mg/L and the quality standard for COD is 25 mg/L. S2 and SW 3 exceeded the standards for COD, detected at 1,785 mg / L, and 2,332 mg / L respectively. Exceedance of oil and grease water quality standard was found at SW2 and SW3 with value of 4 mg/L of 1 mg/L threshold. Exceedances of BOD water quality standards were found at SW2 and SW 3 with a BOD value of 858 mg/L and 1,093 mg / L, respectively. The high BOD and COD levels at SW2 and SW3 could occurred because of the higher organic compounds content in the water, other than microorganism content. All other parameters in SW1 and SW4 met the quality standards.

Microorganisms such as bacteria are responsible for decomposing organic waste. When organic matter such as dead plants, leaves, grass clippings, sewage, or even food waste is present in a water body, the bacteria will begin the process of breaking down this waste. When this happens, aerobic bacteria, robbing other aquatic organisms of the oxygen they need to live, consume much of the available dissolved oxygen.

BOD is a measure of the oxygen used by microorganisms to decompose this waste. If there is a large quantity of organic waste (sourced from e.g., natural, or man-made) in the water supply, there will also be bacteria present working to decompose this waste. In this case, the demand for oxygen will be high (due to all the bacteria) and therefore the BOD level will be high. As the waste is consumed or dispersed through the water, BOD levels will begin to decline.

Nitrates and phosphates in a body of water can contribute to high BOD levels too. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. This results in a high BOD level. When BOD levels are high, dissolved oxygen (DO) levels decrease because the bacteria are consuming the oxygen that is available in the water. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive.

Total Pesticides parameters that were analysed included Aldrin, Total BHC, gamma-BHC (Lindane), Chlordane, Dieldrin, 4-4 DDT, Endrin, Heptachlor, Methoxychlor, and Taxiplane. The laboratory result for wet season shows all parameters of total pesticides contained in surface water are under the regulation limit.

Category 3: Microbiology

Microbiology parameters analysed in surface water samples were faecal coliform, and total coliform. The results of laboratory tests for sampling points showed that almost all of the faecal coliform and total coliform values for the four sampling points (SW1, SW2, SW3, SW4) exceeded the predetermined quality standard (1000 MPN / 100mL for Faecal Coliform and 5000 MPN / 100mL for Total Coliform). All four-sampling point exceeded the standard by ten folds of the value sets on the regulation. This is likely due to the river use by local people (discharging domestic effluent and using for sanitation purposes, brown and black water waste disposal and waste disposal from cow livestock that found in most of the residential areas near the project).

The levels of coliform bacteria in surface water are influenced by several environmental factors. Externally, the surrounding land use pattern and the occurrence of storm water runoff are two major external factors causing microbiologically water quality degradation in surface water (Kistemann et al., 2002; Tong and Chen, 2002; George et al., 2004).

Internally, the physio-chemical and biological conditions also play an important role in controlling the coliform bacteria (Curtis et al., 1992; Davies et al., 1995). The coliform decay rate often increases with elevated water temperature, pH and nutrient scarcity as well as the increasing predation and parasitism (Flint, 1987; Curtis et al., 1992; Davies et al., 1995). In addition, the survival of coliform bacteria can be prolonged or they can sometimes even grow under certain environmental conditions such as proper pH, proper temperature, rich nutrients and abundant suspended particles (Davies et al. 1995; LeChevallie 2003; Juhna et al. 2007).

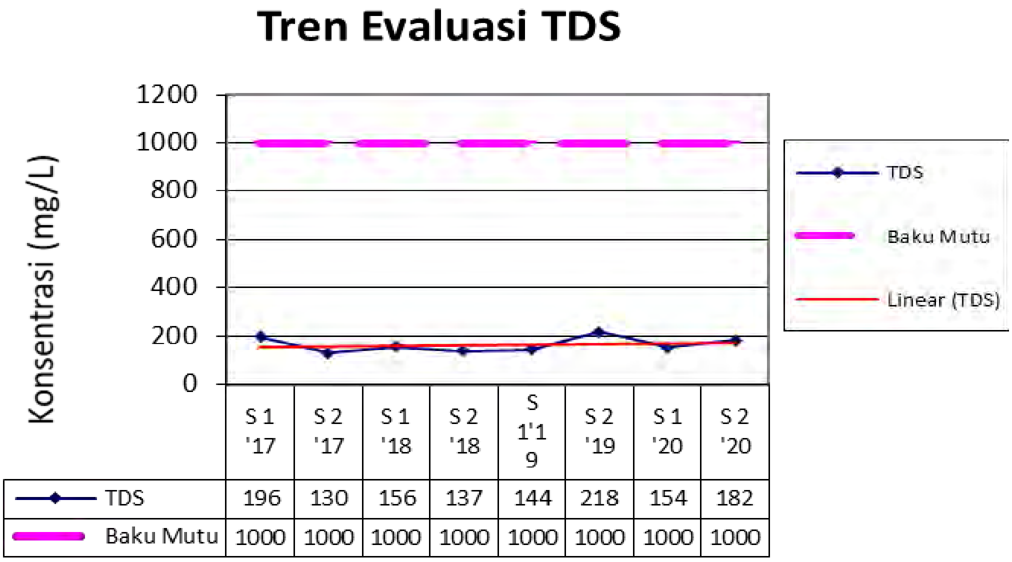
4.2.8 Groundwater

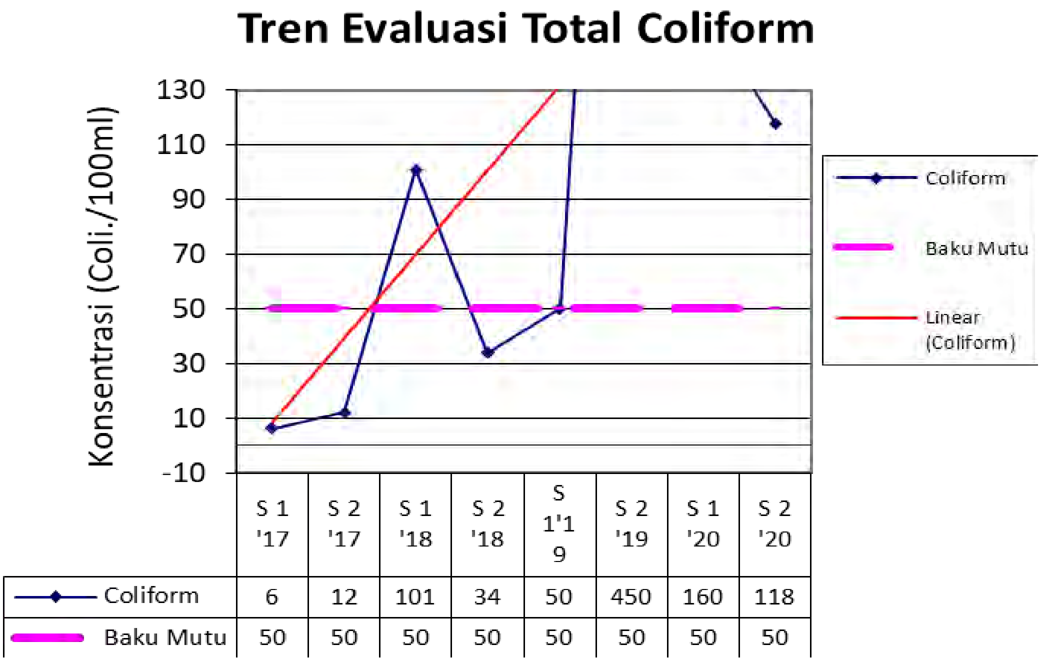
The most productive groundwater basins can be found toward the north of Java and Sumatera, and toward the south of Kalimantan and Sulawesi. Deep groundwater is overexploited in most urbanized areas. This causes rapid drawdown of the groundwater table and land subsidence. Serious impacts are felt in North Jakarta, Bandung, and Semarang (Fulazzaky, 2014).

High levels of chemical contamination were detected in most well especially in the special capital region of Jakarta (Fulazzaky, 2014). In Jakarta, 45% of groundwater had been contaminated by faecal coliform and 80% by Escherichia coli (Indonesia Country Water Assessment, 2016). Major sources of groundwater pollution are septic tank contamination, discharges of untreated domestic wastewater, leachate from landfill, and industrial effluent contamination.

Groundwater monitoring was conducted at a stream within the Project Area at upstream and downstream locations from the Project between 2017 and 2021. The results of the surface water monitoring show that the majority of parameters tested are within the Groundwater Quality Standards (Per Men LHK No 32/2017). The results showed that total coliform exceed by quality standard (***Figure 4-10***) which may be due to the lack of wastewater treatment in neighbouring communities and human and animal faeces/waste from traditional farm and plantation fertilizer.

Figure 4-10: Groundwater Quality Standards for Total Dissolved Solids and Total Coliform (2017 to 2021)





Source: Environmental Management and monitoring reports during 2017-2021. The regulatory limit is shown in pink

4.2.8.1 Updated Primary Groundwater Baseline Data Collection Methodology - 2022

Shallow groundwater quality data was obtained via primary data. Shallow groundwater samples (community spring water) were collected in villages nearby the project location in 3 (three) sampling points (***Table 4-10***).

Table 4-10: Sampling Location of Shallow Groundwater

No	Planned coordinate of the Location Sampling		Rationales for sampling
	East	South	
GW-01	E: 114°11'06,44"	S: 08°04'21,04"	Location of the spring water used by community
GW-02	E: 114°10'32,80"	S: 08°03'33,64"	Location of the spring water used by community
GW-03	E: 114°10'07,72"	S: 08°03'06,93"	Location of the spring water used by community, near settlement NE of the project area

The local community around the Project use groundwater as a source of drinking water and other sanitary needs. Ground water samples were taken in three (3) sampling location points (GW1, GW2, and GW3) that mainly in the form of spring water near the project area (***Figure 4-1***:) with a total of 32 parameters used as references of contamination in ground water. Two of the thirty parameters were tested in situ at the sampling location and included temperature and pH. The samples were taken in February 2022.

4.2.8.2 Primary Groundwater Baseline Data Collection Results

The analysis results for the groundwater samples were compared to the standard quality referring to the Regulation of the Health Ministry of Republic of Indonesia No. 32 Year 2017 concerning Environmental Quality Standards for Environmental Health Requirements. The analysis is shown in ***Table 4-11***.

Table 4-11: Ground Water Quality

Parameter	Unit	Result			Threshold*)
		GW1	GW2	GW3	
Physical properties					
Turbidity	NTU Scale	< 0.5	< 0.5	< 0.5	25
Temperature	°C	19.0	19.0	19.0	Air temperature ± 3°C
Conductivity	µmhos/cm	307	314	325	-
Salinity **	‰	< 2	< 2	< 2	-
Chemical properties					
pH	-	7.7	7.9	7.8	6.5 - 8.5
BOD (5 Day 20°C) **	mg/L	7	5	7	-
COD	mg/L	12	10	14	-
DO **	mg/L	4.1	4.0	4.0	-
Sulphur, as H2S **	mg/L	< 0.005	< 0.005	< 0.005	-
Oxidation Reduction Potential (s)	mg/L	-12	-14	12	-
Total Phosphate as P	mg/L	0.1	0.1	0.1	-
Fluoride (F-)	mg/L	0.2	0.3	0.8	1.5
Nitrogen Total (s)	mg/L	1,6	1,8	1,4	-
Ammonia (NH3-N)	mg/L	0.02	0.05	0.04	-

Parameter	Unit	Result			Threshold*)
		GW1	GW2	GW3	
Cyanide (CN-) **	mg/L	< 0.002	0.004	< 0.002	0.1
Free Chlorine (Cl2) **	mg/L	< 0.02	< 0.02	< 0.02	-
Arsenic (As)	mg/L	< 0.004	< 0.004	0.005	0.05
Total Chromium (Cr) **	mg/L	< 0.010	< 0.010	< 0.010	-
Zinc (Zn)	mg/L	< 0.003	< 0.003	< 0.003	15
Cadmium (Cd) **	mg/L	< 0.001	< 0.001	< 0.001	0.005
Selenium (Se)	mg/L	< 0.003	< 0.003	< 0.003	0.01
Lead (Pb) **	mg/L	< 0.008	< 0.008	< 0.008	0.05
Copper (Cu)	mg/L	0.003	0.004	0.004	-
Nickel (Ni)	mg/L	< 0.009	< 0.009	< 0.009	-
Iron (Fe)	mg/L	< 0.016	< 0.016	< 0.016	1
Silver (Ag) **	mg/L	< 0.005	< 0.005	< 0.005	-
Chromium Hexavalent (Cr6+)	mg/L	< 0.015	< 0.015	< 0.015	0.05
Boron (B)	mg/L	0.03	< 0.013	0.03	-
Mercury (Hg) **	mg/L	< 0.0001	< 0.0001	< 0.0001	0.001
Phenol **	mg/L	< 0.002	< 0.002	< 0.002	-
Oil and Grease **	mg/L	0.3	0.2	0.3	-
Microbiological properties					
Total Coliform **	CFU/100 mL	0	53	41	50
Others					
VOCs (s)	μg/L	< 2	< 0.5	< 0.5	-
SVOCs (s)	μg/L	< 0.01	< 0.01	< 0.01	-
BTEX (s)	mg/L	< 0.5	< 0.5	< 0.5	-
TPH (s)	mg/L	< 0.1	< 0.1	< 0.1	-
PAHs (s)	μg/L	< 0.1	< 0.1	< 0.1	-
PCBs (s)	mg/L	< 0.1	< 0.1	< 0.1	-
Organochlorine (s)	mg/L	< 0.001	< 0.001	< 0.001	-
Organophosphate (s)	mg/L	< 0.001	< 0.001	< 0.001	-
Total Pesticides (s)	mg/L	0.001	0.001	0.001	0.1

*Notes: *) Ministry of Health Regulation No. 32 of 2017 (Attachment I.A)*

Parameters were measured in accordance with the regulation divided into four (4) categories including physical parameters, chemical properties, microbiology, and others (VOC, TPH, PCB, etc.).

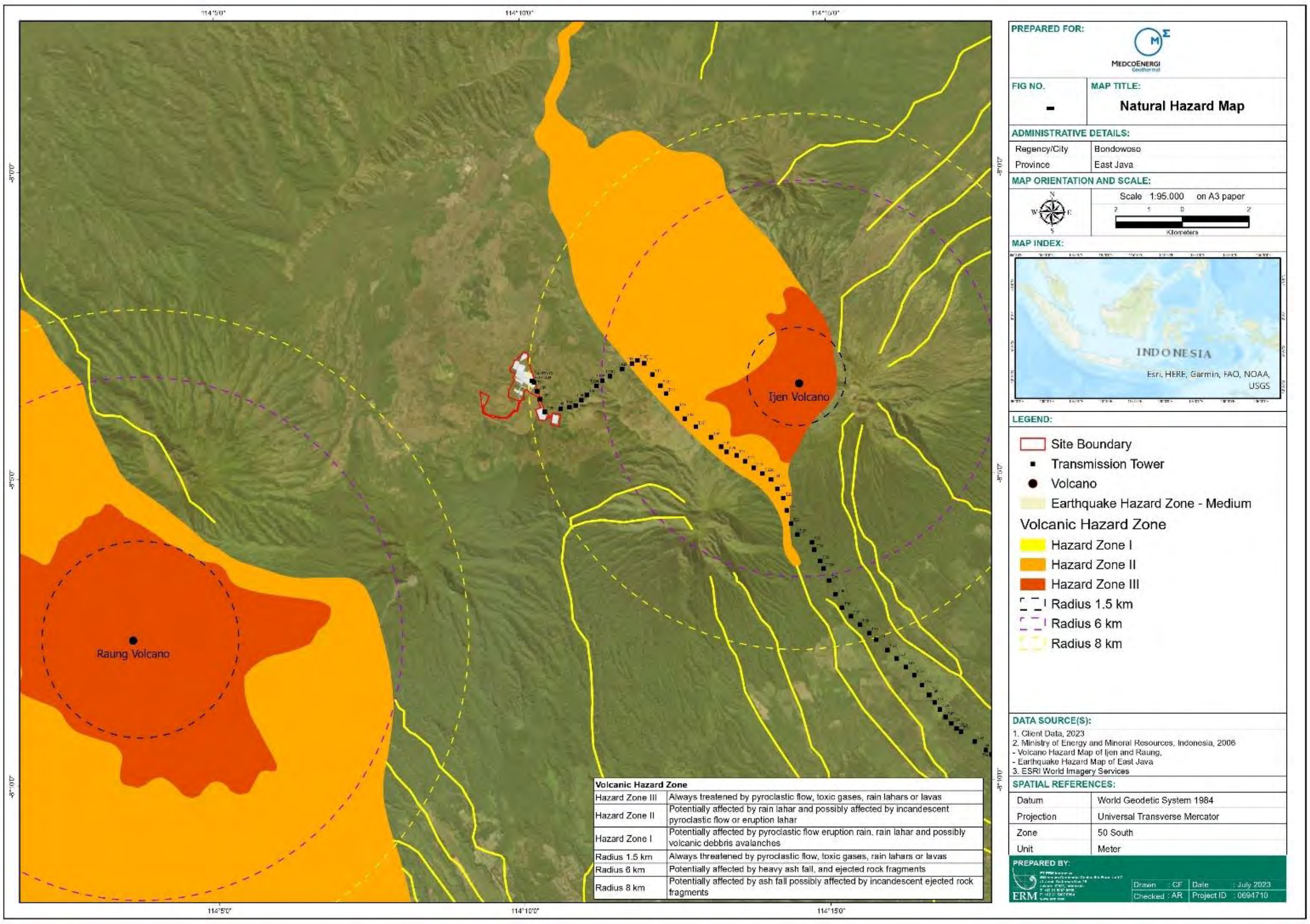
Based on the results of the laboratory analysis, only one microbiology parameter is in accordance with quality standards; i.e. total coliform at GW2 where is exceed the predetermined quality standard of 50 MPN/100mL. Given the location of the spring is open access, there is a possibility that the water is also contaminated by faeces of animals. Other parameters were in line with standards and show that the groundwater is generally unpolluted / not contaminated.

Total coliform does not necessarily indicate recent water contamination by faecal waste; however the presence or absence of these bacteria is often used to determine the general hygienic quality of water (Dayanti *et al.* 2018 in Momba *et al.* 2008). E. coli can survive in ground water between 4 and 12 weeks, depending on environmental conditions (temperature, microflora, etc.). Bacteria and viruses are approximately equally oxidant-sensitive, but parasites are less so. Under the conditions in distribution systems, E. coli will survive for much longer (Edberg *et al*. 2000). The total coliform figure however was only a slight exceedance of the standards.

4.2.9 Natural Hazards

According to National Agency for Disaster Management (BNPB), Indonesia is located within the Pacific Ring of Fire. The country is vulnerable to natural disasters such as earthquakes, volcanic eruptions, tsunamis, floods, landslides, droughts, and forest fires.

Figure 4-11: Natural Hazard Map



4.2.9.1 Earthquakes

Indonesia is situated at the meeting points of three active plates, i.e., the Indo-Australian plate, the Eurasian plate and the Pacific plate. The three plates are moving and thrusting into each other creates a seismic line and a ring of active volcanoes along the Sumatra, Java, Bali and Nusa Tenggara Islands, turning north to the Mollucas and North Sulawesi, parallel with the subduction zones of the two plates.

Data on earthquake incidents in Indonesia with mass casualties is shown in ***Table 4-12*** with earthquakes in Java highlighted.

Table 4-12: Substantial Casualties in Earthquake Events in Indonesia

No.	Year	Magnitude (Mw)	MMI	Killed	Region
1	1896	-	VIII	250	Timor Island
2	1926	7.8	IX	354	West Sumatra
3	1943	-	IX	213	Yogyakarta and Central Java
4	1994	7	IX	1.207	Liwa, Lampung
5	2000	7, 9	X	100	Bengkulu
6	2005	8, 7	VIII	>1.000	Nias Islands
7	2006	6,2	VIII	>5.700	Yogyakarta and Central Java

Source: Centre for Volcanology and Mitigation of Geological Hazards/PVMBG, 2008. National Disaster Management Plan, 2010-2014

Based on the Disaster Earthquake Map of East Java Province, the project site is located in a region with a medium earthquake disaster risk. Geographically, Blawan-Ijen is situated in the Quaternary Volcanic Arc and an active tectonic zone, specifically the subduction zone between the Indo-Australian Plate and the Eurasian Plate, which is approximately 300 km southward towards the Indian Ocean.

4.2.9.2 Volcanic Eruptions

Indonesia contains the most active volcanoes of all countries in the world. The three active tectonic plates causes the subduction zones that form volcanoes. Indonesia has more than 500 volcanoes and 129 are active, all carefully observed by the Centre of Volcanology and Geological Hazard Mitigation, because a number of Indonesian volcanoes show continuous activity. The active volcanoes distributed in Sumatra Island, Java Island, Bali, Nusa Tenggara, North Sulawesi and the Mollucas Island constitute 13% of the world active volcano distribution.

In 2021, Mount Semeru, a volcano in East Java Province erupted. The lava and ash caused important damage and thousands of people were displaced. Casualties was also reported. Records of major volcanic eruptions in Indonesia are shown in ***Table 4-13***.

Table 4-13: Volcanic Eruptions in Indonesia

Volcano	Location	Date of Eruption	Casualties
Mount Semeru	East Java	4 December 2021	34
Merapi	Central Java	3 November 2010	353
Kelut	East Java	10 February 1990	35
Galunggung	West Java	5 April 1982	68
Merapi	Central Java	6 October 1972	29
Kelut	East Java	6 April 1966	212
Agung	Bali	17 March 1963	1,148
Merapi	Central Java	25 November 1930	1,369
Kelut	East Java	19 May 1919	5,110
Awu	North Sulawesi	07 June 1892	1,532
Krakatau	Sunda Strait	26 August 1883	36,600
Galunggung	West Java	08 October 1822	4,011
Tambora	Sumbawa	10 April 1815	71,000+

Source: Indonesia-Investments (https://www.indonesia-investments.com/business/risks/natural-disasters/item243), OCHA service

Natural disasters related to the activities of Raung Volcano and Ijen Volcano have occurred in recent years. Based on the Ijen Volcano Hazard Map (2006), the project site is located within a radius of 8 km from Ijen Volcano which potentially affected by ash fall possibly affected by incandescent ejected rock fragments. The distances between Mount Raung and the project area are approximately 13.3 km. Therefore, the impact of volcanic activity of Raung Volcano in the project area is consideded not significant. The Kawah Wurung area does not affect the disaster-prone areas of Mount Ijen or Mount Raung, and any potential impact would only involve a minor possibility of ashfall from Mount Ijen.

4.2.9.3 Tsunamis

A submarine earthquake or volcanic eruption in the ocean can cause a tsunami water wave which can have devastating effects on the people and objects near the coast. In 2004, Indonesia experienced an earthquake and subsequent tsunami off the coast of Sumatra, killing over 167,000 people in Indonesia and resulted in the displacement of more than half a million of people as thousands of homes were wiped away.

4.2.9.4 Floods

Areas with high risk of flooding are spread all throughout Indonesia, especially in the east coasts of the northern part of Sumatra Island, the north coasts of the western part of Java Island, western and southern parts of Kalimantan Island, the southern parts of Sulawesi Island and the southern parts of Papua. Several cities like Jakarta, Semarang and Banjarmasin suffer periodic flooding, and so are several big rivers such as Bengawan Solo in Java and Benanain River in East Nusa Tenggara (National Disaster Management Plan, 2010-2014). In 2020, Bondowoso (East Java Province) was hit by flash flood where more than 200 houses flooded and 856 peopled were displaced as recorded by the Indonesian National Board for Disaster Management (BNPB)[1].

Referring to the flood potential map, the project site is situated in the middle of the Caldera and at a relatively high elevation. The lowest area is in the northern part of the Caldera (Blawan), approximately 7-8 km away from the project site. Surface water flows from the volcanic ridges in the south and east towards the north. As a result, the project location falls into the safe category regarding the potential for flood disasters.

4.2.9.5 Landslides

Indonesia geologically also faces landslide that causes disaster. The biggest victims and most losses are experienced in debris flows or flash floods, like the one happened in Nias (2001) and Bohorok North Sumatra (2005), Central Sulawesi (2007), West Sumatra (2008) and the latest in Situ Gintung, Banten (2009), that made 82 people died, 103 lost, 179 people injured and 250 houses destroyed/ damaged. In 2021, landslide in East Java triggered by moderate to high-intensity rainfalls killed at least nine people[2].

The potential for landslides is based on the amount of rainfall and the slope conditions of a particular area. The project site is located in Sempol sub-district, the annual rainfall is less than 1000 mm, which falls into the classification of very low rainfall. As for the slope conditions, the project site is situated in the central part of the Kendeng Caldera with relatively flat or gentle slopes. The slopes that are moderately to steep are found on the northern part of the Caldera (Blawan) and the volcanic ridges on the eastern side (Mount Merapi and Ijen Crater) as well as the southern side (Mount Ranteh and Mount Jampit).

4.2.9.6 Droughts

Drought is caused by the decrease in rainfall in a long period that is caused by the interaction of the atmospheric and oceanic aspects and the irregularity of sea surface temperature related to the El Niño phenomenon. Drought leads to insufficiency of water availability for human activities. It also affects significantly crop pattern, water system, irrigation management and the management of other resources. Indonesian regions that are prone to drought include several districts/cities in West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, Riau Islands, nearly all districts/cities in Java Island (in which the Project is located), except for those situated in the easternmost part of Java Island, and several districts/cities in East Nusa Tenggara Province, West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan, North Sulawesi, South Sulawesi, West Sulawesi, North Mollucas and Papua.

4.2.9.7 Forest Fires

Forest and Land Fires occur in Indonesia are mostly caused by human activities in clearing lands for farming, industrial forestry or plantation and this has been made worse by the El Niño phenomenon that triggers drought. Forest fires cause many health-related problems as well as social economic impacts. The haze created by forest fires may disturb neighbouring countries and hence has the potential of upsetting the relations between Indonesia and its neighbouring countries. Regions Indonesia that are prone to forest and land fires include Sumatra and Kalimantan Islands that have large areas of plantation and large scale farming as well as several districts/cities in Sulawesi, East Nusa Tenggara, and Java Island (in which the Project is located).

[1] https://reliefweb.int/report/indonesia/indonesia-and-malaysia-floods-and-landslides-bnbp-bmkg-metmalaysia-wmo-floodlist

[2] https://reliefweb.int/report/indonesia/indonesia-and-malaysia-floods-and-landslides-bnbp-bmkg-metmalaysia-wmo-floodlist

4.3 Terrestrial and Aquatic Biodiversity

This section provides the ecological baseline for the Project Area and Study Area including an assessment of potential critical habitat as per the International Finance Corporation (IFC) Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6).

4.3.1 Ecological Background

4.3.1.1 Nationally Recognized Areas

Protection Forest under the Indonesian Forestry Law (No. 40/1999) is not classified as an IUCN management classification.

Permissible activities under the Law include ecosystem service protection and conservation as well as human uses. Furthermore, the Government regulation No. 23/2021 on forest management allows the utilization of protection forest area for non-forestry development projects with the conditions that the project listed as national strategic development project. This includes mining, religious sector, power plant, transmission line, telecommunication, transportation infrastructure, and defensive system facility. The Protection Forest located within the Project area is shown in ***Figure 4-6***.

Kawah Ijen Natural Reserve was designated based on the Minister of Agricultural decree No.1017/Kpts-II/Um/12/ of 1981, this decree stated that 92 Ha of the Natural Reserve area were designated as Ijen Crater Nature Park while the 2,468 ha is designated for Natural Reserve. Information on this nature reserve is presented in ***Table 4-14***. According to East Java Natural Resources Conservation Centre[1] the general ecosystem in Ijen Crater Nature Reserve consists of:

- Montane Rain Forest, this area distributed between 1,000 and 2,500 m above sea level. The vegetation found is a combination of Mountain Rain Forest and Sub Alpine Rain Forest dominated by Compositae (Eidelweiss) and Ericaceae (Vaccinium).
- Sub Alpine Rain Forest, this area distributed between 2,500 and 4,000 m above sea. The vegetation is dominated by shrubs and shrubs, given the unfavourable environmental conditions and the increasing influence of sulphur compounds.

Table 4-14: Nationally Recognized Areas of Protection

Nationally Recognized Areas	Distance (km)	Details and Triggers
Kawah Ijen Natural Reserve	Adjacent to the transmission line 5 km from the Main Construction Area	Coordinates: -8.056906, 114.241241 IUCN Category: III Area Coverage: 2,468 ha Triggered species: Not available

The proposed transmission line is at its closest point around 500 m from the Kawah Ijen Natural Reserve. According to IUCN, Kawah Ijen area is designated as per IUCN Category III: Natural Monument or Feature, due to the Ijen Crater.

The East Java Natural Resources Conservation Centre reported that wildlife that can be found in the Ijen Crater TWA area includes:

- Black leopard (*Panthera pardus*) – Vulnerable;
- Jungle cat/Leopard (*Felis bengalensis*) – Least Concern;
- Ajag (*Cuon alpinus*) – Endangered;

[1] East Java Natural Resources Conservation Center website: Kawah Ijen Nature Reserve. Available from: https://bbksdajatim.org/cagar-alam-kawah-ijen-merapi-ungup-ungup-2

- Javan langur (*Trachypithecus auratus*) – Vulnerable;
- Flying squirrel (*Petaurista elegan*) – Least Concern;
- Ground squirrel (*Lariscus insignis*) – Least Concern;
- Tree squirrel (Scuridae) – Least Concern;
- Southern Red Muntijak (*Muntiacus muntjak*) – Least Concern;
- Wild boar (*Sus verrucosus*) – Endangered;
- Common Palm Civet (*Herpestes javanicus*) – Least Concern; and
- Javan Mongoose (*Paradoxurus hermaproditus*) – Least Concern.

It is also reported the area are habitat for around 107 bird species, where 21 of them are known to be endemic species. The endemic birds include;

- Pink-headed Fruit Dove (*Ptilinopus porphyreus*) – Least Concern;
- Javan kingfisher (*Halcyon cyanoventris*) – Least Concern;
- Sunda Minivet (*Pericrocotus miniatus*) – Least Concern;
- Orange Spotted Bulbul (*Pycnonotus bimaculatus*) – Near Threatened;
- White-Belled Fantail (*Rhipidura euryura*) – Least Concern; and
- Green jungle fowl (*gallus varius*) – Least Concern.

4.3.1.2 Internationally Recognized Areas of High Biodiversity Value

4.3.1.2.1 Global Ecoregions

Based on Spatial Analyses results, the Project overlaps with two ecoregions: The Eastern Java-Bali Montane Rain Forests (IM0112) and Eastern Java-Bali Rain Forests (IM0113).

4.3.1.2.1.1 The Eastern Java-Bali Montane Rain Forests

According to WWF[1], this ecoregion represents the montane forests of eastern Java and Bali, Indonesia. Based on the Köppen climate zone system, this ecoregion falls in the tropical wet and dry climate zones. The predominant forest types found in the ecoregion include evergreen rain forest, moist deciduous forest, and seasonal and aseasonal montane forest.

Evergreen rain forests of Java contain *Artocarpus elasticus* (Moraceae), *Dysoxylum caulostachyum* (Meliaceae), langsat *Lansium domesticum* (Meliaceae), and *Planchonia valida* (Lecythidaceae) (Whitten et al. 1996). Moist deciduous forests are drier than the evergreen rain forests and have 1,500-4,000 mm of rainfall annually, with a four- to six-month dry season. Common lowland deciduous trees in eastern Java and Bali are *Homalium tomentosum*, *Albizia lebbekoides*, *Acacia leucophloea*, *A. tomentosa*, *Bauhinia malabarica*, *Cassia fistula*, *Dillenia pentagyna*, *Tetrameles nudiflora*, *Ailanthus integrifolia*, and *Phyllanthus emblica*. Many herbaceous plants are confined to the deciduous forests (Whitten et al. 1996).

4.3.1.2.1.2 Eastern Java-Bali Rain Forests[2]

The Eastern Java–Bali Rain Forests ecoregion represents the lowland moist forests of the eastern half of the island of Java and Bali, and the smaller islands off the northern coasts of both.

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[1] https://www.worldwildlife.org/ecoregions/im0112
[2] https://www.oneearth.org/ecoregions/eastern-java-bali-rainforests/

Average annual rainfall ranges from 1,500 to 4,000 mm, with a four to six-month dry season. Therefore, the lowland forests are predominantly moist deciduous, with semi-evergreen rainforest along the moister south coast.

The forests have a sparse canopy, and few trees exceed 25 m in height. Common lowland deciduous trees are *Homalium tomentosum, Albizia lebbekoides, Acacia leucophloea, Acacia tomentosa, Bauhinia malabarica, Cassia fistula, Dillenia pentagyna, Tetrameles nudiflora, Ailanthus integrifolia,* and *Phyllanthus emblica*. The semi-evergreen rainforests of Java are characterized by *Artocarpus elasticus, Dysoxylum caulostachyum, Lansium domesticum,* and *Planchonia valida*.

4.3.1.2.1.3 Key Biodiversity Areas / Important Bird Areas

A Key Biodiversity Area (KBA) is defined as a site that contributes significantly to the global persistence of biodiversity, applicable to terrestrial, freshwater, and marine ecosystems. Sites qualify as global KBAs if they meet one or more of 11 criteria, grouped into the following five categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability. KBAs are usually situated over existing national protected areas (PA), Alliance for Zero Extinction sites (AZEs), Important Bird Areas (IBAs), etc.

There are two KBAs / IBAs located within 1 km of the Project: Gunung Raung to the north and Gunung Ijen to the south-west. A trigger species of these KBAs is the Javan Hawk-eagle (*Nisaetus bartelsi*) listed as Endangered on the IUCN Red List. The KBAs are shown in ***Figure 4-12***.

Birdlife international[1] identified Gunung Raung and Gunung Ijen area are met the IBA global criterion of A1[2], A2[3], A3[4] (2004), these two areas have also relative similarity in terms of species of concerns. The key species of these IBAs including the Javan Hawk-eagle (*Nisaetus bartelsi*) – EN, White-faced Partridge (*Arborophila orientalis*) – VU, and Green Peafowl (*Pavo muticus)* – EN.

Both Gunung Ijen and Gunung Raung IBA also known to be habitat for non-bird species such as *Cuon alpinus, Panthera pardus, Sus verrucosus* and *Trachypithecus auratus* (Nijman 1997).

4.3.1.2.1.4 Endemic Bird Area

An EBA is an area where the distribution of two or more restricted-range bird species is entirely included within the boundary of the EBA. It was observed that two EBAs overlap with the Project Area: The Javan and Bali Forest EBA and the Javan Coastal Zone EBA.

Both EBAs are support several restricted-range species of Java. The Java and Bali EBA includes the monotypic[5] endemic genera, *Psaltria*, which is endemic to Java. Most of the restricted-range species are now virtually confined to montane forest, although there are historical records of several of them from the lowlands, which suggests that before extensive lowland deforestation took place they may also have occurred (at least locally) in lowland forest (BirdLife International[6]).

Table 4-15 presents the internationally recognized area surrounding the project site. The EBAs are shown in ***Figure 4-12***.

[1] http://datazone.birdlife.org/site/factsheet/gunung-raung-iba-indonesia/text

[2] IBA Criterion A1: The site is known or thought regularly to hold significant numbers of a globally threatened species.

[3] IBA Criterion A2: The site is known or thought to hold a significant population of at least two range-restricted species

[4] IBA Criterion A3: The site is known or thought to hold a significant component of the group of species whose distributions are largely or wholly confined to one biome-realm

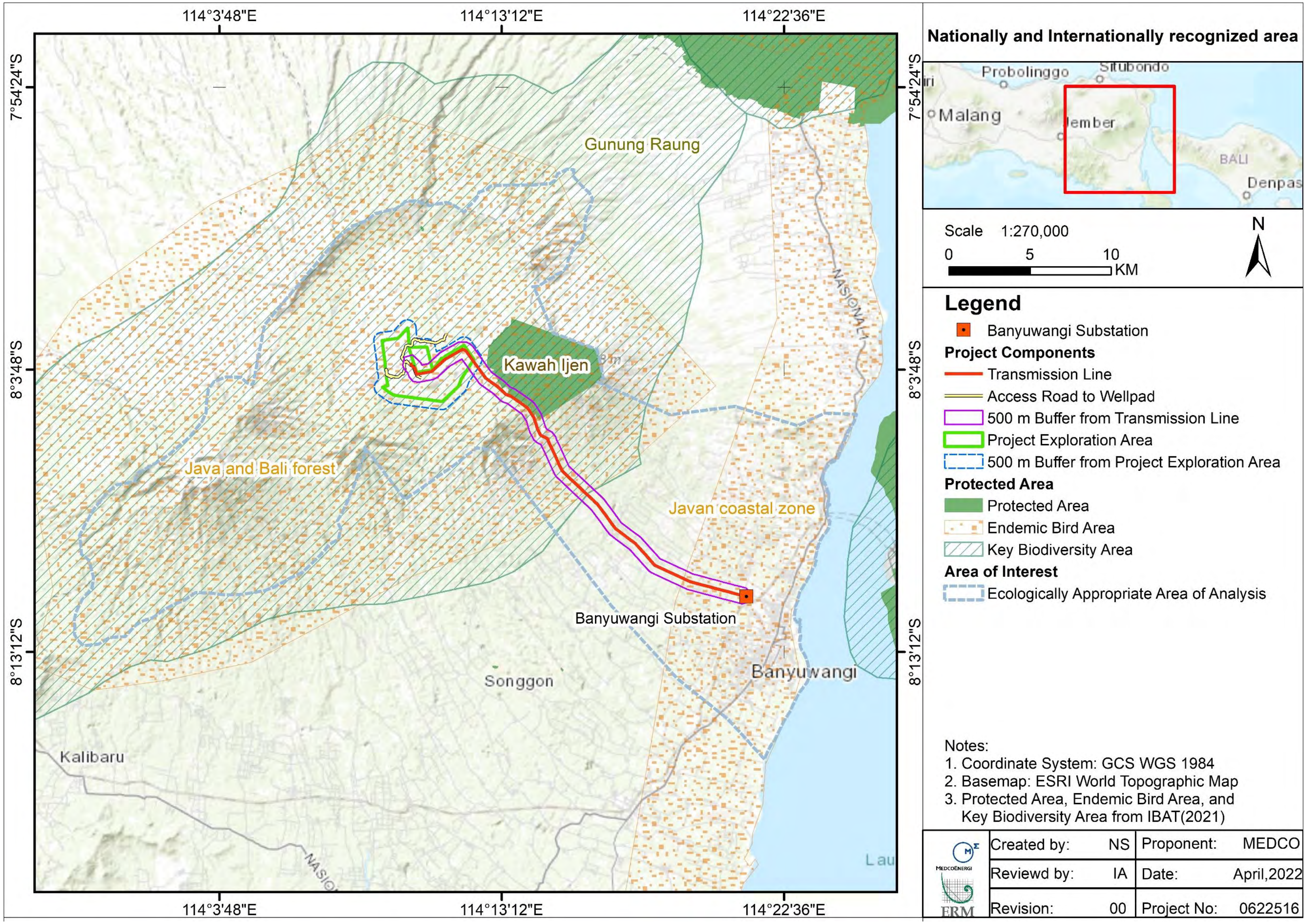
[5] Having only one type or representative, especially (of a genus) containing only one species

[6] BirdLife International Website: Java and Bali Forest EBA. Available from: http://datazone.birdlife.org/eba/factsheet/160

Table 4-15: Internationally Recognized Areas of High Biodiversity Value

Internationally Recognized Areas	Distance (km)	Details and Triggers
Gunung Raung KBA/IBA	0.75	Coordinates: -8.121163, 114.088177 IUCN Category: KBA/IBA Area Coverage: 600 km^2 Trigger species: Javan Hawk-eagle
Gunung Ijen KBA/IBA	0.54	Coordinates: -8.058672, 114.260374 IUCN Category: KBA/IBA Area Coverage: 24.68 km^2 Trigger species: Javan Hawk-eagle
Java and Bali Forest EBA	Overlaps with transmission line and main construction area	Coordinates: -8.032960, 114.073603 IUCN Category: EBA Area Coverage: 18,000 km^2 Trigger species: Several species of Indo-Malayan restricted-range species
Javan Coastal Zone EBA	Overlaps with transmission line	Coordinates: -8.155630, 114.370060 IUCN Category: EBA Area Coverage: 11,000 km^2 Trigger species: Several species of Indo-Malayan restricted-range species

Figure 4-12: Nationally and Internationally Recognized Area



4.3.2 Species of Conservation Significance

Secondary data gathered from Integrated Biodiversity Assessment Tool (IBAT) listed seven species can be considered as species of concerns potentially present around the proposed Project area. The species consist of one insect species, one mammal species, and five bird species.

The East Java Natural Resources Conservation Centre reported that two endangered species (i.e., *Cuon alpinus* and *Sus verrucosus)* are currently potentially present, however detail information on the encounter records, population, and habitat preference of these species were not provided, and the relevant IUCN publication has been utilised to examine the possibility of these species presence within the Ecologically Appropriate Area of Analysis (EAAA) as well as critical habitat assessment. Based on the assessment *Cuon alpinus* and *Sus verrucosus* are not meeting the criteria of Critical habitat trigger species. ***Section 4.3.9*** provides discussion on critical habitat screening of the project.

Data on the KBAs within proximity to the Project area indicates that one endemic and restricted-range insect species may be present surrounding the project site.

The list of conservation significant species that may occur within the vicinity of the Project area are outlined in ***Table 4-16***. These species are considered in the Critical Habitat screening assessment, considering their likelihood of occurrence and data obtained from the baseline assessment.

Table 4-16: Species of Concerns in the AoI

Common name	Scientific name	IUCN Red List status[1]	Presence in the EAAA[2]	PS6 Critical Habitat criteria[3]			Rationale[4]
				1	2	3	
Insects							
Butterfly	*Atrophaneura luchti*	EN	Unconfirmed	Possible	Possible		This restricted range species has an extent of occurrence (EOO) of 1,000-2,000 km^2. It has only been recorded from the Ijen mountain range where it is thought to likely occur at a medium to high altitude where forested areas still occur. No population numbers of this species exists.
Mammals							
Javan Tailless Fruit Bat	*Megaerops kusnotoi*	VU	Unconfirmed	Possible			This VU species has an EOO of 106,897 km^2. It is endemic to the islands of Java, Bali, and Lombok. This species is known to occur in tropical evergreen forests at lowland areas, but likely to also occur at higher elevations. No population numbers of this species exists.
Birds							
White-faced Partridge	*Arborophila orientalis*	VU	Unconfirmed	Possible	Unlikely		This VU species occurs only in East Java, Indonesia. It is a restricted range species with an EOO of 10,800km^2. This species is known to occur in montane evergreen forest, at elevations between 500-2,200m above sea level. The global population estimate is between 10,000-19,999 mature individuals.
Javan Hawk-eagle	*Nisaetus bartelsi*	EN	Unconfirmed	Possible			This EN species only occurs on the island of Java and Bali, Indonesia. It is considered to be a scarce species that is restricted to patches of remaining forest on the islands, IUCN reported the estimate EOO of this species covering 126,000 km^2. Frequently occurring at elevations of

Common name	Scientific name	IUCN Red List status[1]	Presence in the EAAA[2]	PS6 Critical Habitat criteria[3]			Rationale[4]
				1	2	3	
							500-1000m above sea level. The global population estimate is between 600-900 individuals.
Javan Scops-owl	*Otus angelinae*	VU	Unconfirmed	Possible			This VU species is known to occur only in West Java and thought to also likely occur in highland areas of East Java where the project is located. IUCN reported the estimate EOO of this species covering 75,800 km2. The global population estimate is between 2,500-9,999 mature individuals.
Javan Flameback	*Chrysocolaptes strictus*	VU	Unconfirmed	Possible			This VU species occurs only in East Java, and Bali Indonesia. It is a restricted range species with an EOO of 49,500km^2. This species is tolerant of habitat modification, and can occur in a range of habitat types (forest, shrub land, and plantation). A preliminary estimate of the global population estimate suggests this is between 2,500-9,999 mature individuals.
Javan Blue-banded Kingfisher	*Alcedo euryzona*	CR	Unconfirmed	Possible			This CR species only occurs on the island of Java, Indonesia. Although there are very limited confirmed records across the island, it is thought to be under-recorded due to its shy nature, and occurrence in remote areas. This sedentary species can be found close to rocky or slow-flowing streams and large rivers in forested areas between 0-1,500m above sea level. The global population estimate is between 50-249 mature individuals.

Notes:

[1] IUCN Red List status: CR = Critically Endangered; EN = Endangered; VU = Vulnerable

[2] Presence in study area: Unconfirmed= presence unconfirmed but considered possible given the overlap between study area and species range and/or presence of suitable habitat.

[3] Result: Possible = low/no evidence of effort to determine presence or absence, however if the species is found to be present in the study area at significant numbers, the area is likely to meet the threshold for qualifying as Critical Habitat

4.3.3 Invasive Species

Invasive species are any species that are –non-native to a particular ecosystem and whose introduction and spread causes, or are likely to cause, sociocultural, economic or environmental harm or harm to human health (FAO, 2013). Invasive species are naturalised species that reproduce often in large numbers and are spread over a large area, damaging native species (FAO, 2005).

According to the Global Invasive Species Database (GISD) (2017), 174 species have been identified as invasive species in Indonesia and 36 species which listed as invasive species in Java Island presented in ***Table 4-17***. No records were returned for the marine area although there is potential for unreported invasive species to be present.

This information has been used when screening the baseline information to identify invasive species occurring within the Study Area.

Table 4-17: Invasive Species of Java Island

Species	Taxonomic group	Habitat	Status
Anoplolepis gracilipes	Animalia	Terrestrial	Native to Indonesia
Cervus timorensis russa	Animalia	Terrestrial	Native to Indonesia
Cipangopaludina chinensis	Animalia	Freshwater	Native to Indonesia
Columba livia	Animalia	Terrestrial	Native to Indonesia
Oreochromis mossambicus	Animalia	Freshwater	Introduced
Pomacea canaliculate	Animalia	Freshwater	Introduced
Pterygoplichthys disjunctivus	Animalia	Freshwater	Introduced
Pterygoplichthys multiradiatus	Animalia	Freshwater	Introduced
Pterygoplichthys pardalis	Animalia	Freshwater	Introduced
Pterygoplichthys spp.	Animalia	Freshwater	Introduced
Pycnonotus jocosus	Animalia	Terrestrial	Native to Indonesia
Python bivittatus	Animalia	Terrestrial	Native to Indonesia
Rattus exulans	Animalia	Terrestrial	Native southeast Asia
Scyphophorus acupunctatus	Animalia	Terrestrial	Introduced
Viverricula indica	Animalia	Terrestrial	Native to Indonesia
Xenopus laevis	Animalia	Brackish	Introduced
Xylosandrus compactus	Animalia	Terrestrial	Native to Indonesia
Xylosandrus mutilates	Animalia	Terrestrial	Native to Asia
Acacia confuse	Plantae	Terrestrial	Introduced
Alternanthera philoxeroides	Plantae	Terrestrial	Introduced
Angiopteris evecta	Plantae	Terrestrial	Native to Indonesia
Austroeupatorium inulifolium	Plantae	Terrestrial	Introduced
Chromolaena odorata	Plantae	Terrestrial	Introduced
Epipremnum pinnatum	Plantae	Terrestrial	Native to Indonesia
Lespedeza cuneata	Plantae	Terrestrial	Native to Indonesia
Leucaena leucocephala	Plantae	Terrestrial	Introduced
Macfadyena unguis-cati	Plantae	Terrestrial	Introduced
Merremia tuberosa	Plantae	Terrestrial	Introduced
Mikania micrantha	Plantae	Terrestrial	Introduced
Mimosa pigra	Plantae	Terrestrial	Introduced
Myriophyllum aquaticum	Plantae	Terrestrial	Introduced
Neyraudia reynaudiana	Plantae	Terrestrial	Native to Indonesia
Nypa fruticans	Plantae	Terrestrial	Native to Indonesia
Psidium guajava	Plantae	Terrestrial	Introduced
Syzygium cumini	Plantae	Terrestrial	Native to Indonesia
Verbena brasiliensis	Plantae	Terrestrial	Introduced

4.3.4 Biodiversity Baseline Data Collection

4.3.4.1 Secondary Data Collection

Literature search have been conducted for the determination of baseline flora-fauna characteristics of the Project area.

The bibliographic references used during the desktop study included:

- Documentation provided by the client, including Project layout map, previous environmental study conducted by the client;
- IUCN Red List Database;
- IBAT data;
- Important Bird Areas;
- Key Biodiversity area;
- World protected site;
- Indonesian list of protected species;
- Documents and studies conducted by the Government, scientific Institutions and Associations;
- Satellite images and aerial photos; and
- Scientific literature available in public databases and from Universities.

Literature research was performed for endemic, restricted-range critically endangered, endangered, congregatory and migratory species (collectively referred to as species of conservation concern) identified from field survey as well as secondary data analyses provided by IBAT and official conservation agency. The results of the analysis enabled to identify the presence of habitats with the potential for hosting species in the Study Area (i.e., site located within the species range and ecologically suitable to its habitat requirements).

The outputs of the field surveys were compared with literature references in order to make an inventory of flora-fauna species present in the Study Area.

4.3.4.2 Primary Data Collection

The wet season biodiversity study conducted between 15 and 28 February 2022 with the focus of study including terrestrial biodiversity, aquatic biodiversity, and vantage survey for birds. Summary of sampling locations are presented in ***Table 4-18***.

The dry season biodiversity field survey was conducted from 15 June until 25 June 2022, followed by vantage point survey on June, July and August 2022. Six transects, three vantage points, and five freshwater biodiversity sampling points were designated to represent the whole study area.

Transects and points were purposively established within the impact buffer area to represent the actual condition of the study location.

Table 4-18: Terrestrial and Aquatic Biodiversity Sampling Locations

No	Sampling ID	Coordinate East (WGS)	Coordinate South (WGS)	General Description
Terrestrial Biodiversity				
1	Transect 1	114°14'27.09"	8° 5'42.49"	Secondary Forest Area around transmission line, Part of Java-Bali forest Ecosystem, Connected with Ijen Natural Reserve conservation area
2	Transect 2	114°10'18.67"	8° 3'51.54"	Grass land and cultivation area, represent geothermal exploration area and the upper part of transmission line
3	Transect 3	114°13'46.08"	8° 4'42.66"	Secondary Forest Area around transmission line, Part of Java-Bali forest Ecosystem and the Natural Reserve conservation area of Ijen
4	Transect 4	114°16'35.66"	8° 8'26.68"	dryland agriculture area, mainly utilized as coffee and mixed plantation represent mid part of transmission line area
5	Transect 5	114°20'22.11"	8°11'0.75"	disturbed area (wetland agriculture area), represent downstream part of transmission line
6	Transect 6	114°14'15.46"	8° 6'55.50"	Secondary forest area, outside of transmission line, designated as control transect
Vantage Sampling				
7	Van-Bird-01	114°10'21.15"	8° 3'55.72"	Located around the starting point of transmission area, within the geothermal exploration area, a highly disturbed landscape (Grass land and cultivation area) at the highland area, suitable soaring area for birds as targeted species
8	Van-Bird-02	114°14'20.07"	8° 5'33.11"	Located surrounding the transmission line adjacent to the Ijen conservation area, a secondary forest area connecting the natural forests surrounding the conservation area, suitable area representing the potential habitat surrounding the conservation area
9	Van-Bird-03	114°20'11.61"	8°11'2.79"	Located near to the end point of transmission line, an intensive cultivation area, manly coconut and vegetable farming area at the lowland area, suitable soaring area for birds as targeted species
Aquatic Biodiversity				
1	Aquatic 1	114°10'40.54"	7°59'11.09"	Kali Belawan, a creek downstream of the project site, Project is using water from the creek to support the drilling activities. Initially, the sampling location placed around the geothermal exploration area, however it moved downstream due to the field

No	Sampling ID	Coordinate East (WGS)	Coordinate South (WGS)	General Description
				observation found that the river body at the site was dry and considered as temporal water stream
2	Aquatic 2	114°12'20.92"	8° 3'18.32"	Upstream of Kali Pait river around the transmission line area, represent upstream condition
3	Aquatic 2A	114°10'18.82"	7°59'29.22"	downstream of Kali Pait creek near Belawan village area, an additional sampling location to understand the downstream situation of Kali Pait river
4	Aquatic 3	114°12’57.91”	8° 3’44.56”	Upstream of Kali Pait creek, outside river to transmission line area streams to transmission line, part of- Ijen Crater Conservation area, Control river
5	Aquatic 4	114°20'17.16"	8°10'53.78"	Kali Grogol river, close to transmission line area, represent downstream condition of transmission line

Source: ERM 2022

Figure 4-13 and ***Figure 4-14*** present the sampling locations of the terrestrial and aquatic biodiversity surveys.

Figure 4-13: Terrestrial Biodiversity and Vantage Survey Location

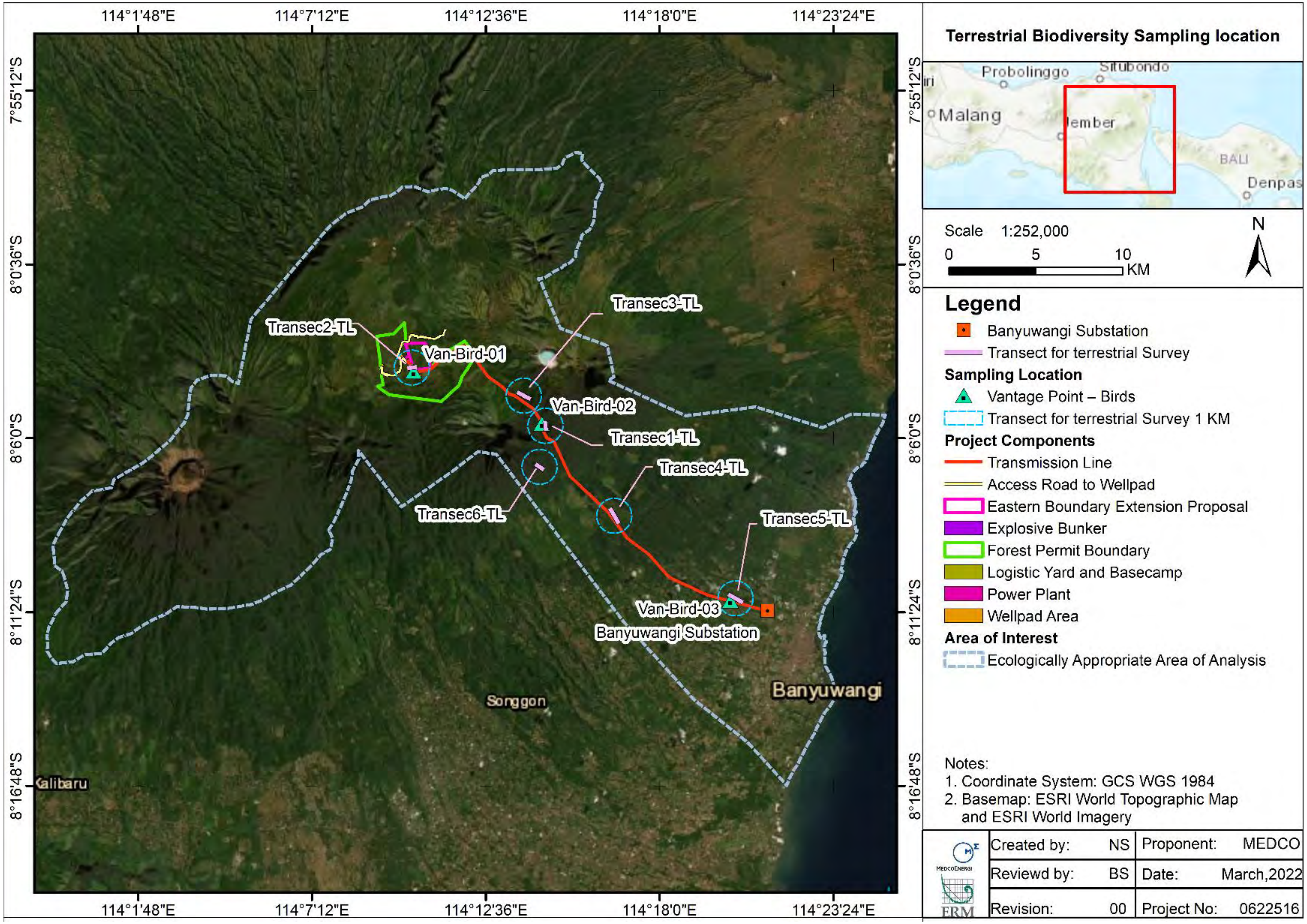
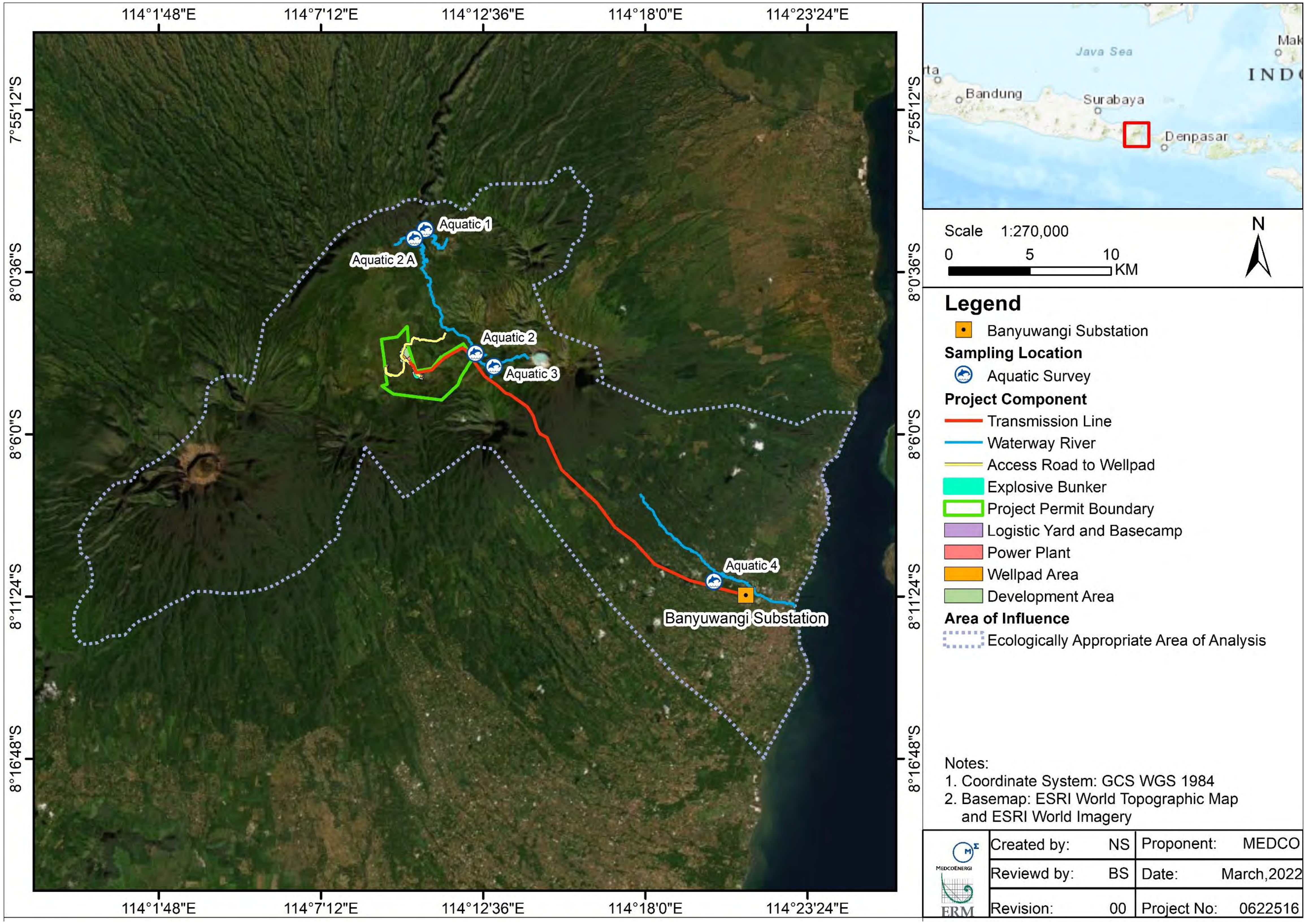


Figure 4-14: Aquatic Biodiversity Sampling Location



4.3.4.2.1 Terrestrial Biodiversity Survey

The Terrestrial flora-fauna survey was conducted within six transects. The survey covered vascular plants, mammals, birds and vegetation, mammals, birds, insect, and herpeto-fauna survey. In addition to the study, ERM also performed vantage survey for birds in three sampling points along the transmission line. It was aimed to understand the potential risk of bird's collision on further transmission line operation.

4.3.4.2.1.1 Land Cover Analyses

The land cover was calculated using ESA Sentinel-2 data with a resolution of 10 meters. Sentinel-2 has multi-spectral resolution, allowing it to detect various types of land cover and represent them as digital numbers. Due to the weather and cloud cover, the imageries were chosen in October 2021, with two scenes of imagery covering the project's study area. Land cover delineation was done using training samples to classify land cover classes based on the fundamental elements of image interpretation. Those elements are colour, hue, texture, association, shape, size, pattern, etc. The land cover types were classified into 8 classes that are Bare Ground, Dryland Mixed Agriculture, Paddy Field, Secondary Forest, Settlement Area, Shrub Land, Water and Other (Clouds and Shadows).

4.3.4.2.1.2 Vegetation survey

The vegetation surveys were conducted within the terrestrial biodiversity sampling location within and surrounding project area. The method included transects crossing all Project components and various habitats within and around the Project area.

Habitat types (e.g., forest, grassland, plantation), structure (e.g., percentage vegetation cover, mean height for each layer), and composition (e.g., plant species and abundance) were recorded along each transect.

Photographs of representative habitats and dominant, threatened, protected, or invasive plant species were taken to obtain better visualization on the study area as well as project site. This information will be utilized to delineate the land cover within the EAAA as well as habitats classification in accordance with IFC PS6.

The survey activities resulted in seven different habitat covers: secondary forest, savanna, scrub, mixed plantations, agricultural land, bare land, and buildings. The survey was conducted in five of these habitats, excluding vacant land and settlements. In general, the research location was disturbed with different levels of severity. The seven sampling areas across different habitats are designed to represent the entire impact buffer area totalling approximately 12,762.43 Ha. Most of the agricultural area covers the study area with 46% being mixed plantations (30%) and agricultural land (16%). The secondary forest also covers a large area, reaching 3,661.83 Ha. The ecosystem conditions found in the study area are mostly modified areas with most of the natural habitats remaining. Habitats found at the six observation stations include agricultural land, shrubs, savannas, secondary forests, and mixed plantations.

In general, the flora and fauna observation stations in the study area are at an altitude of 300-1880 meters above sea level. Most of its habitat at lower altitudes has been modified as agricultural residential areas, while secondary forests and savannas can be found at higher elevations.

4.3.4.2.1.3 Mammal survey

Mammal surveys was conducted to record the presence of direct and signs (faecal pellets, footprints, tracks, feeding signs, hair, breeding sites or nests, road kills, calls) of mammal species within and surrounding the project site.

In order to cover the diurnal and nocturnal species, mammal surveys were started on the morning (07.00-11.00) and continued in the evening (16.00-22.00). The mist net was deployed in each transect to catch and gather data related to the flying mammals, especially fruit eater bats. The nets are placed purposively near the flowering or fruiting tree and in the bat's flying range. Mist nets were installed at approximately 5 to 10 meters above ground, started at 17.30, checked at 20.00, 22.00, and then dismantled. Photographs of observed and or captured species were taken to further confirm species identification.

4.3.4.2.1.4 Bird surveys

Bird surveys were conducted through a combination of line transects and point counts. The Surveys included observation points at every 200 m along the total of 1000 m dedicated transects. All bird species identified by sight or sound within 50 m of the observation point were recorded.

4.3.4.2.1.5 Vantage Point Survey

Vantage point surveys were conducted on three sampling locations along the transmission. The idea was to seek data related to the potential disturbance from the further development of the transmission line to the existing avian species.

Bird expert collected data from a vantage point covering a large area (with visibility around 2 km depending on the natural conditions during sampling conducted) in the study area.

The survey was conducted for three hours in the morning and evening at each vantage point. This survey is planned to be repeated three times each season (wet and dry). Each repetition survey was conducted every months following the initiation of seasonal survey.

4.3.4.2.1.6 Herpeto-fauna surveys

Herpeto-fauna surveys included recording the presence/abundance of animals and field signs along transects during the day and night survey as per mammal survey. The night survey was using a torch (torch counts).

The survey was conducted along 400m cleared path during the survey. During the surveys, searches of likely refuges were made, including edges of the river, puddles, potholes, tree branches and trunks, leaves, decaying wood, and under rocks.

4.3.4.2.1.7 Terrestrial invertebrates

Terrestrial invertebrates (focusing on dragonflies, butterflies, and moths) were sampled in a mix of riparian and forested habitats around the terrestrial transect area. Its involved searching vegetation, sweeping vegetation, breaking off branches, installation of light traps, and fruit traps. Insect nets will be used to capture butterflies and other flying invertebrates. Specimens that cannot be identified in the field will be collected and euthanized for closer taxonomy.

4.3.4.2.2 Aquatic Biodiversity Survey

The aquatic study was performed in five sampling locations within and surrounding project site as well as transmission line area. The data collected in this study were habitat characteristics, water quality of river, aquatic biota (nekton, such as fish and crustacean).

4.3.4.2.2.1 Habitat characteristics

The habitat characteristics of the survey location was observed directly during the survey. Parameters used to describe habitat characteristic of survey sites are physical characteristics, which includes stream characterization, such as description of the stream origin and type; watershed features such as the documentation of general land use along the riverbanks, and characteristic of riparian vegetation features.

4.3.4.2.2.2 Aquatic biota (fish, crab and shrimp)

Aquatic biota was collected using shocker electrofishing (EF) and throw net. Shocker EF was conducted on a riverbank with running water, rocky substrate, and a depth of less than 1 m. The purpose of the EF method is to observe representative river species. Electrofishing was carried out using an electrofishing unit with a power of 100-200 Volt, consisting of 1 unit of iron probe (for electrocution), dip net (to catch the stunned fish being electrocuted) with a mesh size of 2 mm, and one battery capacity of 12 Volt (C-instrument) which was placed in a backpack-shaped case.

Electrofishing is operated by slowly wading through rivers, inspecting edges, shallow areas, and under rocks or edges with a probe and collecting stunned fish or other specimens with a dip net. Electrofishing is operated for one hour at each sampling station, not including the downtime required for relocation between sampling sites, breaks, or downtime due to equipment failure. Within one hour, sampling was carried out 4 times (replicates) every 15 minutes (sub-sample 4x15 minutes). To obtain optimal catch, the electro fisher starts at a point 100 m downstream from the base of each sampling location and operates the electrofishing unit to upstream.

All collected nekton were laboratory samples, then put in a plastic bag and labelled to indicate the sampling location, date, track number, and other information required. Aquatic biota photos are also taken as needed. At the end of the sampling period at each sampling station, nekton was transferred to a new labelled plastic bag containing 70% alcohol.

Species identification for aquatic biota (nekton, such as fish and crustaceans) referred to freshwater fish guidelines that are generally used for the identification of Indonesian inland water species (Kottelat et al. 1993; Kottelat 2013; Haryono & Tjakrawidjaja 2004; Tan 2013).

As for shrimp and crab identification, it refers to several references in the Southeast Asia region (Ng 1988; Wowor et al. 2004; 2009). Aquatic biota (nekton) identification is carried out to the species level.

4.3.4.2.3 Species Data Analyses

In order to understand the threat, endemic, and migration status of each status, ERM performed data comparison analyses of the recorded species against the IUCN Red list data, list of regional endemic species, and invasive species list. The results were utilized to understand the potential presence of critical habitat within and surrounding the project site.

4.3.4.2.3.1 IUCN Red List Data Analyses

The threat status of each species recorded and identified during the terrestrial and aquatic biodiversity study will be analysed using International Union for Conservation of Nature (IUCN) red list criteria[1] as wells as Indonesian Law for Protected Species (Government Decree No. 7/1999) with protected species listed in the Minister of Environmental and Forestry (MoEF) regulation No. P.106/MENLHK/SETJEN/KUM.1/12/2018 on list of protection species in Indonesia.

Threat status of flora species was determined according to the IUCN red list category. The IUCN Red List Categories and Criteria are intended to be an easily and widely understood system for classifying species at high risk of global extinction. It divides species into nine categories: Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (UN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX). Detail description of each category is described in IUCN[2] website.

[1] IUCN Red List of Threatened Species
[2] https://www.iucnredlist.org/

4.3.4.2.3.2 Invasive Species

Data related to invasive species were tabulated and explained. Identification of invasive species was based on several databases, including CABI Invasive Species Compendium (CABI ISC), IUCN Global Invasive Species Database (IUCN GISD), and invasive species listed by the Indonesian Government in the MoEF regulation P.94/MENLHK/SETJEN/KUM.1/12/2016

4.3.4.2.3.3 Quantitative Analyses

Upon the species identification completed, data collected from the field then tabulated and analysed using ecological quantitative formulations;

Importance Value Index (IVI) for vegetation

Species composition found in transects were analysed using species composition formula of Importance Value Index (IVI). The IVI formula = RD + RF + RDo, where RD: Relative Density; RF; Relative Frequency and RDo: Relative Dominance (Dombois & Ellenberg 1974)

Species diversity

Species diversity is composed of two distinct components, the total number of species and the evenness, which gives an indication of the structure of species distribution of a stand (Ludwig & Reynold 1988). Shannon index of diversity (Magurran 1988) follows the equation:

$$H' = -\sum_{i=1}^{S}((p_i)ln(p_i))$$

Where *S* is the number of species and p_i is the proportion of individuals found in the certain species. The evenness shows the degree of uniformity in the distribution of individual species over standardized area. The equation for the evenness index (Pielou 1969 in Magurran 1988) is:

$$E = \frac{H'}{H_{max}} = \frac{H'}{\ln(S)}$$

Where *H'* is the actual degree of evenness and H_{max} is the mathematically maximum possible evenness in a stand.

Simpson (1949) suggested C (Simpson's index of diversity) as a measure diversity. The Simpson measure of diversity express the dominance of or concentration of abundance into the one or two commonest species of the community. In contrast, the information theoretic measure of *H'* express the relative evenness of the abundance of all species. Therefore, Simpson's index is most appropriate if we are most interested in the relative degree of dominance of a few species in the community, rather than the overall evenness of the abundance of the species. The formula of this index was.

$$\mathrm{C} = \sum_{i=1}^{S}\frac{n_i(n_i-1)}{N(N-1)}$$

Where n_i is the number of individuals of the certain species.

Species Richness

Species richness measures provide an instantly comprehensible expression of diversity. A number of simple indices have been derived using some combination of S (the number of species recorded) and N (the total number of individual over all S species). These include Margalef's diversity Index.

$D_{Mg} = (S – 1)/ \ln N$

Community Similarity

Analyses of community similarity between ecosystem (disturbed and disturbed forest) used Ward's minimum variance method (Romersburg 1984), Formula of Ward method that are:

$$d_{ij} = d(\{X_i\}, \{X_j\}) = \|X_i - X_j\|^2$$

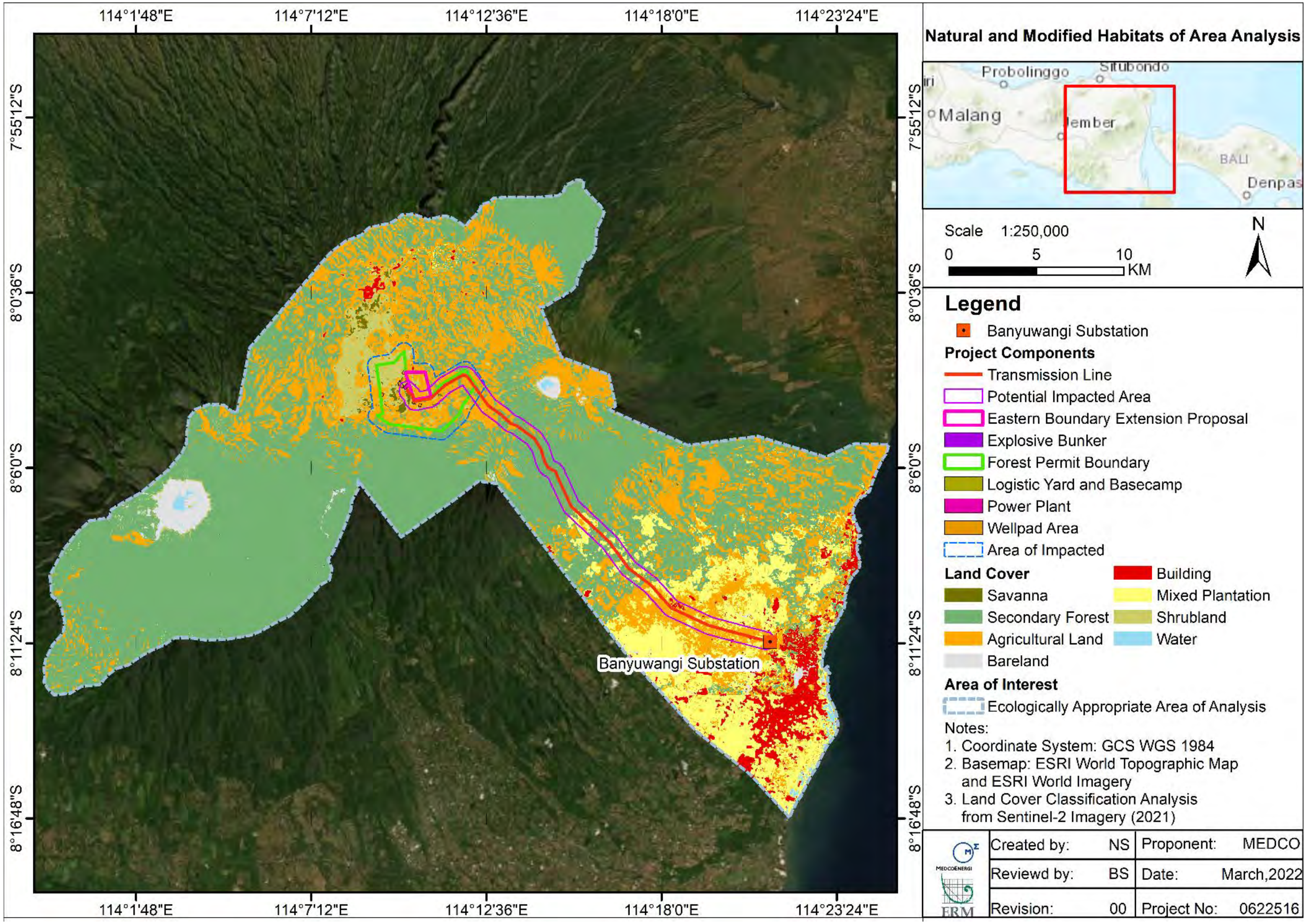
Processing of community similarity analyses used software Minitab 17.

4.3.5 Natural Habitat and Modified Habitat

IFC PS6 identifies two classes of 'habitats' Natural Habitat and Modified Habitat, based on the extent of human modification of the ecosystems. Heavily disturbed and converted ecosystems are considered modified habitat, such as urban areas and monoculture plantations. It is important to note that both natural and modified habitat can be considered as a critical habitat. However, a largely modified surrounding landscape could suggest that it is less likely that significant biodiversity values could be present in significant concentrations to trigger the IFC criteria for critical habitat.

Habitats around the Project are dominated by natural habitats including water bodies, forest areas, and natural features (craters). There are some modified habitats such as Kalianyar village (within 300 m of the closest well pad) and plantations (***Figure 4-15***).

Figure 4-15: Natural and Modified Habitat Map



4.3.6 Terrestrial Flora and Fauna Baseline

The wet and dry season biodiversity studies recorded a total of 290 terrestrial fauna and 345 flora species. It's also noted a total of 21 aquatic species, and 28 plankton genera.

Recorded fauna species consists of 109 birds, 22 mammals, 23 herpetofaunas, 136 insects, 3 fishes, and 18 aquatic macroinvertebrates. Please noted that number of bird species is include result from biodiversity survey and vantage point survey.

Referring to the IUCN red list data base, ERM identified most of the encountered species were listed LC (160 species) and none of them listed as CR, however it is understood that there are one EN, two VU, two NT and the remaining 60 species are listed NE.

In terms of endemic, migratory, and protection status, ERM identified 22 endemic species, three migratory species, and 13 protected species encountered within and surrounding the project site.

Summary of the terrestrial species encountered during the baseline study is presented in ***Table 4-19***.

Table 4-19: Terrestrial species encounter summary

Taxa	Number of species	IUCN Red List							MoEF regulation No P.94/2016	Endemic	Migratory
		CR	EN	VU	NT	LC	DD	NE	Protected		
Flora	345	-	1	-	-	-	-	-	-	2	-
Bird	109	-	2	1	1	105	-	-	8	23	4
Mammal	22	-	-	2	-	20	-	-	3	2	-
Herpeto fauna	23	-	-	-	1	22	-	2	-	1	-
Insect	136	-	-	-	1	25	-	110	2	3	-
Total	635	-	2	3	3	172	-	112	13	27	4

Source: Primary data Collection, ERM 2022

4.3.6.1 Terrestrial Habitat Characteristic

A total of 144 species were present within and surrounding the project site. Due to the individual flora assessment on conservation status is on-going, the species of concerns list are yet to be presented.

Based on Spatial analyses on the project layout, ERM understands that land cover within the EAAA and the project site were dominated by secondary forest, shrub land, paddy field, and dryland mixed agriculture area. It is also noted that there is community settlement, access road, river body and natural lake at the surrounding area.

Survey activity resulted in seven different habitat covers: secondary forest, savannah, shrub land, mixed plantation, agricultural land, bare land, and building. The survey was conducted in five of those habitats, excluding bare land and settlement. In general, the study location is in disturbed conditions with different severity.

The seven sampling areas are representative of the whole project area including a 500 m radius of the main project area covering a total of 2,854.92 Ha. While the total project area including the transmission line is 1,468 Ha. Based on spatial analyses the habitat types to be directly impacted by the project will predominantly consist of modified habitat (53.08 % agricultural land, 27.81% shrub land, 0.32% bare land, and 0.03% existing building), while the natural habitat to be directly impacted by the project consisted of 12.22% of secondary forest and 6.54% of savannah area).

Habitats found in the study area are mostly modified areas with relic natural habitat. Habitats found at the observation stations include agricultural land, shrub land, savannah, secondary forests, and mixed plantation. In general, the flora fauna sampling in the study area is located at an altitude of 300-1,880 meters above sea level. Habitat in the lower altitude is mostly modified as an agricultural and settlement area, while the secondary forest and savannah can be found in the higher altitude.

A summary of the land cover assessment against the project area and the EAAA is presented in ***Table 4-20*** and detailed below:

- Savannah: Small patch of savannah was observed in transect 2, in the Wurung Crater area. This savannah is considered as natural habitat due to its formation in the past. Even though large part of surrounding area is converted into agricultural land, the savannah in Wurung Crater area is preserved and utilized as tourism area. Dominant flora in the savannah are *Eragrostis atrovirens* and Eragrostis *capillaris*. Photos of savannah conditions are presented in ***Figure 4-16***.
- Secondary Forest: Secondary forest has the biggest portion of natural habitat found in study area. The remaining secondary forest habitat is Javan montane forest above 1000 m a.s.l. This habitat is observed at transect 1, 3, and 6. The secondary forest in transect 1 is dominated by *Quercus* spp. and *Magnolia lilifera*. Transect 3 has two different kinds of secondary forest. The upper location has open canopy with montane trees, including *Casuarina junghuhniana, Acacia mearnsii*, and *Eucalyptus alba* and grassland in the forest floor. Meanwhile, the lower part is similar to the forest in transect 1. The secondary forest in transect 6 also similar with the transect 1 but dominated by *Syzygium paucipunctatum* and *Elatostema* sp. Photos of secondary forest conditions at the observation site are presented in ***Figure 4-17***.
- Shrub land: The shrub land habitat found in the observation area is mainly abandoned agricultural land. The agricultural land habitat left behind is undergoing a natural succession and is overgrown by plants with shrub and herb habitus. This habitat can be found in transect 2, 3, 4, and 5. Species that observed in the shrub land habitat including *Paspalum conjugatum, Chromolaena odorata*, and various grass species from Poaceae and Cyperaceae. Photos of bush habitat are presented in ***Figure 4-18***.
- Mixed Plantation: This habitat is the most extensive modified habitat and most widely found in the observation stations. In general, the habitat condition is dominated by the vegetation of coffee (*Coffea robusta*), coconut (*Cocos nucifera*), and other beneficial plants including bitter bean (*Parkia speciosa*), mango (*Mangifera indica*), and cananga (*Cananga odorata*). This habitat was found in transect 2, 4, and 5. Photos of mixed plantation habitat conditions are presented in ***Figure 4-19***.
- Agricultural land: Two kinds of agricultural lands were found in the study area. The agricultural land in the higher altitude in transect 2 mostly planted with potato. Meanwhile, this habitat in the lower altitude in transect 5 mostly planted with corn and rice. Photo of agricultural land habitat conditions are presented in ***Figure 4-20***.

Table 4-20: Land Cover Assessment against the Project Area and the EAAA

Habitat types	Habitat Type	Project Area -Well pad complex, Transmission line and towers		Within 500 m surrounding the Project Area		EAAA (Ha)	
		Area (Ha)	% of total area	Area (Ha)	% of total area	Area (Ha)	% of total area
Natural Habitat	Savana	96.01	6.54	37.35	1.30	279.90	0.40
	Secondary Forest	179.45	12.22	1,111.21	38.92	39,418.86	56.90
Modified Habitat	Agricultural Land	779.28	53.08	1,160.90	40.66	16,753.33	24.18
	Bare land	4.66	0.32	2.37	0.08	984.87	1.42
	Building	0.40	0.03	24.47	0.86	2,126.02	3.07
	Mixed Plantation	0.00	0.00	431.18	15.10	7,435.56	10.73
	Shrub land	408.20	27.81	87.44	3.60	2,277.06	3.29
Total Area		1,468.00	100	2,854.92	100	69,276.00	100

Source: ERM 2022

Figure 4-16: Savana Habitat

Figure 4-17: Secondary Forest Habitat

Figure 4-18: Shrub Land Habitat

Figure 4-19: Mixed Plantation Habitat

Figure 4-20: Agricultural Land

4.3.6.2 Birds

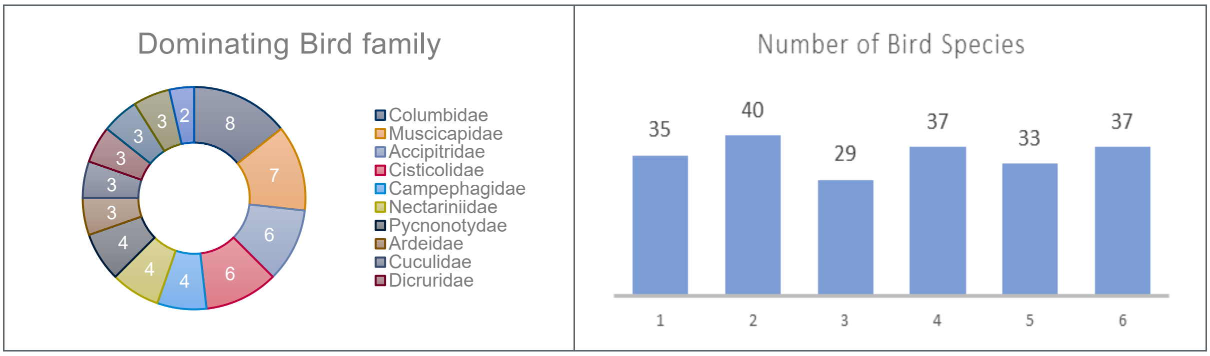
4.3.6.2.1 Rapid Assessment Survey

Survey activity resulted in 96 species from 45 families. ***Table 4-21*** shows the complete list of birds observed during the survey.

Sunda honeybuzzard, barred cuckoo dove, and green junglefowl can be found in five different transects. Sunda honeybuzzard can also be found in all four habitats. Even though those three birds are not common species and live mostly in the natural habitat, they can endure the habitat degradation and adapt in human dominated landscape.

Several species are highly adapted in the disturbed area, such as scaly-breasted munia and sooty-headed bulbul. Those species can be found in all four habitats within four transects and more easily spotted in the modified habitat. On the other hand, almost half of the bird or 32 species can only be found in one transect, including the endangered Javan eafbird, and three birds of prey, black eagle, javan hawk eagle and changeable hawk eagle. Dominant bird families observed are provided in ***Figure 4-21***.

Figure 4-21: Dominating Bird Family and Number of Bird Species in Different Transects



Columbidae family has the highest number of species with eight species, followed by Muscicapidae and Cisticolidae with seven and six species respectively. Columbidae is a family of pigeons and dove that can be found worldwide with most of its species is in the Indomalayan and Australasian realms. They also inhabit various habitats from the pristine forest area to the heavily modified landscape of city. In this both season survey, Columbidae, especially eastern spotted dove can be found in all habitat type.

Table 4-21: List of Observed Birds in Survey Location

No	Family	Common Name	*Scientific Name*	Station						Habitat				Conservation Status				
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Migratory	Endemic
1	Accipitridae	Sunda Honeybuzzard	*Pernis ptilorhynchus*	v	v	v	v	v		v	v	v	v	LC				
2	Accipitridae	Black Eagle	*Ictinaetus malaiensis*		v						v			LC				
3	Accipitridae	Javan Hawk Eagle	*Nisaetus bartelsi*	v					v	v				EN		v		v
4	Accipitridae	Changeable Hawk Eagle	*Nisaetus limnaeetus*					v				v		LC				
5	Accipitridae	Crested Serpent Eagle	*Spilornis cheela*						v	v				LC				
6	Aegithinidae	Common Iora	*Aegithina tiphia*				v			v			v	LC				
7	Alcidinidae	Javan Kingfisher	*Halcyon cyanoventris*					v				v		LC				v
8	Alcidinidae	Collared Kingfisher	*Todiramphus chloris*		v		v	v		v		v	v	VU	II	v		
9	Ardeidae	Javan Pond Heron	*Ardeola speciosa*				v	v		v		v	v	LC				
10	Ardeidae	Cattle Egret	*Ardea ibis*					v				v		LC				
11	Ardeidae	Little egret	*Egretta garzetta*					v				v		LC				
12	Artamidae	White-breasted Woodswallow	*Artamus leucorynchus*				v	v		v		v	v	LC				
13	Bucerotidae	Wreathed Hornbill	*Rhyticeros undulatus*						v	v				LC				
14	Campephagidae	Javan Cuckooshrike	*Coracina javensis*			v			v	v				LC				v
15	Campephagidae	Pied Triller	*Lalage nigra*		v		v				v		v	LC				
16	Campephagidae	Sunda Minivet	*Pericrocotus miniatus*	v					v	v				LC	II	v		v

No	Family	Common Name	*Scientific Name*	Station						Habitat				Conservation Status				
				1	2	3	4	5	6	S F	S H	A G	M P	IUCN	CITES	Protection	Migratory	Endemic
17	Campephagidae	Small Minivet	*Pericrocotus cinnamomeus*				v						v	LC				
18	Caprimulgidae	Savanna Nightjar	*Caprimulgus affinis*		v								v	LC				v
19	Cettiidae	Sunda Bush Warbler	*Horornis vulcanius*	v		v			v	v				LC				
20	Cettiidae	Mountain Leaftoiler	*Phyllergates cucullatus*	v		v			v	v				LC				
21	Chloropseidae	Javan Leafbird	*Chloropsis cochinchinensis*						v	v				LC				v
22	Cisticolidae	Common Tailorbird	*Orthotomus sutorius*				v	v		v		v	v	LC				
23	Cisticolidae	Javan Tailorbird	*Orthotomus sepium*				v	v		v		v	v	LC				v
24	Cisticolidae	Deignan's Prinia	*Prinia polychroa*		v						v			LC				
25	Cisticolidae	Plain Prinia	*Prinia inornata*		v						v			LC				
26	Cisticolidae	Zitting Cisticola	*Cisticola juncidis*		v		v	v		v	v	v	v	LC				
27	Cisticolidae	Golden-headed Cisticola	*Cisticola exilis*		v						v			LC				
28	Columbidae	Barred Cuckoo Dove	*Macropygia unchall*	v	v	v		v	v	v	v	v		LC				
29	Columbidae	Little Cuckoo Dove	*Macropygia ruficeps*	v		v	v		v	v			v	LC				
30	Columbidae	Asian Emerald Dove	*Chalcophaps indica*				v			v				LC				
31	Columbidae	Eastern Spotted Dove	*Spilopelia chinensis*		v		v	v		v	v	v	v	LC				
32	Columbidae	Zebra Dove	*Geopelia striata*				v	v		v		v	v	LC				
33	Columbidae	Grey-cheeked Green Pigeon	*Treron griseicauda*			v				v				LC				
34	Columbidae	Dark-backed Imperial Pigeon	*Ducula lacernulata*	v						v				LC				v

No	Family	Common Name	*Scientific Name*	Station						Habitat				Conservation Status				
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Migratory	Endemic
35	Columbidae	Pink-headed Fruit Dove	*Ptilinopus porphyreus*			v			v	v				LC				v
36	Corvidae	Sunda Crow	*Corvus enca*				v						v	LC				v
37	Cuculidae	Plaintive Cuckoo	*Cacomantis merulinus*	v			v	v		v		v	v	LC				
38	Cuculidae	Sunda Brush Cuckoo	*Cacomantis sepulcralis*		v	v	v			v			v	LC				
39	Cuculidae	Lesser Goucal	*Centropus bengalensis*		v		v	v		v	v	v	v	LC				
40	Dicaeidae	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	v					v	v				LC				
41	Dicaeidae	Javan Flowerpecker	*Dicaeum sanguinolentum*	v	v	v			v	v	v			LC				v
42	Dicruridae	Black Drongo	*Dicrurus macrocercus*				v			v			v	LC				
43	Dicruridae	Ashy Drongo	*Dicrurus Leucophaeus*		v		v			v	v		v	LC			v	
44	Dicruridae	Greater Racket-tailed Drongo	*Dicrurus paradiseus*		v				v	v				LC				
45	Estrildidae	Red Avadavat	*Amandava amandava*		v						v			LC				
46	Estrildidae	Scaly-breasted Munia	*Lonchura punctulata*	v	v		v	v		v	v	v	v	LC				
47	Falconidae	Indonesian Kestrel	*Falco moluccensis*		v			v			v	v		LC				
48	Hirundinidae	Barn Swallow	*Hirundo rustica*				v			v			v	LC			v	
49	Hirundinidae	Pacific Swallow	*Hirundo javanica*		v			v			v	v		LC				
50	Hirundinidae	Daurian Swallow	*Cecropis daurica*				v	v		v		v	v	LC			v	
51	Laniidae	Long-tailed Shrike	*Lanius schach*	v			v		v	v			v	LC				
52	Locustellidae	Striated Grassbird	*Megalurus palustris*	v	v		v			v	v		v	LC				

No	Family	Common Name	*Scientific Name*	Station						Habitat				Conservation Status				
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Migratory	Endemic
53	Megalaimidae	Flame-fronted Barbet	*Psilopogon armillaris*	v		v			v	v				LC				v
54	Meropidae	Chestnut-headed Bee-eater	*Merops leschenaulti*				v	v		v		v	v	LC				
55	Meropidae	Blue-tailed Bee-eater	*Merops philippinus*					v				v		LC				
56	Motacillidae	Paddyfield Pipit	*Anthus rufulus*		v						v			LC				
57	Muscicapidae	Indigo Warbling-flycatcher	*Eumyias indigo*	v		v			v	v				LC				
58	Muscicapidae	Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	v						v				LC			v	
59	Muscicapidae	Mugimaki Flycatcher	*Ficedula mugimaki*	v						v				LC			v	
60	Muscicapidae	Lesser Shortwing	*Brachypteryx leucophris*	v		v			v	v				LC				
61	Muscicapidae	Little Pied Flycatcher	*Ficedula westermanni*			v			v	v				LC				
62	Muscicapidae	Snowy-browed Flycatcher	*Ficedula hyperythra*	v					v	v				LC				
63	Muscicapidae	Sunda Forktail	*Enicurus velatus*						v	v				LC				v
64	Nectariniidae	White-flanked Sunbird	*Aethopyga eximia*	v	v				v	v	v			LC				v
65	Nectariniidae	Ornate Sunbird	*Cinnyris ornatus*	v			v	v		v		v	v	LC				
66	Nectariniidae	Brown-throated Sunbird	*Anthreptes malacensis*				v	v		v		v	v	LC				
67	Nectariniidae	Little Spiderhunter	*Arachnothera longirostra*			v				v				LC				
68	Oriolidae	Black-naped Oriole	*Oriolus chinensis*					v				v		LC			v	
69	Pachycephalidae	Mangrove Whistler	*Pachycephala cinerea*				v			v			v	LC				
70	Paridae	Cinereous Tit	*Parus cinereus*		v						v							

No	Family	Common Name	*Scientific Name*	Station						Habitat				Conservation Status				
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Migratory	Endemic
71	Phasianiidae	Green Junglefowl	*Gallus varius*	v	v		v	v	v	v	v		v	LC				
72	Phasianiidae	Blue-breasted Quail	*Synoicus chinensis*		v						v			LC				
73	Phylloscopidae	Sunda Warbler	*Phylloscopus grammiceps*	v		v			v	v				LC		v		v
74	Phylloscopidae	Mountain Leaf Warbler	*Phylloscopus trivirgatus*	v		v			v	v				LC				
75	Picidae	Banded Yellonape	*Chrysophlegma miniaceum*	v							v	v		LC				
76	Picidae	Crimson-winged Woodpecker	*Picus puniceus*	v										LC				
77	Picidae	Freckle-breasted Woodpecker	*Dendrocopos analis*		v		v	v			v	v	v	LC				
78	Pittidae	Javan Banded Pitta	*Hydronis guajanus*				v		v	v			v	NT		v		v
79	Pnoepygidae	Pygmy Cupwing	*Pnoepyga pusilla*	v		v			v	v				LC				
80	Pycnonotydae	Javan Bulbul	*Ixos virescens*	v		v			v	v				LC				
81	Pycnonotydae	Sooty-headed Bulbul	*Pycnonotus aurigaster*	v	v		v	v	v	v	v	v	v	LC				
82	Pycnonotydae	Sunda Yellow-vented Bulbul	*Pycnonotus analis*		v		v	v		v	v	v	v	LC				
83	Pycnonotydae	Orange-spotted Bulbul	*Pycnonotus bimaculatus*			v				v				LC				
84	Rhipiduridae	White-bellied Fantail	*Rhipidura euryura*	v					v	v				LC				
85	Rhipiduridae	Sunda Pied Fantail	*Rhipidura javanica*		v									LC				
86	Rostratulidae	Greater Painted snipe	*Rostratula benghalensis*		v						v			LC				
87	Sittidae	Blue Nuthatch	*Sitta azurea*	v						v				LC				
88	Strigidae	Collared Scops Owl	*Otus lempiji*		v		v						v	LC				

No	Family	Common Name	*Scientific Name*	Station						Habitat				Conservation Status				
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Migratory	Endemic
89	Sturnidae	Short-tailed Starling	*Aplonis minor*		v						v			LC				v
90	Timaliidae	Crescent-chested Babbler	*Cyanoderma melanothorax*	v						v				LC				v
91	Timaliidae	Javan Scimitar Babbler	*Pomatorhinus montanus*	v						v				LC				v
92	Turdidae	Eyebrowed Thrush	*Turdus obscurus*	v						v				LC				
93	Turnicidae	Barred Buttonquail	*Turnix suscitator*		v		v				v		v	LC				
94	Vangidae	Black-winged Flycatcher-shrike	*Hemipus hirundinaceus*						v	v				LC				
95	Zosteropidae	Javan Heleia	*Apalopteron javanicum*	v	v	v			v	v	v			LC		v		v
96	Zosteropidae	Warbling White-eye	*Zosterops japonicus*	v	v	v			v	v	v			LC				

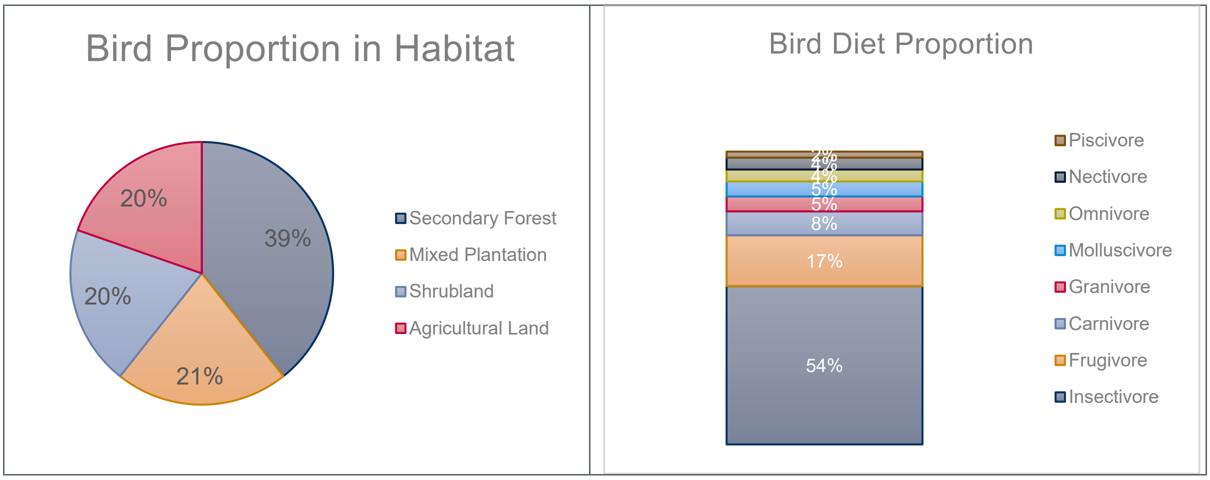
Source: ERM 2022

Notes: SF: Secondary Forest; SH: Shrub Land; MP: Mixed Plantation; AG: Agricultural Land

Transect 2 has the highest number of birds with 40 species. This transect lies between the forest area in the hill and Banyuwangi City in the lowland area making a lot of bird species that utilizing both habitats crossing this area. On the other hand, transect 3 has the lowest number of bird species. Transect 3 located in high altitude, reaching 1880 m a.s.l with relatively low canopy cover due to the montane forest characteristic. Therefore, only small number of birds that can survive in this habitat.

The proportion of bird species in the various land classes are shown in ***Figure 4-22***.

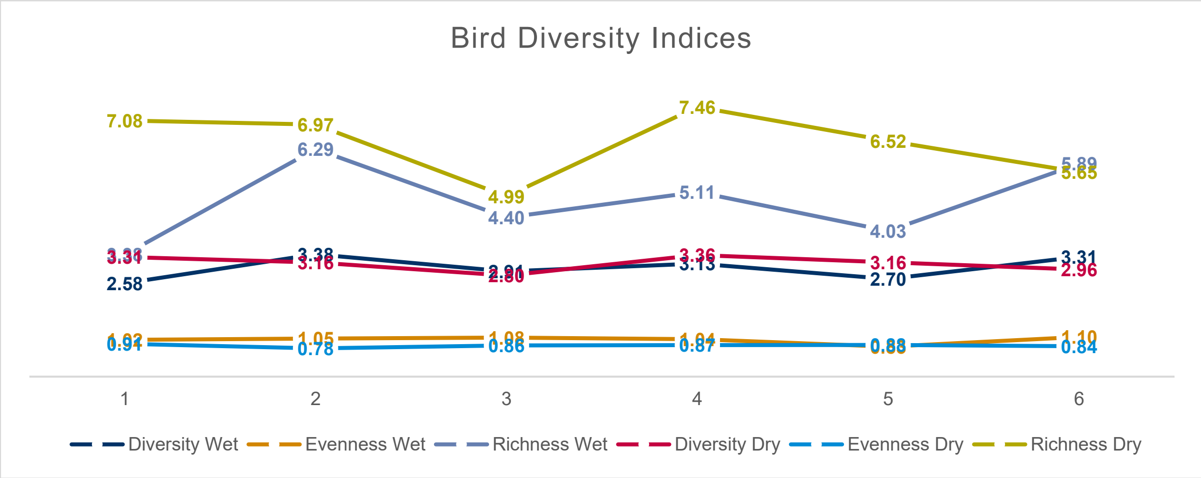
Figure 4-22: Proportion of Bird Species in Various Land Classes and Feeding Type of Birds



The secondary forest is a habitat with the most diverse bird species in the study area. As many as 39% of species were observed in this habitat. The secondary forest in the study area has wide variation from patchy sparse in Transect 3 to the dense old grown in Transect 1 and 6. This variation attract many species to suit their needs and filling the niche within the habitat. Insectivore birds dominates the diet proportion of the survey. Their feed can be easily obtained in the study area considering that the habitat is sparsely covered by canopy and inhabit by large number of insects. The high insect abundance then attracts the insectivorous birds which dominate the bird community at the survey area with a proportion of 54% of the total bird species found.

Bird diversity index in each transect were relatively equal, with the highest and lowest positions changing. In the wet season transect 2 occupies the highest position with 3.38, while in the dry season transect 4 is the highest with 3.36. Evenness index on each transect mostly decreased in the dry season, except for transect 5 which experienced an increase. In transect 5 managed to add significantly as many as 27 species with 54 individuals, so that the distribution of each species was considered even. The calculation of the richness index follows the diversity index, so that in the wet season transect 2 occupies the highest position which was then taken over by transect 4 as the highest in the dry season. ***Figure 4-23*** shows detail of all indices.

Figure 4-23 Diversity, Evenness, and Richness Indices of Bird Species



The diversity is relatively similar across the transects and no domination among all species. However, the richness indices show a fluctuation with 4.99 for the lowest one in Transect 3 and 7.46 for the highest one in Transect 4. The richness indices reflect the number of bird species as shown in ***Figure 4-24***.

Figure 4-24: Birds Observed in the Study Area


Javan Bulbul


Javan Kingfisher


Asian Emerald Dove


Blue Nuthatch

4.3.6.2.2 Vantage point

Survey activity resulted in 72 species from 3 8 families. Below is the complete list of birds observed during the vantage point survey, while the detailed data from the survey is presented in ***Appendix D***.

Table 4-22: List of Observed Birds from the Vantage Point Survey

No	Family	Common Name	*Scientific Name*	IUCN	Point			Elevation	
					VB1	VB2	VB3	<30m	>30m
1	Accipitridae	Black-winged Kite	*Elanus caeruleus*	LC	v				•
2	Accipitridae	Black eagle	*Ictinaetus malaiensis*	LC	v	v	v	•	•
3	Accipitridae	Sunda Honeybuzzard	*Pernis ptilorhynchus*	LC	v	v	v		•
4	Accipitridae	Crested Serpent-eagle	*Spilornis cheela*	LC		v		•	
5	Aegithinidae	Common Iora	*Aegithina tiphia*	LC			v	•	
6	Alcidinidae	Javan Kingfisher	*Halcyon cyanoventris*	LC			v	•	
7	Alcidinidae	Collared Kingfisher	*Todiramphus chloris*	LC	v		v	•	•
8	Apodidae	Glossy Swiftlet	*Collocalia esculenta*	LC	v		v	•	
9	Apodidae	Cave Swiftlet	*Collocalia linchi*	LC	v	v	v	•	
10	Ardeidae	Cattle Egret	*Ardea ibis*	LC			v	•	•
11	Ardeidae	Javan Pond Heron	*Ardeola speciosa*	LC			v	•	
12	Ardeidae	Little egret	*Egretta garzetta*	LC			v	•	
13	Artamidae	White-breasted Woodswallow	*Artamus leucorynchus*	LC	v		v	•	•
14	Bucerotidae	Wreathed Hornbill	*Rhyticeros undulatus*	VU		v			•
15	Campephagidae	Javan Cuckooshrike	*Coracina javensis*	LC	v	v		•	
16	Campephagidae	Pied Triller	*Lalage nigra*	LC	v		v	•	
17	Campephagidae	Sunda Minivet	*Pericrocotus miniatus*	LC	v	v		•	
18	Cettiidae	Sunda Bush Warbler	*Horornis vulcanius*	LC		v		•	
19	Cettiidae	Mountain Leaftoiler	*Phyllergates cucullatus*	LC		v		•	
20	Cisticolidae	Golden-headed Cisticola	*Cisticola exilis*	LC	v			•	
21	Cisticolidae	Zitting Cisticola	*Cisticola juncidis*	LC	v		v	•	
22	Cisticolidae	Common Tailorbird	*Orthotomus sutorius*	LC			v	•	
23	Cisticolidae	Plain Prinia	*Prinia inornata*	LC	v			•	
24	Cisticolidae	Deignan's Prinia	*Prinia polychroa*	LC	v			•	

No	Family	Common Name	*Scientific Name*	IUCN	Point			Elevation	
					VB1	VB2	VB3	<30m	>30m
25	Columbidae	Dark-backed Imperial Pigeon	*Ducula lacernulata*	LC		v		•	•
26	Columbidae	Zebra Dove	*Geopelia striata*	LC			v	•	
27	Columbidae	Ruddy Cuckoo-dove	*Macropygia emiliana*	LC	v			•	
28	Columbidae	Little Cuckoo Dove	*Macropygia ruficeps*	LC	v	v		•	
29	Columbidae	Barred Cuckoo Dove	*Macropygia unchall*	LC	v			•	
30	Columbidae	Pink-headed Fruit Dove	*Ptilinopus porphyreus*	LC	v	v		•	
31	Columbidae	Eastern Spotted Dove	*Spilopelia chinensis*	LC	v		v	•	
32	Columbidae	Wedge-tailed Green Pigeon	*Treron sphenurus*	LC		v		•	
33	Cuculidae	Sunda Brush Cuckoo	*Cacomantis sepulcralis*	LC	v		v	•	
34	Cuculidae	Lesser Goucal	*Centropus bengalensis*	LC	v			•	
35	Cuculidae	Sunda Cuckoo	*Cuculus lepidus*	LC		v		•	
36	Dicaeidae	Javan Flowerpecker	*Dicaeum sanguinolentum*	LC		v		•	
37	Dicaeidae	Orange-bellied Flowerpecker	*Dicaeum trigonostigma*	LC		v		•	
38	Dicruridae	Ashy Drongo	*Dicrurus leucophaeus*	LC		v			•
39	Estrildidae	Javan Munia	*Lonchura leucogastroides*	LC			v	•	
40	Estrildidae	Scaly-breasted Munia	*Lonchura punctulata*	LC	v		v	•	
41	Falconidae	Spotted Kestrel	*Falco moluccensis*	LC	v			•	•
42	Hirundinidae	Pacific Swallow	*Hirundo javanica*	LC	v			•	
43	Laniidae	Long-tailed Shrike	*Lanius schach*	LC	v			•	
44	Locustellidae	Sunda Grasshopper-warbler	*Locustella montis*	LC	v			•	
45	Locustellidae	Striated Grassbird	*Megalurus palustris*	LC	v			•	
46	Megalaimidae	Flame-fronted Barbet	*Psilopogon armillaris*	LC		v		•	
47	Meropidae	Chestnut-headed Bee-eater	*Merops leschenaulti*	LC	v			•	
48	Motacillidae	Paddyfield Pipit	*Anthus rufulus*	LC	v			•	

No	Family	Common Name	Scientific Name	IUCN	Point			Elevation	
					VB1	VB2	VB3	<30m	>30m
49	Muscicapidae	Blue-and-white Flycatcher	*Cyanoptila cyanomelana*	LC		v		•	
50	Muscicapidae	Indigo Warbling-flycatcher	*Eumyias indigo*	LC		v		•	
51	Muscicapidae	Little Pied Flycatcher	*Ficedula westermanni*	LC		v		•	
52	Muscicapidae	Javan Whistling-thrush	*Myophonus glaucinus*	LC		v		•	
53	Nectariniidae	White-flanked Sunbird	*Aethopyga eximia*	LC		v		•	
54	Nectariniidae	Brown-throated Sunbird	*Anthreptes malacensis*	LC			v	•	
55	Nectariniidae	Ornate Sunbird	*Cinnyris ornatus*	LC			v	•	
56	Pachycephalidae	Rusty-breasted Whistler	*Pachycephala fulvotincta*	LC	v			•	
57	Passeridae	Tree Sparrow	*Passer montanus*	LC			v	•	
58	Phasianiidae	Green Junglefowl	*Gallus varius*	LC	v			•	
59	Phylloscopidae	Sunda Warbler	*Phylloscopus grammiceps*	LC		v		•	
60	Phylloscopidae	Mountain Leaf Warbler	*Phylloscopus trivirgatus*	LC		v		•	
61	Picidae	Freckle-breasted Woodpecker	*Dendrocopos analis*	LC	v		v	•	
62	Pittidae	Javan Banded Pitta	*Hydrornis guajanus*	LC			v	•	
63	Pnoepygidae	Pygmy Cupwing	*Pnoepyga pusilla*	LC		v		•	
64	Pycnonotydae	Javan Bulbul	*Ixos virescens*	LC		v		•	
65	Pycnonotydae	Sunda Yellow-vented Bulbul	*Pycnonotus analis*	LC			v	•	
66	Pycnonotydae	Sooty-headed Bulbul	*Pycnonotus aurigaster*	LC	v		v	•	
67	Rhipiduridae	White-bellied Fantail	*Rhipidura euryura*	LC		v		•	
68	Sittidae	Blue Nuthatch	*Sitta azurea*	LC		v		•	
69	Timaliidae	Crescent-chested Babbler	*Cyanoderma melanothorax*	LC		v		•	
70	Trogonidae	Orange-breasted Trogon	*Harpactes oreskios*	LC		v		•	
71	Turnicidae	Barred Buttonquail	*Turnix suscitator*	LC	v		v	•	
72	Zosteropidae	Javan Heleia	*Apalopteron javanicum*	LC		v		•	

Source: ERM 2022

Based on the survey activity, flying paths of the bird communities in the vantage point were stretched from ground level to 230 meters above the terrain. Median for the flying path was 5 meters and the average is 12 meters. Most of the flying path (93 %) fo r the observed birds were under 30 meters, leaving only 7 % of birds that fly above 30 meters.

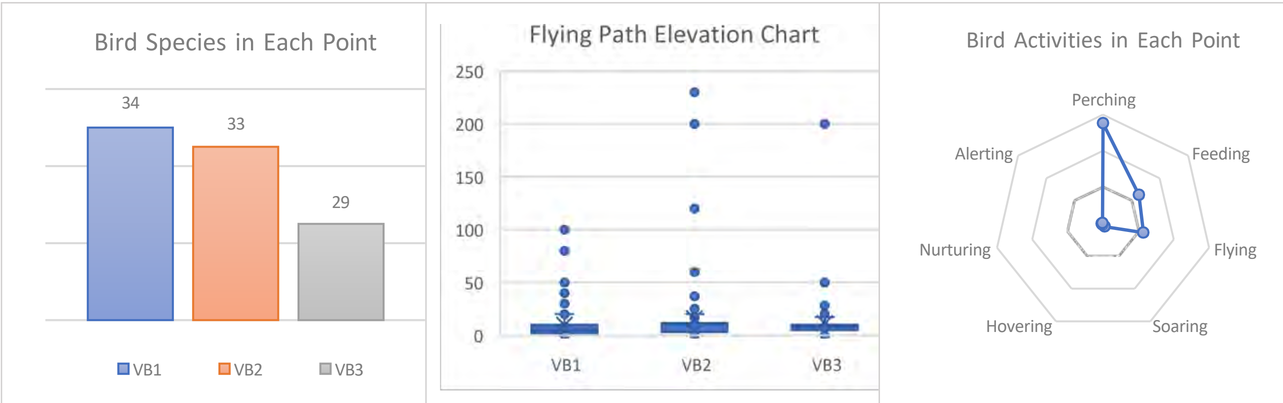


Figure 4-25: Vantage Point Analysis Chart

VB1 has the highest number of birds recorded with 34 species. VB1 share the same location with Transect 2 of terrestrial biodiversity survey. This point lies in the grassland, surrounded by secondary forest and agricultural area. The viewing area in this point is large due to the minimum obstruction around the point. Therefore, large number of the birds were observed during both season of vantage point survey (***Figure 4-25***).

VB2 point has the largest variations of the flying path elevation. VB2 is in the secondary forest near the main road from Banyuwangi to Ijen crater. Even though the viewing area is limited due to the high trees and hilly area in the point location, large number of birds still recorded during the survey. Secondary forest is the most preferred habitat for the birds in the study location.

Most of the birds observed during vantage point survey was perching near the point location. Some of them were also flying crossing the point area and feeding nearby. Perching is the most activities conducted by the birds since most of the birds were small to medium birds that inhabit lower part of the canopy. Other rare activities were soaring, hovering, nurturing, and alerting. All of them were only occasionally conducted by the birds that crossing the point location. Some of them, including soaring and hovering, can only be conducted by specific bird.

Among all observed birds during the vantage point survey, only 10 species that observed flying above 30 meters from the ground. Most of them are birds of prey from Accipitridae and Falconidae family. Those birds are hunting their prey by flying high and glide to the target in high speed. To get the desired height, they utilize the rising air or "thermals" and soaring above it. During the survey, the Sunda honeybuzzard highest point reaches 230 meters above ground. Other species potentially have capability to fly above 30 meters, such as the crested serpent eagle. However, they only fly short during the survey.

4.3.6.3 Mammal

Survey activity resulted in 22 species from 13 families. ***Table 4-23*** is the complete list of mammals observed during the survey.

Table 4-23: List of Observed Mammals in Survey Location

No	Family	Scientific Name	Common Name	Station						Habitat				Conservation Status			
				1	2	3	4	5	6	SH	AG	MP	SF	IUCN	Protection	CITES	Endemic
1	Cercopithecidae	*Macaca fascicularis*	Common long-tailed macaque	V				V	V		V	V		VU	V	II	V
2	Cercopithecidae	*Trachypithecus auratus*	Spangled ebony langur	V		V			V			V		VU	-	II	-
3	Cervidae	*Muntiacus muntjak*	Southern red muntjac	V		V						V		LC	V	-	-
4	Felidae	*Prionailurus bengalensis*	Leopard cat	V				V	V		V	V		LC	V	II	-
5	Herpestidae	*Urva javanica*	Javan mongoose				V					V		LC		III	-
6	Muridae	*Mus caroli*	Ryukyu mouse		V					V				LC		-	V
7	Muridae	*Rattus exulans*	Polynesian rat	V								V		LC	-		-
8	Muridae	*Rattus tiomanicus*	Malaysian field rat	V								V		LC	-		-
9	Mustelidae	*Martes flavigula*	Yellow-throated marten		V							V		LC	-	III	-
10	Pteropodidae	*Chironax melanocephalus*	Black-capped fruit bat	V		V			V			V		LC	-	-	-
11	Pteropodidae	*Cynopterus brachyotis*	Lesser short-nosed fruit bat				V					V		LC	-	-	-
12	Pteropodidae	*Eonycteris spelaea*	Lesser dawn bat					V			V			LC	-	-	-
13	Pteropodidae	*Rousettus amplexicaudatus*	Geoffroy's rousette					V			V			LC	-	-	-
14	Rhinolophidae	*Rhinolophus acuminatus*	Accuminate horseshoe bat						V			V		LC	-	-	-

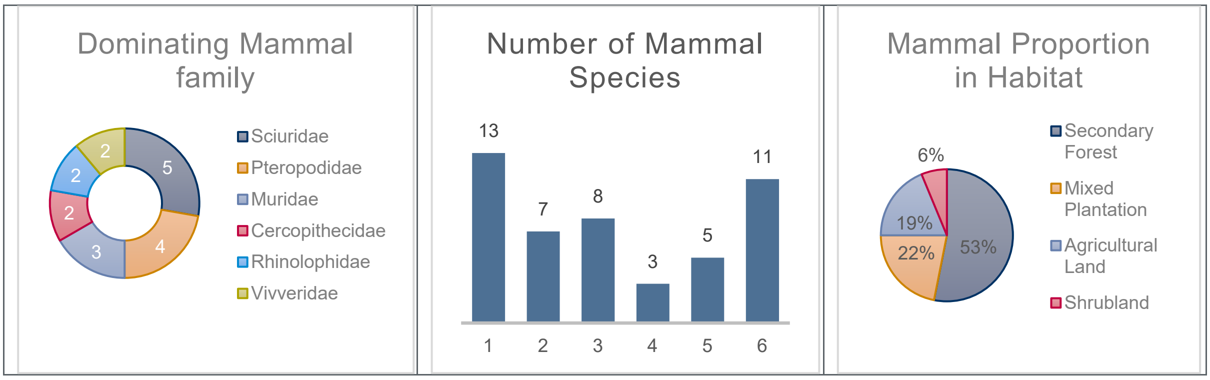
No	Family	Scientific Name	Common Name	Station						Habitat				Conservation Status			
				1	2	3	4	5	6	SH	AG	MP	SF	IUCN	Protection	CITES	Endemic
15	Rhinolophidae	*Rhinolophus affinis*	Intermediate horseshoe bat						V			V		LC	-	-	-
16	Sciuridae	*Callosciurus nigrovittatus*	Black-striped squirrel	V		V			V			V		LC	-	-	-
17	Sciuridae	*Callosciurus notatus*	Plantain squirrel	V	V						V	V	V	LC			
18	Sciuridae	*Petaurista petaurista*	Red giant flying squirrel	V		V			V			V		LC			
19	Suidae	*Sus scrofa*	Wild boar	V		V			V			V		LC	II		
20	Tupaiidae	*Tupaia javanica*	Horsfield's treeshrew		V		V	V			V	V		LC	-		
21	Vespertilionidae	*Miniopterus australis*	Little bent-wing bat		V							V		LC	-		
22	Viverridae	*Paradoxurus hermaphroditus*	Common palm civet	V	V	V			V	V		V	V	LC	III		

Source: ERM 2022, Notes: SF: Secondary Forest; SH: Shrub Land; MP: Mixed Plantation; AG: Agricultural Land

Mammals in the study area were scarcely observed (***Figure 4-26***). Common palm civet was the most common mammal species observed, with encounters in four out of six transects. This species can also be found in almost all habitat types, with agricultural land being the exception. Widespread in south to southeastern asia, it is assumed had large populations, uses a broad range of habitats and was tolerant of extensive habitat degradation and change. This species was adapted for forest living, yet it tolerates living in areas near people: commuting along wires and pipes, sleeping in barns, drains, or roofs during the day, and coming out at night to catch rats or forage fruits, it also eats insects and molluscs.

Big terrestrial mammals were hardly encountered in most part of Java Island due to the pressure from the development for human needs. Only southern red muntjac and wild boar were observed during this study. Both mammals were found in the secondary forest, far from human settlement. Two primates, spangled ebony langur and common long tailed macaque, were also found during this study. Both monkeys were found during both wet and dry season survey of the seven bat species found only Geoffroy's rousette that could be found during both wet and dry season survey. Bat species have higher chance to adapt in the human dominated landscape compared to the big terrestrial mammals due to their flying ability so they could mobilize over long distances. Compared to the primates, bats can feed in the agricultural area without making significant damage to the properties. Therefore, several bat species can coexist with human without further conflict.

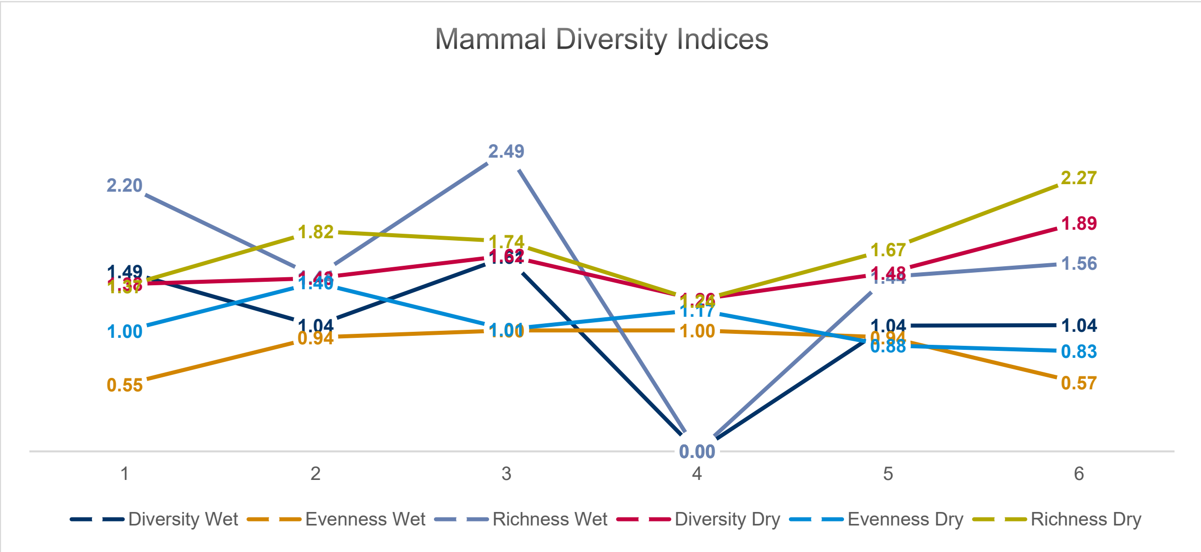
Figure 4-26: Number of Mammal Family and Species in Different Transects and Habitat



Pteropodidae dominates the mammal in the study area with four members. Pteropodidae also called as fruit bats or old world fruit bats since they are primarily frugivorous and widely distributed in the tropics area of the old world. Megabat mostly are unable to do echo location, so they cannot detect the mist net precisely. They rely instead on keen senses of sight and smell to navigate and locate food. But this method is ineffective for Pteropus and Acerodon member that having larger size and capable to highflying.

Transect 1 has the highest number of mammals, with 13 species encountered during both seasonal surveys (***Figure 4-27***). In contrast, transect 4 has the lowest encounter with only three species encountered. Most of the mammal species were found in the secondary forest habitat. Three transects with higher encountered mammals, transect 1, 3, and 6, were crossing the secondary forest which suitable as the habitat of mammals in the study area. The other three were covered mostly by agricultural area, shrub land, and savannah and avoided by most mammals.

Figure 4-27: Diversity, Evenness, and Richness Indices of Mammal Species



In general, there were an increase in the diversity index value from the wet season to the dry season, except for transect 1 which experienced a decrease in the dry season. Transect 3 had the highest diversity value during the dry season with 1.61, but then transect 6 took its place in the dry season with 1.89. In transect 2 there was no large number of mammal species encounters, but there was a significant increase in the evenness index value. This transect had a value of 0.94 in the wet season and was the highest in the dry season with 1.40, although only a total of seven mammal species were found in both seasons. This is because almost every species found was only represented by one individual, so that there is evenness because there was no dominant species. Usually, the holder of the highest diversity index value also has the highest richness index value. Likewise, what happened in transect 3 with a score of 2.49 which was the highest in the wet season, but then transect 6 took its place in the dry season with a value of 2.27.

Mammals observed during the field surveys are provided in ***Figure 4-28***.

Figure 4-28: Mammals Observed in the Study Area


Crab eating macaque


Black-caped fruit bat

Black striped squirrel

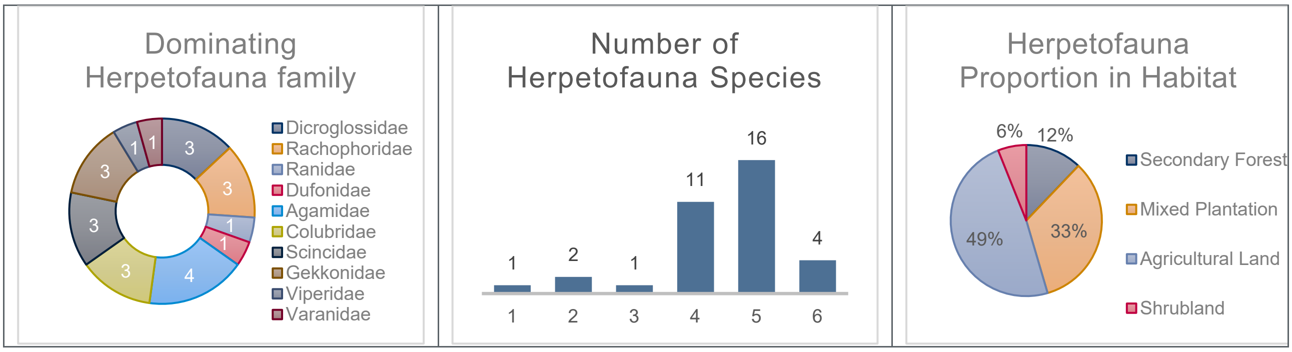
Plantain squirrel

4.3.6.4 Herpeto-fauna

Survey activity resulted in 23 species from 11 families. ***Table 4-24*** is the complete list of herpetofauna observed during the survey.

There are no herpetofauna species found in all transects (***Figure 4-29***), but some species were found in at least three of six transects. Those species were Java bubble-nest frog, four-lined tree frog, and common sub skink. Java bubble-nest frog is a common species that can be found in Sumatra and Java. It inhabits primary submontane and montane forest, and is not found outside forests, adults are often found on shrubs. While four-lined tree frog is commonly observed in the disturbed habitat and indicated from this survey that they were not observed in the secondary forest habitat. Common sub skink is also common species and coexist with human even in the settlement area.

Figure 4-29: Number of Herpetofauna Species in Different Transects and Habitat



Dicroglossidae and Rhacophoridae families has the highest number of amphibians in the study area with three members each. Dicroglossidae which commonly known as fork-tongued frog are occurs in tropical and subtropical regions of Asia and Africa, with most genera and species being found in Asia. While Rhacophoridae family commonly known as shrub frogs or tree frogs since most of the species are arboreal frogs. They spent their lifespan in the tree or shrub and laid their eggs in the self-made sticky foam in the branch. Meanwhile, Agamidae is the largest family of reptiles in the study area with total four species. This is a family of over 300 species of lizards indigenous to Africa, Asia, Australia, and few in Southern Europe.

Transect 5 has the highest number of herpetofauna, with 16 species. This habitat is located near the settlement and have habitat variation including the agricultural land, mixed plantation, and shrubland. Some species of herpetofauna can only be found on this transect, whereas in other places the species are common and well adapted to live around human settlements. In contrast, transect 1 and 3 only found single species, namely Java bubble-nest frog, where this species was found in large numbers in the dry season survey. This encounter pattern is likely due to warmer temperatures providing more abundant feed around the transect.

The study area is stretching in the lowland up to the montane area without large river or natural water reservoir. Some of the small rivers even contain high level of sulfur that cannot hold biodiversity within. Most herpetofauna that highly dependent with available water were avoiding this area and leave the tolerant common species inhabit the study area. Almost half of the herpetofauna were found in the agricultural land habitat. Even though this habitat is highly modified and intensively cared for by villagers, it still provides the basic needs for most of the herpetofauna species. The crop plants grown in this habitat attract insect pests that feed on most amphibians and eventually attract reptiles that act as predators.

Table 4-24: List of Observed Herpetofauna in the Survey Location

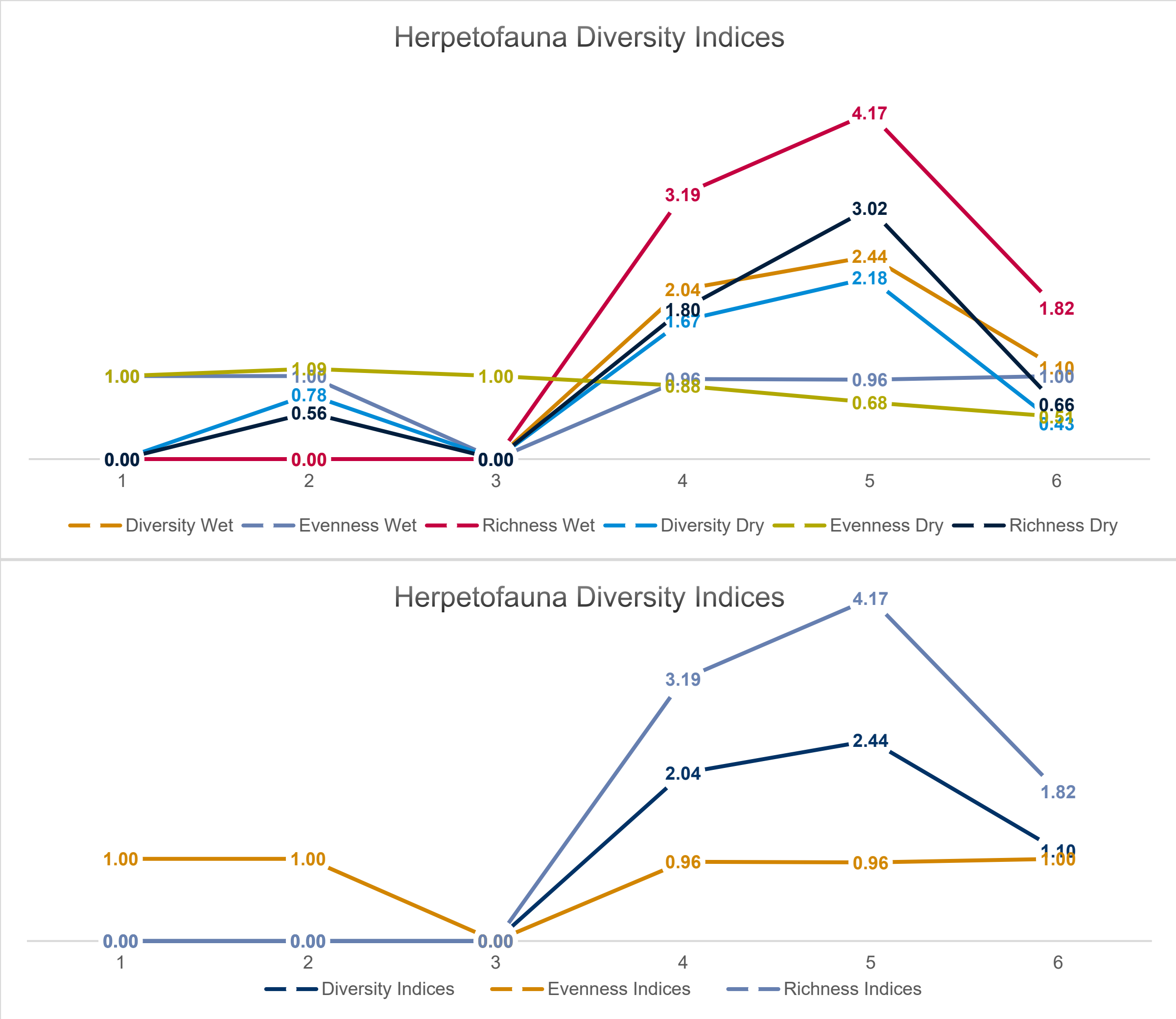
No	Family	Scientific Name	Common Name	Station						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	MP	AG	SH	IUCN	CITES	Protection	Endemic
Amphibian																	
1	Dufonidae	*Phrynoidis aspera*	Java toad					√				√		LC	-	-	-
2	Dicroglossidae	*Fejervarya cancrivora*	Crab-eating frog					√				√		LC	-	-	-
3	Dicroglossidae	*Fejervarya limnocharis*	Asian grass frog				√	√			√	√		LC	-	-	-
4	Dicroglossidae	*Limnonectes microdiscus*	Pygmy creek-frog					√				√		LC	-	-	-
5	Ranidae	*Odorrana hosii*	poisonous rock frog						√	√				LC	-	-	-
6	Rachophoridae	*Polypedates leucomystax*	four-lined tree frog		√		√	√			√	√	√	LC	-	-	-
7	Rachophoridae	*Philautus aurifasciataus*	Java Bubble-nest Frog	√		√			√	√				LC	-	-	-
8	Rachophoridae	*Nyctixalus margaritifer*	Pearly Treefrog						√	√				LC	-	-	√
Reptile																	
9	Scincidae	*Eutropis multifasciata*	common sub skink				√	√			√	√		LC	-	-	-
10	Scincidae	*Eutropis rudis*	Rough Mabuya				√				√			-	-	-	-
11	Scincidae	*Lygosoma quadrupes*	Supple skink				√	√			√			LC	-	-	-
12	Agamidae	*Bronchocela jubata*					√	√			√	√		LC	-	-	-
13	Agamidae	*Bronchocela cristatella*	green crested lizard				√	√			√	√		-	-	-	-
14	Agamidae	*Calotes versicolor*	Changeable Lizard					√				√		LC	-	-	-

No	Family	Scientific Name	Common Name	Station						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	MP	AG	SH	IUCN	CITES	Protection	Endemic
15	Agamidae	*Draco haematopogon*	Red-bearded flying dragon				√		√	√	√			LC	-	-	-
16	Gekkonidae	*Gekko gecko*	Tokay Gecko				√				√			LC	-	-	-
17	Gekkonidae	*Hemidactylus frenatus*						√				√		LC	-	-	-
18	Gekkonidae	*Hemidactylus platyurus*	Flat-tailed house gecko				√				√			LC	-	-	-
19	Colubridae	*Ahaetulla prasina*	oriental whip snake					√				√		LC	-	-	-
20	Colubridae	*Dendrelaphis pictus*	common bronzeback				√	√			√	√		LC	-	-	-
21	Colubridae	*Ptyas korros*	Javan Rat Snake					√				√		NT	-	-	-
22	Viperidae	*Trimeresurus insularis*	white-lipped island pitviper					√				√		LC	-	-	-
23	Varanidae	*Varanus salvator*	Common water monitor					√				√		LC	-	-	-

Source: ERM 2022. Notes: SF: Secondary Forest; SH: Shurb Land; MP: Mixed Plantation; AG: Agricultural Land

Half of the herpetofauna were found in the mixed plantation habitat (***Figure 4-30***). Even though this habitat is highly modified, it still provides the basic needs for most of the herpetofauna species, including the food, water, and shelter. All herpetofauna species that encountered in the secondary forest habitat are amphibian. Poisonous rock frog is the only terrestrial amphibian that found in the secondary forest. This frog was observed in the river in transect 6, located far from the river that contain sulphur.

Figure 4-30: Diversity, Evenness, and Richness Indices of Herpetofauna Species

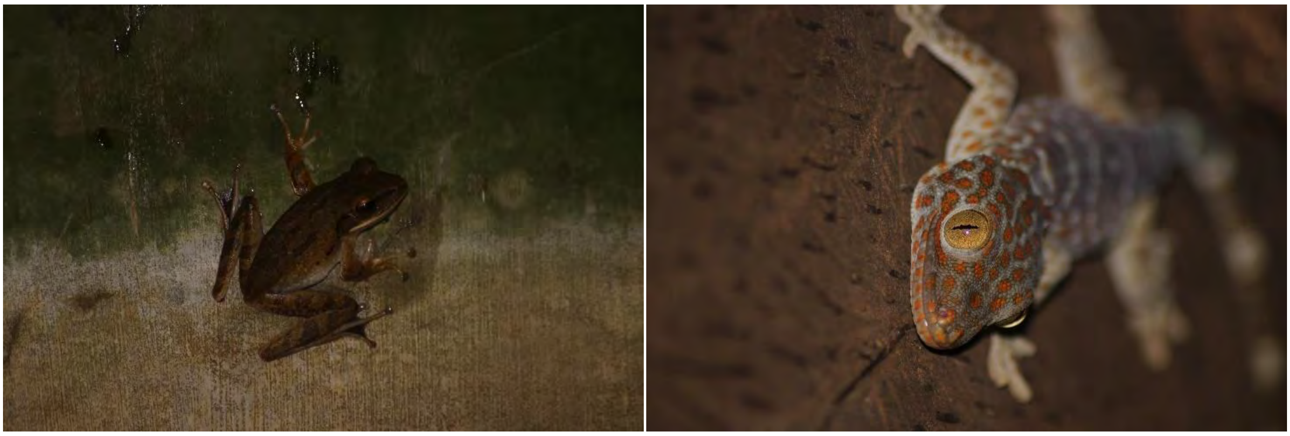


Transect 5 has the highest number of herpetofauna, with 16 species. This habitat is located near the settlement and have habitat variation including the agricultural land, mixed plantation, and shrubland. Some species of herpetofauna can only be found on this transect, whereas in other places the species are common and well adapted to live around human settlements. In contrast, transect 1 and 3 only found single species, namely Java bubble-nest frog, where this species was found in large numbers in the dry season survey. This encounter pattern is likely due to warmer temperatures providing more abundant feed around the transect.

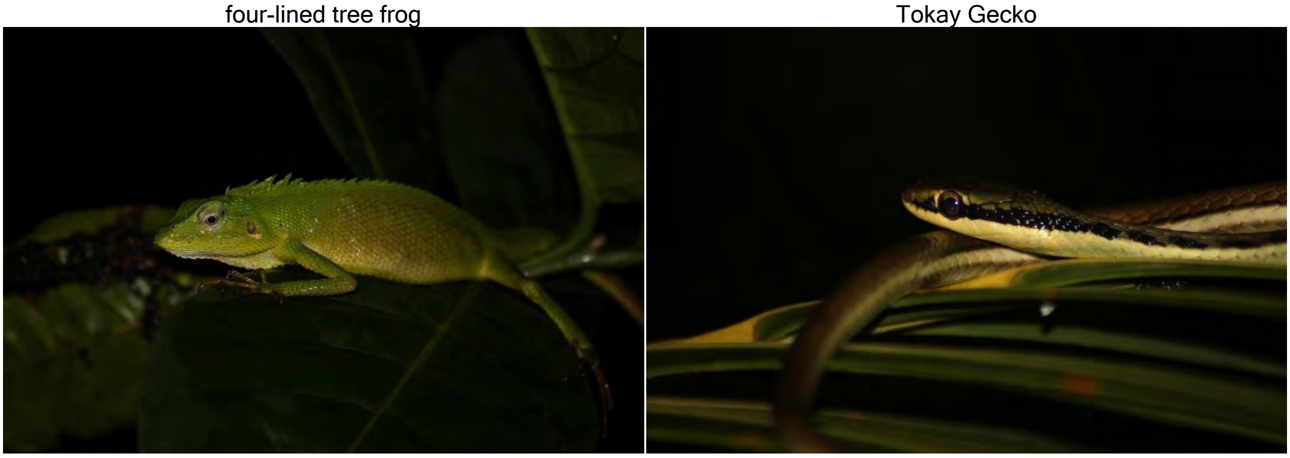
The study area is stretching in the lowland up to the montane area without large river or natural water reservoir. Some of the small rivers even contain high level of sulfur that cannot hold biodiversity within. Most herpetofauna that highly dependent with available water were avoiding this area and leave the tolerant common species inhabit the study area. Almost half of the herpetofauna were found in the agricultural land habitat. Even though this habitat is highly modified and intensively cared for by villagers, it still provides the basic needs for most of the herpetofauna species. The crop plants grown in this habitat attract insect pests that feed on most amphibians and eventually attract reptiles that act as predators.

In the wet season survey, three of six transects got a diversity index value of zero, while the highest was 2.44 on transect 5. Then in the dry season the diversity index value in most transects actually decreased, except for transect 2 which was previously zero to 0.78. This increase was due to the increase in the number of species found from one to two species. While on transect 3, although there was an increase in species from the previous zero to one, it had no significant effect on statistical calculations. Evenness index calculation shows fluctuating changes in several transects. Transect 3 showed a significant increase, from zero to 1.00, which was due to the addition of one species of frog in the dry season survey. While transect 6 experienced a significant decrease from 1.00 to 0.51 due to the large number of individuals found in the dry season. Whereas the number of species found during both season surveys were the same, as many as three species found each. Transect 6 also the transect with the lowest evenness value in the dry season, which means that there was species that was considered dominant because of the encounter of much greater number of individuals than the other species. The result of the calculation of richness index relatively followed the diversity index which places transect 5 as the highest in both the wet and dry season surveys.Herpetofauna observed in the study area are shown in ***Figure 4-31***.

Figure 4-31: Herpetofauna Observed in the Study Area



four-lined tree frog Tokay Gecko



maned forest lizard common bronzeback

4.3.6.5 Insect

Survey activity resulted in 136 species from 20 families. ***Table 4-25*** is the complete list of insects observed during the survey.

Table 4-25: List of Observed Insect in the Survey Location

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
1	Lepidoptera	Callidulidae	*Callidula sp1*						v				v	NE			
2	Lepidoptera	Crambidae	*Bradina diagonalis*		v		v			v				NE			
3	Lepidoptera	Crambidae	*Eurrhyparodes tricoloralis*				v					v		NE			
4	Lepidoptera	Crambidae	*Marasmia sp1*				v					v		NE			
5	Lepidoptera	Drepanidae	*Thyatira batis*			v							v	NE			
6	Lepidoptera	Erebidae	*Aloa cardinalis*				v					v		NE			
7	Lepidoptera	Erebidae	*Amata huebneri*					v			v			NE			
8	Lepidoptera	Erebidae	*Anomis flava*		v					v				NE			
9	Lepidoptera	Erebidae	*Anticarsia irrorata*				v					v		NE			
10	Lepidoptera	Erebidae	*Artaxa sp*	v									v	NE			
11	Lepidoptera	Erebidae	*Asota sp*	v									v	NE			
12	Lepidoptera	Erebidae	*Bastilla sp1*		v					v				NE			
13	Lepidoptera	Erebidae	*Bertula abjudicalis*						v				v	NE			
14	Lepidoptera	Erebidae	*Bertula sp*		v	v				v			v	NE			
15	Lepidoptera	Erebidae	*Bertula sp1*						v				v	NE			
16	Lepidoptera	Erebidae	*Bocana manifestalis*						v				v	NE			
17	Lepidoptera	Erebidae	*Bocana sp*						v				v	NE			

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
18	Lepidoptera	Erebidae	*Bocana sp1*				v		v			v	v	NE			
19	Lepidoptera	Erebidae	*Creatonotos transiens*				v					v		NE			
20	Lepidoptera	Erebidae	*Cyana sp1*		v					v				NE			
21	Lepidoptera	Erebidae	*Daniielithosia sp*	v									v	NE			
22	Lepidoptera	Erebidae	*Eilema lurideola*					v			v			NE			
23	Lepidoptera	Erebidae	*Erebus ephesperis*						v				v	NE			
24	Lepidoptera	Erebidae	*Euproctis chrysorrhoea*				v					v		NE			
25	Lepidoptera	Erebidae	*Garudinia sp*				v				v	v		NE			
26	Lepidoptera	Erebidae	*Hipoepa sp*		v					v				NE			
27	Lepidoptera	Erebidae	*Hypena sp1*						v				v	NE			
28	Lepidoptera	Erebidae	*Hypopyra sp1*					v			v			NE			
29	Lepidoptera	Erebidae	*Leucoma sp*					v			v			NE			
30	Lepidoptera	Erebidae	*Mangina argus*		v					v				NE			
31	Lepidoptera	Erebidae	*Mecodina sp1*						v				v	NE			
32	Lepidoptera	Erebidae	*Mocis sp*			v							v	NE			
33	Lepidoptera	Erebidae	*Mocis sp1*			v							v	NE			
34	Lepidoptera	Erebidae	*Mocis sp2*					v			v			NE			
35	Lepidoptera	Erebidae	*Mocis undata*				v					v		NE			

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
36	Lepidoptera	Erebidae	*Naarda sp*	v					v				v	NE			
37	Lepidoptera	Erebidae	*Nyctemera coleta*				v					v		NE			
38	Lepidoptera	Erebidae	*Nyctemera sp*			v							v	NE			
39	Lepidoptera	Erebidae	*Padenia obliquifascia*						v				v	NE			
40	Lepidoptera	Erebidae	*Pantydia sp1*				v					v		NE			
41	Lepidoptera	Erebidae	*Progonia oileusalis*					v			v			NE			
42	Lepidoptera	Erebidae	*Rusicada sp1*		v					v				NE			
43	Lepidoptera	Erebidae	*Simplicia cornicalis*	v	v					v		v	v	NE			
44	Lepidoptera	Erebidae	*Simplicia sp1*	v									v	NE			v
45	Lepidoptera	Erebidae	*Trigonodes disjuncta*				v					v		NE			
46	Lepidoptera	Erebidae	*Vamuna sp*						v				v	NE			
47	Lepidoptera	Geometridae	*Acropteris sp1*						v				v	NE			
48	Lepidoptera	Geometridae	*Biston sp1*	v									v	NE			
49	Lepidoptera	Geometridae	*Chiasmia sp1*		v					v				NE			
50	Lepidoptera	Geometridae	*Ecliptopera sp*	v									v	NE			
51	Lepidoptera	Geometridae	*Ecliptopera sp1*	v									v	NE		v	
52	Lepidoptera	Geometridae	*Heteralex sp*		v	v				v			v	NE		v	
53	Lepidoptera	Geometridae	*Idaea sp1*	v									v	NE			
54	Lepidoptera	Geometridae	*Lophophelma vigens*	v									v	NE			

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
55	Lepidoptera	Geometridae	*Ourapteryx podaliriata*	v									v	NE			
56	Lepidoptera	Geometridae	*Pelagodes falsaria*		v					v				NE			
57	Lepidoptera	Geometridae	*Scopula sp1*		v							v		NE			
58	Lepidoptera	Geometridae	*Tanaorhinus refflesii*	v									v	NE			
59	Lepidoptera	Geometridae	*Timandra punctinervis*	v		v							v	NE			
60	Lepidoptera	Geometridae	*Timandra sp*						v				v	NE			
61	Lepidoptera	Hesperiidae	*Borbo cinnara*					v			v			NE			
62	Lepidoptera	Hesperiidae	*Choaspes sp1*						v				v	NE			
63	Lepidoptera	Hesperiidae	*Hidari irava*					v			v			NE			
64	Lepidoptera	Hesperiidae	*Koruthaialos sindu*						v				v	NE			
65	Lepidoptera	Hesperiidae	*Potanthus sp1*				v					v		NE			v
66	Lepidoptera	Hesperiidae	*Suastus gremius*					v			v			NE			v
67	Lepidoptera	Hesperiidae	*Taractrocera archias*					v			v			NE			
68	Lepidoptera	Hesperiidae	*Telicota sp1*		v					v				NE			
69	Lepidoptera	Lecithoceridae	*Lecithocera sp*					v			v			NE			
70	Lepidoptera	Lycaenidae	*Udara akasa*	v	v	v				v			v	NE			
71	Lepidoptera	Lycaenidae	*Udara sp*	v									v	NE			
72	Lepidoptera	Lycaenidae	*Zizina otis*		v	v	v			v		v	v	LC			
73	Lepidoptera	Noctuidae	*Adrapsa sp*					v			v			NE			

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
74	Lepidoptera	Noctuidae	*Adrapsa sp1*				v					v		NE			
75	Lepidoptera	Noctuidae	*Leucania sp1*			v							v	NE			
76	Lepidoptera	Noctuidae	*Mythimna sp1*	v									v	NE			
77	Lepidoptera	Noctuidae	*Spodoptera litura*					v			v			NE			
78	Lepidoptera	Nymphalidae	*Acraea issoria*		v					v				NE			
79	Lepidoptera	Nymphalidae	*Cyrestis lutea*						v				v	NE			
80	Lepidoptera	Nymphalidae	*Cyrestis themire*					v				v		LC			
81	Lepidoptera	Nymphalidae	*Elymnias nesaea*					v			v			NE			
82	Lepidoptera	Nymphalidae	*Faunis canens*						v				v	NE			
83	Lepidoptera	Nymphalidae	*hypolimnas bolina*				v	v			v	v		NE			
84	Lepidoptera	Nymphalidae	*Hypolimnas misippus*				v					v		LC			
85	Lepidoptera	Nymphalidae	*Ideopsis gaura*						v				v	NE			
86	Lepidoptera	Nymphalidae	*Ideopsis juventa*					v				v		NE			
87	Lepidoptera	Nymphalidae	*Junonia almana*					v			v			LC			
88	Lepidoptera	Nymphalidae	*Junonia atlites*					v			v			NE			
89	Lepidoptera	Nymphalidae	*Junonia iphita*					v				v		NE			
90	Lepidoptera	Nymphalidae	*Junonia orithya*		v			v		v	v			LC			
91	Lepidoptera	Nymphalidae	*Melanitis leda*				v					v		LC			
92	Lepidoptera	Nymphalidae	*Mycalesis horsfieldi*				v					v		NE			

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
93	Lepidoptera	Nymphalidae	*Mycalesis janardana*				v							LC			
94	Lepidoptera	Nymphalidae	*Mycalesis perseus*				v					v		NE			
95	Lepidoptera	Nymphalidae	*Mycalesis sudra*	v	v	v	v		v	v		v	v	NE			
96	Lepidoptera	Nymphalidae	*Neptis hylas*				v	v				v		NE			
97	Lepidoptera	Nymphalidae	*Orsotriaena medus*				v	v			v	v		NE			
98	Lepidoptera	Nymphalidae	*Parantica sp*						v				v	NT			v
99	Lepidoptera	Nymphalidae	*Symbrenthia hypselis*	v									v	NE			
100	Lepidoptera	Nymphalidae	*Symbrenthia lilaea*	v	v	v			v	v			v	NE			
101	Lepidoptera	Nymphalidae	*Tanaecia iapis*						v				v	NE			
102	Lepidoptera	Nymphalidae	*Ypthima baldus*				v			v		v		NE			
103	Lepidoptera	Nymphalidae	*Ypthima pandocus*	v	v		v		v	v		v	v	NE			
104	Lepidoptera	Nymphalidae	*Zeuxidia sp1*						v				v	NE			
105	Lepidoptera	Papilionidae	*Graphium sarpedon*				v					v		LC			
106	Lepidoptera	Papilionidae	*Papilio memnon*					v				v		NE			
107	Lepidoptera	Papilionidae	*Papilio Paris*	v									v	NE			
108	Lepidoptera	Papilionidae	*Papilio sp*	v									v	NE			
109	Lepidoptera	Papilionidae	*Troides amphrysus*						v				v	LC			
110	Lepidoptera	Papilionidae	*Troides helena*	v					v				v	LC			
111	Lepidoptera	Papilionidae	*Troides sp*		v					v				LC			

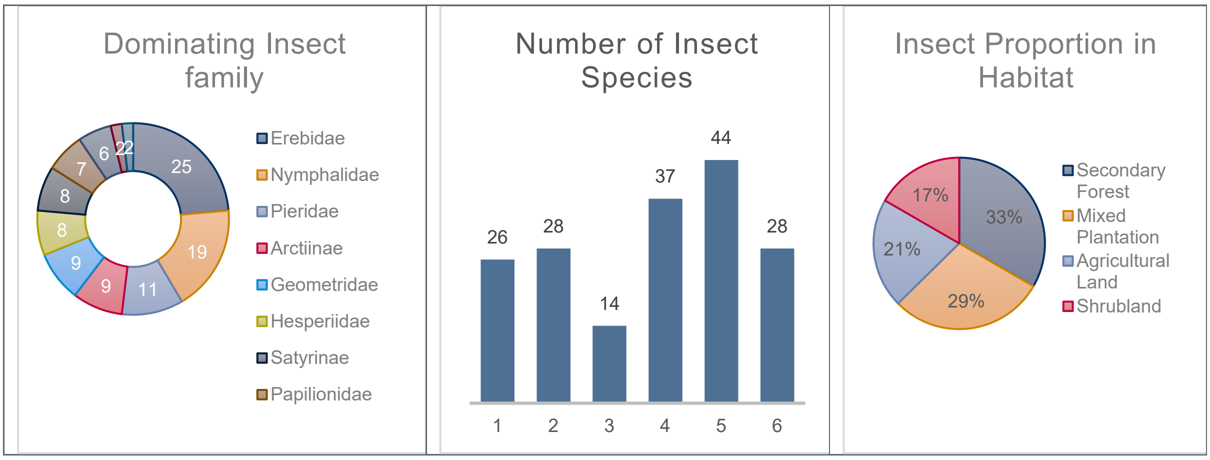
No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
112	Lepidoptera	Pieridae	*Appias libythea*					v			v	v		NE			
113	Lepidoptera	Pieridae	*Appias olferna*					v			v			NE			
114	Lepidoptera	Pieridae	*Delias aurantiaca*	v		v						v	v	NE			
115	Lepidoptera	Pieridae	*Delias belisama*		v	v	v			v		v	v	NE			
116	Lepidoptera	Pieridae	*Eurema blanda*		v			v		v	v	v		NE			
117	Lepidoptera	Pieridae	*Eurema brigitta*		v					v				LC			
118	Lepidoptera	Pieridae	*Eurema hecabe*	v	v		v	v		v	v	v	v	NE			
119	Lepidoptera	Pieridae	*Eurema sari*				v		v	v			v	NE			
120	Lepidoptera	Pieridae	*Eurema sp*					v			v			NE			
121	Lepidoptera	Pieridae	*Leptosia nina*				v	v			v	v		NE			
122	Lepidoptera	Pyralidae	*Cnaphalocrocis medinalis*				v					v		NE			
123	Lepidoptera	Saturniidae	*Cricula trifenestrata*				v					v		NE			
124	Odonata	Calopterygiidae	*Vestalis luctuosa*					v			v	v		LC			v
125	Odonata	Chlorocyphidae	*Rhinocypha fenestrata*					v			v	v		LC			v
126	Odonata	Coenagrionidae	*Ischnura senegalensis*					v			v			LC			
127	Odonata	Coenagrionidae	*Pseudagrion pruinosum*					v			v	v		LC			
128	Odonata	Euphaeidae	*Euphaea variegata*					v				v		LC			

No	Order	Family	Scientific Name	Transect						Habitat				Conservation Status			
				1	2	3	4	5	6	SF	SH	AG	MP	IUCN	CITES	Protection	Endemic
129	Odonata	Libellulidae	*Diplacodes trivialis*					v			v			LC			
130	Odonata	Libellulidae	*Neurothemis terminata*					v			v	v		LC			
131	Odonata	Libellulidae	*Orthetrum sabina*		v		v	v		v	v	v		LC			
132	Odonata	Libellulidae	*Pantala flavescens*		v		v	v		v	v	v		LC			
133	Odonata	Libellulidae	*Potamarcha congener*					v				v		LC			
134	Odonata	Libellulidae	*Trithemis festiva*					v			v			LC			
135	Odonata	Platycnemididae	*Copera marginipes*					v			v	v		LC			
136	Odonata	Platycnemididae	*Prodasineura autumnalis*					v			v	v		LC			

Source: ERM 2022, Notes: SF: Secondary Forest; SH: Shurb Land; MP: Mixed Plantation; AG: Agricultural Land

The insect survey was focused on two major orders that represent the insect biodiversity in the study area (***Figure 4-32***). Lepidoptera was the most diverse species with 14 families, while Odonata has six families. *Mycalesis sudra* was the most common Lepidoptera species found during the survey, which could be found on five of the six transects. Based on literature studies, it is estimated that this species is mostly found in Java and Bali, and is well adapted to various types of habitats. While the most common Odonata species were *Orthetrum sabina* and *Pantala flavescens*, which were found on three of the six transects. Both of these species come from the family Libellulidae, are commonly found around human settlements and are not too disturbed by human activities around them.

Figure 4-32: Number of Insect Species in Different Transects and Habitat



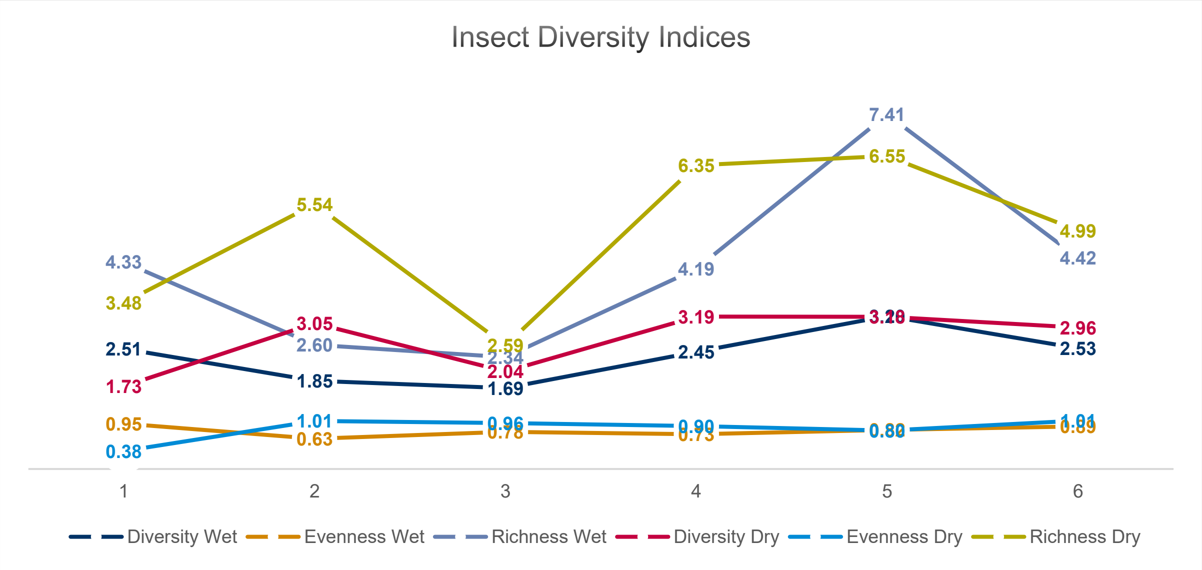
Erebidae is a family of lepidoptera which was commonly found throughout both season surveys with 41 species, followed by Nymphalidae with 27 species. Erebidae is among the largest families of moths by species count and contains a wide variety of well-known macromoth groups. While Nymphalidae family also known as the largest family of butterflies with more than 6.000 species distributed throughout most of the world. Members of these two families are well adapted to live in various habitat types as seen in this survey.

The largest dragonfly family in the study area is Libellulidae with six species. Libellulidae is contain of skimmers or perchers and their relatives, were form the largest dragonfly family with nearly worldwide distribution, these were almost certainly the most often seen of all dragonflies. Aside from the Libellulidae, only small number of family and species of the Odonata that observed in the study area. All Odonata have have aquatic larvae called nymphs and they will spend their early life in the stream or ponds. However, due to the limited water source in the study area, only small numbers of Odonata species were observed.

Based on the survey results, secondary forest and mixed plantation seem to support the most insect species, with a percentage of 33% and 29%, respectively. These two habitats have more or less similar conditions, only the plants species differ but most of the Lepidoptera species were found in the secondary forest habitat, while none of the Odonata species can be found in there. Butterfly needs the flowering plants to provide their diet, and various flora species in the secondary forest can provide that. Meanwhile, Odonata needs the good source of water to establish their life cycle that cannot provided by the secondary forest in the sampling area of this study due to the sulfur content and the physical condition of the river.

Transect 5 (***Figure 4-33***) that covered mostly agricultural area had the highest number of insects with 44 species. Insect relatively prefer open area more than shaded one, especially butterflies and dragonflies that need sufficient heat to fly. In contrast, transect 3 had the lowest encounter with only 14 butterfly species. This transect mostly covered secondary montane forest above 1800 m asl with ambient temperature reaching 10°C. Only a small number of insects are able to live in this kind of habitat.

Figure 4-33: Diversity, Evenness, and Richness Indices of Insect Species



The calculation of the diversity index from the wet to the dry season shows and increase or decrease, some even increase in an extreme way. Statistically, transect 2 experienced an extreme increase from 1.85 to 3.05 even though it was not the transect with the highest number of species, this was probably because the number of species found had doubled in dry season. This significant increase was also seen in the results of evenness and richness index calculations for transect 2. As the transect with the highest number of species, transect 5 was also the highest for the diversity and richness index for both seasons. Although this does not apply to the evenness index because several species are considered dominates the insect community. The richness index for transect 5 decreased significantly from 7.41 to 6.55 but remained the highest in both seasons. The high difference between transect 5 as the highest in almost all aspects and transect 3 as the lowest are reflecting the large gap of the species observed on both transects.

Insect observed in the study area are shown in ***Figure 4-34***.

Figure 4-34: Insect Observed in the Study Area

Pantala flavescens

Udara sp.

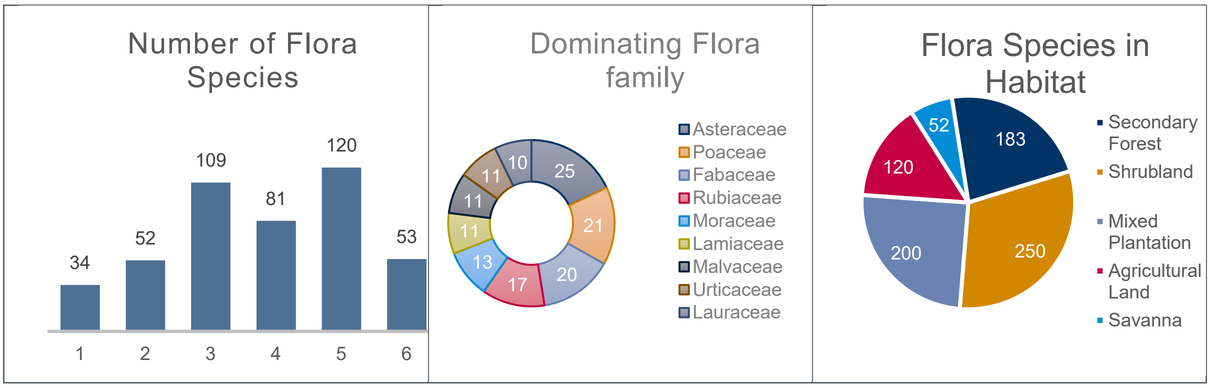
Orsotriaena medus

Pseudagrion pruinosum

4.3.6.6 Vegetation

The flora diversity study resulted in 345 plant species from 90 different families. Asteraceae has the most prominent member with 25 species, followed by Poaceae and Fabaceae and with 21 and 20 species, respectively (***Figure 4-35***).

Figure 4-35: Number of Flora Species, Dominant Flora Family, and Species in Habitat



The highest number of plant species was observed in transect 5, with 120 species. This transect lies in lowland area covers various habitats, mostly mixed plantation and agricultural land. People in the study area tend to plant various kinds of trees, which have an economic benefit. In order to maximize the sunlight people often cut down trees around, resulting in weeds and other understory vegetation to grown.

Shrub land has the highest floral diversity in the study area with 250 species. This shrub land is mainly formed from an abandoned agricultural area that is already covered by pioneer species. A high number of plant species support this natural succession process. The agricultural area dominates the study's sampling area, and most of them are already planted with various species with economic value. In the mixed plantation area, trees are commonly intercropped with different herb species to maximize the monetary value of the land.

Vegetation analysis using quadrat method was only used two plot samples which are transect 1 and 6 that are representative of secondary forest. The other transects were in the form of mixed plantation, intensive agricultural area and or savanna with typical vegetation tends to dominate by specific species, therefore not sufficient for quadrant vegetation analyses ***Table 4-26*** shows the analysis result of the vegetation in those transects.

Table 4-26: Flora Statistics Indices

Transect	Strata	H'	D Mg	E	C
All	Tree	2,568	4,451	0,831	0,113
	Understory	1,362	3,886	0,413	0,419
Transect 1	Tree	1,745	1,883	0,794	0,222
	Understory	0,933	1,784	0,364	0,576
Transect 6	Tree	2,560	4,281	0,903	0,098
	Understory	1,670	3,740	0,549	0,401

Notes: H'=Diversity index; E=Evenness index; D Mg=Richness index; C=Dominance index

Based on table above, transect 6 has higher diversity compared to the transect 1. Almost all indices in transect 6 have higher value than transect 1, except for the dominance index of the understory. Transect 6 has lower dominance value for the understory because *Elatostema* sp. dominate the individual number observed within the plot. Transect 6 designated as a control transect due to its overall condition compared to the other transects. Therefore, it is expected that transect 6 has better forest community than transect 1.

Besides diversity indices, the flora community within an ecosystem can be explained in the importance value index. This index can be shown in the vegetation composition description, including species density, frequency, and dominance. This calculation of species on Transect 1 and Transect 6. ***Table 4-27*** shows the importance of the value index.

Table 4-27: Importance Value Index of Vegetation Composition

Strata	Family	Species	RDe	RF	RDo	IVI
Tree	Lauraceae	Litsea angulata	24,11%	12,07%	25,14%	61,32%
	Celastraceae	Euonymus indicus	16,07%	10,34%	5,61%	32,02%
	Lauraceae	Cryptocarya ferrea var. Ferrea	8,93%	5,17%	13,61%	27,71%
	Moraceae	Ficus annulata	0,89%	1,72%	18,50%	21,12%
	Fagaceae	Quercus argentata	7,14%	8,62%	4,79%	20,56%
Understory	Rubiaceae	Hedyotis prostrata	59,12%	7,35%	-	66,47%
	Urticaceae	Elatostema hirsutum	26,10%	8,82%	-	34,93%
	Smilacaceae	Smilax zeylanica	0,86%	8,82%	-	9,69%
	Apocynaceae	Alyxia reinwardtii	2,69%	5,88%	-	8,57%
	Rubiaceae	Nertera granadensis	1,82%	5,88%	-	7,71%

Notes: RDe=Relative density; RF=Relative frequency; RDo=Relative dominance; IVI=Important value index

Litsea angulata dominates the tree in sampling area with 61,32% IVI. This tree was dominating the sampling location in transect 1 in a total of 25 individuals within five plots. *Quercus argentata* has the highest IVI in transect 6. However, in total this tree only stands in number five because none of them was found in transect 1.

Hedyotis prostrata has the largest IVI among understory species. This species is from Rubiaceae family and dominates the forest floor of transect 1 in all five plots. Meanwhile, *Elastotema hirsutum* is the second highest IVI and dominates the understory of transect 6.

4.3.6.7 Invasive Vegetation

The survey area is an area that has been disturbed due to human activity so it is a place favored by invasive plants. A total of 92 flora species is potentially invasive. Among those, 15 of them are considered as invasive alien species according to the CABI/GISD, and 21 species that are considered invasive according to the Indonesian authority. ***Table 4-28*** shows the invasive species in the study area.

Invasive species in the study area were only observed in transect 2 to 5. There was no invasive species in transect 1 and 6 since both transects were mostly covered by dense secondary forest which prevent the invasive species to grow. Transect 5 has the highest number of invasive flora with 15 species. This transect lies in the lowland and is heavily modified as it is near Banyuwangi City. More invasive species can be easily dispersing to this location due to the high mobility of people around the transect.

Table 4-28: Invasive Species in Survey Location

No	Family	*Scientific Name*	Transect						Invasiveness	
			1	2	3	4	5	6	Global	P.94/2016
1	Amaranthaceae	Alternanthera philoxeroides					V		Alien	
2	Asteraceae	Austroeupatorium inulifolium		V		V			Alien	I
3	Asteraceae	Bidens pilosa				V	V		Alien	I
4	Asteraceae	Chromolaena odorata		V	V	V			-	I
5	Asteraceae	Elephantopus scaber		V					-	I
6	Asteraceae	Galinsoga parviflora		V	V		V		-	I
7	Asteraceae	Mikania micrantha		V	V	V			Alien	
8	Asteraceae	Tithonia diversifolia				V	V		Alien	
9	Cleomaceae	Cleome rutidosperma			V	V			Potential	I
10	Cucurbitaceae	Momordica charantia		V			V		Native	
11	Cyperaceae	Fimbristylis dichotoma		V	V				-	I
12	Euphorbiaceae	Ricinus communis				V	V		Alien	I
13	Fabaceae	Acacia mearnsii			V				Potential	I
14	Fabaceae	Aeschynomene americana			V				Potential	I
15	Fabaceae	Leucaena leucocephala					V		Potential	I
16	Fabaceae	Mimosa pudica		V	V				-	I
17	Gleicheniaceae	Dicranopteris linearis		V			V		-	I
18	Malvaceae	Sida acuta		V	V	V			Alien	
19	Malvaceae	Urena lobata				V			-	I
20	Melastomataceae	Clidemia hirta				V			Potential	I
21	Myrtaceae	Psidium guajava					V		Native	

No	Family	*Scientific Name*	Transect						Invasiveness	
			1	2	3	4	5	6	Global	P.94/2016
22	Onagraceae	Ludwigia hyssopifolia			V				Alien	
23	Oxalidaceae	Oxalis corniculata					V		-	I
24	Passifloraceae	Passiflora foetida				V	V		Alien	I
25	Poaceae	Echinochloa colona		V	V	V	V		Native	I
26	Poaceae	Imperata cylindrica			V		V		Alien	
27	Poaceae	Pennisetum purpureum					V		-	I
28	Pontederiaceae	Monochoria hastata					V		-	I
29	Rubiaceae	Oldenlandia corymbosa		V		V			Alien	I
30	Verbenaceae	Lantana camara		V		V			Alien	I

Imperata cylindrica can be found in four transects mentioned before. Even though this species is highly invasive, this grass is considered as native species and less harmful than the invasive alien species. *Bidens pilosa* and *Sida acuta* were invasive alien species that can be found in three different transects.

Seven invasive species also listed in the 100 of the World's Worst Invasive Alien Species, are *Chromolaena odorata, Mikania micrantha, Leucaena leucocephala, Acacia mearnsii, Clidemia hirta, Imperata cylindrica, and Lantana camara*. Those species, albeit some of them being considered native flora, need to be managed properly to reduce the impact on natural habitat and other biodiversity.

Invasive Species Observed within study area are shown in ***Figure 4-36***.

Figure 4-36: Invasive Species Observed within Study Area

Imperata cylindrica

Bidens pilosa

Sida acuta

Leucaena leucocephala

4.3.7 Aquatic Biodiversity Field Survey

4.3.7.1 Aquatic Habitat Characteristic

In general, the sampling locations are located in high altitude that makes the water conditions are sloping. The type of substrate at the study site is gravel and sand (station A1, A3, and A5) and rocky substrate (A2 and A4). The condition of the rocky substrate and fast currents indicates the upstream segment of the river. Rivers in the upland segment (upstream) are characterized by large rock substrates, fast currents, and narrow river widths. The condition of the bottom substrate of the waters is also very influential on the level of brightness and color of the waters. At the point of observation with sandy and/or muddy substrates, the waters tend to be cloudy, while in the rocky substrate tend to be clear. River condition in the study area is presented in ***Figure 4-37***.

Figure 4-37: River Condition in the Study Area

Point A1

Point A2

Point A3

Point A4

Point A5

4.3.7.2 Fish

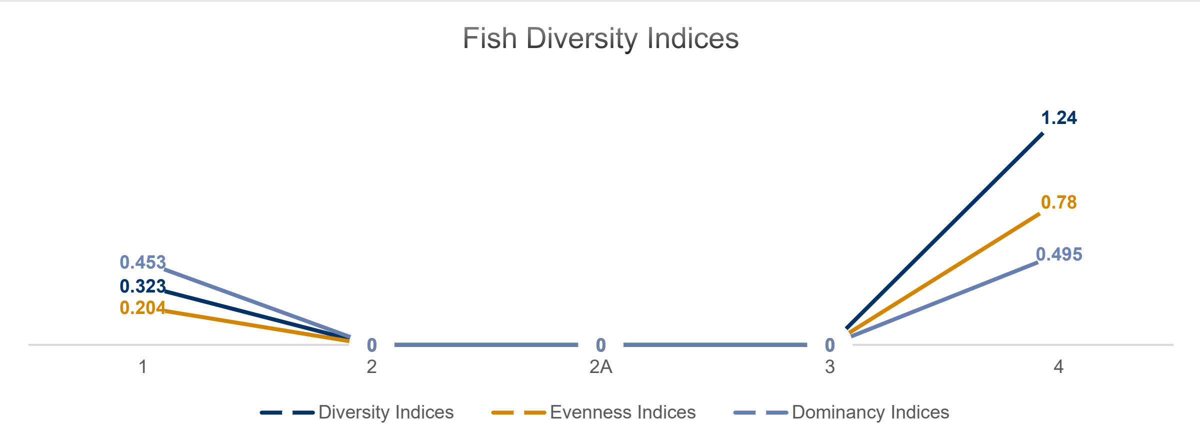
During both the wet and dry seasons observation, 3 species of fish were collected representing 2 families. *Barbodes binotatus* was found in a large population at the study site. While *Gambusia affinis* is found in a small population. *B. binotatus* and *R. caudimaculata* are native Sundaland fish, while *G. affinis* are foreign fish from Central America (Dahruddin et al. 2016). The species richness of fish in Ijen is very low with only 3 species found throughout all sampling locations. The richness of fish species in the highlands is commonly low, but the richness in the study area is the lowest compared to the Cikaniki river in West Java with 9 species (Ridho et al. 2003) and several rivers in Tapanuli highland in North Sumatra with 5-10 species (Rangkuti et al., 2019; 2021) (***Table 4-29***).

Table 4-29: List of Observed Fish in the Survey Location

No	Family	Scientific Name	Local Name	Station				
				A1	A2	A3	A4	A5
1	Cyprinidae	*Barbodes binotatus*	Kelemar	A1				A5
2	Cyprinidae	*Rasbora caudimaculata*	Kelemar	A1				A5
3	Poeciliidae	*Gambusia affinis*	Butebu					A5

The fishes were only caught at station A1 and A5. There were no fish or other aquatic biota at station A2, A3, and A4 since the river in those stations are containing sulphur that leeched from the Ijen crater (***Figure 4-38***). Ecologically, almost no aquatic organisms can live in a river water containing sulphur, with only exception of few microorganisms such as Archaea that able to survive in the flow (Lohr et al. 2006).

Figure 4-38: Diversity, Evenness, and Richness Indices of Fish Species



The low number of encountered fish causing the low diversity index of the fish in the study area. The diversity in station A1 was only 0.32-0.35 and 1.24-1.42 at station A5. *B. binotatus* dominating the fish species.

Fish observed in the study area are shown in ***Figure 4-39***.

Figure 4-39: Fish Observed in the Study Area


Gambusia affinis


Rasbora caudimaculata

4.3.7.3 Macrophyte

Moss (*Marchantia sp.*) is the only aquatic macrophyte sampled. Mosses are plants that are often found in fast-flowing rivers. This plant lives by sticking to rocks both in the middle and on the banks. Fish utilize the mosses attached to the rock of the water's floor as their preferred habitat (Haryono, 2006). Krismono et al., (2007) stated that macrophytes are an important component in the ecosystem as a habitat for fish spawning, fish nursery, susbstrate for natural food and absorbing concentrations of nutrients and heavy metals. In general, the influence of macrophytes on river ecosystems is part of the water stability chain.

4.3.7.4 Macro Invertebrate

The macroinvertebrates found at the study site consisted of 2 Crustaceans (2 families), 9 Molluscs (1 family), 6 Arthropods (5 families), and 1 Porifera (1 family). The composition of macroinvertebrates found in the rainy season consists of 2 crustaceans (2 families), 8 mollusks (1 family), Arthropods from 4 families, and 1 Porifera (1 family); while in the dry season found 3 species of fish from 2 families, 2 Crustaceans (2 families), 9 Mollusca (1 family), Arthropods from 5 families, and 1 Porifera (1 family). Family Palaemonidae is represented by 1 Species; Parathelphusidae represented 1 species; Thiaridae is represented by 8 species; while the others represent Arthropoda and Porifera, each of which is in low abundance. The *Parathelphusa convexa* crab is a macroinvertebrate found at points A1 and A5, while other macroinvertebrates are only found at one point A1 or A5. Thiaridae was represented by 9 species, among these species, *Tarebia granifera* was in the moderate abundance category, while the others represented Arthropoda and Porifera, each of which was in low abundance. Detailed list of the macroinvertebrate in the survey location is provided in ***Table 4-30***.

Table 4-30: List of Observed Macroinvertebrate in the Survey Location

No	Order	Family	Scientific Name	Local Name	Station				
					A1	A2	A3	A4	A5
Crustacea									
1	Decapoda	Palaemonidae	*Macrobrachium empulipke*	Udang					A5
2	Decapoda	Parathelphusidae	*Parathelphusa convexa*	Kepiting	A1				A5
Mollusca									
3	Neotaenioglossa	Thiaridae	*Corbicula javanica*						A5
4	Neotaenioglossa	Thiaridae	*Lymnaea rubiginosa*		A1				
5	Neotaenioglossa	Thiaridae	*Melanoides maculata*						A5
6	Neotaenioglossa	Thiaridae	*Melanoides tuberculata*						A5
7	Neotaenioglossa	Thiaridae	*Sulcospira testudinaria*						A5
8	Neotaenioglossa	Thiaridae	*Physasatra sp*						A5
9	Neotaenioglossa	Thiaridae	*Tarebia granifera*		A1				
10	Neotaenioglossa	Thiaridae	*Thiara rudis*						A5
11	Neotaenioglossa	Thiaridae	*Thiara scabra*		A1				
Arthropoda									
12	Ephemeroptera	Baetidae			A1				
13	Coleoptera	Hydrophilidae			A1				
14	Trichoptera	Goeridae			A1				
15	Trichoptera	Hydropsychidae							A5
16	Hemiptera	Nepidae							A5
17	Araneae	Pisauridae	*Dolomedes sp.*		A1				

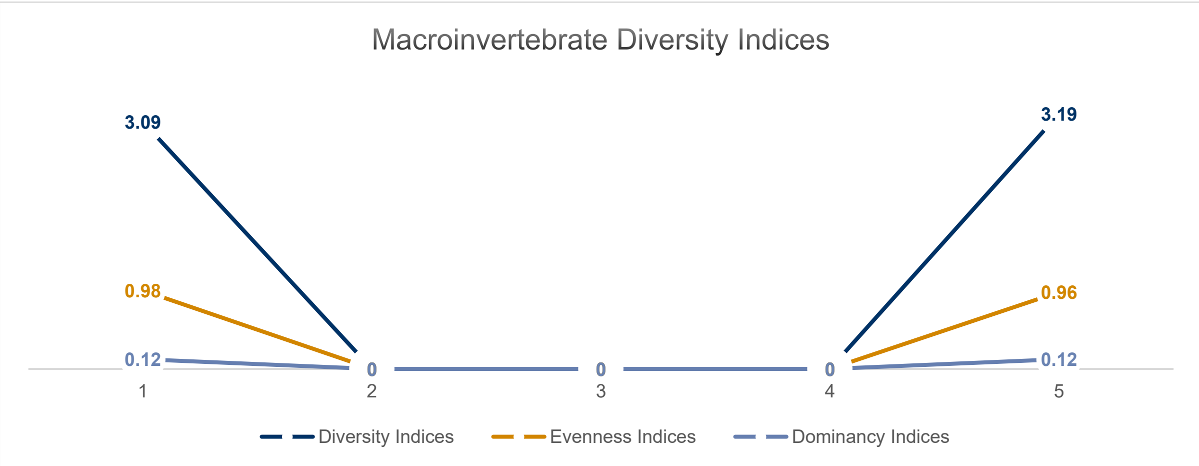
No	Order	Family	Scientific Name	Local Name	Station				
					A1	A2	A3	A4	A5
Porifera									
18	Poecilosclerida	Coelosphaeridae	*Tubifex.sp*		A1				

Macroinvertebrates found in the rainy and dry seasons include *Parathelphusa convexa*, *Lymnaea rubiginosa*, *Melanoides maculate*, *Melanoides tuberculate*, *Sulcospira testudinaria*, *Tarebia granifera*, *Thiara rudis*, *Thiara scabra*, Hydrophilidae, Nepidae and *Tubifex* sp.; while other species that are only found in the rainy season are *Corbicula javanica*, Baetidae and Hydropsychidae; while other species that are only found in the dry season include Physasatra sp, Goeridae, and Pisauridae (Dolomedes sp). The composition of fauna found during the dry and rainy seasons is not very diverse. Likewise, the number of species and individuals found during the rainy and dry seasons. The diversity of fish both spatially and temporally varies. Fish diversity is greater in the main river than in the major tributaries and minor tributaries; Overall, the five stations belong to the order of major tributaries where the diversity is lower than in the main river where the smaller the order of the river (upstream region), the smaller the heterogeneity of the habitat and in turn will provide a narrow niche for fish species to live their lives (Kadye et al., 2008).

Like fish, macroinvertebrates in the study area were only found at points A1 and A5. This is because stations 2-4 are river flows containing sulfur from the Ijen crater, where ecologically very few aquatic organisms can live in river water containing sulfur, only a few microorganisms such as Archaea are found. able to survive in the flow of the river (Lohr et al. 2006).

The richness of macroinvertebrates in the study area is quite high, represented by the presence of mollusks with 8 species. Rangkuti study in 2019 and 2021 did not find any mollusks upstream in the Tapanuli highlands, North Sumatra Province. The report from LIPI 2020 stated that 66 species of freshwater snails live spread in the waters of rivers, lakes, swamps, and lakes in Java. The high diversity of macroinvertebrates in the study area caused a high index of macroinvertebrate diversity in the study area, namely 3.09 at station A1 and 3.19 at point A5 in the wet season and 2.99 at point 1 and 3.24 at point 5 in the dry season. Therefore, uniformity is high (0.96-0.98) with low dominance (0.12). (***Figure 4-40***).

Figure 4-40: Diversity, Evenness, and Richness Indices of Macroinvertebrate Species



The richness of macroinvertebrates in the study area is high, represented by the presence of molluscs with 8 species (

Figure 4-41). Station A1 and A4 have relatively similar value of the indices with high diversity and evenness and low dominancy. However, the porifera was only found in the station A1.

Figure 4-41: Herpetofauna Observed in the Study Area

Macrobrachium empulipke

Parathelphusa convexa

Sulcospira testudinaria

Hydrophilidae, larvae

4.3.8 Species of Conservation Concern within and Surrounding the Project Site

Four different criteria are used to determine conservation significance: Indonesian Law, global frameworks, migratory behavior, and endemicity.

The Indonesian Government protects its flora and fauna by regulation under Government Regulation Number 7 Year 1999. The latest protected flora and fauna list is registered under Ministry of Environment and Forestry Decree Number P.106/MENLHK/SETJEN/KUM.1/12/201 with further explanation and technical instructions in GR no 7 year 1999.

Global frameworks to assess flora and fauna pertain to the IUCN Red List of Threatened Species. Species with status as Endangered (EN), Critically Endangered (CR) and Vulnerable (VU) in the IUCN Red List are considered species with conservation significance.

Endemicity means flora and fauna species can only be found in a specific region, from national to smaller region. Also, to conform to the IFC requirement, species with an extent of occurrence less than 50.000 km^2 are considered restricted range species. Migratory species move from one habitat to another during different times of the year. They cannot live in the same environment all year round due to seasonal limitations in food, sunlight, and temperature. Indonesia is visited mainly by the migratory bird during wintering season as a flyway between Asia and Australia, but some spend the wintering season in Indonesia.

Based on the criteria mentioned above, one floral species and 32 faunal species are considered species with conservation significance, including 24 birds, three mammals, one herpetofauna, and four insect species. A detailed list of species with conservation significance is in the ***Table 4-31***. Here the sampling locations where the species were encountered for each are also provided.

Table 4-31: List of Species with Conservation Significance in Survey Location

No	Family	Scientific Name	English Name	Conservation Status					Transect					
				IUCN	GR	CITES	Migratory	Endemic	1	2	3	4	5	6
	Bird													
1	Accipitridae	*Ictinaetus malaiensis*	Black Eagle	LC	P	II				2				
2	Accipitridae	*Nisaetus bartelsi*	Javan Hawk Eagle	EN		II		E	1					6
3	Accipitridae	*Nisaetus limnaeetus*	Changeable Hawk Eagle	LC	P	II							5	
4	Accipitridae	*Pernis ptilorhynchus*	Sunda Honeybuzzard	LC	P	II	M		1	2	3	4	5	
5	Alcidinidae	*Halcyon cyanoventris*	Javan Kingfisher	LC				E					5	
6	Campephagidae	*Pericrocotus miniatus*	Sunda Minivet	LC				E	1					6
7	Chloropseidae	*Chloropsis cochinchinensis*	Javan Leafbird	EN	P	II		E						6
8	Cisticolidae	*Orthotomus sepium*	Javan Tailorbird	LC				E				4	5	
9	Columbidae	*Ducula lacernulata*	Dark-Backed Imperial Pigeon	LC				E	1					
10	Columbidae	*Treron griseicauda*	Grey-Cheeked Green Pigeon	LC				E			3			
11	Dicaeidae	*Dicaeum sanguinolentum*	Javan Flowerpecker	LC				E	1	2	3			6
12	Hirundinidae	*Hirundo rustica*	Barn Swallow	LC			M					4		
13	Megalaimidae	*Psilopogon armillaris*	Flame-Fronted Barbet	LC	P			E	1		3			6
14	Muscicapidae	*Cyanoptila cyanomelana*	Blue-And-White Flycatcher	LC			M		1					
15	Muscicapidae	*Eumyias indigo*	Indigo Warbling-Flycatcher	LC				E	1		3			6
16	Nectariniidae	*Aethopyga eximia*	White-Flanked Sunbird	LC				E	1	2				6
17	Phasianiidae	*Gallus varius*	Green Junglefowl	LC				E	1	2		4	5	6
18	Pycnonotydae	*Ixos virescens*	Javan Bulbul	LC				E	1		3			6

No	Family	Scientific Name	English Name	Conservation Status					Transect					
				IUCN	GR	CITES	Migratory	Endemic	1	2	3	4	5	6
19	Pycnonotydae	*Pycnonotus bimaculatus*	Orange-Spotted Bulbul	NT				E			3			
20	Rhipiduridae	*Rhipidura euryura*	White-Bellied Fantail	LC	P			E	1					6
21	Rostratulidae	*Rostratula benghalensis*	Greater Painted-Snipe	LC	P					2				
22	Timaliidae	*Cyanoderma melanothorax*	Crescent-Chested Babbler	LC				E	1					
23	Timaliidae	*Pomatorhinus montanus*	Javan Scimitar Babbler	LC				E	1					
24	Turdidae	*Turdus obscurus*	Eyebrowed Thrush	LC			M		1					
25	Zosteropidae	*Apalopteron javanicum*	Javan Heleia	LC	P			E	1	2	3			6
	Mammal													
26	Cercopithecidae	*Trachypithecus auratus*	East Javan Langur	VU	P	II		E	1					6
27	Cervidae	*Muntiacus muntjak*	Red Muntjak	LC	P				1		3			
28	Felidae	*Prionailurus bengalensis*	Leopard Cat	LC	P	II							5	6
	Herpetofauna													
29	Rachophoridae	*Nyctixalus margaritifer*	Pearly Treefrog	LC				E						6
	Insect													
30	Calopterygidae	*Vestalis luctuosa*	Ebony Jewelwing	LC				E					5	
31	Chlorocyphidae	*Heliocypha fenestrata*	Common Blue Jewel	LC				E					5	
32	Papilionidae	*Troides amphrysus*	Malayan Birdwing	LC	P									6
33	Papilionidae	*Troides helena*	Common Birdwing	LC	P									6

*Notes: GR=Government Regulation 7/1999; P=Protected M=Migratory Species; E=Endemic Species; LC=Least Concern; NT=Near Threatened; VU=Vulnerable; EN=Endangered; II=Appendix II CITES; Sum=Individual number; *) = introduced species*

Thirty three species with conservation significant were found during this survey. However, Arabica Coffee is not considered as a conservation significant species due to this species being widely utilized as an agricultural commodity throughout the region and well known as an introduced species.

A total of thirteen species are protected under GR 7 Year 1999, including eight birds, three mammals, and two insect species. East Javan Langur, categorized as Vulnerable (VU) by the IUCN, is among the protected species. This langur, compared to a sympatric species. The West Javan Ebony Langur, has a larger natural range including Java, Bali, Lombok, and smaller offshore islands. However, both species suffered the same fate as they were often captured for illegal pet trade, food, and medicine. The langur is also threatened by the available habitat decrease or development over years. During this survey, a total of 21 individuals of East Javan Langur were observed in the forest in transect 1 and 6.

Ijen highland is not preferred area as the flyway for the migratory bird. However, some of them still may crossing this area during the migration. Survey results showed that four migratory birds were observed, including Sunda Honeybuzzard, Barn Swallow, Blue-And-White Flycatcher, And Eyebrowed Thrush. In addition, since this survey was not conducted during the migration period, there is a possibility that those species are resident and choose to inhabit the study area.

Remaining natural habitat in Java preserve the diverse endemic species that are rarely found in the modified habitat. A total of 17 birds, one mammal, one amphibian and two damselflies are endemic species. Among those species, each species is categorized as endangered, vulnerable, and near threatened. Refer to the IUCN, most of the endemic species are relatively abundant and categorized as least concern.

Photos of key species of conservation concern are provided in ***Figure 4-42***.

Figure 4-42: Species with Conservation Significance in the Study Location

East Javan Langur

Red Muntjak faeces

4.3.9 Initial Critical Habitat Screening

An initial critical habitat screening was undertaken with reference to IFC PS6[1] to assess the biodiversity significance of the area. This method aims to identify the potential priority biodiversity present at the project site, including species and ecosystems that meet the criteria and quantitative thresholds for qualification under PS6.

This initial screening is based on information available within from online databases, secondary literature sources as well as the baseline study performed within and surrounding project site. The baseline survey was conducted for two season, wet and dry. The wet season survey was from February 2022, followed by the dry season survey from June 2022. The species list from both surveys is presented in ***Appendix B***.

The critical habitat screening has applied a precautionary approach where there is uncertainty about the population, range and distribution of potentially occurring biodiversity features within the Project study area and Ecologically Appropriate Area of Analysis (EAAA). It is therefore possible that once

[1] Including the IFC PS6 Guidance Note (2019)

further data is available some species may be subsequently screened out, or additional species or receptors identified.

4.3.9.1 Ecologically Appropriate Assessment Area

ERM defined the Project's Ecologically Appropriate Area(s) of Analyses ("EAAA") through spatial reviews on the potential presence of ecosystems that regularly occurs in the project's area of influence that may qualify for critical habitat (refer to PS 6 guidance note (GN59[1])).

Referring to the IFC PS 6 GN 59 (2019), the EAAA delineation requires consideration of: (i) the likely geographic area or extent of anticipated project activities and impacts; (ii) the full extent of ecosystems that might be affected in any way; and (iii) any additional areas that have a functional role in supporting those ecosystems or their associated biodiversity, for example the limits of relevant river catchments or watersheds needed to support a wetland.

The spatial scope should be ecologically determined and defined, encompassing wider distributions of potentially affected biodiversity features and the ecological patterns, processes, and functions that are necessary for maintaining them throughout this distribution. EAAAs typically extend well beyond a Project's physical footprint, and are usually anticipated to be greater than the PAoI, while taking into account individual species ecology. It is nevertheless permissible to have an EAAA that capture a number of species or to have a series of EAAAs depending on ecosystem or ecological factors.

ERM delineated the EAAA based on an understanding of habitat connectivity and continuity in the wider landscape, the extent of the Project's potential impacts across the landscape, and the presence of distinct geographical barriers, such as mountains, large rivers, and catchments.

The Project overlaps with two ecoregions: The Eastern Java-Bali Montane Rain Forests (IM0112) and Eastern Java-Bali Rain Forests (IM0113). Forest areas that occur in these ecoregions are widespread across eastern Java and Bali, Indonesia, but fragmented due to anthropogenic factors such as clearance for logging, agriculture and settlement purposes. What is remaining is scattered throughout the landscape in small patches, of which conservation significant species such as the Javan Hawk Eagle (*Nisaetus bartelsi*), and the Javan Tailless Fruit Bat (*Megaerops kusnotoi*) are associated with.

Given the widespread but patchy nature of these forest habitat types, and that impacts on such areas are likely to affect the Project's priority biodiversity, a reasonable contiguous forest area was therefore considered a sensible unit of analysis to include species that regularly occur in the project's area of influence.

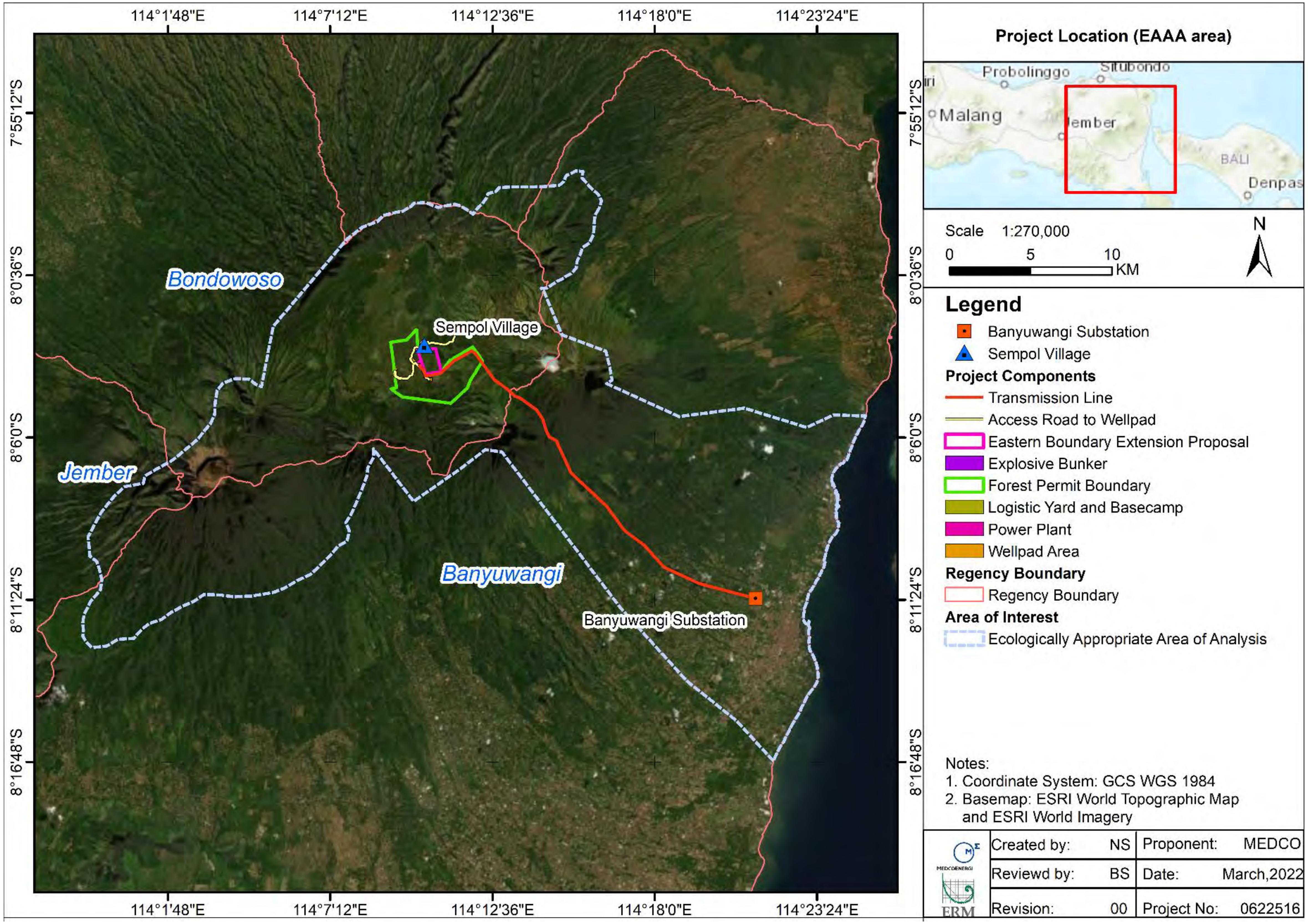
Limits of the EAAA were based on established areas of importance for the distribution of species and ecosystems, and/or the ecological patterns, processes, features and functions that are necessary for maintaining them. These include:

- **Gunung Raung and Gunung Ijen IBAs**, areas recognised for its biodiversity value, and is delineated based on biodiversity values which trigger the established biological criteria (International Union for Conservation of Nature (IUCN) 2016).
- **Water catchments**, distinct ecological units for freshwater biodiversity (Saunders et al. 2002), while the high altitude and steep topography of catchment boundaries potentially serve as a natural physical barrier to terrestrial biodiversity.

Based on spatial analyses, the total area of EAAA of this study covering 695.7 km^2 comprise of secondary forest, mixed plantation, agricultural area, savannah, barren land and small portion of community housing area. The Project's EAAA is shown in ***Figure 4-43***

[1] GN59 states: The project should identify an ecologically appropriate area of analysis to determine the presence of critical habitat for each species with regular occurrence in the project's area of influence, or ecosystem, covered by Criteria 1-4. The client should define the boundaries of this area taking into account the distribution of species or ecosystems (within and sometimes extending beyond the project's area of influence) and the ecological patterns, processes, features, and functions that are necessary for maintaining them.

Figure 4-43: EAAA Map



4.3.9.2 Screen against IFC PS6 Critical Habitat Criteria

Biodiversity features were screened against IFC PS6 Critical Habitat criteria (IFC PS6 paragraph 16) to identify habitat important for threatened species (e.g., Critically Endangered and Endangered species), endemic or range-restricted species, migratory species, threatened or unique ecosystems and areas associated with key evolutionary processes.

Critical Habitat may not be limited to pristine or highly biodiverse areas but can include both modified and natural habitats where these meet the Critical Habitat criterion. The screening process against the paragraph 16 criteria is informed by the additional guidance provided in GN69 to 97 of the 2019 update of the 2012 guidance. ***Table 4-32*** details the quantitative qualifying requirements for Criteria 1 to 3 (i.e., thresholds). The likely qualifying interests for Criterions 4 and 5 are subject to research and expert opinion. The criteria listed have been used to complete this assessment.

The five criteria are 'triggers' in that if an area of habitat meets any one of the criteria. It will be considered Critical Habitat irrespective of failing to meet any other criterion. This approach is generally more cautious but is used more widely in conservation.

Critical Habitat criteria therefore have two distinctive characteristics. First, components of biodiversity are essentially assigned to only two levels of conservation significance, those that trigger Critical Habitat and those that do not. Secondly, each criterion is applied separately and not in combination, meaning that the scores are not cumulative. A species may be screened in on more than one criterion (e.g., a CR species that is also endemic or range restricted).

Table 4-32: Critical Habitat Criteria

Criteria	Thresholds
Criterion 1: Critically Endangered (CR) / Endangered (EN) species	(a) Areas that support globally-important concentrations of an IUCN Red-listed EN or CR species (0.5 % of the global population AND 5 reproductive units of a CR or EN species); (b) Areas that support globally-important concentrations of an IUCN Red-listed VU species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in (a). (c) As appropriate, areas containing nationally/regionally-important concentrations of an IUCN Red-listed EN or CR species.
Criterion 2: Habitat of significant importance to endemic and/or restricted-range species	(a) Areas that regularly hold ≥ 10 % of the global population size AND ≥ 10 reproductive units of a species.
Criterion 3: Habitat supporting globally significant concentrations of migratory species and/or congregatory species	(a) Areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 % of the global population of a migratory or congregatory species at any point of the species' lifecycle. (b) Areas that predictably support ≥ 10 % of the global population of a species during periods of environmental stress.
Criterion 4: Highly threatened and/or unique ecosystems	(a) Areas representing ≥ 5 % of the global extent of an ecosystem type meeting the criteria for IUCN status of CR or EN. (b) Other areas, not yet assessed by IUCN, but determined to be of high priority for conservation by regional or national systematic conservation planning.
Criterion 5: Areas associated with key evolutionary processes	No set thresholds

Note: Restricted-range/ Endemic Species = Terrestrial species with global distributions of less than 50,000km^2, Aquatic species in habitats that do not exceed 200 km width at any point (for example, rivers), restricted range is defined as having a global range of less than or equal to 500 km linear geographic span (i.e., the distance between occupied locations furthest apart); Migratory species = Any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem); Congregatory Species = Species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis: Source: IFC, 2019.

A long list of biodiversity features are obtained from online databases and secondary literature sources, such as the Integrated Biodiversity Assessment Tool (IBAT) and available online literature.

In the absence of reliable population data, proxies such as the proportion of a species' distribution in the area, can be used to inform Critical Habitat determination. Appropriate population surrogates including extent of occurrence, range, or known sites of occurrence (mainly derived from the IUCN Red List data), were used to determine significance with respect to the global population (see IFC (2019) Guidance Note 77). Expert opinion and professional knowledge were used to make a reasonable judgement of potential significance.

4.3.9.3 Results of the Initial Critical Habitat Screening

4.3.9.3.1 Summary of the Results

This initial critical habitat screening finds that the EAAA potentially qualifies as critical habitat under IFC PS6 criterion 1. A total of eight species (one insect species, one mammal species, and six bird species) have been identified as potentially critical habitat-qualifying biodiversity features. ***Figure 4-43*** present the Critical habitat map within the EAAA.

Based on the spatial analyses the Critical habitat calculation within the EAAA presented in ***Table 4-33***.

Table 4-33: Critical Habitat Calculation

Total CH within EAAA (Ha)	CH within Project boundary (Ha)	CH within 500 m radius of the project area	CH within 20 m of the transmission line
40,572.53	179.45	1,624.99	43.71

Source: ERM, 2022

4.3.9.3.2 Critical Habitat Criterion 1

A total of eight species (one insect, one mammal, and six bird species) have been identified throughout the desktop and baseline data collection as potentially triggering critical habitat under Criterion 1. ***Table 4-34*** present the list of species potentially triggering critical habitat criterion 1. While their rationale for inclusion presented in ***Table 4-36.***

Table 4-34: Criterion 1 Potential Critical Habitat Trigger Species

S/N	Common Name	Scientific Name	Source of data	IUCN Red List [a]	Presence in EAAA[b]	Presence Likelihood
Insect						
1	-	*Atrophaneura luchti*	IBAT	EN	Unconfirmed	Unlikely
Mammal						
2	Javan Tailless Fruit Bat	*Megaerops kusnotoi*	IBAT	VU	Unconfirmed	Unlikely
Bird						
3	White-faced Partridge	*Arborophila orientalis*	IBAT	VU	Unconfirmed	Possible
4	Javan Hawk-eagle	*Nisaetus bartelsi*	IBAT	EN	Confirmed	Possible
5	Javan Scops-owl	*Otus angelinae*	IBAT	VU	Unconfirmed	Possible
6	Javan Flameback	*Chrysocolaptes strictus*	IBAT	VU	Unconfirmed	Possible
7	Javan Blue-banded Kingfisher	*Alcedo euryzona*	IBAT	CR	Unconfirmed	Possible
8	Javan Leafbird	*Chloropsis cochinchinensis*	Baseline	EN	Confirmed	Possible

Notes: a) IUCN Red List status: CR = Critically Endangered; EN = Endangered; VU = Vulnerable. There is no national Red List available for Indonesia. b) Presence in study area: Unconfirmed= presence unconfirmed but considered possible given the overlap between study area and species range and/or presence of suitable habitat. c) Result: Possible = low/no evidence of effort to determine presence or absence, however if the species is found to be present in the study area at significant numbers, the area is likely to meet the threshold for qualifying as Critical Habitat

4.3.9.3.2.1 Trachypithecus auratus

It is understood that during the baseline study, ERM also observed the present of the East Javan langur (*Trachypithecus auratus)* – status as Vulnerable (VU) within and surrounding the project site, however these species was not considered as critical habitat criterion 1 trigger species due to some considerations.

IUCN[1] reported that *T. auratus* is endemic to Indonesia, where it occurs on the islands of Java, Bali and Lombok, and smaller offshore islands. The species occurs in mangrove, beach, and freshwater swamp forests, ever-wet lowland and hill forests, dry deciduous forests, and montane forest up to 3,500 m. In addition, it occurs in various forest plantations, such as teak, rasamala, and acacia, often in parts where remands of natural forest remain. IUCN estimated EOO of this species covering around 168,882 km^2 throughout Java and Bali Island.

There is no available information provide detail global population of this species, however IUCN reported the characteristic distribution of this species is more prefer the lowland forest rather than highland forest. Group sizes in montane areas and lowland rainforest are typically on the order of six or seven individuals and group sizes in coastal forests typically comprise between 10 and 11 individuals. Moreover, very large groups of 20 to 30 individuals are regularly recorded in coastal forest but not in montane or inland rainforest (Kool 1993, Nijman 2014, Supriatna et al. 1988).

Considering this species distribution and the project impacts to the existing habitat on the project area (mostly in the hill montane area), ERM concludes that the typical habitat presents around the project area cannot be considered as areas that support globally-important concentrations of an IUCN Red-listed VU species. The loss of species/habitat due to project activities would not significantly impact the global population of the species that might result in the change of the IUCN Red List status to EN or CR.

4.3.9.3.2.2 Cuon alpinus (Dholes)

IUCN reported[2] that this species are resident to Bangladesh; Bhutan; Cambodia; China; India; Indonesia; Lao People's Democratic Republic; Malaysia; Myanmar; Nepal; Thailand. In Indonesia, it is distributed in Sumatra and Java Island (see ***Figure 4-44***).

Population estimates of Dholes are not available for any country. Therefore, IUCN made an attempt to estimate the total population of Dholes by classifying countries within their current distribution as having high (1,500-3,000), medium (750-1,500), or low (250-750) numbers of Dholes. With the largest subpopulations presumed to be in the Western Ghats of India

it is a habitat generalist, and can occur in a wide variety of vegetation types, including: primary, secondary and degraded forms of tropical dry and moist deciduous forests; evergreen and semi-evergreen forests; temperate deciduous forests; boreal forests; dry thorn forests; grassland–scrub–forest mosaics; temperate steppe; and alpine steppe. Consequently, their elevation range is from sea level to as high as 5,300 m asl in Ladakh (R. Simpson pers. comm.)

Given the number of estimate population, relatively wide range EOO (***Figure 4-44***) and the presumed largest population of this species were not in Indonesia, it is concluded that this species is not considered as species of concerns for the project.

[1] © The IUCN Red List of Threatened Species: Trachypithecus auratus – published in 2021.https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T39848A17988500.en

[2] The IUCN Red List of Threatened Species: Cuon alpinus – published in 2015. http://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T5953A72477893.en

Figure 4-44: *Cuon Alpinus* Distribution Map

4.3.9.3.2.3 Sus verrucosus

IUCN[1] reported that this species occurs in at least 10 isolated areas on mainland Java, although some additional, probably very small populations, might survive elsewhere (Semiadi and Meijaard 2006). For example, recently another pocket area was found in Banjar (West Java), though intensive survey work is needed to establish the size of the area and the population (Semiadi 2007 unpubl. data). There are no estimates of overall population size, but the species has shown a rapid population decline in recent decades.

The species occurs both in cultivated landscapes and in teak forest plantations (Semiadi and Meijaard 2006), with the highest density thought to occur between Semarang and Surabaya on both sides of the border between the provinces of Central and East Java. Recent data (Semiadi 2008, unpubl data) indicate that near Banjar (West Java) there is a possibility of significant numbers of animals in a fragmented teak forest and mixed local and agricultural forest.

The *Sus verrucosus* Distribution Map presented in ***Figure 4-45*** shows that the project locations are not within the distribution area of this species, therefore this species is not considered as species of concern for the Project.

[1] The IUCN Red List of Threatened Species: Sus verrucosus – published in 2016. http://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T21174A44139369.en

Figure 4-45: *Sus Verrucosus* Distribution Map

4.3.9.3.3 Critical Habitat Criterion 2

A total of 29 species (17 bird species, 2 amphibian species, 7 insect species, and 3 mammal species) were identified to be restricted range species as defined under GN74. Out of these 29 species, only one insect species has been identified to potentially result in the categorization of the area as critical habitat under Criterion 2. It is a butterfly species called *Atrophaneura luchti*, this species is listed in ***Table 4-35,*** with its rationale for inclusion presented in ***Table 4-36***.

Referring IUCN[1] *Atrophaneura luchti* has a very restricted range in the Ijen Mountains of eastern Java (Collins and Morris 1985). It is likely that its hostplant belongs to the family Aristolochiaceae. Its estimated extent of occurrence, based on the area of the Ijen Mountains, is estimated between 1,000 and 2,000 km^2, although it may be much smaller, given that only few locality data exist for this species.

There is a continuing decline in the area and extent of habitat for this species due to increasing human pressures which are seen across Java and have led to around 5% forest loss in the area where the species occurs. However, no suitable habitat for this species was found in the Project area, so the Project is not expected to result in any direct impacts.

Table 4-35: Criterion 2 Critical Habitat Trigger Species

S/N	Common Name	Scientific Name	Source of data	IUCN Red List [a]	Presence in EAAA[b]	Screening result[c]
Insect						
1		*Atrophaneura luchti*	IBAT	EN	Unconfirmed	Unlikely

Notes:

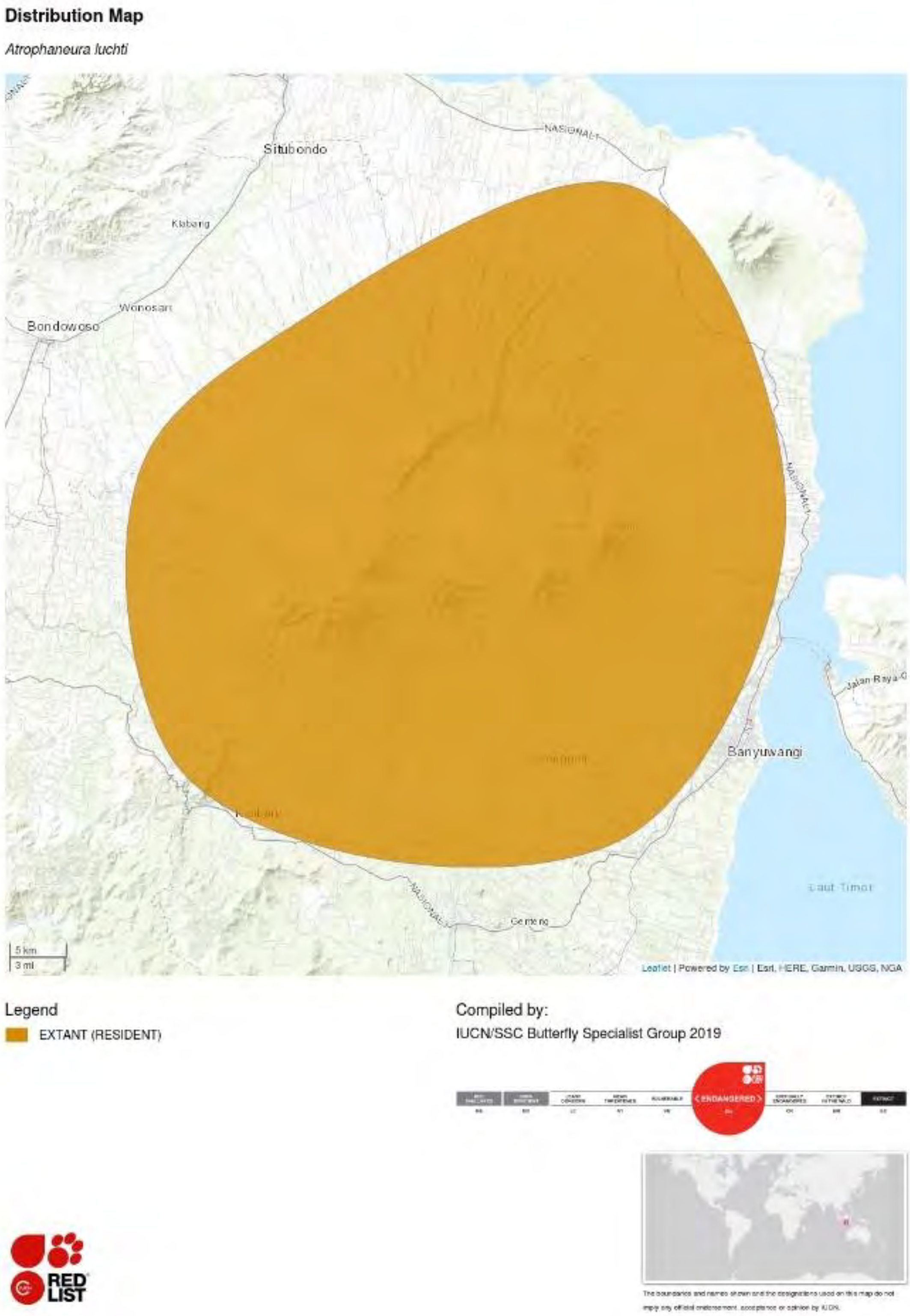
a IUCN Red List status: EN = Endangered. There is no national Red List available for Indonesia.

b Presence in study area: Unconfirmed= presence unconfirmed but considered possible given the overlap between study area and species range and/or presence of suitable habitat.

c Result: Possible = low/no evidence of effort to determine presence or absence, however if the species is found to be present in the study area at significant numbers, the area is likely to meet the threshold for qualifying as Critical Habitat

[1] The IUCN Red List of Threatened Species: Atrophaneura luchti – published in 2019. http://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T2377A122599164.en

Figure 4-46: *Atrophaneura Luchti* Distribution Map



4.3.9.3.4 Critical Habitat Criterion 3

Out of the 215 species identified to be migratory species, no species have been identified to potentially result in the categorization of the area as critical habitat under Criterion 2. No species have also been assessed to have individuals which congregates in large groups on a cyclical or otherwise regular and/or predictable basis in the EAAA to potentially result in the categorization of the area as critical habitat under Criterion 3. There is therefore no species that triggers the Project as being located in critical habitat under Criterion 3 (***Table 4-36***).

4.3.9.3.5 Critical Habitat Criterion 4

Ecosystems present in the EAAA have not been formally evaluated against the IUCN Red List for ecosystems. Ecosystems within the EAAA do not qualify under Criterion 4.

There were no areas within the project site that have been determined to be of high priority for conservation by regional or national systematic conservation planning. Kawah Ijen Natura Reserve area within the EAAA is recognised as a legally conservation area through Minister of Agricultural decree No.1017/Kpts-II/Um/12/ of 1981. However, the area is classified as an IUCN Category III protected area, so that the area does not trigger critical habitat criterion 4.

4.3.9.3.6 Critical Habitat Criterion 5

IFC PS6 describes this Criterion trigger to be one of the following:

- Physical features of a landscape that might be associated with particular evolutionary processes (for example isolated areas, areas of high endemism, spatial heterogeneity, environmental gradients, edaphic interfaces, biological corridors or sites of demonstrated importance to climate change adaptation); and/or
- Subpopulations of species that are phylogenetically or morpho-genetically distinct and may be of special conservation concern given their distinct evolutionary history. The latter includes evolutionarily significant units and evolutionarily distinct and globally endangered species.

The freshwater and terrestrial EAAA does not contain landscape that maybe associated with particular evolutionary processes, therefore, the EAAA would not qualify the Project as Critical Habitat under Criterion 5.

A summary of the critical habitat assessment is provided in ***Table 4-36***. A Biodiversity Action Plan (BAP) has been prepared for the Project that documents how the project proposes to achieve No Net Loss of natural habitat and Net Gain of biodiversity value for critical habitat (see ***Appendix K***)

Table 4-36: Critical Habitat 1, 2 and 3 Trigger Species and Rationale for Inclusion

Common name	Scientific name	IUCN Red List status[1]	Presence in the EAAA[2]	PS6 Critical Habitat criteria[3]			Rationale[4]
				1	2	3	
Insects							
A species of Butterfly	*Atrophaneura luchti*	EN	Unconfirmed	Possible	Possible		This restricted range species has an extent of occurrence (EOO) of 1,000-2,000 km^2. It has only been recorded from the Ijen mountain range where it is thought to likely occur at a medium to high altitude where forested areas still occur. No population numbers of this species exists. With the suitable habitat within the EAAA is 394 km^2 or 39% of this species habitat, and the given habitat present within the area are directly connected with the main habitat of this species, it is possible that this species could be present at concentrations that may trigger Criterion 1 and 2.
Mammals							
Javan Tailless Fruit Bat	*Megaerops kusnotoi*	VU	Unconfirmed	Possible			This VU species has an EOO of 106,897 km^2. It is endemic to the islands of Java, Bali, and Lombok. This species is known to occur in tropical evergreen forests at lowland areas, but likely to also occur at higher elevations. No population numbers of this species exists. With suitable habitat present within the EAAA is 394 km^2 or around 0.4% of total habitat distribution and given the high threaten to the remaining habitat, it is considered the existing habitat within the EAAA has possibility meet the criteria that may trigger Criterion 1.
Birds							
White-faced Partridge	*Arborophila orientalis*	VU	Unconfirmed	Possible	Unlikely		This VU species occurs only in East Java, Indonesia. It is a restricted range species with an EOO of 10,800 km^2. This species is known to occur in montane evergreen forest, at elevations between 500-2,200m above sea level. The global population estimate is between 10,000-19,999 mature individuals. To meet the threshold for Criterion 1, the wider area needs to support >50 mature individuals (0.5% of the global population estimate) while to meet the threshold for Criterion 2, the needs to support >1000 mature individuals ($\geqslant$ 10 % of the global population size AND $\geqslant$ 10 reproductive units of the species). Based on the presence of extensive suitable habitat (secondary forest) within the EAAA (around 394 Km^2 or 4% of total global EOO), it is possible that this species could be present at concentrations that may trigger Criterion 1 however it is unlikely trigger Critical Habitat Criterion 2.
Javan Hawk-eagle	*Nisaetus bartelsi*	EN	Confirmed	Possible			This EN species only occurs on the island of Java and Bali, Indonesia. It is considered to be a scarce species that is restricted to patches of remaining forest on the islands, frequently occurring at elevations of 500-1000m above sea level. The global population estimate is between 600-900

Common name	Scientific name	IUCN Red List status[1]	Presence in the EAAA[2]	PS6 Critical Habitat criteria[3]			Rationale[4]
				1	2	3	
							individuals. To meet the threshold for Criterion 1, the wider area needs to support >3 individuals (0.5% of the global population estimate). Based on the presence of extensive suitable habitat within the EAAA, and this species' very low numbers, and the EAAA comprising more than 0.5% of this species' distribution, it is possible that this species could be present at concentrations that may trigger Criterion 1.
Javan Scops-owl	*Otus angelinae*	VU	Unconfirmed	Possible			This VU species is known to occur only in West Java and thought to also likely occur in highland areas of East Java where the EAAA is located. The global population estimate is between 2,500-9,999 mature individuals. To meet the threshold for Criterion 1, the wider area needs to support >12 individuals (0.5% of the global population estimate). With the EAAA comprising more than 0.5% of this species' distribution, there is no conclusive evidence to suggest that the EAAA will not be able to contain 0.5% of this species' small global population, thereby possibly meeting Criterion 1.
Javan Flameback	*Chrysocolaptes strictus*	VU	Unconfirmed	Possible	Unlikely		This VU species occurs only in East Java, and Bali Indonesia. It is a restricted range species with an EOO of 49,500km^2. This species is tolerant of habitat modification, and can occur in a range of habitat types (forest, shrub land, and plantation). A preliminary estimate of the global population estimate suggests this is between 2,500-9,999 mature individuals. To meet the threshold for Criterion 1, the wider area needs to support >12.5 individuals (0.5% of the global population estimate). Based on the spatial analyses of the EAAA, it is understood that the potential suitable habitat within the EAAA is around 394 Km2 or 0.8% of total global EOO) and given the low population numbers, it is possible that this species could be present at concentrations that may trigger Criterion 1. However, it is unlikely that Critical habitat Criterion 2 triggered due to the total suitable habitat is below than 10% of global EOO.
Javan Blue-banded Kingfisher	*Alcedo euryzona*	CR	Unconfirmed	Possible			This CR species only occurs on the island of Java, Indonesia. Although there are very limited confirmed records across the island, it is thought to be under-recorded due to its shy nature, and occurrence in remote areas. This sedentary species can be found close to rocky or slow-flowing streams and large rivers in forested areas between 0-1,500m above sea level. The global population estimate is between 50-249 mature individuals. To meet the threshold for Criterion 1, the wider area needs to support at least 1 individual (0.5% of the global population estimate). Based on the presence of suitable habitat within the EAAA, this species' very low numbers, and the EAAA comprising more than 0.5% of this species' distribution, it is possible that this species could be present at concentrations that may trigger Criterion 1.

Common name	Scientific name	IUCN Red List status[1]	Presence in the EAAA[2]	PS6 Critical Habitat criteria[3]			Rationale[4]
				1	2	3	
Javan Leafbird	*Chloropsis cochinchinensis*	EN	Confirmed	Possible			BirdLife International (2022) reported that this species is endemic to Java Island, Indonesia. It has EOO of 142,000 km2. IUCN reported It occurs in a number of protected areas, and is considered uncommon, but may still be locally common (Eaton et al. 2016). It's distributed between 100 and 1800 above sea level with suitable habitat including Subtropical/Tropical moist lowland and mountain, garden and plantation area. The global population of this species is unknown but the species has been considered rare for some time (Wells 2016). More recently it has been only infrequently observed at sites where it was easy to see in the recent past (Eaton in litt. 2016), or indeed has completely disappeared (S. van Balen in litt. 2019). Its population is suspected to be undergoing a very rapid decline owing to capture for the cage bird trade, which may be exacerbated by past habitat loss greatly reducing the area of suitable habitat. With the EAAA comprising around 0.3% of this species' distribution and the fact that this species population is rapidly declining, there is no conclusive evidence to suggest that the EAAA will not be able to contain 0.5% of this species' small global population, thereby possibly meeting Criterion 1.

Notes:

[1] **IUCN Red List status**: **CR** = Critically Endangered; **EN** = Endangered; **VU** = Vulnerable

[2] **Presence in study area**: **Unconfirmed**= presence unconfirmed but considered possible given the overlap between study area and species range and/or presence of suitable habitat.

[3] **Result**: **Possible** = low/no evidence of effort to determine presence or absence, however if the species is found to be present in the study area at significant numbers, the area is likely to meet the threshold for qualifying as Critical Habitat

4.4 Socio-Economic Baseline

4.4.1 Surrounding Communities and Properties

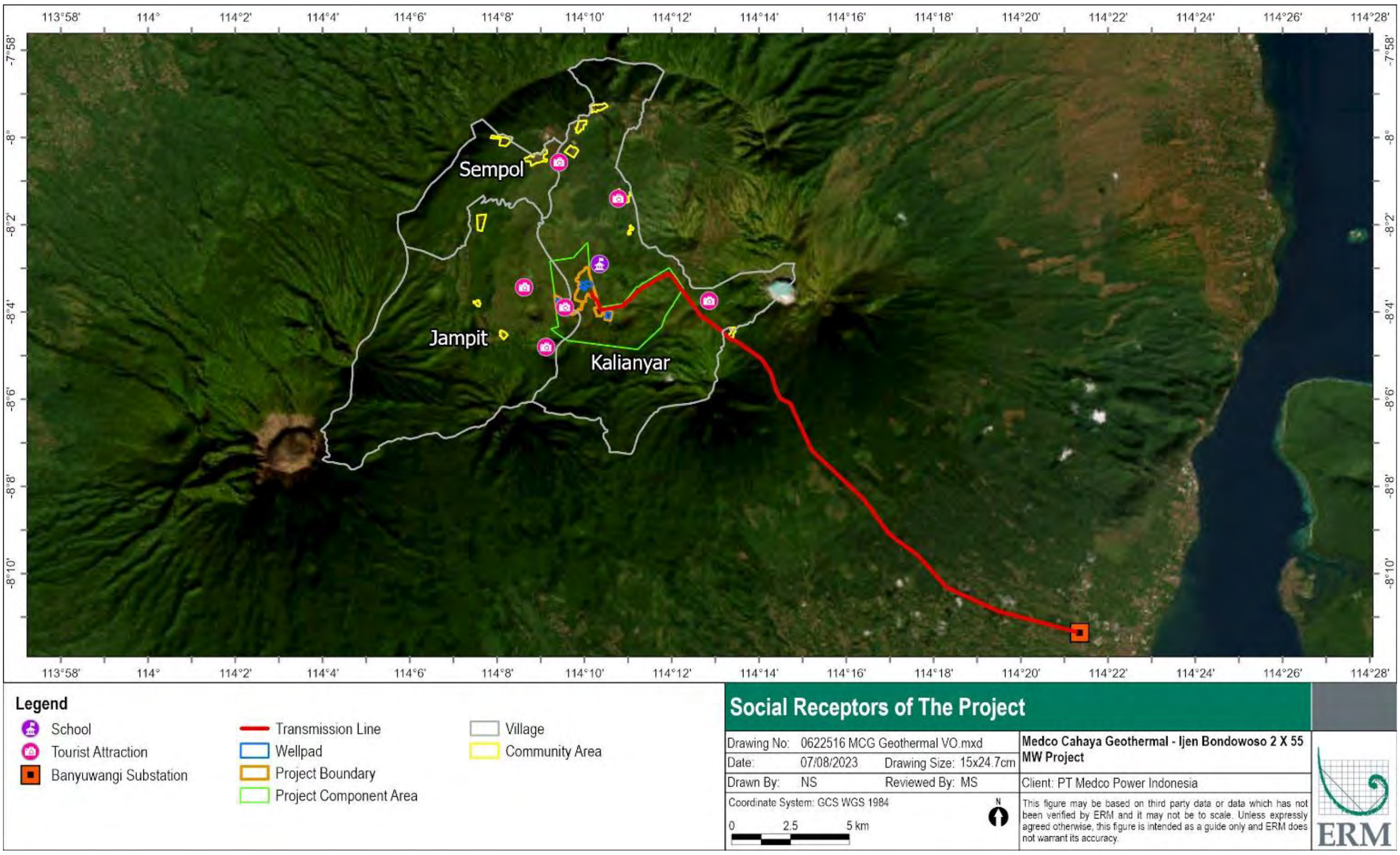
The Project site is surrounded by savanna, plantations and agriculture. The nearest hospital is Puskesmas Sempol located 5.10 km north of the Project site.

The surroundings of the Project site include:

- **North**: North of the Project site is savanna land. A hut is located approximately 120 m to the north and the nearest house is located approximately 4.70 km to the north within a village.
- **East:** East of the Project site is savanna land. A hut is located approximately 130 m to the east and the nearest house is located approximately 210 m to the north in the village closest to the Project site.
- **South**: South of the Project site is savanna land. A hut is located approximately 50 m to the south.
- **West**: West of the Project site is savanna land. A hut is located approximately 90 m to the west and the nearest house is located approximately 2 km to the west within a village.

Key sensitive social receptors near the Project area shown in ***Figure 4-47***.

Figure 4-47: Key Social Receptors



4.4.2 Overview

The AoI of the Project includes two regencies, namely Bondowoso and Banyuwangi, five districts and multiple villages, as listed in ***Table 4-37***. Kalianyar Village will be mainly affected by the construction of the power plant, while Sempol Village will be affected by the process of mobilization of heavy equipment during the construction phase. The remaining villages will be potentially impacted by transmission line development from Ijen to the Banyuwangi substation in Giri.

Table 4-37: Administrative Areas in the Project Area

Administration Study Boundary				Project Component
City	District	Village	Area (km^2)	
Bondowoso	Ijen	Sempol	18.55	Current workers accommodation
		Jampit	67.89	Adjacent to the geothermal Power Plant, wells and other supporting facilities
		Kalianyar	76	Geothermal Power Plant, wells, other supporting facilities, and transmission line
Banyuwangi	Licin	Tamansari	100.39	Transmission line
	Kalipuro	Pesucen	18.21	Transmission line
		Bulusari	25.42	Transmission line
	Glagah	Anyar	31.08	Transmission line
	Giri	Grogol	6.94	Transmission line
		Giri	4.07	Transmission line

Source: Ijen District in Figures, 2021; Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Glagah District in Figures, 2021; Giri District in Figures, 2021

Both Bondowoso and Banyuwangi Regencies are located in the horseshoe area of East Java Province, which is the easternmost tip of Java Island which is directly adjacent to the Bali Strait. Bondowoso is the only landlocked regency among six regencies located in the horseshoe area.

4.4.3 Land Use and Land Ownership

Land access and land ownership systems need to be considered given the Project will acquire a large amount of land to develop the Project, particularly for transmission line development which the ranges from 225 m2 – 625 m2 in each tower and the distance between towers is 200 - 500 m spread along the 28.3 km path. ***Table 4-38*** presents the potential transmission line area, which is mostly located in Banyuwangi Regency. The characteristic of land use in the potential transmission line area varies from rural to urban area.

Table 4-38: Transmission Line Area

Regency	District	Village	Land Use Characteristic	Land Use
Bondowoso	Ijen	Kalianyar	Rural	Forestry Area
Banyuwangi	Licin	Tamansari	Rural	Forestry Area
	Kalipuro	Bulusari	Rural	Paddy field/ garden
		Pesucen	Rural	Paddy field/ garden
	Glagah	Kampung Anyar	Rural	Forestry Area and private coffee plantation

Regency	District	Village	Land Use Characteristic	Land Use
	Giri	Grogol	Rural	Paddy field/ garden
		Giri	Urban	Garden

Source: MCG, 2021

The land use conditions along the proposed transmission line route can be described as a mix of forestry and agriculture areas (***Table 4-39***). According to MCG documentation dated August 2021, the agriculture areas cover paddy field, coffee, coconut, avocado, banana, papaya, cassava, taro, bamboo, chillies, mahogany, teak tree and various seasonal fruit trees (mangosteen, mango, durian, and rambutan).

Table 4-39: Designated Transmission Line Location and Land Use

No	Transmission Line Tower Location	Description of Land Use	Land Owners	Picture
1	Kalianyar Village, Ijen District, Bondowoso	Located in a pasture area belonging to Perhutani and close to tourism spot, namely Wurung Crater (approximately less than 50 m from the tourism spot).	Perhutani	
2	Tamansari Village, Licin District, Banyuwangi	Located in a forestry area belonging to Perhutani and close to tourist attractions, such as Ranti Mountain Campground (approximately 100 m) and Geopark Ijen (approximately 300 m). Two cafes (and home stay) were observed near the location of the transmission line tower (less than 100 m away).	Perhutani	

No	Transmission Line Tower Location	Description of Land Use	Land Owners	Picture
3	Giri, Giri District, Banyuwangi	Located in a community's garden with following agriculture products observed: coconut, banana and mango. Access to the tower location uses a narrow paved residential road. The width of the road is about 3 meters (maximum); the road can only be passed by 1 passenger car.	Local community (individual title)	

Since the project will only acquire land within the Project footprint area, this section will describe the condition of land access, ownership and use in the study boundary area, especially potential transmission line area.

4.4.3.1 General Overview of Administrative and Legal Framework

The National Land Agency / BPN is the agency that is responsible for registering and issuing land certificates. The legal certificate of land ownership is only issued to the land owner that is registered in BPN and proven legally. According to the Indonesian Law Number 5 of 1960 regarding Agrarian Principles, there are five types of legal land and house ownership as follows:

- Freehold Title (Sertifikat Hak Milik/ SHM). SHM is a type of certificate with full rights of land ownership by the certificate owner. SHM is also evident of the strongest ownership of land or houses. The ownership status is also unlimited as long as the owned land is not traded or inherited.
- Certificate of Building Use Rights (Sertifikat Hak Guna Bangunan/ SHGB). SHGB is a type of certificate where the certificate owner can only use the land to construct buildings or other needs within a certain period of time, while the land ownership is held by the state. SHGB has a certain time limit, usually 20 to 30 years, and can be extended.
- Certificate of Flats Unit Rights (Sertifikat Hak Satuan Rumah Susun/ SHSRS). SHSRS can be associated with ownership of a vertical house or flats built on land with joint ownership.
- Girik is not a certificate of land ownership but a type of village administration for land that shows the land ownership for tax purposes. Girik is also known as Surat Keterangan Tanah/ SKT or in English as the Letter / Permit which usually is issued by the village head or head of district. Based on Indonesian Regulation No.5 of 1960, land ownership should be owned with land rights certificate, hence the Girik/ SKT cannot be associated with the land ownership certificate. The land ownership certificate has a higher legal standing than Girik/ SKT. Girik/ SKT document includes the number of the land plot, total land area, and land owner by purchase or inheritance.
- Certificate of Purchase/ Grant (Akta Jual-Beli/ AJB). AJB is also not a certificate but a sale and purchase agreement. AJB also becomes proof of the transfer of land rights as a result of buying and selling activity. AJB can occur in various forms of land ownership, both property rights, building rights, and Girik/ SKT. Proof of ownership in the form of AJB is usually very susceptible to multiple AJB fraud, hence should be immediately converted into a freehold title.

There is limited information regarding the land ownership status in Bondowoso and Banyuwangi Regency at present. As informed by the Regional Mid-Term Development Plan (*Rencana Pembangunan Jangka Menengah Daerah*/ RPJMD) of Banyuwangi Regency and other publicly available data, there is an increase of the number of land deed issued in Banyuwangi, as provided in ***Table 4-40***.

Table 4-40: Land Certificates Issuance in Banyuwangi

Indicator	Year					
	2016	2017	2018	2019	2020	2021
The number of land deed issuance	25,330	44,091	73,659	85,097	40,209	64,352

Source: RPJMD of Banyuwangi, 2021

4.4.3.2 Land and House Assets

There is a distinct status on land and house assets in the project footprint in Bondowoso and Banyuwangi Regency. Based on discussion and KII with village and informal leaders, those residing in Kalianyar Village, Bondowoso, live in state house[29] belonging to state Plantation Company (PT Perkebunan Nusantara or known as PTPN XII) or their own house built on the plantation land.

Ownership of an official (legitimate) Occupancy Permit (*Surat Izin Penghunian*/ SIP) is obligatory to be able to inhabit the State House; however only approximately 3% of those living in a state house hold valid permit (SIP), according to Kalianyar Village head. After the official is no longer in office due to retirement, she/ he is obliged to return the occupied state house to the state; but, as informed by PTPN representative, many retired officials remain in the state houses (for generations) under the pretext that their children are replacing the jobs they left behind. Also, it is prohibited to change the physical form of the house; the initial form of the house should be maintained. However, it is observed that many renovate the state house against the applicable rules (***Figure 4-48***).

Figure 4-48: Renovated State House in Ijen, Bondowoso

Legal complexities are also observed for those living in the house built on the plantation land. The possession of valid certificate, such as SHGB is not evident. They argue that their family has lived there for generations. Nevertheless, they are fully aware of the risk of expropriation in the future.

In another hand, most of the communities residing in the Study Area in Banyuwangi Regency live in their own house or family house, inherited from parents. Some own a house in the same area as their garden/ plantation; this is mostly observed in the rural villages, such as Bulusari and Grogol Village. Regarding land ownership, the majority owns about 0.2 to 1.5 ha of land, as per village data and KII with village leaders in Bulusari and Grogol Village.

In terms of a legal framework for the household assets, the majority of the people who reside in rural area possess Girik or Petok D; only few hold a certificate (SHM). Petok D is considered equivalent to land title certificate prior the establishment of 1960 Agrarian Law. However, it is no longer valid proof

[29] State house is defined as a building owned by the state and functions as a residence and a means of fostering family and supporting the implementation of the duties of officials and/or civil servants. See Government Regulation Number 40 of Year 1994 for further inquity on state house.

of land ownership. Meanwhile, those who reside in an urban area, such as Giri Village, mostly hold a certificate.

The community who do not hold a certificate or only have a land use / borrow right from the land owner, are categorized as vulnerable in terms of permitting. As the project will acquire land having the appropriate documentation will be critical during the compensation eligibility process as it will determine who the legal owners of the household are.

4.4.4 Population and Demographics

4.4.4.1 Population

4.4.4.1.1 Bondowoso Regency

Bondowoso Regency has a total population of 778,525 people in 2021, consisting of 383,325 males and 395,200 females. The female population was 3% higher than the male population with a sex ratio of 97. The population growth rate compared to the 2020 population was 0.31%.

The study area covers one district in Bondowoso Regency; Ijen District. The population of Ijen District was 11,896 people in 2020. This comprises of 6,027 males and 5,869 females. Male population was higher than females with a sex ratio of 102. Population growth rate per year between 2010 and 2020 is reported to be 0.56%. Ijen has the lowest population density in Bondowoso District, which is 58/ km^2.

The potentially impacted villages in Ijen District include Sempol and Kalianyar Village. ***Table 4-41*** presents the population, population density, and number of households in those two villages.

Table 4-41: Population within Project Area in Bondowoso in 2021

Village	Population	Population Density/ km^2	Household
Sempol	1,975	106	748
Jampit	1,569	23	N/A
Kalianyar	3,079	40.5	1,065

Source: Primary data (Sempol and Kalianyar Village Profile, 2021); Ijen District in Figures, 2021.

4.4.4.1.2 Banyuwangi Regency

Based on data from Banyuwangi Regency in Figures (2022), the population of Banyuwangi Regency was 1,718,462 people in 2021 consisting of 860,245 males and 858,217 females. This suggests that the male population was slightly higher than the female population with a sex ratio of 100.2. The population growth rate compared to the 2020 population was 0.91%.

The Project, particularly for the transmission line development, will be located in multiple districts in Banyuwangi Regency, namely Kalipuro, Licin, Glagah and Giri District. Among these four districts, Kalipuro has the highest population up to 84,172 people in 2021, with sex ratio of 100.3. The population growth rate between 2010 and 2020; reaching 0.94%. Meanwhile the population density is 271/ km^2.

Giri has the highest population density of 1,494/ km^2, given its urban setting; it ranks second after Banyuwangi District. The population of Giri was 31,834 people in 2021, with sex ratio of 100. The population growth rate between 2010 and 2020; reaching 1.04%.

Glagah's population is comparable with Giri, with a total population of 36,667 people in 2021, with sex ratio of 96.8. However, in terms of population density, Glagah's figure is much smaller than Giri's, which is 478/km^2. The population growth rate in Glagah is 0.72 for period of 2010 to 2020.

Licin is the least populous district in Banyuwangi with a population of 2,952 people and population density of 174/ km^2 in 2021. Meanwhile the sex ratio in Licin is 100.6, meaning that there are more male population than female. The population growth rate between 2010 and 2020 is 0.55%. Licin ranks second as the area with the second lowest population growth in Banyuwangi district.

There are six potentially impacted villages in the aforementioned districts in Banyuwangi Regency. **Table 4-42** presents the population, population density, and number of households in those villages.

Table 4-42: Population within Project Area in Banyuwangi in 2020

District	Village	Population	Population Density/ km^2	Household
Licin	Tamansari	6,867	68	Unknown
Kalipuro	Pesucen	4,411	242	Unknown
	Bulusari	4,068	160	Unknown
Glagah	Kampung Anyar	4,815	154	1,776
Giri	Grogol	5,203	749	1,900
	Giri	6,167	1,515	Unknown

Source: Kampung Anyar Village, 2021; Grogol Village, 2021; Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Giri District in Figure, 2021.

4.4.4.2 Age and Gender Distribution

4.4.4.2.1 Gender Profile

Population by gender at the regency and district level has been briefly discussed in **Section 4.4.4.1**. The following takes a deeper look on gender data at the village level. This data could be leveraged to further inform the development of gender responsive Project engagement activities.

4.4.4.2.1.1 Bondowoso Regency

Table 4-43 provides population by gender in villages in the AoI in Bondowoso Regency. Sempol has slightly higher female population with sex ratio of 98. The male population in Kalianyar is greater with the sex ratio of 104.

Table 4-43: Population by Gender within Project Area in Bondowoso in 2021

Village	Male Population	Female Population	Total Population	Sex Ratio
Sempol	978	997	1,975	98
Jampit	811	758	1,569	107
Kalianyar	1,573	1,506	3,079	104

Source: Primary data (Sempol and Kalianyar Village Profile, 2021); Ijen District in Figures, 2022

4.4.4.2.1.2 Banyuwangi Regency

Table 4-44 presents population by gender in six villages in the AoI in Banyuwangi Regency. Among these 6 villages, four of them have higher female population as indicated by sex ratio figure. These include Pesucen, Kampung Anyar, Grogol and Giri Village.

Table 4-44: Population by Gender within Project Area in Banyuwangi in 2020

District	Village	Male Population	Female Population	Total Population	Sex Ratio
Licin	Tamansari	3,468	3,399	6,867	102
Kalipuro	Pesucen	2,198	2,213	4,411	99.3
	Bulusari	2,062	2,006	4,068	102.8
Glagah	Kampung Anyar	2,384	2,431	4,815	98
Giri	Grogol	2,591	2,612	5,203	99
	Giri	3,065	3,102	6,167	98.8

Source: Ijen District in Figures, 2021; Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Glagah District in Figures, 2021; Giri District in Figures, 2021

4.4.4.2.2 Productive Age

The basic indicator for employment is the proportion of the productive age population aged 15-64 who are employed. The age dependency refers to dependents or people younger than 15 or older than 64, to the population. There are a number of individuals categorised as productive age group that the Project may consider for employment, depending on their educational level, experience and skill required.

4.4.4.2.2.1 Bondowoso Regency

69% of the total Bondowoso population or equivalent to 538,291 people belong to the productive age group. The remaining 31% are deemed unproductive with 20% are in the age group of 0 – 14 years old and 11% in the 65+ years old age group, as provided in ***Table 4-45***. The dependency ratio is estimated at 45, indicating that for every 100 people in productive age, there are 45 people who have yet to reach productive age or who are not within productive age.

Table 4-45: Productive Age Group by Gender in Bondowoso in 2021

Age group	Population		Total	Category Productivity
	Male	Female		
0-14	79,118	76,372	155,490	Non-productive age
15-64	267,568	270,723	538,291	Productive age
65+	36,459	48,105	84,564	Non-productive age
Total	**383,145**	**395,200**	**778,345**	

Source: Bondowoso in Figures, 2022

The age characteristic of Ijen District – the location of the main construction of the Project – is rather similar to Bondowoso, as presented in ***Table 4-46***. The productive age group dominates the population of Ijen District at 71%. The remaining 29% of the population belonged to the unproductive age groups. Meanwhile, the dependency ratio is around 41.

Table 4-46: Productive Age Group by Gender in Ijen District in 2020

Age group	Population		Total	Category Productivity
	Male	Female		
0-14	1,222	1,128	2,350	Non-productive age
15-64	4,291	4,150	8,441	Productive age
65+	514	591	1,105	Non-productive age
Total	**6,027**	**5,869**	**11,896**	

Source: Ijen District in Figures, 2021

The above figure is comparable at the village level; the majority of population of the villages in the AoI, namely Kalianyar and Sempol, is at the productive age, refer to ***Table 4-47***; 66% of Kalianyar Village and 78% of Sempol Village. The dependency ratio for Kalianyar and Sempol Village is 52 and 28.

Table 4-47: Productive Age Group by Gender within Project Area in Bondowoso in 2021

Village	Age group	Population		Total	Category Productivity
		Male	Female		
Sempol	0-14	N/A	N/A	104	Non-productive age
	15-64	N/A	N/A	1,546	Productive age
	65+	N/A	N/A	325	Non-productive age
Jampit	0-14	N/A	N/A	N/A	Non-productive age
	15-64	N/A	N/A	N/A	Productive age
	65+	N/A	N/A	N/A	Non-productive age
Kalianyar	0-14	370	369	739	Non-productive age
	15-64	1,176	1,142	2,318	Productive age
	65+	237	231	468	Non-productive age

Source: Primary data (Sempol and Kalianyar Village Profile, 2021)

As observed during the survey, most of the people within working age in the villages in Bondowoso, are engaged in agricultural activity to support the household needs. People aged over 64 years still work in the farm or plantation regardless of their age and health condition.

4.4.4.2.2.2 Banyuwangi Regency

The productive age population in Banyuwangi Regency is 69% of the total population or 1,194,067 people. 20% of the population have yet to reach productive age (***Table 4-48***). The remaining 11% of the population are not within productive age anymore. Meanwhile, the dependency ratio is around 44.

Table 4-48: Productive Age Group by Gender in Banyuwangi in 2021

Age group	Population		Total	Category Productivity
	Male	Female		
0-14	184,359	175,180	359,539	Non-productive age
15-64	597,814	596,253	1,194,067	Productive age
65+	78,072	86,804	164,876	Non-productive age
Total	860,245	858,237	1,718,482	

Source: Banyuwangi in Figures, 2022

The age characteristic at the district where the transmission line will be traversed, is similar to Banyuwangi figure, as provided in ***Table 4-49***. Most of the population belongs to the productive age group. The percentage of productive age group in each district ranges from 69% to 72% of the total population. Meanwhile the dependency ratio is ranging between 38 and 46. This is comparably lower than Kalianyar Village, the main location of Project's construction.

Table 4-49: Productive Age Group by Gender within Project Area in Banyuwangi in 2020

District	Age group	Population		Total	Category Productivity
		Male	Female		
Licin	0-14	3,050	2,785	5,835	Non-productive age
	15-64	10,449	10,374	20,823	Productive age
	65+	1,319	1,483	2,082	Non-productive age
Kalipuro	0-14	9,641	8,976	18,617	Non-productive age
	15-64	29,031	29,417	58,448	Productive age
	65+	3,173	3,447	6,620	Non-productive age
Glagah	0-14	3,859	3,613	7,472	Non-productive age
	15-64	12,425	12,667	25,092	Productive age
	65+	1,792	2,176	3,968	Non-productive age
Giri	0-14	3,413	3,290	6,703	Non-productive age
	15-64	11,125	10,876	22,001	Productive age
	65+	1,294	1,623	2,917	Non-productive age

Source: Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Glagah District in Figures, 2021; Giri District in Figures, 2021.

4.4.4.3 Religion

To date, the Central Bureau of statistics has classified religions in Indonesia into seven (7) categories, namely Islam, Christianity, Catholicism, Buddhism, Hinduism, Konghucu, and others[30], with Islam being the predominant religion. Religion data could be leveraged to inform the development of Project engagement activities.

[30] Central Bureau of Satistics. Glossary. Retrieved from: https://www.bps.go.id/istilah/index.html?Istilah_sort=keyword_ind [Accessed February 2022]

4.4.4.3.1.1 Bondowoso Regency

Through secondary village data collection and key informant interview (KII), ERM identified that people residing in the study area in Ijen District, Bondowoso Regency are all Muslim, as listed in ***Table 4-50***. Although statistic data from Sempol Village is unavailable, it was confirmed during the KII with village apparatus that almost all people in Sempol Village are Muslim. This came unsurprised given that Bondowoso at large is known for its strong Islamic tradition following Nahdlatul Ulama (NU), one of the biggest Islamic organization in Indonesia.

Table 4-50: Population by Religion within Project Area in Bondowoso in 2021

Village	Islam	Christianity	Catholicism	Buddhism	Hinduism	Others
Sempol	N/A	N/A	N/A	N/A	N/A	N/A
Jampit	N/A	N/A	N/A	N/A	N/A	N/A
Kalianyar	3,079	-	-	-	-	-

Source: Primary data (Kalianyar Village Profile, 2021)

Multiple worship facilities, especially mosques and mushola, are observed within the Project Area to accommodate religious practices (***Table 4-51***). Besides, several fundraising activities carried out by the locals for the construction and renovation of mosques were spotted within the Project Area. Apart from religious activities, mosques are often used as a place to gather for community activities, as informed through the KII with religious leader in Kalianyar Village.

Table 4-51: Worship Facilities within Project Area in Bondowoso

Village	Mosque	Mushola
Sempol	7	14
Jampit	3	-
Kalianyar	6	10

Source: Primary data (Sempol and Kalianyar Village Profile, 2021); Ijen District in Figure, 2022

4.4.4.3.1.2 Banyuwangi Regency

Just like Bondowoso, Banyuwangi also upholds a strong Islamic tradition. This is commonly observed in the horseshoe area of East Java. However, a slightly diverse population is reported in the study area in Banyuwangi Regency, as presented in ***Table 4-52***. Islam still being the predominant religion with small percentage of Christianity, Catholicism, and Buddhism. Giri and Tamansari has the most diverse population in terms of religion. This is understandable given that Giri is situated in an urban setting with more heterogeneous community.

Table 4-52: Population by Religion within Project Area in Banyuwangi in 2020

District	Village	Islam	Christianity	Catholicism	Buddhism	Hinduism	Others
Licin	Tamansari	6,815	18	4	7	-	2
Kalipuro	Pesucen	4,415	14	-	5	-	1
	Bulusari	4,054	-	-	1	-	1
Glagah	Kampung Anyar	4,910	5	5	-	-	-
Giri	Grogol	5,015	1	3	-	-	-
	Giri	5,934	121	13	11	-	-

Source: Kampung Anyar Village Profile, 2021; Grogol Village Profile, 2021; Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Giri District in Figure, 2021.

Multiple worship facilities, especially mosques, are observed within the Project Area to accommodate religious practices. ***Table 4-53*** lists the number of worship facilities in the Project Area in Banyuwangi Regency.

Table 4-53: Worship Facility within Project Area in Banyuwangi

District	Village	Mosque	Musholla	Protestant Church	Vihara
Licin	Tamansari	11	5	4	1
Kalipuro	Pesucen	11	5	-	-
	Bulusari	20	13	-	-
Glagah	Kampung Anyar	9	27	-	-
Giri	Grogol	9	21	-	-
	Giri	6	24	-	-

Source: Kampung Anyar Village Profile, 2021; Grogol Village Profile, 2021; Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Giri District in Figure, 2021.

4.4.4.4 Ethnicities

The ethnicity data within the Study Area is mainly derived from discussion and KII with village apparatus and informal leaders. It is observed that villages are not used to recording ethnicity data.

In general, people within the Project Area in Bondowoso are belong to Madurese ethnic group, followed by Javanese ethnic group. Madurese has strong influence in the cultural life in the area. The majority of the local villagers speak in Madurese language, including the non-Madurese people.

The dominant ethnic group in the Project Area in Banyuwangi Regency are include Osing, Madurese, and Javanese ethnic group, followed by Balinese. Javanese is the largest group in Kampung Anyar Village, Glagah District; Osing is the biggest ethnic group in Grogol Village, Giri Village; Madurese is reported as the majority of the population in Bulusari Village, Kalipuro District. Through KII with village leader, it is presumably that similar ethnic group congregates in the same RT/RW (smaller neighbourhood), but there is always small number of people from other ethnicity that stay among villagers.

Osing is known as the native of Banyuwangi, which some consider it a sub-culture of Javanese group. Osing people speak in Osing dialect and they mostly reside in the central and northern part of Banyuwangi Regency, includes Banyuwangi District, Rogojampi District, Sempu District, Glagah District, Singojuruh District, Giri District, Kalipuro District and Songgon District. A detailed assessment of the Osing People is provided in ***Section 4.4.11***.

It should be noted that it is common for people to have various ethnic backgrounds in Indonesia and still use Bahasa Indonesia for daily and formal language purposes. Although some have a strong local accent which influenced by the ethnic background.

4.4.5 Land Acquisition Process

The land acquisition process for the transmission line will involve various landowners, namely state company (Perhutani), private plantation (Kalibendo), and project affected communities in several villages in Banyuwangi Regency. Therefore, various methods are expected to take place, depending on the landowners. The land acquisition process is detailed in the Land Acquisition Framework which serves as a standalone document to the ESIA.

The TL will run through village areas, forest areas and plantations (as summarised in **Table 6-46**). According to MCG's chief security and community relation on the ground, the land acquisition process involving project affected communities will be conducted in three villages, namely Bulusari, Grogol, and Giri Village. Initial identification of landowners indicates that there are a total of 31 affected landowners;

18 landowners in Grogol, 8 landowners in Bulusari, 2 in Pesucen and 3 landowners in Giri, Banyuwangi. It was reported that not all of the landowners have land certificates. However, these landowners will need to be considered in the acquisition process regardless of legal status. The land acquisition process is ongoing and a land use survey will need to be conducted as part of this process.

The current status of the land acquisition compensation process for the TT PAHs is provided in ***Table 4-54***.

Table 4-54: Summary of Land Acquisition and Compensation for the Transmission Line

Location	Land Acquisition*		
	Area (M^2)	Compensation Method	Land Type
Bulusari	2450	Cash/Transfer	Gardening
Grogol	5010	Cash/Transfer	Gardening/ Farmland
Giri	1425	Cash/Transfer	Gardening
Pesucen	800	Cash/Transfer	Farmland
Kampung Anyar	1750	Cash/Transfer	Plantation
TOTAL AREA	**11,435**		

*does not include land acquired for the ROW.

MCG is currently collecting information about the land required for the ROW and census data to align with IFC PS5 guidelines around collecting census data to effectively determine livelihood restoration measures based on appropriate and consistent compensation and eligibility criteria. Commencing on the 20th of July 2023, an ongoing initiative is underway to facilitate the dissemination of information pertaining to the ROW compensation plan within the villages directly impacted by the ROW project. This stakeholder engagement, referred to as comprehensive socialization effort, aims to ensure that the local communities possess a clear understanding of the resettlement action plan's intricacies and implications.

A Land Acquisition Framework and Livelihood Restoration Plan were developed for the Project which details the cut-off date, eligibility, entitlement, compensation package and livelihood restoration plan in accordance with applicable national regulations and international best practice standards (IFC Performance standard) are essential for the Project. Economic Profile and Livelihoods

4.4.5.1 General Economic Conditions

Gross Regional Domestic Product (GRDP) and GRDP per capita are commonly used as indicators for determining the size of a regency's local economy. The GRDP is a basic measure of the value added from economic activity or a total value of production of goods and services within a regency level per year. The higher the GRDP of the regency, the better the level of the local economy within its composite districts and villages. This measure does not include income inequality factors. Although there are limitations, this indicator is sufficient to determine the level of the economy of a region at the macro level.

Table 4-55 presents GRDP growth rate of Bondowoso and Banyuwangi Regency for a period of 2017 to 2021. National figure is included as a comparison in assessing the economic conditions of these two regencies. Bondowoso's economic performance is generally weaker than the national average, except in 2020 where the COVID-19 pandemic affects almost all economic sectors in Indonesia. In another hand, Banyuwangi performs better than the national average.

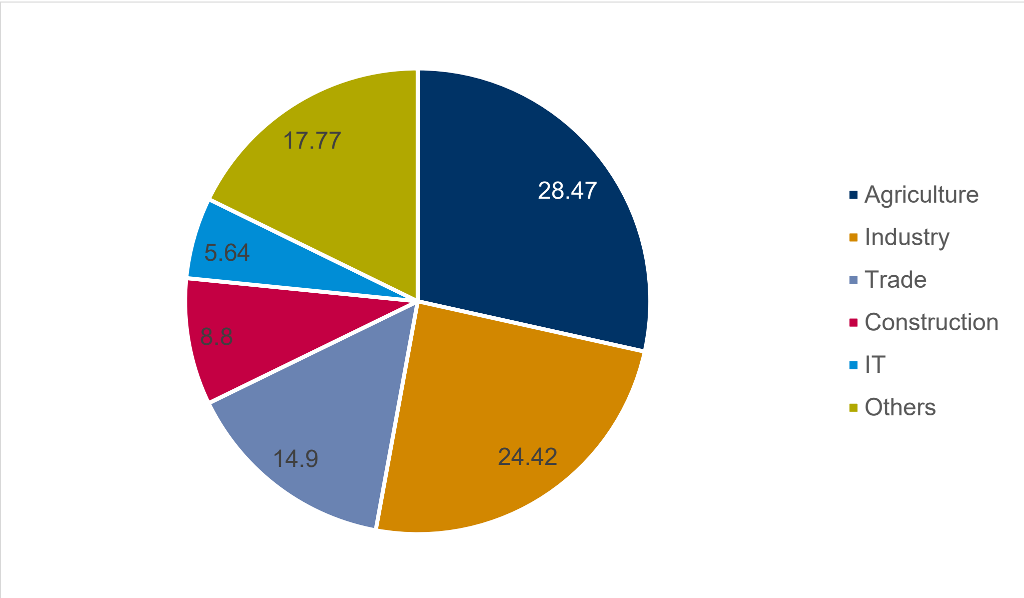
Table 4-55: GRDP Growth Rate in the Project Area

Regency	GRDP Growth Rate (%)				
	2017	2018	2019	2020	2021
Bondowoso	5.03	5.08	5.30	-1.36	3.49
Banyuwangi	5.45	5.84	5.55	-3.58	4.08
Indonesia	5.07	5.17	5.02	-2.07	3.69

Source: Central Bureau of Statistic, 2022; Bondowoso in Figures, 2022; Banyuwangi in Figures, 2022

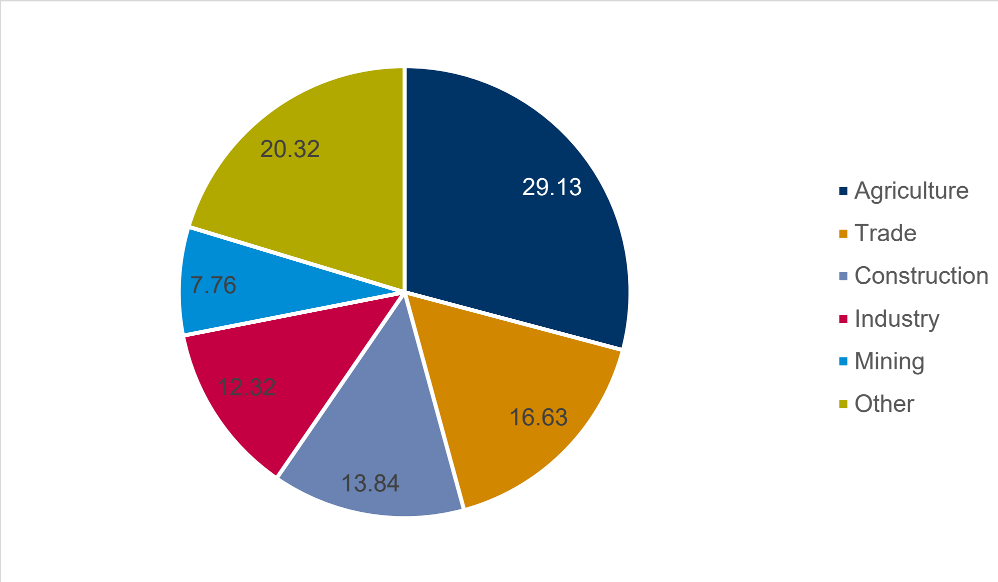
The agriculture sector is the main source of income in both Bondowoso and Banyuwangi Regency. At most, the sector contributes up to 29% of the local economy. The detailed figure is illustrated in ***Figure 4-49*** and ***Figure 4-50***.

Figure 4-49: GRDP by Sector (%) in Bondowoso in 2021



Source: Bondowoso in Figures, 2022

Figure 4-50: GRDP by Sector (%) in Banyuwangi in 2021



Source: Banyuwangi in Figures, 2022

4.4.5.2 Labour Force

The workforce participation level represents labour supply available to produce goods and services. ***Table 4-56*** shows the labour force condition in Bondowoso and Banyuwangi. The labour force participation rate (LFPR) for male population, both in Bondowoso and Banyuwangi is higher than female population. It is observed that the unemployment rate of these two regencies is smaller than province average, which is 5.74.

Table 4-56: Workforce Condition in the Project Area in 2021

Regency	Workforce				LFPR*	Unemployment Rate
	Work		Unemployment			
	Male	Female	Male	Female		
Bondowoso	258,225	188,428	10,288	10,547	73.89	4.46
Banyuwangi	531,061	352,457	33,573	17,086	72.32	5.42

Source: Bondowoso in Figures, 2022; Banyuwangi in Figures, 2022

*Labour Force Participation Rate

The main livelihood of communities differs between Bondowoso and Banyuwangi. The majority of the labour force in Bondowoso (45.7%) are engaged in farming. Meanwhile, most of Banyuwangi's labour farce (44%) work in service sector, followed by agriculture sector at 35.5%, refer to ***Table 4-57*** for detailed figures.

Table 4-57: Labour Force Population by Sector

Sector	Agriculture	Industry	Service
Bondowoso* (2021)	204,486	87,302	154,865
Banyuwangi (2020)	310,189	178,879	384,453

Source: Bondowoso in Figures, 2022; Central Bureau of Statistic of Banyuwangi, 2021

Table 4-58 presents the job status of labour force in Bondowoso and Banyuwangi Regency. The majority of economically active individuals in Bondowoso are casual workers in agriculture sector; this conforms to the data of labour force by sector in ***Table 4-57***. However, the number is comparable with self-employed and labourer figures. The biggest portion of labour force in Banyuwangi are labourers, with a proportion for male workers up to 61%. The number is considerably high, compared to other type of job status.

Table 4-58: Job Status by Gender in 2021

Job Status	Bondowoso		Banyuwangi	
	Male	Female	Male	Female
Self-employed	55,906	40,080	117,397	75,974
Employer assisted by temporary worker/ unpaid worker	50,717	31,336	102,465	47,971
Employer assisted by permanent worker/ paid worker	18,903	4,159	34,248	10,472
Labour/Employee/Worker	53,128	33,388	158,009	98,542
Casual Worker	67,454	34,458	82,102	31,114
Family Worker/Unpaid Worker	12,117	45,007	36,840	88,384

Source: Bondowoso in Figures, 2022; Banyuwangi in Figures, 2022

4.4.5.3 Minimum Wage and Income

The standard minimum wages in both Bondowoso and Banyuwangi Regency within the last three years has been steady. A slight increase is observed in 2022 (***Table 4-59***).

Table 4-59: Minimum Wage in the Project Area

Regency	Regional Minimum Wages		
	2020	2021	2022
Bondowoso	IDR 1,954,705.75	IDR 1,954,705.75	IDR 1,958,640.12
Banyuwangi	IDR 2,314,278.87	IDR 2,314,278.87	IDR 2,328,899.12

Source: East Java Province Government, 2021

The regency minimum wages, refer to ***Table 4-59,*** are higher than the monthly household income of communities within the Project area, both in Bondowoso and Banyuwangi Regency. Based on discussion and KII with village leader, their monthly household income is around IDR 1,500,000.00. This is mostly generated from the agriculture sector, where the daily wages of farmworkers ranging from IDR 35,000.00 to IDR 50,000.00.

4.4.5.4 Local Livelihood

The majority of people within the Project area are working as farmers and farmworkers, while few people work as daily labourer with unstable income and have small businesses of groceries shops. Detailed data is presented in ***Table 4-60*** and ***Table 4-61***. Statistic data is not available for all villages within the Project area, however; this can be used to inform the general trend of main occupation of people in the vicinity of the Project.

Table 4-60: Main Occupation by Gender in Sempol, Kalianyar, and Grogol in 2021

Occupation	Sempol Village		Kalianyar Village		Grogol Village	
	Male	Female	Male	Female	Male	Female
Farmworker[31]	235	75	750	760	678	456
Farmer	212	57	-	-	-	-
Cattleman	-	-	600	-	-	-
Daily labourer	-	-	-	-	375	154
Private company employee	25	20	400	200	50	100
Driver	-	-	50	-	6	-
Civil servant & village apparatus	13	7	12	13	33	12
Migrant worker	-	-	5	9	-	-
Small & middle entrepreneurs	72	22	5	6	-	-
Merchant	-	-	2	1	2	5
Military/ Police	1	-	3	-	-	-
Medical personnel	1	1	-	-	-	-
Mechanic	-	-	-	-	4	-
Teacher	-	-	-	-	10	5
Carpenter	-	-	-	-	6	-
Architect	-	-	-	-	4	-
Dresser	-	-	-	-	1	3
Religious leader	-	-	-	-	4	2
Sailor	-	-	-	-	2	-

Source: Primary data (Sempol, Kalianyar, and Grogol Village Profile, 2021)

As seen in ***Table 4-60***, the occupations in Sempol and Kalianyar are less varied than Grogol Village. They are mostly concentrated in natural resource-based sector, such as farmer and cattlemen. Interesting figure is observed on the number of male and female farmworkers in Kalianyar; the number of female worker is higher than the male. This is the opposite of Sempol and Grogol, where the number of male farmworkers is higher than female.

Table 4-61: Main Occupation in Kampung Anyar and Bulusari in 2021

Occupation	Kampung Anyar Village	Bulusari Village
Farmworker[32]	485	1002
Farmer	1409	-
Cattleman	182	-
Mining	-	102

[31] Based on the Central Bureau of Statistic, farmworker is defined as people who work in other people's fields for wages.
[32] Based on the Central Bureau of Statistic, farmworker is defined as people who work in other people's fields for wages.

Occupation	Kampung Anyar Village	Bulusari Village
Company employee	116	-
Driver	6	21
Civil servant	5	-
Small & middle entrepreneurs	3	-
Merchant	60	377
Midwife	1	-
Teacher	9	-
Architect/ Consultant	4	-
Services	60	161
Finance	-	6
Industry	-	84
Electricity, water & gas	-	4
Construction	-	217

Source: Primary data (Kampung Anyar and Bulusari Village Profile, 2021)

Nearly all farming activities in Sempol and Kalianyar, Bondowoso are undertaken on Perhutani or PTPN XII land; this is different with farmers in villages in Banyuwangi who farm on their own land. Different land leasing scheme is adopted by Perhutani and PTPN. According to head of Forest Village Community Institution (*Lembaga Masyarakat Desa Hutan*/ LMDH) of Kalianyar, land leasing scheme on PTPN land is calculated per hectare per one growing season; the fee is around IDR 3.2 million per hectare. In another hand, the applicable scheme for Perhutani land is profit sharing, where Perhutani is entitled for 20% of the profit (sales of crops minus costs).

It should be noted that farmers from nearby villages – Jampit Village – are seen to cultivate potatoes within the Study Area, however not instead the currently permitted area. According to the farmers, they have been farming in the area way before the commencement of the Project. Domesticated animals such as cows and goats are found the in the Project AOI, particularly nearby the wells, geothermal plants and its supporting facilities. It indicates that the areas nearby the plant are used not only as farming areas but also grazing land and areas used to collect animal feed.

There are various agriculture products cultivated by the farmers in the vicinity of the Project area, namely potatoes, carrots, leek, cabbage, mangosteen, avocados, coffee and spices (such as clove). According to primary data from Kalianyar Village (see ***Table 4-62***), potato and cabbage are the main agriculture products. The same findings are also reported in Sempol Village's profile; potato and cabbage are deemed as the main agriculture commodities of the village.

Table 4-62: Agriculture Products in Kalianyar Village

No	Product	Farm Area (ha)	Yield (tonnes/ ha)
1	Corn	15	45
2	Ground nut	1	1
3	Long beans	0.5	0.2
4	Red beans	10	1
5	Chillies	3	0.5
6	Potato	50	6

No	Product	Farm Area (ha)	Yield (tonnes/ ha)
7	Cabbage	25	30
8	Carrot	5	1
9	Orange	20	0.5

Source: Primary data (Kalianyar Village Profile, 2021)

Potatoes are harvested twice a year in the month of February through April and June. The average yield is approximately 1-2 tonnes. The selling price to middlemen depends on the quality and size ranging from 2,000 IDR/kg to 6,000 IDR/kg. There are no local shops nearby and the farming yields are transported to local markets in Banyuwangi. Irrigation for plants in the surrounding geothermal plant area depends heavily on rain. During dry seasons, farmers will utilise rubber and coffee plantations for alternative farming activities.

Coffee plantations are largely managed by Perhutani or PTPN XII. The harvest season for coffee is unknown and could not be predicted regularly. For initial harvest season, coffee can yield between 10-15 kg/tree and about 30-40 kg/tree in the next harvest seasons. The selling price ranges between IDR 1,700/kg to 2,400/kg depending on the harvesting seasons and quality of the bean.

Avocadoes are also among the major agriculture products for the local communities, as informed during discussion with local stakeholders. During harvest season, average yield is between 2-4 quintal[33] per trees and can be sold at IDR 12,000/kg. More varied commodities are reported in the area of transmission line in Banyuwangi.

Apart from the aforementioned crops, there are other plants observed within the Project area, particularly in Banyuwangi, including banana, cassava, papaya, Chinese albizia, rubber as well as coconut. A summary of other information collected on the ground related to main agricultural commodities are provided in ***Table 4-63***. These information is solely gathered from interviews with locals during ERM site visit in March 2022.

[33] a unit of weight equal to 100 kilograms (about 220 pounds)

Table 4-63: Main Crops near the Project Area

Main Crops	Harvest frequency	Selling price	Project Area
Coffee	1-2 times	IDR 1,700/kg to 2,400/kg	Banyuwangi and Bondowoso Area
Mangosteen	Once every 2-3 years	IDR 7,000/kg	Banyuwangi area (Bulusari)
		IDR 30,000/kg	Banyuwangi area (Pesucen)
Avocado	Once a year	IDR 10,000/kg	Banyuwangi and Bondowoso Area
Durian	Once a year	IDR 10,000-25,000/Fruit	Banyuwangi Area
Clove	Once a year	IDR 75,000 – 100,000/kg	Banyuwangi and Bondowoso Area
Coconut	Every three months	IDR 5,000-10,000/kg	Banyuwangi Area
Cabbage	NA	IDR 500-2000/kg	Bondowoso Area
Potato	Twice a year	IDR 2,000 to 6,000/kg	Bondowoso Area

Source: Informant Interviews, 2022

4.4.6 Education

Access to and quality of education are key determinants of the quality of human capital in a country. The section below discuss the education condition in the social study boundary, mainly at the regency level. The data in district level and village level is presented where available.

4.4.6.1 Level of Education

Level of education is illustrated through three main indicators, namely literacy rate, mean years of schooling, and school participate rate. Literacy rate indicates the proportion of people ages 15 and above who can read and write. Mean years of schooling suggests the average number of completed years of education of a country's population aged 15 years and older, excluding years spent repeating individual grades. School enrolment rate measured the ratio between the numbers of students of a particular age group enrolled in all levels of education by the size of the population of that age group.

4.4.6.1.1 Bondowoso Regency

Table 4-64 presents the literacy rate in Bondowoso per age category. It is observed that the older the age, the lower the literacy rate.

Table 4-64: Literacy Rate per Age Category in Bondowoso in 2021

Regency	15-19	20-29	30-39	40-49	50-59	60-69	70+
Bondowoso	100	99.57	98.37	91.38	70.44	45.61	34.54

Source: Bondowoso in Figures, 2022

Mean years of schooling in Bondowoso is presented in ***Table 4-65***. A gap is observed, compared to the provincial average (East Java Province) which is increasing annually. This could suggest crucial issue with education in the regency (as noted through local KIIs).

Table 4-65: Mean Years of Schooling in Bondowoso

Regency	2019	2020	2021
Bondowoso	5.71	5.93	5.94
East Java Province	7.59	7.78	7.88

Source: Central Bureau of Statistic of East Java Province, 2022

There is a decreasing trend of school enrolment rate in Bondowoso in all education level, refer to ***Table 4-66***. This is strengthened by findings from discussion with youth groups in Kalianyar Village; many decided to leave lower secondary school (SMP) to work in the plantations (for male student) or get married (for female student). In addition, village officials are of the opinion that the absence of job opportunities, especially for high school graduates, also encourages students to drop out of school.

Table 4-66: School Enrolment Rate in Bondowoso

Education Level	Bondowoso	
	2020	2021
Primary school (SD, MI)	99.68	99.41
Lower secondary school (SMP, MTS)	97.71	97.49
Upper secondary school (SMA, SMK, MA)	71.83	71.24

Source: Bondowoso in Figures, 2022

Those three education indicators at the regency level reflect the findings at Kalianyar Village, Bondowoso, which is the main location of development area. The majority of the population have only completed primary school, refer to ***Table 4-67***. Through KIIs, the Head of Kalianyar Village emphasized human capital challenge in his village, citing lack of education background as one of the pressing issues.

Table 4-67: Highest Level of Education of People in Kalianyar Village in 2022

Hamlet	Highest Level of Education (%)			
	Primary school	Lower secondary school	Upper secondary school	University
Blawan 1	65	20	10	5
Blawan 2	65	20	10	5
Plalangan 1	35	30	20	15
Plalangan 2	35	30	20	15
Mas Rejo Mulyo	65	20	10	5
Watu Capil	65	20	10	5
Kebun Jeruk	70	15	10	5
Margahayu	55	25	15	5
Curah Macan	70	10	10	5

Source: Primary Data (Kalianyar Village Office, 2022)

4.4.6.1.2 Banyuwangi Regency

Table 4-68 presents the literacy rate in Banyuwangi per age category. It is observed that the older the age, the lower the literacy rate. Compared to Bondowoso's figure (refer to ***Table 4-64***), Banyuwangi seems to perform better, especially in the older age category (50+).

Table 4-68: Literacy Rate per Age Category in Banyuwangi in 2021

Regency	15-19	20-29	30-39	40-49	50-59	60-69	70+
Banyuwangi	100	100	98.45	96.81	90.86	75.35	56.91

Source: Banyuwangi in Figures, 2022

Mean years of schooling in Banyuwangi is provided in ***Table 4-69.*** It is observed that Banyuwangi is behind the provincial average, although a bigger gap is observed in Bondowoso (see ***Table 4-65***).

Table 4-69: Mean Years of Schooling in Banyuwangi

Regency	2019	2020	2021
Banyuwangi	7.13	7.16	7.42
East Java Province	7.59	7.78	7.88

Source: Central Bureau of Statistic of East Java Province, 2022

A decreasing trend of school enrolment rate is observed in Banyuwangi in all education level in 2021, with an exception for lower secondary school, see ***Table 4-70***.

Table 4-70: School Enrolment Rate in Banyuwangi

Education Level	Banyuwangi	
	2020	2021
Primary school (SD, MI)	99.03	98.92
Lower secondary school (SMP, MTS)	81.32	82.39
Upper secondary school (SMA, SMK, MA)	62.37	62.28

Source: Banyuwangi in Figures, 2022

Turning to the (available) village data as provided in **Table 4-71**, the figure seems aligned with the overall findings at the regency level, despite the incomplete data in all education category. The data suggests that the majority of the population only completed primary school. Furthermore, substantial numbers of drop out in Grogol Village is recorded at primary school level.

Table 4-71: Highest Level of Education of People in Kampung Anyar, Bulusari, and Grogol Village in 2021

Highest Level of Education	Kampung Anyar Village	Bulusari Village	Grogol Village
Drop out of primary school	80	200	1,146
Primary school	900	6,669	549
Lower secondary school	324	1,128	N/A
Upper secondary school	26	799	N/A
University	N/A	76	130

Source: Primary data (Kampung Anyar, Bulusari & Grogol village profile, 2021)

An interesting finding was observed in Grogol Village, where those who had never attended school consisted of more female population (1,003 people) than male population (942 people). However, there are currently more female students (185 people) than male students (164 people) at all school levels.

4.4.6.2 Education Infrastructure

4.4.6.2.1 Bondowoso Regency

Bondowoso in Figures (2022) highlights the number of school facilities in the district, without specifying particular facilities the schools might have. There are several school facilities available in the village in Bondowoso, as can be seen in ***Table 4-72*.** All villages have primary school (elementary school). However, for the higher education level – lower and upper secondary school – is only available in Sempol Village. Many attend school in other districts, particularly at the city centre, which approximately 45 minutes from Ijen District, as informed through discussion and KII with village apparatus. They do not commute, but live in a boarding house near the school and only come home occasionally during school holidays.

4.4.6.2.2 Banyuwangi Regency

There are several school facilities available in the villages in Banywuangi, as can be seen in ***Table 4-73*.** All villages have primary school, including Islamic school equivalent to elementary school level (locally known as *madrasah ibtidaiyah*/ MI). However, higher education level – lower and upper secondary school – is only available in certain villages, such as Bulusari and Giri Village. Many go to other villages that are relatively close and have school facilities or go to school in the city centre which is relatively close, which only takes about 30 to 45 minutes.

Table 4-72: School Facilities* in Villages in Bondowoso in 2021

Village	Primary School			Lower Secondary School			Upper Secondary School		
	Building	Distance	Teacher	Building	Distance	Teacher	Building	Distance	Teacher
Sempol	2	100 meter	17	1	100 meter	24	1	100 meter	12
Jampit	2	N/A	N/A	-	-	-	-	-	-
Kalianyar	3	N/A	8	-	-	-	-	-	-

Notes: school facilities include public, private, and Islamic school (madrasah ibtidaiyah-equivalent to primary school, madrasah tsanawiyah-equivalent to lower secondary school, and madrasah aliyah-equivalent to upper secondary school)

Source: Primary data (Sempol & Kalianyar Village profile, 2021); Ijen District in Figure, 2021

Table 4-73: School Facilities* in Villages in Banyuwangi in 2021

Village	Primary School			Lower Secondary School			Upper Secondary School		
	Building	Distance	Teacher	Building	Distance	Teacher	Building	Distance	Teacher
Tamansari	5	N/A	38	-	-	-	-	-	-
Kampung Anyar	2	N/A	14	-	-	-	-	-	-
Pesucen	4	N/A	30	1	N/A	9	-	-	-
Bulusari	2	N/A	16	2	N/A	19	2	N/A	24
Grogol	5	N/A	56	1	N/	19	-	-	-
Giri	3	N/A	48	1	N/A	19	1	N/A	14

Notes: school facilities include public, private, and Islamic school (madrasah ibtidaiyah-equivalent to primary school, madrasah tsanawiyah-equivalent to lower secondary school, and madrasah aliyah-equivalent to upper secondary school)

Source: Primary data (Kampung Anyar & Grogol Village profile, 2021); Licin District in Figures, 2021; Kalipuro District in Figure, 2021; Giri District in Figures, 2021

4.4.6.3 Vocational Training

Besides the formal education, the Government of Indonesia has also established vocational training centres to provide job-specific technical training. These programs generally focus on providing hands-on instruction, and can lead to certification. Vocational training programs are usually preferred by community members who wish to work directly after graduating from secondary school.

Vocational training centres (locally referred as BLK) are reported in both Bondowoso and Banyuwangi Regencies. These centres provide various training programs in the following sector: automotive, hotel management, and creative industries. It was reported that 208 participants were enrolled in the 2021 training and certification program offered by BLK Banyuwangi.[1]

Community Learning Activity Centre (locally referred as PKBM) – an educational facility to provide non-formal education for local community – is also observed in Jampit Village, Bondowoso, namely PKBM Hayatul Amin (***Figure 4-51***). This PKBM is managed by local religious leader and offers the equivalence education package program (Paket A, Paket B and Paket C), pre-school education, and various trainings (music, make-up, cooking and batik).

Figure 4-51: Program of PKBM Hayatul Amin in Jampit Village, Ijen

[1] Source: https://banyuwangikab.go.id/berita-daerah/ratusan-anak-muda-banyuwangi-dapat-pelatihan-dan-sertifikasi-kompetensi-gratis.html

4.4.7 Health

4.4.7.1 Community Health

4.4.7.1.1 Bondowoso Regency

According to Bondowoso in Figures (2022), the top three diseases recorded in the regency include essential hypertension, gastritis, and gastroenteritis. With regard to sexually transmitted disease, especially HIV-AIDS, there is an increase of cases in Bondowoso compared to the previous years. In 2020, there are 264 HIV and AID cases, with 33 deaths due to AIDS (Health Agency of Bondowoso Regency, 2020).

At the district level, the community health centre in Ijen District – the study area – records 15 most prevalent health issues as presented in ***Table 4-74***. It should be noted that the records do not only cover Sempol, Jampit, and Kalianyar Village – the villages in the AoI – but also other villages under Ijen District. Essential hypertension was recorded as the most prevalent diseases, followed by influenza, gastritis, IDDM and spinal diseases. The community perceived their health condition as good with the main health issue perceived as muscle disorder due to working in the agriculture fields.

Table 4-74: Top 15 Diseases Recorded in Ijen District in 2021

Disease	Total Cases
Essential (primary) hypertension	689
Influenza	599
Gastritis and duodenitis	554
Insulin dependent diabetes mellitus (IDDM)	552
Other spinal diseases	398
Pharyngitis	376
Other headache syndromes	263
Undefined diarrhoea and gastroenteritis	208
Common cold	208
Non-insulin dependent diabetes mellitus	207
Allergic Skin Disease	203
Arthritis, osteoarthritis	184
Tonsillitis	176
Migraine	159
Liquid metabolism disorder	151
Total	**4,927**

Source: Sempol Community Health Centre, 2022

Apart from the diseases listed above, there are various source of risks for community safety, namely community conflict and natural disasters. Bondowoso has a history of community conflict involving minority religious communities, but the 2006 conflict has been handled accordingly and no recurrence of the incident is observed. With regard to natural disaster, Bondowoso is particularly prone to volcanic eruptions, landslides, hurricanes, and floods. Heavy floods were specifically reported in the Project's main works area – Sempol and Kalianyar Village – in 2020-2021, yet no casualties were recorded.

4.4.7.1.2 Banyuwangi Regency

Hypertension ranks first as the most diseases recorded in the regency in 2021. It is followed by ISPA and non-insulin dependent diabetes mellitus. Regarding sexually transmitted disease, especially HIV-AIDS, higher figures are observed in Banyuwangi, compared to Bondowoso. The total of HIV and AIDS cases in the regency are up to 586 cases with 86 deaths (Health Agency of Banyuwangi Regency, 2020). Importantly, Banyuwangi is among top-five city/regency in East Java Province with the highest HIV and AIDS cases (Health Agency of East Java Province, 2018).

District level data is not available across all districts in the AoI in Banyuwangi. ***Table 4-75*** lists the top 15 diseases in the villages under the authority of Kelir Community Health Centre, including Bulusari and Pesucen Village, Kalipuro District, Banyuwangi. ISPA is recorded as the most prevalent disease.

Table 4-75: Top 15 Diseases Recorded by Kelir Community Health Centre in January 2022

Disease	Total Cases
Acute upper respiratory infections of multiple and unspecified sites	120
Essential (primary) hypertension	93
Common cold	43
Unspecified respiratory tuberculosis	29
Gastritis	28
Disturbance in tooth eruption	26
Necrosis of pulp	25
Dermatitis	23
Myalgia	22
Influenza	21
Scabies	20
Non-insulin dependent diabetes mellitus	19
Headache	18
Pulpitis	18
Arthritis	18
Total	**523**

Source: Kelir Community Health Centre, 2022

4.4.7.2 Health Infrastructure

4.4.7.2.1 Bondowoso Regency

There is one community health centre near the Project Area in Ijen District, Bondowoso; it is particularly located in Sempol Village, namely Sempol Community Health Centre (locally referred as *Puskesmas*). The area of work of the Sempol Community Health Centre covers all villages under Ijen District, including Sempol, Jampit, and Kalianyar Village. Jampit is reported to be the farthest village from the community health centre, which is about 15 km. It should be noted that the Sempol community health centre also provides inpatient treatment; this considered essential given the difficult access from the district to the hospital.

Sempol Community Health Centre is supported by three village-level community health centres. Two of them are located in Jampit and Kalianyar. Communities typically go to village-level health centre if they have mild symptoms. Besides health facilities listed in ***Table 4-76***, hamlet-level health centre (locally referred as *Ponkesdes*) is observed in Curah Macan Hamlet – the closest settlement area to the Project Area. According to the local communities, many access health service in the hamlet-level health centre to obtain medicine for minor disease; they prefer to go to the health centre, rather than nearby stall to get medicine.

Table 4-76: Health Facilities in Villages in Bondowoso in 2020

Village	Hospital	Maternal Hospital	Community Health Centre (*inpatient*)	Village-Level Community Health Centre	Clinic/ Health Centre	Pharmacy	Maternal & Child Health Services
Sempol	-		1	-	-	-	3
Jampit	-		-	1	-	-	-
Kalianyar	-		-	1	-	-	5

Source: Primary Data (Sempol & Kalianyar Village Profile, 2021); Ijen District in Figures, 2021

The number of health personnel is provided in ***Table 4-77***. Health personnel is mostly stationed at the district-level community health centre in Sempol Village. However, according to local community, at least there is one midwife in each village-level community health centre.

Table 4-77: Health Personnel in Villages in Bondowoso in 2020

Village	Doctor	Midwife	Shaman (helps with childbirth)	Nurse Practitioner (*mantri kesehatan*)
Sempol	2	6	4	4
Jampit	-	1	7	2
Kalianyar	-	1	3	1

Source: Ijen District in Figures, 2021

4.4.7.2.2 Banyuwangi Regency

There is restricted number of health facilities in villages in Banyuwangi Regency, as presented in ***Table 4-78***; the majority of the health facility is located at the district level. Only two village-level community health centre are reported in Pesucen and Giri Village. Communities often go to nearby health facility in nearby villages to access health services. Also, many prefer go to big hospital at the city centre which is about 10-15 km from the villages. This was confirmed through discussion and KII with village officers in Pesucen and Grogol Village.

Table 4-78: Health Facilities in Villages in Banyuwangi in 2020

Village	Hospital	Maternal Hospital	Community Health Centre (*inpatient*)	Village-Level Community Health Centre	Clinic/ Health Centre	Pharmacy	Maternal & Child Health Services
Tamansari	-	-	-	-	-	-	10
Kampung Anyar	-	-	-	-	-	-	5
Pesucen	-	-	-	1	-	-	9
Bulusari	-	-	-	-	-	-	8
Grogol	-	-	-	-	-	-	10
Giri	-	-	-	1	2	-	9

Source: Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Glagah District in Figures, 2021; Giri District in Figures, 2021.

Health personnel are mostly stationed at the health centre in the district level. The number of health personnel in village level is low, refer to ***Table 4-79***.

Table 4-79: Health Personnel in Villages in Banyuwangi in 2020

Village	General & Specialist Doctor	Dentist	Midwife	Nurse
Tamansari	9	-	-	-
Kampung Anyar	-	-	1	1
Pesucen	-	-	-	-
Bulusari	-	-	1	-
Grogol	-	-	2	-
Giri	6	-	4	-

Source: Primary Data (Kampung Anyar and Bulusari Village Profile, 2021); Licin District in Figures, 2021; Kalipuro District in Figures, 2021; Giri District in Figures, 2021.

4.4.8 Utilities

4.4.8.1 Water

4.4.8.1.1 Bondowoso Regency

The majority of households in Bondowoso use clean (metered) tap water provided by state-owned water utility company (locally referred as PDAM). The number of PDAM customers for households' increases by 1.32%, reaching 19,516 customers in 2020. An exception is reported only for Ijen District. According to Ijen District in Figures (2021), all villages in Ijen District use water spring as clean water source. This is confirmed through discussion with local communities, especially those reside in Jampit and Kalianyar Village. They have been using water spring for household use, such as drinking, washing, and cooking for years. Communities install pipes and hoses to drain clean water from the source to their houses.

In another hand, the majority of communities in Sempol Village use water from wells in their house area for households use. It is reported that there is no fee collected with regard to clean and drinking water access in Sempol Village.

Primary data from Sempol and Kalianyar Village office suggests other clean and drinking water sources that have been used by communities, as listed in ***Table 4-80***. It is reported that 73% households in Kalianyar Village use water spring as clean and drinking water source.

Table 4-80: Clean and Drinking Water Source in Villages in Bondowoso

Village	Tap water	Drilling well	Well	Water spring	River
Sempol	√	√	√	√	√
Kalianyar	√	×	×	√	√

Source: Primary Data (Sempol & Kalianyar Village Profile, 2021)

4.4.8.1.2 Banyuwangi Regency

According to Banyuwangi in Figures (2022), most of households in Banyuwangi use clean (metered) tap water provided by PDAM. An exception is reported for some districts, including Licin District located in the AoI for the transmission line development. PDAM customers are reported in other potentially impacted districts in Banyuwangi, such as Glagah, Kalipuro, and Giri District, see ***Table 4-81***.

Table 4-81: Number of PDAM Customers and Distributed Clean Water in Glagah, Kalipuro & Giri in 2021

District	Number of Customers	Distributed Water (m^3)	Value (IDR)
Glagah	2,253	41,653	145,117,268
Kalipuro	9,786	180,923	630,322,940
Giri	6,809	125,885	438,572,338

Source: Banyuwangi in Figures, 2022

Through primary data from village office and KII with village leaders, it is reported that communities in Tamansari, Kampung Anyar, and Bulusari Village use spring water from Kalibendo Plantation (***Figure 4-52***) as a source of domestic and drinking water. Pipes were installed to distribute water to each house in those three villages. A small fee is collected from each household to maintain the pipe installation. A similar mechanism is also reported in Grogol Village, as informed by Village Secretary through KII.

Figure 4-52: Patemon Water Spring in Kalibendo Plantation

4.4.8.2 Energy

4.4.8.2.1 Bondowoso Regency

Along with the increasing population, the number of electricity customers in Bondowoso is also increasing annually; the number of electricity customers in 2020 is reported to be 235,580 – an increase of 6.23% from 2019. The increase is also observed in Ijen District, see ***Table 4-82***.

Table 4-82: Number of Electricity User in District in Bondowoso

District	2017	2018	2019	2020	2021
Ijen	2,929	3,122	3,383	3,608	4,107

Source: Bondowoso in Figures, 2022

According to Ijen in Figure (2021), all households in villages in the AoI in Ijen, namely Sempol, Jampit, and Kalianyar Village have secured electricity access from State Electricity Company (locally referred as PLN), see ***Table 4-83***.

Table 4-83: Household Population by Electricity Source in 2020

Village	State Electricity Company	Non-State Electricity Company
Sempol	748	-
Jampit	601	-
Kalianyar	1,345	-

Source: Ijen District in Figures, 2021

It is also reported that all households in those three villages in the AoI use a 3 kg Liquefied Petroleum Gas (LPG) for cooking. 3 kg LPG is a subsidized cooking fuel; it is specifically targeted for poor household and micro-enterprise.

4.4.8.2.2 Banyuwangi Regency

The number of electricity customers in Banyuwangi is 589,072 in 2021. ***Table 4-84*** provides detailed electricity customer in potentially impacted districts in Banyuwangi, namely Licin, Glagah, Kalipuro and Giri from year to year. Number of electricity customers is reported to have increased in all districts.

Table 4-84: Number of Electricity User in District in Banyuwangi

District	2017	2018	2019	2020	2021
Licin	7,477	7,868	8,412	8,753	9,050
Glagah	10,102	10,474	11,542	12,048	12,469
Kalipuro	23,675	25,030	26,390	27,645	28,704
Giri	10,520	11,003	11,426	11,855	12,326

Source: Banyuwangi in Figures, 2022

Statistical data at the village level is limited. However, as confirmed through KII with Bulusari, Grogol, Kampung Anyar and Giri village leaders, all households in the aforementioned villages have connected to national grid facilities provided by PLN.

4.4.8.3 Waste Management

Domestic waste management awareness among local communities within the Project Area is considerably low. For instance, waste segregation is not commonly practiced. Community members mostly burn domestic waste on vacant plantation area or dump them in the ground. Some also dispose plastic waste on nearby river; this is specifically reported in Bulusari Village.

It is particularly observed that there are pile of cabbage leaf litter on the side of road in Sempol and Kalianyar Village which causes an unpleasant odour. Local communities argue that this is mainly due to the irresponsible behaviour of cabbage middlemen that dispose poor quality cabbage leaves on the side of the road.

According to primary data from village offices, temporary landfills are available in Sempol, Kalianyar, and Grogol Village. There are two temporary landfills reported in Kalianyar Village and one temporary landfill in Grogol Village. Waste pick services to collect domestic waste from the community is only reported in Sempol Village.

4.4.9 Road and Transportation Network

As described in the project description, the Project mainly uses existing regency roads belong to Bondowoso Regency and local roads belong to PTPN XII for transport and personnel access to the Site, especially for the geothermal power plant. While transportation mobility plan for the transmission line has yet to be developed.

4.4.9.1.1 Bondowoso Regency

The total length of roads in Bondowoso in 2021 is 1,464,156 km, consisting of 68,880 km provincial road and 1,395,276 km regency road; 95% of roads in Bondowoso are under the authority of the regency government. Most of the regency roads are asphalted (81.6%), while the rest are still gravel and soil. In general, Bondowoso roads are mostly in good condition, but there is a decrease on road's condition as indicated in ***Table 4-85***.

Table 4-85: Condition of Regency Road in Bondowoso (km)

Road's Condition	2020	2021
Good	881,122	808,043
Moderate	88,964	174,669
Damage	195,450	76,145
Severely damage	229,730	336,419
Total	1,395,266	1,395,276

Source: Bondowoso in Figures, 2022

The road conditions to access villages in Ijen District are asphalted, but there are some areas with uneven surface. The roads are generally winding and uphill, with a width of approximately 3 to 3.5 meter. Road users are mainly dominated by tourist cars heading to the tourism destinations in the vicinity (e.g. Ijen Crater, Wurung Crater, Blawan hot spring, etc.), agriculture transporter cars and trucks, and communities heading to the plantation or collecting grass for animal feed using motorbikes.

Figure 4-53: Road Access to Project Site in Ijen District

Public transportation is present in Ijen District. It is only operated during the day. As informed by stall owners in Sempol Village, some community members use this public transportation to send goods or even buy groceries (with the help of the driver). Public transport fares are around IDR 25,000.00 one way.

4.4.9.1.2 Banyuwangi Regency

The total length of roads in Banyuwangi in 2021 is 2,985.29 km. This comprises of 122.97 km national road, 91.07 provincial road, and 2,711.25 regency road. 90% of roads in Banyuwangi are under the authority of the regency government. Most of the regency road has been asphalted, around 62.3%. This is followed by gravel and soil. ***Table 4-86*** presents the condition of the regency road in Banyuwangi from year to year. It suggests that 50% of Banyuwangi roads in 2021 are in a good condition. This is increased by 4.6% compared to 2020, but has decreased compared to 2019.

Table 4-86: Condition of Regency Road in Banyuwangi (km)

Road's Condition	2017	2018	2019	2020	2021
Good	1,161.44	1,493.75	1,674.23	1,349.80	1,412.37
Moderate	191.39	158.80	112.36	592.95	645.33
Damage	198.31	166.29	123.12	198.05	213.97
Severely damage	1,220.11	952.43	762.31	630.45	499.59
Total	**2,771.25**	**2,771.25**	**2,672.02**	**2,771.25**	**2,771.25**

Source: Banyuwangi in Figures, 2022

The regency road near the transmission route is winding and steep with no lighting. The road has been asphalted, but uneven surface is observed in some areas. The width of the road is uneven; ranging from 3 to 6 m and is prone to landslide. The road is relatively quiet. Only a few number vehicles heading to Ijen Crater is passing by. Apart from that, the road is mostly used by community members who collect grass for animal feed using motorbikes. According to local residents, at least one victim dies in traffic accidents on this road every year.

The majority of village road in potentially impacted villages in Banyuwangi is not in good condition. Only a small portion is paved, while the majority is still macadam and dirt road.

Figure 4-54: Road Access in Villages in AoI in Banyuwangi

Kampung Anyar Village

Pesucen Village

Bulusari Village

Giri Village

4.4.10 Vulnerable Groups

The IFC's Guidance Notes on Performance Standards on Environmental and Social Accountability (2012) explains that vulnerability may stem from an individual's or group's race, colour, sex, language, religion, political, or other opinion, national or social origin, property, birth or other status, gender, ethnicity, culture, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources.

Based on the documents review and field observation, the community members below can be categorised as potentially vulnerable groups in the Project Area:

- People with poor living condition; with income below the poverty line and live in a crowded surrounding with sanitation and hygiene issues within the Project AoI;
- Landless people/people without legitimate land ownership documentation/certificates. This category includes informal land users and squatters;
- Elderly, disabled people, women and children with multiple disadvantages/ vulnerability factors such as poor, head of household/ sole bread winner. Especially if these groups' income is solely generated from activities substantially affected by the Project. They are also having multiple disadvantages, as there are few opportunities for them to work for the Project due to physical limitations and lack of required skills; and
- Farmers and other local people who are prone to hazards due to close proximity with the power plant.

The local communities have aspects of vulnerability as presented above, many are landless without legitimate land titles, farming close to the project area, and have elderly populations. The local communities who are categorised as vulnerable groups may be more sensitive to the Project's negative impacts. Hence, special attention shall be paid to these community members or groups in the impact assessment.

4.4.11 Indigenous People Screening

The objective of the Indigenous People (IP) Screening was to understand if indigenous communities are present within the project area and further assess the potential impacts as a result of the project. According to the IFC PS7, IPs are a distinct, vulnerable, social and cultural group possessing the following characteristics in varying degrees:

- Self-identified as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats, ancestral territories or areas of seasonal use or occupation, as well as to the natural resources in these areas;
- Customary cultural, economic, social, or political institutions that are separate from those of the dominant society and culture; and
- A distinct language or dialect, often different from the official language of the country or region in which they reside.

Indigenous Peoples can often be marginalised in terms of access to economic, social, or cultural rights. Marginalisation can be more impactful for IP, particularly women including widows, children, elderly, the ill and those with mental health issues and physical and intellectual disabilities. Indigenous peoples may not have a strong voice in society, as such their need will be under represented during project consultations. In terms of land ownership and land use for IP, they may not have a legal right despite their attachment to the land, however, their customary rights should be recognised and incorporated into the assessment process.

The data collection and analysis process was undertaken through a desktop review, along with in-depth observations and Key Informant Interview (KII) with village leaders and relevant stakeholder. These processes informed the presence of Osing people –natives of Banyuwangi – in the Project Area. Osing is reportedly the largest ethnic group in Grogol Village, Giri District, Banyuwangi – one of the villages in the Area of Influence (AoI) of the transmission line development.

The Osing people are known as the descendant of the ancient Blambangan Kingdom community who exiled themselves to Banyuwangi. The majority of Osing people are adherents of Islam as the result of Islamization which dates back to the 15th to 19th century (West, 2010).

The Indonesian government classifies the Osing People as Indigenous. The Osing people are known for their unique language, which is also called Osing. This language belongs to the Austronesian family, which has its roots in ancient Javanese and Balinese languages, indicating historical connections and influences from neighbouring regions.

Based on an interview with an Osing community leader - which was conducted for the Project on 29 August 2023 - the Osing community is dispersed across various areas in East Java Province, including Bondowoso, Situbondo, Jember, and Banyuwangi districts. Historically, during the Blambangan Kingdom's reign, the cultural center of the Osing community shifted along with the Kingdom's centers, with one such center located in Macan Putih Village, Banyuwangi District. Generally, there are no distinct cultural, economic, social, and political institutions between Osing people and the dominant society.

The Osing people who still adhere to Osing customs and culture currently reside primarily in Kemiren Village, Glagah District, Banyuwangi; some of whom still reside in a traditional Osing house. Kemiren Village is currently designated as an Osing traditional village which has become one of the main tourist destinations in Banyuwangi. According to the community leader, the decision to label Kemiren Village as a "Tourist Village" by the Ministry of Tourism and Creative Economy seems more economically driven than rooted in historical or cultural significance. The village itself is approximately 5 km from the Project Area.

As informed through the KII with the Secretary of Grogol Village, Osing people mostly rely on the agriculture sector to meet the household needs, but they do not have typical collective attachment to ancestral territories commonly found in other Indigenous Peoples. Presently, due to changes in land ownership resulting from the onset of Dutch colonialism in the East Java region, no traditional land spaces dedicated to Osing rituals remain. Back in the 1980s, certain ceremonies were carried out to determine the harvest day and ways to harvest. Nowadays, Osing customs and culture are not widely practiced, especially among young people; most of the population has blended in the dominant culture of where they reside.

18 PAHs impacted by land acquisition for the Transmission Tower (TT) identified as Osing, as a result Indigenous People are directly affected by the Project. The stakeholder engagement revealed the forest land that was acquired for the Project Site did not have cultural significance or used for livelihood activities by locals; however it is noted that apart from the consultation with the Osing youth group, no focus group consisting exclusively of Osing people has taken place. In terms of the directly affected households, socialization in the form of focus group discussions was conducted and each of the households were informed of the Project as well as the impacts on their land. The socializations with the Osing households were conducted on the following dates:

- Bulusari Village – 20 July 2023
- Pecusen Village – July 2023
- Grogol Village – 25 and 26 July 2023
- Giri Village - 28 July 2023

During these stakeholder consultations, MCG provided information on the Project including technical information on the transmission line and land acquisition resulting from the Project. MCG also informed them of health and safety concerns under the RoW, the land acquisition mechanisms and process, compensation for land and crops within the tower footing and RoW, as well as ownership of the crops after the compensation is paid. Each of the households impacted signed the minutes of the meeting, indicating their consent.

As part of the SEP, MCG plans to undertake engagement with Osing representatives and community members either this year or the following year, to ensure a more comprehensive and equitable approach to livelihood restoration efforts. The engagement will be culturally appropriate, accessible and in a language that can be understood by the IP.

The site surveys conducted for this Project did not identify any physical displacement, which includes cultural heritage and collective attachment, limiting the impact to Osing households to economic impacts. The field survey for the ROW and the Landscape and Visual Impact Assessment (LVIA) study results also did not mention the existence of cultural heritage.

According to the IFC PS, there should be livelihood restoration/other mitigation measures to support households to adjust to the loss of land. As a result, Osing households impacted by land acquisition will benefit from the overall livelihood restoration programs outlined in the LRP. The Project will ensure that language barriers have not and will not impede the Osing PAPs from accessing livelihood restoration benefits and compensation. The Project has ensured that the Project will not produce significant changes to livelihoods of the Osing people. In addition, as evidenced by the census data, and meeting notes, MCG has free, prior and informed consent from the affected households.

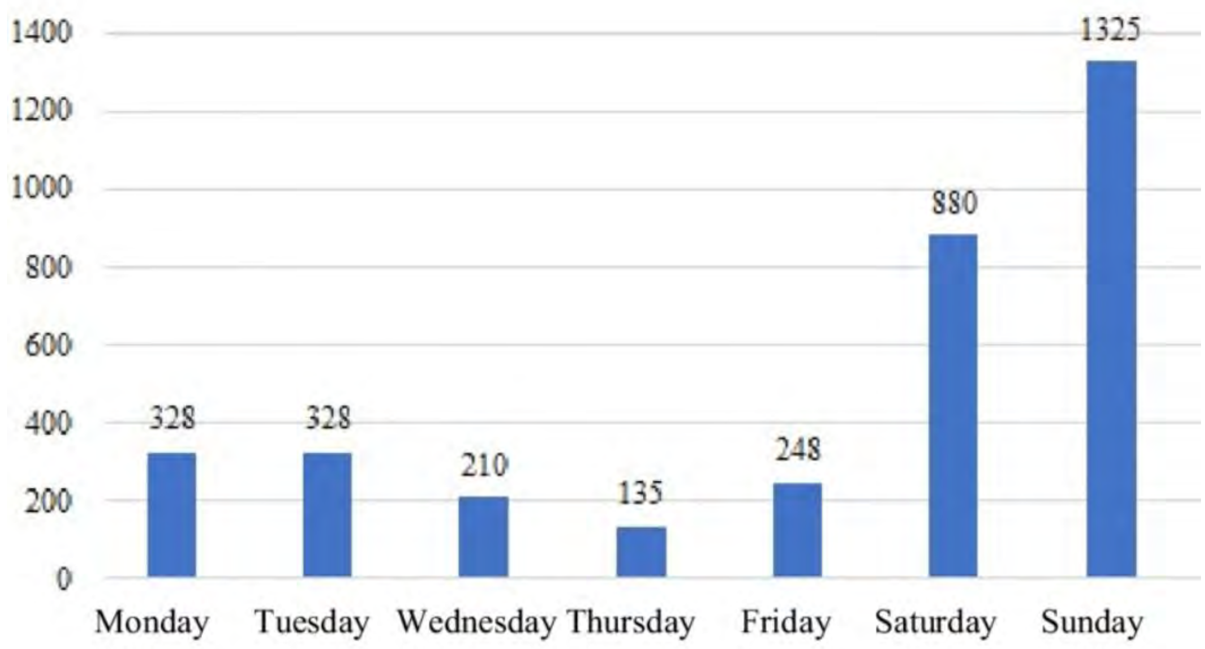
Based on information gathered through desktop research, stakeholder consultation, and field survey there is no impact on lands and natural resources that are traditionally owned or under customary use, no physical displacement, and no impact on critical cultural heritage. In turn, at this stage, it is deemed the consultations conducted by MCG, and the additional engagement with the Osing people to be held, has included the participation of the IP and the Project will not require a separate Indigenous Peoples Development Plan. In addition, no opposition has been faced by the Project from the Osing people throughout the various rounds of consultation that have been conducted since 2018.

4.4.12 Tourism

The Project is located within the Kawah Warang (Wurung) Park which is a tourism hiking area known for scenic views and a number of crater features such as Kawah Wurung and Kawah Ilalang which are adjacent to the access road and transmission line respectively.

Kawah Ijen is a composite volcano located at the easternmost part of Java Island in Indonesia and hosts the largest natural acidic lake in the world[1]. This crater is a popular tourism site as is located within the Kawah Ijen Crater Park. Tourism was on hiatus since March 2020 (due to COVID) and re-opened in July, 2020. The crater attracts around 500 tourists' daily and this number can increase to 4,000 daily tourists during long holidays[23]. Data from 2016 (the latest available data set for the area) shows up to 1,325 daily tourist in the peak tourism season (April to September) (***Figure 4-55***).

Figure 4-55: Daily Tourism Numbers in April-September (2016)



Source: Purnomo, Agus & Wiradimadja, A & Kurniawan, Bayu. (2019). Diversification of tourism product in KSPN Ijen. IOP Conference Series: Earth and Environmental Science. 243. 012079. 10.1088/1755-1315/243/1/012079.

One of the key attractions of the Ijen Crater is the sulphur miners. These are people from the local communities that collect sulphur from the crater and can carry around 80 kg per trip for around 7 cents (USD) per kilogram. They are employed by PT Candi Ngrimi. Since 2010, tourism at the site has become more popular and these miners are now part of the tourism attraction[4]. At its closest point, this tourism site is located 300 m from the transmission line route and around 2.5 km from the main construction area.

In addition, the Project is located in an area defined as the "Ijen Geopark" containing a number of geological, cultural, and biodiversity sites. The biological sites are discussed in more detail in ***Section 4.3.1.2*** and cultural sites in ***Section 4.4.13***. Ijen National Geopark was established on November 30, 2018 through the decision of the Indonesian National Geopark Committee. Based on administrative boundaries, Ijen National Geopark is located in 2 regencies, namely Banyuwangi Regency and part of

[1] USGS website, 2015: Kawah Ijen volcanic activity: A review. Available from: [Kawah Ijen volcanic activity: A review | U.S. Geological Survey (usgs.gov)]

[2] https://www.thejakartapost.com/travel/2020/07/14/east-javas-ijen-crater-reopens-to-tourists.html

[3] Zen, Moh & Wulandari, Dwi. (2016). Development Strategy of the Tourism Industry in Banyuwangi Regency (Case Study: Natural Park Ijen Crater Banyuwangi). IOSR Journal of Business and Management. 18. 41-47. 10.9790/487X-1808014147.

[4] https://borgenproject.org/tourists-at-kawah-ijen-crater/

Bondowoso Regency, East Java Province. The locations of the tourism areas in location of the Project is provided in ***Figure 4-56***.

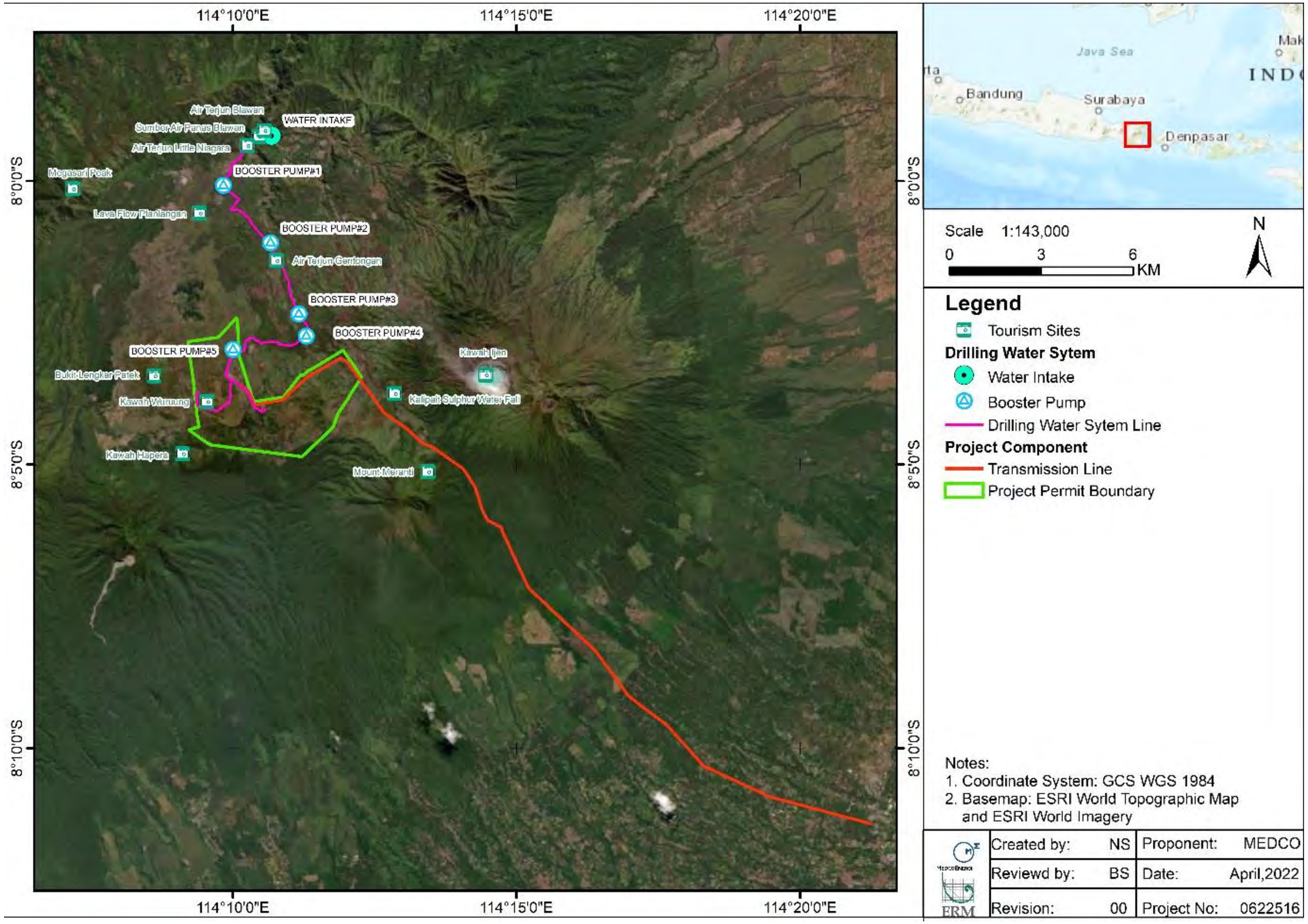
The tourism sites within the Ijen Geopark and Study Area and the distance from the Project is shown in ***Table 4-87***. There are numerous sites within 500 m of the Project facilities.

Table 4-87: Tourism Sites in Study Area and Distance from Project

Name	Distance from Project (km)
Kawah Ijen/ Blue Fire (Ijen Crater)	3.02
Kalipait Water fall	0.67
Kawah Wurung (Wurung Crater)	0.10
Sumber Air Panas Blawan (Blawan Hot Spring)	0.06
Air Terjun Blawan (Blawan Waterfall)	0.24
Air Terjun Little Niagara (Little Niagara Waterfall)	0.04
Air Terjun Gentongan (Gentongan Waterfall)	0.04
Black Lava Plalangan (Lava Flow Plalangan Geosite)	1.05
Puncak Kaldera Megasari (Megasari Peak)	4.98
Bukit Jabal Kamit	1.27
Kawah Hapera	0.77
Mount Meranti	0.76

The existing tourism destinations in Kalianyar village are managed by Tourism, Youth, and Sport Agency of Bondowoso Regency. The village office does not obtain any direct revenue. However, the village is currently planning to develop the tourism potential and the community expectations are for the Project to support this initiative (from ESIA engagement).

Figure 4-56: Tourism Sites near the Main Construction Area



4.4.13 Cultural Heritage

According to UNESCO definition, cultural heritage can be either tangible or intangible. Tangible cultural heritage is defined as moveable or immoveable objects, sites, structures, groups of structures, and natural features and landscape that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significant. It may be located in urban or rural settings and maybe above or below ground, or under water. It also includes places of worship, buried artefacts, cemeteries and archaeological assets, etc. While the intangible cultural heritage involves customary/cultural law, understanding, knowledge, practices, innovations, and relationship of the community with nature.

Desktop review, observation, and Key Informant Interviews (KII) with local communities were conducted to identify potential cultural heritage near and within the Project Area. Through document review, it is reported that approximately 1,400 megalithic sites were discovered in Bondowoso regency. However, none was identified in Ijen District (Tourism, Youth and Sport Agency of Bondowoso Regency, 2018); they are mainly discovered in the western and southern part of Bondowoso Regency.

KIIs with local communities mainly inform the presence of community-valued cultural heritage, such as burial sites and water springs. There were no specific concerns from local communities identified for cultural heritage during the Project consultation and engagement.

Table 4-88 presents information on all identified cultural sites near the Project Area and there locations are shown in ***Figure 4-57***.

The majority of these sites are located over 10 km from the Project and unlikely to be impacted. However, the Mbah Parto Rejo Astama burial site is located 780m from the nearest well pad (well pad 5). The burial site has significant cultural and spiritual importance for people in Jampit and surrounding area as well as others from outside East Java.

There are also three mosques that are located within 1 km of the proposed transmission line route.

Table 4-88: Cultural Sites near the Project Area

Code	Name	Area	Type	Status	Explanation	Distance from Project (km)
Nationally registered cultural heritage						
CH01	Macan Putih (White Tiger) Site  Coordinate Points: -8.251936417487016, 114.27796340871757	Banyuwangi, East Java	Site	Verified	The White Tiger site was once a forest called Sudimara which was cleared to build the capital of the kingdom of Blambangan (1655-1691). Based on the results of excavations at the Site, the following structures/ sites/ objects are found: ■ brick structure that is suspected to be the wall of the Royal capital with an estimated area of 2.5 km^2 ■ former canals ■ artefacts in the form of animal bones, ceramic fragments from Europe and China, as well as various pottery The main building of The White Tiger is made out of limestone and is predicted to be similar to Sukuh Temple in Karanganyar, Central Java. This site has been registered and verified in the national registration of cultural heritage at BPCB (Cultural Heritage Preservation Agency).	22 km
CH02	Inggrisan 	Banyuwangi, East Java	Building	Determined	This house complex was built in 1811 during the British transitional reign in Java. It was used as an army headquarters during the Japanese occupation, then used by the Banyuwangi White Tiger Battalion. The management of the Inggrisan House Complex is currently under KODIM 0825 Banyuwangi.	25 km

Code	Name	Area	Type	Status	Explanation	Distance from Project (km)
	Coordinate Points: -8.210854978159531, 114.37563342868027					
Cultural Sites in Geoparks						
CH03	Megalithic Maskuning Kulon Sites  Coordinate Points: -7.977769, 113.887500	Bondowoso, East Java	Sites	-	Maskuning Kulon Megalithic Site is located in Maskuning Kulon Village, Pujer District, Bondowoso Regency. This site has 58 dolmens[39] located in cluster and neatly arranged. The Kulon Maskuning Site is one of the largest dolmens in East Java with dimensions approximately 275 cm long, 180 cm wide and 180 cm high.	31 km
CH04	Petilasan of Rawa Bayu	Banyuwangi, East Java	Site	-	Rawa Bayu site is a relic of blambangan kingdom near the lake in the forest area. This site is frequently visited by people who perform Hindu religious rituals.	11 km

[39] a type of single-chamber megalithic tomb, usually consisting of two or more vertical megaliths supporting a large flat horizontal capstone or "table"

Code	Name	Area	Type	Status	Explanation	Distance from Project (km)
	 Coordinate Points: 8.179806, 114.172361					
CH05	Canting Butha Sumber (Cave)  Coordinate Points: -7.937650, 114.019400	Bondowoso, East Java	Structure	-	A natural cave serving as a place for meditation. The cave was established in 1394 AD. Below this cave, is a stream the Angkrek River that does not dry out throughout the year and is used for freshwater.	20 km
CH06	Umpak Sanga	Banyuwangi, East Java	Site	-	Umpak Sanga site is located in Tembokrejo village, Muncar sub-district. Originally, the site had an area of approximately 2 ha and is one of the important	43 km

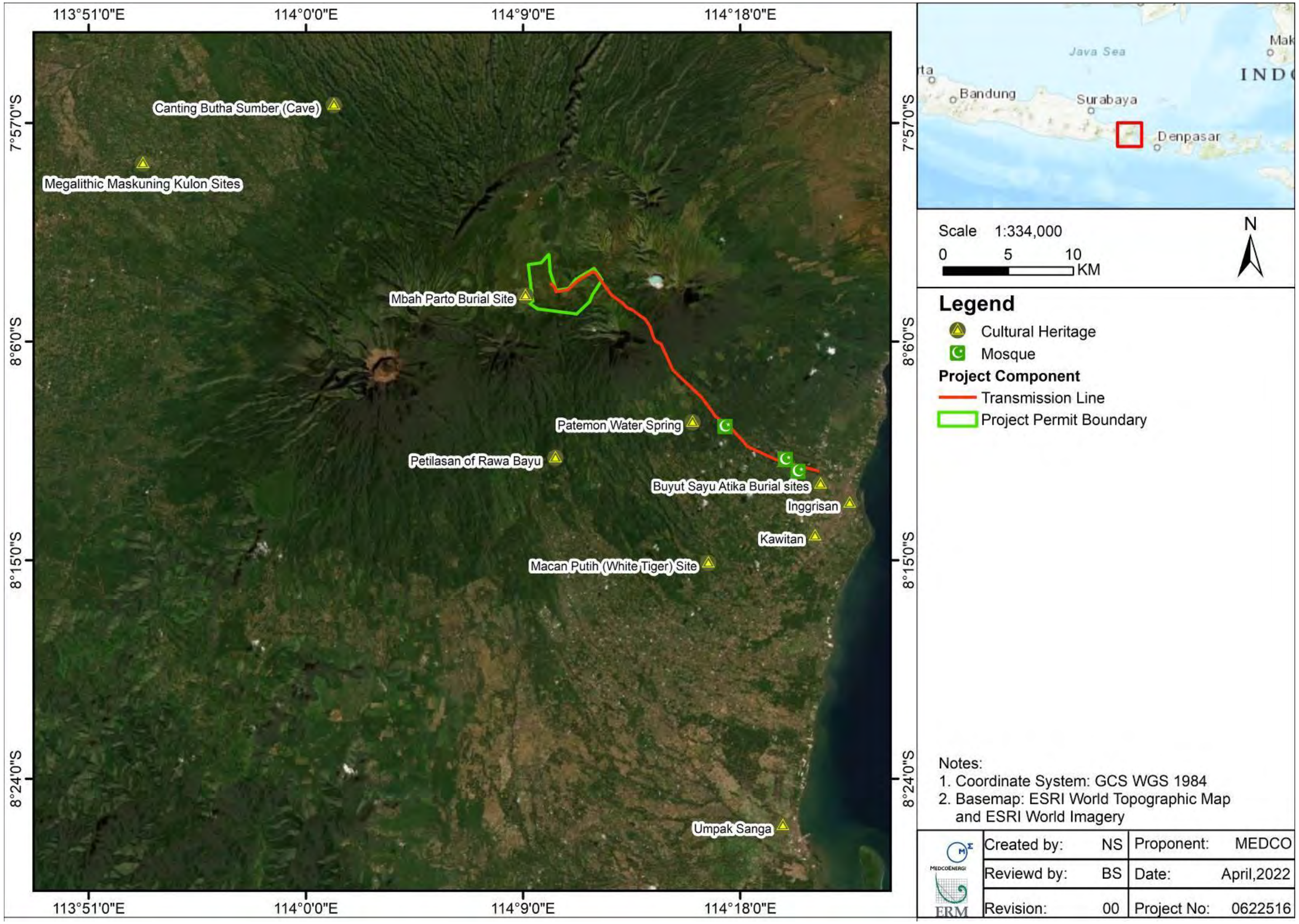
Code	Name	Area	Type	Status	Explanation	Distance from Project (km)
	 Coordinate Points: -8.432230257416435, 114.32945931155477				landmarks indicating the existence of Blambangan Kingdom in the 14th century AD (Wibowo, 2020).	
CH07	Kawitan  Coordinate Points: -8.233430524229707, 114.35174821534653	Kalipuro, Banyuwangi, East Java	Site	-	Kawitan site is suspected to be a gate of one of the relics of the kingdom of Blambangan (14th century AD). The gate is made out of limestone and has strong geologically historic value. Based on past research, it is believed that in the southeastern corner of Java island or what is now known as Plengkung was once used as the first landing site of Austronesian people in 3500 BC. This site is currently used as a Hindu holy place in the Tegaldlimo area.	25 km

Code	Name	Area	Type	Status	Explanation	Distance from Project (km)
Community-valued cultural Heritage						
CH08	Buyut Sayu Atika Burial sites  Coordinate Points: -8.197880926282775, 114.35555849630786	Banyuwangi, East Java	Site	-	Buyut Sayu Atika was known as the mother of Sunan Giri – one of nine Islamic missionary known as Wali Songo. It has substantial spiritual significance for people in Banyuwangi as well as others in Java. The burial site itself is firstly discovered in 1920s.	23 km
CH09	Mbah Parto Burial Site  Coordinate Points: -8.068552197039809, 114.15167777484068	Jampit, Bondowoso, East Java	Site	-	Mbah Parto Rejo Astama was one of the first local people who live in the area during the colonial era. He was a community leader for people in Ijen area as well as an islamic missionary. There was an Islamic boarding school next to the burial site with a total of 36 students. This school has existed for approximately 8 years. The burial site has significant cultural and spiritual importance for people in Jampit and surrounding area as well as others from outside East Java.	0.50 km

Code	Name	Area	Type	Status	Explanation	Distance from Project (km)
CH10	Patemon Water Spring  Coordinate Points: -8.155317364858522, 114.26702623950302	Kalibendo Plantation, Banyuwangi, East Java	Natural Feature		Patemon, which it is located in Kalibendo Plantation area, is a pivotal source of freshwater for multiple villages nearby including those in the Project AoI. As well as provisioning freshwater, the water spring is reportedly becoming an important / sacred place to visit for spiritual activities. This information is based on multiple interviews with locals, village authorities, and Kalibendo staff members.	12 km

Source: Cultural heritage national registration web; Ijen Geopark Web; Banyuwangi Geopark; Key Informant Interviews (2022)

Figure 4-57: Location of Cultural Heritage in the Study Area



4.4.14 Traffic

The Bondowoso Regency is not traversed by the *Pantura*[40] main route which connects Banyuwangi – Situbondo – Probolinggo – Pasuruan – Surabaya, nor is it passed by the central main route which connects Banyuwangi – Jember – Lumajang – Probolinggo – Pasuruan – Surabaya. The major road in the Bondowoso Regency is the provincial route between Bondowoso - Situbondo and Bondowoso - Jember. Likewise,

The roads directly in the Project area are listed in ***Table 4-88*** and shown in ***Figure 4-58***.

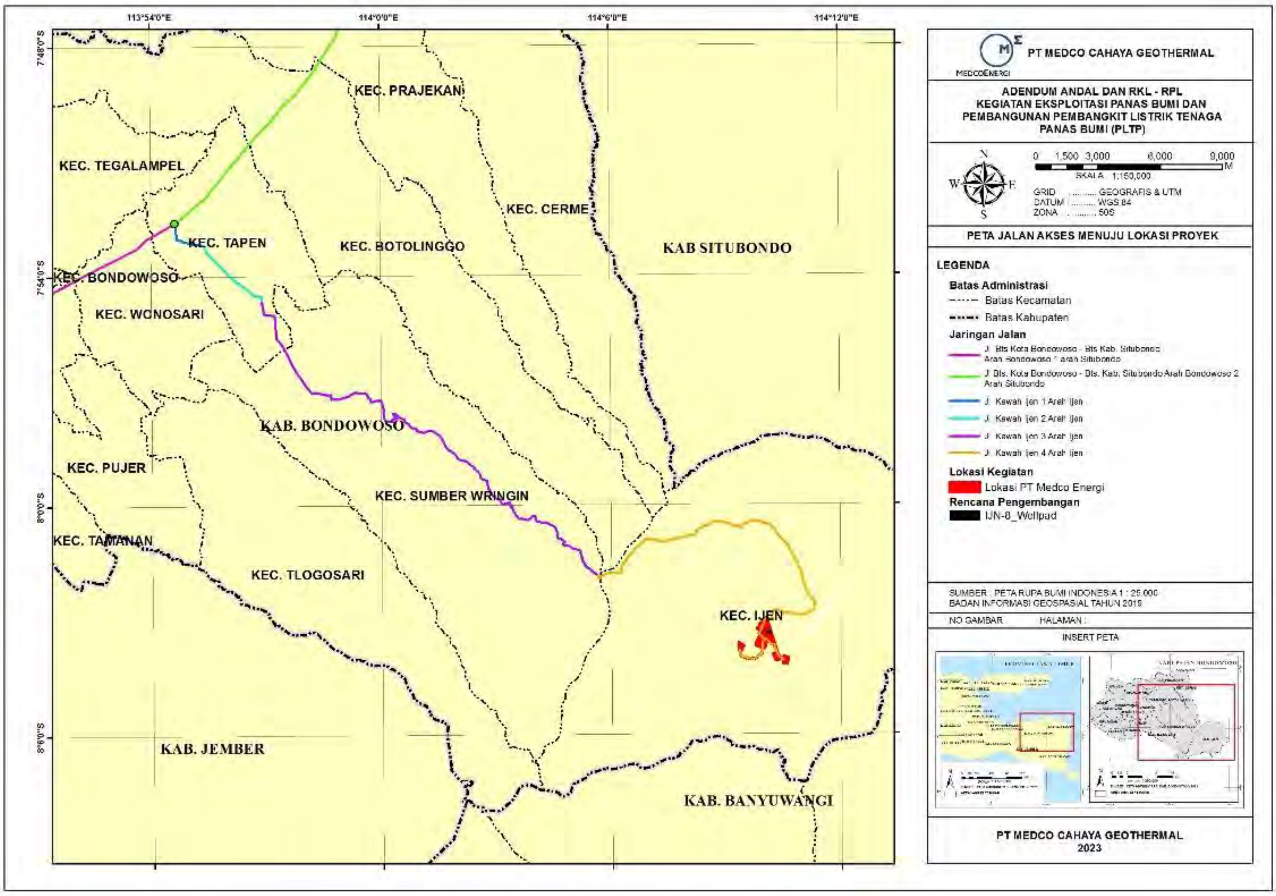
Table 4-89: Road Codification

No	First Code	Last Code	Road Name
1	101	102	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 1 to Situbondo
2	102	101	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 1 to Situbondo
3	101	201	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 2 to Situbondo
4	201	101	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 2 to Bondowoso
5	101	301	Jl. Kawah Ijen 1 to Ijen
6	301	101	Jl. Kawah Ijen 1 to Wonosari
7	301	401	Jl. Kawah Ijen 2 to Ijen
8	401	301	Jl. Kawah Ijen 2 to Wonosari
9	401	501	Jl. Kawah Ijen 3 to Ijen
10	501	401	Jl. Kawah Ijen 3 to Wonosari
11	501	601	Jl. Raung Sumber to Sumberwringin
12	601	501	Jl. Raung Sumber to Wonosari
13	501	701	Jl. Kawah Ijen 4 to Ijen
14	701	501	Jl. Kawah Ijen 4 to Wonosari
15	101		Simpang 3 Indomaret Garduatak
16	501		Simpang 3 Masjid An Nur

Source: Traffic Impact Assessment Document PT Medco Cahaya Geothermal, 2021

[40] *Pantura* (*Pantai Utara*) is the major road in Java Island, passes through five provinces along the north coast, Banten, Jakarta, West Java, Central Java and East Java. It connects Merak and Ketapang.

Figure 4-58: Roads in the Project Area[41]



The existing condition of traffic in the Project location regarding Level of Service (LOS) is present in ***Table 4-90*** and ***Figure 4-58*** was conducted during working days.

Table 4-90: Existing Traffic Road Performance in 2021

No	Road Name	Vehicle Capacity	Volume (PCE*/hour)	VCR**	Speed (km/hour)	LOS
1	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 1 to Situbondo	1298	918.5	0.71	53.64	C
2	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 1 to Situbondo	1298	981.25	0.76	51.23	C
3	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 2 to Situbondo	1298	974.25	0.75	51.49	C

41 Translation of Map Legend
Legenda : Legend; Batas Administrasi: Administrative Boundaries; KAB: Abbreviation of Kabupaten (Regency); KEC: Kecamatan (Regency); Batas Administratsi: Administrative Boundaries; Batas Kecamatan: District Boundaries; Batas KabuPengembangan: Boundaries; Jaringan Jalan: Road Network; Lokasi Kegiatan: Project Location; Renancana Pengembangan: Development Plan

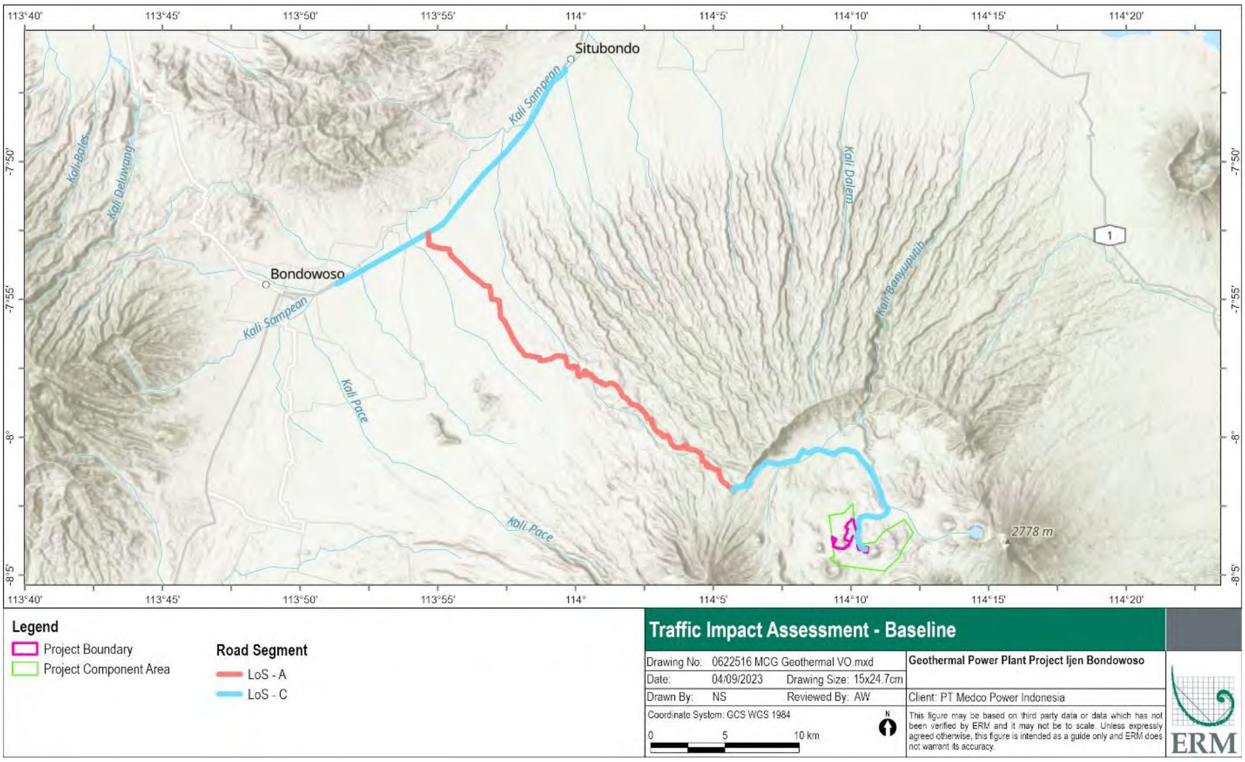
No	Road Name	Vehicle Capacity	Volume (PCE*/hour)	VCR**	Speed (km/hour)	LOS
4	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 2 to Bondowoso	1298	880.5	0.68	55.13	C
5	Jl. Kawah Ijen 1 to Ijen	960	269.25	0.28	49.13	A
6	Jl. Kawah Ijen 1 to Wonosari	960	300.25	0.31	48.28	A
7	Jl. Kawah Ijen 2 to Ijen	960	239.5	0.25	49.89	A
8	Jl. Kawah Ijen 2 to Wonosari	960	251.75	0.26	49.59	A
9	Jl. Kawah Ijen 3 to Ijen	960	195.5	0.20	50.89	A
10	Jl. Kawah Ijen 3 to Wonosari	960	193.5	0.20	50.93	A
11	Jl. Raung Sumber to Sumberwringin	960	69.5	0.07	52.72	A
12	Jl. Raung Sumber to Wonosari	960	79.75	0.08	52.64	A
13	Jl. Kawah Ijen 4 to Ijen	960	92	0.10	52.52	A
14	Jl. Kawah Ijen 4 to Wonosari	960	74.25	0.08	52.68	A

*PCE: Passenger Car Equivalent/PCU: Passenger Car Unit

** VCR: Volume Capacity Ratio

Source: Traffic Impact Assessment PT Medco Cahaya Geothermal, 2021

Figure 4-59: Existing Traffic Road Performance in 2021



As ***Table 4-89*** indicates, the roads in the Project area are currently functioning well with Levels of Services between A and C.

4.4.15 Household Surveys

This section provides a summary of household surveys conducted in the AMDAL. A total of 99 households in 6 villages in the Ijen District were interviewed.

The calculation of sample size was determined with Slovin's formula with 10% margin of error. The total number of households was determined based on the number of households in Ijen District that are connected to the PLN electricity grid, which equals 4,437 households. The respondents of the household survey were chosen by random sampling.

Table 4-91: Household Survey Respondents

No.	Village	Number of Respondents
1	Sempol	27
2	Kalianyar	16
3	Sumber rejo	8
4	Kalisat	12
5	Kaligedang	8
6	Jampit	28
	Total	**99**

Source: MCG

The household surveys collected primary data on the level of education, livelihood, income level, house ownership status, religion and perceptions of the project.

Based on the results of the questionnaire on the education level of the people living in Ijen District, majority of the respondents (68.69%) stated that they had completed high school/equivalent level education. 20.20% of the respondents completed university level education, while 6.06% completed only junior high and 5.05% completed up to elementary school.

In terms of livelihoods, 31.31% of the respondents were self-employed, 17.17% were farmers and 13.13% were civil servants. The remaining respondents stated that they were gardeners (7.07%), traders (3.03%), company employees (1.01%) and other (27.27%).

Level of income was assessed by measuring the expenditure incurred by the respondents for their daily needs. The majority of respondents (49.49%) stated that they spend between 1,000,000 IDR (66 USD) and 2,000,000 IDR (131.82 USD) per month. 22.22% of respondents spend between 500,000 IDR (32.95 USD) and 1,000,000 IDR (66 USD) per month and 18.18% spend between 2,000,000 IDR (131.82 USD) and 3,000,000 IDR (197.73 USD) per month. At either end of the spectrum, 7.07% spend less than 500,000 IDR (32.95 USD) per month and only 3.03% spend more than 3,000,000 IDR (197.73 USD) per month.

A large proportion of the respondents interviewed resided in their parents house (35.35%) or on land owned by the plantation (32.32%). While 29.29% owned their own house and 3.02% rented their house. Based on responses, it can be seen that the length of stay of the respondents in the area is mostly > 20 years (50.51%), the second longest amount of time stated by the respondents is 11 to 20 years (26.26%). While 18.18% lived in the area between 5 to 10 years and 5.05% less than 5 years.

The majority of the respondents practiced Islam (99.98%), while 1.01% practiced Hinduism.

<u>Community Perceptions of the Project</u>

All of the respondents, with the exception of 1 person, were aware of the Project. The respondents were informed by their subdistrict heads, neighbours, through the media, and through public consultations. 98% of the respondents (all except 2) approved of the Project. Reasons stated for their approval of the Project include the following:

- The Project will create jobs;
- The Project will open new business fields;
- Improvement of the community's/regional economy; and
- Development.

40% of the respondents stated that although they approved of the Project, they also had concerns. The most significant concern (43.43%) was that labour will be sourced from outside of the region, followed by concerns over environmental pollution (36.36%). Other concerns included:

- Traffic and congestion; and
- Noise.

The respondents provided a number of recommendations to MCG. 55.56% recommended that labour recruitment should prioritize local community members. 11.11% stressed that the development must be in accordance with the principle of maintaining, protecting and preserving the environmental and social ecosystem. 4.04% of the respondents stated that the Project should not disturb the community's clean water sources while 8.08% stressed that the economy of the community should be improved.

4.5 Ecosystem Services

4.5.1 Defining Ecosystem Services

Ecosystem Services (ES) are defined as the benefits that people, including businesses, derive from ecosystems (IFC 2012). These services are substantial and varied, underpinning basic human health and survival needs as well as supporting economics activities, the fulfilment of people's potential, and enjoyment of life.

In order to provide a uniform basis to assess the status of all major global habitat across all of the word's bioregions, the United Nation's Millennium Ecosystem Assessment (UN 2005) combine diverse ES typologies into a consistent classification scheme.

There are four categories of ES defined in Millennium Ecosystem Assessment as outlined in IFC Performance Standard 6:

- Provisioning Services - services and goods that can be extracted from ecosystem to support human needs - including tangible assets such as fresh water, food, fibre, timber and medicinal plants;
- Regulating Services – include the regulation of surface water purification, carbon storage, and sequestration, climate regulation, protection from natural hazard, air quality, erosion and pests;
- Cultural Services - non-material benefits including natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment;
- Supporting services - the natural process essential to the maintenance of the integrity, resilience, and functioning of ecosystem, thereby supporting the delivery of all other benefits. They include soil formation, nutrient cycling, and primary production.

4.5.2 Applicable Standards and Guidelines

The International Finance Corporation's (IFC) performance standards require projects to assess and preserve the benefits from ES. The IFC also requires that the environmental and social risks and impacts identification process considers a project's dependence on ES. A fundamental component is to apply the mitigation hierarchy to determine measures to limit impacts on ES.

ERM has utilized the WRI Guidelines: *Weaving Ecosystem Service into Impact Assessment* to guide the approach used to assess ES in relation to the project. The ES review was undertaken following a five-stage approach (WRI 2014):

- Screening assessment to Identify ES that may occur within the study area;
- Data Collection and prioritization for ‘screened in’ ES;
- Scoping; to refine the list of ES based on those identify in the study area and potentially impacted by the project;
- Prioritization to identify ES importance to beneficiaries.

Impact Assessment to identify the impacts to ES and their human beneficiaries as a result of the project (This will be conducted in the Environmental, Social, and Health Impact Assessment Report).

4.5.3 Screening and Scoping

4.5.3.1 Approach

4.5.3.1.1 Area of Influence

The Area of Influence (AoI) as defined in the WRI Guidelines: *Weaving Ecosystem Service into Impact Assessment* is the

“*…area relevant to the assessment of project impacts and dependencies on priority ecosystem services. It includes (1) the ecosystems that supply the priority ecosystem services and (2) the locations where the project and affected stakeholders access priority ecosystem services*.”

For the purposes of this ES screening, the AoI will consist of community areas and sites with potentially high biodiversity importance, as shown in ***Figure 4-12***.

4.5.3.1.2 Screening

An ES screening assessment was undertaken to determine the likely ES values that could be potentially important to affected communities. The types of ES that have been defined in the WRI Guideline is used as a basis to crosscheck ES that may or may not be found in the AoI; potential ES in the AoI that corresponds with the definition is then screened in for prioritization. ES that are not found in the AoI are then screened out.

4.5.3.1.3 Scoping

The scoping exercise was undertaken in order to refine the list of ES that:

- Potential Beneficiaries: Known and potential beneficiaries for a service were identified and where possible identifying people at the local, national, and / or global level;
- Sources of Impact: Potential sources of impact were considered based on the social data obtained for the site;
- Project Dependence: IFC PS-6 requires that the ES assessment take into consideration any services that the Project may rely upon during construction, operation and/or decommissioning. Therefore, all services for which there is a potential project dependency were scoped into the prioritisation stage.

The goal of the scoping exercise was to identify a list of ES to be assessed during through the surveys.

4.5.3.2 Results

This assessment was done using available sources of data, including information collected during the scoping visit, social surveys and local interviews. The results of the screening assessment are contained in ***Table 4-92***.

Table 4-92: ES Screening Assessment

ES Type	Definition of ES Type [a]	Currently Known ES in the AoI	Screened in?
Provisioning Services			
Food: wild-caught fish and shellfish & aquaculture	Fish caught for subsistence or commercial sale; Fish, shellfish, and/or plants that are bred and reared in ponds, enclosures, and other forms of fresh- or salt-water confinement for harvesting	There is limited fish abundance and diversity especially in areas where sulphur leeching occurs into local water courses. The villages did not report a strong reliance of fish for sustenance or sale.	No
Food: wild meat	Animals hunted for primarily for food (recreational hunting covered under cultural services)	The surrounding of the Project site is primarily natural and plantation habitat. Some hunting activity for wild meat by the community is anticipated. However, this would not be in the main development area. No significant impacts to this service are anticipated.	No
Food: herbs and plants	Herbs and plants collected for food by local people	The surrounding of the Project site is primarily natural habitat. Some collection of herbs in likely. However, this would not be in the main development area. No significant impacts to this service are anticipated.	No
Food: cultivated crops	Annual and permanent crops grown for subsistence use and commercial sale	There are anticipated to be some agricultural areas along the transmission line route.	Yes
Livestock farming	Sedentary and nomadic livestock farming	There are no livestock farming in the Project Area, no livestock farming activities by the communities are anticipated.	No
Biomass fuel	Wood, dung and plant matter collected for charcoal, fuel	No known biomass fuel used in the AoI.	No
Timber and wood products	Wood collected for local use or for sale as timber, wood pulp and paper	No known timber use identified within the AoI.	No
Non- Timber Forest Products (NTFP)	Non-timber products collected from the forest. For example, cane, palm, straw, cotton, hemp, twine and rope, natural rubber	No use of non-timber products was identified within the AoI.	No
Freshwater	Freshwater for bathing, drinking, irrigation, laundry, household and industrial use	There is some recorded use of water sources for domestic purposes.	Yes
Biochemical, natural medicines, pharmaceuticals	Natural medicines, biocides, food additives, pharmaceuticals and other biological material for commercial or domestic use. For	No use of traditional medicines identified by the community.	No

ES Type	Definition of ES Type [a]	Currently Known ES in the AoI	Screened in?
	example, pelts, carved or decorative animal products, live animal trade		
	Genes and genetic information used for animal breeding, plant improvement, and biotechnology	Use of genes and genetic information for animal husbandry practice was not found within the AoI.	No
Regulating Services			
Ecosystem functions	The influence ecosystems have on air quality by extracting chemicals from the atmosphere (i.e., serving as a "sink") or emitting chemicals to the atmosphere (i.e., serving as a "source")	The AoI is not a significant chemical sink or source to the atmosphere.	No
	Carbon sequestration (impacts on global climate change) regulation of temperature, shade air quality by vegetated areas	The AoI does not play an important role in carbon sequestration or temperature regulation.	No
	Role played by vegetation and bacteria in the filtration and decomposition of organic wastes and pollutants and the assimilation and detoxification of compounds	The AoI does not play a role in the filtration and decomposition of organic wastes and pollutants and the assimilation and detoxification of compounds.	No
	Role of natural habitats (e.g., wetlands, beaches, reefs) in protecting crops, buildings, recreation areas from waves, wind and flooding from coastal storms	The AoI does not play host to important natural habitats that protect against waves, wind and flooding.	No
	Regulation of fire frequency and intensity (e.g., dense forest can provide firebreaks)	The AoI does not play a significant role in the regulation of fire frequency and intensity.	No
	Predators from forests, grassland areas, etc. may control pests attacking crops or livestock	The AoI does not play a role in managing predators and pests.	No
	Influence ecosystems have on the incidence and abundance of human pathogens	The AoI does not influence the incidence and abundance of human pathogens.	No
	Role of vegetation in regulating erosion on slopes and riparian areas	The AoI does not regulate erosion on slopes as the area is relatively flat.	No
	Birds, insects and some small mammals pollinate certain flora species, including some agricultural crops	The AoI has limited natural habitat and no agricultural crops in the main development area, the presence of pollinators is not considered to be significant.	No

ES Type	Definition of ES Type [a]	Currently Known ES in the AoI	Screened in?
Cultural Services			
Spiritual, religious or cultural value	Natural spaces or species with spiritual, cultural or religious importance	No natural spaces or species with spiritual, cultural or religious importance has been identified in the AoI.	No
	Cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources.	The Project AoI is not considered important areas for cultural value on traditional practices.	No
	Use of natural spaces and resources for tourism and recreation (e.g., swimming, boating, hunting, bird-watching, fishing)	Various ecotourism services have been identified in the Project AoI associated with the local craters. .	Yes
	Cultural value placed on the aesthetic value provided by landscapes, natural landmarks	No cultural value placed on aesthetic value provided by landscape, natural landmarks identified in the area.	No
	Information derived from ecosystems used for intellectual development, culture, art, design, and innovation	The AoI is not considered important for information derived from ecosystems used for intellectual development, culture, art, design, and innovation.	No
	Ornamental resources	The AoI is not considered important ornamental resources.	No
Existence Values			
Non-use value of biodiversity (e.g. existence, bequest value)	Species and areas valued globally as of high conservation value	Species and areas valued globally as of high conservation value has been identified in the AoI.	Yes
	Formation of biological material by plants through photosynthesis and nutrient assimilation	The AoI does not play an important role in the formation of biological material by plants through photosynthesis and nutrient assimilation	No
	Flow of nutrients (e.g., nitrogen, sulphur, phosphorus, carbon) through ecosystems	The AoI does not play an important role in the flow of nutrients through ecosystems.	No
	Flow of water through ecosystems in its solid, liquid, or gaseous forms	The AoI is not considered important for water cycle due to small water bodies (i.e. ponds) have been identified within the AoI.	No
	Natural soil-forming processes throughout vegetated areas	The AoI does not play a role in the natural formation of soil forming processes.	No
	Natural spaces that maintain species populations and protect the capacity of ecological communities to recover from disturbances.	The AoI does not contain natural spaces that maintain species populations and protect the resilience capacity of ecological communities.	No

Notes: [a] WRI Guidelines: Weaving Ecosystem Service into Impact Assessment

4.5.4 Ecosystem Services Prioritisation

4.5.4.1 Approach

The WRI guidelines and IFC PS6 requires that priority ES are identified and impacts to those services are assessed (IFC 2012). The prioritization process is aimed at identifying those services for which Project impacts would be most likely to result in adverse impacts on project affected communities and other beneficiaries. Using the information collected through the baseline data collection and stakeholder engagement processes, ES were prioritized according to a priority matrix ranking two criteria:

- Importance of the ES to the beneficiary which considers the intensity of use, degree of dependence and the importance expressed by the project affected communities; and
- Irreplaceability of the ES, which refers to the availability of alternatives, the accessibility, cost and appetite for those alternatives as discussed with the beneficiary.

4.5.4.2 Results

After compiling baseline information on the importance and irreplaceability of each service, these ratings were combined to assign a priority rating to the service grading from Low to Major as shown in the ES prioritization matrix in ***Table 4-93***.

ES identified as High priority or Major priority were considered Priority ES. The weight given to each of these components varied slightly depending upon the service, but stakeholder values were given precedence over other criteria where the rating was not clear.

In addition to the above, according to the IFC definition of priority ES, all services for which project dependencies are identified are considered priority services. The importance and irreplaceability of services relied upon by the Project was assessed through the same prioritization process outlined above, with the Project filling the role of the beneficiary.

In addition to the prioritization exercise, the baseline data collection process provided the opportunity to collect information on the status, trends and sustainability of resource use as they pertain to the habitats and species that support ES. This information was gathered through secondary sources and field studies by the environment team and where appropriate through engagement with local stakeholders. This information is important for the assessment of impacts on ES and therefore on local people as the final receptors of these changes.

Table 4-94 outlines the beneficiaries, potential sources of impact and project dependence for each service, and whether the service was scoped into or out of the ES assessment.

This section provides an assessment of the potential Project impact to ES using the criteria provided.

Table 4-93: ES Prioritization Matrix

Importance of Beneficiaries		Irreplaceability: High	Irreplaceability: Moderate	Irreplaceability: Low
Low	The service is used and valued by parts of the community, but it is not important in maintaining quality of life or livelihoods of Project Affected Communities.	Low Priority	Low Priority	Moderate Priority
Medium	The service is readily used by some members of the Project Affected Communities for income or subsistence, but they are not dependent upon the service for their livelihoods, and not everyone utilises the service.	Low Priority	Moderate Priority	High Priority
High	The service is highly important in maintaining the livelihoods of the Project Affected Communities, and is used by most of the community regularly.	Moderate Priority	High Priority	Major Priority
Essential	The service is essential to maintain the health of the Project Affected Communities, and the service is used by all members of the community.	High Priority	Major Priority	Major Priority

Irreplaceability Definition	
High	Many spatial alternatives exist that are readily available to the Project Affected Communities, and there are no major impediments to their usage.
Moderate	Spatial alternatives exist but are either less accessible than the affected service, or there are other barriers to their use such as distance, cost and skills required to access the service.
Low	There are few to no spatial alternatives available to the Project Affected Communities.

Table 4-94: Results of Prioritization

ES	Trends and Sustainability	Beneficiaries	Importance to Beneficiaries	Irreplaceability	Potential Alternatives	Priority?
Provisioning Services						
Food: cultivated crops	There are anticipated to be some agricultural areas along the transmission line route.	Local farmers	The agriculture are used for income or subsistence.	During the construction of the transmission line; temporary loss of crops will occur	Alternative food sources may be purchased by local people. The project will provide compensation for land.	Low Priority
Fresh water	There is some recorded use of water sources for domestic purposes.	Local communities	Some people utilises the water bodies for domestic water and irrigation.	Water use by the project will be pumped from local rivers utilised by communities.	Alternative water sources may be used by local people.	Low Priority
Cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources.	Various ecotourism services have been identified in the Project AoI associated with the local craters. .	Local communities and tourists	Tourism areas are located next to the main development area	These areas rely on natural habitats.	N/A	High Priority
Species and areas valued globally as of high conservation value	Species and areas valued globally as of high conservation value has been identified in the AoI.	Local communities and tourists	Ecotourism to these regions relating to biodiversity	These areas rely on natural habitats.	N/A	High Priority

5 STAKEHOLDER ENGAGEMENT

This section provides overview on stakeholder engagement and consultation carried out during the confirmatory site visit and consultation activities previously conducted by ERM. This is a preliminary identification of stakeholder group in general, and hence, detailed and comprehensive stakeholder mapping and engagement plan is necessary, as part of the requirement for IFC PS 1.

5.1 Methodology and Approach

The methodology and approach on stakeholder consultation and the engagement process focused on gathering information from selected stakeholders relevant to the Project. In order to obtain data and information, a site visit and public consultation / interviews were conducted with relevant stakeholders. Information presented in this Chapter is based on site visit supported by secondary data from government agencies.

5.1.1 Purpose and Objective of Stakeholder Engagement

The stakeholder engagement approach seeks to define a technically and culturally appropriate approach to consultation and disclosure. The goal of this plan is to ensure adequate information is provided to the project affected people and other stakeholders in a timely manner, and that these groups are provided sufficient opportunity to voice their opinions and concerns that may influence Project decisions. The approach gives recognition to, and is carried out in a manner consistent with, local cultural norms of the area and of Indonesia as a whole.

The key objectives are summarised as follows:

- To keep the affected communities and stakeholders informed of Project activities;
- To generate and document a broad community support for the Project in allowing effective Environmental and Social Management Plan (ESMP) implementation;
- To improve communications between the interested parties; and
- To document the development of formal public consultation.

5.1.2 Stakeholder Engagement Principles

The following principles have been identified for driving and guiding the stakeholder engagement activities:

- The engagement strategy has been designed and implemented in a manner that is appropriate and cognisant of the specific economic, social, and cultural context of Jakarta, Indonesia, specifically Tangerang and South Tangerang cities;
- Information disclosure has been weighed risks and benefits. Considerations for non-disclosure have been weighed against the need for transparency and stakeholder groups to be informed;
- Engagement has been a two-way dialogue which has involved informing, listening and seeking inputs, as well as sharing and exchanging views;
- Engagement has been free of intimidation and coercion;
- The Project has worked to ensure that it appropriately provides updates to potentially affected and relevant stakeholders. The frequency of these updates have been commensurate to Project risks and any changes to the Project; and
- The Project has provided a feedback / grievance mechanism and opportunities to incorporate received feedback into the Project. The feedback/grievance mechanism has been disclosed to impacted stakeholders.

In summary, the main principles were:

- Inclusive: The consultations were organised to ensure representation of potentially affected and interested stakeholders. Separate Focus Group Discussions (FGDs) were undertaken with local communities, city leaders, farmers, and women;
- Sharing of information: At the local level consultations, special emphasis was given to build community level understanding of the Project and all the information was provided in Indonesia Bahasa language; and
- Participatory: Stakeholders were encouraged to participate in the consultations and were always given the opportunity to ask questions.

5.2 Identification of Stakeholders

The following section outlines the groups and organisations considered key stakeholders for the Project. Stakeholders are defined as individuals, communities, groups and institutions who:

- Are most likely to experience, at significant levels, any potential negative and / or positive impacts of the proposed Project;
- Have the mandate over the various elements of the Project's activities (such as Government institutions); and
- Are considered vulnerable members of the community within the proposed project area.

The key stakeholders for the Project are outlined in the sections below.

5.2.1 Central and Provincial Government

This stakeholder group consists of ministries and provincial authorities who has a role in regulating the project, such as granting permits and approvals and monitoring compliance.

The authorities, which are likely to have the maximum influence on the Project, include:

- Ministry of Energy and Mineral Resources;
- Ministry of Environment and Forestry, and
- Environmental Agency of East Java Province.

5.2.2 Local Government

This stakeholder group consists of government agencies (at Regency level) and community leaders at the district and village levels who have the power to regulate or otherwise influence the Project in terms of establishing policy, granting permits and approvals for the Project, monitoring and enforcing compliance with the applicable rules and regulations and making available the necessary infrastructure and resources for the Project.

Some of the key authorities at the Regency (Bondowoso and Banyuwangi) and local level include the following:

- Environmental Agency of Bondowoso and Banyuwangi Regency;
- One-stop Integrated Service Agency of Bondowoso and Banyuwangi Regency;
- Head of Ijen District;
- Head of Licin District;
- Head of Glagah District;
- Head of Kalipuro District;
- Head of Giri District;

- Head of Sempol Village;
- Head of Kalianyar Village;
- Head of Tamansari Village;
- Head of Kampung Anyar Village;
- Head of Pesucen Village;
- Head of Bulusari Village;
- Head of Grogol Village; and
- Head of Giri Village.

5.2.3 Projected Affected Communities

This group includes people who may be directly or indirectly affected by the Project's presence and activities and their representatives (leaders and other influential people).

This group will include (but not be limited to) the following:

- People of Sempol Village;
- People of Kalianyar Village;
- People of Jampit Village;
- People of Tamansari Village;
- People of Kampung Anyar Village;
- People of Bulusari Village;
- People of Pesucen Village;
- People of Grogol Village;
- People of Giri Village;

Informal leader from villages; and

Vulnerable groups.

5.2.4 Local Community Organization

This group comprises of those who may have an interest in the Project and its social and environmental aspects. It includes members of civil society organisations such as citizens' associations, environmental and social groups, etc.

Some local community organizations that have been identified include:

- Local activists in Bondowoso;
- Youth associations in Sempol Village; and
- Student association in Bondowoso

5.3 Past Stakeholder Consultations

MCG has conducted multiple rounds of consultations and held several stages of negotiation since 2018. Based on MCG's stakeholder engagement database, consultations were conducted with various different groups of stakeholders including local authorities, community leaders, affected community members, youth groups, women's groups, Osing representatives and community groups. As of 14 July 2023, MCG had conducted 172 consultations with various stakeholders (in addition to the household surveys conducted with affected households). Community concerns were primarily related to land acquisition. In addition, communities also raised issues related to infrastructure, health, environment, safety, security, economy and education. Concerns and comments from the community were listed in MCG's stakeholder engagement database and in the meeting notes. Follow up actions were also outlined for each concern. As a result of the consultations, several towers were moved based on community members' inputs.

In terms of the directly affected households, socialization in the form of focus group discussions was conducted and each of the households were informed of the Project as well as the impacts on their land. The socializations were conducted on the following dates:

- Bulusari Village – 20 July 2023
- Pecusen Village – July 2023
- Grogol Village – 25 and 26 July 2023
- Giri Village - 28 July 2023

During these stakeholder consultations, MCG provided general information on the Project including technical information on the transmission line and land acquisition resulting from the Project. MCG also informed them of health and safety concerns under the RoW, the land acquisition mechanisms and process, compensation for land and crops within the tower footing and RoW, as well as ownership of the crops after the compensation is paid. Each of the households impacted signed the minutes of the meeting, indicating their consent.

Figure 5-1: Stakeholder Consultations with Giri Village

Figure 5-2: Stakeholder Consultations with Bulusari Village

Figure 5-3: Stakeholder Consultations with Grogol Village

Figure 5-4: Stakeholder Consultations with Pesucen Village

5.4 Stakeholder Engagement During the ESIA

5.4.1 Engagement Activities

Stakeholder engagement during the ESIA preparation focuses on relevant stakeholder that potentially will influence to project. There are some stakeholder had been engaged and interviews by ERM Team during the site visit, such as village head, informal leader, religious leader, youth, women, and community members from villages around project area.

The stakeholder engagement/ public consultation and disclosure program aims at informing the stakeholders of project plans and activities in a manner that promotes open dialogue among all interested parties, and focuses on effecting dialogue with those who are or will be affected by the Project.

The Project has conducted series of disclosure program during community consultation as part of the socio-economic baseline data collection for the ESIA which will be the basis for conducting the Project impact assessment. ERM conducted the consultation activities on behalf of the Project during the period of 1 – 9 March 2022.

Key informant interviews and discussions with key local stakeholders were the main approaches undertaken during the fieldwork. This has included engagement/ consultation meetings with village government officers/ authorities of the affected villages, key village figures, and representatives of the affected communities. ***Table 5-1*** presents the stakeholders involved in the consultations for the ESIA baseline study/ data collection.

Table 5-1: Stakeholders Involved in the Consultations for ESIA Baseline Study

No	Location	Key Stakeholders Involved
1	Ijen District	■ Head of Sempol Village ■ Head of Kalianyar Village ■ Religious leader of Kalianyar Village ■ Youth representative of Kalianyar Village ■ Women representative of Sempol Village ■ Community leader of Jampit Village ■ Head of LMDH / Forest village community organization Kalianyar ■ Head of Ijen Community Health Centre ■ Local farmers – land users within the Project Area ■ Representative of PTPN XII ■ Representative of Perhutani
2	Glagah District	■ Secretary of Kampung Anyar Village ■ Osing youth ■ Representative of Kalibendo Plantation
3	Kalipuro District	■ Head of Bulusari Village ■ Secretary of Bulusari Village ■ Head of Bulupayung Hamlet, Bulusari ■ Head of Kelir Community Health Centre
4	Grogol District	■ Head of Giri Village ■ Secretary of Giri Village ■ Secretary of Grogol Village

During the consultation, the following information was provided to the stakeholders:

- Description of the Project and the potential environmental and social impacts; and
- ESIA process (steps of Project activities that will be conducted within the ESIA process) and Project activities.

5.4.2 Summary of Consultation Activities Undertaken for draft ESIA Presentation

As mentioned in the previous section that ERM team has conducted several interviews with relevant stakeholder during the site visit, particularly with key informant. ***Table 5-2*** provides a summary of consultation activities undertaken as part of the ESIA process.

Table 5-2: Summary of Consultation Conducted for ESIA

Date	Location	Mode of Engagement	Stakeholder Involved	Key Messages
02/03/2022	Kalianyar Village, Bondowoso	Key Informant Interviews	Head of Kalianyar Village ([redacted])	■ The existing tourism destinations in Kalianyar village is managed by Tourism, Youth, and Sport Agency of Bondowoso Regency. Village office does not obtain any direct revenue. However, the village is currently planning to develop the tourism potential and the Project is expected to support this initiative. ■ Project is expected to continue the CSR program, particularly in conducting local hiring. Besides, Project is expected to accept local vocational high school graduates to work on the Project.
			Religious leader of Kalianyar Village ([redacted]	■ Communities initially had concerns regarding the potential disturbance on the community's clean water source due to Project operation. However, MCG has clarified that the Project will not be using the community's clean water source. ■ Communities are currently supporting the Project and have no concerns at all. ■ Project is expected to continue the existing community development program which involves providing assistance to renovate worship facilities (mosques) and conduct local hiring for the unskilled workforce.
			Youth representative of Kalianyar Village ([redacted]	■ Youth decided to leave lower secondary school (SMP) to work in the plantation (for male student) or get married (for female student). The absence of matching job opportunities is also considered as one of the reasons of high figure of student drop out in lower and upper secondary school (SMP and SMA). ■ Project is expected to create job opportunities as a pulling factor of students going to school.
03/03/2022	Power plant area, Kalianyar Village, Bondowoso	Key Informant Interviews	Local farmers in Power plant area	■ Farmers were collecting potatoes and utilizing the land nearby MCG plant facilities. ■ Potatoes are collected and sold through middlemen. Detailed information on the price and quantity is available in local livelihood section ■ Farmers rely on rain as irrigation for the farmland. For larger farmland, farmers use basins to store water for irrigation ■ Farmers are aware that the land is formally owned by Perhutani and currently used and borrowed by MCG

Date	Location	Mode of Engagement	Stakeholder Involved	Key Messages
	Curah Macan hamlet in Kalianyar, Bondowoso	Key Informant Interview	Head of LMDH / Forest village community organization ([redacted]	■ Community supports the project and has no concerns on the existence of MCG's project located near the hamlet other than the steam kick happened in 2020[42]. ■ MCG has communicated with communities to clarify the steam kick incident and ensure health and safety of the people nearby ■ Local recruitment should be prioritized for Curah Macan ethnic group, as the closest community area from the Project.
	Kalibendo, Kampung Anyar Village, Banyuwangi	Key Informant Interview	One of owners of the Kalibendo plantation ([redacted]	■ Engagement for the transmission line is being done by the MCG team and the team will continue to communicate with the plantation owner for any project development. ■ Community is supportive of the project ■ Plantation owner has received some inquiries from the community related to compensation for those people whose land is affected by the transmission line ■ Compensation should be fair, transparent and benefiting the affected communities
04/03/2022	Kalibendo, Kampung Anyar Village, Banyuwangi	Key Informant Interview	Osing people ([redacted]	■ Osing cultural norms and values are not practised by young people anymore ■ Osing people are living modern live like the rest of other Madurans and Javanese people ■ Osing people use distinct dialect in comparison with the rest of east Javanese dialect
	Kopendugu Hamlet, Grogol Village, Banyuwangi	Key Informant Interview	Grogol Village Secretary [redacted]	■ Socializations for the transmission line were done by MCG team several times; initial boundary marking, public consultation for EIA process, follow-up visit by MCG to the potential affected landowners ■ Further socialization and involvement of *KJPP* consultant (certified asset assessor) will be carried out in the near future ■ The village secretary received inquiries/ concerns from the community related to compensation ■ Compensation should be transparent, fair and benefiting the affected people ■ Communities whose land is passed by the transmission line feel the need of their land to be compensated as they will be affected in terms of the height of the plantations, their plantation condition during TL construction and operation, lower land pricing for land under TL, health and safety during TL construction

[42] This steam kick incident occurred while drilling IJN 6-1. The drilling penetrated a shallow depth high temperature steam reservoir at 630 m. This incident can occur during geothermal drilling and was mitigated with the installation of a BOP (Blow Out Preventer). During the incident, the BOP functioned properly, however due to the increase of pressure and temperature of the well, the steam flowed to the surface. No harmful gases were detected that could harm the local community, and the situation was properly controlled. MCG managed the steam kick and stabilized the well by pumping heavy drilling mud. The incident was reported to relevant government bodies and communicated to local authorities and communities.

Date	Location	Mode of Engagement	Stakeholder Involved	Key Messages
05/03/2022	Bulupayung Hamlet, Bulusari, Banyuwangi	Key Informant Interview	Bulupayung head of hamlet, Bulusari Village ([redacted]	■ Engagement for the transmission line was conducted by MCG team ■ There are no current issues related to the Project. However, affected landowners are waiting for further information related to the next step of the acquisition process
06/03/2022	Sempol Village, Banyuwangi	Key Informant Interview	Wife of the Sempol Village head ([redacted]	■ The informant was not informed/ is not aware of any socializations for the Project by MCG team. ■ There are few concerns related to access road and traffic due to MCG's mobilization of equipment . ■ Mobilization of equipment has caused multiple road traffic and delay travel time by 2-4 hours. This has impacted communities who need to commute for emergency reasons (i.e. sick family members) ■ Vehicle noise creates disturbance/ inconvenience during night time in the community residential area.
	Sempol Village, Banyuwangi	Key Informant Interview	Head of Perhutani Forest Management in Sempol Area ([redacted]	■ Cooperative model between Perhutani Belawan and local community is regulated through LMDH / Forest village community organization with sharing profit of 70:30 (70% of harvest profit goes to the community member of LMDH and 30% of the profit goes to Perhutani). ■ Community shall also comply with annual technical plan of Perhutani for allocated land area such as for green space, managing main crops, etc. ■ All six (6) LMDHs have established contract agreement with Perhutani indicating legitimate partnership ■ Disputes related to utilised land area between communities are settled by the head of Perhutani forest management
	Sempol Village, Banyuwangi	Key Informant Interview	PTPN XII Supervisor ([redacted]	■ Cooperative models involving PTPN XII and communities utilizing PTPN's land are two things; rent price per hectare determined by harvest revenue and selling price of the crop, and daily labour wage for farmers that are engaged indirectly through renters especially in harvest seasons ■ Fresh water for drinking, eating and other household use for community in Sempol is sourced from Taman spring water located nearby in Sempol area
07/03/2022	Bulusari Village, Banyuwangi	Informal Discussions	Bulusari Office Staff members	■ General socioeconomic condition of communities in Bulusari village: main livelihood activity is farming, 85% of the people are Madurans, 10% -15% are Osing people, water resources are from Patemon water spring in Kalibendo plantation area as well as water spring in Meranti mountain.

Date	Location	Mode of Engagement	Stakeholder Involved	Key Messages
	Kalipuro District Office, Banyuwangi	Key Informant Interview	Bulusari Village head ([redacted] and Village secretary ([redacted]	■ Socializations for the transmission line were done by MCG team several times; initial boundary marking, public consultation for EIA process, follow-up visit by MCG to the potential affected landowners (7 initially identified affected landowners) ■ Initially identified landowners inquire about the realization of the project and negotiation process for land acquisition ■ Proactive communication with MCG to inform affected landowners the current progress and the tentative timeline for negotiation is required ■ Local communities would like to gain better information on the development of transmission line, safety aspects of it and the likely impacts during construction and operation ■ Land parcels laid on the transmission boundary plot are farmland belongs to individual persons (non-communal).
	Giri Village (Urban Village), Banyuwangi	Key Informant Interview	Giri Village Head [redacted] and Village Secretary [redacted]	■ Socializations for the transmission line were done by MCG team several times; initial boundary marking, public consultation for EIA process, follow-up visit by MCG to the potential affected landowners (3 initially identified affected landowners) ■ Land parcels laid on the transmission boundary plot are farmland belongs to individual persons (non-communal). Plants include but not limited to coconut trees, Chinese albizia (Sengon), corn, and teak ■ Majority of the local community in Giri are unaware of the Project ■ Limited socializations may lead to negative perception and risk of social unrest ■ Inclusive and continuous socializations targeted for directly and indirectly affected people the surrounding communities and other related stakeholders are essential
08/03/2022	Jampit Village, Bondowoso	Key Informant Interview	Community and Religious Leader ([redacted]	■ Historically and socially important burial site and Islamic boarding school are existed since colonial era. Location is approximately 1-2 km from the power plant location ■ Community learning centre (*PKBM*) is initiated and running under close supervision of the regency level of education agency. ■ PKBM provides non-formal standardized education for elementary, junior and high school level as well as life skill/ vocational trainings in music, art, and culinary art ■ Community is supportive of the project ■ The steam kick incident did not affect people in Jampit area ■ Donations to Jampit community have been provided by MCG several times

Source: Key Informant Interviews, 2022

5.5 Social Perception Study

MCG conducted a social perception study in 2021. The focus of this assessment is the perception and attitude of the community towards the development of the PT MCG Geothermal Power Plant. The data we collect comes from residents of the Ijen sub-district which are divided into Kalianyar Village, Sempol Village, Jampit Village, Curah Macan Hamlet, Plalangan Hamlet, Margahayu Hamlet, and Bondowoso City.

5.5.1 Identification of Surrounding Community Perceptions

The community around the activity location is aware of a project carried out by PT Medco Cahaya Geothermal. All geothermal well exploration areas (IJN 01 to IJN 06) are located in the administrative area of Kalianyar Village. In general, the people in Ijen Sub-district provide positive support for the geothermal well exploitation and power plant development activities because they are aware of the positive benefits. Public perception of the planned activity is summarized in ***Table 5-3***.

Table 5-3: Community Perception of Planned Activities

No.	Public Perception	Amount
Positive Perception		
1	Opening up informal employment	91.6%
2	Absorb local labour	
3	Increase people's income	
4	Improve the economy	
5	Compensation for affected objects	
6	There is a community development program	
7	Improving the quality of education	
Negative Perception		
1	Disturb the local community activities	8.3%
2	Potential to destroy nature	
3	Changing the current forms of livelihood for the local people to other forms of employment i.e. farmer to construction worker	
4	Others	
Total		100%

Source: Questionnaire Results, 2021

5.5.2 Identification of Local Community Proposals

The community around the activity location provides a number of proposals and suggestions to the initiator regarding the plan for geothermal well exploitation and power plant development. In general, the proposals and suggestions from the community along with the responses of PT Medco Cahaya Geothermal can be seen in ***Table 5-4***.

Table 5-4: Suggestions from Neighbouring Communities and MCG Responses

No	Community's Proposal	Response by PT MCG
1	In fulfilling the workforce, the initiator must prioritize the local community in the Ijen District area, unless it requires workers who have the skills and skills.	PT MCG is committed to absorbing local workers, especially in the Ijen District area. This has been done by PT MCG in the implementation of Geothermal Well Exploration activities. However, for jobs that require skills and competencies, PT MCG must recruit workers who have the required competencies.
2	Implementation of activities must preserve nature and the surrounding environment.	Preserving nature and the surrounding environment is a joint commitment between PT MCG and the surrounding community because this is part of the regulations that must be implemented collaboratively
3	The implementation of activities should not interfere with the clean water source of the surrounding community.	The fulfilment of clean water needs carried out by PT MCG does not interfere with the clean water source of the surrounding community because the fulfilment of water needs for drilling, amounting to 83 L/second, is carried out by taking water from the Ampar River.
4	The initiator adheres to local customs and applies the norms and beliefs that have been believed.	PT MCG is fully committed to always complying with social norms, religion, and customs that are believed by the surrounding community
5	The proponent establishes risk mitigation and emergency response system in the event of a hazard and must be informed to the community around PT MCG that has conducted a risk mitigation study and emergency response in case of an accident.	This is PT MCG's main priority for the workforce and the surrounding community
6	Prioritizing coordination and communication with local officials	PT MCG is committed to continuing good communication with all stakeholders in Ijen District, Bondowoso Regency
7	Implementing CSR programs for the development needs of communities directly affected	PT MCG is committed and makes it a priority to implement CSR in affected communities

5.6 Grievance Redress Mechanism

External stakeholders, such as village authorities, community figures and other key stakeholders, are currently communicating directly with MCG chief security and community relations through phone calls or face to face meetings, as confirmed through multiple interviews with local stakeholders in the Project AoI. It is necessary for the Project to establish grievance redress and handling mechanism that is transparent, culturally appropriate, readily accessible, and at no cost and without retribution for Project-Affected Communities. The grievance mechanism should be disclosed to the stakeholders, especially Project-Affected Communities. Training for the affected communities on the use of grievance mechanism shall be conducted if it's deemed necessary. The Grievance Redress Mechanism is detailed in ***Appendix G***.

6 IMPACT ASSESSMENT

6.1 Impact Assessment Methodology

6.1.1 Introduction

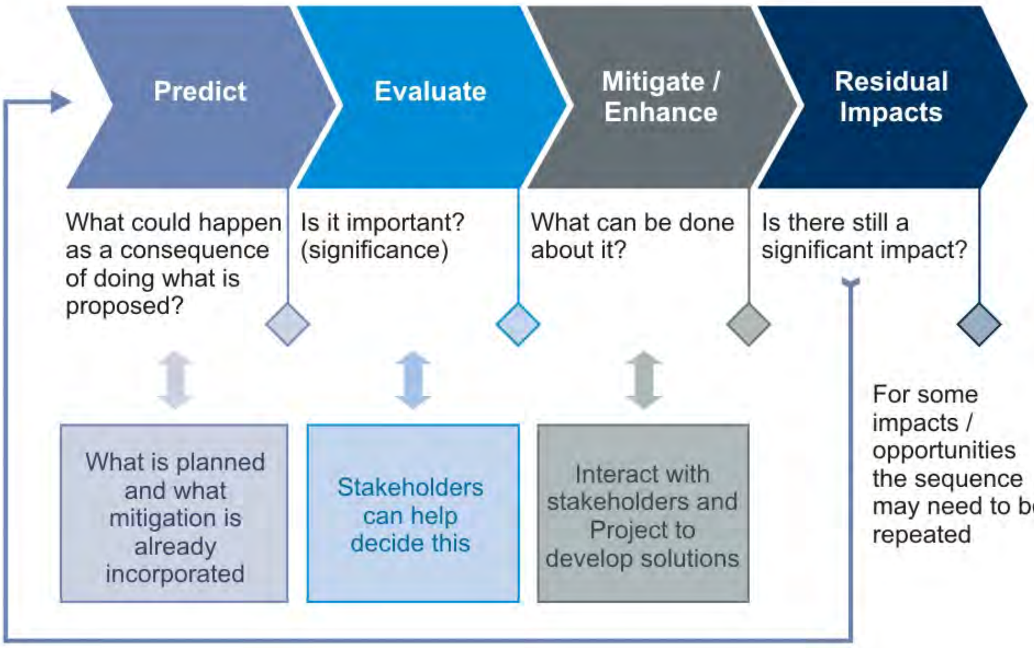
This section assesses the manner in which the Project will interact with elements of the physical, ecological or social environment to produce impacts to resources/ receptors. It has been organized as per the operational and decommissioning phases of the project life cycle to understand the risks and impacts associated with each phase.

6.1.2 Impact Assessment

Impact identification and assessment starts with scoping and continues through the remainder of the ESIA Process covering all phases of the Project from Pre-construction to Post-closure. The principal ESIA steps are summarises in ***Figure 6-1*** and comprise:

- **Impact Prediction**: to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities;
- **Impact Evaluation**: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and Enhancement**: to identify appropriate and justified measures to mitigate potential negative impacts and enhance potential positive impacts; and
- **Residual Impact Evaluation**: to evaluate the significance of potential impacts assuming effective implementation of mitigation and enhancement measures.

Figure 6-1: Impact Assessment Process



6.1.2.1 Prediction of Impacts

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors are elaborated and evaluated. The diverse range of potential impacts considered in the ESIA process typically results in a wide range of prediction methods being used, including quantitative, semi-quantitative and qualitative techniques.

6.1.2.2 Evaluation of Impacts

Once the prediction of potential impacts is complete, each potential impact is described in terms of its various relevant characteristics (e.g., type, scale, duration, frequency, extent). The terminology and designations used to describe impact characteristics are shown in ***Table 6-1***.

Table 6-1: Impact Characteristics Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the potential impact to the Project (in terms of cause and effect).	■ Direct ■ Indirect ■ Induced
Extent	The "reach" of the potential impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	■ Local ■ Regional ■ International
Duration	The time period over which a resource / receptor is potentially affected.	■ Temporary ■ Short term ■ Long term
Scale	The size of the potential impact (e.g., the size of the area with the potential to be damaged or impacted, the fraction of a resource that could potentially be lost or affected, etc.).	[no fixed designations; intended to be a numerical value or a qualitative description of "intensity"]
Frequency	A measure of the constancy or periodicity of the potential impact.	[no fixed designations; intended to be a numerical value or a qualitative description]

The definitions for the *type* designations are shown in ***Table 6-2***. Definitions for the other designations are resource/receptor-specific and are discussed in the resource/receptor-specific impact assessment chapters presented later in this Report.

Table 6-2: Impact Type Definitions

Type	Definition
Direct	Potential impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Potential impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Potential impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of workers resulting from the importation of a large Project workforce).

The above characteristics and definitions apply to planned and unplanned events. An additional characteristic that pertains only to unplanned events is *likelihood*. The *likelihood* of an unplanned event occurring is designated using a qualitative scale, as described in ***Table 6-3***.

Table 6-3: Definitions for Likelihood Designations

	Likelihood	Definitions
1	**Incidental**	Very unlikely, not known in the industry.
2	**Minor**	Unlikely to occur but known of in the industry.
3	**Moderate**	Likely to occur once or more in life of the Project.
4	**Major**	Likely to occur once or twice per year.
5	**Severe**	Will likely occurs more than twice per year or is continuous or certain to occur.

Once impact characteristics are defined, the next step in the impact assessment phase is to assign each potential impact a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent;
- Duration;
- Scale; and
- Frequency.

For unplanned events, impact 'consequence' is used instead of Magnitude. Although determining the Consequence uses the same impact characteristics as of Magnitude, additional characteristics are considered based on the definitions provided for the physical, biological, and social environment, as shown in ***Table 6-4***.

Table 6-4: Impact Scale of Consequence for Unplanned Events

	Incidental	Minor	Moderate	Major	Severe
Physical Environment	Impacts such as localised or short term effects or environmental media, meeting all environmental standards	Impacts such as widespread, short-term impacts to environmental media, meeting all environmental standards	Impacts such as widespread, long-term effects on environmental media, meeting all environmental standards	Impacts such as significant, widespread and persistent changes in environmental media OR Exceedance of environmental standards	Exceedance of environmental standards and fine/ prosecution
Biological Environment	Impacts such as localised or short term effects on habitat or species	Impacts such as localised, long term degradation of sensitive habitat or widespread, short-term impacts to habitat or species	Impacts such as localised but irreversible habitat loss or widespread, long-term effects on habitat or species	Impacts such as significant, widespread and persistent changes in habitat or species	Impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Social Environment	Slight, temporary, adverse impact on a few individuals	Temporary (<1 year), adverse impacts on community which are within international health standards	Adverse specific impacts on multiple individuals that can be restored in <1 year OR One or more injuries, not lost-work injuries.	Adverse long-term, multiple impacts at a community level, but restoration possible. OR One or more lost-work injuries to a member of the public including permanently disabling injuries.	Adverse long-term, varied and diverse impacts at a community level or higher – restoration unlikely. OR Fatalities of public.

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

In the case of a potential positive impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the purpose of the ESIA to indicate that the Project is expected to result in a potential positive impact, without characterising the exact degree of positive change likely to occur.

In the case of potential impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised. However, the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterising the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors may also be considered, such as legal protection, government policy, stakeholder views and economic value. As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis.

The sensitivity/vulnerability/importance designations used herein for all resources/ receptors are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in ***Table 6-5***: Impact Significance. Whereas for unplanned events, impact significance is designated with a different matrix, shown in ***Table 6-6***.

Table 6-5: Impact Significance

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Negligible
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	Major
	Large	Moderate	Major	Major

Table 6-6: Impact Significance for Unplanned Events

		Likelihood of Occurrence				
		Incidental	**Minor**	**Moderate**	**Major**	**Severe**
Consequence	**Incidental**	Negligible	Negligible	Negligible	Negligible	Negligible
	Minor	Negligible	Minor	Minor	Minor	Moderate
	Moderate	Minor	Minor	Moderate	Moderate	Major
	Major	Moderate	Moderate	Major	Major	Major
	Severe	Major	Major	Major	Major	Major

Source: ERM.

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations that enter into the matrix. ***Box 6-1*** provides a context for what the various impact significance ratings signify.

It is important to note that impact prediction and evaluation take into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the ESIA Process). This avoids the situation where an impact is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls.

Box 6-1: Context of Impact Significances

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity, or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/vulnerability/importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its' effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of EIA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholder to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

It is important to note that impact prediction and evaluation takes into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the IA Process).

An activity – impact interaction matrix for construction and operation phases of the Project is presented in ***Figure 6-2***, which has been further used to assess the impact significance at activity levels on environmental, ecological and social resources.

6.1.2.3 Identification of Mitigation and Enhancement Measures

Once the significance of a potential impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. For the purposes of this ESIA, ERM has adopted the following Mitigation Hierarchy:

- **Avoid at Source, Reduce at Source**: avoiding or reducing at source through the design of the Project (e.g., avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity);
- **Abate on Site**: add something to the design to abate the impact (e.g., pollution control equipment, traffic controls, perimeter screening and landscaping);
- **Abate at Receptor**: if an impact cannot be abated on-site then control measures can be implemented off-site (e.g., noise barriers to reduce noise impact at a nearby residence or fencing to prevent animals straying onto the site);
- **Repair or Remedy**: some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures; and
- **Compensate in Kind, Compensate Through Other Means**: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries access, recreation and amenity space).

The priority in mitigation is to first apply mitigation measures to the source of the potential impact (i.e., to avoid or reduce the magnitude of the potential impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

6.1.2.4 Residual Impact Evaluation

Once mitigation and enhancement measures are declared, the next step in the ESIA Process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the implementation of the proposed mitigation and enhancement measures.

6.2 Results of Scoping Assessment / Impact Identification

Following the determination of Area of Influence, a Scoping Matrix (***Figure 6-2***) was used as a tool to support a methodological identification of potential interactions each Project activity may have on the range of resources/receptors within the AoI. It consists of, on one side of the matrix, a list of Project activities during the construction and operation phases which may give rise to significant impacts. These are set against a list of environmental and social resources/receptors within the AoI with potential to interact. Entries in the matrix cells are colored to indicate following potential impacts:

	Key
	Scoped in - Potentially significant impact requiring further assessment
	Scoped out - Potential interaction unlikely to be significant
	Positive impacts - An interaction with positive impact expected
	An interaction is not reasonably expected

Figure 6-2: Scoping Matrix

ACTIVITIES	RECEPTORS																			
	Physical						Biological					Human								
Project Activity	Ambient Air Quality	Climate	Noise Levels	Soil	Water Resources	Water Quality (surface, ground)	Birds	Aquatic Fauna and Flora	Terrestrial Habitats and Flora	Terrestrial Fauna (mammals/Reptiles/etc.)	Protected Areas/ Critical/ Sensitive Habitat	Community Health, Safety & Security	Traffic and Transport	Livelihoods	Cultural Heritage	Tourism/ Recreation	Employment & Income	Utilities (e.g. water, onshore waste facilities)	Visual Impact & Aesthetic	Occupational Health and Safety and Security
Pre-Construction, and Construction Phase																				
Land Preparation / Earthworks																				
Construction of Power Plant																				
Pipeline laying																				
Waste disposal																				
Installation of Transmission Line																				
Well drilling (exploration, production, and reinjection) and blasting																				
Worker influx and accommodation																				
Transport of materials and wastes																				
Operation and Maintenance Phase																				
Operation of Power Plant																				
Operation of Transmission Line																				
Routine maintenance																				
Waste transport and disposal																				
Decommissioning																				
Decommissioning																				
Unplanned Events																				
Pipeline / well failure																				
Chemical spills																				
Collision with people / fauna																				
Fire / Explosion																				
Natural Hazards (flooding, landslides, earthquakes, volcanic eruptions)																				

Table 6-7 provides a rationale for the scoping of the impacts of Project related impacts, which may potentially result in significant effects.

Table 6-7: Rationale for Scoping of Impacts

Topics	Pre-construction, Construction, and Drilling	Operation and Maintenance
Air Quality & Climate Change	**Scoped in:** ■ The closest residential property to the Project is located approximately 300 m of the nearest well pad. There are also potential communities within 500 m of the transmission line route. ■ There is potential for air emissions and dust generation from construction to impact ambient air quality as well as local communities. ■ The main activity that would emit H2S air emissions is well testing. Because non-condensable geothermal gases, including H2S, are heavier than air, the gases can accumulate in confined spaces and low-lying areas.	**Scoped out:** ■ Geothermal power plant emissions are negligible compared to other fossil fuel combustion-based power plants. The Project will re-inject gases into re-injection wells with no venting. ■ However, unplanned air emissions are scoped into the assessment from well blowouts.
Noise	**Scoped in:** ■ There closest residential property to the Project is located approximately 300 m from the nearest well pad. There are also potential communities within 500 m of the transmission line route. ■ There is potential for noise generation from construction to impact ambient noise as well as local communities, particularly from transmission line installation and well drilling.	**Scoped out:** ■ Noise during operation will be limited to maintenance activities (vehicle movements).
Soil	**Scoped in:** ■ Construction and operational may affect soil quality through drilling, construction of power plant and transmission line. ■ One of the primary concerns during construction activities is soil erosion/landslides. Potential impacts to soils from erosion are expected to primarily occur in areas where the slopes are moderately steep or steep (i.e., 3 to 17 degrees slopes). ■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause soil contamination.	**Scoped out:** ■ Soil impacts will not be significant during regular operation and maintenance. ■ However, spills, and leaks are scoped into the assessment.
Water Resources / Quality	**Scoped in:** ■ The water resource use during construction and drilling could impact local water quantity. ■ The construction and testing activities associated with the Project may result in negative impacts to water resources within the Project footprint. Potential impacts could include changes to downstream surface runoff patterns; over-extraction of surface water from the nearby rivers; and changes in surface and groundwater quality. ■ Drilling and injection works have the potential to affect groundwater quality if geothermal liquid, wash water, mud, and drill cuttings (collectively referred to as “process wastewater”) are not managed properly. ■ Also, if equipment and machinery used during construction activities do not receive appropriate and scheduled maintenance, they would have the potential to leak fuel or lubricants that can reach surface water (streams/rivers) or groundwater bodies.	**Scoped in:** ■ The water resource use during operation could impact local water quantity. ■ The groundwater table also may be affected through planned or unplanned discharges.

Topics	Pre-construction, Construction, and Drilling	Operation and Maintenance
	■ The groundwater table also may be affected through planned or unplanned discharges.	
Visual & aesthetics / Landscape	**Scoped in:** ■ The presence of the equipment during construction will have visual impacts on the surrounding environment.	**Scoped in:** ■ The presence of the power plant and transmission line during operation will have visual impacts on the surrounding environment.
Protected and Sensitive Areas	**Scoped in:** ■ Noise impacts and presence of plant and equipment may cause behavioural responses and temporary habitat loss during construction. ■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to fauna.	**Scoped in:** ■ During operation, the transmission line may pose a collision risk hazard. Particularly for migrating or resident sensitive species that are present in the neighbouring Protected Area.
Terrestrial Fauna (Mammals / Reptiles/ etc.)	**Scoped in:** ■ Ground works would result in the direct loss and disturbance of vegetation and wildlife habitat and may introduce or spread invasive and exotic plant species within the road improvement/expansion locations, well pads, and injection pads and immediate surrounding areas. ■ The use of heavy machinery during construction and increased vehicular traffic along access roads could result in direct mortality or injury of wildlife species. ■ The use of heavy machinery during construction and well drilling may generate localized vibrations sufficient to harm ground-dwelling terrestrial biota. ■ Project-related vehicular traffic may cause vehicular-related wildlife mortality or injury. Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to fauna.	**Scoped in:** ■ During operation, the transmission line may pose a collision risk hazard. Particularly for migrating or resident sensitive species that are present in the neighbouring Protected Area.
Terrestrial Flora	**Scoped in** ■ Vegetation clearance at the power plant, transmission line towers, well pads, and along pipeline alignment will impact terrestrial flora. ■ As above, ■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to flora.	**Scoped out:** ■ Impact to flora are unlikely during general operation. ■ However, impacts from unplanned events will be assessed.
Aquatic Flora and Fauna	**Scoped in:** ■ Water withdrawals from the nearby rivers have the potential to decrease available aquatic habitat and fragment existing aquatic habitat in the river. ■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to fauna and flora.	**Scoped in:** ■ Water withdrawals from the nearby rivers have the potential to decrease available aquatic habitat and fragment existing aquatic habitat in the river. ■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to fauna and flora.
Community Health, Safety and Security Local Community	**Scoped in:** ■ The land where the Project will be developed, is current owned by MCG. The land required for transmission line may include temporary economic resettlement. ■ Air and noise emissions during construction could cause health impacts to local communities / receptors with a few 100 metres of the Project.	**Scoped in:** ■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to local communities' health.

Topics	Pre-construction, Construction, and Drilling	Operation and Maintenance
	■ Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to local communities' health.	
Workforce / Occupational H&S	**Scoped in:** ■ Impacts to the workforce include labour and working conditions, human rights, and requirement for migrant labour) as well as health and safety.	**Scoped in:** ■ Impacts to the workforce include labour and working conditions, human rights, and requirement for migrant labour) as well as health and safety.
Traffic and Transport / Navigation	**Scoped in:** ■ The presence of the vehicles and equipment onshore may cause impacts to transport and traffic via exclusion from navigation routes during construction. ■ Use of local access roads can impact local traffic and increase risk of accidents / collisions.	**Scoped out:** ■ The presence of the vehicles during operation will be limited for the 69 workers. As such, this is not considered to be significant. ■ Collisions and accidents are however scoped into the assessment.
Livelihoods	**Scoped in:** ■ Agriculture sector is the main source of income in Bondowoso and Banyuwangi Regency. The closest community is around 300 m from the well pad (Kaliyanar). ■ There is economic displacement as a result of the transmission line. ■ Indirect impacts from wastewater, waste may impact local agriculture which could in turn impact livelihoods.	**Scoped out:** ■ Land impacts will occur during the pre-construction phase and limited impacts to land and livelihoods will occur during operation.
Cultural Heritage	**Scoped in:** ■ There is a burial site within 800 m of the well pad locations and three mosques within 500 m of the proposed transmission line route. ■ The Kawah Ijen is also considered as a form of cultural heritage tourism. The impacts to the nature reserve and tourism sites will be assessed. ■ There are no cultural heritage sites or place of religious importance within the main development area.	**Scoped in:** ■ As per construction phase. ■ Impacts from unplanned events will also be assessed.
Tourism / Recreation	**Scoped in:** ■ The site clearance and presence of equipment during construction will have impacts to landscape and visual for nearby tourism sites. ■ The Ijen Crater tourism site is located at its closest point around 300 m from the transmission line. ■ The Project is located within the Kawah Warang (Wurung) Park which is a tourism hiking area known for scenic views and a number of crater features such as Kawah Wurung and Kawah Ilalang which are adjacent to the access road and transmission line respectively.	**Scoped in:** ■ The presence of the power plant and transmission line will have impacts to landscape and visual for nearby tourism sites.
Utilities	**Scoped in:** ■ Waste generation during construction and operation could impact local waste handling and disposal facilities.	**Scoped out:** ■ There will be limited waste generation during operation of the power plant and transmission line. ■ Waste will be managed with a Waste Management Plan during operation.

6.3 Pre-Construction, Construction, and Drilling Phase – Impact Assessment

This section provides the impact assessment for the pre-construction, construction, and drilling phases of the Project based on the impacts scoped into the assessment. It should be noted that all drilling (exploration, production and reinjection) is discussed under this phase as the impacts will be broadly similar.

6.3.1 Impact on Ambient Air Quality and Climate Change

6.3.1.1 Potential Impacts

The following activities can have impacts to ambient air quality during the Construction Phase of the Project:

- Land Preparation / Earthworks;
- Construction of Power Plant;
- Well drilling;
- Pipeline laying; and
- Transport of materials and wastes.

Dust can result in unacceptable impacts to ambient air quality if not managed accordingly. The dust could impact residential properties, schools, and hospitals, which are sensitive to dust exposure. The dust emission is defined based on the anticipated works of construction and operation phase. The assessment presented in this section does not consider the potential impact to ambient air quality from vehicles using access roads as these impacts during construction are temporary and the impacts during operations are small (primarily limited to the estimated 69 permanent employees.

Fugitive dust and exhaust emissions from vehicles travelling on access roads can result in unacceptable impacts to ambient air quality if not managed accordingly. Dust generation may temporarily impact air quality in the surrounding area. Site clearance prior to construction of the Project will cause potential impacts on air quality.

During well drilling and testing, impacts on air quality can be caused by hydrogen sulphide (H_2S) emissions. Carbon dioxide is also in the steam vented out during blow testing, although its emissions are considered negligible compared to fossil fuel combustion sources (IFC EHS Guidelines for Geothermal Power Generation, 2007).

Details of the proposed stack and emission rate of the pollutants from the proposed Project have been presented in ***Table 6.8***.

Table 6.8 Emissions from the Proposed Stacks (Construction Phase)

Stack ID	Source	UTM Coordinates		Emission Source Capacity (kg/s)	Stack Parameters					Emission Rate (g/s)	
		Easting (m E)	Northing (m S)		Exist Gas Temp. (̊C)	Internal Dia. (m)	Stack Height (m)	Exit Gas Velocity (m/s)	Flow Rate (m^3/hr)	NO_2	CO
ST-01	Fire Water Tank - Welding Engine	187842.98	9108267.14	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-02	Fire Water Tank - Welding Engine	187835.00	9108267.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-03	Service Water Tank - Welding Engine	187872.51	9108244.29	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-04	Service Water Tank - Welding Engine	187864.00	9108244.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-05	Condensate ACC - Welding Engine	187903.1	9108163.64	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-06	Condensate ACC - Welding Engine	187894.00	9108163.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-07	MAPA Workshop Bar Bending - Welding Engine	187735.47	9108296.84	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-08	MAPA Workshop Bar Bending - Welding Engine	187728.00	9108296.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-09	Pipeline - Welding Engine	188006.71	9108152.67	0.001	530	0.076	1.5	35	571.59	0.360	0.006

Stack ID	Source	UTM Coordinates		Emission Source Capacity (kg/s)	Stack Parameters					Emission Rate (g/s)	
		Easting (m E)	Northing (m S)		Exist Gas Temp. (̊C)	Internal Dia. (m)	Stack Height (m)	Exit Gas Velocity (m/s)	Flow Rate (m^3/hr)	NO_2	CO
ST-10	Pipeline - Welding Engine	188001.00	9108151.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-11	Pipeline - Welding Engine	187839.57	9108310.16	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-12	Pipeline - Welding Engine	187835.00	9108310.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-13	Pipeline - Welding Engine	187674.17	9108341.92	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-14	Pipeline - Welding Engine	187669.00	9108341.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006
ST-15	Pipeline - Welding Engine	187903.51	9108351.32	0.001	530	0.076	1.5	35	571.59	0.360	0.006
St-16	Pipeline - Welding Engine	187896.00	9108351.00	0.001	530	0.076	1.5	35	571.59	0.360	0.006

6.3.1.2 Embedded/in-built Controls

The following embedder controls will be included based on Good International Industry Practise (GIIP):

- Basic measures;
  - Paving the main access road;
  - Spraying water to minimize fugitive dust along any temporary roads or other disturbed areas as dictated by weather conditions
  - Compliance with the flying-dust mitigation standard and monthly training at the worksite
  - No incineration of construction waste at worksite
  - Use of low pollution equipment and in good condition
- Earthworks;
  - Wheel wash at the entrance and cargo box cover shall be checked
  - Cargo box cover of dump truck to prevent the dust scattering
  - Work is suspended when wind velocity exceeds 8m/sec and dust-prevention cover sheet on excavated soil
  - Speed limit at worksite to 20 km/h

6.3.1.3 Impact Evaluation and Significance

6.3.1.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for ambient air quality has been provided in ***Table 6-9*** and

Table 6-10, respectively.

Table 6-9: Sensitivity Assessment Criteria for Air Quality

Sensitivity Criteria	Contributing Criteria	
	Human Receptors	Ecological Receptors
Low	Locations where human exposure is transient.	Locally designated sites; and / or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team).
Medium	Few Receptors (settlements) within 1 km of project activity area	Nationally designated sites.
High	Densely populated receptors (settlements) within 1 km of project activity area	Internationally designated sites

Table 6-10: Criteria for Impact Magnitude for Assessment of Impact to Air Quality

Magnitude	Criteria
Negligible	■ Low levels of emissions/ dust generation due to Project activity ■ Impact extent is local ■ Temporary dust generation and emission from Projects
Small	■ Soil type with large grain size (e.g. sand) ■ Impact extent is local ■ Dust generation and emissions from Projects for short duration
Medium	■ Moderately dusty soil type (e.g. silt) ■ Impact extent is local to regional ■ Dust generation and emission from Projects for long duration
Large	■ Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) ■ Impact extent is local to international ■ Significant process emissions from Project for the entire Project cycle

6.3.1.3.2 Impact Significance

The sources of air emissions for the Project are limited to vehicle emissions, fugitive dust, emissions from the use of powered mechanical equipment (e.g., gensets), and releases of hydrogen sulfide during well drilling and testing. There are national protected areas within 1 km of the transmission line (Kawah Ijen Nature Reserve) and the Project site is located within 1 km of the Gunung Raung and Gunung Ijen Key Biodiversity Areas (KBAs). The nearest residential area of the power plant site is in Margahayu Sub-village, Kalianyar Village, which is about 600 m from one of the drilling points (Well Pad 8). The main activities of local residents are farming and animal husbandry, whose activities are less than 200 m from the drilling location. From baseline data collected for the Project (refer to ***Section 4.2.2***), ambient air quality levels indicate no exceedances of regulatory standards. The receptor sensitivity is therefore considered to be **medium**.

The main activity that would emit H_2S air emissions is steam blow testing. Because non-condensable geothermal gases, including H_2S, are heavier than air, the gases can accumulate in confined spaces and low-lying areas. Steam blow testing would occur for 1 to 3 months after drilling of the exploratory drill pads. Silencers and wellhead valves would be installed during blow testing.

Air dispersion modelling was conducted to assess point source air emissions during construction and operations.

The model predicted results are provided for short term averaging periods 1-hour, 8-hour or 24-hour and Annual Average in ***Table 6.11*** and ***Table 6.12***.

Table 6.11 Predicted Max. GLC from the Proposed Project (Construction Phase)

		1 hr	24 hr	Annual	1 hr	08 hr	Annual
Pollutants		NO_2			CO		
Concentration (µg/m³)		79.45	11.84	3.19	1.32	0.52	0.05
Co-ordinates (UTM)	**Easting (m E)**	188607.00	188107.00	187607.00	188607.00	188107.00	187607.00
	Northing (m S)	9107449.00	9107949.00	9108449.00	9107449.00	9107949.00	9108449.00
Distance and Direction from the Project Boundary		~248 m East	Within Project Boundary	Within Project Boundary	~248 m East	Within Project Boundary	Within Project Boundary
Indonesian AAQS (µg/m³)		200.00	65.00	50.00	10,000.00	4,000.00	-
WHO Standards (µg/m³)			25.00	10.00		4,000.00	

The "-" indicates no standards.

Table 6.12 Predicted Max. GLC from the Proposed Project

Pollutant		1 hr	24 hr	Annual
H_2S (µg/m³)		48.61	5.53	1.15
Co-ordinates (UTM)	**Easting (m E)**	187107.00	187607.00	187607.00
	Northing (m S)	9107949.00	9108449.00	9108449.00
Distance and Direction from the Project Boundary		~195 m West	Within Project Boundary	Within Project Boundary
Indonesian AAQS (µg/m³)				-
WHO Standards (µg/m³)		-	150.00	-

The '-' indicates no standards.

The baseline ambient air quality concentrations in the study area have been used to estimate the resultant (baseline + model predicted) GLC as provided in ***Table 6.13***.

Table 6.13 Resultant GLC from the Proposed Project (Construction Phase)

Monitoring Locations ID	Baseline 1 hourly Max Conc. (μg/m³)		Model predicted 1 hourly Max Conc. (μg/m³)		Resultant (Model Predicted + Baseline) 1 hourly Max Conc. (μg/m³)		Compliance Status
	NO_2	CO	NO_2	CO	NO_2	CO	
UA 1	6.00	618.00	10.51	0.18	16.51	618.18	**Compliant**
UA 2	5.50	195.00	75.11	1.25	80.61	196.25	
UA 3	5.50	470.00	36.61	0.61	42.11	470.61	
UA 4	6.00	550.00	16.50	0.27	22.50	550.27	
Indonesian AAQS					200.00	10,000.00	

Based on the results of the air dispersion modelling, the localized extent of impacts, the short-term duration of construction when most emissions would occur (about 21 months), and the proposed embedded controls, the impact magnitude is assessed to be **small**.

As such, the impact significance is classified as **minor**.

In terms of climate change, the Project will temporarily emit CO2 during construction from vehicle use and power generation, but the magnitude of these are relatively small and temporary in duration. There will also be some release of CO2 during operations. These releases are small compared with the those from a fossil fuel-based power plant. According to the Guidance Note on Climate Change Risk Assessment , for all projects, in all locations, when combined Scope 1 and Scope 2 emissions are expected to be more than 100,000 tonnes of CO2 equivalent annually, the CCRA is to include consideration of climate-related 'Transition Risks' (as defined by the Task Force on Climate-Related Financial Disclosures (TCFD)) . The CCRA must also include a completed alternatives analysis which evaluates lower GHG intensive alternatives. TCFD Recommendations state that "Transitioning to a lower-carbon economy may entail extensive policy, legal, technology, reputation and market changes to address mitigation and adaptation requirements related to climate change".

It is not expected that the Project will emit more than 100,000 tonnes of CO2 equivalent annually and, therefore, the Project Proponent is not obliged to assess the Transition Risk analysis.

A Climate Change Risk Assessment was also conducted to understand the potential high-level physical risks to the Project from climate change (**Appendix J**). The Climate Change Risk Assessment consisted of a review of current and future physical hazards in the Project. The assessment identified potential high-risk levels for water availability and extreme heat in 2030 and 2050 scenarios.

High water stress signifies constrained access to water resources. This scarcity of water supply introduces an obstacle concerning the project's water needs, which includes cooling, condensing, and treatment of geothermal fluids. Consequently, there is a possibility of encountering disruptions in operational processes if the cooling and condensing systems of the plant experience compromised functionality. Such suboptimal performance has the potential to induce periods of operational downtime, thereby giving rise to potential financial setbacks. To address this risk, it is recommended to include a water risk assessment in the feasibility / engineering studies. This can lead to identification of which project components may implement water conservation measures.

The potential high risk of extreme heat can lead to several consequences. Additionally, extreme heat can cause equipment to overheat or fail, resulting in operational disruptions. This can lead to downtime and reduced power availability. It is recommended to implement water-efficient technologies and practices, such as optimizing cooling systems, reducing leaks, and recycling water, to minimize water usage and increase the plant's water efficiency during extreme heat events.

6.3.1.4 Additional Mitigation, Management, and Monitoring

A number of additional measures have been proposed for dust generation during construction of the power plant and well pads:

- Conduct ambient air quality monitoring at two sensitive receptors (households nearest to the drilling location at Pad 8). Monitoring should be conducted monthly during the construction phase to ensure the Project meets ambient air quality standards;
- Prepare and implement an Air Quality Management Plan during construction and drilling activities;
- Record all dust and air quality complaints under the Grievance Mechanism and follow up by identifying the causes and taking appropriate measures to reduce emissions in a timely manner;
- Record any exceptional incidents that lead to significant fugitive dust emissions off the Project area and make a record of the action taken to resolve the issue and reduce the possibility of it occurring again in the future;
- Ensure soil stockpiles are located as far as possible from receptors and are covered or sprayed to minimize fugitive dust;
- Ensure regular maintenance of all diesel-powered equipment in accordance with manufacturers specifications;
- Switch off machinery and equipment when not in operation;
- Undertake regular on-site inspections, where receptors (including roads) are nearby, to monitor dust and record inspection results. Inspections should include regular dust soiling checks of surfaces such as vehicles and window sills within 100 m of the construction site boundary;
- Use low sulphur fuels in heavy good vehicles and diesel-powered equipment; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

To avoid or reduce the environmental/offsite and occupational exposure to geothermal gases (mainly H_2S that may cause health hazards and odour nuisance) during exploratory activities, the following mitigation measures are recommended (aside from air pollution controls incorporated into Project design such as injection of non-condensable gases with geothermal fluids):

- Install an H_2S gas-monitoring network, taking into account the location of emissions sources and areas of community use and habitation. Operate the H_2S gas monitoring system continuously to facilitate early detection and warning.
- If necessary, use abatement systems to remove H_2S emissions from non- condensable gases. Examples of H_2S controls include wet or dry scrubber systems or a liquid phase/oxidation system.
- Provide adequate ventilation of nearby low-lying occupied buildings to avoid H_2S accumulation.
- Provide workers with educational materials, training, and Personal Protective Equipment (PPE) to protect them from H_2S emissions.

- Require mandatory pre-employment asthmatic sensitivity screening by Ministry of Health for all workers assigned in the drilling phase.
- If H_2S monitoring identifies an offsite human health risk, then relocate nearby receptors (i.e., community members) that could be affected by H_2S emissions.
- Develop and implement an emergency response system that covers accidental releases of H2S emissions.

6.3.1.5 Residual Impact Significance

Based on the above additional measures, the residual impact significance is expected to be reduced to **minor** for construction (***Table 6-14***).

Table 6-14: Impact Assessment for Air Quality: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Elevated ambient concentrations of dust, PM_{10} and $PM_{2.5}$ from construction related activities will have a negative impact on air quality.				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be up to 350 m from the construction site boundary. Impacts are likely to be direct, localised, and short-term (intermittent within the 21-month Construction Phase).				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the pipelines / power plant / transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.2 Impact on Ambient Noise

6.3.2.1 Potential Impacts

The following activities can have impacts to ambient noise quality during the Construction Phase of the Project.

- Land Preparation / Earthworks;
- Construction of Power Plant;

- Installation of the transmission line;
- Well drilling (exploration) and blasting;
- Pipeline laying; and
- Transport of materials and wastes.

Drilling activities would occur in sequence (i.e., drill rig installation and drilling). Drilling at each well pad would occur intermittently for 21 months and consist of noise generating equipment such as a drill rig, generator, drilling mud mixing/separation facility, and mud pump. The drill rig would likely be a trailer - mounted hydraulic powered top-drive rig. Drilling operations would be carried out 24 hours per day. Silencers and wellhead valves equipped with blow-out preventer would be installed for blow testing.

Large equipment and heavy cargo shall be transported via sea and unloaded on the Jetty either in Banyuwangi Seaport around 150 km from the site or Probolinggo Seaport, around 170 km from the Site. Transport and personnel access to the site is via the existing roads. An access road will be paved for the Project with a total length of 8 km. Vehicle traffic would be intermittent, likely occur during daytime hours, and would mostly occur only during the first stage of construction. Therefore, noise impacts from these sources are not expected to be significant.

Similarly, heavy equipment associated with access road construction and drill site preparation would also generate some noise (i.e., bulldozer, graders, dump trucks, loaders, and cranes). However, noise from these sources would be intermittent, temporary, and likely occur only during daytime hours.

Construction activity can result in varying degrees of ground vibration, depending on the equipment and methods employed. Operation of construction equipment causes ground vibrations, which unlike noise, vibration dissipates rapidly over a distance as such that the magnitude and extent of vibration impacts are commonly minimal when, compared to noise.

In the standard operation, explosives may be used, however, only for pipe recovery activity (due to stuck pipe) such as severing or back off activity.

During construction phase of the Project, major noise generating sources will be:

Table 6.15 Major Noise Sources during Construction Phase

S.N.	Source	Type of Source	No. of Source	Hours of Operation	Sound Power Level Lw (dBA)
1	Firewater Tank	Welding Engine & Heavy Eqpt.	2	7	83
2	Service Water Tank	Welding Engine & Heavy Eqpt.	2	7	83
3	Condenser ACC	Heavy Eqpt.	1	7	20
4	MAPA Workshop	Grinding Machine & Generator	2	7	75
5	Pipeline	Welding Engine & Heavy Eqpt.	2	7	50
6	Pipeline	Welding Engine & Heavy Eqpt.	2	7	50
7	Pipeline	Welding Engine & Heavy Eqpt.	2	7	50
8	Pipeline	Welding Engine & Heavy Eqpt.	2	7	50

Source: MCG

6.3.2.2 Existing Controls

All noise emissions to be in line with the requirements in ***Section 2.4*** of this ESIA. The following in built controls will be included based on Good International Industry Practise (GIIP):

- Selection of low noise and vibration methods;
- Installing sound barrier at worksite;
- Use low vibration equipment and methods; and

- Adjustment of working hours, based on public hearings for residents. Set construction working hours, namely during working hours (08.00 – 17.00), so as not to disturb residents' rest hours

6.3.2.3 Impact Evaluation and Significance

6.3.2.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for ambient noise has been provided in ***Table 6-16*** and ***Table 6-17***, respectively.

Table 6-16: Criteria for Impact Magnitude for Assessment of Impact to Noise Level

Magnitude	Criteria
Negligible	■ Predicted noise levels are at or less than 3 dB (A) above the relevant limits / thresholds ■ Human exposure is transient within 500 m of project site ■ Impact extent is local ■ Temporary exposure
Small	■ Predicted noise levels are 3 to less than 5 dB (A) above the relevant limits / thresholds ■ Human exposure is transient within 500 m of project site ■ Impact extent is local ■ Short-term exposure
Medium	■ Predicted noise levels are between 5 and 10 dB (A) above the relevant limits / thresholds ■ Impact extent is local to regional ■ Long-term exposure
Large	■ Predicted noise levels are at or more than 10 dB (A) above the relevant limits / thresholds ■ Impact extent is local to international ■ Permanent exposure

Table 6-17: Criteria for Noise Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	■ Existing ambient noise is already under stress and/ or public health is very sensitive to change (children, schools). ■ Receptors include educational/ religious/ medical facilities within 500 m of project site ■ Internationally designated sites and/or areas of specific ecological interest within 500 m of project site
Medium	■ Existing noise quality conditions already shows some signs of stress and/ or supports ecological resources that could be sensitive to change in noise quality (protected species, migratory birds, protected areas). ■ Receptors include residential and recreational space' within 500 m of project site ■ Nationally designated sites and/or areas of specific ecological interest within 500 m of project site
Low	■ Existing noise quality condition is good and the ecological resources that it supports are not sensitive to a change in noise quality. ■ Receptors include industrial, retail or transient receptors within 500 m of project site ■ Locally designated sites; and/or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team) within 500 m of project site.

6.3.2.3.2 Impact Significance

As mentioned in ***Section 4.4.6***, the main activities of local residents are farming and animal husbandry, and some of these activities occur less than 200 m from the drilling location. The nearest residential area of the power plant site is in Margahayu Sub-village, Kalianyar Village, which is about 600 m from one of the drilling locations (Well Pad IJN-8). From baseline data collected for the Project (refer to ***Section 4.2.3***), ambient noise levels are shown to be generally in accordance with the standard with some exceedances reported during the night-time. Given the above, the receptor sensitivity is assessed to be **medium**.

The resultant noise levels at receptor locations due to the proposed Project during construction and operation phases are summarised in ***Table 6.18*** below:

Table 6.18 Resultant Noise Level during Construction Phase

Location ID	Baseline Noise Level (dBA)		Incremental Noise Level (dBA)	Predicted or Resultant Noise Levels (dBA)		Standard dBA (MoE Dec.#48/1996)
	Daytime	Nighttime	Day/Night-time	Daytime	Nighttime	Day/Night-time
AN-01	63	44	8.76	63.00	44.00	55
AN-02	46	49	20.82	46.01	49.01	70
AN-03	45	46	11.51	45.00	46.00	70

The above table indicates that the predicted or resultant noise level during construction phase varies between 45.0 dBA (AN-03) to 63.0 dBA (AN-01) during daytime and 44.0 dBA (AN-01) to 49.0 dBA (AN-02) during Nighttime. The resultant levels when compared with baseline levels table indicates the following:

- All incremental noise levels are well within the prescribed standards.
- The predicted or resultant noise levels suggests that the noise due to the proposed operation will reach to background levels.
- The predicted or resultant (baseline + predicted) noise levels for construction and operation phases are within the prescribed standards except at AN-01 (village settlement) where it is exceeding (63 dBA) during daytime. This exceedance is due to the baseline noise level during daytime (63 dBA).
- The changes to the existing baseline levels from the proposed project i.e., resultant noise at the residential location AN-01 from the proposed project will be insignificant (change less than 1 dBA).
- The maximum incremental noise levels during construction and operation phases are found to be occurring close to Site boundary.

The impacts will occur intermittently throughout the operational phase which is scheduled to last for a maximum of 21 months. As the impact magnitude is considered to be **small** based on the duration of drilling and the use of explosives.

As such, the impact significance is assessed to be **minor**.

6.3.2.4 Additional Mitigation Measures

A number of additional measures have been proposed:

- Project activity noise monitoring will be required for noise generation at main Project Site to ensure the standards in ***Section 2.4*** are met;

- Conduct ambient noise monitoring at two sensitive receptors (households nearest to the drilling location at Pad 8). Monitoring should be conducted monthly during the construction phase during drilling to ensure no changes from ambient baseline conditions;
- Where necessary, install acoustic enclosures for equipment casing radiating noise;
- Ensure equipment is maintained as per operating standards;
- Record all noise complaints under the Grievance Mechanism and follow up by identifying the causes and taking appropriate measures to reduce noise in a timely manner;
- Normal working hours of the contractor should be in line with Indonesian legal requirements;
- Limit the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community. Shut down or throttled down between work periods for machines and construction plant items (e.g. trucks) that may be in intermittent use;
- Reduce the number of equipment operating simultaneously as far as practicable;
- Orientate equipment known to emit noise strongly in one direction so that the noise is directed away from receptors as far as practicable;
- Any activity that has the potential to generate impulsive noise will be avoided where possible when in close proximity to noise sensitive receptors;
- During the works, unnecessary noise due to idling diesel engines and fast engine speeds will be avoided when lower speeds are sufficient;
- Prepare a Noise and Vibration Management Plan covering the land preparation, drilling and blasting activities. This plan should include details of monitoring required as well as mitigation measures, and roles and responsibilities of the EPC and MCG;
- Blasting activities should be agree with and communicated to the local communities prior to commencing. Timely notification of blasting activities should be provided to local communities; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.3.2.5 Residual Impact Significance

Based on the above additional measures, the residual impact significance is expected to remain at **minor** for construction (***Table 6-19***).

Table 6-19: Impact Assessment for Ambient Noise: Construction Phase

Impact Significance				
Impact Nature	Negative	Positive		Neutral
	Potential noise impacts would be considered to be adverse (negative).			
Impact Type	Direct	Indirect		Induced
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional		International

Impact Significance					
Impact Scale	The scale of the impact is likely to be up to 350 m from the construction site boundary. Impacts are likely to be direct, localised, and short-term (intermittent within the 21 month Construction Phase).				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the pipelines / power plant / transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.3 *Impact on Water Resources and Quality*

6.3.3.1 *Potential Impacts*

The following activities can have impacts to surface and groundwater quality during the Construction Phase of the Project.

- Land Preparation / Earthworks;
- Installation of the transmission line;
- Construction of Power Plant;
- Well drilling (exploration);
- Pipeline laying; and
- Transport of materials and wastes.

The construction and drilling activities associated with the Project may result in negative impacts to water resources within the Project footprint. Potential impacts could include changes to downstream surface runoff patterns; over-extraction of surface water from a nearby river; and changes in surface and groundwater quality. ***Table 6-20*** summarizes the activities and potential impacts associated with the Project.

Table 6-20: Summary of Relevant Project Activities and Potential Key Impacts on Water Resources

Project Activity	Key Potential Impact
■ Access improvements andtransportation ■ Drill site preparation (i.e., earthwork,clearing, and grubbing works) ■ Drill rig installation and drilling ■ Exploratory blow testing ■ Injection of geothermal fluids	■ Potential over-extraction of watercourses ■ Changes to downstream surface runoffpatterns ■ Silting of watercourses ■ Potential degradation of surface and groundwater quality due to accidental ■ spills/releases or geothermal fluids

6.3.3.1.1 Drilling Fluids

Drilling fluids would be temporarily stored in the mud pond while the injection well is constructed. Drilling and injection works have the potential to affect groundwater quality if geothermal liquid, wash water, mud, and drill cuttings (collectively referred to as "process wastewater") are not managed properly.

6.3.3.1.2 Earth Works

Surface water hydrology can be affected during the construction activities for the wastewater treatment plant and its associated facilities. Construction activities can result in compaction of soils and an increase in impermeable (or slowly permeable) surfaces. The subsequent increase in surface runoff may in turn increase the risk of flooding. Additionally, certain activities may encourage soil erosion and increase the sediment loads of nearby streams.

Construction activities may also have significant impacts on groundwater hydrology and quality. The site may need to be drained to provide suitable conditions for the engineering works to occur, resulting in temporary changes to ground flow. Also, contaminated soil, if present, from a previous land use may be disturbed during construction works, causing pollutants such as heavy metals to enter ground and surface waters.

6.3.3.1.3 Sedimentation

The construction activities will include excavation and handling of substantial quantities of soil. The generation of sediment-laden run off could be transferred to the nearby freshwater bodies, which could increase total suspended solids and turbidity in receiving waters.

6.3.3.1.4 Waste, Chemicals, Fuel, and Oils Storage, Handling and Disposal

Construction activities can generate large amounts of waste materials that then need to be disposed of. Construction waste includes waste that is generated during construction activities (such as packaging, or the products of demolition) and materials that are surplus to requirements (due to over-ordering or inaccurate estimating).

During the construction phase, waste, chemicals, fuel, and oils storage, handling, and disposal, have the potential to cause surface water and groundwater contamination through direct release or from contaminated storm-water runoff.

6.3.3.1.5 Domestic Wastewater

Domestic-type wastewater will arise from the construction workforce. Black and grey water will arise from the construction workforce and from facilities serving site workers. It is estimated that an average of 450 workers (***Section 3.3.5***) will be working on-site during the construction phase of the Project. This is the number of workers for Phase 1 and is therefore a conservative estimate of the impacts to water quality. With an assumed sewage generation rate of 0.19 m^3 per worker per day (Hong Kong Environmental Protection Department, 2005), up to about 85 m^3 of sanitary wastewater will be generated per day, mostly from the labour camp and site office. Mismanagement of wastewater would have the potential to result in contamination of surface waters, which may result in localised land/ecological contamination, impacts to health, odour nuisance and attraction of vermin.

6.3.3.1.6 Wastewater Management

Wastewater discharge and runoff during the construction phase may lead to contamination of freshwater sources if not managed appropriately. During the construction phase, there are a number of anticipated wastewater sources.

Wastewater will be generated from the site offices, workers' camp and any other mobile toilet used on site. Grey water will be generated from canteens and hand wash stations. Periods of high rainfall could lead to overflow, or rapid through-flow, of the effluent to surface water prior to its full digestion in the septic tanks. Raw sewage can affect surface water quality by promoting the growth of algae and delivering pathogens that may be harmful to human and ecological receptors. Sanitary wastewater is generally characterized as having a high concentration of solids (suspended and dissolved), biochemical oxygen demand (BOD) and chemical oxygen demand (COD), nutrients (nitrogen, ammonia) and faecal coliform counts. The organic substances (e.g. hydrocarbon, protein) are decomposed in water, and the decomposition of organic matter will reduce the oxygen content dissolved in water.

6.3.3.1.7 Dewatering / Commissioning

During construction activity, dewatering may be carried out, to collect the water to be pumped or permitted to flow by gravity to discharge or storage areas. These construction activities could cause runoff of unconsolidated sediments during rainfall. The generation of sediment-laden run off could be transferred to the nearby freshwater bodies, which could increase total suspended solids and turbidity in receiving waters.

6.3.3.2 Embedded/In-Built Controls

The following in built mitigation measures have been provided in line with GIIP:

- Permit for pollution discharge facilities and installation as per Indonesia Standards;
- Installation and operation of septic tank and sedimentation ponds;
- Car wash at the site shall be prohibited;
- Prevention of erosion by providing diversion channel; and
- Installation of sewer and septic tank which is connected to wastewater treatment facilities.

6.3.3.3 Impact Evaluation and Significance

6.3.3.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for water has been provided in ***Table 6-21*** and ***Table 6-22***, respectively.

Table 6-21: Criteria for Impact Magnitude for Assessment of Impact to Water

	Extent / Duration / Scale / Frequency
Large	Change in water quality over a large area that lasts over the course of several months with quality likely to cause secondary impacts on marine ecology; and/or routine exceedance of benchmark effluent discharge limits.
Medium	Temporary or localised change in water quality with water quality returning to background levels thereafter and/or occasional exceedance of benchmark effluent discharge limits.
Small	Slight change in water quality expected over a limited area with water quality returning to background levels within a few metres and/or discharges are well within benchmark effluent discharge limits.
Negligible	Immeasurable, undetectable or within the range of normal natural variation.

Table 6-22: Criteria for Water Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Existing water quality is already under stress and/ or the ecological resources it supports are very sensitive to change (secondary ecological or health impacts are likely).

Medium	Existing water quality already shows some signs of stress and/ or supports ecological resources that could be sensitive to change in water quality.
Low	Existing water quality is good and the ecological resources that it supports are not sensitive to a change in water quality.

6.3.3.3.2 Impact Significance

The impact on surface and ground water during construction is related to drilling and wastewater discharges and waste management from the workers camps and construction sites.

Water will be extracted from nearby river as per the current operating procedure of the Site.

The impact will be localised and short-term and with the above mentioned industry practice mitigation measures in place, the magnitude of the impact is considered to be **medium**.

The receptor sensitivity is considered **medium** given that nearby water sources are not polluted and are not used for drinking and domestic use.

The impact significance associated with surface water and groundwater during the construction is considered **moderate**.

6.3.3.4 Additional Mitigation, Management, and Monitoring Measures

A number of additional measures have been proposed:

- All discharges will be in compliance with legislation standards in ***Section 2.4***;
- Conduct monthly water quality sampling at least at one location upstream of water intake and one location downstream of Project influence for the normal suite of parameters, including the anticipated chemical constituents of the geothermal liquids; For groundwater quality sampling, construct upstream and downstream monitoring wells.
- Earthworks to form the final surfaces should be followed up with surface protection and drainage works to prevent erosion caused by rainstorms;
- All drainage facilities and sediment control structures will be inspected on a regular basis and maintained to confirm proper and efficient operation at all times and particularly during rainstorms. Deposited silt and grit will be removed regularly;
- Reuse treated storm water onsite where possible to meet some of the water needs of the Project.
- Inject geothermal fluids (brine) in injection wells, well below surface aquifer units;
- Provide sufficient process wastewater storage to avoid the release of any untreated water into surface waters;
- Sewage will be discharged into an adequately sized leak proof septic tank;
- Grey water from showers and canteen kitchens (including that from basins, sinks and floor drains) should be discharged into soaking pit equipped with grease traps. Grease will be treated as oil waste;
- Domestic, construction, and hazardous waste as well as sewage sludge will be disposed of by a registered and licensed waste vendor to approved landfill and / or treatment facility;
- Storage of chemicals, fuel, and oil in adequately bunded impervious areas, as per international bunding and storage requirements;
- Debris and refuse generated on-site should be collected, handled, and disposed of properly to avoid entering the receiving waters. Stockpiles of cement and other construction materials should be kept covered when not being used; and

- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.3.3.5 Residual Impact Significance

Based on implementation of the proposed mitigation and management measures, it is assessed that the water quality impact will be reduced to **Minor** (***Table 6-23***).

Table 6-23: Impact Assessment for Surface Water and Groundwater Quality: Construction Phase

Impact Significance					
Impact Nature	Negative		Positive		Neutral
	Surface water and groundwater quality and quantity impact from the construction activities is negative.				
Impact Type	Direct		Indirect		Induced
Impact Duration	Temporary	Short-term	Long-term		Permanent
Impact Extent	Local		Regional		International
Impact Scale	The scale of the impact is likely to be up to a few kilometres from the construction site boundary and in the abstraction location. Impacts are likely to be direct, localised, and long-term (intermittent within the 21 month Construction Phase).				
Frequency	Impacts will arise intermittently from construction activities.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low		Medium		High
Impact Significance	Negligible	Minor	Moderate		Major
Residual Magnitude	Negligible	Small	Medium		Large
Residual Impact significance	Negligible	Minor	Moderate		Major

6.3.4 Impact on Soil Environment

6.3.4.1 Potential Impacts

The following activities can have impacts to soil quality and topography during the Construction Phase of the Project.

- Land preparation and civil works;
- Installation of the transmission line;
- Drilling of wells;
- Power plant construction; and

- Storage, handling and disposal of waste and materials.

The construction and operation activities associated with the Project—including land clearance, grading, excavated material disposal, and placement—have the potential to impact the geomorphology, landscape, and soils of the Project area. Potential impacts could include soil erosion and soil contamination. In addition, the construction of well pads, and auxiliary facilities (e.g., water storage pond) would result in the loss of land with soils used, or that are suitable for use, for forest and agro-forest activities. A summary of the Project activities and potential impacts, by phase, is provided in *Table 6-24*: Summary of Relevant Project Activities and Potential Key Impacts on Soils.

Table 6-24: Summary of Relevant Project Activities and Potential Key Impacts on Soils

Project Activity	Key Potential Impact
■ Land/vegetation clearance and grubbing ■ Topsoil removal and the nature of the underlying soils and rock that would be exposed ■ Excavation ■ Excavated material placement ■ Feeder road improvements ■ Landscape grading and re-contouring ■ Soil stabilization and replacement ■ Heavy equipment movement during earthwork activities ■ Wastewater discharges from well pads during drilling and testing phases ■ Laying pipeline for water supply	■ Potential increase in soil erosion (i.e., gully erosion) ■ Loss of land/soils suitable for agriculture ■ Potential contamination of soils due to accidental spills/releases ■ Potential landslides due to steep slopes

Soil erosion/landslides, soil contamination, and loss of land/soils are potential negative impacts on soils of the Project area.

The excavated material of the well pads would be disposed or reused offsite in accordance with environmental acts and regulations of Indonesia and waste management guidelines established by WBG. Earthwork activities would also include the excavation of mud ponds and geothermal fluid ponds within the drill pad area, injection pads, and a water storage pond and some rudimentary drainage structures outside. Other activities that may cause soil erosion are associated with runoff from roads (i.e., parallel to the roads or from culverts).

Earthworks and exploration drilling activities would involve the use of equipment/vehicles that use fuels and lubricants, and generate some hazardous materials. Localized soil contamination can occur if this equipment does not receive proper and frequent maintenance or if a suitable area is not assigned for storage of hazardous materials, lubricants, and fuels.

Oil, chemical and, waste from construction site or vehicle during construction phase can also cause soil contamination. Sources of pollutions are likely to be similar to the ones identified in the source of impacts to surface water – refer to ***Section 6.3.3.1***.

6.3.4.2 Embedded/In-Built Controls

The controls to be implemented for the Project will include the following:

- Reuse of topsoil as backfill wherever possible;
- Schedule activities (as far as possible) to avoid extreme weather event such as heavy rainfall and high winds;
- Re-vegetate areas with temporary land cover, conducting progressive rehabilitation;
- Minimise the amount of soil handling;

- Stabilise exposed areas;
- Cover or spray water on stockpiles of excavated material or backfill;
- Reduce or prevent sediment runoff through use of settlement ponds, silt fences;
- Demarcate routes for movement of heavy vehicles;
- Strip and placing soils when dry, and not when wet; and
- Restrict the height of topsoil stockpiles to minimise compaction, restricted to 2 m.

6.3.4.3 Impact Evaluation and Significance

6.3.4.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for soil has been provided in ***Table 6-25*** and ***Table 6-26***, respectively.

Table 6-25: Criteria for Impact Magnitude for Assessment of Impact to Soil

	Extent / Duration / Scale / Frequency
Large	Change in soil quality over a large area that lasts over the course of several months with quality likely to cause secondary impacts on ecosystems and nearest household or community. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area, ecosystem or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	The change in soil quality exceeds the expected. Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Soil quality changes correspond to the expected range. Change remains within the range commonly experienced within the household or community.

Table 6-26: Criteria for Soil Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Existing soil quality is already under stress and/ or the ecological resources it supports are very sensitive to change (secondary ecological or health impacts are likely).
Medium	Existing soil quality already shows some signs of stress and/ or supports ecological resources that could be sensitive to change in soil quality.
Low	Existing soil quality is good and the ecological resources that it supports are not sensitive to a change in soil quality.

6.3.4.3.2 Impact Significance

All metals, pesticides, PCB, and Total Petroleum Hydrocarbon contained in the soil are within the regulation limit and present in low concentrations suggesting limited soil contamination in the Project Area. As such, the receptor sensitivity is considered to be **medium**.

Any storm water and run-off from the site will be managed. Impacts to soil during construction will be short-term and localised. The impacts are expected to be of **medium** magnitude.

As such, significance of impacts to soil quality is considered **moderate**.

6.3.4.4 Additional Mitigation, Management, and Monitoring Measures

A number of additional measures have been proposed:

- Appropriate management of black and grey wastewater as well as management, storage and disposal of waste as per good international industry practices;
- Appropriate management of chemicals by implementing good international industry standards;
- Store chemicals, fuel, and oil in adequately sheltered and impervious bund as per international best practices;
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report);
- Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers should be surrounded by bunds to contain the volume being stored in case of accidental spillage; and
- Develop and implement a Soil Erosion and Sediment Control Plan including control measures such as the use of silt fences, installation of temporary and permanent drainage systems to manage water runoff from the construction areas, and use of sediment basins;
- Use appropriate best management practices during clearance activities, to the extent practicable, such as: schedule construction activities during the dry season, especially on steeply sloped areas; limit clearing and disturbance to the approved work zone area only; minimize the area of bare soil at any one time within the approved work zone as much as possible; and progressively stabilize and revegetate disturbed areas;
- Reuse excavated material for slope stabilization of the exploration drilling and injection pads; and
- Installation of skips and bins:
  - Skips and bins should be strategically placed within the campsite and construction site.
  - The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour.
  - The skips and bins at both the construction campsite and construction site should be emptied regularly to prevent overfilling.
  - Disposal of the contents of the skips and bins should be done at an approved disposal site.

6.3.4.5 Residual Impact Significance

Based on implementation of the proposed mitigation and management measures, it is assessed that impact significance to soils will reduce to **Minor** (***Table 6-27***).

Table 6-27: Impact Assessment for Soil and Topography: Construction Phase

<table>
<tr><th colspan="5">Impact Significance</th></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td colspan="2">Neutral</td></tr>
<tr><td colspan="4">Soil quality impact from the construction activities is negative.</td></tr>
<tr><td>Impact Type</td><td>Direct</td><td>Indirect</td><td colspan="2">Induced</td></tr>
<tr><td>Impact Duration</td><td>Temporary</td><td>Short-term</td><td>Long-term</td><td>Permanent</td></tr>
<tr><td>Impact Extent</td><td>Local</td><td>Regional</td><td colspan="2">International</td></tr>
</table>

Impact Significance

Impact Scale	The scale of the impact is likely localised to the construction site boundary. Impacts are likely to be direct, localised, and long-term (intermittent within the 21 month Construction Phase).							
Frequency	Impacts will arise continuously from construction activities.							
Impact Magnitude	Positive	Negligible	Small	Medium	Large			
Resource Sensitivity	Low	Medium	High					
Impact Significance	Negligible	Minor	Moderate	Major				
Residual Magnitude	Negligible	Small	Medium	Large				
Residual Impact significance	Negligible	Minor	Moderate	Major				

6.3.5 *Impact on Landscape and Visual*

A Landscape and Visual Impact Assessment Study was conducted for the Project and is attached as ***Appendix I***. The assessment concludes that the Project will have minor to moderate impacts on landscape and visual resources with the implementation of mitigation and management measures. Although the area is characterized by numerous tourist sites, it is considered to have good capacity to absorb the type of change envisaged by the Project, as geothermal power plants are generally compatible with volcanic landscapes. Intangible cultural heritage is not expected to be impacted by the Project as the construction and operation activities do not affect:

- areas with significant spiritual, cultural or religious importance; cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources; or
- cultural value placed on the aesthetic value provided by landscapes, natural landmark; information derived from ecosystems used for intellectual development, culture, art, design, and innovation or ornamental resources.

The stakeholders consulted during the ESIA process did not raise any concerns related to tangible or intangible assets with some community members perceiving the Project to have a positive impact on tangible and intangible cultural heritage by continuing the existing community development program, especially in providing assistance to renovate worship facilities (mosques).

6.3.5.1 *Potential Impacts*

6.3.5.1.1 Landscape

Landscape sensitivity can be assessed by the ability of a particular landscape character to absorb aesthetic alterations. Landscape impacts may occur upon a landscape characteristic as a direct result of the presence of the Project within an area of a particular landscape character. The area identified for the Project has a predominant abundance of cropland and grassland.

The presence of the transmission line towers is likely to cause impacts to landscape value. The Project key activities that are likely to have negative impacts on landscape include:

- Site preparation, excavation and filling works;
- Installation of the transmission line;

- Power plant construction; and
- Storage, handling and disposal of waste and materials.

The construction and operation activities associated with the Project—including land clearance, grading, excavated material disposal, and placement—have the potential to impact the landscape.

6.3.5.1.2 Visual

Visual impacts refer mainly to the visual character changes of available views resulting from project development, such as:

- obstruction of existing views;
- removal of screening elements, thereby exposing viewers to unsightly views;
- the introduction of new elements into the views;
- and intrusion of foreign elements into the viewshed of landscape features.

The presence of the towers for the transmission line is likely to cause impacts to visual.

6.3.5.2 Existing Controls

The controls to be implemented for the Project will include the following:

- The extent of the construction areas should be limited where possible to minimise impact to surrounding area; and
- Cut and fill slopes as well as areas disturbed by construction activity are suitably top soiled and vegetated / covered as soon as is possible after final shaping.
- Demarcate Project boundaries and minimize areas of surface disturbance;
- Where possible locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation;
- Maintenance of construction site – good housekeeping on site to avoid litter and minimize waste.
- Existing tracks/roads should be used for access where possible;
- Minimize night lighting in order to guarantee the minimum safety level;
- Foreseen within the environmental management system, the preparation of a restoration management plan including indigenous species replanting, construction yards landscaping and rehabilitation; and
- Structures should have a non-reflective finish and the colour should be appropriate in order to merge itself as much as possible within the landscape.

6.3.5.3 Impact Evaluation and Significance

The assessment of impacts on landscape and visual amenity was undertaken in accordance with accepted methodologies derived from best practice guidelines.

Impact significance for landscape and visual amenity is generally derived on the basis of the following main factors:

- The quality/importance of the landscape/visual amenity as a resource/function that is potentially affected;
- The sensitivity of the landscape/visual amenity towards Project activities;
- The magnitude of change to the receiving landscape and visual amenity as a result of the Project.

6.3.5.3.1 Criteria for Assessing Impact Significance - Landscape

The impact magnitude and receptor sensitivity criteria for landscape has been provided in ***Table 6-28*** and ***Table 6-29***, respectively.

Table 6-28: Landscape Magnitude of Effect Criteria

	Extent / Duration / Scale / Frequency
Large	A clearly evident and frequent /continuous change in landscape characteristics affecting an extensive area.
Medium	A moderate change in landscape characteristics, frequent or continuous, and over a wide area, or a clearly evident change either over a restricted area or infrequently perceived.
Small	A small change in landscape characteristics over a wide area or a moderate change either over a restricted area or infrequently perceived.
Negligible	An imperceptible, barely or rarely perceptible change in landscape characteristics.

Table 6-29: Landscape Sensitivity Criteria

Category	Designation / Importance / Vulnerability
High	A landscape protected by a regional (structure plan) or national designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.
Medium	A landscape protected by a structure plan or national policy designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.
Low	A moderately valued landscape, perhaps a locally important landscape, or where its character, land use, pattern and scale may have the capacity to accommodate a degree of the type of change envisaged.

6.3.5.3.2 Impact Significance - Landscape

The potential impacts from the construction phase likely to have negative impacts on landscape, will include mainly vegetation clearance and site preparation (excavation) for both the geothermal plant and the transmission line construction. Impacts will be limited to areas adjacent to the Project.

Although the area is characterized by numerous tourist sites, it is considered to have good capacity to absorb the type of change envisaged by the Project, which is why the sensitivity of the landscape resource (LCU A and LCU B) is expected to be **medium**. Intangible cultural heritage is not expected to be impacted by the Project as the construction and operation activities do not affect natural spaces or species with spiritual, cultural or religious importance; cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources; cultural value placed on the aesthetic value provided by landscapes, natural landmark; information derived from ecosystems used for intellectual development, culture, art, design, and innovation or ornamental resources. The stakeholders consulted during the ESIA process did not raise any concerns related to tangible or intangible assets with some community members perceiving the Project to have a positive impact on tangible and intangible cultural heritage by continuing the existing community development program, especially in providing assistance to renovate worship facilities (mosques). The magnitude of change of landscape would be **medium**.

As such, the significance of impacts due to change in landscape is considered to be **moderate.**

6.3.5.3.3 Criteria for Assessing Impact Significance - Visual

The impact magnitude and receptor sensitivity criteria for visual amenity has been provided in ***Table 6-28*** and ***Table 6-29***, respectively.

Table 6-30: Visual Magnitude of Effect Criteria

	Extent / Duration / Scale / Frequency
Large	Major changes in view at close distances, affecting a substantial part of the view, continuously visible for a long duration, or obstructing a substantial part or important elements of the view.
Medium	Clearly perceptible changes in views at intermediate distances, resulting in either a distinct new element in a significant part of the view, or a more wide-ranging, less concentrated change across a wider area.
Small	Minor changes in views, at long distances, or visible for a short duration, perhaps at an oblique angle, or which blends to an extent with the existing view.
Negligible	A change which is barely visible, at very long distances, or visible for a very short duration, perhaps at an oblique angle, or which blends with the existing view.

Table 6-31: Visual Sensitivity Criteria

Category	Designation / Importance / Vulnerability
High	Larger numbers of viewers and/or those with proprietary interest and prolonged viewing opportunities such as residents and users of attractive and well-used recreational facilities. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being high.
Medium	Small numbers of residents and moderate numbers of visitors with an interest in their environment. Larger numbers of recreational road users. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being medium.
Low	Small numbers of visitors with interest in their surroundings. Viewers with a passing interest not specifically focussed on the landscape e.g. workers, commuters. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being low.

6.3.5.3.4 Impact Significance - Visual

When determining the significance of visual effects, the following is taken into account:

- Large scale changes which introduce new discordant or intrusive elements into the view are more likely to be significant than small changes or changes involving features already present in the view;
- Changes in views from recognized and important viewpoints or amenity routes are likely to be more significant than changes affecting less important paths and roads; and
- Changes affecting large numbers of people are generally more significant than those affecting a relatively small group of users. However, in wilderness landscapes the sensitivity of the people who use the areas may be very high and this will be reflected in the significance of effect.

The visual impact is a product of the magnitude of change to the existing baseline conditions, the landscape context, and the sensitivities of Visual Sensitive Receptors (VSRs).

The viewshed analysis shows that the proposed towers have the potential to be visible in the nearby areas, although not continuously due to the variability of the landscape for the area surrounding the Project and the presence of vegetation.

Specific considerations were made for each VSR, and the impact significance, receptor sensitivity, and impact magnitude is summarized in ***Table 6-32***.

Table 6-32: Summary of Visual Impact

VSR	Site	Sensitivity of receptor	Magnitude of visual effect	Significance of visual effect
VSR01	Near the Karona Berg Homestay and Cafe	Medium	Medium	Moderate
VSR02	In a field to the right of to the Gantasan Bike Park	Medium	Small	Minor
VSR03	On the Jl. Kawah Ijen road, after the Erek Erek Geoforest	Low	Small	Negligible
VSR04	At the Bukit Harapan, IJEN, on the road	Medium	Medium	Moderate
VSR05	After the Air Terjun Ijen, on the road to the Plant	Medium	Negligible	Negligible
VSR06	In the Pal Pakis town	Medium	Small	Minor
VSR07	On the road near Masjid Nur Rohmah	Low	Medium	Minor
VSR08	On the road outside the Banyuwangi Substation	Low	Negligible	Negligible
VSR09	In a field near Warung Pangklang jpl 16 cafe	Low	Negligible	Negligible
VSR10	On the road to SD Negeri Kalianyar Dsn Curah Macan school	Low	Negligible	Negligible
VSR11	On the road to the Plant, after VSR 5	Low	Small	Negligible
VSR12	On the road, about 2 km from the SD Negeri Kalianyar Dsn Curah Macan school	Low	Small	Negligible
VSR13	On the road to the Plant, before Pos 3 Margahayu office	Medium	Negligible	Negligible
VSR14	Near the creek at Air Terjun Ijen	Medium	Negligible	Negligible
VSR15	On the road near the creek and VSR 14	Medium	Negligible	Negligible
VSR16	At the Bondowoso sign near Warkop Sederhana café	Medium	Medium	Moderate
VSR17	At the Injection Wellpad 2 site	Low	Small	Negligible
VSR18	On the road near Vicky AMS Retail 3	Medium	Medium	Moderate

6.3.5.4 Additional Mitigation Measures

6.3.5.4.1 Landscape Value

In order to mitigate the landscape impacts, there are different actions that should be considered, especially during the construction phase, such as:

- Demarcate construction boundaries and minimize areas of surface disturbance;
- Where possible, locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation;
- For the construction site maintenance, conduct good housekeeping on site to avoid litter and minimize waste;
- Use existing tracks/roads for access, where possible; and
- Within the environmental management system, prepare a restoration management plan including replanting indigenous species, and landscaping and rehabilitating construction yards.

6.3.5.4.2 Visual

The following identifies mitigation measures to be applied for visual impacts, including:

- Where possible, locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation;
- For the construction site maintenance, conduct good housekeeping on site to avoid litter and minimize waste;
- Minimize night lighting while guaranteeing the minimum safety level;
- Use of materials that will minimize light reflection should be used for all Project components; and
- Existing vegetation should be retained to the greatest extent possible. Vegetation should be retained along roads, and other Project infrastructure.

6.3.5.5 Residual Impact Significance

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would be ***Minor*** to ***Moderate*** (***Table 6-33***).

Table 6-33: Residual Impact Assessment for Landscape and Visual

<table>
<tr><th colspan="21">Impact Significance</th></tr>
<tr><td rowspan="2">Impact Nature</td><td colspan="7">Negative</td><td colspan="7">Positive</td><td colspan="6">Neutral</td></tr>
<tr><td colspan="20">Landscape and topography impact from the construction activities is negative.</td></tr>
<tr><td>Impact Type</td><td colspan="7">Direct</td><td colspan="7">Indirect</td><td colspan="6">Induced</td></tr>
<tr><td>Impact Duration</td><td colspan="5">Temporary</td><td colspan="5">Short-term</td><td colspan="5">Long-term</td><td colspan="5">Permanent</td></tr>
<tr><td>Impact Extent</td><td colspan="7">Local</td><td colspan="7">Regional</td><td colspan="6">International</td></tr>
<tr><td>Impact Scale</td><td colspan="20">Impact scale is considered small given the construction activities will only be mainly visible to the visual sensitive receivers within the Project Area of Influence.</td></tr>
<tr><td>Frequency</td><td colspan="20">Impacts will arise continuously from construction related activities</td></tr>
<tr><td>Impact Magnitude</td><td colspan="4">Positive</td><td colspan="4">Negligible</td><td colspan="4">Small</td><td colspan="4">Medium</td><td colspan="4">Large</td></tr>
<tr><td>Resource Sensitivity</td><td colspan="7">Low</td><td colspan="7">Medium</td><td colspan="6">High</td></tr>
<tr><td>Impact Significance</td><td colspan="5">Negligible</td><td colspan="5">Minor</td><td colspan="5">Moderate</td><td colspan="5">Major</td></tr>
<tr><td>Residual Magnitude</td><td colspan="5">Negligible</td><td colspan="5">Small</td><td colspan="5">Medium</td><td colspan="5">Large</td></tr>
<tr><td>Residual Impact significance</td><td colspan="5">Negligible</td><td colspan="5">Minor</td><td colspan="5">Moderate</td><td colspan="5">Major</td></tr>
</table>

6.3.6 Impact on Biodiversity

6.3.6.1 Potential Impacts

The following activities can have impacts on terrestrial flora during the Construction Phase of the Project.

- Site preparation, excavation and filling works;
- Drilling activities;
- Installation of the transmission line;
- Night l
- lighting;
- Transport and materials and wastes.

Impacts to biological resources can be divided into two broad categories: direct and indirect. Direct impacts consist of physical disturbance or damage to a habitat or species. Examples include, but are not limited to:

- Disturbance or loss of habitat;
- Species disturbance and displacement;
- Direct Mortality or injury to individuals (particularly species of conservation significance);
- Temporary and permanent barrier creation, edge effects and fragmentation;
- Direct mortality to the aquatic fauna due to water withdrawals at the water intake location; and
- Decrease available aquatic habitat and fragment existing aquatic habitat due to water intake.

Indirect impacts occur when Project-related activities affect biological resourcesin a manner other than a direct loss of the resource. Examples include, but are not limited to:

- Temporary disturbance of wildlife, leading to displacement of wildlife from suitablehabitats;
- Changes in an individual's or population's habitat use or life history pattern due to disturbance from increased noise, vibration, lighting, human activity, visual disturbance, or transportation activity;
- Increased competition for resources or habitat due to displacement ofindividuals from the affected area into the territory of other animals;
- Degradation of water quality leading to impacts on aquatic biota; and
- Increased hunting/fishing pressure due to human population influx.

Direct and indirect impacts to biodiversity can occur during the following Project activities:

- Access improvements and transportation, which may result in vegetationloss, noise, and vehicular mortality;
- Drill site preparation, which would result in vegetation loss, noise, and wildlife disturbance and displacement;
- Drill rig installation and drilling, which would create noise and air emissions and related disturbance of wildlife and require water abstraction;
- Exploratory testing, which would create noise and air emissions; and
- Night activities that require artificial light could interfere light cycles of nocturnal species.

Table 6-34 provides a summary of the potential sources of direct and indirect Project impacts on terrestrial and aquatic biological resources.

Table 6-34: Summary of Potential Project Impacts on Terrestrial and Aquatic Biological Resources

Impact Type	Project Activities
Direct	<u>Terrestrial Impacts</u> ■ Ground works would result in the direct loss and disturbance of vegetation and wildlife habitat and may introduce or spread invasive and exotic plant species within the road improvement/expansion locations, exploration well pads, and injection pads and immediate surrounding areas. ■ The use of heavy machinery during construction and increased vehicular traffic along access roads could result in direct mortality or injury of wildlife species. ■ The use of heavy machinery during construction and well drilling may generate localized vibrations sufficient to harm ground-dwelling terrestrial biota. ■ Project-related vehicular traffic may cause vehicular-related wildlife mortality or injury. ■ Artificial lights from the projects could interfere night activities of nocturnal species. <u>Freshwater Aquatic Impacts</u> ■ Installation of the water intake structure has the potential to injure or kill aquatic fauna. ■ Entrainment in the water intake has the potential to kill larval aquatic organisms. ■ Water withdrawals from the Kali Belawan River have the potential to decrease available aquatic habitat and fragment existing aquatic habitat in the Kali Belawan River.
Indirect	<u>Terrestrial Impacts</u> ■ Project-related vehicular traffic and site preparation activities may create dust, the accumulation of which can inhibit vegetative growth. ■ Operation of the drill rig and steam blow testing would create noise, causing wildlife displacement from the drill sites and the surrounding vicinity, which would modify wildlife use of the affected area and temporarily fragment habitat. ■ Operation of the drill rig and related drilling and testing activities would generate air emissions, the accumulation of which could inhibit growth of vegetation or adversely affect susceptible wildlife resources. ■ Project-related activities would indirectly result in the temporary degradation of habitat quality within the protected areas located immediately adjacent to the pad sites including Kawah Ijen Nature Reserve. <u>Freshwater Aquatic Impacts</u> ■ Unplanned events such as spills or leaks of hazardous materials or brine could degrade water quality and cause stress or mortality of aquatic organisms. ■ Project-related influx of workers and improved road access to the Project Site could increase hunting or fishing pressure and mortality of terrestrial and aquatic biota.

6.3.6.2 Embedded/in-built Controls

Impacts to water, soil, air, and noise (as assessed in ***Section 6.3.1 to 6.3.4***) can have indirect impacts to biodiversity. The controls proposed under these sections are also applicable here.

6.3.6.3 Impact Evaluation and Significance

6.3.6.3.1 Criteria for Assessing Impact Significance

The biodiversity receptors used in this assessment have the following importance ratings:

- Terrestrial Vegetation and Habitat – Medium importance because of the disturbed nature of the majority of the vegetation and habitats in the Project Area, the dominance of common and widespread vegetation species, and the habitat's high regenerative capacity. However, some portions of the impacted area will be natural secondary forest adjacent with the protected areas of Kawah Ijen and potential habitat for the critical habitat trigger species.
- Terrestrial Wildlife – High importance because of the relatively high diversity of species that occur in and around the Project Area, including species listed as Endangered by the International Union for the Conservation of Nature (IUCN), and the use of the area as a wildlife movement corridor across Kawah Ijen nature reserve.
- Aquatic Habitat – Low importance because the river has been impacted by human activities such as intensive farming and placing cattle cages along the river sides, recurring sedimentation events, which limit the availability of high-quality benthic habitat in the channel, and therefore limit the sensitivity of the physical habitat in the river to Project-related impacts. The river is not protected or recognized by experts as a habitat of specific conservation interest and supports species listed as Least Concern by the IUCN. Over the baseline, the project activities will likely contribute to minimally to sedimentation and land clearance will be limited along the Right of Way (RoW) of the transmission line located far from the existing river.
- Aquatic Biota – Low importance because the baseline condition of the river has been disturbed with limited availability of high-quality benthic habitat in the channel. The closest river from the project site is Kali Pait which is a creek from the Ijen Crater. This river contains high sulphur and not suitable habitat for fish microorganism.
- Rare and restricted range species –High importance because of the mix of IUCN Red List Vulnerable and Endangered species and restricted range species that occur within and around the Project Area.
- Protected Areas – High importance due to their nationally protected status and their importance to the maintenance of rare and restricted range species populations.

The impact magnitude and receptor sensitivity criteria for biodiversity has been provided in ***Table 6-35*** and ***Table 6-36***, respectively.

Table 6-35: Habitat-Impact Assessment Criteria

Habitat Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	**Small**	**Medium**	**Large**
		Effect is within the normal range of variation	Affects only a small area of habitat, such that there is no loss of viability/ function of the habitat	Affects part of the habitat but does not threaten the long-term viability/ function of the habitat	Affects the entire habitat, or a significant portion of it, and the long-term viability/ function of the habitat is threatened.
Negligible	Habitats with negligible interest for biodiversity.	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Low	Habitats with no, or only a local designation / recognition, habitats of significance for species listed as of Least Concern (LC) on IUCN Red List of Threatened Species, habitats which are common and widespread within the region, or with low conservation interest based on expert opinion.	**Negligible**	**Negligible**	**Minor**	**Moderate**
Medium	Habitats within nationally designated or recognised areas, habitats of significant importance to globally Vulnerable (VU) Near Threatened (NT), or Data Deficient (DD) species, habitats of significant importance for nationally restricted range species, habitats supporting nationally significant concentrations of migratory species and / or congregatory species, and low value habitats used by species of medium value.	**Negligible**	**Minor**	**Moderate**	**Major**
High	Habitats within internationally designated or recognised areas; habitats of significant importance to globally Critically Endangered (CR) or Endangered (EN) species, habitats of significant importance to endemic and/or globally restricted-range species, habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species.	**Negligible**	**Moderate**	**Major**	**Critical**

Table 6-36: Species-Impact Assessment Criteria

Baseline Species Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	**Small**	**Medium**	**Large**
		Effect is within the normal range of variation for the population of the species	Effect does not cause a substantial change in the population of the species or other species dependent on it	Effect causes a substantial change in abundance and/or reduction in distribution of a population over one, or more generations, but does not threatened the long term viability/ function of that population dependent on it.	Affects entire population, or a significant part of it causing a substantial decline in abundance and/or change in and recovery of the population (or another dependent on it) is not possible either at all, or within several generations due to natural recruitment (reproduction, immigration from unaffected areas).
Negligible	Species with no specific value or importance attached to them.	**Negligible**	**Negligible**	**Negligible**	**Negligible**
Low	Species and sub-species of LC on the IUCN Red List, or not meeting criteria for medium or high value.	**Negligible**	**Negligible**	**Minor**	**Moderate**
Medium	Species on IUCN Red List as VU, NT, or DD, species protected under national legislation, nationally restricted range species, nationally important numbers of migratory, or congregatory species, species not meeting criteria for high value, and species vital to the survival of a medium value species.	**Negligible**	**Minor**	**Moderate**	**Major**
High	Species on IUCN Red List as CR, or EN. Species having a globally restricted range (i.e. plants endemic to a site, or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range	**Negligible**	**Moderate**	**Major**	**Critical**

Baseline Species Sensitivity/ Value		Magnitude of Effect on Baseline Habitats			
		Negligible	Small	Medium	Large
	for bird species) less than 50,000 km^2), internationally important numbers of migratory, or congregatory species, key evolutionary species, and species vital to the survival of a high value species.				

6.3.6.3.2 Terrestrial Habitat loss and degradation

6.3.6.3.3 Impact Significance

Varying habitats support the lifecycles of fauna were identified within the Project area. This included habitat for breeding, foraging and roosting. Removal of the habitat reduces the habitat available to resident species and the ecological value of the area.

The baseline study shows that, there were 635 species observed within and surrounding the project site. These species consisted of 345 flora, 109 birds, 22 mammals, 23 herpeto-fauna and 136 insect species. Most of the encountered species were listed LC (172 species). However, two of them known to be endangered species which are Javan Hawk-eagle (*Nisaetus bartelsi*) Javan leafbird (*Chloropsis cochinchinensis*).

In addition to the baseline, the secondary data analyses from IBAT report also indicates that some species of conservation significance might also present within and surrounding project site, these species include: *Atrophaneura luchti* - endangered and restricted to Ijen crater conservation area; Javan Blue-banded Kingfisher *(Alcedo euryzona)* – Critical Endangered; and some endemic but not restricted range and vulnerable species like Javan Tailless Fruit Bat *(Megaerops kusnotoi),* White-faced Partridge *(Arborophila orientalis),* Javan Scops-owl *(Otus angelinae), and* Javan Flameback *(Chrysocolaptes strictus)*

Based on habitat, the project area is in mostly modified habitat in the form of agricultural land, shrub and bare land (***Table 6-37***). A small portion of natural habitat within the project area comprises of savannah and secondary forest area.

Table 6-37: Habitat Types within and Surrounding Project Area

Habitat types	Habitat Type	Project Area -Well pad complex, Transmission line and towers		Within 500 m surrounding the Project Area		EAAA (Ha)	
		Area (Ha)	% of total area	Area (Ha)	% of total area	Area (Ha)	% of total area
Natural Habitat	Savana	96.01	6.54	37.35	1.30	279.90	0.40
	Secondary Forest	179.45	12.22	1,111.21	38.92	39,418.86	56.90
Modified Habitat	Agricultural Land	779.28	53.08	1,160.90	40.66	16,753.33	24.18
	Bare land	4.66	0.32	2.37	0.08	984.87	1.42
	Building	0.40	0.03	24.47	0.86	2,126.02	3.07
	Mixed Plantation	0.00	0.00	431.18	15.10	7,435.56	10.73
	Shrub land	408.20	27.81	87.44	3.60	2,277.06	3.29
Total Area		1,468.00	100	2,854.92	100	69,276.00	100

Source: ERM 2022

The entire project boundary of the project area has an approximate area of 1,468 ha. It comprises of 1,190 ha modified habitat (779 Agricultural land, 408 shrub land, 4.7 bare land and 0.4 as existing buildings) and 275.5 ha natural habitat (179.5 ha secondary forest and 96 ha savanna)**.** Based on the project design, not all the total project boundary will be converted into project facility or development area. The project will require a total of 228.1 ha of which comprise 100.9 ha of development area within the power plant and well pads area, 17.7 ha of road access, and 109.5 ha of transmission line area (including RoW).

Based on habitat impact calculation, it is known that the project will have direct impact to a total of 67.10 ha natural habitats and 161.00 ha modified habitat. Detail of impacted habitats due to project development presented in ***Table 6-38***.

Table 6-38: Project Impact to the Habitats

Project Feature		Area of Impacted (Ha)								
Feature	Area (Ha)	Modified Habitat						Natural Habitat		
		Agricultural Land	Bare land	Building	Mixed Plantation	Shrub land	Total	Savanna	Secondary Forest	Total
Development Area	100.90	39.90	3.00	0.40	0.00	40.40	83.70	17.10	0.10	17.20
Access Road to Well pad	17.70	8.30	0.10	0.00	0.00	2.70	11.10	0.80	5.80	6.60
Transmission Line	109.50	44.00	0.00	0.00	20.30	1.90	66.20	0.00	43.30	43.60
Total	228.1	92.20	3.10	0.40	20.30	45.00	161.00	17.90	49.20	67.10

Source: ERM 2022

Most of the modified habitats are distributed in the well pads, proposed power plant area and the downstream portion of transmission line in Banyuwangi. The secondary forest area is located in the mid part of the transmission line area are connected to Kawah Ijen natural conservation area.

Baseline study has identified species of conservation significance (potential critical habitat triggers) within and surrounding the project site. It includes Javan Hawk-eagle (*Nisaetus bartelsi* - EN), Javan leafbird (*Chloropsis cochinchinensis*- EN) and the potential other species of conservation significance outlined in IBAT, i.e., *Atrophaneura luchti* - (EN); Javan Blue-banded Kingfisher (*Alcedo euryzona* - CR), Javan Tailless Fruit Bat (*Megaerops kusnotoi* - VU), White-faced Partridge (*Arborophila orientalis* - VU), Javan Scops-owl (*Otus angelinae* - VU), and Javan Flameback (*Chrysocolaptes strictus* -- VU).

The critical habitat assessment identified that the suitable habitat for conservation significance species identified within and surrounding the project site was the natural secondary forest and the existing Kawah Ijen natural reserve area. Therefore, these areas considered as critical habitat.

The land clearing and preparation to the portion of the natural habitat, particularly the secondary forest (49.20 ha) along the mid part of transmission line, access road and development area will not expect to have major impact to the existing wildlife habitat due to the impact will likely only impact approximately 0.12% of the total natural habitat within EAAA.

The sensitivity of the critical natural habitats considered to be **High,** clearing of vegetation and impacts to habitats is considered to be a direct impact to biodiversity values. The sensitivity of modified habitats are considered to be **Low**.

The magnitude of effect is likely to be **Small** as it will affect only a small area of habitat, but without the loss of viability/function of the habitat. The overall impact is therefore likely to be **Moderate** for Natural Habitat and **Negligible** for Modified Habitat before Mitigation Measures.

6.3.6.4 Additional Mitigation, Management, and Monitoring Measures

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- No clearing of natural critical habitats occurs outside the project area.

- Access roads will be defined before the beginning of the construction activities. Some of the public roads may need to be used for access. Driving out of the access roads by the construction vehicles taking part of the construction activities will not be allowed.
- Speed of vehicles will be limited, in order to limit emission of dust in non-paved access roads and in order to limit the risk of accidents with fauna.
- If possible, staging vegetation clearance following the development progress will be conducted, to enable fauna to move to other areas.
- Clearing vegetation outside of designated areas will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation outside designated areas.
- The Project owner shall provide training to staff and workers on all rules, regulations and information concerning restrictions related to unauthorised clearing of vegetation, as well as the punishment that can expected if any staff or worker or other person associated with the Project violates rules and regulations.
- The planned vegetation clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing.
- All land rehabilitation will be undertaken using native indigenous species. The area of landscaping within the Project area shall re-establish habitat values.
- A Biodiversity Action Plan has been prepared to document how the Project will achieve no net loss of natural habitat and net gain in biodiversity for critical habitat (see ***Appendix K***).

The following monitoring measures are recommended:

- Regular (weekly) checks during construction are to occur along all project boundaries to ensure compliance with clearing within marked boundaries;
- Records are to be kept and regularly reviewed (3 monthly) for implementation of the workforce training program for fauna/flora awareness;
- Records are to be kept and regularly reviewed (3 monthly) of all personnel entering and exiting the project area through checkpoints, including results of all random inspections undertaken for poached flora/fauna;
- A monitoring plan should be carried out to record invasive alien species in the project area of influence aimed at removing new populations and preventing them from spreading throughout the AoI. In addition, prompt revegetation (i.e., sowing of native herbaceous species and/or planting native shrubs/trees) on bare soil with natural or semi-natural vegetation will reduce the spread of alien species.
- Monitoring of rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections (3 monthly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.

6.3.6.5 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to reduce to **Minor** for critical Natural Habitat and **Negligible** for modified habitat (***Table 6-39***).

Table 6-39: Impact Assessment for Habitat loss and degradation: Construction Phase

Impact Significance

Impact Nature	Negative	Positive	Neutral		
	Loss of Natural critical habitat particularly the secondary forest (49.20 ha or 0.12% of the total habitat within EAAA) along the mid part of transmission line				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local within the construction site boundary.				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low (Modified habitat)	Medium	High (Critical natural habitat)		
Impact Significance	Negligible (Modified habitat)	Minor	Moderate (Critical natural habitat)	Major	
Residual Magnitude	Negligible (Modified habitat)	Small (Critical natural habitat)	Medium	Large	
Residual Impact significance	Negligible (Modified habitat)	Minor (Critical natural habitat)	Moderate	Major	

6.3.6.5.1 Terrestrial Species disturbance and displacement

6.3.6.5.1.1 Impact Significance

The disturbance and displacement of resident fauna species within the footprint will primarily be caused by light, noise and vibration impacts during construction. These impacts are considered to be indirect impacts caused by the use of project machinery and equipment.

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 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 it is expected to be 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.

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 localised. Terrestrial fauna likely to be disturbed include all resident species, including birds, mammals and herpetofauna identified in the Project area.

Baseline biodiversity study noted that Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered and Javan leafbird (*Chloropsis cochinchinensis*) – endangered is present within the study area. Additionally, IBAT report also mentioned some species of conservation significance potentially present around the project site, i.e., *Atrophaneura luchti* - endangered and restricted to Ijen Crater conservation area; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; as well as some endemic but not restricted range and vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*).

These species are likely to be disturbed through the operation of machinery and clearing activities. It is not considered that disturbance of these species is of concern as they are having capacity to move to other part of the habitats.

The species may be temporarily displaced from the Project area during construction and are likely to return to areas rehabilitated during operation. Some minor disturbance impacts to these species may occur from construction activities, including along the Transmission Line during construction. Impacts are expected to reduce during operation.

The direct mortality or injury of any rare or restricted range species and indirect impacts on wildlife, particularly rare and restricted range species most likely resulted from the land clearing and the transportation activities. However, this will not significantly impact since most of the transportation will use the existing transportation routes. The land clearing should be done within the disturbed area. The rare or restricted range species identified within the study area are typically sensitive species and expected to be temporarily migrated during the presence of disturbance.

Given the present of endangered and potential present of restricted range species within the project area, the sensitivity of the species is considered **High**. The magnitude of effect due to disturbance and displacement of fauna in terrestrial habitats is likely to be **Small** as the effect will not cause a substantial change in the population of the species present, or other species dependent on them during construction. The overall significance of this impact is therefore **Moderate** for the species.

6.3.6.5.1.2 Additional Mitigation, Management, and Monitoring Measures

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- Use of signs and/or fences in access roads and construction sites, to avoid any impact to areas out of the Project footprint. Protective measures should be implemented especially on the locations of active construction works. Use of fences in the construction sites will also avoid the entrance of fauna and avoiding accidents.
- A fauna shepherding protocol is to be implemented in the project area to ensure that fauna have vacated the area prior to any clearance work.
- Additional mitigation measures are outlined in the impact mitigation of mortality conservation significance bird and bat species.

The following activities should be applied during construction:

- Records on habitat impact should be done and regularly reviewed (3 monthly basis) during construction following the application of the Fauna Shepherding Protocol.
- Revegetation (i.e., the sowing of native herbaceous species on topsoil and/or the planting of native shrubs/trees) should be undertaken as soon as possible after clearance and construction. This should be well monitored.
- A monitoring plan should be carried out to record invasive alien species populations in the project area of influence and aimed at removing new populations and preventing them from spreading throughout the AoI.

6.3.6.5.1.3 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to remain as **Minor** for terrestrial species (***Table 6-40***).

Table 6-40: Impact Assessment for Species disturbance and displacement: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Potential disturbance to the rare or restricted range species; Javan leafbird (*Chloropsis cochinchinensis*) – endangered; *Atrophaneura luchti* - endangered and restricted to Ijen crater conservation area; Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; and some endemic but not restricted range and vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.6.5.2 Terrestrial Habitat's Temporary and Permanent Barrier Creation, Edge Effects and Fragmentation

6.3.6.5.2.1 Impact Significance

Construction activities relating to linear infrastructure have potentially create a temporary barrier to fauna movement (for some fauna groups). This includes construction of the access roads, the transmission line and other infrastructure. Most other Project components are discrete areas that may be navigated around by moving fauna. The construction of access roads and transmission line will primarily be within Modified Habitat, however the transmission line along natural secondary forest connected to the Kawah Ijen conservation area. Temporary barriers within the forest area may disrupt the movement of wildlife inhabitant to the forest.

Temporary and permanent barrier creation will occur during construction. This will include the construction of linear infrastructure such as the access road and transmission line and may impact the movement of fauna within the landscape, particularly bird species.

Edge effects are an indirect impact of land clearing during construction and throughout operation and can have temporary and permanent impacts. 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 recognised as a contributor to habitat 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).

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 habitats 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 within the project area is not considered to be a significant impact as the infrastructure design does not lead to isolation of habitat patches. The observation during the survey shows that the present of access road and electricity distribution cable along the road sides does not limit the species movement.

Given the present of endangered and potential present of restricted range species within the project area, the sensitivity of the species is considered **High**.

The magnitude of effect due to disturbance and displacement of terrestrial habitats is likely to be **Small** as the effect will not cause a substantial change in the population of the species present, or other species dependent on them during constructions. The overall significance of this impact is therefore **Moderate.**

6.3.6.5.2.2 Additional Mitigation, Management, and Monitoring Measures

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- Planting of native indigenous flora adjacent to the road to reduce impacts on habitat connectivity;
- Appropriate rehabilitation of disturbed areas using native vegetation is to occur to facilitate movement of fauna species.

The following monitoring measures will be applied during construction:

- Records are to be kept and regularly reviewed (3 monthly basis) on the planting of indigenous flora in the disturbed areas; and

- Monitoring of rehabilitation success/failure to be done on all replanting sites. Monitoring should consist of regular inspections (3 monthly) to determine plant establishment. Where plant establishment identified to be failed, then replanting to be done.

6.3.6.5.2.3 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to remain as **Minor** for terrestrial species (***Table 6-41***).

Table 6-41: Impact Assessment for Temporary and Permanent Barrier Creation, Edge Effects and Fragmentation: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Potential disturbance to the rare or restricted range species; Javan leafbird (*Chloropsis cochinchinensis*) – endangered; *Atrophaneura luchti* - endangered and restricted to Ijen crater conservation area; Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; and some endemic but not restricted range and vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.6.5.3 *Terrestrial Species Direct mortality caused by Vehicle Strike, Hunting and Poaching*

6.3.6.5.3.1 Impact Significance

Mortality of individual fauna may occur during construction due to vehicle or machinery strike or falling debris during clearing activities; and worker influx and hunting/poaching of extant fauna.

During construction, vehicle and machinery use may strike fauna within the Project area, however this is likely to impact livestock rather than species of conservation significance. Clearance activities within the natural critical habitat however may impact species of conservation significance, although these are likely to be birds.

Hunting and poaching by local people and the workforce may impact on species of conservation significance, especially birds captured for the animal trade that may occasionally visit the Project area. These species include the Javan leafbird (*Chloropsis cochinchinensis*) – endangered *Atrophaneura luchti* - endangered and restricted to Ijen crater conservation area; Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; and some endemic but not restricted range and vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*).

Provision of education and socialization on speed limitation and prohibition of hunting/poaching activities is important to be prepared during the project execution and community engagement program. The purpose of this approach is to inform and educate the workers and community regarding conservation and identify alternative livelihoods for people reliant on the wildlife trade.

Given the present of endangered and potential present of restricted range species within the project area, the sensitivity of the species is considered **High**. The magnitude of effect due to disturbance and displacement of fauna in terrestrial habitats is likely to be **Medium** as the effect may affect a portion of a population and may bring about a change in abundance and/ or distribution over one or more generations. The overall significance of this impact is therefore **Major** for the species.

6.3.6.5.3.2 Additional Mitigation, Management, and Monitoring Measures

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- Hunting and poaching must be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation;
- The Project owner shall provide training to staff and workers on all rules, regulations and information concerning restrictions related to hunting and poaching. The punishment should be applied if any staff or worker or other person associated with the Project violates rules and regulations;
- All vehicles have to be maintainned a speed of a maximum of 40km/hr within work sites to reduce the risk of fauna strike; and
- Collaboration with local government and conservation agencies are encouraged in developing campaigns and programmes for banning hunting and poaching activities within and surrounding project site.

The following monitoring measures will be applied during construction:

- Records of socialization, training, campaigns and collaboration with stakeholders are to be done and regularly reviewed (6 monthly); and
- Monitoring of flora fauna abundance and its diversity should be conducted at annual basis.

6.3.6.5.3.3 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to remain **Minor** significance (***Table 6-42***).

Table 6-42: Impact Assessment for Direct mortality caused by Vehicle Strike, Hunting and Poaching: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Potential disturbance to the rare or restricted range species; Javan leafbird (*Chloropsis cochinchinensis*) – endangered; *Atrophaneura luchti* - endangered and restricted to Ijen crater conservation area; Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; and some endemic but not restricted of vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.6.5.4 Decrease aquatic habitat and fragment existing habitat due to the installation of water intake

6.3.6.5.4.1 Impact Significance

Impacts on aquatic habitat are habitat loss and habitat fragmentation due to extraction of water from the Balawan River and the loss of continuity between the remaining habitats, particularly at the dry season when the river in the lowest debit. The water withdrawal would reduce the amount of habitat available to aquatic organisms throughout the river and reduce the local populations of aquatic organisms within the river.

Baseline study that was conducted in the Balawan River indicated that the river has low diversity. Two species of fish (*Barbodes binotatus* and *Rasbora caudimaculata)* and seven species of macro-invertebrates were found during the survey. None of the species is listed as endemic or protected.

The sensitivity of the Balawan river habitat considered to be **Low** due to low diversity and none of the species found were critical habitat trigger species.

The magnitude of effect due to extraction of water from Balawan River is likely to be **Small** as the effect is localized. Impacts are expected to be short time period and not change in abundance and/ or distribution over one or more generations. The overall significance of this impact is therefore **Negligible** for the habitat.

6.3.6.5.4.2 Additional Mitigation, Management, and Monitoring Measures

No additional mitigation is required.

6.3.6.5.4.3 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact remains **Negligible** significance (***Table 6-43***).

Table 6-43: Impact Assessment for Decrease Aquatic Habitat and Fragment Existing Habitat due to the Installation of Water Intake: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Habitat of Balawan River				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.6.5.5 Direct Mortality and loss Freshwater Aquatic Biodiversity Species

6.3.6.5.5.1 Impact Significance

As per described in the impact assessment of the Balawan River aquatic habitat, the river has low diversity. Sensitivity is **Low** and the impact magnitude of water withdrawal from Balawan river will likely to be **Small** as the effect is localized, and short time period. These activities expected to not change in abundance and/ or distribution over one or more generations of fish and macroinvertebrates. The overall significance of this impact is therefore **Negligible** for the habitat.

6.3.6.5.5.2 Additional Mitigation, Management, and Monitoring Measures

No additional mitigation is required.

6.3.6.5.5.3 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to remain **Negligible** significance (***Table 6-44***).

Table 6-44: Impact Assessment for Mortality and Loss Freshwater Aquatic Biodiversity due to the installation of Water Intake: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Non Protected and conserved species within Balawan River				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.6.5.6 Overview of Key Kawah Ijen Nature Reserve Impacts

6.3.6.5.6.1 Impact Significance

A segment of the transmission line and towers (I.e., towers T-21, T-22, T-25 and T-26) of the project will be constructed close to the Kawah Ijen Nature Reserve area.

Kawah Ijen Nature Reserve area is nationally protected area, recognized as IUCN Category: III conservation area, and part of Javan and Bali Forest Endemic Bird Area and Gunung Raung -

Gunung Ijen Key Biodiversity area. The Kawah Ijen conservation area is also known to be critical habitat for the *Atrophaneura luchti* – and endangered and restricted range butterfly species that can only be found at surrounding Ijen crater conservation area.

Given the status and importance of the habitat, the Kawah Ijen Nature Reserve area can be considered as **High** sensitivity. The magnitude of effect of land clearing to the adjacent area of Kawah Ijen is likely to be **Small** as it will affect only a small area or border area without the loss of viability/function of the habitat. The overall impact is therefore likely to be **Moderate.**

6.3.6.5.6.2 Additional Mitigation, Management, and Monitoring Measures

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- Apply same mitigation approach for terrestrial habitat loss mitigation;
- No clearing of habitat within the Kawah Ijen Nature Reserve area;
- Provide sufficient buffer space of transmission line ROW to avoid clearing any part of Kawah Ijen Nature Reserve area; and
- Active coordination with local ranger officer to define safe area for clearing, placing equipment and temporary camp.

The following monitoring measures are recommended:

- Apply same monitoring approach for terrestrial habitat loss mitigation

6.3.6.5.6.3 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to reduce to **Negligible** (***Table 6-45***).

Table 6-45: Impact Assessment for Key Kawah Ijen Nature Reserve Impacts: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Impact of Kawah Ijen Nature Reserve area due to transmission line construction				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local (67.1 ha or 0.17% of the total natural habitat within EAAA) within the construction site boundary.				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		

Impact Significance

Impact Significance	Negligible	Minor	Moderate	Major
Residual Magnitude	Negligible (Modified habitat)	Small	Medium	Large
Residual Impact significance	Negligible (Modified habitat)	Minor	Moderate	Major

6.3.7 *Impact on Livelihoods and Land Acquisition*

6.3.7.1 Potential Impacts

The total land required for the Project is 2,822.2 ha. The land inside the concession area (Project Site) is currently owned by MCG. As such, there is no physical displacement within this area. However, it was noted from KIIs and field visits that farmers from nearby villages – Jampit Village –cultivate potatoes close to the Development Area. These are not within the Project permit boundary.

The transmission line will run through village areas, forest areas and plantations. According to MCG's chief security and community relation on the ground, the land acquisition process involving project affected communities will be conducted in three villages, namely Bulusari, Grogol, and Giri Village. Initial identification of landowners indicates that there are a total of 31 affected landowners; 18 landowners in Grogol, 8 landowners in Bulusari, 2 in Pesucen and 3 landowners in Giri, Banyuwangi. It was reported that not all of the landowners have land certificates. However, these landowners will need to be considered in the acquisition process regardless of legal status. The land acquisition process is ongoing and a land use survey will need to be conducted as part of this process.

As outlined in ***Table 6-46***, the power plant will have permanent infrastructure within the Project Area, representing about 40.9452 hectares (ha), and temporary infrastructure on 0.2523 ha of the total footprint. For the transmission line, excluding the ROW, there will be acquisition of 2,780.5 ha for the transmission towers and no temporary area. The approximate permanent land required for the ROW is 24.2 ha. The worker accommodation for the construction phase is covered by the temporary power plant facility, which is owned by MCG.

The current status of the land acquisition compensation process is provided in *Error! Reference source n ot found.*.

Table 6-46: Summary of Land Requirements

Project Component	Previous Land use	Rationale for Land Requirement	Land Requirement (m2)	Affected Groups
ɔwer Plant	Production Forrest	The total area of power plant and supporting facilities is 41.1975 ha, of which permanent buildings/facilities is 40.9452 ha and temporary buildings/facilities is 0.2523 ha.	Permanent: 40.9452 ha Temporary: 0.2523 ha **Total**: 41.1975 ha	0 PAHs 0 PAPs
Transmission Line (not including Right of Way)	Production Forest Protected Forest Plantation	Transmission line is 28.3 km, consisting of 83 towers. For the 36 towers outside forest area, land has been acquired (1,143.5 ha). For the 47 towers inside forest area, land acquisition is an ongoing process through the PPKH permit (1,637 ha).	Permanent: 2,781 ha Temporary: 0 ha **Total**: 2,781 ha	31 PAHs 110 PAPs
Right of Way	Production Forest Protected Forest Plantation	The 28.3 km ROW consists of 12.1 km with HGU - Cultivation Rights Title (Kalibendo area) and SHM - Certificate of Ownership. The remaining 16.2 km is for Production Forest and Protected Forest land areas. With a planned width of 20 m x 12100 m, the land area that will be compensated is 24.2 ha (outside forestry area).	Permanent: 24.2 ha Temporary: ha **Total**: 24.2 ha	250 PAHs (Approx) 1,055 PAPs (Approx)[43]
Worker accommodation	Production Forest	The worker accommodation covers an area of 0.0905 ha, including: camp/worker building, recreation hall, mess hall, kitchen, laundry & iron building, and garbage disposal site.	Permanent: 0 ha Temporary: 0.0905 ha **Total**: 0.0905 ha	0 PAHs 0 PAPs

Table 6-47: Summary of Land Acquisition and Compensation for the Transmission Line

Location	Land Acquisition*		
	Area (M^2)	Compensation Method	Land Type
Bulusari	2450	Cash/Transfer	Gardening
Grogol	5010	Cash/Transfer	Gardening/ Farmland
Giri	1425	Cash/Transfer	Gardening
Pesucen	800	Cash/Transfer	Farmland
Kampung Anyar	1750	Cash/Transfer	Plantation
TOTAL AREA	**11,435**		

*does not include land acquired for the ROW.

MCG is currently collecting information about the land required for the ROW and census data to align with IFC PS5 guidelines around collecting census data to effectively determine livelihood restoration measures based on appropriate and consistent compensation and eligibility criteria. Commencing on the 20th of July 2023, an ongoing initiative is underway to facilitate the dissemination of information pertaining to the ROW compensation plan within the villages directly impacted by the ROW project.

43 Based on an average household size of 4.22 for East Java (Global Data Lab, 2023) https://globaldatalab.org/areadata/table/hhsize/IDN/

This stakeholder engagement, referred to as comprehensive socialization effort, aims to ensure that the local communities possess a clear understanding of the resettlement action plan's intricacies and implications.

6.3.7.2 Existing Controls / Mitigation

The controls committed to be implemented for the Project will include the following:

- EPC Contractor will target local employment and provide on the job vocational training, where possible.
- The design of the transmission line has considered potential settlement areas and been routed into non inhabited areas were possible.
- The Project is conducting land acquisition process currently and a land use survey is being conducted.
- A Land Acquisition Framework **(Appendix L)** and a Livelihood Restoration Plan **(Appendix M)** were developed for the Project to bring the Project into compliance with Lenders safeguards requirements, particularly those of the International Finance Corporation (IFC) Performance Standards (PS).

6.3.7.3 Impact Evaluation and Significance

6.3.7.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for local communities has been provided in ***Table 6-48*** and ***Table 6-49***, respectively.

Table 6-48: Criteria for Impact Magnitude for Assessment of Impact to Local Communities

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 6-49: Criteria for Local Community Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.3.7.3.2 Impact Significance

Based on the land use survey that was conducted for the transmission line (not including ROW) the receptor sensitivity is considered to be **medium**. Existing farmland / agricultural land in the footprint of the transmission line towers will need to be compensated. It is estimated that 2,805.2 ha of potential land will need to be acquired for the Project (exclusively for the transmission line) and approximately 31 households will be impacted by the transmission line and 250 households will be impacted by the ROW. There is no physical displacement from the Project. As such, the impact magnitude is **medium**. As such, the impact significance is **moderate**.

The Project may bring job opportunities for the local communities. MCG is committed to absorbing local workers, especially in the Ijen District area. This has been done by MCG in the implementation of Geothermal Well Exploration activities. However, for jobs that require skills and competencies, MCG must recruit workers who have the required competencies. Job opportunities generated for the Project will have **Positive** impacts on local economy and livelihoods.

6.3.7.4 Additional Mitigation and Management

The following additional mitigation is proposed:

- Physical displacement and resettlement should be avoided through refining of the transmission line route;
- In addition to the Land Acquisition Framework and the livelihood Restoration Plan which were developed for the Project, MCG should implement the following:
  - Conduct a land use survey for all households to be impacted by land acquisition during the installation of the transmission pipeline. This should assess any economic displacement to be caused by the Project;
  - The land acquisition process will need to comply with Indonesian legislation (GR 19/2021), and make reference to international standards (IFC PS);
  - The avoidance and minimisation principle of impacts related to land will be applied to the entire Project including the temporary land requirement;
  - There should be no forced eviction by the Project. The Project should put in place a non-tolerance of forced eviction and land grab policy;
  - Ensure that the affected population’s access to legal or other appropriate remedies is not restricted by the Project;
  - Ensure that the stakeholders have access to a grievance mechanism for the communication of any grievances and concerns regarding the land acquisition;
  - Avoid land within natural resources and critical cultural heritage under traditional ownership and/or customary use;
  - Ensure that the payment of compensation and disbursal of entitlements for impacted assets, including temporary impacts, are completed prior to the physical use of the land; and
  - The entitlements shall be identified based on the principles of replacement cost with the aim to improve the standard of living.
- A third-party Land Acquisition Audit Survey should be conducted. This should include:
  - Desk based review of available documentation from the Project linked to land and landowner identification, negotiation, compensation and rehabilitation measures etc.
  - Review of land acquisition process with respect to the applicable standards and identify areas of non-conformance against IFC PS5.

- Meetings with key stakeholder groups including the Project, resettlement committees etc. as relevant.
- Sample survey of impacted households.
- Recommend correct actions to align with the requirements of IFC PS5.

6.3.7.5 Significance of Residual Impact

The creation of jobs for local people will have a **positive** impact on the local community. With the additional mitigation measures, the residual impact to livelihoods is considered to reduce to **minor** (***Table 6-50***).

Table 6-50: Impact Assessment for Displacement and Livelihoods: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Livelihood impacts from the construction activities are positive (job creation) and negative (economic displacement).				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be localised to the Project Site.				
Frequency	Impacts will arise through pre-construction / land acquisition				
Impact Magnitude	Positive	Low	Medium	High	
Resource Sensitivity	Low	Medium	High		
Impact significance	Positive	Negligible	Minor	Moderate	Major
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.8 Impact on Cultural Heritage

6.3.8.1 Potential Impacts

The following activities can have impacts to infrastructure service during the Construction Phase of the Project.

- Site preparation, excavation and filling works;
- Drilling and pipeline installation;

- Installation of the transmission line;
- Transportation of equipment, supplies and workforce.

The air, noise, and dust emissions during construction can cause impacts to local cultural heritage within 500 m of the Project. Impacts will be similar to those discussed in ***Section 6.4.1 to 6.4.3***. There is no known tangible or intangible heritage in the Project Area however, there are tangible heritage sites next to the Project boundary and therefore it is possible to discover artefacts during excavation works.

6.3.8.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- Establish and implement a Grievance Mechanism; and
- Consider special religious events / activities during the development of construction schedule.

6.3.8.3 Significance of Impact

6.3.8.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for cultural heritage has been provided in ***Table 6-51*** and ***Table 6-52***, respectively.

Table 6-51: Criteria for Impact Magnitude for Assessment of Impact to Cultural Heritage

	Extent / Duration / Scale / Frequency
Large	Change in cultural heritage over a large area that lasts over the course of several months with quality likely to cause secondary impacts on ecosystems and nearest household or community. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area, ecosystem or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	The change in cultural heritage exceeds the expected. Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Cultural heritage changes correspond to the expected range. Change remains within the range commonly experienced within the household or community.

Table 6-52: Criteria for Cultural Heritage Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.3.8.3.2 Impact Significance

The Mbah Parto Rejo Astama burial site is located 780m from the nearest well pad (well pad 5). The burial site has significant cultural and spiritual importance for people in Jampit and surrounding area as well as others from outside East Java. All other identified heritage sites are located over 10 km from the Project (refer to ***Section 4.4.14***).

Impacts to the mosques along the transmission line route from air and noise emissions will be transitional and temporary during the construction. Considering the existing controls and mitigation measures will be carried out, the cultural heritage impacts from the Project are expected to be of **small** magnitude. Receptor sensitivity is considered **medium** given the local importance of these sites.

The significance of impacts to cultural heritage is considered **minor.**

6.3.8.4 Additional Mitigation, Management and Monitoring

These additional mitigation, management, and monitoring measures are as follows:

- A cultural heritage management plan will be prepared to guide the workers on the protection of cultural heritage sites, structures and values that may be impacted by the Project;
- Develop the construction planning in discussion with the relevant cultural heritage in order to make sure that any Project activity near them (e.g. transport of large equipment) does not take place during special religious activities;
- Carry out pre-construction engagement with religious leaders (e.g. discuss planning works with religious leaders around major religious holidays if the construction area is within 500 m from the mosques);
- Implement a Chance Find Procedure. When artefacts are found during construction activities, work must stop. The Contractor should report to the relevant ministries; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.3.8.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would reduce to **minor** (***Table 6-53***).

Table 6-53: Impact Assessment for Cultural Heritage: Construction Phase

<table>
<tr><th colspan="5">Impact Significance</th></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td colspan="2">Neutral</td></tr>
<tr><td colspan="4">Cultural heritage impacts from the construction activities are negative.</td></tr>
<tr><td>Impact Type</td><td>Direct</td><td>Indirect</td><td colspan="2">Induced</td></tr>
<tr><td>Impact Duration</td><td>Temporary</td><td>Short-term</td><td>Long-term</td><td>Permanent</td></tr>
<tr><td>Impact Extent</td><td>Local</td><td>Regional</td><td colspan="2">International</td></tr>
<tr><td>Impact Scale</td><td colspan="4">The scale of the impact is likely to be localised to heritage sites within 500 m of the Project and only during construction.</td></tr>
<tr><td>Frequency</td><td colspan="4">Impacts will arise from installation of the transmission line and main project construction works.</td></tr>
</table>

Impact Significance

Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Impact Magnitude	Negligible	Small	Medium	Large	
Impact Significance	Negligible	Minor	Moderate	Major	

6.3.9 Impacts to Tourism

6.3.9.1 Potential Impacts

The following activities can have impacts to tourism during the Construction Phase of the Project.

- Site preparation, excavation and filling works;
- Drilling and pipeline installation;
- Installation of the transmission line;
- Transportation of equipment, supplies and workforce.

The air, noise, and dust emissions during construction could cause impacts to local tourism up to 500 m of the Project. Issues from tourism can include restriction of access to hiking / tourism sites and landscape and visual impacts from presence of facilities.

Impacts will be similar to those discussed in ***Section 6.4.1*** to ***6.4.3*** and ***Section 6.4.5***.

6.3.9.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- Existing controls from air, noise, and water impacts (***Section 6.4.1 to 6.4.3***) as well as impact to landscape (***Section 6.3.5***) should be adopted; and
- Establish and implement a Grievance Mechanism.

6.3.9.3 Significance of Impact

6.3.9.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for tourism has been provided in ***Table 6-54*** and ***Table 6-55,*** respectively.

Table 6-54: Criteria for Impact Magnitude for Assessment of Impact to Tourism

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 6-55: Criteria for Tourism Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.3.9.3.2 Impact Significance

The main Project Site is located within the Kawah Warang (Wurung) Park which is a tourism hiking area known for scenic views and a number of crater features such as Kawah Wurung and Kawah Ilalang which are adjacent to the access road and transmission line respectively. The transmission line runs adjacent to Kawah Ijen. This crater is a popular tourism site as is located within the Kawah Ijen Crater Park. At its closest point, this tourism site is located 300 m from the transmission line route and around 2.5 km from the main construction area. The water distribution network is also located in the Blawan River which contains a number of waterfalls utilised for tourism purposes.

There is likely to be a visual impact from the construction of the Project on local craters that are utilised for panoramic views.

Given that both the main construction site and transmission line are within 500 m of tourism sites, the impact magnitude is considered to be **medium**. Based on the above, the receptor sensitivity is **high** resulting in **major** impact significance**.**

6.3.9.4 Additional Mitigation, Management and Monitoring

Additional mitigation, management, and monitoring measures are as follows:

- The footprint of the Project will be minimised during the design stage and existing vegetation shall be retained as far as practicable;
- Landscape planting will be implemented by planting native tree species which are fast growing in nature;
- Do not allow the workforce to stay in local guesthouses to ensure that space for tourists is not impacted by the Project;
- Develop and implement a Stakeholder Engagement Plan (SEP) and Grievance Mechanism; including communication with local tourism operators. Tourism operators should be consulted on

the need to conduct a Visual Impact Assessment. If this is deemed necessary by operators, this should be conducted;

- There will be no restriction on access to local tourism sites. Activities should be conducted in consultation with local tourism operators and relevant ministries;
- At least four weeks prior to construction activities, relevant authorities and stakeholders (i.e., local tourism operators, tourism associations, and local villagers) will be alerted to the final works area design as well as the construction programme and any specific restrictions;
- Continual engagement will be undertaken with stakeholders to assess the impacts of restricted access to hiking trails;
- Community grievance mechanism will record the number of persons raising grievances and recorded and documented measures to addressed grievances; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.3.9.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would reduce to **moderate** (***Table 6-56***).

Table 6-56: Impact Assessment for Tourism: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Tourism impacts from the construction activities are negative.				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be localised to heritage sites within 500 m of the Project such as the craters. Impacts will be long terms (during 21 month construction and drilling phase).				
Frequency	Impacts will arise throughout the construction and installation phase.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Impact Magnitude	Negligible	Small	Medium	Large	

Impact Significance				
Impact Significance	Negligible	Minor	Moderate	Major

6.3.10 Impact on Infrastructure and Services (including Traffic and Transport)

6.3.10.1 Potential Impacts

The following activities can have impacts to infrastructure service during the Construction Phase of the Project.

- Transportation of equipment, supplies and workforce;
- Labour, equipment, and services supply;
- Storage, handling and disposal of waste, fuel, chemical, oil, gas.

The above activities are impacting on the existing infrastructure (roads network, waste stream, population influx, healthcare system, etc.). The transmission line will be constructed alongside the existing road network and the access road to the Project (8 km) will be upgraded for vehicle movements. Workers will be based on site.

6.3.10.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- Workers to be accommodated on site and not in local villages;
- Dispose of the waste generated by the Project at licensed landfill sites by registered and licensed waste management vendor; and
- Site reinstatement and rehabilitation will be performed including repairing any damage caused as part of the construction activities and reinstating existing access roads when needed.

6.3.10.3 Significance of Impact

6.3.10.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for infrastructure and services has been provided in ***Table 6-57*** and ***Table 6-58***, respectively.

Table 6-57: Criteria for Impact Magnitude for Assessment of Impact to Infrastructure and Services

	Extent / Duration / Scale / Frequency
Large	Change in infrastructure services over a large area that lasts over the course of several months with quality likely to cause secondary impacts on ecosystems and nearest household or community. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area, ecosystem or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	The change in infrastructure services exceeds the expected. Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.

	Extent / Duration / Scale / Frequency
Negligible	Infrastructure changes correspond to the expected range. Change remains within the range commonly experienced within the household or community.

Table 6-58: Criteria for Infrastructure and Services Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.3.10.3.2 Impact Significance

Given the existing controls the magnitude of impacts from traffic increases and worker influx impacts to healthcare are expected to be **small** given the relatively small number of workers (370). The receptor is **medium** given the village located within 500 m of the Site and nearby the proposed access road. The impact from the transmission line installation will be transient and unlikely to have significance impacts. The impact significance during the construction is considered **minor.**

6.3.10.4 Additional Mitigation, Management and Monitoring

Additional mitigation, management, and monitoring measures are as follows:

- Record complaints under the Grievance Mechanism process and follow up by identifying the causes and responding appropriately within 48 hours of receiving the complaint to mitigate the disturbance;
- Traffic Management Plan (TMP) should be developed in accordance with the Traffic Impact Analysis (ANDALALIN) Approval No. 188.45/005/ANDALALIN/430.9.6/2021 issued by the environment and transportation agencies. The TMP should be developed to indicate the traffic routes to be followed, speed limit to be complied with, hours of mobilization activities in order to manage traffic flow. The TMP shall be socialized to all the relevant parties/personnel involved in the Project’s mobilization activities;
- Project should have a healthcare facility on Site which includes a nurse/doctor to treat workers directly whenever possible. This will reduce pressure on the local healthcare facilities. The healthcare workers will be recruited from outside the local villages to avoid impacting existing providers; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.3.10.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would be remain **minor** (***Table 6-59***).

Table 6-59: Impact Assessment for Infrastructure Services: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Infrastructure services impacts from the construction activities are negative. Especially in relation to traffic and transport.				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of this impact is limited to the road networks alongside the access roads.				
Frequency	Impacts will arise continuously from construction related activities.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Impact Magnitude	Negligible	Small	Medium	Large	
Impact Significance	Negligible	Minor	Moderate	Major	

6.3.11 *Impact to Community Health and Safety (including Vulnerable Groups)*

6.3.11.1 Potential Impacts

The following activities can have impacts to community health and safety during the Construction Phase of the Project.

- Drilling activities;
- Installation of the transmission line;
- Construction of the power plant and facilities;
- Transportation of equipment, supplies, and workforce; and
- Labour, equipment, and services supply.

The construction activities could have potential direct and negative impact on human health. They might also cause significant nuisance issues from noise and dust generation. Regarding ambient air quality, it is likely that potential negative impacts will arise continuously during the construction phase of the Project. Health impacts from fugitive dust, PM_{10} and $PM_{2.5}$ include:

- Effects on breathing and respiratory systems; and
- Decreased lung function and symptomatic effects, including acute bronchitis, particularly in children and asthmatics.

Nuisance issues from fugitive dust are typically related to soiling of surfaces and obscuration of visibility. During construction, noise generation may cause nuisance to nearby residential areas located around 600 m from the Project.

The influx of construction workers and in-migration could change the disease profile in the community resulting in declining community health and well-being.

The handling, transport and treatment of the Project waste during construction may also result in risks to public health due to contamination of water resources and spread of disease carrying species such as rats.

The in-migration of workers may change community dynamics. It is anticipated that the nominated EPC Contractor will be a foreign company and may hire foreign workers for the Project. Cultural differences have the potential to cause friction in the community, especially if local customs and traditions are not respected by workers.

During public consultation for the Project, local communities were concerned about unplanned events and accidents. This is addressed in ***Section 6.6***.

6.3.11.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- All workers, except those based in Project Area, will be accommodated in the labour camp during construction;
- Provide training on the most common communicable diseases to all workers to raise awareness of the likely diseases, symptoms, preventative measures, transmission routes, and treatment;
- Ensure health check-ups of all labourers employed and fit to work assessments;
- Provide access for workers to healthcare services (facilities) and medical care;
- Community grievances in relation to the conduct of security personnel and safety issues or activities should be addressed in accordance with the Project established Grievance Procedure;
- As part of the stakeholder engagement activities, communities near the Project Area should be informed about the risks and consequences of trespassing. Such engagement should start prior to the start of construction activities;
- Speed limit of 20 km/h shall be enforced within the construction site; and
- Security team to monitor entrance to the construction site.

6.3.11.3 Significance of Impact

6.3.11.3.1 Criteria for Assessing Impact Significance

The sensitivity criteria and impact magnitude criteria for local communities has been provided in ***Table 6-60*** and ***Table 6-61***, respectively.

Table 6-60: Criteria for Impact Magnitude for Assessment of Impact to Local Communities

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 6-61: Criteria for Local Community Receptor Sensitivity

Magnitude	Criteria
Negligible	Project does not impact on environmental, health and safety issues to the surrounding community as the project implements good international industry practices and environmental, health, safety guidelines, following national law/regulations on Environmental, Health and Safety as well as other Recognised internationally sources.
Small	Project will impact on community health, safety and security within villages in the AoI.
Medium	Project will impact on community health, safety and security at regional level.
Large	Project impacts on community health, safety and security at a national level.

6.3.11.3.2 Impact Significance

In terms of the work force, the construction would be long term (around 21 months and include 370 workers. The local communities have aspects of vulnerability; many are landless without legitimate land titles, farming close to the project area, and have elderly populations. The local communities who are categorised as vulnerable groups may be more sensitive to the Project’s negative impacts. As such, impact magnitude is **medium**. Receptor sensitivity is expected to be **medium** given the limited number of villages in the area (only one village in 500m of the main development area). The impact significance for community health and safety are expected to be **moderate**.

6.3.11.4 Additional Mitigation, Management and Monitoring

All the mitigation presented in the air, noise and water impact assessment sections will be implemented.

The additional mitigation, management, and monitoring measures are as follows:

- Traffic Management Plan (TMP) should be developed. The Traffic Management Plan should be developed to indicate the traffic routes to be followed and speed limit to be complied with in order to reduce risk to the local communities;
- Develop and implement a Workforce Code of Conduct which will be adhered to by all Contractors and employees. Advise employees to always follow the norms and customs that apply in society.;
- A Stakeholder Engagement Plan should be developed to ensure local communities are kept updated on Project activities;
- A Waste Management Plan should be developed to ensure adequate and legally acceptable control and management of transport and disposal of all wastes on and off site;

- The Project will ensure that signs are put up around construction sites advising people of the risks associated with trespass. All signs should be in diagram form to ensure those with low levels of literacy understand the signs;
- The Project will ensure that there is adequate fencing around construction site to minimise the risk of trespass. Fencing will be checked periodically to ensure that it is in good condition and to look for any signs of entry;
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report); and
- Community grievances in relation to the health and safety issues or activities should be addressed in accordance with the Project's established Grievance Procedure.

6.3.11.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would be reduced to **minor** (***Table 6-62***).

Table 6-62: Impact Assessment for Community Health and Safety: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Potential impacts would be a negative occurrence				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Impact scale is considered small given it is a localized Project.				
Frequency	Impacts will arise continuously from construction related activities.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.12 Impact to Occupational Health and Safety and Workforce

6.3.12.1 Potential Impacts

The following activities can have impacts to occupational health and safety during the Construction Phase of the Project.

- Drilling activities;
- Installation of the transmission line;
- Construction of the power plant and facilities;
- Transportation of equipment, supplies, and workforce; and
- Labour, equipment, and services supply.

The main risks and hazards from working on construction sites include but not limited to:

- Working at height;
- Moving objects;
- Slips, trips, and falls;
- Noise;
- Hand arm vibration syndrome;
- Material and manual handling;
- Electricity;
- Exhaustion due to long working hours;
- Confined spaces; and
- Airborne fibres, materials, organic and inorganic dust and gas.

Apart from particulate matter, the most common air pollutants are SO_2, NO_x, VOCs and CO. The impacts of SOx, CO and particulate emissions on the human health, depending upon the degree of exposure, have been correlated with nausea, localized pains, weakness in extensor muscles, tremors, palpitations, indigestions, dizziness, irritation of eyes, nervousness, and anxiety.

During well drilling and testing, impacts on air quality can be caused by hydrogen sulphide (H_2S) emissions. Carbon dioxide is also in the steam vented out during blow testing, although its emissions are considered negligible compared to fossil fuel combustion sources (IFC EHS Guidelines for Geothermal Power Generation, 2007).

The drilling and construction involves high-risk activities with the potential for accidents that may result in injuries and potential fatalities as well as lost man-hours. Employees of local contractors and those in the supply chain may not have international standard training in occupational health and safety, covering issues such as use of personal protective equipment, and in general, there is poor enforcement of occupational health and safety regulations so the vulnerability of contractors and workers is expected to be **medium**.

6.3.12.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- An **Occupational Health and Safety Plan** will be prepared and implemented covering:
  - Clear signs and signals e.g., safety hat required, no entry due to construction areas, etc.;
  - Provision of appropriate and sufficient Personal Protective Equipment (PPE);
  - Prohibition of drinking or the use of any drugs during work hours;

- Provision of first aid kits and personnel, and emergency unit on site; and
- Provide relevant training to ensure staff are aware of the Health and Safety protocol and requirements of the Project

- The project will comply with Indonesia labour laws (as per ***Chapter 3*** of this ESIA);
- All staff will have medical check-ups prior to commencing work, where required;
- Create and implement an environmental management system for the project. It will include mandatory health and safety training courses for all workers and contractors, including handling of hazardous material. This training will take place prior to work starting on operation. Training course attendance will be recorded and monitored by the Project. The plan shall be issued and approved prior to start any construction activity; and
- Provide workers with the required and appropriate personal protective equipment (PPE) such as eye protection, work gloves and protective boots to undertake site activities.

6.3.12.3 Significance of Impact

6.3.12.3.1 Criteria for Assessing Impact Significance

The sensitivity criteria and impact magnitude criteria for local communities has been provided in ***Table 6-63*** and ***Table 6-64***.

Table 6-63: Criteria for Impact Magnitude for Assessment of Impact to Workers

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or labourers in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the labour workforce.

Table 6-64: Criteria for Workers Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.3.12.3.2 Impact Significance

The receptors are the workforce at the site who, with existing controls in place, are expected to be of **medium** sensitivity. The project involves earthworks, electrical installation, drilling, and use of large machinery and as such, the impact magnitude is expected to be **medium**.

Therefore, the significance of impacts to occupational health and safety is considered to be **moderate.**

6.3.12.4 Additional Mitigation, Management and Monitoring

The additional mitigation, management, and monitoring measures are as follows:

- Installation of hydrogen sulphide monitoring and warning systems. The number and location of monitors should be determined based on an assessment of plant locations prone to hydrogen sulphide emission and occupational exposure;
- Development of a contingency plan for hydrogen sulphide release events, including all necessary aspects from evacuation to resumption of normal operations;
- Monitoring, recording and reporting of Health, Safety and Environmental (HSE) matters as per good international industry practice shall be done on a monthly basis;
- Project should have a healthcare facility on Site which includes a nurse/doctor to treat workers directly whenever possible. This will reduce pressure on the local healthcare facilities. The healthcare workers will be recruited from outside the local villages to avoid impacting existing providers;
- Ensure activities are supervised by trained personnel;
- Suitable training is required for all employees who work at height. Employees should be trained in working on different pieces of equipment and surfaces, such as how to work safely on scaffolding, ladders, and roofs;
- Provide walkways that are clearly designated as walkways, having good conditions underfoot, and being well lit;
- Implement good housekeeping practice as such keeping work and storage areas tidy and designating specific areas for waste collection;
- If a surface is slippery with mud, it should be treated with stone. Any areas that are slippery should be signposted, and footwear with a good grip should be worn;
- Construction workers should be given appropriate protection when using vibrating tools, and equipment should be well maintained;
- Where duties involve manual handling, adequate training must be provided;
- Reversing movements of vehicles and mobile plant should be minimized by providing, where possible, drive through circulation routes. Where reversing is unavoidable, turning heads should be provided and banksmen should be deployed to guide reversing vehicles and plant where necessary; and steps should be taken to ensure that banksmen wear high-visibility safety vests and use walkie-talkie or similar equipment for effective communication;
- Safety reversing devices such as reversing video device (RVD), cross view mirror, parking sensor, and reversing alarm and warning light shall be used when applicable;
- Ensure loading and unloading of material is undertaken as per good international industry practices; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.3.12.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would be reduced to **minor** (***Table 6-65***).

Table 6-65: Impact Assessment for Occupational Health and Safety: Construction Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Occupational health and safety impacts from the construction activities are negative.				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Impact scale is considered small given the localized to the immediate Project Site over 21 months construction.				
Frequency	Impacts will arise continuously from construction related activities.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.3.13 Impact on Employment

6.3.13.1 Potential Impacts

A total of 450 workers are required for peak labour during construction phase. In the construction phase, 77% of labour or 346 persons will be employed from local areas, especially in the Ijen district. It is highlighted that there are training opportunities available to enable some villagers to work in these positions.

According to the social baseline, the main occupations of the local community residing in Ijen District is in the natural resource-based sector, such as farmers and cattlemen. The estimated household income generated from the agricultural sector is around 1,500,000 IDR. The daily wages of farmers range from 35,000 IDR to 50,000 IDR, much lower than the minimum wage of Bondowoso (1,958,640.12 IDR) and Banyuwangi (2,328,899.12 IDR) Regencies in 2022. The employment opportunities of the Project may bring opportunities to generate more income for the local community.

In addition to direct employment, there may be indirect employment opportunities. For instance, the Project or workers require short-term accommodation in nearby towns, or the purchase of goods and services from local businesses. The increased demand may result in an associated increase in employment.

Stakeholder engagement with village heads, religious leaders and youth representatives of Kalianyar Village identified positive impacts associated with the Project, with anticipated benefits, most notably in the form of employment. Furthermore, community perception surveys for the ESIA and the AMDAL demonstrated that community members are anticipating employment opportunities as a result of the Project.

6.3.13.2 Existing Controls

The following controls are committed for the Project:

- The Project will aim to employ local workers where possible.
- The Project has already recruited 50 local workers and will employ additional workers during the construction phase.

6.3.13.3 Significance of Impacts

6.3.13.3.1 Methodology for Assessment of Impact Significance

The potential economic opportunities are assessed in accordance with the criteria set out in ***Table 6-66*** and ***Table 6-67***.

Table 6-66: Social Impact Magnitude Criteria

Magnitude	Definition
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the AoI and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Early evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community
Positive	In the case of positive impacts, it is generally recommended that no magnitude be assigned, unless there is ample data to support a more robust characterisation. It is usually sufficient to indicate that there will be a positive impact, without characterising the exact degree of positive change likely to occur.

Table 6-67: Social Impact Sensitivity Criteria

Sensitivity	Definition
Low	Villagers have low vulnerability/sensitivity; consequently has a high ability to adapt to changes brought by the project
Medium	Some, but few areas of vulnerability/sensitivity; retaining an ability to at least adapt in part to change brought by the project
High	Profound or multiple levels of vulnerability/vulnerability/sensitivity that undermine the ability to adapt to changes brought by the project

6.3.13.3.2 Impact Significance

The employment impact to the local community mainly will bring the economic opportunities and improve local livelihood of the community. Considering the estimated monthly income from the primary form of livelihood in the Project area is lower than the minimum wages of the Regencies and positive perception including expectation of employment opportunities as a result of the Project.

The impact magnitude is **positive** as economic opportunities allow affected villagers to improve their livelihoods.

Based on the above, the impact significance of economic opportunities manifested through local employment and training opportunities has a **positive** impact significance.

6.3.13.4 Additional Mitigation, Management, and Monitoring Measures

Employment recruitment to the local community considered as a positive impact. However, the recruitment mechanism and processes need to be carried out properly to manage the expectations from the local community toward the Project. The following additional mitigation measures are proposed:

- Ensure the recruitment process of the local workers will be carried out in an open and transparent manner.
- Prioritize the Project affected people, vulnerable group, including the local workforce in Ijen District if possible.
- Involve and collaborate with the village government for the local worker's recruitment

6.3.13.5 Residual Impact Significance

The residual impact significance of the impact of economic opportunities for affected villagers remains **Positive**.

Table 6-68: Impact Assessment for Employment

Impact Significance					
Impact Nature	Negative		Positive		Neutral
	Employment recruitment impacts from the construction activities are positive (job creation)				
Impact Type	Direct		Indirect		Induced
Impact Duration	Temporary	Short-term		Long-term	Permanent
Impact Extent	Local		Regional		International
Impact Scale	The scale of the impact is likely to be localised to the Project Site.				
Frequency	Impacts will arise through pre-construction and construction phase.				
Impact Magnitude	Positive	Low		Medium	High

6.3.14 Impact on Traffic

Level of Service (LOS) is a qualitative measure used to relate the quality of motor vehicle traffic service. LOS is used to analyze roadways and intersections by categorizing traffic flow and assigning quality levels of traffic based on performance measure like vehicle speed, density, congestion, etc. LOS is generally presented as Levels A to F, which are defined as follows:

- LOS A: Free-flow traffic with individual users virtually unaffected by the presence of others in the traffic stream.

- LOS B: Stable traffic flow with a high degree of freedom to select speed and operating conditions but with some influence from other users.
- LOS C: Restricted flow that remains stable but with significant interactions with others in the traffic stream. The general level of comfort and convenience declines noticeably at this level.
- LOS D: High-density flow in which speed and freedom to maneuver are severely restricted and comfort and convenience have declined even though flow remains stable.
- LOS E: Unstable flow at or near capacity levels with poor levels of comfort and convenience.
- LOS F: Forced traffic flow in which the amount of traffic approaching a point exceeds the amount that can be served. LOS F is characterized by stop-and-go waves, poor travel times, low comfort and convenience,

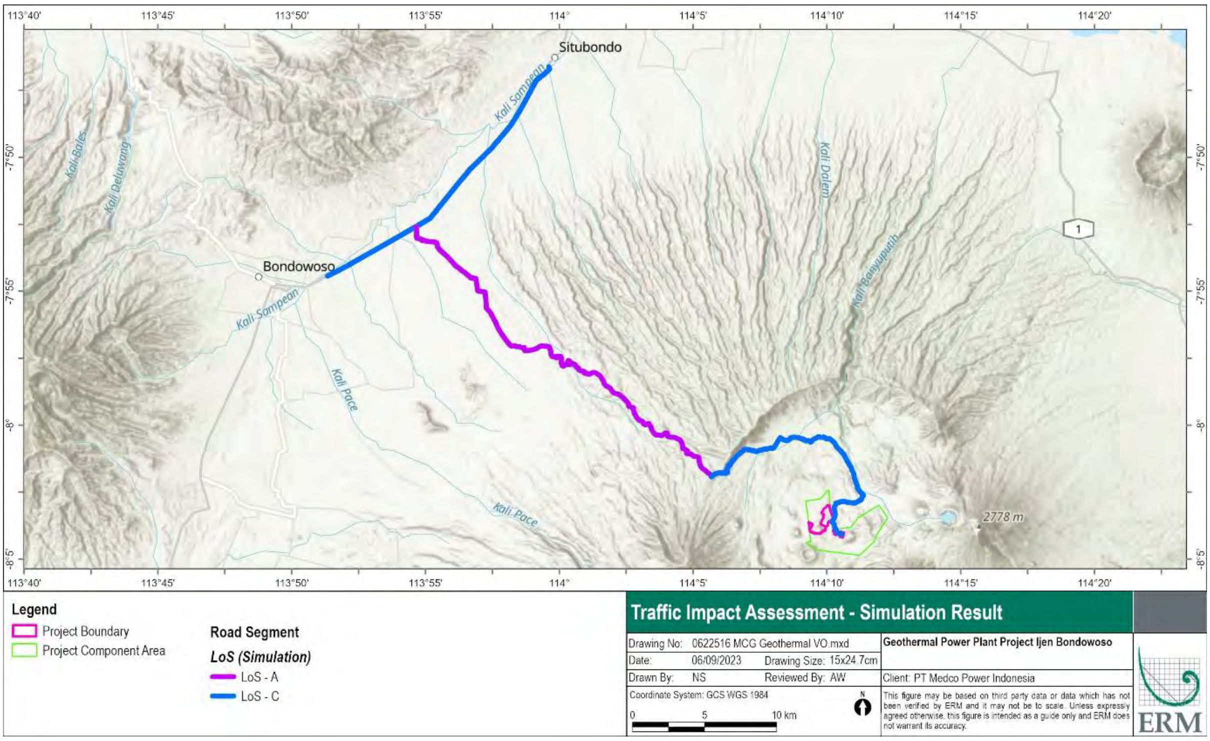
The Project will generate additional traffic during the construction phase as a result of workers commuting to the site as well as truck deliveries of equipment and supplies. The equipment and supplies will primarily be transported via Surabaya-Progolinggo Road and continue using the national road to Bondowoso Regency. This additional vehicular traffic was added to the existing traffic volumes on the same 14 road segments discussed in the baseline chapter. As ***Table 6-69*** indicates, all road segments would maintain the same LOS as pre-construction levels (I.e., LOS A to C). LOS is a qualitative measure used to relate the quality of motor vehicle traffic service (see ***Figure 6-64***)

Table 6-69: Simulation of Road Traffic Performance in the Construction Phase in 2021

No	Road Name	Capacity	Volume (PCE*/hour)	VCR**	Speed (km/hour)	LOS
1	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 1 to Situbondo	1298	928.5	0.72	53.25	C
2	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 1 to Situbondo	1298	991.25	0.76	50.85	C
3	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 2 to Situbondo	1298	984.5	0.76	51.10	C
4	Jl. Bts. Kota Bondowoso - Bts. Kab. Situbondo to Bondowoso 2 to Bondowoso	1298	890.75	0.69	54.73	C
5	Jl. Kawah Ijen 1 to Ijen	960	289.5	0.30	48.58	A
6	Jl. Kawah Ijen 1 to Wonosari	960	320.5	0.33	47.69	A
7	Jl. Kawah Ijen 2 to Ijen	960	266.75	0.28	49.20	A
8	Jl. Kawah Ijen 2 to Wonosari	960	279	0.29	48.87	A
9	Jl. Kawah Ijen 3 to Ijen	960	226.75	0.24	50.20	A
10	Jl. Kawah Ijen 3 to Wonosari	960	224.75	0.23	50.25	A
11	Jl. Raung Sumber to Sumberwringin	960	73.5	0.08	52.69	A
12	Jl. Raung Sumber to Wonosari	960	83.75	0.09	52.60	A
13	Jl. Kawah Ijen 4 to Ijen	960	131.25	0.14	52.03	A

No	Road Name	Capacity	Volume (PCE*/hour)	VCR**	Speed (km/hour)	LOS
14	Jl. Kawah Ijen 4 to Wonosari	960	113.5	0.12	52.27	A

Figure 6-3: Simulation of Road Traffic Performance in the Construction Phase in 2021



During stakeholder consultations, several complaints were noted regarding traffic levels and traffic congestion during the exploration stage. In order to avoid these same issues occurring again during the construction phase, the Project proposes to implement the following measures;

- Equipment and supplies delivery will be carried out in stages and during off-peak hours to reduce traffic congestion;
- Heavy vehicles, like those causing the delays that local residents were complaining about, will be limited to night-hours and will be escorted by police.

Based on this analysis, it is concluded that the Project would have minor impact on local roads during construction as indicated by their LOS.

6.4 Operational and Maintenance Phase – Impact Assessment

This section provides the impact assessment for the operational and maintenance phases of the Project based on the impacts scoped into the assessment.

6.4.1 Impact to Surface and Groundwater

6.4.1.1 Source of Impact

The following activities can have impacts to surface and groundwater quality during the Operational Phase of the Project.

- Operation and maintenance of power plant and transmission line.

The operational phase will include wastewater from the office, which will be treated through sewage treatment plant/ Septic Tank. Wastewater shall be treated and re-used as process water. The only discharge into the surface waters will be treated water. In addition, there will be domestic solid waste during operation, which will be collected and segregated for recyclable and non-recyclable waste (i.e., paper, plastic). All waste will be disposed to a designated waste facility.

If the above wastes are not stored and disposed of appropriately, they have the potential to cause impacts to surface water quality through leakage or rainfall runoff, and groundwater quality through leaching processes.

The majority of the generated wastes from the Project during the operation phase will be non-hazardous. A small proportion of the waste generated will be hazardous, including used paint, engine oils, hydraulic fluids, and waste fuel, spent solvents from equipment cleaning activities, and spent batteries or spent acid/alkali from the maintenance of machinery on site.

Based on previous experience with similar projects, the total approximate quantities of non-hazardous and hazardous waste that could be a potential source of impact during this stage (assuming a maximum of 70 workers per day) include:

- 50-100 kg/day of solid (non-hazardous) waste; and
- 20-30 kg/month hazardous waste.

6.4.1.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- The Project Proponent will handle, store and dispose of all waste in accordance with applicable guidelines;
- All discharges will be in compliance with national standards and WBG EHS guidelines (as provided in ***Chapter*** **2**);
- Site drainage facilities should be developed following the design basis below:
  - Designed to convey the runoff from a 100 years' rainfall event.
  - Provide oily water separator at the tie-in point of the existing drainage system.
  - Convey surface runoff and roof drainage away from the equipment and buildings.
- Conduct monthly water quality sampling at least at one location upstream of water intake and one location downstream of Project influence for the normal suite of parameters, including the anticipated chemical constituents of the geothermal liquids;
- Water resource mitigation measures:
  - Install a continuous water level recorder on the abstraction location at the existing stream gauge near MCG's proposed water intake to develop a flow record that would allow for better management of the water resource; and
  - Reuse treated storm water onsite where possible to meet some of the water needs of the Project.
- All drainage facilities and sediment control structures will be inspected on a regular basis and maintained to confirm proper and efficient operation at all times and particularly during rainstorms. Deposited silt and grit will be removed regularly.

6.4.1.3 Significance of Impact

6.4.1.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for water has been provided in ***Table 6-70*** and ***Table 6-71***, respectively.

Table 6-70: Criteria for Impact Magnitude for Assessment of Impact to Water

	Extent / Duration / Scale / Frequency
Large	Change in water quality over a large area that lasts over the course of several months with quality likely to cause secondary impacts on marine ecology; and/or routine exceedance of benchmark effluent discharge limits.
Medium	Temporary or localised change in water quality with water quality returning to background levels thereafter and/or occasional exceedance of benchmark effluent discharge limits.
Small	Slight change in water quality expected over a limited area with water quality returning to background levels within a few metres and/or discharges are well within benchmark effluent discharge limits.
Negligible	Immeasurable, undetectable or within the range of normal natural variation.

Table 6-71: Criteria for Water Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Existing water quality is already under stress and/ or the ecological resources it supports are very sensitive to change (secondary ecological or health impacts are likely).
Medium	Existing water quality already shows some signs of stress and/ or supports ecological resources that could be sensitive to change in water quality.
Low	Existing water quality is good and the ecological resources that it supports are not sensitive to a change in water quality.

6.4.1.3.2 Impact Significance

The impact on surface and ground water during operation is related to wastewater disposal and waste management from the maintenance works. The impact will be localised and short-term and with the above mentioned industry practice mitigation measures in place, the magnitude of the impact is considered to be **small**. The receptor sensitivity is considered **medium**. The impact significance associated with surface water and groundwater during the operation is considered **Minor**.

6.4.1.4 Additional Mitigation and Management

No additional mitigation is considered to be required for the operation of the Project.

6.4.1.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would remain **minor** (***Table 6-72***).

Table 6-72: Impact Assessment for Surface and Groundwater Quality: Operational Phase

Impact Significance							
Impact Nature	Negative		Positive			Neutral	
	Surface water quality impact from the operation activities is negative.						
Impact Type	Direct		Indirect			Induced	
Impact Duration	Temporary	Short-term		Long-term		Permanent	
Impact Extent	Local		Regional			International	
Impact Scale	Localised around the power plant area.						
Frequency	Impacts will arise continuously from operation related activities.						
Impact Magnitude	Positive	Negligible	Small		Medium		Large
Resource Sensitivity	Low		Medium			High	
Impact Significance	Negligible	Minor		Moderate		Major	

6.4.2 Impact on Landscape and Visual

6.4.2.1 Potential Impacts

6.4.2.1.1 Landscape

Landscape sensitivity can be assessed by the ability of a particular landscape character to absorb aesthetic alterations. Landscape impacts may occur upon a landscape characteristic as a direct result of the presence of the Project within an area of a particular landscape character. The area identified for the Project has a predominant abundance of cropland and grassland.

The presence of the transmission line towers is likely to cause impacts to landscape value. The Project key activities that are likely to have negative impacts on landscape include:

- Site preparation, excavation and filling works;
- Installation of the transmission line;
- Power plant construction; and
- Storage, handling and disposal of waste and materials.

The construction and operation activities associated with the Project—including land clearance, grading, excavated material disposal, and placement—have the potential to impact the landscape.

6.4.2.1.2 Visual

Visual impacts refer mainly to the visual character changes of available views resulting from project development, such as:

- obstruction of existing views;
- removal of screening elements, thereby exposing viewers to unsightly views;
- the introduction of new elements into the views;
- and intrusion of foreign elements into the viewshed of landscape features.

The presence of the towers for the transmission line is likely to cause impacts to visual.

6.4.2.2 Existing Controls

The controls to be implemented for the Project will include the following:

- The extent of the construction areas should be limited where possible to minimise impact to surrounding area; and
- Cut and fill slopes as well as areas disturbed by construction activity are suitably top soiled and vegetated / covered as soon as is possible after final shaping.
- Demarcate Project boundaries and minimize areas of surface disturbance;
- Where possible locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation;
- Maintenance of construction site – good housekeeping on site to avoid litter and minimize waste.
- Existing tracks/roads should be used for access where possible;
- Minimize night lighting in order to guarantee the minimum safety level;
- Foreseen within the environmental management system, the preparation of a restoration management plan including indigenous species replanting, construction yards landscaping and rehabilitation; and
- Structures should have a non-reflective finish and the colour should be appropriate in order to merge itself as much as possible within the landscape.

6.4.2.3 Impact Evaluation and Significance

The assessment of impacts on landscape and visual amenity was undertaken in accordance with accepted methodologies derived from best practice guidelines.

Impact significance for landscape and visual amenity is generally derived on the basis of the following main factors:

- The quality/importance of the landscape/visual amenity as a resource/function that is potentially affected;
- The sensitivity of the landscape/visual amenity towards Project activities;
- The magnitude of change to the receiving landscape and visual amenity as a result of the Project.

6.4.2.4 Criteria for Assessing Impact Significance - Landscape

The impact magnitude and receptor sensitivity criteria for landscape has been provided in ***Table 6-28*** and ***Table 6-29***, respectively.

Table 6-73: Landscape Magnitude of Effect Criteria

	Extent / Duration / Scale / Frequency
Large	A clearly evident and frequent /continuous change in landscape characteristics affecting an extensive area.
Medium	A moderate change in landscape characteristics, frequent or continuous, and over a wide area, or a clearly evident change either over a restricted area or infrequently perceived.
Small	A small change in landscape characteristics over a wide area or a moderate change either over a restricted area or infrequently perceived.
Negligible	An imperceptible, barely or rarely perceptible change in landscape characteristics.

Table 6-74: Landscape Sensitivity Criteria

Category	Designation / Importance / Vulnerability
High	A landscape protected by a regional (structure plan) or national designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.
Medium	A landscape protected by a structure plan or national policy designation and/ or widely acknowledged for its quality and value; a landscape with distinctive character and low capacity to accommodate the type of change envisaged.
Low	A moderately valued landscape, perhaps a locally important landscape, or where its character, land use, pattern and scale may have the capacity to accommodate a degree of the type of change envisaged.

6.4.2.5 Impact Significance - Landscape

The potential impacts from the construction phase likely to have negative impacts on landscape, will include mainly vegetation clearance and site preparation (excavation) for both the geothermal plant and the transmission line construction. Impacts will be limited to areas adjacent to the Project.

Although the area is characterized by numerous tourist sites, it is considered to have good capacity to absorb the type of change envisaged by the Project, which is why the sensitivity of the landscape resource (LCU A and LCU B) is expected to be **medium**. Intangible cultural heritage is not expected to be impacted by the Project as the construction and operation activities do not affect natural spaces or species with spiritual, cultural or religious importance; cultural value placed on traditional practices such as hunting, fishing, crafts and use of natural resources; cultural value placed on the aesthetic value provided by landscapes, natural landmark; information derived from ecosystems used for intellectual development, culture, art, design, and innovation or ornamental resources. The stakeholders consulted during the ESIA process did not raise any concerns related to tangible or intangible assets with some community members perceiving the Project to have a positive impact on tangible and intangible cultural heritage by continuing the existing community development program, especially in providing assistance to renovate worship facilities (mosques). The magnitude of change of landscape would be **medium**.

As such, the significance of impacts due to change in landscape is considered to be **moderate.**

6.4.2.6 Criteria for Assessing Impact Significance - Visual

The impact magnitude and receptor sensitivity criteria for visual amenity has been provided in ***Table 6-28*** and ***Table 6-29***, respectively.

Table 6-75: Visual Magnitude of Effect Criteria

	Extent / Duration / Scale / Frequency
Large	Major changes in view at close distances, affecting a substantial part of the view, continuously visible for a long duration, or obstructing a substantial part or important elements of the view.
Medium	Clearly perceptible changes in views at intermediate distances, resulting in either a distinct new element in a significant part of the view, or a more wide-ranging, less concentrated change across a wider area.
Small	Minor changes in views, at long distances, or visible for a short duration, perhaps at an oblique angle, or which blends to an extent with the existing view.
Negligible	A change which is barely visible, at very long distances, or visible for a very short duration, perhaps at an oblique angle, or which blends with the existing view.

Table 6-76: Visual Sensitivity Criteria

Category	Designation / Importance / Vulnerability
High	Larger numbers of viewers and/or those with proprietary interest and prolonged viewing opportunities such as residents and users of attractive and well-used recreational facilities. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being high.
Medium	Small numbers of residents and moderate numbers of visitors with an interest in their environment. Larger numbers of recreational road users. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being medium.
Low	Small numbers of visitors with interest in their surroundings. Viewers with a passing interest not specifically focussed on the landscape e.g. workers, commuters. The quality of the existing view, as likely to be perceived by the viewer, is assessed as being low.

6.4.2.7 Impact Significance - Visual

When determining the significance of visual effects, the following is taken into account:

- Large scale changes which introduce new discordant or intrusive elements into the view are more likely to be significant than small changes or changes involving features already present in the view;
- Changes in views from recognized and important viewpoints or amenity routes are likely to be more significant than changes affecting less important paths and roads; and
- Changes affecting large numbers of people are generally more significant than those affecting a relatively small group of users. However, in wilderness landscapes the sensitivity of the people who use the areas may be very high and this will be reflected in the significance of effect.

The visual impact is a product of the magnitude of change to the existing baseline conditions, the landscape context, and the sensitivities of Visual Sensitive Receptors (VSRs).

The viewshed analysis shows that the proposed towers have the potential to be visible in the nearby areas, although not continuously due to the variability of the landscape for the area surrounding the Project and the presence of vegetation.

Specific considerations were made for each VSR, and the impact significance, receptor sensitivity, and impact magnitude is summarized in ***Table 6-32***.

Table 6-77: Summary of Visual Impact

VSR	Site	Sensitivity of receptor	Magnitude of visual effect	Significance of visual effect
VSR01	Near the Karona Berg Homestay and Cafe	Medium	Medium	Moderate
VSR02	In a field to the right of to the Gantasan Bike Park	Medium	Small	Minor
VSR03	On the Jl. Kawah Ijen road, after the Erek Erek Geoforest	Low	Small	Negligible
VSR04	At the Bukit Harapan, IJEN, on the road	Medium	Medium	Moderate
VSR05	After the Air Terjun Ijen, on the road to the Plant	Medium	Negligible	Negligible
VSR06	In the Pal Pakis town	Medium	Small	Minor
VSR07	On the road near Masjid Nur Rohmah	Low	Medium	Minor
VSR08	On the road outside the Banyuwangi Substation	Low	Negligible	Negligible
VSR09	In a field near Warung Pangklang jpl 16 cafe	Low	Negligible	Negligible
VSR10	On the road to SD Negeri Kalianyar Dsn Curah Macan school	Low	Negligible	Negligible
VSR11	On the road to the Plant, after VSR 5	Low	Small	Negligible
VSR12	On the road, about 2 km from the SD Negeri Kalianyar Dsn Curah Macan school	Low	Small	Negligible
VSR13	On the road to the Plant, before Pos 3 Margahayu office	Medium	Negligible	Negligible
VSR14	Near the creek at Air Terjun Ijen	Medium	Negligible	Negligible
VSR15	On the road near the creek and VSR 14	Medium	Negligible	Negligible
VSR16	At the Bondowoso sign near Warkop Sederhana Cafe	Medium	Medium	Moderate
VSR17	At the Injection Wellpad 2 site	Low	Small	Negligible
VSR18	On the road near Vicky AMS Retail 3	Medium	Medium	Moderate

6.4.2.8 Additional Mitigation Measures

Landscape Value

In order to mitigate the landscape impacts, there are different actions that should be considered, especially during the construction phase, such as:

- Demarcate construction boundaries and minimize areas of surface disturbance;
- Where possible, locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation;
- For the construction site maintenance, conduct good housekeeping on site to avoid litter and minimize waste;
- Use existing tracks/roads for access, where possible; and
- Within the environmental management system, prepare a restoration management plan including replanting indigenous species, and landscaping and rehabilitating construction yards.

Visual

The following identifies mitigation measures to be applied for visual impacts, including:

- Where possible, locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation;

- For the construction site maintenance, conduct good housekeeping on site to avoid litter and minimize waste;
- Minimize night lighting while guaranteeing the minimum safety level;
- Use of materials that will minimize light reflection should be used for all Project components; and
- Existing vegetation should be retained to the greatest extent possible. Vegetation should be retained along roads, and other Project infrastructure.

6.4.2.9 Residual Impact Significance

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would be ***Minor*** to ***Moderate*** (***Table 6-33***).

Table 6-78: Residual Impact Assessment for Landscape and Visual

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Landscape and topography impact from the construction activities is negative.				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	Impact scale is considered small given the construction activities will only be mainly visible to the visual sensitive receivers within the Project Area of Influence.				
Frequency	Impacts will arise continuously from construction related activities				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.4.3 Impact on Biodiversity

6.4.3.1 Potential Impacts

The following activities can have impacts to terrestrial flora during the operation Phase of the Project.

- The operation of power plant;

- The operation of transmission line;
- The ROW maintenance.

Impacts to biological resources can be divided into two broad categories: direct and indirect. Direct impacts consist of physical disturbance or damage to a habitat or species. Examples include, but are not limited to:

- Disturbance of habitat due to maintenance of RoW; and
- Mortality Avifauna Infrastructure Strike.

6.4.3.2 Impact Evaluation and Significance

6.4.3.2.1 Criteria for Assessing Impact Significance

The biodiversity receptors used in this assessment have the following importance ratings:

- Terrestrial Vegetation and Habitat – Medium importance because of the disturbed nature of the majority of the vegetation and habitats in the Project Area, the dominance of common and widespread vegetation species, and the habitat's high regenerative capacity. However, some portion of impacted area will be natural secondary forest that adjacent with the protected areas of Kawah Ijen and potential habitat for the critical habitat trigger species.
- Terrestrial Wildlife – Medium importance because of the relatively high diversity of species that occur in and around the Project Area, including species listed as Endangered by the International Union for the Conservation of Nature (IUCN), and the use of the area as a wildlife movement corridor across Kawah Ijen nature reserve.
- Rare and restricted range species – High importance because of the mix of IUCN Red List Vulnerable and Endangered species and restricted range species that occur within and around the Project Area.
- Protected Areas – High importance due to their nationally protected status and their importance to the maintenance of rare and restricted range species populations.

The impact magnitude and receptor sensitivity criteria for biodiversity has been provided in ***Table 6-35*** and ***Table 6-36***, respectively.

6.4.3.2.2 Impact Significance

Additional impacts to the habitat during operation phase is expected resulted from the maintenance of RoW. The impacts are expected to be minor impact since the dedicated RoW is considered disturbed area.

Impact during from the maintenance of RoW can cause disturbances to the surrounding habitats particularly the transmission area surrounding Kawah Ijen Natural Reserve area which known to be habitat for conservation significance species.

The sensitivity of the habitats within the RoW is considered to be **Medium,** due to some part of the project is adjacent to the Kawah Ijen Natural reserve area, and therefore specific attention to this area is required.

The magnitude of effect is likely to be **small** as it will only occur in very short period and at limited area without causing loss of viability/function of the habitat. The overall impact is therefore likely to be **Minor**
Mitigation Measures.

6.4.3.3 Additional Mitigation, Management, and Monitoring Measures

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- Apply same mitigation approach for terrestrial habitat loss mitigation;
- No clearing any habitat of Kawah Ijen Nature Reserve area;
- Provide sufficient buffer space of transmission line ROW to avoid clearing the part of Kawah Ijen Nature Reserve area;
- Active coordination with local ranger officer to define safe area for clearing, placing equipment and temporary camp.

The following monitoring measures are recommended:

- Apply same monitoring approach for terrestrial habitat loss mitigation.

6.4.3.4 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact is to reduce to **Negligible** (***Table 6-79***).

Table 6-79: Impact Assessment for Disturbance of Habitat due to Maintenance of RoW: Operation Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Non Protected and conserved species within Balawan River				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is likely to be local				
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.4.3.4.1 Mortality Avifauna and Bat due to Infrastructure Strike

6.4.3.4.2 Impact Significance

It is understood that the surrounding project site is known to be habitat for conservation significance of birds and bats species, these species include the Javan leafbird (*Chloropsis cochinchinensis*) – endangered; Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; and some endemic but not restricted range of vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*).

Collide with the transmission line causing individual mortality of birds and bats including the above-mentioned conservation significance of birds and bats species. The present of the transmission line will be long time and the risk of collision will be present along the operation of the transmission line.

Given the present of endangered and potential present of restricted range species within the project area, the sensitivity of the species is considered **High**. The magnitude of effect is likely to be **Medium** as the effect may affect a portion of a population and may bring about a change in abundance and/ or distribution over one or more generations. The overall significance of this impact is therefore **Major** for the species.

6.4.3.4.3 Additional Mitigation, Management, and Monitoring Measures

The Avoidance measures for mortality of bats and avifauna due to infrastructure strike are not possible to be applied. Therefore, mitigation measures are recommended to be implemented to minimise the impact.

It is recommended that the following mitigation measures be applied in relation to habitat impacts during construction:

- Use of bird deflectors on the length of the power line. The deflectors will increase line visibility by thickening the appearance of the line for easier detection by avifauna;
- Moveable markers of contrasting colours (e.g., black and white) that protrude above and below the line, and be placed 5-10 m apart;
- Removing the thin neutral or earth (shield) wire above the high voltage transmission lines where feasible, and where this is not possible, marking the line to make it more visible;
- Minimising the vertical spread of power lines. Having lines in a horizontal plane reduces collision risk;
- Habitat manipulation to influence flight activity and bird behaviour, e.g., tree lines under the high voltage lines to increase visibility;
- Insulating cables close to poles, at least 70 cm on both sides and around perching areas, and up to at least 140cm; and
- Hanging insulators under cross arms and poles, provided the distance between a likely perch (mainly the transmission tower crossarm) and the energised parts (conductors) is at least 70 cm.

The following monitoring measures are recommended:

- Regular inspections of the transmission line routes (3 monthly) during construction is to occur to identify any fauna mortality that has occurred. Where patterns in species mortality or conservation significance species are identified, advice from a suitably qualified person should be sought to alter mitigation measures to reduce future potential impacts.

6.4.3.4.4 Residual Impact Significance

In view of the implementation of mitigation measures, the residual impact remains of **Minor** significance (***Table 6-80***).

Table 6-80: Impact Assessment for Species Mortality Avifauna and Bat due to Infrastructure Strike: Operation Phase

Impact Significance				
Impact Nature	Negative	Positive	Neutral	
	Potential impact to the rare or restricted range species; Javan leafbird (*Chloropsis cochinchinensis*) – endangered; Javan Hawk-eagle (*Nisaetus bartelsi*) – Endangered; Javan Blue-banded Kingfisher (*Alcedo euryzona*) – Critical Endangered; and some endemic but not restricted of vulnerable species like Javan Tailless Fruit Bat (*Megaerops kusnotoi*), White-faced Partridge (*Arborophila orientalis*), Javan Scops-owl (*Otus angelinae*), and Javan Flameback (*Chrysocolaptes strictus*			
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional	International	
Impact Scale	The scale of the impact is likely to be local			
Frequency	Impacts will arise intermittently from land preparation activities and installation of the power plant and transmission line.			
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High	
Impact Significance	Negligible	Minor	Moderate	Major
Residual Magnitude	Negligible	Small	Medium	Large
Residual Impact significance	Negligible	Minor	Moderate	Major

6.4.4 Impacts to Tourism

6.4.4.1 Potential Impacts

The following activities can have impacts to infrastructure service during the Operational Phase of the Project.

- Presence of the power plant, wells pads and transmission lines.

Issues from tourism can include restriction of access to hiking / tourism sites and landscape and visual impacts from presence of facilities. The visual impact is discussed in ***Section 6.3.5***.

Impacts will be similar to those discussed in ***Section 6.3.9.***

6.4.4.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- Existing controls for visual and landscape (***Section 6.3.5***) should be adopted; and
- Establish and implement a Grievance Mechanism.

6.4.4.3 Significance of Impact

6.4.4.3.1 Criteria for Assessing Impact Significance

The impact magnitude and receptor sensitivity criteria for tourism has been provided in ***Table 6-81***, and ***Table 6-82***, respectively.

Table 6-81: Criteria for Impact Magnitude for Assessment of Impact to Tourism

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 6-82: Criteria for Tourism Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.4.4.3.2 Impact Significance

The main Project Site is located next to the Kawah Warang (Wurung) Park which is a tourism hiking area known for scenic views and a number of crater features such as Kawah Wurung and Kawah

Ilalang which are adjacent to the access road and transmission line respectively. The transmission line runs adjacent to Kawah Ijen. This crater is a popular tourism site as is located within the Kawah Ijen Crater Park. At its closest point, this tourism site is located 300 m from the transmission line route and around 2.5 km from the main construction area.

There is likely to be a visual impact from the operation of the Project on local craters that are utilised for panoramic views.

Given that both the power plant and transmission line are within 500 m of tourism sites, the impact magnitude is considered to be **medium**. The receptor sensitivity is **high** resulting in **major** impact significance**.**

6.4.4.4 Additional Mitigation, Management and Monitoring

Additional mitigation, management, and monitoring measures are as follows:

- Landscape planting will be implemented by planting native tree species which are fast growing in nature;
- There will be no restriction on access to local tourism sites. Activities should be conducted in consultation with local tourism operators and relevant ministries;
- Do not allow the workforce to stay in local guesthouses to ensure that space for tourists is not impacted by the Project;
- Develop and implement a Stakeholder Engagement Plan (SEP) and Grievance Mechanism; including communication with local tourism operators. Tourism operators should be consulted on the need to conduct a Visual Impact Assessment. If this is deemed necessary by operators, this should be conducted;
- At least four weeks prior to construction activities, relevant authorities and stakeholders (i.e., local tourism operators, tourism associations, and local villagers) will be alerted to the final works area design as well as the construction programme and any specific restrictions;
- Continual engagement will be undertaken with stakeholders to assess the impacts of restricted access to hiking trails;
- Community grievance mechanism will record the number of persons raising grievances and recorded and documented measures to addressed grievances; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.4.4.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would reduce to **moderate** (***Table 6-83***).

Table 6-83: Impact Assessment for Tourism: Operational Phase

Impact Significance					
Impact Nature	Negative	Positive	Neutral		
	Tourism impacts from the construction activities are negative.				
Impact Type	Direct	Indirect	Induced		
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local	Regional	International		
Impact Scale	The scale of the impact is permanent likely to be localised to heritage sites within 500 m of the Project such as the craters.				
Frequency	Impacts will arise throughout the operational phase.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Impact Magnitude	Negligible	Small	Medium	Large	
Impact Significance	Negligible	Minor	Moderate	Major	

6.4.5 Impact to Community Health and Safety

6.4.5.1 Potential Impacts

The following activities can have impacts to community health and safety during the Operation Phase of the Project.

- Operation of the power plant and transmission lines.

The influx of workers and in-migration could change the disease profile in the community resulting in declining community health and well-being. The handling, transport and treatment of the Project waste during construction may also result in risks to public health due to contamination of water resources and spread of disease carrying species such as rats.

The in-migration of workers may change community dynamics. It is anticipated that the nominated EPC Contractor will be a foreign company and may hire foreign workers for the Project. Cultural differences have the potential to cause friction in the community, especially if local customs and traditions are not respected by workers.

During public consultation for the Project, local communities were concerned about accidents, these are discussed in ***Section 6.5***.

6.4.5.2 Existing Controls / Mitigation

The controls to be implemented for the Project will include the following:

- All workers, except those based in Project Area, will be accommodated in the labour camp during operation;
- Provide training on the most common communicable diseases to all workers to raise awareness of the likely diseases, symptoms, preventative measures, transmission routes, and treatment;
- Ensuring health check-ups of all labourers employed to screen pre-existing communicable diseases;
- Provide access for workers to healthcare services (facilities) and medical care;
- Community grievances in relation to the conduct of security personnel and safety issues or activities should be addressed in accordance with the Project established Grievance Procedure;
- As part of the stakeholder engagement activities, communities near the Project Area should be informed about the risks and consequences of trespassing. Such engagement should start prior to the start of construction activities; and
- Speed limit of 20 km/h shall be enforced within the Project site.

6.4.5.3 Significance of Impact

6.4.5.3.1 Criteria for Assessing Impact Significance

The sensitivity criteria and impact magnitude criteria for local communities has been provided in ***Table 6-84***, and ***Table 6-85***, respectively.

Table 6-84: Criteria for Impact Magnitude for Assessment of Impact to Local Communities

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 6-85: Criteria for Local Community Receptor Sensitivity

Magnitude	Criteria
Negligible	Project does not impact on environmental, health and safety issues to the surrounding community as the project implements good international industry practices and environmental, health, safety guidelines, following national law/regulations on Environmental, Health and Safety as well as other Recognised internationally sources.
Small	Project will impact on community health, safety and security within villages in the AoI.
Medium	Project will impact on community health, safety and security at regional level.
Large	Project impacts on community health, safety and security at a national level.

6.4.5.3.2 Impact Significance

In terms of the work force, there will be around 70 workers during operation. As such, impact magnitude is **small**. Receptor sensitivity is expected to be **medium** given the number of villages in the area. The impact significance for community health and safety are expected to be **minor**.

6.4.5.4 Additional Mitigation, Management and Monitoring

All the mitigation presented in the air, noise and water impact assessment sections will be implemented.

The additional mitigation, management, and monitoring measures are as follows:

- Traffic Management Plan (TMP) should be developed. The Traffic Management Plan should be developed to indicate the traffic routes to be followed and speed limit to be complied with in order to reduce risk to the local communities;
- Develop and implement a Workforce Code of Conduct which will be adhered to by all Contractors and employees;
- A Stakeholder Engagement Plan should be developed to ensure local communities are kept updated on Project activities;
- A Waste Management Plan should be developed to ensure adequate and legally acceptable control and management of transport and disposal of all wastes on and off site;
- The Project will ensure that there is adequate fencing around the site to minimise the risk of trespass. Fencing will be checked periodically to ensure that it is in good condition and to look for any signs of entry;
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report); and
- Community grievances in relation to the health and safety issues or activities should be addressed in accordance with the Project's established Grievance Procedure.

6.4.5.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the above-recommended additional mitigation and management measures, it is expected that the residual impact significance would remain **minor** (***Table 6-86***).

Table 6-86: Impact Assessment for Community Health and Safety: Operational Phase

Impact Significance				
Impact Nature	Negative	Positive	Neutral	
	Potential impacts would be a negative occurrence			
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional	International	
Impact Scale	Impact scale is considered small and localised to the main site and long term over the construction period (21 months)			

Impact Significance					
Frequency	Impacts will arise continuously from operation.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High		
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Magnitude	Negligible	Small	Medium	Large	
Residual Impact significance	Negligible	Minor	Moderate	Major	

6.4.6 *Impact to Occupational Health and Safety*

6.4.6.1 *Source of Impact*

The following activities can have impacts to occupational health and safety during the Operational Phase of the Project.

- Operation and maintenance of the power plant and transmission line.

The expected impacts due to the maintenance of the power plant and transmission line during operation will be similar to those discussed in the construction phase (***Section 6.3.12***) with less risks linked to spread of disease as the number of employees will be much less than during construction phase.

6.4.6.2 *Existing Controls / Mitigation*

The controls that committed to be implemented for the Project will include the following:

- An **Occupational Health and Safety Plan** will be prepared and implemented covering:
  - Clear signs and signals e.g., safety hat required, no entry due to construction areas, etc.;
  - Provision of appropriate and sufficient Personal Protective Equipment (PPE);
  - Prohibition of drinking or the use of any drugs during work hours;
  - Provision of first aid kits and personnel, and emergency unit on site; and
  - Provide relevant training to ensure staff are aware of the Health and Safety protocol and requirements of the Project
- The project will comply with Indonesia labour laws (as per ***Chapter 2*** of this ESIA);
- All staff will have medical check-ups prior to commencing work, where required;
- Create and implement an environmental management system for the project. It will include mandatory health and safety training courses for all workers and contractors, including handling of hazardous material. This training will take place prior to work starting on operation. Training course attendance will be recorded and monitored by the Project. The plan shall be issued and approved prior to start any construction activity; and
- Provide workers with the required and appropriate personal protective equipment (PPE) such as eye protection, work gloves and protective boots to undertake site activities.

6.4.6.3 Significance of Impact

6.4.6.3.1 Criteria for Assessing Impact Significance

The sensitivity criteria and impact magnitude criteria for local communities has been provided in ***Table 6-87***, and ***Table 6-88***, respectively.

Table 6-87: Criteria for Impact Magnitude for Assessment of Impact to Local Communities

	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

Table 6-88: Criteria for Local Community Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.

6.4.6.3.2 Impact Significance

The receptors are the workforce at the site who, with existing controls in place, are expected to be of **medium** sensitivity. The project involves general operation and maintenance of the power plant and as such, the impact magnitude is expected to be **small**.

Therefore, the significance of impacts to occupational health and safety is considered to be **minor.**

6.4.6.4 Additional Mitigation, Management and Monitoring

The additional mitigation, management, and monitoring measures are as follows:

- Installation of hydrogen sulphide monitoring and warning systems. The number and location of monitors should be determined based on an assessment of plant locations prone to hydrogen sulphide emission and occupational exposure;
- Development of a contingency plan for hydrogen sulphide release events, including all necessary aspects from evacuation to resumption of normal operations;
- Ensure First Aid Station / Clinic with qualified doctor and nurse (on 24/7 stand-by) and ambulance is available;
- Ensure activities are supervised by trained personnel;
- Provide walkways that are clearly designated as walkways, having good conditions underfoot, and being well lit;

- Implement good housekeeping practice as such keeping work and storage areas tidy and designating specific areas for waste collection;
- Where duties involve manual handling, adequate training must be provided;
- Reversing movements of vehicles and mobile plant should be minimized by providing, where possible, drive through circulation routes. Where reversing is unavoidable, turning heads should be provided and banksmen should be deployed to guide reversing vehicles and plant where necessary; and steps should be taken to ensure that banksmen wear high-visibility safety vests and use walkie-talkie or similar equipment for effective communication;
- Safety reversing devices such as reversing video device (RVD), cross view mirror, parking sensor, and reversing alarm and warning light shall be used when applicable;
- Ensure loading and unloading of material is undertaken as per good international industry practices; and
- Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP (***Chapter 8*** of this ESIA Report).

6.4.6.5 Significance of Residual Impact

With the implementation of the above existing control and mitigation measures, as well as the recommended additional mitigation and management measures, it is expected that the residual impact significance would remain **minor** (***Table 6-89***).

Table 6-89: Impact Assessment for Occupational Health and Safety: Operational Phase

Impact Significance				
Impact Nature	Negative	Positive	Neutral	
	Negative impacts from risk of injury or fatality.			
Impact Type	Direct	Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local	Regional	International	
Impact Scale	Localised to the Project Area.			
Frequency	For the duration of the Project.			
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low	Medium	High	
Impact Significance	Negligible	Minor	Moderate	Major

6.4.7 Impact on Employment

6.4.7.1 Potential Impacts

During operation, as the power plant will be automated, there will only be around 69 workers employed. Most workers will be sourced locally, especially in the Ijen District area. It is highlighted that there are training opportunities available to enable some villagers to work in these positions.

Baseline data identified that around 19.5% of the labour force in Bondowoso Regency work in industrial sectors, and 20.5% of the labour force in Banyuwagi Regency are working in industrial sectors. On this basis, it is expected that there is capacity for the villagers within and nearby the Project AoI to be employed in unskilled work, and perhaps some semi-skilled and skilled work, for the Project during operation.

In addition to direct employment, there may be indirect employment opportunities. For instance, foreign workers may require short-term accommodation in nearby towns, or the purchase goods and services from local businesses. The increased demand may result in an associated increase in employment.

Stakeholder engagement with village heads, religious leader and youth representative of Kalianyar Village identified positive impacts associated with the Project, with anticipated benefits, most notably in the form of employment. There is also an expectation that the Project will support village tourism development plan to improve their potential to obtain revenue to the village.

6.4.7.2 Existing Controls

The following controls are committed for the Project:

- The Project will aim to employ local workers where possible.
- The Project has already recruited 50 local workers and will employ additional workers during the construction phase.

6.4.7.3 Significance of Impacts

6.4.7.3.1 Methodology for Assessment of Impact Significance

The potential economic opportunities are assessed in accordance with the criteria set out in ***Table 6-90*** and

Table 6-91.

Table 6-90: Social Impact Magnitude Criteria

Magnitude	Definition
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the AoI and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Early evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community
Positive	In the case of positive impacts, it is generally recommended that no magnitude be assigned, unless there is ample data to support a more robust characterisation. It is usually sufficient to indicate that there will be a positive impact, without characterising the exact degree of positive change likely to occur.

Table 6-91: Social Impact Sensitivity Criteria

Sensitivity	Definition
Low	Villagers have low vulnerability/sensitivity; consequently has a high ability to adapt to changes brought by the project
Medium	Some, but few areas of vulnerability/sensitivity; retaining an ability to at least adapt in part to change brought by the project
High	Profound or multiple levels of vulnerability/vulnerability/sensitivity that undermine the ability to adapt to changes brought by the project

6.4.7.3.2 Impact Significance

The employment impact to the local community mainly will bring the economic opportunities and improve local livelihood of the community even though the number of workers is lower compared to the construction phase.

The impact magnitude is **positive** as economic opportunities will allow affected villagers to improve their livelihoods.

Based on the above, the impact significance of economic opportunities manifested through local employment and training opportunities has a **positive** impact significance.

6.4.7.4 Additional Mitigation, Management, and Monitoring Measures

Employment recruitment to the local community is considered as a positive impact. However, recruitment mechanism and processes need to be carried out properly to manage the expectations from the local community toward the Project. The following additional mitigation measures are proposed:

- Ensure the recruitment process of the local workers will be carried out in an open and transparent manner.
- Prioritize the Project affected people, including the local workforce in Ijen District if possible.
- Involve and collaborate with the village government for the local worker's recruitment.

6.4.7.5 Residual Impact Significance

The residual impact significance of the impact of economic opportunities for affected villagers remains **Positive.**

Table 6-92: Impact Assessment for Employment

Impact Significance				
Impact Nature	Negative		Positive	Neutral
	Employment recruitment impacts from the construction activities are positive (job creation)			
Impact Type	Direct		Indirect	Induced
Impact Duration	Temporary	Short-term	Long-term	Permanent
Impact Extent	Local		Regional	International

Impact Significance				
Impact Scale	The scale of the impact is likely to be localised to the Project Site.			
Frequency	Impacts will arise through operational phase.			
Impact Magnitude	Positive	Low	Medium	High

6.4.8 *Compatibility with Recent UNESCO Global Geopark Designation*

The potential implications to the Project due to the recent designation of Ijen as an UNESCO Global Geopark was assessed within the definition of a UNESCO Geopark and found to be compatible as there is nothing stated in UNESCO's criteria for designating Geoparks that precludes facilities like geothermal power plants.[44] The proposed project is consistent with the concepts of a "working landscape" and "sustainable development", which as basic principles of the UNESCO Global Geopark program. It should also be noted that the Project was already in the exploration stage of development at the time of the UNESCO designation. Therefore the Project is compatible with UNESCO's criteria. Multiple UNESCO Geoparks, such as Azores and Reykjanes UNESCO Global Geoparks contain geothermal power plants.[45] A key criteria for Geoparks to retain their status is to "use the heritage, in connection with all other aspects of that area's natural and cultural heritage, to promote awareness of key issues facing society in the context of the dynamic planet we all live on, including but not limited to increasing knowledge and understanding of: geoprocesses; geohazards; climate change; the need for the sustainable use of Earth's natural resources; the evolution of life and the empowerment of indigenous peoples."

6.5 Decommissioning Phase – Impact Assessment

This section presents the conceptual level of impact assessment during decommissioning phase of the Project. Similar to the impact assessment methodology in the construction and operational phase, the impact assessment process of decommissioning phase will identify elements of the physical, ecological or social environment to produce impacts on resources/ receptors.

Prediction of impact during decommissioning phase will be conducted according to the consequence of the Project and its associated activities. The stages and activities of the Project decommissioning phase generally be categorized into three (3) key phases as follows:

- Pre-decommissioning activities :includes the detailed planning)development of the decommissioning plan) and approval procedures;
- Decommissioning activities :removal of plant machinery & equipment and demolition, decommissioning of facilities, infrastructure, decontaminated land assessment and rehabilitation; and
- Post-decommissioning activities: site survey, close-out report and field monitoring as necessary.

6.5.1 *Potential Impacts*

The potential impacts during the decommissioning phase will be related to workforce demobilization and land rehabilitation.

[44] UNESCO. Statutes of the International Geoscience and Geoparks Programme. 2015. Statutes of the International Geoscience and Geoparks Programme - UNESCO Digital Library

[45] UNESCO. UNESCO Global Geoparks using the Earth's heat | UNESCO..https://www.unesco.org/en/articles/unesco-global-geoparks-using-earths-heat

- **Workforce Demobilization -** When the operation of the Project is completed, workforce demobilization needs to be carried out in compliance with the employment contract between MCG and the relevant workforce. According to the AMDAL, it is estimated 69 Project workers from the operational phase will be demobilized.
- **Land Rehabilitation -** Land rehabilitation will also need to be carried out with well closure procedures and demolition of the main infrastructure, geothermal network installations, geothermal power plant units, and supporting facilities and environmental management.

6.5.1.1 Significance of Impacts

6.5.1.1.1 Methodology for Assessment of Impact Significance

The potential economic opportunities are assessed in accordance with the criteria set out in ***Table 6-90*** and

Table 6-91.

Table 6-93: Social Impact Magnitude Criteria

Magnitude	Definition
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the AoI and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Early evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community
Positive	In the case of positive impacts, it is generally recommended that no magnitude be assigned, unless there is ample data to support a more robust characterisation. It is usually sufficient to indicate that there will be a positive impact, without characterising the exact degree of positive change likely to occur.

Table 6-94: Social Impact Sensitivity Criteria

Sensitivity	Definition
Low	Villagers have low vulnerability/sensitivity; consequently has a high ability to adapt to changes brought by the project
Medium	Some, but few areas of vulnerability/sensitivity; retaining an ability to at least adapt in part to change brought by the project
High	Profound or multiple levels of vulnerability/vulnerability/sensitivity that undermine the ability to adapt to changes brought by the project

6.5.1.1.2 Impact Significance

The receptors are the workforce at the site who, with existing controls in place, are expected to be of **medium** sensitivity. Decommissioning will leave the affected workers without a means to earn an income and as such the impact magnitude is expected to be **medium**.

Therefore, the significance of impacts to decommissioning is considered to be **moderate.**

6.5.1.2 Additional Mitigation, Management, and Monitoring Measures

Worker demobilization is likely to cause a negative impact on the local community's livelihood. The mechanism and demobilization processes need to be carried out properly to manage the expectations of the local community toward the Project. The following mitigations are proposed:

- Ensure the demobilization process of the local workforce will be carried out in a transparent manner.
- Inform the demobilized local workforce at least one month prior to the end of the contract period.
- Inform the village government about the demobilization of the local workers recruitment.
- Apply the well abandonment procedure.

6.5.1.3 Residual Impact Significance

The residual impact significance of the impact of decommissioning is therefore minor**.**

Table 6-95: Impact Assessment for Decommissioning

Impact Significance					
Impact Nature	Negative		Positive	Neutral	
	Negative impacts from workers being demobilized and land left unproductive.				
Impact Type	Direct		Indirect	Induced	
Impact Duration	Temporary	Short-term	Long-term	Permanent	
Impact Extent	Local		Regional	International	
Impact Scale	Localised to the Project Area.				
Frequency	For up to 5 years after the Project is decommissioned.				
Impact Magnitude	Positive	Negligible	Small	Medium	Large
Resource Sensitivity	Low		Medium	High	
Impact Significance	Negligible	Minor	Moderate	Major	
Residual Impact Magnitude	Negligible	Small	Medium	Large	
Impact Significance	Negligible	Minor	Moderate	Major	

6.6 Unplanned Events

This chapter presents the probable impacts of unplanned events associated with construction and operation of the Project. The unplanned events are those that potentially arise from technical failure, human error, or as a result of natural phenomena.

The assessment of unplanned impacts considers the probability of events occurring and an estimate of the severity of consequences. The assessment of the severity of impacts due to fire and explosion is based on the worst case scenario, where it is assumed that safety devices and associated measures fail to operate properly resulting in the incidents.

6.6.1 Scope of Impact Assessment of Unplanned Events

This assessment addresses the following unplanned events:

- Blow out from wells;
- Spillage of fuel, oil, and hazardous materials;
- Traffic accidents;
- Fire and Explosion;
- Subsidence: and
- Natural unplanned events such as floods, landslides, earthquakes and volcanic eruptions.

6.6.2 *Impact Assessment Methodology*

To evaluate potential impacts from unplanned events, a risk-based approach is used to define:

- the most likely unplanned events leading to environmental, social and/or community health impacts; and
- those unplanned events with the most significant potential environmental, social and/or community health impacts overall. Impact significance for unplanned events is therefore determined by evaluating the combination of likelihood and consequence.

6.6.2.1 *Assess the Scale of Consequence*

Indicative levels of consequence for potential impacts from unplanned events can be defined for the physical, biological, and social environment as provided in ***Table 6-96.***

Table 6-96: Indicative Levels of Consequence for Potential Impacts from Unplanned Events

	Incidental (A)	Minor (B)	Moderate (C)	Major (D)	Severe (E)
Physical Environment	Impacts such as localised or short term effects or environmental media, meeting all environmental standards	Impacts such as widespread, short-term impacts to environmental media, meeting all environmental standards	Impacts such as widespread, long-term effects on environmental media, meeting all environmental standards	Impacts such as significant, widespread and persistent changes in environmental media OR Exceedance of environmental standards	Exceedance of environmental standards and fine/ prosecution
Biological Environment	Impacts such as localised or short term effects on habitat or species	Impacts such as localised, long term degradation of sensitive habitat or widespread, short-term impacts to habitat or species	Impacts such as localised but irreversible habitat loss or widespread, long-term effects on habitat or species	Impacts such as significant, widespread and persistent changes in habitat or species	Impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Social Environment	Slight, temporary, adverse impact on a few individuals	Temporary (<1 year), adverse impacts on community which are within international health standards	Adverse specific impacts on multiple individuals that can be restored in <1 year OR One or more injuries, not lost-work injuries.	Adverse long-term, multiple impacts at a community level, but restoration possible. OR One or more lost-work injuries to a member of the public including permanently disabling injuries.	Adverse long-term, varied and diverse impacts at a community level or higher – restoration unlikely. OR Fatalities of public.

6.6.2.2 *Assessing the Likelihood*

For the purposes of assessment, the likelihood of an unplanned event occurring can be classified as follows:

1 - Remote, not known in the industry;

2 - Very unlikely, known of in the industry;

3 - Unlikely, may occur once or more in life of the Project;

4 - Likely, may occur once or twice per year;

5 - Expected, may occur more than twice per year.

6.6.2.3 Assessing the Significance

The consequences and likelihood of potential unplanned events are combined to determine the overall impact significance using the risk matrix shown in ***Table 6-97***.

For potential impacts that are determined to have an impact significance of Moderate or Major, risk reduction measures are identified; these can include measures that reduce the likelihood of the event from occurring (i.e., preventive barriers), those that reduce the consequences on sensitive receptors/resources if the event were to occur (i.e., mitigation or recovery measures), and those that affect the likelihood and consequence.

Table 6-97: Risk Matrix for Potential Unplanned Events

		Likelihood of Occurrence				
		Incidental (1)	**Minor (2)**	**Moderate (3)**	**Major (4)**	**Severe (5)**
Consequence	**Incidental (A)**	Negligible	Negligible	Negligible	Negligible	Negligible
	Minor (B)	Negligible	Minor	Minor	Minor	Moderate
	Moderate (C)	Minor	Minor	Moderate	Moderate	Major
	Major (D)	Moderate	Moderate	Major	Major	Major
	Severe (E)	Major	Major	Major	Major	Major

6.6.3 Assessment of Potential Impacts

Based on the Project activities, the potential unplanned events that were considered to have the highest potential environmental and social risks during all phases of the Project were shown in ***Table 6-98.*** Noted that for the commissioning and operational phases, only indicative project activities were listed. A more comprehensive evaluation of potential impacts would be conducted once sufficient detailed design information is available.

Table 6-98: Unplanned Events Leading to Potential Impacts

Project Phase	Activity	Potential Receptors Affected
Pre-construction, Construction, and Drilling	Small scale leakage and spill incidents from site-preparation / construction activities	Users of surface water and groundwater in nearby communities
	Traffic collisions	Users of the public roadways utilised by the Project.
	Fire and explosion	Nearby communities
	Well blow out	Nearby communities Forest, habitats, flora, and fauna in the vicinity of the site.
	Subsidence	Nearby communities Forest, habitats, flora, and fauna in the vicinity of the site.
	Natural Hazards – Flooding / landslides / earthquakes / volcanic eruptions	Nearby communities Forest, habitats, flora, and fauna in the vicinity of the site.
Operation and Maintenance	Small scale leakage and spill incidents from activities on site	Users of surface and ground water in nearby communities
	Traffic collisions	Users of the public roadways utilised by the Project
	Fire and explosion	Nearby communities

Project Phase	Activity	Potential Receptors Affected
		Forest, habitats, flora, and fauna in the vicinity of the site.
	Well blow out	Nearby communities Forest, habitats, flora, and fauna in the vicinity of the site.
	Subsidence	Nearby communities Forest, habitats, flora, and fauna in the vicinity of the site.
	Natural Hazards – Flooding / earthquakes / landslides / volcanic eruptions	Nearby communities Forest, habitats, flora, and fauna in the vicinity of the site.

Potential impacts from these events are described in detail in the following sections. These potential impacts had been classified using this risk-based impact assessment methodology. It should be noted that this methodology was different than that applied to potential impacts from planned activities, as the assessment of potential impacts from unplanned events must consider likelihood as well. Because a risk-based assessment methodology had been used, worst-case scenarios had been considered.

A summary of potential Project-related hazards, contributing causes, and consequences for the Project workforce, nearby communities and/or surrounding environment were summarised in ***Table 6-99***.

In order to reduce Project risk from the key potential unplanned events, the standard mitigation hierarchy should be applied. For the purposes of this assessment mitigation measures were discussed in the following sections where the pre-mitigation significance of the unplanned event is greater than minor.

Unlike impacts from planned activities, mitigation of unplanned events should consider both pre-event preventative actions (that reduce the likelihood of the cause of the potential impact) and post-event mitigation that reduces the magnitude of the consequence.

Table 6-99: Potential Impacts from Unplanned Events and Pre-mitigation Risk Ranking

No.	Unplanned Event	Cause	Consequence	Risk Ranking Pre-mitigation
Pre-Construction / Construction / Drilling				
1.	Small scale leakage and spill incidents from site preparation/ Construction activities	Corrosion, dropped objects, or other damages to storage oil tanks/mobile gas stations; failure to secure valves; failure to maintain large mobile construction plant.	Workers and Communities – No available onsite fuel storage so likelihood of spillage of oil, lubricant to ground water and soil contamination is Low. The effects on surrounding communities utilizing groundwater resources is Low.	3B (Minor)
			Environment – No available onsite fuel storage so likelihood of spillage of oil, lubricant to ground water and soil contamination is Low.	3B (Minor)
2.	Road traffic transporting personnel or materials involved in a collision	Wet/dark conditions, driver distraction, fatigue, other dangerous drivers, variable road conditions; rural areas with pedestrian road users	Workers and Communities – Traffic accidents that involved community members, resulting in injury or fatality. Accidents might require use of local medical emergency services in the Project area and could temporarily decrease access to these services for local residents.	4E (Major)
		As above with livestock in the road	Workers and Communities – Traffic accident with livestock leading to death of livestock and loss/reduction in community member's livelihood.	4C (Moderate)
3.	Fire and explosion	Leakage and spill incidents of flammable materials, malfunctioning equipment and failure to operate large mobile construction vehicle,	Workers and Communities – Based on the liquid fuel storage volumes the potential exists for exposure to ignited due to malfunctioned equipment and resulting in potentially severe injuries to employees and spread to nearby communities' members.	3D (Major)
			Environment: – Based on the liquid fuel storage volumes potential for ignition of leakage or spill of oil/chemicals due to human errors and malfunctioned short-circuit equipment, accidents might lead to uncontrollable wildfire, loss of crops and habitat, causing injury and life-threatening of local community.	3D (Major)
4.	Well Blow out		Workers and Communities – Can be exposed to toxic releases and from spillage of fluids resulting in potentially	3D (Major)

No.	Unplanned Event	Cause	Consequence	Risk Ranking Pre-mitigation
		Well blow out, although rare, can result in the release of toxic drilling additives and fluids, as well as hydrogen sulfide gases from underground formations. Pipeline ruptures may also result in the surface release of geothermal fluids and steam containing heavy metals, acids, mineral deposits, and other pollutants.	severe injuries to employees and spread to nearby communities' members.	
			Environment: – spillage and releases could lead to uncontrollable wildfire, loss of crops and habitat, causing injury and life-threatening of local community.	3D (Major)
5.	Subsidence	Construction or excavation of tunnels and extracting geothermal steam can cause localized subsidence in the surrounding areas through excavation, removing water or steam from underground, vibrations and construction of new structures in land use. Theses mechanisms can lead to redistribution on the ground.	Workers and Communities: Land subsidence can result in loss of human life, damage to infrastructure, and increase the risk of flooding. Environment: Land subsidence can result in damage/ death of local flora and fauna, it also disrupt ecosystem and groundwater resources.	2D (Moderate)
6.	Natural Hazards	Heavy rainfall that exceeds the capacity of the natural drainage system may cause flash flood event and landslides. Clearing vegetation for site preparation increases the rate of run-off and flood risks to downstream areas. Given the proximity to Mt. Ijen, volcanic eruptions and earthquakes are also a possibility. The withdrawing of mass (steam boiled from water) and heat to run the plant, can cause the surrounding rock to contract inducing earthquakes and volcanic eruptions as a result of the contractional stresses.	Workers and Communities: Floods, landslides, earthquakes and volcanic eruptions can result in loss of human life, damage to property, destruction of crops, and loss of livestock that affects livelihoods. Environment: A large-scale flood, landslide, earthquake or volcanic eruption could result in damage/death of local flora and fauna. A volcanic eruption or earthquake can cause irreversible damage for years to come.	4D (Major)
Operation and Maintenance				
1.	Small scale spill from activities on-site	Corrosion, dropped objects or other damage to small storage vessels; failure to secure valves; failure to maintain equipment.	Workers and Communities – There would be use of oil, fuel across the site during commissioning and operation phase of the Project for operation & maintenance (O&M) services. As a result, there was a risk that small volumes of oil and fuel could be spilled on-site.	3C (Moderate)
			Environment - There would be use of oil, fuel across the site during commissioning and operation phase of the Project for operation & maintenance (O&M) services. As	3C (Moderate)

No.	Unplanned Event	Cause	Consequence	Risk Ranking Pre-mitigation
			a result, there was a risk that small volumes of oil and fuel could be spilled on-site that leads to soil contamination and water quality degradation.	
2.	Fire and explosion	Leakage and spill incidents of flammable materials, malfunctioning equipment, short-circuit power,	Workers and Communities – A large-scale fire could result in injuries to people in the surrounding communities, or in the worst-case fatalities. Explosions of malfunctioned equipment could result in rapid spread of fire and projectile spread of debris. This could result in injuries to people in the surrounding communities, or in the worst-case fatalities.	2E (Major)
			Environment: – A large-scale fire could result in damage/death of local flora and fauna. Accidents might lead to uncontrollable wildfire, loss of crops and habitat given the environment settings at the Project area. Explosions could result in rapid spread of fire and projectile spread of debris. This could result in damage/death of local flora and fauna.	3C (Moderate)
3.	Well Blow out	Well blow out, although rare, can result in the release of toxic drilling additives and fluids, as well as hydrogen sulfide gases from underground formations. Pipeline ruptures may also result in the surface release of geothermal fluids and steam containing heavy metals, acids, mineral deposits, and other pollutants.	Workers and Communities – Can be exposed to toxic releases and from spillage of fluids resulting in potentially severe injuries to employees and spread to nearby communities' members.	3D (Major)
			Environment: – spillage and releases could lead to uncontrollable wildfire, loss of crops and habitat, causing injury and life-threatening of local community.	3D (Major)
4.	Subsidence	The injection or extraction of any fluid and steam from the underground reservoir can cause compaction of reservoir rocks, and the pore spaces underground may collapse eventually.	Workers and Communities: – Land subsidence can cause structural damage to buildings or other infrastructures, and may result in loss of human life of local communities. Environment: – Land subsidence could have consequences on landslide, flooding, and ecology. Land collapse may change ground water reservoir and may disrupt wildlife habitats. These consequences cause irreversible damage to surrounding areas.	2D (Moderate)

No.	Unplanned Event	Cause	Consequence	Risk Ranking Pre-mitigation
5.	Natural Hazards	Heavy rainfall that exceeds the capacity of the natural drainage system may cause flash flood event and landslides. Clearing vegetation for site preparation increases the rate of run-off and flood risks to downstream area. Given the proximity to Mt. Ijen, volcanic eruptions and earthquakes are also a possibility. The withdrawing of mass (steam boiled from water) and heat to run the plant, can cause the surrounding rock to contract inducing earthquakes and volcanic eruptions as a result of the contractional stresses.	Workers and Communities: Floods, landslides, earthquakes and volcanic eruptions can result in loss of human life, damage to property, destruction of crops, and loss of livestock that affects livelihoods. Environment: A large-scale flood, landslide, earthquake or volcanic eruption could result in damage/death of local flora and fauna. A volcanic eruption or earthquake can cause irreversible damage for years to come.	4D (Major)

6.6.3.1 During Pre-Construction, Construction, and Drilling

6.6.3.1.1 Leakage and Spill Incidents

Background

There would be many large mobile plant items that would be powered by diesel oil and would contain relatively small reservoirs of lube oil and hydraulic oil, with the potential for environmental damage if the materials are lost to ground. Mobile plant will include:

- Pipe-laying cranes and plant;
- Excavators;
- Heavy goods vehicles;
- Fork-lift trucks; and
- Fuel trucks.

During site preparation and the early stages of construction any accidental release of oils would be to unpaved areas. Hence, the oil would seep into the ground and potentially groundwater if the release was not responded to immediately. Lube oils were not expected to be readily biodegradable. However, any release was likely to be small and if there was immediate response, the residual amount released would result in negligible damage to the environment.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental onshore spills are summarised in ***Table 6-100***.

Table 6-100: Preventative and Mitigation Measures of Leakage and Spills Incidents

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Design the site to include good site management practices to ensure that the products are properly stored on site (e.g., secondary containment, double walled tanks, over filling alarm system).	EPC Contractor	Before site preparation
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event.	MCG	Before site preparation
Prevent	Ensure good inspection and maintenance procedures for large mobile construction plant to minimize small leaks and spills.	EPC Contractor	During site preparation and construction
Mitigate	Prepare an Emergency Preparedness and Response Plan to cover accidental and emergency situations. This Plan will detail:	MCG	Planning stage (construction and operations)

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
	■ Planning coordination: including procedures for informing local communities about emergency response, documentation and first aid / medical treatment; ■ Emergency equipment: including equipment in the project design and any additional emergency equipment; ■ Training: employees and contractors will be trained in emergency response procedures; ■ Auditing: audit records will be maintained on how the Plan is being implemented.		
Mitigate	Implement Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	EPC Contractor / KWS	During construction, commissioning and operations

Residual Impacts

Because the majority of the mitigation presented was preventative, the primary goal of these measures was to reduce the likelihood of the unplanned event from occurring. However, if the event occurred, the consequence of the oil spills could potentially remain as severe. In these cases, the mitigation measured described in the previous section would apply to minimize impacts.

		Impact Significance
Without Mitigation Measures	Workers and Communities	3B Minor
	Environment	3B Minor
With Mitigation Measures	Workers and Communities	2B Minor
	Environment	2B Minor

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly;
- Daily inspection of any secondary containment of oil/chemical on site and ensure good maintenance procedures to minimize small leaks and spills.

6.6.3.1.2 Traffic Accidents

Background

Receptors for increased road safety risks during Project site preparation and construction included drivers, passengers, and non-motorized travelers on public roads. Although existing road users were likely to be accustomed to existing safety risks associated with poor road conditions, these receptors were unlikely to have experience driving or sharing the road with heavy trucks, of the type likely to be used during Project site preparation and especially construction.

Site preparation would require a number of vehicle trips to deliver construction equipment and supplies, as well as daily trips of employee. Additionally, the Project Site is located in mountainous area, the traffic conditions is quite unfavorable.

Based on this analysis, it was assumed that road safety risks increase roughly in proportion with increased vehicular traffic congestion. Road safety risks would also increase due to degraded road infrastructure conditions.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

Active mitigation measures that would be used to further mitigate potential road safety risks were provided in ***Table 6-101***. These measures included development of a Traffic Management Plan that would address scheduling of road activity, monitoring conditions of public roads, and active traffic controls at the Project site entrance.

Table 6-101: Preventative and Mitigation Measures of Traffic Accident

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Developed and implemented a Traffic Management Plan. This should include measures such as: ■ Active traffic controls (e.g., flaggers to direct traffic at the Project site entrance); and ■ Schedule construction deliveries and employee shift changes to minimize traffic congestion and delay.	EPC Contractor	Site preparation and construction
Prevent	Design an H&S plan and good safety practices for the transportation (e.g., alcohol policy, good driving practice).	EPC Contractor	Construction
Prevent	Upgrade the access road to the Project site.	MCG	Site Preparation
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event.	MCG	Before site preparation
Mitigate	Develop an Emergency Preparedness and Response Plan.	MCG	Prior to site preparation
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	Construction

Residual Impacts

Because the majority of the mitigation presented as preventative, the primary goal of these measures was to reduce the likelihood of the unplanned event from occurring. However, if the event occurred, the consequence of the traffic accidents could potentially remain as severe. In these cases, the mitigation measures described in the previous section would apply to minimize impacts.

		Impact Significance
Without Mitigation Measures	Workers and Communities	4E Major
	Communities (livestock)	4C Moderate
With Mitigation Measures	Workers and Communities	3E Major
	Communities (livestock)	2B Minor

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in the Traffic Management Plan (TMP) should be conducted;
- Regular road condition monitoring along the transportation route to understand road quality during construction phase.

6.6.3.1.3 Fire and Explosion

Background

Onsite fuel requirement during construction phase will be diesel. Fuels will be provided for daily requirements and transported to the site by fuel specialized trucks. The onsite delivery of fuel or lubricant will be at designated location that will have an impervious base. So, risk of fire and explosion at the site will be reduced.

In addition to the failure of malfunctioning and/or outdated machinery and equipment could be also led to the risk of fires and explosions.

Large scale fires, or worst-case explosions, could potentially release smoke and fumes in the broader area generating health issues associated with inhalation of toxic substances and uncontrollable wildfire that would contribute to a loss of crops and habitats and impacts on the economics of the area (e.g., community and workers jobs and incomes).

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental fire and explosion are summarized in ***Table 6-102***.

Table 6-102: Preventative and Mitigation Measures of Fire and Explosion

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Implement on-site prevention measures such as (i) Equip the site with proper equipment (such as fire extinguishers, proper communication equipment) and regularly inspect and maintain them; (ii) Prepare the Fire prevention and Fighting Plan that ensure compliance and Fighting; (iii) Conduct firefighting training to the	MCG	Site preparation and construction

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
	emergency support team, contractors and workers on site and camping areas.		
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event.	MCG	Site preparation and construction
Mitigate	Develop an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation. The Emergency response plan should include: ■ Immediately pull the nearest fire alarm if a fire occurs, report the event to shift supervisor or foreman immediately for emergency response; ■ When the emergency alarm sounds, all employees shall stop all activities and move to emergency assembly places immediately; ■ Limit the fire areas by utilizing the appropriate firefighting equipment, if the fire is small and controllable; and ■ Follow the procedure included in the Emergency Response and Evacuation Plan to take actions.	MCG	Site preparation
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During construction & Operation

Residual Impacts

Because the majority of the mitigation presented was preventative, the primary goal of these measures was to reduce the likelihood of the unplanned event from occurring. However, if the identified events occurred, the consequences remained the same level. In these cases, the post-event measures described in the previous section would apply to minimize impacts.

		Impact Significance
Without Mitigation Measures	Workers and Communities	3D Major
	Environment	3D Major
With Mitigation Measures	Workers and Communities	2C Minor
	Environment	2C Minor

Monitoring and Auditing

- A monthly audit program shall be established to check the implementation of emergency response and evacuation plan, staff training, equipment inspection, and firefighting drills.

6.6.3.1.4 Well Blow Out

Background

Well blow out, although rare, can result in the release of toxic drilling additives and fluids, as well as hydrogen sulphide gases from underground formations.

Pipeline ruptures may also result in the surface release of geothermal fluids and steam containing heavy metals, acids, mineral deposits, and other pollutants.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental blow out events are summarized in ***Table 6-103.***

Table 6-103: Preventative and Mitigation Measures of Well Blow Out

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Installation of blow out preventer on the well heads and drilling rigs.	MCG	During drilling
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During drilling
Prevent	Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection.	MCG	During drilling
Prevent	Conduct pressure monitoring and install shut off valves.	MCG	During drilling
Mitigate	Develop an Emergency Preparedness and Response Plan.	MCG	Prior to drilling
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During drilling

Residual Impacts

It is noted that the likelihood of occurrence of well blow outs is rare. The project could also provide mitigation measures to minimize impacts and damage caused.

		Impact Significance
Without Mitigation Measures	Workers/Communities	4D Major
	Environment	4D Major
With Mitigation Measures	Workers/Communities	3C Moderate
	Environment	3C Moderate

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly.

6.6.3.1.5 Subsidence

Background

Site preparation, construction and well drilling can potentially have many effects on subsidence due to their activities that required excavation to install the underground structures, which can change natural soil and rock layers. The extraction of groundwater during the construction phase will have temporary or permanent extraction, the extraction may drop the water table, leading to land subsidence.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental land subsidence events are summarized in ***Table 6-104***.

Table 6-104: Preventative and Mitigation Measures of Subsidence

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	The potential subsidence due to surface alteration nearby facilities location will be studied and assessed to prevent subsidence event.	MCG	Prior to Construction
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During site preparation and construction
Prevent	Implement periodic routine inspection and maintenance procedures (in line with international best practice).	MCG	During site preparation and construction
Mitigate	Develop an Emergency Preparedness and Response Plan	MCG	Prior to Construction
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During Site preparation and construction

Residual Impacts

It is noted that the likelihood of occurrence of subsidence is rare. The project should ensure however, that the introduction of hard surface areas does not effect to the surface hydrothermal alteration. The project could also provide mitigation measures to minimize impacts and damage caused by subsidence event.

		Impact Significance
Without Mitigation Measures	Communities	4D Major
With Mitigation Measures	Communities	3C Moderate

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly.

6.6.3.1.6 Natural Hazards

Background

Java has frequent earthquakes and flash floods which should be accounted for in the project design. The current regency road also experiences landslides and the site is seismically active which could result in volcanic eruptions.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental nature hazard events are summarized in ***Table 6-105.***

Table 6-105: Preventative and Mitigation Measures of Natural Hazards

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Incorporation of siting and safety engineering criteria to prevent failures due to natural disasters. Including design to seismic code: SNI 03-1726-2002.	MCG	Prior to Construction
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During site preparation and construction
Prevent	Implement periodic routine inspection and maintenance procedures (in line with international best practice).	MCG	During site preparation and construction
Prevent	Install warning system, signal boards, flood prevention systems.	MCG	Prior to Construction
Mitigate	Develop an Emergency Preparedness and Response Plan.	MCG	Prior to Construction
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During Site preparation and construction

Residual Impacts

It is noted that the likelihood of occurrence of natural hazards will not be increased by the project. The project should ensure however, that the introduction of hard surface areas does not increase the potential for flash flood etc. where possible. The project could also provide mitigation measures to minimize impacts and damage caused by floods, landslides, earthquakes and volcanic eruptions.

		Impact Significance	
Without Mitigation Measures	Communities	4D Major	
With Mitigation Measures	Communities	3C Moderate	

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly.

6.6.3.2 During Operation and Maintenance

6.6.3.2.1 Leakage and Spill Incidents

Background

There would be use of oil, fuel including hydrocarbons, across the site during commissioning and operation phase of the Project for operation & maintenance (O&M) services. As a result, there was a risk that small volumes of oil and fuel could be spilled on-site. The risk of these spills reaching the environment would be minimal in paved areas.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental onshore spills are summarised in ***Table 6-106***.

Table 6-106: Preventative and Mitigation Measures of Leakage and Spills Incidents

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Implement good site management practices to ensure that the products are properly stored on site and in areas where spills will not easily reach the environment (e.g. in paved areas with secondary containment).	MCG	Prior to operation
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During operation
Mitigate	Prepare an Emergency Preparedness and Response Plan to cover accidental and emergency situations. This Plan will detail: ■ Planning coordination: including procedures for informing local communities about emergency response, documentation and first aid / medical treatment; ■ Emergency equipment: including equipment in the project design and any additional emergency equipment; and ■ Training: employees and contractors will be trained in emergency response procedures. ■ Auditing: audit records will be maintained on how the Plan is being implemented.	MCG	Before operation
Mitigate	Implement Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During operation

Residual Impacts

Because the majority of the mitigation presented was preventative, the primary goal of these measures was to reduce the likelihood of the unplanned event from occurring. However, if the event occurred, the consequence of the hydrocarbon spills could potentially remain as severe. In these cases, the post event measures described in the previous section would apply to minimize impacts.

		Impact Significance
Without Mitigation Measures	Workers and Communities	3C Moderate
	Environment	3C Moderate
With Mitigation Measures	Workers and Communities	2C Minor
	Environment	2B Minor

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly;
- Daily inspection of any secondary containment of oil/chemical on site and ensure good maintenance procedures to minimize small leaks and spills.

6.6.3.2.2 Fire and Explosion

Background

Plant failure could cause fires. Air quality will deteriorate due to the large plume of particles and other pollutants produced by explosion or fire. Explosion and fire will lead to the loss of terrestrial flora, which might further result in the loss of terrestrial fauna. Explosion or fire will also pose health and safety risk to local communities as well as workers.

Large scale fires, or worst-case explosions, could potentially release smoke and fumes in the broader area generating health issues associated with inhalation of toxic substances and uncontrollable wildfire that would contribute to a loss of crops and habitats and impacts on the economics of the area (e.g., community and workers jobs and incomes).

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental fire and explosion are summarized in ***Table 6-107***.

Table 6-107: Preventative and Mitigation Measures of Fire and Explosion

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During operation
Prevent	Implement routine inspection and maintenance procedures (in line with international best practice) for any hazardous substances’ storage vessels	MCG	During operation
Prevent	Install warning system, signal boards, lighting protection system	MCG	Prior to operation

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
	where risks of fire and explosion exposed		
Mitigate	Implement Emergency Preparedness and Response Plan with forest fire protection and monitor contractors to ensure consistent implementation Provide regularly safety and fire prevention & fighting drills.	MCG	During operation

Residual Impacts

Because the majority of the mitigation presented was preventative, the primary goal of these measures was to reduce the likelihood of the unplanned event from occurring. However, given the likelihood of the event is well-known in the industry and have been occurring sporadically, hence, the possibility of such incident still remains the same. In these cases, the mitigation measures described in the previous section would potentially apply to minimize the severity on communities and surrounding environment.

		Impact Significance
Without Mitigation Measures	Workers and Communities	2E Major
	Environment	2D Moderate
With Mitigation Measures	Workers and Communities	2D Moderate
	Environment	2C Minor

Monitoring and Auditing

- A monthly audit program shall be established to check the implementation of emergency response and evacuation plan, staff training, equipment inspection, and firefighting drills.

6.6.3.2.3 Well Blow Out

Background

Well blow out, although rare, can result in the release of toxic drilling additives and fluids, as well as hydrogen sulphide gases from underground formations.

Pipeline ruptures may also result in the surface release of geothermal fluids and steam containing heavy metals, acids, mineral deposits, and other pollutants.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental blow out events are summarized in ***Table 6-110.***

Table 6-108: Preventative and Mitigation Measures of Well Blow Out

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	Installation of blow out preventer on the well heads.	MCG	During operation
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During operation
Prevent	Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection.	MCG	During operation
Prevent	Conduct pressure monitoring and install shut off valves.	MCG	During operation
Mitigate	Develop an Emergency Preparedness and Response Plan.	MCG	Prior to operation
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During operation

Residual Impacts

It is noted that the likelihood of occurrence of occurrence of well blow outs is rare. The project could also provide mitigation measures to minimize impacts and damage caused by floods.

		Impact Significance
Without Mitigation Measures	Workers/Communities	4D Major
	Environment	4D Major
With Mitigation Measures	Workers/Communities	3C Moderate
	Environment	3C Moderate

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly.

6.6.3.2.4 Subsidence

Background

Site preparation, construction and well drilling can potentially have many effects on subsidence due to their activities that required excavation to install the underground structures, which can change natural soil and rock layers. The extraction of groundwater during the construction phase will have temporary or permanent extraction, the extraction may drop the water table, leading to land subsidence.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental land subsidence events are summarized in ***Table 6-104***.

Table 6-109: Preventative and Mitigation Measures of Subsidence

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	The potential subsidence due to surface alteration nearby facilities location will be studied and assessed to prevent subsidence event.	MCG	Prior to Construction
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During site preparation and construction
Prevent	Implement periodic routine inspection and maintenance procedures (in line with international best practice).	MCG	During site preparation and construction
Mitigate	Develop an Emergency Preparedness and Response Plan	MCG	Prior to Construction
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During Site preparation and construction

Residual Impacts

It is noted that the likelihood of occurrence of subsidence is rare. The project should ensure however, that the introduction of hard surface areas does not significantly affect natural infiltration. The project could also provide mitigation measures to minimize impacts and damage caused by subsidence event.

		Impact Significance
Without Mitigation Measures	Communities	4D Major
With Mitigation Measures	Communities	3C Moderate

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly.

6.6.3.2.5 Natural Hazards

Background

Java has frequent earthquakes and flash floods which should be accounted for in the project design. The current regency road also experiences landslides and the site is seismically active.

Significance (Before Mitigation)

The significance is provided in ***Table 6-99***.

Mitigation Measures

All preventative and mitigation measures proposed to reduce the likelihood and severity of accidental nature hazard events are summarized in ***Table 6-110.***

Table 6-110: Preventative and Mitigation Measures of Natural Hazards

Type of Control (i.e. Prevent/ Mitigate)	Management Control	Responsibility - Organisation	Timing
Prevent	The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	MCG	During operation
Prevent	Implement periodic routine inspection and maintenance procedures (in line with international best practice).	MCG	During operation
Prevent	Install warning system, signal boards, flood prevention systems.	MCG	Prior to operation
Mitigate	Develop an Emergency Preparedness and Response Plan.	MCG	Prior to operation
Mitigate	Implement an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	MCG	During operation

Residual Impacts

It is noted that the likelihood of occurrence of natural hazards will not be increased by the project. The project should ensure however, that the introduction of hard surface areas does not increase the potential for flash flood etc. where possible. The project could also provide mitigation measures to minimize impacts and damage caused by floods.

		Impact Significance
Without Mitigation Measures	Communities	4D Major
With Mitigation Measures	Communities	3C Moderate

Monitoring and Auditing

- Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly.

7 CUMULATIVE IMPACT ASSESSMENT

7.1 Introduction

Cumulative impacts are "*those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones*" (IFC, 2013). The multiple and successive environmental and social impacts caused by existing activities or conditions, combined with the possible incremental impacts that could result from future proposed and/or planned projects, can potentially generate greater cumulative impacts than would be expected in the case of a single project (IFC, 2013). According to the IFC, the assessment and management of cumulative impacts is appropriate when there is concern that a project or activity under consideration could contribute to generating cumulative impacts on one or more valued environmental and social component (VEC) (IFC, 2013).

This chapter presents the cumulative impact assessment (CIA) for the Project conducted to evaluate the potential contribution of the Project towards the cumulative impacts on the resources identified as VECs.

Following good international industry practice, this CIA follows the IFC's Good Practice Handbook—Cumulative Impact Assessment and Management: Guidance for Private Sector in Emerging Markets (the "Handbook") (IFC, 2013). The Handbook provides a methodology for identifying the most significant cumulative impacts; the methodology includes a desktop review of publicly available information and consultation with key stakeholders.

This methodology focuses on environmental and social components, referred to in the handbook as VECs, which are: (1) rated as "critical" by potential project-affected communities and/or the scientific community; and (2) cumulatively impacted by the project under evaluation, by other projects, and/or by natural environmental and social external drivers (IFC, 2013). The methodology is considered consistent with the IFC Performance Standards (PS), especially PS 1 — Assessment and Management of Environmental and Social Risks and Impacts, and PS 6 — Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC, 2012).

7.2 Objective and Scope

The overall objective of this CIA is to identify and assess the contribution by the Project to cumulative impacts in the Project AoI. It is based on information presented throughout prior chapters of this ESIA, information provided by the Project Sponsor, and information available in the public domain. The specific objectives are to:

- Identify VECs that could be impacted cumulatively in areas potentially affected by the Project, considering input from stakeholders through the consultation process and the scientific community;
- Identify other existing and planned projects and external environmental and social drivers that could cumulatively impact VECs;
- Undertake a high-level assessment of potential cumulative impacts on VECs, considering the Project and the other identified existing and planned projects and external drivers in the area; and
- Recommend a management framework for the integrated management of potential cumulative impacts.

7.3 Methodology

7.3.1 Definitions of Key Terminology for the CIA

The following are definitions for key terminology used in the CIA (IFC, 2013).

Cumulative Impact: Impacts that result from the successive, incremental, and/or combined effects of an action, project, or activity added to other existing, planned, and/or reasonably anticipated actions, projects, or activities. For practical reasons, the identification, assessment, and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concern and/or concerns of affected communities.

CIA: Process to identify and evaluate cumulative impacts.

Other Projects: Existing, planned, or reasonably expected future developments, projects and/or activities potentially affecting VECs.

External Drivers: Sources or conditions that could affect or cause physical, biological, or social stress on VECs, such as natural environmental and social drivers, human activities, and external stressors. These can include climate change, population influx, natural disasters, or deforestation, among others. These are typically less defined and planned than Other Projects.

VEC: Environmental and social components considered as important by the scientific community and/or project-affected communities. VECs may include:

- Physical features, habitats, wildlife populations (e.g., biodiversity, water supply);
- Ecosystem services (e.g., protection from natural hazards, provision of food);
- Natural processes (e.g., water and nutrient cycles, microclimate);
- Social conditions (e.g., community health, economic conditions); and
- Cultural heritage or cultural resources aspects (e.g., archaeological, historic, or traditional sites).

VECs reflect the public and scientific community's "concern" or special interest about environmental, social, cultural, economic, or aesthetic values. VECs are considered the ultimate recipients of cumulative impacts because they tend to be at the ends of ecological pathways.

7.3.2 Limitations

The limitations applicable to this CIA include: (1) incomplete information about other projects and activities (e.g., the information is not available in the public domain); (2) uncertainty with respect to the implementation of future projects; and (3) difficulty in establishing thresholds or limits of acceptable change for VECs, and therefore the significance of cumulative impacts.

7.4 Determination of Spatial and Temporal Boundaries

Based on the identified Other Projects and VECs for the CIA, it was determined that the Project AoI (a 5 km radius from the Project is sufficient to serve as the spatial boundary of the CIA, in that it covers: (1) the extent of the VECs, and (2) the extent of the potential impacts from the Project, other projects, and external drivers.

Temporal delimitation for a CIA is frequently a challenge due to the uncertainty inherent to potential future projects and activities. For this reason, good international industry practice suggests consideration of a 10-year temporal boundary when conducting a CIA.

The CIA used this suggested time horizon for other projects and external drivers due to their uncertainty. As the Project has a greater level of certainty, a 30-year temporal boundary is used with respect to the Project, considering the operational life expectancy of the project (30 years).

7.5 Identification of Other Projects and External Drivers

7.5.1 Other Projects

The proposed second stage of the project (Unit 2) is included as a reasonably foreseeable project. This would involve constructing 12 more production wells and six more injection wells. No additional land acquisition would be required, and the transmission line constructed for Unit 1 would be sufficient to evacuate the power from Unit 2, with no additional construction required.

Otherwise, there is limited industry in the area. Other projects are mainly neighbouring plantation areas and production forests.

7.5.2 External Drivers

Regionally present external drivers and stressors were identified through the ESIA, including the following:

- Natural hazards (e.g., earthquake, flooding, landslides, volcanic eruptions and climate risks) as discussed in ***Section 4.2.9***.

7.6 VEC Identification and Selection

7.6.1 Overview

To be included in a CIA, a VEC must first be confirmed to be valued by some identifiable stakeholder group and/or the scientific community. Second, the VEC must be reasonably expected to be affected by both the Project components under evaluation (i.e., the geothermal power plant and transmission line) and some combination of other projects and/or external drivers. Input from stakeholders has been collected as part of the ESIA stakeholder engagement and consultation process.

7.6.2 Selection of VECs

Potentially eligible VECs were analysed against the following criteria: (1) confirmed to be valued by an identifiable stakeholder group (in the case of local communities, identified by a representative number of communities in the AoI) and/or the scientific community; (2) reasonably expected to be potentially impacted by the Project; and (3) reasonably expected to be potentially impacted by some combination of other projects and/or external drivers. ***Table 7-1*** summarizes the VEC screening results for this CIA.

Table 7-1: Selected VECs for Inclusion in CIA

VEC	Valued by Stakeholders or Scientific Community	Significantly Affected by the Project*	Potentially Affected by One or More Other Projects	Potentially Affected by One or More External Drivers	VEC Selected for the CIA
Air quality	Yes	No	No	No	No
Noise	Yes	No	Yes	No	No
Water quality	Yes	No	Yes	Yes	No
Soil	Yes	No	No	No	No
Topography and landscape	Yes	Yes	Yes	Yes	Yes
Biodiversity	Yes	Yes	Yes	Yes	Yes
Land and Livelihoods	Yes	Yes	Yes	Yes	Yes
Cultural Heritage	Yes	No	No	Yes	No

VEC	Valued by Stakeholders or Scientific Community	Significantly Affected by the Project*	Potentially Affected by One or More Other Projects	Potentially Affected by One or More External Drivers	VEC Selected for the CIA
Tourism	Yes	Yes	Yes	Yes	Yes
Infrastructure and Services	Yes	No	Yes	Yes	No
Community safety and wellbeing	Yes	Yes	Yes	Yes	Yes
Operational Health and Safety	Yes	Yes	No	No	No

CIA = cumulative impact assessment; VEC = valued environmental and social component

** A residual impact significance rating of **Moderate** or above.*

Several environmental and social receptors or components were not selected as potentially eligible for the CIA because they were not identified as components of value or concern by stakeholders; not reasonably expected to be significantly impacted by the Project; or not reasonably expected to be potentially impacted by some combination of other projects and/or external drivers.

7.6.3 Assessment of Cumulative Impacts on VECs

The significance of cumulative impacts is not evaluated in terms of the magnitude of change, but instead in terms of VEC response and the resulting condition and sustainability. If cumulative impacts do not exceed the VEC threshold, the development of the project under assessment is considered acceptable. Given the intrinsic limitations of CIAs carried out by a private developer, the present study was not intended to obtain sufficient baseline information to establish thresholds of the selected VECs and therefore establish the significance of the cumulative impacts. Instead, based on the current ESIA-generated information and publicly available information, cumulative impacts were categorized by priority using the following definitions:

- **High Priority**: The VEC is expected to be or is currently being adversely impacted by other projects and/or external drivers and the future addition of the Project could incrementally contribute to the potential adverse impact. Actions should be implemented in the short term to mitigate potential adverse cumulative impacts on the VEC.
- **Medium Priority**: The VEC could potentially be impacted by other projects and/or external drivers, and the Project could potentially incrementally contribute to the adverse impact. Actions should be implemented in the medium term to mitigate potential adverse cumulative impacts on the VEC.
- **Low Priority**: The VEC is not expected to be potentially impacted by other projects and/or external drivers, and therefore the Project impacts would not be expected to contribute to an adverse cumulative impact. No actions are required to mitigate potential adverse cumulative impacts on the VEC beyond Project mitigation measures.

Table 7-2 summarizes the assessment of cumulative impacts for the VECs identified for the CIA.

Table 7-2: Cumulative Impact Assessment

VEC	Potential Impacts from the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Significance
Topography and landscape	▪ The presence of the power plant, well pads, and transmission line would be noticeable to local communities and tourism	▪ Other projects include plantation and production forests neighbouring the Project. These would have visual impacts from deforestation and presence of facilities.	▪ The area is prone to earthquakes and may be subject to flooding events.	▪ The presence of the power plant and transmission line would contribute to the visual impacts caused by production / plantation areas.	**Minor**
Biodiversity	▪ The project is located next to the Kawah Ijen Nature Reserve with associated species of conservation concern,	▪ Other projects include plantation and production forests neighbouring the Project. These would have impacts from deforestation and habitat loss.	▪ The area is prone to earthquakes and may be subject to flooding events.	▪ The transmission line and power plant would contribute to the impacts to habitat loss for local species.	**Moderate**
Land and Livelihoods	▪ The land utilised for the project covers plantation forest and agricultural land (transmission line).	▪ Other projects include plantation and production forests neighbouring the Project. These would have impacts on land use of local communities.	▪ The area is prone to earthquakes and may be subject to flooding events.	▪ Land used by the Project would contribute to land loss in the area. However, the main construction area is already permitted to MCG and the transmission line impacts would be temporary.	**Minor**
Tourism	▪ The presence of the power plant, well pads, and transmission line would be noticeable to local communities and tourism	▪ Other projects include plantation and production forests neighbouring the Project. These would have visual impacts from deforestation and presence of facilities.	▪ The area is prone to earthquakes and may be subject to flooding events.	▪ The presence of the power plant and transmission line would contribute to the visual impacts caused by production / plantation areas but the power plant is compatible with a	**Minor**

VEC	Potential Impacts from the Project	Potential Impacts from Other Projects	Potential Impacts from External Drivers	Cumulative Impact	Significance
				geopark designation and the transmission line has little effect on areas of tourism interest	
Community health and safety	■ Project activities and traffic would be noticeable from the baseline conditions. ■ Should the construction lead to any in-migration and establishment of labour accommodation within the community, there is a risk of spread of communicable diseases and other security issues.	■ Potentially significant impacts to traffic volume from transportation of agricultural products (by trucks) could result in increased congestion, accidents, and reduced air quality.	■ The area is prone to earthquakes and may be subject to flooding events.	■ Cumulatively, impacts would put additional stress on the existing road network in the Project AoI. This could result in an increase in traffic accidents particularly on roads with sensitive receptors.	**Minor**

7.6.4 Cumulative Impact Management

Project design features and management measures included in the current ESIA provide a means to mitigate the specific contributions of the Project to effects on VECs, following the mitigation hierarchy (refer to mitigation measures in ***Chapter 8***). At the Project level, these measures are considered sufficient to address the contributions of the Project to cumulative impacts.

Ultimately, the management of cumulative impacts is the responsibility of government and regional planners. However, it is considered best international practice that private-sector developers make best efforts to engage relevant stakeholders and promote management of cumulative impacts in their project areas (IFC, 2013; Franks et al., 2010).

8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

This Section provides the Environmental and Social Management Plan (ESMP) for the planning and operation of the Project. This ESMP provides the procedures and processes, which will be applied to the Project activities to check and monitor compliance and effectiveness of the mitigation measures to which MCG has committed. In addition, this ESMP is used to ensure compliance with statutory requirements and corporate sustainability policies.

The ESIA process has identified key environmental, social and health issues, impacts and risks associated with the Project, which require the implementation of a wide range of mitigation measures. The necessary actions required to manage these issues, impacts and risks are presented in this ESMP; these include identification of all Project commitments (including legislative and IFC compliance requirements), mitigation measures that have been identified from the impact assessment, and other best practice measures designed to avoid, minimise or reduce negative impacts and enhance positive impacts. Hence, the objectives of the ESMP are to:

- Identify the set of responses to potentially adverse impacts;
- Define the responsibilities for implementation and monitoring;
- Determine requirements for ensuring that mitigation and management measures are implemented effectively and in a timely manner; and
- Describe the means for meeting those requirements.

The purpose of this Chapter is to demonstrate how the mitigation commitments made through the Impact Assessment (IA) Process will be put into practice, monitored and upheld. The content of this chapter is crucial to bridge the findings of the IA with the implementation of the mitigation measures and to provide an early framework of management systems / monitoring regimes that will help to deliver these IA commitments.

Specifically, this Chapter provides information and instructions on how environmental, social, and health commitments of the Project will be managed from pre-construction through the construction and operation phases. The ESMP is a living document which:

- Incorporates the environment and social mitigation measures identified as a result of the ESIA process into a comprehensive framework to facilitate and ensure appropriate management throughout the Project cycle;
- Outlines the required regulatory monitoring detailed within the Project's ESIA;
- Provides a framework to incorporate commitments into the Project plans and procedures for activities that have risks, as identified in the IA;
- Presents responsibilities for meeting ESMP requirements including the provision of training;
- Provides a framework for the implementation of specific management plans by the contractor; and
- Defines the monitoring/verification and reporting program (including corrective actions).

8.1 ESMP Link to an Environmental and Social Management System

An effective Environmental and Social Management System (ESMS) is a dynamic and continuous process initiated and supported by management, and involves engagement between the developer, its workers, local communities directly affected by the project and, where appropriate, other stakeholders.

This ESMP will be part of the future construction and operational activities, and as the future construction and operational plans are prepared, these are expected to confirm how these commitments will be incorporated into the Project's ESMS. This implementation will be under the responsibility of the EPC (Engineering Procurement Construction) Contractor and MCG.

It is noted that MCG have a drafted ESMS system in place that will be required to be in operation for the Project.

8.2 Roles and Responsibilities for Implementing the ESMP

The key parties and their primary roles in implementing the ESMP are as follows:

- MCG – as the Project Proponent is responsible for the overall Project monitoring, ensuring compliance with environmental policy and obligations in the ESMP;
- EPC Contractor is responsible for complying with ESMP requirements set out by MCG; and
- Other operational contractors – responsible for complying with the ESMP requirements set out by MCG.

ERM has provided guidance on the types of roles and responsibilities that would be required for implementation of the ESMP during construction and operation.

8.2.1 MCG – Project Director

MCG's Project Director is responsible for all construction activities and accountable for overall Health, Safety, Security, and Environment ("HSSE") performance of the Project.

Expectations for the role in terms of implementing a management system would include:

- Actively promoting and participating in the Project HSSE Plan;
- Ensuring that the ESMP, procedures and work practices are implemented across the Project;
- Ensuring that the ESMP reflects the requirements of the Project in terms of resources and budget;
- Ensuring that all legislative and company requirements are complied with;
- Ensuring that all work scopes are conducted in accordance with the Project HSSE rules and regulations, work practices and procedures, as detailed in this ESMP and other associated documentation;
- Ensuring that all contractors are made aware of their roles and responsibilities with regard to HSSE management;
- Ensuring that HSSE is regularly discussed and reported on i.e. in the weekly contractor progress meeting;
- Ensuring that all contractors are evaluated throughout the duration of the Project, as to their capabilities and performance; and
- Ensuring implementation of HSE audit recommendations for non-compliances.

8.2.2 MCG - HSSE Department

MCG's HSSE Department would be expected to undertake the following roles:

- Manage, review and develop the HSSE program to ensure that it fulfils Project requirements, including measures observed in this ESMP, and monitor the implementation including e.g., patrolling the job site daily to ensure construction works' compliance to Project HSSE Procedures and safe working practices;
- Coordinate and evaluate the effectiveness of all program elements;
- Liaison with related government bodies as necessary;
- Manage the Project HSSE team and supervise them to ensure that all areas of the project are given the required level of safety support and attention;

- Ensure proper housekeeping and waste disposal in accordance with company requirements and regulations;
- Ensure that the respective control areas are given in the required level of safety support and attention including e.g., only safety-approved material and equipment are allowed to be brought onto site;
- Ensure that all HSSE reports/findings of any unsafe conditions/practices is brought to the attention of field management and those are immediately corrected, and coordinate accident/incident investigations and report to Project Director; and
- Manage HSSE Audits and report the results to the Project Director.

8.2.3 Stakeholder Manager

The Stakeholder Manager, employed by MCG, would be expected to undertake the following roles:

- Coordinate and evaluate the effectiveness of all program elements;
- Manage the implementation of stakeholder relations and grievance management to ensure that all social-related requirements in this ESMP are implemented;
- Manage the implementation of community health program, including coordination with HSSE team on OHS measures associated with management of impact to community health;
- Coordinating with HSSE team on implementation of the Project vehicle safety measures associated with management of impact to community safety;
- Coordinating with HR (Human Resources) person to ensure implementation of labour-related measures required in this ESMP;
- Consultation with community and liaison with relevant stakeholders in implementing the required stakeholder and grievance management measures, including liaison with related government bodies as necessary;
- Leading collaboration to establish and implement the Project grievance mechanism during construction phase, and supervise contractor’s social performance as required in this ESMP; and
- Managing social monitoring and reporting the results to the Project Manager.

8.2.4 EPC's Site Representatives/ HSSE Department

The EPC and its contractors, depending on their work scopes, would be expected to have an HSSE team. The contractors' site representatives or HSSE Department should be assigned clear responsibilities and expectations with respect to implementing the Project’s HSSE expectations and should be fully responsible for implementing any required expectations which fall under their work scopes. More specifically, they will:

- Actively promote and implement all Project HSSE plans related with the work they are preforming. The contractor will make sure that all activities under his/her responsibility shall follow all safety regulation/requirements, coordinating with the Project Director; and
- Ensure that committed resources (personnel, material, and equipment) used are consistent with achieving the objectives and requirements of the Project’s HSSE plans.

8.2.5 EPC Employees

EPC employees and subcontractors involved in the Project will be qualified through training, experience, or knowledge. Non-supervisory personnel employed on the Project shall:

- Familiarise themselves with the concept of the Project HSSE rules and regulations;

- Work in accordance with Project HSSE Plan, safe work practices, and method statements, risk assessments, permits to work and any other instructions that apply to their works;
- Use only tools/equipment and materials, which have been approved for use, and employ them only for the purpose for which they were designed;
- Take an active part in the protection of themselves, fellow workers, property and the environment from accidental losses;
- Immediately report to his respective supervisor or HSSE officer/inspector if any potential hazards (relates to unsafe conditions and/or unsafe acts), which could lead to an accident, are found;
- Report promptly to immediate supervisor and HSSE officer/inspector if any incidents/near misses as well as injuries, regardless how minor; and
- Shall attend project safety training and drills programs as required.

8.3 Training Program and Capacity Building

8.3.1 Construction Phase

Prior to commencement of major civil works at site, a suitably qualified in-house/ external expert will be appointed by the EPC contractor in consultation with MCG to develop and deliver a training program on implementation of the ESMP, monitoring and reporting will be conducted in line with the applicable reference framework for the Project. The training will include the following topics:

- Environment, Health and Safety Policy of the EPC contractor;
- Environment and fundamentals of environmental pollution in relation to the Project;
- EHS management plans prepared by the EPC Contractor;
- Do’s and Don’ts for the construction workers;
- Safety procedures and guidelines;
- Internal reporting and response system;
- Hazardous chemicals and waste handling;

In addition, specific training will be provided to the team involved in environmental and social monitoring and reporting, which will include:

- Applicable environmental and social guidelines and standards;
- Sampling site selection guidelines in line with environmental monitoring plan;
- Sample collection, storage, transportation and analysis procedures;
- Solid and hazardous waste management;
- Quality assurance and quality control;
- Environmental monitoring report preparation.

The training will help in capacity building and implementation of the ESMP during the construction phase of the Project. It will also help in ensuring internal and external monitoring and verification of the environmental and social performance of the Project. The timeframe for reporting and verification during the construction phase will be agreed between MCG, the EPC contractor, and the Lenders.

8.3.2 Operation Phase

Prior to the commencement of Project operation, a suitably qualified in-house/ external environmental expert will be engaged by MCG to develop and deliver a training program on operation phase environmental and social monitoring and reporting. The topics will be mostly same as that during the construction phase. However, it will also include following modules, which are specific to the operation phase:

- Hazardous chemicals and waste management;
- Occupational health and safety programs, including Emergency Response Plan for both employee and nearby communities;

The training will help in capacity building and implementation of the ESMP during the operation phase of the Project. It will also help in ensuring internal and external monitoring and verification of the environmental and social performance of the Project. The timeframe for reporting and verification during the construction phase will be agreed between MCG, the EPC contractor, and the Lenders.

8.4 Corporate Social Responsibility

The Project should also consider plans to support the development of tourism in the region. This was identified through ESIA consultation activities as an expectation of the local communities.

8.5 ESMP Commitments from the Impact Assessment

The potential adverse impacts, mitigation measures, and management responsibilities during the construction phase and operation phase are listed in ***Table 8-1*** and ***Table 8-2***, respectively.

Table 8-1: Pre-Construction, Construction, and Drilling Phase – ESMP Commitments

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
Air Quality					
Basic measures; ■ Paving the main access road ■ Spraying water to minimize fugitive dust along any temporary roads or other disturbed areas as dictated by weather conditions ■ Compliance with the flying-dust mitigation standard and monthly training at the worksite ■ No incineration of construction waste at worksite ■ Use of low pollution equipment and in good condition ■ Use of mobilization vehicle that meets the technical requirements and passes the motor vehicle test ■ Cover the body of the mobilization vehicle with a plastic or tarpaulin cover, especially when transporting materials that have the potential to cause dust (soil and cement)	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
Earthworks; ■ Wheel wash at the entrance and cargo box cover shall be checked ■ Cargo box cover of dump truck to prevent the dust scattering ■ Work is suspended when wind velocity exceeds 8m/sec and dust-prevention cover sheet on excavated soil ■ Speed limit at worksite to 20km/h	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Conduct ambient air quality monitoring at two sensitive receptors (households nearest to the drilling location at Pad 8). Monitoring should be conducted monthly during the construction phase to ensure the Project meets ambient air quality standard.	Air Quality Monitoring	EPC Contractor / Third Party	Construction Phase	Monitoring Reports	30,000 - 60,000 USD per year
■ Prepare and implement an Air Quality Management Plan (AQMP) during construction and drilling activities	Site Audit	EPC Contractor	Prior to Construction Phase	AQMP	Included in EPC Costs
■ Record all dust and air quality complaints under the Grievance Mechanism and follow up by identifying the causes and taking appropriate measures to reduce emissions in a timely manner	Grievance records	Project Administrator	Prior to Construction Phase	Grievance Mechanism	Included in MCG HSSE costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Record any exceptional incidents that lead to significant fugitive dust emissions off the Project area and make a record of the action taken to resolve the issue and reduce the possibility of it occurring again in the future	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure soil stockpiles are located as far as possible from receptors and are covered or sprayed to minimize fugitive dust	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure regular maintenance of all diesel-powered equipment in accordance with manufacturers specifications	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Switch off machinery and equipment when not in operation	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Use low sulphur fuels in heavy good vehicles and diesel powered equipment	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Maintain speed limit at 20 kilometres per hour (km/h), where possible	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Undertake regular on-site inspections, where receptors (including roads) are nearby, to monitor dust and record inspection results. Inspections should include regular dust soiling checks of surfaces such as vehicles and window sills within 100 m of the construction site boundary	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures.	Site Audit	MCG	Construction Phase	Monthly HSSE Reports	Included in MCG HSSE Costs
■ Install an H_2S gas-monitoring network, taking into account the location of emissions sources and areas of community use and habitation. Operate the H_2S gas monitoring system continuously to facilitate early detection and warning.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ If necessary, use abatement systems to remove H_2S emissions from non-condensable gases. Examples of H_2S controls include wet or dry scrubber systems or a liquid phase/oxidation system.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide adequate ventilation of nearby low-lying occupied buildings to avoid H_2S accumulation.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide workers with educational materials, training, and Personal Protective Equipment (PPE) to protect them from H_2S emissions	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Require mandatory pre-employment asthmatic sensitivity screening by Ministry of Health for all workers assigned in the drilling phase.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ If H_2S monitoring identifies an offsite human health risk, then relocate nearby receptors (i.e., community members) that could be affected by H_2S emissions.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Develop and implement an emergency response system that covers accidental releases of H_2S emissions.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
Ambient Noise					
■ Selection of low noise and vibration methods	Design Documentation	EPC Contractor	Pre-Construction Phase	Design Reports	Included in EPC Costs
■ Installing Sound barrier at worksite	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Using low vibration equipment and methods	Design Documentation	EPC Contractor	Pre-Construction Phase	Design Reports	Included in EPC Costs
■ Adjustment of working hours, based on public hearings for residents. Set construction working hours, namely during working hours (08.00 – 17.00), so as not to disturb residents' rest hours.	Design Documentation	EPC Contractor	Pre-Construction Phase	Design Reports	Included in EPC Costs
■ Coordinate with village officials and local community if the construction activities are to be carried out outside the agreed working hours.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Project activity noise monitoring will be required for noise generation at main Project Site to ensure the standards in Section 2.4 are met	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Conduct ambient noise monitoring at two sensitive receptors (households nearest to the drilling location at Pad 8). Monitoring should be conducted monthly during the construction phase during drilling to ensure no changes from ambient baseline conditions	Noise Monitoring	EPC Contractor / Third Party	Construction Phase	Monitoring Reports	30,000 - 60,000 USD per year
■ Where necessary, install acoustic enclosures for equipment casing radiating noise.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure equipment is maintained as per the preventive maintenance schedule	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Limit the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community. Shut down or throttled down between work periods for machines and construction plant items (e.g. trucks) that may be in intermittent use	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Reduce the number of equipment operating simultaneously as far as practicable	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Orientate equipment known to emit noise strongly in one direction so that the noise is directed away from sensitive receptors as far as practicable	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Any activity that has the potential to generate impulsive noise will be avoided where possible when in close proximity to noise sensitive receptors.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ During the works, unnecessary noise due to idling diesel engines and fast engine speeds will be avoided when lower speeds are sufficient	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Normal working hours of the contractor should be in line with Indonesian legal requirements.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Implement a speed limit for mobilization of heavy equipment and materials	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Mobilization of heavy equipment and materials to be escorted	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Coordinate with the local community to inform the Project's mobilization activities prior to the activity	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Record all noise complaints under the Grievance Mechanism and follow up by identifying the causes and taking appropriate measures to reduce noise in a timely manner	Communication Records	EPC Contractor	Construction Phase	Grievance Mechanism	Included in EPC Costs
■ Prepare a Noise and Vibration Management Plan (NVMP) covering land preparation, drilling and blasting activities. This plan should include details of monitoring required as well as mitigation measures, and roles and responsibilities of the EPC and MCG;	Site Audit	EPC Contractor	Prior to Construction Phase	NVMP	Included in EPC Costs
■ Blasting activities should be agree with and communicated to the local communities prior to commencing. Timely notification of blasting activities should be provided to local communities; and	Communication Records	EPC Contractor	Construction Phase	Communication Records	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Reports	Included in MCG HSSE Costs
■ Conduct structural and drilling assessment prior to start of construction.	Site Audit	EPC Contractor	Pre-Construction Phase	Audit Reports	Included in EPC Costs
Water Resources and Quality					
■ Permit for pollution discharge facilities and installation as per Indonesian Standards	Pollution Permit	EPC Contractor	Pre-Construction Phase	Permit	Included in EPC Costs
■ Collect groundwater samples, in order to establish water quality baseline prior to start of construction.	Site Audit	MCG	Pre-Construction Phase	Audit Reports	Included in MCG HSSE Costs
■ Installation and operation of septic tank and sedimentation ponds	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Car wash at the site shall be prohibited	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Prevention of erosion by providing diversion channel	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Treat wastewater in a bioreactor type wastewater treatment plant with a capacity of 14.4 m3/day	Design	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Develop and implement an emergency response system for the wastewater treatment plant	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Coordinate with licensed third party for the handling, transport, and disposal of wastewater treatment plant sludge/waste	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Installation of sewer and septic tank which is connected to wastewater treatment facilities	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ All discharges will be in compliance with legislation standards in ***Section 2.4***	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Conduct monthly water quality sampling at least at one location upstream of water intake and one location downstream of Project influence for the normal suite of parameters, including the anticipated chemical constituents of the geothermal liquids. For groundwater quality sampling, construct upstream and downstream monitoring wells.	Monitoring Records	EPC Contractor / third party	Construction Phase	Monitoring Report	30,000 - 60,000 USD per year
■ Keep daily records for pH, TSS and discharge parameters of groundwater	Monitoring Records	EPC Contractor / third party	Construction Phase	Monitoring Report	Included in EPC Costs
■ Earthworks to form the final surfaces should be followed up with surface protection and drainage works to prevent erosion caused by rainstorms.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Separate wastewater channels from rainwater runoff drainage	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ All drainage facilities and sediment control structures will be inspected on a regular basis and maintained to confirm proper and efficient operation at all times and particularly during rainstorms. Deposited silt and grit will be removed regularly.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Water abstraction activities to be carried out in accordance with the permit; ■ Reuse treated storm water onsite where possible to meet some of the water needs of the Project.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Inject geothermal fluids (brine) in injection wells, well below surface aquifer units	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide sufficient process wastewater storage to avoid the release of any untreated water into surface waters	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Sewage will be discharged into an adequately sized leak proof septic tank.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Grey water from showers and canteen kitchens (including that from basins, sinks and floor drains) should be discharged into soaking pit equipped with grease traps. Grease will be treated as oil waste	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide temporary storages for domestic waste in the form of closed and segregated tanks based on the type of solid waste generated. Use watertight containers to prevent leachate from seeping through or spilling over.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Provide temporary storages for hazardous waste in accordance with the technical approval for hazardous waste management as per Indonesian regulation. This includes segregating hazardous waste based on its type and characteristics, equipped with symbols and labels, record keeping of hazardous waste handling, develop and implement an emergency response system for hazardous waste management, and report hazardous waste balance to MoEF.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide warning signs to dispose waste in the space provided.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Domestic, construction and hazardous waste as well as sewage sludge will be disposed of periodically (every three days or according to conditions at the Project site) by a registered and licensed waste vendor to approved landfill and / or treatment facility.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Coordinate with the local sanitary agency on the collection, storage, transport and disposal activities of waste generated by the Project	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Storage of chemicals, fuel, and oil in adequately bunded impervious areas, as per good international industry practices	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Debris and refuse generated on-site should be collected, handled and disposed of properly to avoid entering the receiving waters. Stockpiles of cement and other construction materials should be kept covered when not being used	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	KWS	Construction Phase	Monthly HSSE Reports	Included in KWS HSSE Costs
■ Develop and implement a Water Quality Protection and Management Plan for surface water and groundwater as required as per PP 22/2021.	Site Audit	EPC Contractor	Prior to Construction Phase	Soil Erosion Plan	Included in EPC Costs
■ Develop and implement a Drilling Mud and Cuttings Management Plan. The management plan shall include collection, storage, transport, and disposal of drilling mud and cuttings. This includes arrangement of supervisors to ensure that drilling mud and cuttings are properly handled and not scattered around the Project area.	Site Audit	EPC Contractor	Prior to Construction Phase	Drilling Mud and Cuttings Management Plan	Included in EPC Costs
Soil Quality					

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Reuse of topsoil as backfill wherever possible	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Schedule activities (as far as possible) to avoid extreme weather event such as heavy rainfall and high winds	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Re-vegetate areas with temporary land cover, conducting ‘progressive rehabilitation	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Minimise the amount of soil handling	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Stabilise exposed areas	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Cover or spray water on stockpiles of excavated material or backfill	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Reduce or prevent sediment runoff through use of settlement ponds, silt fences.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Demarcate routes for movement of heavy vehicles	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Pave and maintain access road to be used for movement of heavy vehicles	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Strip and placing soils when dry, and not when wet	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Restrict the height of topsoil stockpiles to minimise compaction, restricted to 2 m	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Appropriate management of black and grey wastewater as well as management, storage and disposal of waste as per good international industry practices	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Appropriate management of chemicals by implementing good international industry standards	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Store chemicals, fuel, and oil in adequately sheltered and impervious bund as per good international industry practices	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers should be surrounded by bunds to contain the volume being stored in case of accidental spillage	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Develop and implement a Soil Erosion and Sediment Control Plan including control measures such as the use of silt fences, installation of temporary and permanent drainage systems to manage water runoff from the construction areas, and use of sediment basins	Site Audit	EPC Contractor	Prior to Construction Phase	Soil Erosion Plan	Included in EPC Costs
■ Use appropriate best management practices during clearance activities, to the extent practicable, such as: schedule construction activities during the dry season, especially on steeply sloped areas; limit clearing and disturbance to the approved work zone area only; minimize the area of bare soil at any one time within the approved work zone as much as possible; and progressively stabilize and revegetate disturbed areas	Site Audit	EPC Contractor	Prior to Construction Phase	Soil Erosion Plan	Included in EPC Costs
■ Reuse excavated material for slope stabilization of the exploration drilling and injection pads	Site Audit	EPC Contractor	Prior to Construction Phase	Soil Erosion Plan	Included in EPC Costs
■ Installation of skips and bins: - Skips and bins should be strategically placed within the campsite and construction site. - The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour. - The skips and bins at both the construction campsite and construction site should be emptied regularly to prevent overfilling. - Disposal of the contents of the skips and bins should be done at an approved disposal site	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Reports	Included in MCG HSSE Costs
Landscape and Visual Character					
■ Demarcate construction boundaries and minimize areas of surface disturbance	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Where possible, locate laydown areas and construction camps in areas that are already disturbed or cleared of vegetation	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Cut and fill slopes as well as areas disturbed by construction activity are suitably top soiled and vegetated / covered as soon as is possible after final shaping.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ The Project should retain vegetation at the edge of power plant, drill and injection pads, as well as water storage ponds, to screen these facilities from view from the nearby tourism sites	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ For the construction site maintenance, conduct good housekeeping on site to avoid litter and minimize waste	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ The laydown area, which will no longer be required for the operational stage, should be landscaped with suitable vegetation after the construction work is completed	Site Audit	EPC Contractor	Post-Construction	Close Out report	Included in EPC Costs
■ Use existing tracks/roads for access, where possible	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Within the environmental management system, prepare a restoration management plan including replanting indigenous species, and landscaping and rehabilitating construction yards	Site Audit	EPC Contractor	Post-Construction	Close Out report	Included in EPC Costs
■ Avoid up lighting of structures but rather direct the light downwards and focused on the object to be illuminated	Site Audit	EPC Contractor	Construction Phase	Monthly HSE Report	Included in EPC Costs
■ Minimize night lighting while guaranteeing the minimum safety level	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ All external light fittings shall not allow light to shine upwards	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ All security and street/road lighting shall have “blinkers” or be specifically designed to ensure light is directed downwards while preventing side spill	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Colours for the structures can be used to complement the surrounding area. Lighter colours such as shades of light grey, off-white and light brown may be utilised to reduce the visibility of the structures	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Use of materials that will minimize light reflection should be used for all Project components	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Existing vegetation should be retained to the greatest extent possible. Vegetation should be retained along roads, and other Project infrastructure	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	KWS	Construction Phase	Monthly HSSE Reports	Included in KWS HSSE Costs
Biodiversity					
■ No clearing of natural critical habitat occurs outside the project area	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Access roads will be defined before the beginning of the construction activities. Some of the public roads may need to be used for access. Driving out of the access roads by the construction vehicles taking part of the construction activities will not be allowed	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Speed of vehicles will be limited, in order to limit emission of dust in non-paved access roads and in order to limit the risk of accidents with fauna.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ If possible, staging vegetation clearance following the development progress will be conducted, to enable fauna to move to other areas.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Clearing vegetation outside of designated areas will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation outside designated areas;	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ The Project owner shall provide training to staff and workers on all rules, regulations and information concerning restrictions related to unauthorised clearing of vegetation, as well as the punishment that can expected if any staff or worker or other person associated with the Project violates rules and regulations	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ The planned vegetation clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ All land rehabilitation will be undertaken using native indigenous species. The area of landscaping within the Project area shall re-establish habitat values	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ A Biodiversity Action Plan has been prepared to document how the Project will achieve no net loss of natural habitat and net gain in biodiversity for critical habitat (see ***Appendix K***)	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Regular (weekly) checks during construction are to occur along all project boundaries to ensure compliance with clearing within marked boundaries	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Records are to be kept and regularly reviewed (3 monthly) for implementation of the workforce training program for fauna/flora awareness	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Records are to be kept and regularly reviewed (3 monthly) of all personnel entering and exiting the project area through checkpoints, including results of all random inspections undertaken for poached flora/fauna	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ A monitoring plan should be carried out to record invasive alien species in the project area of influence aimed at removing new populations and preventing them from spreading throughout the AoI. In addition, prompt revegetation (i.e., sowing of native herbaceous species and/or planting native shrubs/trees) on bare soil with natural or semi-natural vegetation will reduce the spread of alien species.	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Monitoring of rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections (3 monthly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Use of signs and/or fences in access roads and construction sites, to avoid any impact to areas out of the Project footprint. Protective measures will be implemented especially on the locations of active construction works. Use of fences in the construction sites will also avoid the entrance of fauna in them, avoiding accidents	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ A fauna shepherding protocol is to be implemented in the project area to ensure that fauna have vacated the area prior to any clearance work	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Additional mitigation measures are outlined in the impact mitigation of mortality conservation significance bird and bat species	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Records are to be kept and regularly reviewed (3 monthly basis) during construction on the application of the Fauna Shepherding Protocol.	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Revegetation (i.e., the sowing of native herbaceous species on top soils and/or the planting of native shrubs/trees) will be undertaken as soon as possible after clearance and construction. This should be well monitored.	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ A monitoring plan should be carried out to record invasive alien species populations in the project area of influence and aimed at removing new populations and preventing them from spreading throughout the AoI.	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Planting of native indigenous flora adjacent to the road to reduce impacts on habitat connectivity.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Appropriate rehabilitation of disturbed areas using native vegetation is to occur to facilitate movement of fauna species	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Records are to be kept and regularly reviewed (3 monthly basis) on the planting of indigenous flora in the disturbed areas; and	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Monitoring of rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections (3 monthly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Hunting and poaching will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation. Signs of no hunting and poaching to be installed onsite.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ The Project owner shall provide training to staff and workers on all rules, regulations and information concerning restrictions related to hunting and poaching, as well as the punishment that can expected if any staff or worker or other person associated with the Project violates rules and regulations	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ All vehicles are to maintain a speed of a maximum of 40km/hr within work sites to reduce the risk of fauna strike.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Collaboration with local government and conservation agencies in developing campaigns and programmes banning hunting and poaching activities within and surrounding project site.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Records of socialization, training, campaigns and collaboration with stakeholders are to be kept and regularly reviewed (6 monthly)	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs
■ Monitoring of flora fauna abundance and diversity to be conducted at annual basis	Monitoring Records	EPC Contractor	Construction Phase	Monitoring Report	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ No clearing of habitat within the Kawah Ijen Nature Reserve area	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide sufficient buffer space of transmission line ROW to avoid clearing any part of Kawah Ijen Nature Reserve area	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Active coordination with local ranger officer to define safe area for clearing, placing equipment and temporary cam	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Pay appropriate compensation to Perhutani according to applicable regulations	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
Community Health and Safety					
■ All workers, except those based in Project Area, will be accommodated in the labour camp during construction	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide training on some of the most common communicable diseases to all workers to raise awareness of the likely diseases, symptoms, preventative measures and transmission routes as well as treatment	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure health check-ups of all labourers employed at the Project Area to screen pre-existing communicable diseases	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide access to workers to healthcare services (facilities) and medical care in case of sickness	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Community grievances in relation to the conduct of security personnel and safety issues or activities should be addressed in accordance with the Project's established Grievance Procedure	Grievance Records	EPC Contractor	Construction Phase	Grievance Mechanism	Included in EPC Costs
■ As part of the stakeholder engagement activities, communities near the Project Area should be informed about the risks and consequences of trespassing. Such engagement should start prior to the start of construction activities	Engagement Records	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Speed limit of 20 km/h shall be enforced within the construction site	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Security team to monitor entrance to the construction site	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Traffic Management Plan (TMP) should be developed. The Traffic Management Plan should be developed to indicate the traffic routes to be followed and speed limit to be complied with in order to reduce risk to the local communities.	Site Audit	EPC Contractor	Prior to Construction Phase	Traffic Management Plan	Included in EPC Costs
■ Develop and implement a Workforce Code of Conduct, which will be adhered to by all Contractors and employees. Advise employees to always follow the norms and customs that apply in society.	Site Audit	EPC Contractor	Prior to Construction Phase	Workforce Code of Conduct	Included in EPC Costs
■ A Stakeholder Engagement Plan should be developed to ensure local communities are kept updated on Project activities	Site Audit	EPC Contractor	Prior to Construction Phase	Audit Reports	Included in EPC Costs
■ A Waste Management Plan should be developed to ensure adequate and legally acceptable control and management of transport and disposal of all wastes on and off site	Site Audit	EPC Contractor	Prior to Construction Phase	Waste Management Plan	Included in EPC Costs
■ Where possible, the Project will ensure that signs are put up around construction sites advising people of the risks associated with trespass. All signs should be in diagram form to ensure those with low levels of literacy understand the signs	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ The Project will ensure that there is adequate fencing around construction site to minimise the risk of trespass. Fencing will be checked periodically to ensure that it is in good condition and to look for any signs of entry.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Reports	Included in MCG HSSE Costs
■ Community grievances in relation to the health and safety issues or activities should be addressed in accordance with the Project's established Grievance Procedure	Grievance Records	EPC Contractor	Construction Phase	Grievance Mechanism	Included in EPC Costs
Land and Livelihoods					
■ Inform the schedule of Project activities to the local officials and local community	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ The design of the transmission line has considered potential settlement areas and been routed into non inhabited areas were possible.	Design	MCG	Prior to Construction Phase		Included in MCG costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ The Project is conducting land acquisition process currently and a land use survey is being conducted.	Land Acquisition records	EPC Contractor	Prior to Construction Phase	RAP	Included in EPC Costs
■ Physical displacement and resettlement should be avoided through refining of the transmission line route	Design Documentation	EPC Contractor	Prior to Construction Phase	Design Records	Included in EPC Costs
■ Prepare a Resettlement Action Plan (RAP) including measures for compensation of use of land with local homeowners. This should include the following: o Conduct a land use survey for all households to be impacted by land acquisition during the installation of the transmission pipeline. This should assess any economic displacement to be caused by the Project; o The land acquisition process will comply with Indonesian legislation (GR 19/2021), and make reference to international standards (IFC PS); o The avoidance and minimisation principle of impacts related to land will be applied to the entire Project including the temporary land requirement; o The land procurement process should be undertaken in an informed and participatory manner based on the principles of Informed Consultation and Participation; o There should be no forced eviction for the Project. The Project should put in place a non-tolerance of forced eviction and land grab policy; o Ensure that the affected population's access to legal or other appropriate remedies is not restricted by the Project; o Ensure that the stakeholders have access to a grievance mechanism for the communication of any grievances and concerns regarding the land acquisition;	Land Acquisition records	EPC Contractor	Prior to Construction Phase	RAP	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
o Avoid land within natural resources and critical cultural heritage under traditional ownership and/or customary use; o Ensure that the payment of compensation and disbursal of entitlements for impacted assets, including temporary impacts, are completed prior to the physical use of the land; and o The entitlements shall be identified based on the principles of replacement cost with the aim to improve the standard of living.					
■ Conduct a land use survey for all households to be impacted by land acquisition during the installation of the transmission pipeline. This should assess any economic displacement to be caused by the Project; o Desk based review of available documentation from the Project linked to land and landowner identification, negotiation, compensation and rehabilitation measures etc. o Review of land acquisition process with respect to the applicable standards and identify areas of non-conformance against IFC PS5. o Meetings with key stakeholder groups including the Project, resettlement committees etc. as relevant. o Sample survey of impacted households. o Recommend correct actions to align with the requirements of IFC PS5.	Land use survey	EPC Contractor	Prior to Construction Phase	Survey records	Included in EPC Costs
Occupational Health and Safety					
An Occupational Health and Safety Plan will be prepared and implemented covering: ■ Clear signs and signals e.g., safety hat required, no entry due to construction areas, etc; ■ Provision of appropriate and sufficient Personal Protective Equipment (PPE); ■ Prohibition of drinking or the use of any drugs during work hours; ■ Provision of first aid kits and personnel, and emergency unit on site; and	Site Audit	EPC Contractor	Prior to Construction Phase	Occupational Health and Safety Management Plan	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Provide relevant training to ensure staff are aware of the Health and Safety protocol and requirements of the Project					
■ The project will comply with Indonesian labour laws, International Labour Organization (ILO) standards and good international industry practices	Labour Contracts	EPC Contractor	Pre-Construction Phase	Monthly HSE Report	Included in EPC Costs
■ All staff will have medical check-ups prior to commencing work, where required.	Labour Contracts	EPC Contractor	Pre-Construction Phase	Monthly HSE Report	Included in EPC Costs
■ Create and implement an environmental management system for the project. It will include mandatory health and safety training courses for all workers and contractors, including handling of hazardous material. This training will take place prior to work starting on operation. Training course attendance will be recorded and monitored by the Project.	ESMS	MCG	Pre-Construction Phase	ESMS	Included in MCG HSSE Costs
■ Installation of hydrogen sulphide monitoring and warning systems. The number and location of monitors should be determined based on an assessment of plant locations prone to hydrogen sulphide emission and occupational exposure	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Development of a contingency plan for hydrogen sulphide release events, including all necessary aspects from evacuation to resumption of normal operations	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Provide workers with helmets and other personal protective equipment (PPE) such as eye protection, work gloves and protective boots. Ensure all staff wear appropriate PPE.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Monitoring, recording and reporting of Health, Safety and Environmental (HSE) matters as per good international industry practice shall be done on a monthly basis	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Project should have a healthcare facility on Site which includes a nurse/doctor to treat workers directly whenever possible. This will reduce pressure on the local healthcare facilities. The healthcare workers will be recruited from outside the local villages to avoid impacting existing providers	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure activities are supervised by trained personnel	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Suitable training is required for all employees who work at height. Employees should be trained in working on different pieces of equipment and surfaces, such as how to work safely on scaffolding, ladders, and roofs	Site Audit	EPC Contractor	Construction Phase	Training Reports	Included in EPC Costs
■ Provide walkways that are clearly designated as walkways, having good conditions underfoot, and being well lit	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Implement good housekeeping practice - Keeping work and storage areas tidy and designating specific areas for waste collection	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ If a surface is slippery with mud it should be treated with stone. Any areas that are slippery should be signposted, and footwear with a good grip should be worn	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Construction workers should be given appropriate protection when using vibrating tools, and equipment should be well maintained	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Where duties involve manual handling, adequate training must be provided	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Reversing movements of vehicles and mobile plant should be minimized by providing, where possible, drive through circulation routes. Where reversing is unavoidable, turning heads should be provided and banksmen should be deployed to guide reversing vehicles and plant where necessary; and steps should be taken to ensure that banksmen wear high-visibility safety vests and use walkie-talkie or similar equipment for effective communication	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Safety reversing devices such as reversing video device (RVD), cross view mirror, parking sensor, and reversing alarm and warning light shall be used when applicable	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure loading and unloading of material is undertaken as per good international industry practices	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Employment					
■ EPC Contractor will target local employment and provide on the job vocational training, where possible.	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Prioritize local workers from Ring 1 to Ring 6 (as per the AMDAL) as much as 77% of the total construction workers required, in accordance with the required specifications.	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Coordinate with Village officials, public figures, and publish workforce opportunity related announcements at the Village office.	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ The Project will aim to employ local workers where possible	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Ensure the recruitment process of the local workers will be carried out in an open and transparent manner	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Collaborate with local residents to provide catering (meals) for construction workers. Provide decent wages according to competence and the amount of work performed.	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Prioritize the Project affected people, vulnerable group, including the local workforce in Ijen District if possible	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Involve and collaborate with the village government for the local worker's recruitment	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Ensure that the community have access to a grievance mechanism for the communication of any grievances and concerns regarding workforce opportunities and Project activities.	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Develop work contracts for all workers, including casual daily workers.	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
■ Prioritize the purchase of construction materials from around the Project site, if available	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Provide space for local communities to open businesses	Procurement process	EPC Contractor	Prior to Construction Phase	Procurement records	Included in EPC Costs
Infrastructure Service					
■ Workers to be accommodated on site and not in local villages	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Dispose of the waste generated by the Project at licensed landfill sites by registered and licensed waste management vendor	Site Audit	EPC Contractor	Construction Phase	Waste Manifests	Included in EPC Costs
■ Site reinstatement and rehabilitation will be performed including repairing any damage caused as part of the construction activities and reinstating existing access roads when needed	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Record complaints under the Grievance Mechanism process and follow up by identifying the causes and responding appropriately within 48 hours of receiving the complaint to mitigate the disturbance	Grievance Records	EPC Contractor	Construction Phase	Grievance Mechanism	Included in EPC Costs
■ Traffic Management Plan (TMP) should be developed in accordance with the Traffic Impact Analysis (ANDALALIN) Approval No. 188.45/005/ANDALALIN/430.9.6/2021 issued by the environment and transportation agencies. The TMP should be developed to indicate the traffic routes to be followed, speed limit to be complied with, hours of mobilization activities in order to manage traffic flow. The TMP shall be socialized to all the relevant parties/personnel involved in the Project's mobilization activities.	Site Audit	EPC Contractor	Prior to Construction Phase	Traffic Management Plan	Included in EPC Costs
■ Ensure that the mobilization vehicles are in good condition and proven by proper motor vehicle test (KIR test)	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Ensure that over dimension and over loading (ODOL) does not occur during project mobilization activities by considering the weight and capacity of the vehicles	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Install traffic signs, including speed limits, in coordination with the Bondowoso Regency Environment and Transportation Agency, and ensure that the signs are installed in locations that are not obstructed by trees and readable by traffic users.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Install warning lights/signs at project entrances and exits	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Prohibit mobilization vehicles to park outside the Project area	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Place control officers at the project site during mobilization activities to arrange traffic flow and ensure that speed limits are enforced.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Coordinate with the Bondowoso Regency Environment and Transportation Agency related to the Project's mobilization activities, including the required permits, and any road improvement plan needed to support the project activities.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Coordinate with village officials and inform local community and nearby residents on the Project's mobilization and demobilization activities	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Equipment demobilization activities to be carried out outside the peak hours, and not carried out simultaneously.	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Immediately carry out road repairs when there is a road damage associated by the Project activities	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Project should have a healthcare facility on Site which includes a nurse/doctor to treat workers directly whenever possible. This will reduce pressure on the local healthcare facilities. The healthcare workers will be recruited from outside the local villages to avoid impacting existing providers	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Develop and implement Waste Management Plan that promote good international industry practices such as waste avoidance, reduction, segregation and recycling when possible	Site Audit	EPC Contractor	Prior to construction phase	Waste Management Plan	Included in EPC Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Cultural Heritage					
■ Establish a Grievance Mechanism by engaging with local communities prior to starting construction activities	Grievance records	MCG	Prior to Construction Phase	Grievance Mechanism	Included in MCG HSSE Costs
■ Implement a Chance Find Procedure. When artefacts are found during construction activities, work must stop. The Contractor should report to the relevant ministries	Site Audit	EPC Contractor	Construction Phase	Chance Find Procedure	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Consider special religious events / activities during the development of construction schedule	Design Documentation	MCG	Prior to Construction Phase	Design Records	Included in MCG HSSE Costs
■ Develop the construction planning in discussion with the relevant cultural heritage sites in order to make sure that any Project activity does not take place during special religious activities	Engagement Records	EPC Contractor	Construction Phase	Schedule	Included in EPC Costs
■ Carry out pre-construction engagement with religious leaders (e.g. discuss planning works with religious leaders around major religious holidays if the construction area is within 500 m around the religious sites)	Engagement Records	MCG	Prior to Construction Phase	Stakeholder Engagement Plan	Included in MCG HSEE Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
■ A cultural heritage management plan (CHMP) will be prepared to guide the workers on the protection of cultural heritage sites, structures and values that may be impacted by the Project.	Site Audit	MCG	Construction Phase	CHMP	Included in MCG HSSE Costs
Tourism					
■ Establish and implement a Grievance Mechanism.	Grievance records	MCG	Prior to Construction Phase	Grievance Mechanism	Included in MCG HSSE Costs
■ The footprint of the Project will be minimised during the design stage and existing vegetation shall be retained as far as practicable	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Landscape planting will be implemented by planting native tree species which are fast growing in nature	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Do not allow the workforce to stay in local guesthouses to ensure that space for tourists is not impacted by the Project;	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ Develop and implement a Stakeholder Engagement Plan (SEP) and Grievance Mechanism; including communication with local tourism operators. Tourism operators should be consulted on the need to conduct a Visual Impact Assessment. If this is deemed necessary by operators, this should be conducted;	Engagement Records	MCG	Construction Phase	SEP	Included in MCG HSSE Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ There will be no restriction on access to local tourism sites. Activities should be conducted in consultation with local tourism operators and relevant ministries	Site Audit	EPC Contractor	Construction Phase	Audit Reports	Included in EPC Costs
■ At least four weeks prior to construction activities, relevant authorities and stakeholders (i.e., local tourism operators, tourism associations, and local villagers) will be alerted to the final works area design as well as the construction programme and any specific restrictions	Engagement Records	MCG	Construction Phase	SEP	Included in MCG HSSE Costs
■ Continual engagement will be undertaken with stakeholders to assess the impacts of restricted access to hiking trails	Engagement Records	MCG	Construction Phase	Stakeholder Engagement Plan	Included in MCG HSSE Costs
■ Community grievance mechanism will record the number of person raising grievances and recorded and documented measures to addressed grievances	Grievance records	MCG	Prior to Construction Phase	Grievance Mechanism	Included in MCG HSSE Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP	Site Audit	MCG	Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Unplanned Events					
General					
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event	Site Audits	EPC Contractor	Prior to Construction Phase	SEP	Included in EPC Costs
Prepare and implement an Emergency Preparedness and Response Plan (EPRP) to cover accidental and emergency situations. This Plan will include leaks and spill, collisions, natural hazards, and fire and explosions and will also detail: ■ Planning coordination: including procedures for informing local communities about emergency response, documentation and first aid / medical treatment; ■ Emergency equipment: including equipment in the project design and any additional emergency equipment; and ■ Training: employees and contractors will be trained in emergency response procedures.	Site Audits	EPC Contractor	Prior to Construction Phase	EPRP	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Auditing: audit records will be maintained on how the Plan is being implemented.					
Leaks and Spills					
■ Design the site to include good site management practices to ensure that the products are properly stored on site (e.g., secondary containment, double walled tanks, over filling alarm system)	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
■ Ensure good inspection and maintenance procedures for large mobile construction plant to minimize small leaks and spills	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
Prepare an Emergency Preparedness and Response Plan to cover accidental and emergency situations. This Plan will detail: ■ Planning coordination: including procedures for informing local communities about emergency response, documentation and first aid / medical treatment; ■ Emergency equipment: including equipment in the project design and any additional emergency equipment; ■ Training: employees and contractors will be trained in emergency response procedures; ■ Auditing: audit records will be maintained on how the Plan is being implemented.	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
■ Daily inspection of any secondary containment of oil/chemical on site and ensure good maintenance procedures to minimize small leaks and spills.	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
Vehicle Collisions					
Developed and implemented a Traffic Management Plan (TMP). This should include measures such as:	Site Audits	EPC Contractor	Prior to Construction Phase	TMP	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Active traffic controls (e.g., flaggers to direct traffic at the Project site entrance); and ■ Schedule construction deliveries and employee shift changes to minimize traffic congestion and delay					
■ Design an H&S plan and good safety practices for the transportation (e.g., alcohol policy, good driving practice).	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ Upgrade the access road to the Project site	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event.	Site Audits	MCG	Prior to Construction Phase	SEP Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in the Traffic Management Plan (TMP) should be conducted	Site Audits	EPC Contractor	Prior to Construction Phase	TMP	Included in EPC Costs
■ Develop an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation.	Site Audits	MCG	Prior to Construction Phase	Audit Report	Included in MCG HSSE Costs
■ Regular road condition monitoring along the transportation route to understand road quality during construction phase	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
Fire and Explosion					
■ Implement on-site prevention measures such as (i) Equip the site with proper equipment (such as fire extinguishers, proper communication equipment) and regularly inspect and maintain them; (ii) Prepare the Fire prevention and Fighting Plan that ensure compliance and Fighting; (iii) Conduct firefighting training to the emergency support team, contractors and workers on site and camping areas	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will	Site Audits	MCG	Prior to Construction Phase	SEP Report	Included in MCG HSSE Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
provide regular information on safety drills and guidance to residents in the event of an unplanned event.					
Develop an Emergency Preparedness and Response Plan and monitor contractors to ensure consistent implementation. The Emergency response plan should include: ■ Immediately pull the nearest fire alarm if a fire occurs, report the event to shift supervisor or foreman immediately for emergency response; ■ When the emergency alarm sounds, all employees shall stop all activities and move to emergency assembly places immediately; ■ Limit the fire areas by utilizing the appropriate firefighting equipment, if the fire is small and controllable; and ■ Follow the procedure included in the Emergency Response and Evacuation Plan to take actions.	Site Audits	MCG	Prior to Construction Phase	Audit Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Well Blow out					
■ Installation of flow rate measuring devices	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ Installation of blow out preventer on the well heads and drilling rigs	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response	Site Audits	MCG	Prior to Construction Phase	SEP Report	Included in MCG HSSE Costs
■ Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ Conduct pressure monitoring and install shut off valves	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Develop an Emergency Preparedness and Response Plan	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Subsidence					
The potential subsidence due to surface alteration nearby facilities location will be studied and assessed to prevent subsidence event.	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	Site Audits	MCG	Prior to Construction Phase	SEP Report	Included in MCG HSSE Costs
Implement periodic routine inspection and maintenance procedures (in line with international best practice).	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly	Site Audits	MCG	Prior to Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Natural Hazards					
■ Incorporation of siting and safety engineering criteria to prevent failures due to natural disasters. Including design to seismic code: SNI 03-1726-2002	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response.	Site Audits	MCG	Prior to Construction Phase	SEP Report	Included in MCG HSSE Costs
■ Implement periodic routine inspection and maintenance procedures (in line with international best practice)	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs
■ Install warning system, signal boards, flood prevention systems.	Site Audits	EPC Contractor	Prior to Construction Phase	Audit Report	Included in EPC Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Develop and implement an emergency preparedness and response plan (EPRP) which incorporates in the event of natural hazards. The EPRP is to be socialized to all Project personnel, other relevant parties, and the local community.	Site Audits	EPC Contractor	Prior to Construction Phase	EPRP	Included in EPC Costs

Table 8-2: Operational and Decommissioning Phase – ESMP Commitments

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
Air Quality					
■ Reduce H_2S emissions using economically feasible technological approach	Design	MCG	Prior to Operation Phase	Design Reports	Included in MCG HSSE Cost
■ Install a device (e.g., fan) at the H2S emission point which can minimize the H2S concentration	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Install an H2S gas-monitoring network, taking into account the location of emissions sources and areas of community use and habitation. Operate the H2S gas monitoring system continuously to facilitate early detection and warning.	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Secure well pad locations and establish a safe zone for local residents. Inform the local community not to construct buildings in Zone 1 (as per the AMDAL).	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Periodic maintenance on machines, equipment, and other air pollutant source units	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Maintenance of green open space by prioritizing the ecological function of plants in the environment to maintain ambient air quality	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Ensure to use demolition equipment that is functional and in good condition.	Site Audit	MCG	Decommissioning Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
Ambient Noise					
■ Plant vegetation that functions as a sound barrier to reduce noise generated during Project operations	Site Audit	MCG	Prior to operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Install silencer/muffler to reduce noise during Project operations	Site Audit	MCG	Prior to operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Use of equipment that has low noise and vibration levels	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Carry out periodic maintenance of equipment	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Develop and implement a Noise and Vibration Management Plan	Site Audit	MCG	Operation Phase	Noise and Vibration Management Plan	Included in MCG HSSE Cost
Surface Water and Groundwater Quality					
■ The Project will handle, store and dispose of all waste in accordance with applicable guidelines.	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Site drainage facilities should be developed following the design basis below: - Designed to convey the runoff from a 100 years' rainfall event. - Provide oily water separator at the tie-in point of the existing drainage system. - Convey surface runoff and roof drainage away from the equipment and buildings.	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ All drainage facilities and sediment control structures will be inspected on a regular basis and maintained to confirm proper and efficient operation at all times and particularly during rainstorms. Deposited silt and grit will be removed regularly.	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Treat wastewater in a bioreactor type wastewater treatment plant with a capacity of 14.4 m3/day	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Develop and implement an emergency response system for the wastewater treatment plant	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Coordinate with licensed third party for the handling, transport, and disposal of wastewater treatment plant sludge/waste	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Conduct monthly water quality sampling at least at one location upstream of water intake and one location downstream of Project influence for the normal suite of parameters, including the anticipated chemical constituents of the geothermal liquids. For groundwater quality sampling, construct upstream and downstream monitoring wells.	Monitoring Records	MCG / third party	Operation Phase	Monitoring Report	30,000 - 60,000 USD per year
■ Keep daily records for pH, TSS and discharge parameters of groundwater	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Separate wastewater channels from rainwater runoff drainage	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Water resource mitigation measures: o Install a continuous water level recorder on the abstraction location at the existing stream gauge near MCG's proposed water intake to develop a flow record that would allow for better management of the water resource o Reuse treated storm water onsite where possible to meet some of the water needs of the Project. o Conduct resistivity tests and drill logs in the infiltration area and its surroundings o Record keeping of daily discharge	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Carry out reduce, reuse, recycle of wastes	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Maintain proper housekeeping of the Project area, prohibit littering, and provide signage for all Project personnel to maintain cleanliness of the site.	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Provide temporary storages for domestic waste in the form of closed and segregated tanks based on the type of solid waste generated. Use watertight containers to prevent leachate from seeping through or spilling over.	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Provide temporary storages for hazardous waste in accordance with the technical approval for hazardous waste management as per Indonesian regulation. This includes segregating hazardous waste based on its type and characteristics, equipped with symbols and labels, record keeping of hazardous waste handling, develop and implement an emergency response system for hazardous waste management, and report hazardous waste balance to MoEF.	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Provide warning signs to dispose waste in the space provided.	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Domestic, construction and hazardous waste as well as sewage will be disposed of periodically (every three days or according to conditions at the Project site) by a registered and licensed waste vendor to approved landfill and / or treatment facility.	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Coordinate with the local sanitary agency on the collection, storage, transport and disposal activities of waste generated by the Project	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
Landscape and Visual Character					
■ The Project should retain vegetation at the edge of power plant, to screen these facilities from view from the nearby tourism sites	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Demarcate construction boundaries and minimize areas of surface disturbance	Site Audit	MCG	Operation Phase	Audit Reports	Included in EPC Costs
■ Cut and fill slopes as well as areas disturbed by construction activity are suitably top soiled and vegetated / covered as soon as is possible after final shaping	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Use existing tracks/roads for access, where possible	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Avoid up lighting of structures but rather direct the light downwards and focused on the object to be illuminated	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ All external light fittings shall not allow light to shine upwards	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Minimize night lighting while guaranteeing the minimum safety level	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Security and street/road lighting shall have "blinkers" or be specifically designed to ensure light is directed downwards while preventing side spill	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Colours for the structures can be used to complement the surrounding area. Lighter colours such as shades of light grey, off-white and light brown may be utilised to reduce the visibility of the structures	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
Biodiversity					
■ No clearing any habitat of Kawah Ijen Nature Reserve area	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Provide sufficient buffer space of transmission line ROW to avoid clearing the part of Kawah Ijen Nature Reserve area	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Active coordination with local ranger officer to define safe area for clearing, placing equipment and temporary camp	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Use of bird deflectors on the length of the power line. The deflectors will increase line visibility by thickening the appearance of the line for easier detection by avifauna	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Moveable markers of contrasting colours (e.g., black and white) that protrude above and below the line, and be placed 5-10 m apart	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Removing the thin neutral or earth (shield) wire above the high voltage transmission lines where feasible, and where this is not possible, marking the line to make it more visible	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Minimising the vertical spread of power lines. Having lines in a horizontal plane reduces collision risk	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Habitat manipulation to influence flight activity and bird behaviour, e.g., tree lines under the high voltage lines to increase visibility	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Insulating cables close to poles, at least 70 cm on both sides and around perching areas, and up to at least 140cm	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Hanging insulators under cross arms and poles, provided the distance between a likely perch (mainly the transmission tower crossarm) and the energised parts (conductors) is at least 70 cm	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Regular inspections of the transmission line route (3 monthly) during construction is to occur to identify any fauna mortality that has occurred. Where patterns in species mortality or conservation significance species are identified, advice from a suitably qualified person should be sought to alter mitigation measures to reduce future potential impacts	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Backfilling the Project footprint using the original soil or stockpiled soil as a form of top soil conservation	Site Audit	MCG	Decommissioning Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Using organic or chemical fertilizers to increase soil fertility	Site Audit	MCG	Decommissioning Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Carry out revegetation of the Project area using plant species that are in accordance with the characteristics of the Project area, and plant species which are a source of animal feed. Revegetation and rehabilitation activities to be carried out in coordination with the local nature conservation agency (BKSDA).	Site Audit	MCG	Decommissioning Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Hunting and poaching will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation	Site Audit	MCG	Decommissioning Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Collaboration with the local nature conservation agency (BKSDA) to procure a program to increase fauna abundance in the Project area	Site Audit	MCG	Decommissioning Phase	Monthly HSSE Report	Included in MCG HSSE Cost
Tourism					
■ Establish and implement a Grievance Mechanism	Grievance records	MCG	Prior to Operation Phase	Grievance Mechanism	Included in MCG HSSE Costs
■ Landscape planting will be implemented by planting native tree species which are fast growing in nature	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ There will be no restriction on access to local tourism sites. Activities should be conducted in consultation with local tourism operators and relevant ministries	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Do not allow the workforce to stay in local guesthouses to ensure that space for tourists is not impacted by the Project;	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Develop and implement a Stakeholder Engagement Plan (SEP) and Grievance Mechanism; including communication with local tourism operators. Tourism operators should be consulted on the need to conduct a Visual Impact Assessment. If this is deemed necessary by operators, this should be conducted;	Engagement Records	MCG	Operation Phase	SEP	Included in MCG HSSE Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ At least four weeks prior to construction activities, relevant authorities and stakeholders (i.e., local tourism operators, tourism associations, and local villagers) will be alerted to the final works area design as well as the construction programme and any specific restrictions	Site Audit	MCG	Operation Phase	Audit Reports	Included in MCG HSSE Costs
■ Continual engagement will be undertaken with stakeholders to assess the impacts of restricted access to hiking trails	Engagement Records	MCG	Operation Phase	Stakeholder Engagement Plan	Included in MCG HSSE Costs
■ Community grievance mechanism will record the number of person raising grievances and recorded and documented measures to addressed grievances	Engagement Records	MCG	Operation Phase	Stakeholder Engagement Plan	Included in MCG HSSE Costs
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP	Grievance records	MCG	Prior to Operation Phase	Grievance Mechanism	Included in MCG HSSE Costs
■ Organize educational tourism programs of the geothermal power plant by considering the Project's terms and conditions, if possible	Engagement Records	MCG	Operation Phase	Stakeholder Engagement Plan	Included in MCG HSSE Costs
Community Health and Safety					
■ All workers, except those based in Project Area, will be accommodated in the labour camp during operation	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Costs
■ Provide training on the most common communicable diseases to all workers to raise awareness of the likely diseases, symptoms, preventative measures, transmission routes, and treatment	Training	MCG	Operation Phase	Training Records	Included in MCG HSSE Cost
■ Ensuring health check-ups of all labourers employed and fit to work assessments	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Provide access for workers to healthcare services (facilities) and medical care	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Community grievances in relation to the conduct of security personnel and safety issues or activities should be addressed in accordance with the Project established Grievance Procedure	Communication Records	MCG	Operation Phase	Grievance Mechanism	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ As part of the stakeholder engagement activities, communities near the Project Area should be informed about the risks and consequences of trespassing. Such engagement should start prior to the start of construction activities	Communication Records	MCG	Operation Phase	Stakeholder Engagement Plan	Included in MCG HSSE Cost
■ Speed limit of 20 km/h shall be enforced within the construction site	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Traffic Management Plan (TMP) should be developed. The Traffic Management Plan should be developed to indicate the traffic routes to be followed and speed limit to be complied with in order to reduce risk to the local communities	Site Audit	MCG	Prior to Operation Phase	TMP	Included in MCG HSSE Costs
■ Develop and implement a Workforce Code of Conduct which will be adhered to by all Contractors and employees	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ A **Waste Management Plan** should be developed to ensure adequate and legally acceptable control and management of transport and disposal of all wastes on and off site	Site Audit	MCG	Operation Phase	Waste Management Plan	Included in MCG HSSE Cost
■ The Project will ensure that there is adequate fencing around the project site to minimise the risk of trespass. Fencing will be checked periodically to ensure that it is in good condition and to look for any signs of entry	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ A **Stakeholder Engagement Plan** (SEP) should be developed to ensure local communities are kept updated on Project activities	Engagement Records	MCG	Operation Phase	SEP	Included in MCG HSSE Cost
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures outlined in the ESMP	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Community grievances in relation to the health and safety issues or activities should be addressed in accordance with the Project's established Grievance Procedure	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
Land and Livelihoods					
■ Coordinate with local officials regarding Corporate Social Responsibility that will be given to the community	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Carry out outreach to the public regarding the operational period of the Project	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
Occupational Health and Safety					
■ The project will comply with Indonesia labour laws (as per **Chapter 2** of this ESIA).	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Provide workers with the required and appropriate personal protective equipment (PPE) such as eye protection, work gloves and protective boots to undertake site activities.	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Create and implement an environmental management system for the project. It will include mandatory health and safety training courses for all workers and contractors, including handling of hazardous material. This training will take place prior to work starting on operation. Training course attendance will be recorded and monitored by the Project. The plan shall be issued and approved prior to start any operational activity.	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
An **Occupational Health and Safety Plan** will be prepared and implemented covering: ■ Clear signs and signals e.g., safety hat required, no entry due to construction areas, etc.; ■ Provision of appropriate and sufficient Personal Protective Equipment (PPE); ■ Prohibition of drinking or the use of any drugs during work hours; ■ Provision of first aid kits and personnel, and emergency unit on site; and ■ Provide relevant training to ensure staff are aware of the Health and Safety protocol and requirements of the Project.	Site Audit	MCG	Operation Phase	Occupational Health and Safety Plan	Included in MCG HSSE Cost
■ Installation of hydrogen sulphide monitoring and warning systems. The number and location of monitors should be determined based on an assessment of plant locations prone to hydrogen sulphide emission and occupational exposure	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Development of a contingency plan for hydrogen sulphide release events, including all necessary aspects from evacuation to resumption of normal operations	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Provide workers with helmets and other personal protective equipment (PPE) such as eye protection, work gloves and protective boots. Ensure all staff wear appropriate PPE	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Monitoring, recording and reporting of Health, Safety and Environmental (HSE) matters as per good international industry practice shall be done on a monthly basis	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Project should have a healthcare facility on Site which includes a nurse/doctor to treat workers directly whenever possible. This will reduce pressure on the local healthcare facilities. The healthcare workers will be recruited from outside the local villages to avoid impacting existing providers	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Ensure activities are supervised by trained personnel	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Suitable training is required for all employees who work at height. Employees should be trained in working on different pieces of equipment and surfaces, such as how to work safely on scaffolding, ladders, and roofs	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Provide walkways that are clearly designated as walkways, having good conditions underfoot, and being well lit	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Implement good housekeeping practice - Keeping work and storage areas tidy and designating specific areas for waste collection	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ If a surface is slippery with mud, it should be treated with stone. Any areas that are slippery should be signposted, and footwear with a good grip should be worn	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Construction workers should be given appropriate protection when using vibrating tools, and equipment should be well maintained	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Where duties involve manual handling, adequate training must be provided	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Reversing movements of vehicles and mobile plant should be minimized by providing, where possible, drive through circulation routes. Where reversing is unavoidable, turning heads should be provided and banksmen should be deployed to guide reversing vehicles and plant where necessary; and steps should be taken to ensure that banksmen wear high-visibility safety vests and use walkie-talkie or similar equipment for effective communication	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Safety reversing devices such as reversing video device (RVD), cross view mirror, parking sensor, and reversing alarm and warning light shall be used when applicable	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Ensure loading and unloading of material is undertaken as per good international industry practices	Site Audit	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Cost
■ Monthly site audits will be carried out to verify the project compliance with the mitigation measures	Site Audit	MCG	Construction Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Employment					
■ Coordinate with Village officials and publish workforce opportunity related announcements at the Village office.	Procurement process	MCG	Prior to Operation Phase	Procurement records	Included in MCG HSSE Cost
■ Prioritize local employment. Create priority zones for workforce recruitment in the area closest to the Project location.	Procurement process	MCG	Prior to Operation Phase	Procurement records	Included in MCG HSSE Cost
■ Ensure that recruitment process is conducted in a transparent manner. Workforce recruitment mechanism to be disclosed to the community.	Procurement process	MCG	Prior to Operation Phase	Procurement records	Included in MCG HSSE Cost
■ Develop work contracts for all workers, including casual daily workers.	Procurement process	MCG	Prior to Operation Phase	Procurement records	Included in MCG HSSE Cost

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
Unplanned Events					
General					
■ The Project will implement the SEP and a robust stakeholder engagement program on emergency response. Engagement on emergency response will provide regular information on safety drills and guidance to residents in the event of an unplanned event	Site Audits	EPC Contractor	Prior to Construction Phase	SEP	Included in EPC Costs
Prepare and implement an Emergency Preparedness and Response Plan (EPRP) to cover accidental and emergency situations. This Plan will include leaks and spill, collisions, natural hazards, and fire and explosions and will also detail: ■ Planning coordination: including procedures for informing local communities about emergency response, documentation and first aid / medical treatment. ■ Emergency equipment: including equipment in the project design and any additional emergency equipment. ■ Training: employees and contractors will be trained in emergency response procedures. ■ Auditing: audit records will be maintained on how the Plan is being implemented.	Site Audits	EPC Contractor	Prior to Construction Phase	EPRP	Included in EPC Costs
Leaks and Spills					
■ Design the site to include good site management practices to ensure that the products are properly stored on site (e.g., secondary containment, double walled tanks, over filling alarm system)	Site Audits	MCG	Prior to Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Ensure good inspection and maintenance procedures for large mobile construction plant to minimize small leaks and spills	Site Audits	MCG	Prior to Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly	Site Audits	MCG	Prior to Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Daily inspection of any secondary containment of oil/chemical on site and ensure good maintenance procedures to minimize small leaks and spills.	Site Audits	MCG	Prior to Operation Phase	Audit Report	Included in MCG HSSE Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
Fire and Explosion					
■ Implement routine inspection and maintenance procedures (in line with international best practice) for any hazardous substances' storage vessels	Site Audits	MCG	Prior to Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Install warning system, signal boards, lighting protection system where risks of fire and explosion exposed	Site Audits	MCG	Prior to Operation Phase	Audit Report	Included in MCG HSSE Costs
■ A monthly audit program shall be established to check the implementation of emergency response and evacuation plan, staff training, equipment inspection, and firefighting drills.	Site Audits	MCG	Prior to Operation Phase	Monthly HSSE Audit	Included in MCG HSSE Costs
Well Blow Out					
■ Installation of flow rate measuring devices	Site Audits	MCG	Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Installation of blow out preventer on the well heads and drilling rigs	Site Audits	MCG	Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Regular maintenance of wellheads and geothermal fluid pipelines, including corrosion control and inspection	Site Audits	MCG	Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Conduct pressure monitoring and install shut off valves	Site Audits	MCG	Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly	Site Audits	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Costs
Natural Hazards					
■ Implement periodic routine inspection and maintenance procedures (in line with international best practice)	Site Audits	MCG	Operation Phase	Audit Report	Included in MCG HSSE Costs

Mitigation Measures	Verification Method	Responsible Party	Frequency / Duration	Reporting	Budget
■ Install warning system, signal boards, flood prevention systems	Site Audits	MCG	Operation Phase	Audit Report	Included in MCG HSSE Costs
■ Monthly monitoring the implementation of all proposed mitigation measures specified in Emergency Preparedness and Response Plan should be conducted properly. The EPRP is to be socialized to all Project personnel, other relevant parties, and the local community.	Site Audits	MCG	Operation Phase	Monthly HSSE Report	Included in MCG HSSE Costs

8.6 Management Plans for the Project

The following management plans are recommended to be developed by the EPC Contractor prior to construction of the Project:

- Air Quality Management Plan (Construction and Drilling Phase);
- Noise and Vibration Management Plan (Construction and Drilling Phase);
- Soil Erosion and Sediment Control Plan (Construction and Drilling Phase);
- Waste Management Plan (Construction, Drilling, and Operation);
- Biodiversity Action Plan (Pre-Construction Phase);
- Water Quality Protection and Management Plan for Surface Water and Groundwater (Construction, Drilling, and Operation);
- Traffic Management Plan (Construction, Drilling, and Operation);
- Occupational Health and Safety Plan (Construction, Drilling, and Operation);
- Hazardous Material Management Plan (Construction, Drilling, and Operation);
- Biodiversity and Pest Control Management Plan (Pre-Construction Phase);
- Cultural Heritage Management Plan (Pre-Construction Phase); and
- Land Acquisition and Resettlement Action Plan (Pre-Construction Phase);

A framework for each of the above management plans is provided in ***Table 8-3***.

Table 8-3: Framework for Required Management Plans

Management Plan	Framework
Air Quality Management Plan	■ **Objectives**: The prime objective of the Air Quality Management Plan is to provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures. ■ **Legal Requirements**: Will align with GR22 of 2021 regarding Implementation of Environmental Protection and Management, and make reference to the WBG EHS and PS1, 3, and 4. ■ **Roles and Responsibilities**: MCG, EPC and operations contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Construction Phase. ■ **Management Actions**: As per ***Table 8-1***. ■ **Reporting and Monitoring**: Monitoring requirements as per ***Table 8-4***.
Noise Management Plan	■ **Objectives**: The prime objective of the Noise Management Plan is to provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures. ■ **Legal Requirements**: Will align with Decree of Environmental Ministry No. 48/1996 on Noise level Quality Standard and Ministry of Manpower and Transmigration Decree No 51 of 1999, and make reference to the WBG EHS and PS1, 3, and 4. ■ **Roles and Responsibilities**: MCG, EPC and operations contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Construction Phase. ■ **Management Actions**: As per ***Table 8-1***. ■ **Reporting and Monitoring**: Monitoring requirements as per ***Table 8-4***.
Waste Management Plan	■ **Objectives**: The Waste Management Plan (WMP) provides the procedures and processes which will be applied to the Project activities to check and monitor compliance and effectiveness of the mitigation measures to which the Project has

Management Plan	Framework
	committed to in order to minimise environmental impacts through the appropriate management of waste generated during Project lifecycle. ■ **Legal Requirements**: The WMP will align with Act No. 18 of 2008 regarding Waste Management, and make reference to the WBG EHS and PS1 and 3. ■ **Roles and Responsibilities**: MCG, EPC and operations contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Construction and Operational Phase. ■ **Management Actions**: As per **Table 8-1** and **Table 8-2**. ■ **Reporting and Monitoring**: Waste quantities and disposal routes will be recorded. Monitoring requirements as per ***Table 8-4***. Any non-compliances with the management actions will be recorded.
Water Quality Protection and Management Plan for Surface Water and Groundwater	■ **Objectives**: The Water Quality Protection and Management Plan for Surface Water and Groundwater provides the procedures and processes which will be applied to the Project activities to check and monitor compliance and effectiveness of the mitigation measures to which the Project has committed to in order to minimise environmental impacts through the appropriate management of water utilised during the Project lifecycle. ■ **Legal Requirements**: The Water Quality Protection and Management Plan for Surface Water and Groundwater will align with PP No. 22 of 2021 concerning the Implementation of Environmental Protection and Management and make reference to the WBG EHS and PS1 and 3. ■ **Roles and Responsibilities**: MCG, EPC and operations contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Construction and Operational Phase. ■ **Management Actions**: As per **Table 8-1** and **Table 8-2**. ■ **Reporting and Monitoring**: Amount of water utilised and discharged will be monitored and recorded. Monitoring requirements as per ***Table 8-4***. Any non-compliances with the management actions will be recorded.
Soil Erosion and Sediment Control Plan	■ **Objectives**: The objective of the Soil Erosion and Sediment Control Plan is to provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures. ■ **Legal Requirements**: Will align with GR22 of 2021 regarding Implementation of Environmental Protection and Management, and make reference to the WBG EHS and PS1, 3, and 4. ■ **Roles and Responsibilities**: MCG, EPC and operations contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Construction Phase. ■ **Management Actions**: As per ***Table 8-1***. ■ **Reporting and Monitoring**: Monitoring requirements as per ***Table 8-4***
Occupational Health and Safety Plan	■ **Objectives**: The objective of the Occupational Health and Safety Management Plan (OHSMP) is to provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures. ■ **Legal Requirements**: **Legal Requirements**: Will align with Act No. 1 of 1970 regarding Occupational Health & Safety, and make reference to the WBG EHS and PS1, and 2. ■ **Roles and Responsibilities**: MCG, EPC and operations contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Construction and Operational Phase. ■ **Management Actions**: As per ***Table 8-1*** and ***Table 8-2***. ■ **Reporting and Monitoring**: Monitoring requirements as per ***Table 8-4***. Any non-compliances with the management actions will be recorded.
Hazardous Material Management Plan	■ **Objectives**: The Hazardous Material Management Plan will outline the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures, including the use, storage, transport, and disposal of hazardous materials required for the Project.

<table>
<tr><th>Management Plan</th><th>Framework</th></tr>
<tr><td></td><td>
■ Legal Requirements: Will align with GR No 74/2001, and make reference to the WBG EHS and PS1 and 3.
■ Roles and Responsibilities: MCG, EPC and operations contractor roles and responsibilities will be outlined.
■ Implementation Schedule: during Construction and Operation Phase.
■ Management Actions: As per Table 8-1.
■ Reporting and Monitoring: Monitoring requirements as per Table 8-4
</td></tr>
<tr><td>Traffic Management Plan</td><td>
■ Objectives: The prime objective of the Traffic Management Plan (TMP) is to provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures.
■ Legal Requirements: The TMP will align with Act No 22/2009, Government Regulation in lieu of Law No. 2/2022, Traffic Impact Analysis (ANDALALIN) Approval No. 188.45/005/ANDALALIN/430.9.6/2021 and make reference to the WBG EHS and PS1, 3, and 4.
■ Roles and Responsibilities: MCG, EPC and operations contractor roles and responsibilities will be outlined.
■ Implementation Schedule: during Construction Phase.
■ Management Actions: As per Table 8-1.
■ Reporting and Monitoring: Monitoring requirements as per Table 8-4. Any non-compliances with the management actions will be recorded.
</td></tr>
<tr><td>Biodiversity and Pest Control Management Plan</td><td>
■ Objectives: The Biodiversity and Pest Control Management Plan will provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures.
■ Legal Requirements: Will align with Act No 5/1990, GR No 23/2021, and make reference to the WBG EHS and PS1 and 6.
■ Roles and Responsibilities: MCG, EPC and operations contractor roles and responsibilities will be outlined.
■ Implementation Schedule: during Construction and Operation Phase.
■ Management Actions: As per Table 8-1.
■ Reporting and Monitoring: Monitoring requirements as per Table 8-4
</td></tr>
<tr><td>Cultural Heritage Management Plan</td><td>
■ Objectives: The objective of the Cultural Heritage Management Plan is to provide the procedures and processes to check and monitor compliance and effectiveness of the mitigation measures.
■ Legal Requirements: Will align with GR22 of 2021 regarding Implementation of Environmental Protection and Management, and make reference to the WBG EHS and PS1, 3, and 4.
■ Roles and Responsibilities: MCG, EPC and operations contractor roles and responsibilities will be outlined.
■ Implementation Schedule: during Construction and Operational Phase.
■ Management Actions: As per Table 8-1 and Table 8-2.
■ Reporting and Monitoring: Monitoring requirements as per Table 8-4. Any non-compliances with the management actions will be recorded.
</td></tr>
<tr><td>Land Acquisition and Resettlement Action Plan</td><td>
■ Objectives: The main objectives of the Land Acquisition and Resettlement Action Plan (LARAP) are the following:
o To avoid, and when avoidance is not possible, to minimize displacement by exploring alternative project designs for both permanent land acquisition and temporary land use;
o To avoid forced eviction;
o To anticipate and avoid or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by:
o Providing compensation for loss of assets at replacement cost;
o To improve, or restore, the livelihoods and standards of living of displaced persons; and
o To take into account gender issues and avoid exacerbating inequalities.
</td></tr>
</table>

Management Plan	Framework
	■ **Legal Requirements**: The LARAP will align with the requirements of the GR19/2021 as well as good international practises (such as WBG EHS). ■ **Roles and Responsibilities**: MCG, and EPC contractor roles and responsibilities will be outlined. ■ **Implementation Schedule**: during Pre-Construction Phase. ■ **Management Actions**: As per ***Table 8-1***. ■ **Reporting and Monitoring**: Monitoring requirements as per ***Table 8-4***. Any non-compliances with the management actions will be recorded.

8.7 Environmental and Social Monitoring Program

Monitoring is a means of verifying overall effectiveness of the management and mitigation measures contained within the management plans listed above. Key objectives of the monitoring process are to:

- Confirm effectiveness of management and mitigation measures;
- Ensure compliance with Applicable Standards (Indonesian standards, IFC Performance Standards and WBG EHS Guidelines);
- Monitoring the status of, and impacts on, identified sensitive receptors;
- Provide an early warning that any of the control measures or practices are failing to achieve their desired performance and ensure changes can be implemented to remedy these practices;
- Determine whether environmental and social changes are attributable to Project activities, or as a result of other activities or natural variation; and
- Provide a basis for continual review and improvements to Project design and execution.

8.7.1 Performance Indicators and Monitoring Schedule

Physical, biological and social environmental management components of particular significance have been identified as performance indicators. This includes the tentative parameters to be measured, methods to be utilised, sampling locations, frequency of measurements, detection limits, cost and responsibilities for implementation and supervision.

However, it is to be noted that the detailed and specific monitoring measures will be developed and included within the relevant management plans. The monitoring components of the various management plans will be refined and finalised during plan development.

Impact monitoring will be undertaken during the life of the Project to verify the predicted levels of residual impacts from the Project and the effectiveness of the various management plans.

8.7.2 Reporting Mechanism for Environmental and Social Monitoring Program

A robust reporting system will provide the Project with the necessary feedback mechanisms to ensure quality and timely implementation of the works. The reporting system will ensure regular flow of information from the Project site to the Project headquarters and, as necessary, to regulatory authorities and funding agencies. The reporting system will provide a mechanism to ensure that the measures proposed in the Project's ESMP are implemented.

Prior to the commencement of the construction activities, MCG will finalise the format and frequency for reporting on the status and progress of environmental and social monitoring.

During construction and operation phases, it is recommended that the report shall be submitted to the relevant authorities and funding agencies on a regular basis. Frequency will be agreed with relevant authorities and funding agencies.

However, it is recommended that EPC submit the report to the relevant authorities and funding agencies on six-monthly basis during construction and on annually basis during operation.

The format will be designed to meet all the compliance conditions associated with the local and international requirements. The contractor will be required to submit the duly filled up reporting form on the agreed frequency to MCG.

The Projects monitoring program is shown in ***Table 8-4***.

Table 8-4: Project Monitoring Programme

Project Stage/ Affected Component	Potential Impact / Activity	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility
Construction Phase						
General	Inspection of mitigation commitment compliance	General compliance with mitigation measures presented in the ESMP	Power plant location and transmission line route	Visual inspection of all active work areas	Daily – Reported Monthly.	EPC Contractor (supervised by MCG HSSE Team)
Air quality	Conduct monitoring of air emissions at receptors and Project Site.	Sulphur dioxide (SO2), Carbon monoxide (CO), Nitrogen dioxide (NO2), O3 (Oxidant), PM2.5, and PM10.	At two receptors (near well pad 2).	As per Government Regulation No. 41 Year 1999 regarding Air Pollution Control (PP41/1999) and WBG EHS Guidelines (General)	Monthly during construction (frequency can be reduced to 6-monhly if results within standards)	EPC Contractor / Third Party
Ambient Noise	Conduct monitoring of noise levels at receptors and Project Site.	Sound level (dB) – day and night time.	At two receptors (near well pad 2).	As per Decree of Environmental Ministry No. 48/1996 and WBG EHS Guidelines (General)	Monthly – during construction (frequency can be reduced to 6-monhly if results within standards)	EPC Contractor / Third Party
Surface Water Quality	Conduct monitoring of surface water quality at receptors and Project Site.	As per Ministry of Environment and Forestry 68/Menlhk/Setjen/Kum.1/8/2016 and WBG EHS (water and Sanitation)	At stream / river abstraction point. .	As per Ministry of Environment and Forestry 68/Menlhk/Setjen/Kum.1/8/2016 and WBG EHS (water and Sanitation)	Monthly during construction (frequency can be reduced to 6-monhly if results within standards)	EPC Contractor / Third Party
Occupational Health and Safety	Accidents or incidents due to construction activities, workers' health	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas	As defined in Occupational Health & Safety Plan	As defined in Occupational H&S Plan	EPC Contractor
Waste	Impact from non-hazardous wastes storage, transport and disposal	Implementation of Waste Management Plan (WMP)	Project activity areas	Compliance to the WMP	Unplanned audit twice a year	EPC Contractor
	Impact from hazardous wastes storage, transport and disposal	Implementation of Waste Management Plan (WMP)	Project activity areas	Compliance to the WMP	Unplanned audit twice a year	EPC Contractor
Biodiversity	Impacts to terrestrial flora	Regular (weekly) checks during construction are to occur along all project boundaries to ensure compliance with clearing within marked boundaries;	Main development area and transmission line	Compliance against ESMP	Weekly basis	EPC Contractor
		Records are to be kept and regularly reviewed (3 monthly) for implementation of the workforce training program for fauna/flora awareness	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
		Records are to be kept and regularly reviewed (3 monthly) of all personnel entering and exiting the project area through checkpoints, including results of all random inspections undertaken for poached flora/fauna	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
	Impacts to terrestrial fauna	Records are to be kept and regularly reviewed (3 monthly basis) during construction on the application of the Fauna Shepherding Protocol.	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
		Revegetation (i.e. the sowing of native herbaceous species on top soils and/or the planting of native shrubs/trees) will be undertaken as soon as possible after clearance and construction. This should be well monitored.	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
		A monitoring plan should be carried out to record invasive alien species populations in the project area of influence and aimed at removing new populations and preventing them from spreading throughout the AoI.	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor

Project Stage/ Affected Component	Potential Impact / Activity	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility
	General biodiversity impacts	Records are to be kept and regularly reviewed (3 monthly basis) on the planting of indigenous flora in the disturbed areas	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
		Monitoring of rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections (3 monthly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
		Records of socialization, training, campaigns and collaboration with stakeholders are to be kept and regularly reviewed (6 monthly); and	Main development area and transmission line	Compliance against ESMP	Quarterly basis	EPC Contractor
		Monitoring of flora fauna abundance and diversity to be conducted at annual basis.	Main development area and transmission line	Compliance against ESMP	Annual basis	EPC Contractor
Social	Local employment	Percentage of local (directly from the Project Area of Influence (AoI)) employed during construction	Project activity areas	Compliance against ESMP	Start of construction and bi-monthly after.	EPC Contractor
	Stakeholder Engagement	Number or frequency of engagement	Villages within the AoI	Compliance against the Stakeholder Engagement Plan	Monthly	MCG HSSE Team
	Grievance Mechanism	Number and resolution of grievances	Neighbouring communities around the Project activity areas	Compliance of resolution duration of grievance with Grievance Mechanism	Weekly	EPC Contractor
	Impact to traffic	Permit and code of conduct	Roads used for construction	Unplanned Compliance audit against worker Code of Conduct	Every 4 months. During large mobilization of vehicles or equipment.	EPC Contractor
	Impact to existing facilities	State of Public infrastructures	Roads used for construction	Capacity to use the infrastructure safely	Monthly	EPC Contractor
	Impacts to health and safety of the community	Worker training, grievances, accident log, implementation of Community H&S monitoring and surveillance programme, implementation of worker code of conduct	Project activity areas	Compliance against Community H&S Plan	■ Bi monthly review of training log; ■ Monitoring and review of accidents due to construction (daily monitoring and monthly review). ■ Community health and safety monitoring and surveillance program. ■ Daily monitoring of construction area, worker camp and surrounding; ■ Regular unplanned audit on worker code conduct; ■ Monthly visual inspection of first aid facilities and records. ■ Weekly review of grievance log.	EPC Contractor
Community Health and Safety	Community disturbance and potential safety hazard due to road traffic	Accidents, incidents and complaints	Roads used for transport of workers and construction material	Incidents, accidents and community complaints	Based on occurrence and yearly	EPC Contractor
	Public concerns	Complaints from community	Neighbouring communities around the Project activity areas	As per the grievance redress mechanism	Continuous	MCG HSSE Team

Project Stage/ Affected Component	Potential Impact / Activity	Parameters to be Monitored	Location	Measurements	Frequency	Responsibility
Operation Phase						
Discharge Water Quality	Conducting monitoring of treated wastewater from operation	As per Regulation No.32-2017 th, Ministry of Health Indonesian Republic	At discharge location	As per Regulation No.32-2017 th, Ministry of Health Indonesian Republic	During operation – frequency to be confirmed by EPC Contractor	MCG HSSE Team
Waste	Impact to soil, groundwater, surface water, biodiversity and human receptors	Implementation of Waste Management Plan (WMP)	Project activity areas	Compliance to the WMP	Unplanned audit yearly	MCG HSSE Team
Biodiversity	Impacts to biodiversity	Regular inspections of the transmission line routes (3 monthly) during construction is to occur to identify any fauna mortality that has occurred. Where patterns in species mortality or conservation significance species are identified, advice from a suitably qualified person should be sought to alter mitigation measures to reduce future potential impacts.	Transmission line	Compliance against ESMP	Quarterly Basis	MCG HSSE Team
Social	Local employment	Percentage of local (directly from the Project AoI) employed during operation	Villages within the AoI	Compliance against ESMP	Start of operation and yearly after.	MCG HSSE Team
	Grievance Mechanism (all impact)	Number and resolution of grievances	Neighbouring communities around the Project activity areas	Compliance of resolution duration of grievance with Grievance Mechanism	Weekly	MCG HSSE Team
	Impacts to health and safety of the community	Compliance with operation plans	Project activity areas	Percentage of non-compliance against plans	■ Bi-yearly review of training log. ■ Bi-yearly review of compliance against community health and safety monitoring and surveillance programme. ■ Conduct regular unplanned audit of the worker code of conduct. ■ Bi-yearly unplanned audit of waste management activities. ■ Monthly visual inspection of first aid facilities and record, review of employment records and health insurance subscription records.	MCG HSSE Team
	Impact to occupational health and safety	Accidents or incidents due to operation activities, workers' health	Project activity areas	Near-misses, incidents, occupational diseases, dangerous occurrences	As defined in operation phase Health & Safety Plan	MCG HSSE Team

8.8 Updating the ESMP

This ESMP will be updated, revised and reviewed internally on regular basis to ensure particularly that ESMP continuing suitability, adequacy and effectiveness regarding the Project commitment to continual improvement. The ESMP of the Project will be monitored and reviewed on half-yearly basis.

Furthermore, in the event of an unanticipated impact and design change with respect to the Project Standards (including Indonesian Government and IFC requirements); the ESMP would be updated as necessary.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

This ESIA report has been prepared based on the technical report provided by PT Medco Cahaya Geothermal, Results in scoping matrix and reports relevant to the Project, site visits, environmental and social baseline data collection and the stakeholder engagement.

The potential environmental and social impacts attribution during the construction and operation phases of the Project were assessed. This ESIA report also assess qualitative and quantitative impacts, identify significance of each potential impact as well as recommend mitigation measures to minimise and reduce the impacts.

Cumulative impacts, particularly on community health and safety and biodiversity, have also been assessed.

Table 9.1 provides a summary of residual impact significance. All impacts have been mitigated to **moderate** at worst case, and have a range of mitigation, management and monitoring measures to ensure no significant impacts to the environment or people.

Table 9.1: Summary of Residual Impact Significance

Impact Type	Residual Impact Significance	
	Construction	Operation
Physical Environment Impact Assessment		
Impacts on Ambient Air Quality	**Minor**	**Not scoped into assessment**
Impacts on Ambient Noise	**Minor**	**Not scoped into assessment**
Impacts on Surface Water and Groundwater Quality	**Minor**	**Minor**
Impacts on Soil Environmental	**Minor**	**Not scoped into assessment**
Impact on Landscape and Visual	**Minor to Moderate**	**Minor to Moderate**
Impacts on Topography and Landscape	**Moderate**	**Moderate**
Biological Environment Impact Assessment		
Impact on Biodiversity	**Negligible to Moderate**	**Negligible to Minor**
Social Impact Assessment		
Impact on Livelihoods and land Acquisition	**Minor**	**Not scoped into assessment**
Impact on Cultural Heritage	**Minor**	**Not scoped into assessment**
Impact on Tourism	**Moderate**	**Moderate**
Impact on Infrastructure and Services (including Traffic and Transport)	**Minor**	**Not scoped into assessment**
Impact to Community Health and Safety	**Minor**	**Minor**
Impact to Occupational Health and Safety	**Minor**	**Minor**
Impact on Employment	**Positive**	**Positive**

Impact Type	Residual Impact Significance	
	Construction	Operation
Unplanned Events		
Leakage and spill incidents	**Minor**	**Minor**
Traffic accidents	**Minor**	**Minor**
Fire and explosion	**Minor**	**Minor**
Well blow out	**Moderate**	**Moderate**
Natural hazards	**Moderate**	**Moderate**
Cumulative Impacts		
Topography and landscape	**Minor**	
Biodiversity	**Negligible to Moderate**	
Land and Livelihoods	**Minor**	
Tourism	**Minor**	
Community health and safety	**Minor**	

The major concerns raised through the stakeholder engagement were related to impacts to tourism and biodiversity, air and noise and safety. Landscape, biodiversity and tourism impacts remain as a **moderate** significance. Management plans and monitoring will be conducted throughout the construction and operation to ensure the Project complies with these commitments.

Unplanned events, although lower likelihoods, have been given **minor** to **moderate** ratings for leakage and spill incidents, fire and explosions, traffic accidents, well blow out and natural hazards.

Cumulative Impacts are remaining as **negligible** to **moderate** significance.

9.2 Recommendations

For all the impacts identified in the study, mitigation, management, and monitoring measures have been proposed and included in the ESMP chapter, including the schedule for monitoring. If any impacts result in more severe significance that assess in this report, actions to be taken by the Project proponent or its contractors are also described.

The effective implementation of the ESMP and adherence with the Indonesian laws and standards and WBG guidelines will assist in minimising the environmental impacts to acceptable levels. With continued engagement with local stakeholders and monitoring as proposed in the ESMP, the environmental and social assessment of the Project ascertains that the Project is unlikely to cause any significant environmental and social impacts and will bring benefits to local stakeholders and increased access to reliable supply of electricity to the region.

The following management plans will be required to be prepared for the project in order to ensure the project reduces, avoid, and mitigates the potential project impacts:

- Air Quality Management Plan (Construction and Drilling Phase);
- Noise and Vibration Management Plan (Construction and Drilling Phase);
- Soil Erosion and Sediment Control Plan (Construction and Drilling Phase);
- Waste Management Plan (Construction, Drilling, and Operation);
- Biodiversity Action Plan (Pre-Construction Phase);
- Water Quality Protection and Management Plan for Surface Water and Groundwater (Construction, Drilling, and Operation);

- Traffic Management Plan (Construction, Drilling, and Operation);
- Occupational Health and Safety Plan (Construction, Drilling, and Operation);
- Hazardous Material Management Plan (Construction, Drilling, and Operation);
- Biodiversity and Pest Control Management Plan (Pre-Construction Phase);
- Cultural Heritage Management Plan (Pre-Construction Phase); and
- Land Acquisition and Resettlement Action Plan (Pre-Construction Phase);

The monitoring measures have been proposed during construction and operation of the Project (***Table 9.2***).

Table 9.2: Environmental and Social Monitoring Programme

Project Stage/ Affected Component	Parameters to be Monitored	Location	Responsibility
Construction Phase			
General	General compliance with mitigation measures presented in the ESMP	Power plant location and transmission line route	EPC Contractor (supervised by MCG HSSE Team)
Air quality	Sulphur dioxide (SO2), Carbon monoxide (CO), Nitrogen dioxide (NO2), O3 (Oxidant), PM2.5, and PM10.	At two receptors (near well pad 2).	EPC Contractor / Third Party
Ambient Noise	Sound level (dB) – day and night time.	At two receptors (near well pad 2).	EPC Contractor / Third Party
Surface Water Quality	As per Ministry of Environment and Forestry 68/Menlhk/Setjen/Kum.1/8/2016 and WBG EHS (water and Sanitation)	At stream / river abstraction point.	EPC Contractor / Third Party
Occupational Health and Safety	Near-misses, incidents, occupational diseases, dangerous occurrences	Project activity areas	EPC Contractor
Waste	Implementation of Waste Management Plan (WMP)	Project activity areas	EPC Contractor
	Implementation of Waste Management Plan (WMP)	Project activity areas	EPC Contractor
Biodiversity	Regular (weekly) checks during construction are to occur along all project boundaries to ensure compliance with clearing within marked boundaries;	Main development area and transmission line	EPC Contractor
	Records are to be kept and regularly reviewed (3 monthly) for implementation of the workforce training program for fauna/flora awareness	Main development area and transmission line	EPC Contractor
	Records are to be kept and regularly reviewed (3 monthly) of all personnel entering and exiting the project area through checkpoints, including results of all random inspections undertaken for poached flora/fauna	Main development area and transmission line	EPC Contractor
	Records are to be kept and regularly reviewed (3 monthly basis) during construction on the application of the Fauna Shepherding Protocol.	Main development area and transmission line	EPC Contractor
	Revegetation (i.e. the sowing of native herbaceous species on top soils and/or the planting of native shrubs/trees) will	Main development area and transmission line	EPC Contractor

Project Stage/ Affected Component	Parameters to be Monitored	Location	Responsibility
	be undertaken as soon as possible after clearance and construction. This should be well monitored.		
	A monitoring plan should be carried out to record invasive alien species populations in the project area of influence and aimed at removing new populations and preventing them from spreading throughout the AoI.	Main development area and transmission line	EPC Contractor
	Records are to be kept and regularly reviewed (3 monthly basis) on the planting of indigenous flora in the disturbed areas	Main development area and transmission line	EPC Contractor
	Monitoring of rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections (3 monthly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.	Main development area and transmission line	EPC Contractor
	Records of socialization, training, campaigns and collaboration with stakeholders are to be kept and regularly reviewed (6 monthly); and	Main development area and transmission line	EPC Contractor
	Monitoring of flora fauna abundance and diversity to be conducted at annual basis.	Main development area and transmission line	EPC Contractor
Social	Percentage of local (directly from the Project Area of Influence (AoI)) employed during construction	Project activity areas	EPC Contractor
	Number or frequency of engagement	Villages within the AoI	MCG HSSE Team
	Number and resolution of grievances	Neighbouring communities around the Project activity areas	EPC Contractor
	Permit and code of conduct	Roads used for construction	EPC Contractor
	State of Public infrastructures	Roads used for construction	EPC Contractor
	Worker training, grievances, accident log, implementation of Community H&S monitoring and surveillance programme, implementation of worker code of conduct	Project activity areas	EPC Contractor
Community Health and Safety	Accidents, incidents and complaints	Roads used for transport of workers and construction material	EPC Contractor

Project Stage/ Affected Component	Parameters to be Monitored	Location	Responsibility
	Complaints from community	Neighbouring communities around the Project activity areas	MCG HSSE Team
Operation Phase			
Discharge Water Quality	As per Regulation No.32-2017 th, Ministry of Health Indonesian Republic	At discharge location	MCG HSSE Team
Waste	Implementation of Waste Management Plan (WMP)	Project activity areas	MCG HSSE Team
Biodiversity	Regular inspections of the transmission line routes (3 monthly) during construction is to occur to identify any fauna mortality that has occurred. Where patterns in species mortality or conservation significance species are identified, advice from a suitably qualified person should be sought to alter mitigation measures to reduce future potential impacts.	Project activity areas	MCG HSSE Team
Social	Percentage of local (directly from the Project AoI) employed during operation	Villages within the AoI	MCG HSSE Team
	Number and resolution of grievances	Neighbouring communities around the Project activity areas	MCG HSSE Team
	Compliance with operation plans	Project activity areas	MCG HSSE Team
	Accidents or incidents due to operation activities, workers' health	Project activity areas	MCG HSSE Team

APPENDIX A ENVIRONMENTAL BASELINE DATA

APPENDIX B SPECIES SUMMARY FROM BASELINE SURVEY

APPENDIX C IBAT REPORT

APPENDIX D VANTAGE POINT SURVEYS

APPENDIX E ENGAGEMENT RECORDS

APPENDIX F STAKEHOLDER ENGAGEMENT PLAN

APPENDIX G GRIEVANCE REDRESS MECHANISM

APPENDIX H EMERGENCY MANAGEMENT PLAN

APPENDIX I LANDSCAPE AND VISUAL IMPACT ASSESSMENT

APPENDIX J CLIMATE CHANGE RISK ASSESSMENT

APPENDIX K BIODIVERSITY ACTION PLAN

APPENDIX L LAND ACQUISITION FRAMEWORK

APPENDIX M LIVELIHOOD RESTORATION PLAN

APPENDIX N AIR QUALITY IMPACT ASSESSMENT

APPENDIX O NOISE IMPACT ASSESSMENT