Draft Biodiversity Action Plan (BAP) and Critical Habitat Assessment (CHA)

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INO: Rantau Dedap Geothermal Power Project (Phase 2)

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BIODIVERSITY ACTION PLAN

(INTERIM REPORT)

PT SUPREME ENERGY RANTAU DEDAP (PT SERD)

Lahat Regency, Muara Enim Regency and Pagar Alam City,

SOUTH SUMATRA PROVINCE

25 November 2016

BIODIVERSITY ACTION PLAN

PT Supreme Energy Rantau Dedap

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ABBREVIATIONS

ADB	=	Asian Development Bank
AMDAL		*Analisis Mengenai Dampak Lingkungan Hidup* (Environmental Impact Assessment)
AP	=	Action Plan
APL	=	*Area Penggunaan Lain* (Other Use Area)
BAP	=	Biodiversity Action Plan
BMEP	=	Biodiversity Monitoring and Evaluation Program
BOEMP		Biological Offset and Ecological Management Plan
BBSNP	=	Bukit Barisan Selatan National Park
CITES	=	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DMU	=	Discrete Management Unit
EBA	=	Endemic Bird Area
EOO	=	Estimated extent of occurrence
GoI	=	Government of Indonesia
HL	=	*Hutan Lindung* (Protection Forest)
IBA	=	Important Bird Area
IFC	=	International Finance Corporation
IUCN	=	International Union for Conservation of Nature and Nature Resources
KBA	=	Key Biodiversity Area
KTPB	=	*Kepala Teknik Panas Bumi* (Geothermal Technical Head)
MoEF	=	Ministry of Environment and Forestry
MoEF	=	Ministry of Environment and Forestry
PT SERD	=	PT Supreme Energy Rantau Dedap
PS6	=	IFC's Performance Standard 6
TCL	=	Tiger Conservation Landscape
TNBBS	=	Taman Nasional Bukit Barisan Selatan
WWF	=	World Wide Fund for Nature

1 INTRODUCTION

1.1 Project Background

PT Supreme Energy Rantau Dedap (PT SERD) plans to develop a geothermal energy power plant project that is located administratively in three regions: Muara Enim Regency, Lahat Regency, and Pagar Alam Regency (the 'Project'). The Project is expected to support the Indonesian government's policy of energy diversification and reduction in the consumption of fossil fuel, reduction of electricity and fuel subsidies, as well as utilization of geothermal resources, which have high economic potential in Rantau Dedap.

Based on the AMDAL document, the geothermal development plans generally include construction and operation of the geothermal power units and construction of supporting infrastructure, while the electricity distribution is the responsibility of the offtaker (PLN). These activities have potential to cause environmental impacts such as reduced air quality and water quality, changes in land use and biodiversity, improved transportation, increased job and business opportunities, and modified public perception.

The Project site is located in mostly Protected Forest Area (*Hutan Lindung* or HL area). These HL areas are connected to Bukit Barisan Selatan National Park (BBSNP). BBSNP is part of the World Heritage Site, Tropical Rainforest Heritage of Sumatra (TRHS), which is enlisted for its novel biodiversity. Project activities may indirectly affect the BBSNP area.

A Biodiversity Action Plan (BAP) was prepared for the Project in accordance with International Finance Corporation (IFC) Performance Standards Guidelines and Asian Development Bank (ADB) Safeguards, so as to assess whether the Project meets relevant international environmental standards.

1.2 Rational for this Report

The land status of PT SERD geothermal project is located within Protected Forest (*Hutan Lindung* or HL) and Other Use Area (*Areal Penggunaan Lain* or APL). Based on the baseline study, the area is habitat to several endangered species and can potentially be categorized as a critical habitat. Therefore, the development of Biodiversity Action Plan (BAP) documents is necessary to describe the project's potential impact and mitigation efforts and the efforts to control the impact of the project.

BAP will be used as a reference to managing biodiversity in project area of PT SERD. This BAP is a plan that includes set of actions that lead to the conservation or enhancement of biodiversity for a specific site or project. The report is not rigid and can be improved in accordance with existing condition of the study area.

1.3 General Approach

The project will be approached using field recognition, biodiversity studies, literature, and workshop to maximize BAP for PT SERD.

1.4 Project Description

PT Supreme Energy Rantau Dedap (PT SERD) plans to develop a Geothermal Power plant project in South Sumatra. The Geothermal Working Area (Wilayah Kerja Panas Bumi, WKP) is located in Rantau Dedap, Muara Enim Regency, Lahat Regency and Pagar Alam City, South Sumatra Province. It covers an area of approximately 35,460 ha. BBSNP is located 27.3 km to the south of the Project.

Exploration commenced in 2014-2015, in which three wellpads were produced (wellpads I, C, and B) and a total of six wells (RD-I1, RD-I2, RD-C1, RD-C2, RD-B1 and RD-B2). From these six exploration wells, four wells were developed to become production wells (RD-I1, RD-I2, RD-C1, and RD-C2). The two remaining wells were developed to be brine injection wells (RD-B1 and RD-B2) due to their far proximity from the power plant area. Each wellpad has an approximate area of 2-4 ha.

Four new wellpads will be constructed for development wells, namely wellpads L, M, N, and X. Wellpads L and M are designed for production wells whereas wellpads N and X are for contingency production wells in case make-up wells are required.

The first phase of the project development is to develop a power plant with a design capacity of 92 MW using dual flash technology, a proven technology with reliability close to 100% and its supporting facilities that include pipelines (production, re-injection, and fresh water); access roads; office buildings and storage yard; switchyard, substations (built and operated by PLN); and water treatment facilities. The next phase of the project is the gradual advancement of the power plant capacity from 92 MW to 250 MW.

The Project aims to address some of the electricity needs of the Sumatra region, which will be supplied through the Indonesian Government's Perusahaan Listrik Negara (PLN) transmission lines and grid.

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

Project Schedule

The project construction is scheduled to commence in 2017. In general, the project comprises of four main stages of development, namely pre-construction, construction, operation, and post-operation. This project schedule is developed with the assumption there will be no delay in any stage of development.

Table 1-1 Project schedule

Project Stage	2016-2017	2018-2020	2020-2050	>2050
Pre-construction				
Construction				
Operation				
Post-operation				

Notes: The geothermal power plant operation will last approximately 25 years and is open for extension, thus the post-operation stage would depend on the operation stage conclusion

Project Configuration

The Rantau Dedap Geothermal Power Plant taps into a hydrothermal system; injection wells are to be drilled to reinject brine and condensate water.

1.4.1 Capacity

The proposed power plant has an ultimate total capacity of 250 MW. Based on initial evaluation of exploration results and numerical modeling of the reservoir, initial power plant capacity will be of 92 MW in total, using dual flash steam cycle technology.

1.4.2 Dual Flash Power Plant

The selection of technology will largely depend on the total proven heat energy and its variation of produced geothermal fluid (steam and brine) and well production capacities. Other factors will also influence technology selection: topography and land availability, availability of equipment, and economic considerations (e.g., required capital and operating costs). The selection of technology will aim to balance costs and benefits.

With results obtained from the initial exploration activities, a dual flash steam cycle is being considered. Steam entering the steam turbine is delivered from two sources of different pressure: high pressure (HP) and low pressure (LP) steam. Most of the LP steam is generated from the HP brine, supplemented by wells that produce LP steam.

1.4.3 Project Components

The main project components are consisted of:

Production Wells, Injection Wells, and Wellpads

To fulfill the first phase power plant capacity of 92 MW, an estimated amount of 26 wells are planned. These wells consist of 12 production wells, two injection wells, five contingency wells, as well as four make-up wells and three make-up wells at 14 and 24 years after COD, respectively.

The production wells are divided into two types based on their steam production, namely High Pressure (HP) wells and Low Pressure (LP) wells. There will be six HP wells and three LP wells. HP wells have an average capacity of 7.8MW per well whereas LP wells can generate approximately 3.6MW per well. Based on the Feasibility Study, the HP wells can generate a total amount of 79.2MW whereas the LP wells produce 31.2MW.

Injection (or reinjection) wells are required to discharge brine and condensate back to the formation. This will avoid brine pollution to the surrounding environment as well as providing closed water cycle to the geothermal system.

Pipelines

Pipeline consists of pipes for wet steam, dry steam, and for draining brine and condensate to injection wells as well as pipes for fresh water supply.

There are two types of steam pipeline system: 1) a two-phase pipeline system that flows HP and LP steam from the well to the separator station (SS), and 2) a one-phase pipeline system that flows dry steam from the SS to the power plant.

The pipeline route will follow existing roads or dedicated corridors to facilitate construction and maintenance during production operation. Cut and fill are necessary in some sections of the pipeline corridors to provide stable slopes and safe operating conditions.

Drainage channels will be built parallel to the pipeline in addition to inspection roads. At some

sections, structures to cross roads, rivers, or other features are to be built.

Power Plant

Overall, the steam is converted into power through a set of three main steps: 1) steam production in the wellhead, 2) steam and brine separation in the separator station, and 3) steam is delivered from the SS to the power plant through the pipeline system.

Steam from the wellheads will enter separator to separate steam phase from liquid phase (brine). Brine will be reinjected to the formation, while the separated steam will then enter a scrubber to purify the steam from impurities such as silica.

The purified steam then enters a turbine, which rotates the turbine shaft to produce mechanical energy and the generator converts this mechanical energy into electricity energy. This is then channeled to a switchyard and then to PLN's transmission network cable after its voltage is increased from 11 kV to 150 kV using a step-up transformer unit.

Switchyard and Transmission Line

PT SERD switchyard is located within the Power Plant area, and is provided to allow connection of future units and to include the Revenue Meters. The interface between PT SERD and PLN is at the high voltage gantry of the switchyard, which is used for connection to the PLN transmission line.

Access Roads

Access roads and wellpads have been mostly constructed in the exploration phase. Improvement of roads to wellpads and construction of new roads for transportation of equipment and materials needed in preparing the new wellpads (i.e. Wellpad L, M, N, and X) and conducting operational well drilling will be carried out as needed.

Additional Supporting Facilities

PT SERD will also build a domestic water supply and treatment, waste water treatment plant, chemical storage, warehouse, workshop, firefighting system, emergency power system, office buildings, and accommodation complex.

Land Requirements

The total land required for the project is approximately 124.5 ha. Most of this land is located in the Protected Area, which amounts to 115 ha. The remaining area, 9.5 ha, is located at the Other Use Area.

Table 1-2 Project land requirement

No	Facility	Area (m^2)	
		Non-Forest	Forest
Acquired land			
1.	Road access	46,311	531,324
2.	Total wellpad area	-	105,483
3.	Other facilities	48,814	57,087
	Subtotal	95,125	693,894
Additional required land			
1.	Road access	-	62,880
2.	Total wellpad area (L, N, M, X)	-	80,000

No	Facility	Area (m^2)	
		Non-Forest	Forest
Acquired land			
3.	Geothermal power plant	-	30,000
4.	Separator station	-	4,000
5.	Other facilities	-	107,500
6.	Contingency	-	171,726
	Subtotal	-	456,106
	Total	**95,125**	**1,150,000**

Source: PT SERD

1.5 Structure of this Document

This report is structured as follows:

- Chapter 2 presents the aim and general objectives of the PT SERD BAP;
- Chapter 3 summarises the legislative and policy frameworks at international and national levels together with the PT SERD ESIA process and its key findings with regard to biodiversity;
- Chapter 4 describes the biodiversity baseline and includes information on ecoregions, nature conservation areas, habitats, flora and fauna within the study area;
- Chapter 5 includes a Critical Habitat Assessment to establish which IFC PS6 requirements are applicable to this project;
- Chapter 6 describes impact assessment analysis of PT SERD Geothermal project and mitigation;
- Chapter 7 is the Biodiversity Action Plan, objectives include information on the mitigation ranking, BAP implementation, monitoring, and reporting.

2 SCOPE AND OBJECTIVES

2.1 Project Scope

Chapter 1.4 describes project description of the PT SERD Geothermal project.

2.2 Scope of this Report

The development of the PT SERD BAP follows the IFC Guidance Note 6 (IFC, 2012b). It is important to recognize that a BAP is not just the production of a single document which details what actions are needed for the conservation and management of biodiversity. A BAP is a process from which a BAP document is formulated through the review of previous studies and from consultation with local stakeholders. The ESIA and AMDAL are parts of this process in that the ecological assessments of the ESIA provide the baseline upon which the BAP objectives and conservation priorities are based. A BAP should include eight specific tasks:

Task 1: Determination of the legal, regulatory, planning, permitting & third party requirements;

Task 2: Desktop assessment of the project;

Task 3: Baseline survey of the biodiversity;

Task 4: Biodiversity impact assessment.

2.3 Aim and Objectives

The aim of the Supreme Energy Rantau Dedap Biodiversity Action Plans (PT BAP) is to achieve "no net biodiversity loss" as a result of the Project by ensuring that the biodiversity is protected and enhanced where possible. The BAP has been developed in consultation with the stakeholders and biodiversity experts.

The General objective of the PT BAP is to provide a comprehensive strategy and specific, implementable actions aimed at the protection and conservation of biodiversity during the construction and operation Geothermal Power Plan. The specific objectives of the PT BAP are to:

- Review existing biodiversity baseline information and legislative/policy frameworks for the Study Area;
- Implement a consultation process with relevant stakeholders and biodiversity experts to inform priorities and actions for biodiversity conservation;
- Undertake a Critical Habitat Assessment to determine the IFC PS6 requirements for the Project;
- Identify priorities and actions for biodiversity conservation, in consultation with stakeholders and biodiversity experts;
- Institutional partnerships for implementing the BAP;
- An awareness raising and capacity building program of the relevant stakeholders including local communities and organizations involved in BAP implementation (government departments and local NGOs);
- Establish a monitoring and evaluation program for biodiversity allowing for the success of the BAP interventions to be assessed;

- A monitoring and evaluation plan to ensure that the measures outlined in the BAP are implemented.

This BAP includes both long-term biodiversity conservation actions and on-site mitigation measures linked to the construction and operation activities of the Project. The biodiversity baseline, conservation actions and mitigation in this BAP supplement the information in the PT EIA, ESHIA, and Biodiversity Report (Greencap, 2016). Additional conservation opportunities/actions will be identified during the BAP process, following a comprehensive desktop review and consultation with stakeholders and biodiversity experts.

The conservation actions have been established with the aim of achieving 'no net loss' to biodiversity in accordance with IFC PS6 (IFC, 2012a, 2012b). IFC PS6 requires evidence that the mitigation hierarchy has been applied, that avoidance is prioritized, and that offsets are measurable and only applied as a last resort where residual impacts are unavoidable.

3 POLICY AND REGULATORY FRAMEWORK

3.1 International Regulation

Indonesia had ratified international laws and conventions such as:

Ramsar Convention (1971)

The Ramsar Convention also known as the Convention on Wetlands is an international treaty for the conservation and sustainable use of wetlands. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971. The Convention's mission is conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. The Convention uses a broad definition of wetlands. It includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites such as fish ponds, rice paddies, reservoirs and salt pans.

World Heritage Convention (1972)

The World Heritage Convention (WHC) which was adopted in the General Conference of UNESCO on 16 November 1972. This convention was aimed to protect the world's cultural and natural heritage. The "natural heritage" defined in the WHC may be in line with biodiversity conservation, which should have (Article 2):

- "natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view;
- geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation;
- natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty."

The WHC addresses that each State Party should be committed to the conservation of their respective heritage sites. Heritage sites located within a State Party's sovereignty will be the responsibility of the State. The State is committed to the protection and conservation of their heritage sites, to the utmost of its own resources, and where appropriate, with any international assistance and cooperation

Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975)

Convention on International Trade in Endangered Species of Wild Fauna and Flora also known as the Washington Convention. The convention is a multilateral treaty to protect endangered plants and animals. It was drafted as a result of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature (IUCN). The convention was opened for signature in 1973 and CITES entered into force on 1 July 1975. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild.

The Convention on the Conservation of Migratory Species of Wild Animals

The Convention on the Conservation of Migratory Species of Wild also known as the Convention on Migratory Species (CMS) aims to conserve terrestrial, marine and avian migratory species throughout their range. It is an intergovernmental treaty, concluded under the aegis of the United Nations Environment Program, concerned with the conservation of wildlife and habitats on a global scale. The CMS covers a great diversity of migratory species. The Appendices of CMS include many mammals, including land mammals, marine mammals and bats; birds; fish; reptiles and one insect. Among the instruments, AEWA covers 255 species of birds that are ecologically dependent on wetlands for at least part of their annual cycle. EUROBATS covers 52 species of bat, the Memorandum of Understanding on the Conservation of Migratory Sharks seven species of shark, the IOSEA Marine Turtle MOU six species of marine turtle and the Raptors MoU 76 species of birds of prey.

United Nations Convention on Biological Diversity (1992)

United Nations Convention on Biological Diversity Flora also known as the Biodiversity Convention had ratified by 157 country leaders in Rio de Janeiro Brazil. Indonesia is the 8th country ratified this regulation. The Convention has three main goals:

- conservation of biological diversity (or biodiversity);
- sustainable use of its components; and
- fair and equitable sharing of benefits arising from genetic resources.

In other words, its objective is to develop national strategies for the conservation and sustainable use of biological diversity. It is often seen as the key document regarding sustainable development.

Regional Regulations

As part of the Asia continent as well as ASEAN, Indonesia has also become part of regional agreements related to biodiversity and ecosystem conservation.

3.1.1 Asia Plant Protection Agreement for the Asia and Pacific Region (1955)

Indonesia is a member of the Asia and Pacific Plant Protection Commission. The Plant Protection Agreement for Asia and Pacific Region is an intergovernmental treaty and administered by the Asia and Pacific Plant Protection Commission. The Plant Protection Agreement for the Asia and Pacific Region (formerly the Plant Protection Agreement for South-East Asia and Pacific Region) was approved by the 23rd Session of the FAO Council in November 1955 and entered into force on 2 July 1956. The FAO Council approved amendments to the Agreement in 1967, 1979, 1983 and 1999. This agreement aims to prevent the introduction into and the spread within the Asia and Pacific Region of destructive plant diseases and pests. Introduction of exotic species is considered to as a threat to biodiversity and ecosystem stability.

3.1.2 ASEAN Declaration on Heritage Parks and Reserves (1984)

Member States of ASEAN established the ASEAN Heritage Parks to generate greater awareness and conservation of the ASEAN region's natural heritage. The declaration was issued after Member States proposed criteria and guidelines for the establishment and management of protected areas in the ASEAN region. The declaration's contextual message is declared as:

"Recognizing that conservation areas should be managed to maintain ecological processes and life support systems, preserve genetic diversity; ensure sustainable utilization of species and ecosystems; and maintain wilderness that are of scenic, cultural, educational, research, recreational and tourism values;"

Similar to the WHC, this declaration addresses that Member Parties are responsible for the conservation and management of heritage parks located in its sovereignty.

3.1.3 Agreement on the Conservation of Nature and Natural Resources (1985)

Apart from the establishment of ASEAN heritage parks, ASEAN Member States also agreed upon conserving nature and natural resources. This agreement addresses, among others, integrating conservation and development, species and ecosystem protection, and environmental planning

3.2 National Regulation

Indonesia legislation comprises the Constitution, environmental laws, international agreements, subordinate legislation, normative acts, presidential orders and governmental decrees, ministerial orders, instructions and regulations. Along with the national regulations, Indonesia is signatory to a number of international conventions, including those related to environmental protection (see in table 1).

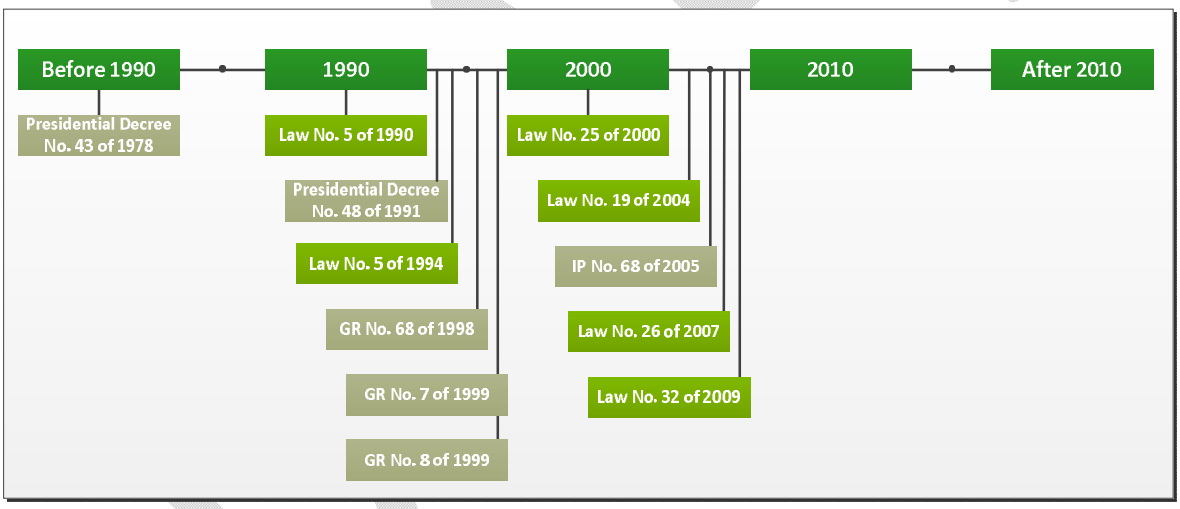


Figure 3-1 Flow Line Indonesia Regulations Development

The Ministry of Environmental and Forestry (MoEF) is responsible for regulating the natural environment. The MoEF participates in the development environmental state policy and implements all policies designed for the protection and conservation of the environment and for the sustainable use and management of Indonesia natural resources. This includes controlling activities that have a potential adverse impact on the environment and natural resources and issuing environmental licenses and permits.

Table 3-1 Indonesia Regulations regarding Biodiversity

No	Regulation	Substance
1.	Presidential Decree No. 43 of 1978 on Convention International Trade in Endangered Species of Wild	Indonesia Government had ratified Convention on International Trade in Endangered Species of Wild Fauna And Flora. This convention also known as the Washington Convention. Washington Convention is a multilateral treaty

No	Regulation	Substance
	Fauna and Flora	to protect endangered plants and animals. It was drafted as a result of a resolution adopted in 1963 at a meeting of members of the International Union for Conservation of Nature (IUCN). The convention was opened for signature in 1973 and CITES entered into force on 1 July 1975. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild. Restrictions, prohibition and monitoring of species of flora and fauna, especially endangered.
2.	Law No.5 of 1990 on Biological Natural Resources Conservation and its Ecosystems	Stressing safeguards such as buffer system protection, preservation of biodiversity, prohibited activities and sanctions. The Act also gives a description of the nature reserve zone, community and conservation area. Emphasizes land conservation.
	Presidential Decree No. 48 of 1991 on the Ratification of the Convention on Wetlands (Ramsar)	The provisions on the conservation of wetlands Determining wetland sites that have international interest
3.	Law No. 5 of 1994 on Ratification United Nations Convention on Biological Diversity	Regulate the conservation and sustainable use, equitable benefit sharing and transfer of technology. The protection of traditional knowledge and biosafety
4.	Government Regulation (GR) No. 68 of 1998 on Wildlife Reserve and Natural Conservation Zones	The aim of this regulation is the management of Wildlife Reserves and Nature Conservation Zones to establish and foster the protection of biological resources and ecosystem balance, so that efforts to raise the prosperity and quality of life of the community can be supported
5.	Government Regulation (GR) No.7 of 1999 on Flora And Fauna Species Conservation	The conservation of flora and fauna has the following objectives to avoid extinction of flora and fauna species; to safeguard genetical purity and species diversity of flora and fauna; to conserve the equilibrium and stability of the ecosystem so as to be useful for the sustainable well-being of mankind.
6.	Government Regulation (GR) No.8 of 1999 on Exploitation of Wild Animals and Plants	The exploitation of plants and wildlife's can be done in the following form of activities: Study, research and development; Breeding; Sports Game; Trade; Exhibition; Exchange; Cultivation of plants for its medical properties; and Pets.
7.	Law No. 25 of 2000 on the National Development Program (PROPENAS 2000 to 2004)	Include a variety of ecosystem management plan, but does not specifically mention biodiversity issues
8.	Law No.19 of 2004 on forestry	Set the function, planning and management of forests, including the role of the wider community and Set up a regional forest protection comparison as ecosystem
9.	Instruction President (IP) No. 4 of 2005 on the acceleration of actions to combat illegal logging	Instruction to 18 state institutions to take action in accordance with the authority and give priority to efforts in combating illegal logging The establishment of a national labor force (national task force) which consists of echelon I officials from all agencies that give instructions under the coordination of Coordinating Minister for Political, Legal and Security

No	Regulation	Substance
		The establishment of a team for coordination, monitoring and evaluationworking unit of a joint task force whose members include government officials and NGOs
10.	Law No. 26 of 2007 on Spatial Planning	Management of protected areas, the area of cultivation and conversion and management of protected areas
11.	Law No. 32 of 2009 on Environmental Protection and Management	Set the principles, objectives and goals of environmental management in Indonesia, the rights and obligations of the community, authority for environmental management, environmental conservation, environmental planning requirements, supervisory, administrative sanctions, environmental auditing, environmental dispute resolution

The Indonesian Biodiversity Strategy and Action Plan 2015 -2020 (IBSAP) prepared by the Ministry of National Development Planning Agency (BAPPENAS) in corporation with MoEF and Indonesian Institute of Sciences (LIPI). Target from IBSAP 2015-2020 following Aichi Targets (AT) and adapted toIndonesian conditions. IBSAP targets the following:

1. Awareness and participation of various parties through formal and informal education programs (AT-1);
2. Implementation of management sustainable biodiversity on planning and implementation national and local development for economic improvement of the community (AT-2);
3. Realization of an incentives and disincentives system in the effort and management of biological resources (AT-3);
4. Increased availability and implementation supporting regulations for sustainable production and consumption (AT-4);
5. Develop ex situ conservation area for protection of local species (AT-5);
6. Implement regulation for sustainable management and harvesting (AT-6);
7. Increasing areas for agriculture, plantations and farms with sustainable management (AT-7);
8. Decrease pollution levels which damage biodiversity resources and function of ecosystems (AT-8);
9. Prevention and eradication of invasive alien species (AT-9);
10. Decrease anthropogenic pressure level for coral reef and other endangered ecosystems effected by climate change (AT-10) ;
11. Sustainable preservation and increasing conservation areas (AT-11);
12. Implementation and effort to prioritize protected endangered species population as national conservation priority species (AT-12);
13. Develop seeding system, genetic breeding, and domestication of wildlife species, as well as breeding of wildlife species (AT-13);
14. Increasing function of integrated ecosystem to ensure improvement of important services (water, health, livelihood, tourism) (AT-14).
15. Realization of conservation and restoration of ecosystems in degraded areas (AT-15).

16. Implement ratification of Nagoya Protocol and derivate instrument with regulation and Institutional forms of central and local executive (AT-16);
17. Implement new IBSAP in various stages (AT-17);
18. Develop innovation of local wisdom and improvement of bioprospecting capacity for conservation and utilization sustainable biodiversity (AT-18);
19. Sustainably increase science and technological capacity to biodiversity management (AT-19);
20. Identify resources and effective budgeting in implementation of sustainable biodiversity management (AT-20);
21. Comprehensive and integrated mapping data and biodiversity information;
22. Implementation of conflicts resolution related to biodiversity management as comprehensive.

3.3 Third Party Requirements

The Project is required to meet the international standards of the IFC, which is part of the World Bank Group. The international environmental and social safeguard policies of these organizations are outlined below.

3.3.1 International Finance Corporation (IFC) Standards and Guidance

The IFC PS6 (IFC, 2012a) and Guidance Note 6 (IFC, 2012b) has been used on the Project as best practice and international standard. In accordance with IFC PS6, habitats are divided into modified, natural and critical habitats. Critical habitats can be either modified or natural habitats supporting high biodiversity value, including:

- Habitats of significant importance to critically endangered and/or endangered species (IUCN Red List);
- Habitats of significant importance to endemic and/or restricted-range species;
- Habitats supporting globally significant concentrations of migratory species and/or congregator species;
- Highly threatened and/or unique ecosystems; and/or
- Areas associated with key evolutionary processes.

A BAP is required for all projects located in critical habitat (IFC, 2012a) and is recommended for projects that have the potential to significantly impact natural habitat (IFC, 2012b). The Project ESIA has highlighted the potential presence of critical habitats within the zone of influence of the Project. A Critical Habitat Assessment is included in Section 5 of this document.

Specific reference has been made to the following IFC environmental standards and guidance:

- IFC General Environmental, Health and Safety (EHS) Guidelines (2007)
- IFC EHS Guidelines for Geothermal Power Generation (2007)

3.3.2 Asian Development Bank (ADB) Standards

The ADB Safeguards Policy Statement (SPS) 2009 sets out policy principles and outlines the delivery process for ADBs safeguard policy in relation to environmental safeguards. The ADB has

adopted a set of specific safeguard requirements that borrowers/clients are required to meet in addressing environmental and social impacts and risks. ADB staff will ensure that borrowers/clients comply with these requirements during project preparation and implementation.

The safeguard policies are operational policies that seek to avoid, minimize or mitigate the adverse environmental and social impacts of projects including protecting the rights of those likely to be affected or marginalized by the development process. ADBs safeguard policy framework in the SPS consists of three operational policies on the environment, indigenous people and involuntary resettlement. ADB has developed Operational Procedures to be followed in relation to the SPS policies and these are included in the ADB Operations Manual.

Requirements for assessing and addressing biodiversity effects of projects are set out within ADB Safeguard Requirements 1: Environment, Section D8 'Biodiversity Conservation and Sustainable Natural Resource Management'. This document is included as an appendix to the SPS.

Section D8 requires the environmental assessment process to focus on the major threats to biodiversity and for the borrower/client to identify measures to avoid, minimize, or mitigate potentially adverse impacts and risks and, as a last resort, propose compensatory measures, such as biodiversity offsets, to achieve no net loss or a net gain of the affected biodiversity.

Obligations on the borrower/client differ depending on whether the habitat is classified as modified, natural or critical. For areas of critical habitat the requirements state that no project activity will be implemented in areas of critical habitat unless:

- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function;
- The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised;
- For any lesser impacts, mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post-project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity.

When the project involves activities in a critical habitat, ADB requires the borrower/client to retain qualified and experienced external experts to assist in conducting the assessment. Details are the Project compliance are given in **Table 3-2**.

Table 3-2 Project's Compliance with the Lenders' Requirements

No.	Lenders Requirements	Project compliance	Rationale
1	There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function;	√	The total of area affected by the Project within the DMU is approximately 106 ha (see Table 5.3). This is the equivalent to 0.05% of the entire land coverage within Bukit Jambul Gunung Patah Protection Forest Landscape. See **Chapter 6.1**.

No.	Lenders Requirements	Project compliance	Rationale
2	The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised;	√	It is considered that there will be no measurable adverse effects on the viability of the population of endemic and restricted range; endangered or critically endangered species in the PT SERD Project Area as a result of the development as only a very small proportion of their habitat will be affected.
3	For any lesser impacts, mitigation measures will be designed to achieve at least no net loss of biodiversity. They may include a combination of actions, such as post-project restoration of habitats, offset of losses through the creation or effective conservation of ecologically comparable areas that are managed for biodiversity while respecting the ongoing use of such biodiversity by Indigenous Peoples or traditional communities, and compensation to direct users of biodiversity.	√	**Sections 7** is the proposed actions to be undertaken for the habitats and species of conservation value identified with the aim of achieving no net loss to biodiversity and a net gain in critical habitats.

4 BIODIVERSITY BASELINE

4.1 Methodology

4.1.1 Study Area

The main purpose of the study is to identify the home range and habitats of wildlife, especially endangered species. The biodiversity study focused around the area where project activities are located in the Protected Area. Objective of the study is to assess the diversity within the Project footprint and surrounding areas, and focusing on endangered species. The study area is shown in **Figure 4-2**.

The study area location intersects with the Sumatran montane rainforest ecosystem region. Based on data from AMDAL study, most of the ecosystem in the project boundary is a montane rainforest (58%).

The survey is designed to measure the biodiversity of surrounding of project footprint area. Biodiversity surveys conducted over several time intervals, i.e. before exploration activities (Jan 2014), during exploration (Sept 2014 – Jan 2015) and after exploration stage July – October 2016. Time Schedule of biodiversity study is presented in **Figure 4-1**.

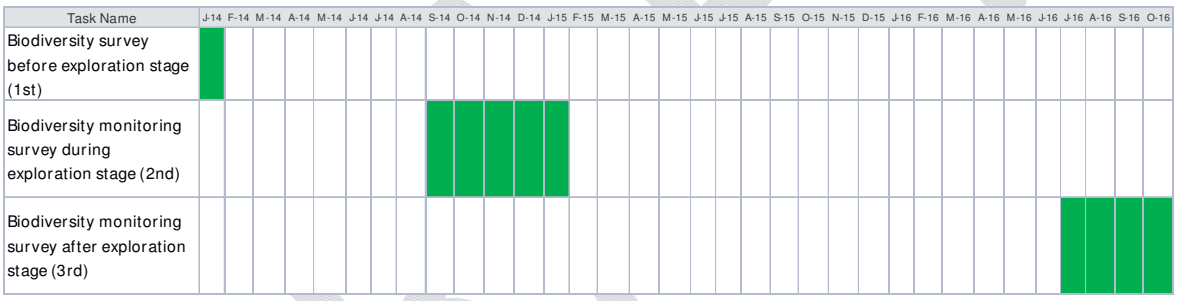


Figure 4-1 Time Schedule of Biodiversity Study

Figure 4-2 Study area

4.1.2 Desktop Information

Secondary data will be gathered from relevant agencies from available relevant reference journals, reports and documents that describe the existing conditions in the project area and describe the existing environmental conditions in the project area (where possible and where information is available). Secondary data also include previous UKL and UPL report, Baseline study for ANDAL, RKL and RPL documents and recent high-level biodiversity report if available. Data and information will also be collected from the Forestry Office in South Sumatera and other offices concerned. The following data sets listed in **Table 4-1** were consulted for the biodiversity assessment.

Table 4-1 Datasets used in the biodiversity assessment

No.	Dataset	Year	Source
1	Global Biodiversity Hotspots	2011	IBAT
2	WWF Terrestrial Ecosystems	2015	WWF
3	RAMSAR Wetlands	2015	IBAT
4	UNESCO MAB	2015	UNESCO
5	World Heritage Sites	2015	UNESCO
6	Key Biodiversity Areas	2015	IBAT
7	Endemic Bird Areas	2015	IBAT
8	World Database of Protected Areas	2015	IBAT
9	IUCN Threatened Species Grid	2014	IBAT download
10	IUCN Red list of threatened species	2015	IUCN Red List
11	Global Biodiversity Information Facility (GBIF)	2015	GBIF
12	Bird database	2016	Cornell University
13	Land cover	2011	Ministry of Forestry
14	Tiger Conservation Landscape	2016	WWF

4.1.3 Field Surveys

In general, the survey focused on habitats used by the target species, particularly in the affected area that are potentially impacted by activities of PT SERD. To achieve the goal, studies used observational approach, point count methods, and camera traps.

The study area for large mammals focused on forest and adjacent habitats. The study identified home range using signs of the existence of species, such as photos/videos, faeces, prints, fur/feathers, scratches, and sounds. For primate troops, the survey focused on forest edge habitats.

4.1.4 Data collection

4.1.4.1 Flora

The study of flora/terrestrial vegetation requires collection of data on density and abundance of flora, including structure, composition, diversity, as well as an importance value index.

In addition, it also determines the types of protected species, cultivated crops and house garden plants around the project site.

The Checkered Path Method is used for assessing vegetation. Observation plots for seedlings are (2x2m) in size, saplings (5x5) m, and trees 10x10 m. For trees and saplings, measurements, diameters and species identification data are recorded, and for seedlings just species identification are recorded).

- Seedling : From smallest size to vegetation with height < 1.5 m.
- Sapling : Height from 1.5 m with trunk diameters to 10 cm.
- Stake/pole : diameter 10 to 19 cm.
- Tree : diameter ≥ 20 cm.

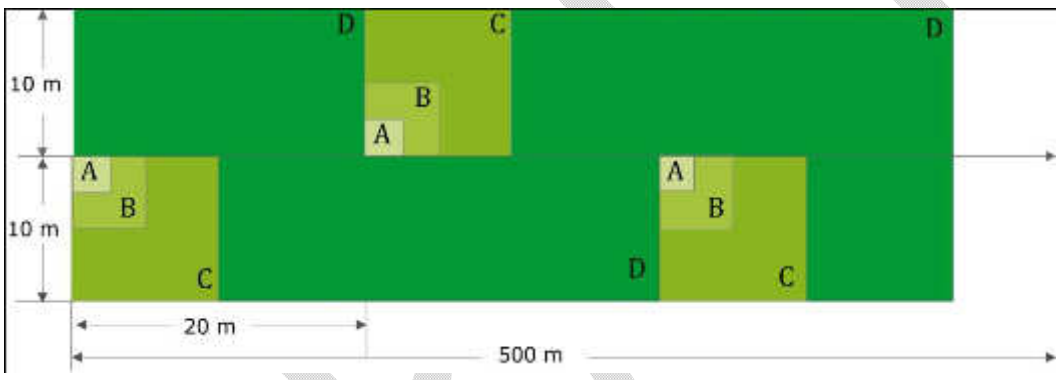


Figure 4-3 Line Transect

4.1.4.2 Fauna

Wildlife observations are conducted in accordance with good reconnaissance survey techniques with direct and indirect counts. Target animals for observation include those of the mammal, bird, reptile, and amphibian groups. General observations will be made on the existing diversity of wildlife, with observation and analysis carried out on species belonging to key species, extinction threats, as well as indicative species of environmental quality. Investigators will also conduct interviews with the local communities to assess the diversity of wildlife that once inhabited the region (historical data).

Data collection will be done using a combination of methods in accordance with targeted species that are observed and in accordance with standard methods that exist in each field. If possible, photographs of the animals observed will be obtained. Methods to be used are described below.

4.1.4.2.1 Mammalia

Mammal observations will be done by using direct and indirect counts. The species and abundance of all species of mammal that were found are recorded.

Line transect

The Survey used a line transect method along 500 meters. Field study activities aimed to obtain information on target species and habitat character. Some of the data collected included presence of target species and potential vegetation feed. The data recorded are

species name, number of individuals of each species and location of the findings, means of finding species, i.e. abandoned signs such as faeces, tracks, and fur. Identification of feed vegetation along the path for certain mammalian and primates were recorded during these observations.

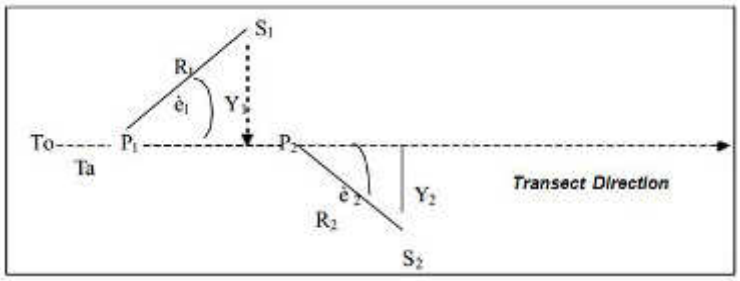


Figure 4-4 Line Transect Method

Rapid Observation

Rapid observation is a non-transect method of data collection along an existing route. Survey route follows the movement of the target species. In addition to line transects, surveyors also followed the existing foot trails in the forest. Basically, this technique is the same as the line transect, differing in the use of the existing trails on ridges or along streams, as well as along the borders between plantations and forest. In total, surveyors walked 20 kilometres along both line transects and existing foot trails.

For large mammals, the survey was focused on ridges and hills. Ridges are commonly used by animals as movement routes. For primate species, the routes followed their food trees in the forest and along the edge of forest bordering plantation areas. The information of habitat use was derived from direct findings and information from local residents and project workers.

Camera Trap

Camera traps are very useful in terms of wildlife monitoring, as this technique can provide visual data of targeted species and can record in real-time continuously at specific times (depending on battery lifetime).

To obtain maximum information, camera traps were placed in appropriate locations, such as areas identified as natural pathways and corridors or sites identified as areas of activity of animals that are usually characterized by traces, scratches or other marks. Therefore, the installation of camera traps is adapted to the target species.

Table 4-2 Installation of camera trap

No	Location	Coordinate		Date	
		South	East	Start	Stop
1	Wellpad D Route (D1)	4.20012°	103.3781°	17-10-2014	29-01-2015
2	Adjacent of Plantation and Forest (PL1)	4.20713°	103.4137°	21-10-2014	29-01-2015
3	Wellpad I-1 (I1)	4.23598°	103. 3593°	13-10-2014	29-01-2015
4	Wellpad I-2 (I2)	4.24240°	103.3663°	15-10-2014	18-12-2014
5	Wellpad B-1 (B1)	4.22214°	103.3991°	14-10-2014	29-01-2015
6	Wellpad B-2 (B2)	4.21791°	103.4184°	17-10-2014	29-01-2015
7	Wellpad E	4.20702°	103.3800°	16-10-2014	19-10-2014

No	Location	Coordinate		Date	
		South	East	Start	Stop
8	Wellpad C (C1)	4.21733^{O}	103.3837^{O}	20-10-2014	29-01-2015
9	Route to Puyang (P2)	4.21943^{O}	103.3709^{O}	19-12-2014	29-01-2015
10	Wellpad E (E1)	4.20702^{O}	103.3800^{O}	25-12-2014	29-01-2015

Figure 4-5 Camera Traps

Mouse Trap

Traps were installed to obtain the diversity of small mammals, particularly rats group (Rodentia). The survey installed 15 traps at one location and was checked continuously. Traps were moved to other locations when species findings does not increase. **Figure 4-6** depicts a trap location

Figure 4-6 Mouse Trap

Concentration Count

Concentration count observations were conducted at a point that is suspected as a location with high chances of wildlife encounters, such as a location of food source, water and shelter. Observations are conducted in a 'blind' so as not to interfere with the activity of animals. This method was used to survey populations of herbivores, primates and carnivores.

Community Interview

Large portions of the study area in the lower altitudes have been converted into villages and coffee plantations. Surveyors surveyed the remaining forests adjacent to the plantations where people still find Leaf monkeys (*P. melalophos*). In the villages, interviews with people have been conducted specifically on their experiences with wildlife that still exist in the area. Residents were questioned on whether they had seen specific animals in recent years (up to 3 years back). People are also asked whether they hunt animals or if they have experienced threats from wildlife during their residence in the village. These interviewed villages have been identified based on the results of a previous reconnaissance trip.

4.1.4.2.2 Aves

Data collection of Aves used the line transect method and concentration count. Observations were made along existing tracks in the morning starting 6:00 a.m. through 11:00 am. Bird species observed outside these times were also recorded. Coat color, beak shape, foot, and special features of the birds that were found will be considered. Identification of the species of birds found were confirmed with field manuals (MacKinnon et al., 2000). Bird species observed were recorded in the list of bird species, each consisting of 20 species of birds, each bird species recorded only once in the recording list.

4.1.4.2.3 Reptiles and Amphibians

Reptile and amphibian species presence was observed by using night visual encounters and line transects. The observations were carried out at night by browsing water bodies and forests that are usual habitats of reptiles and amphibians. Species encountered were collected by hand, sorted, and then brought to the observation station for further identification.

4.1.4.3 Habitat Classification and Analysis

Habitats were classified as natural and modified habitat. Analysis of habitats was completed using land cover approach, field ground checks, and vegetation study literature.

Land cover information was obtained using remote sensing and spatial analysis. High-resolution satellite image data were downloaded from Google Earth (2014) combined with Landsat 8 (acquisition year 2016). Analysis of satellite image acquisition using visual interpretation methods were conducted with the results guiding ground truthing in the field. Field observations were used to divide land cover into five classes (**Table 4-3)**.

Table 4-3 Land Cover Classification

Species	Habitat Type	Description
Forest	Natural Habitat	Areas dominated by tree cover, with dense canopy cover, and sparse cover (formerly logged).
Lake	Natural Habitat	Area dominated by water.
Shrub	Natural Habitat	Natural areas dominated by ground vegetation cover. In

Species	Habitat Type	Description
		the field, vegetation was recorded in seedling and sapling growth stages.
Dry-land Agriculture	Modified Habitat	Areas with lower vegetation cover that have particular patterns that indicate human interference.
Paddy field/wetland Agriculture	Modified Habitat	Areas with lower vegetation cover, with terraced regular patterns and appear inundated with water type colors.

4.1.4.4 Stakeholder Engagement on Biodiversity Values

Stakeholder engagement will be conducted using workshops. The workshop participants are species experts, NGOs, Universities, Regional and Local Governments, and other companies around the study area.

4.2 Baseline Study and Literature Review

4.2.1 Vegetation

In general, the study area is a montane ecosystem. The results of cluster analysis showed that a high similarity exists between the vegetation types of Wellpad E and Wellpad I. In the meantime, the species composition in Wellpad B was very different. This might be due to the somewhat lower altitude (<2,000 masl) of Wellpad B than the other two. To summarize, the vegetation types of montane habitat in the study area could be categorized into two types of ecosystem i.e. lower montane and montane. The complete list of flora species can be found in **Appendix IV**.

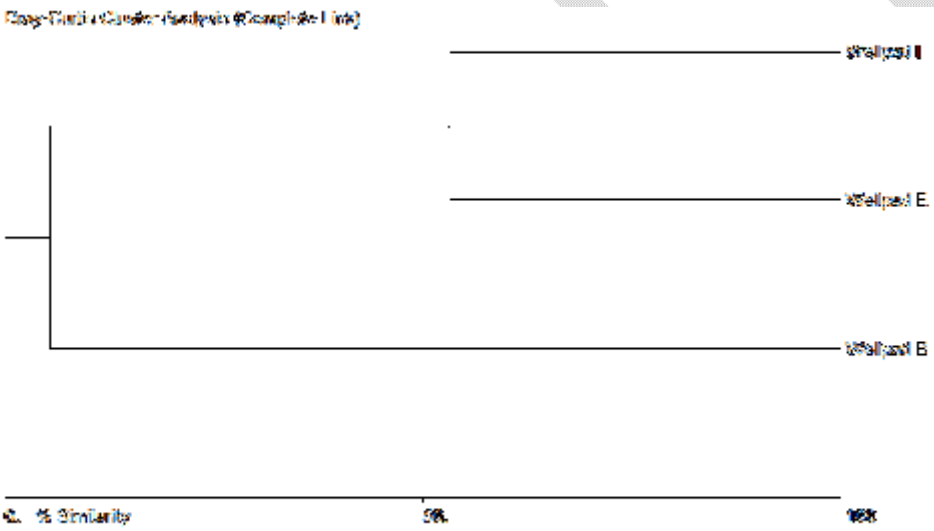


Figure 4-7 Cluster analysis of vegetation data

4.2.2 Sub-montane Forest Ecosystem

Wellpad B (elevation 1,700 masl) and Wellpad E (2,000 masl) is representative of the Sub-montane forest ecosystem. The observation of trees in the growth stage with a diameter over 60 cm was recorded consist of Puspa (*Schima wallichii*), Pasang (*Quercus* sp.), Medang (*Litsea* sp.), and Kebe elang (*Aglaia* sp.). Undergrowth plants, among others, were composed of Kelat groups (*Syzygium* sp.), Baso (*Caryota mitis*), and Kekawi (*Lasianthus* sp.) On the forest floor were found species such as *Begonia isoptera*, *Begonia muricata*, and *Begonia multangula*. Also recorded was *Balanophora* sp., a parasitic plant that roots on trees of *Quercus* sp. Some pioneer plants were found, including Sepat (*Ficus* sp.) and Jelatang (*Laportea stimulant*).

A secondary mountain plant species found to be quite dominant is Maleuleu (*Litsea cubeba*). Palm groups, especially species of rattan, are rarely found, because elevation factors in the study area do not support growth of these species. The species distribution caused by altitude (elevation effect) factors is *Vaccinium varingiaefolium* (epiphyte species). Another common plant is edelweiss (*Anaphalis longifolia*). Plant species mentioned are common species found in the mountain forests of Java as well as Sumatra.

On Wellpad E, dominant flora species are Lengkedai (*Dacrycarpus imbricatus*) and Lengkedai daun (*Taxus sumatranus*). Both trees are commonly used for building material by local communities. Lengkedai daun, endemic to Sumatra, here is was found quite dominant and abundant in the hilly areas. This plant became famous because of its alleged potential as

cancer drug, but this factor is still in research. Other tree species recorded are *Syzygium* sp., Medang, Cihu (*Schima wallichii*) and *Litsea cubeba*. In the second canopy layer are found *Syzygium lineatum* with elliptical leaves, *Neolitsea* sp., *Evodia latifolia*, and *Litsea* sp. On the forest floor was recorded *Sarcandra glabra*, *Argostemma montanum*, *Begonia muricata* as dominant species, as well as *Sonerilla* sp., *Medinilla speciosa*, *Polygonum* sp., and *Ficus* sp.

4.2.3 Montane Forest Ecosystem

Wellpad I (2,200 masl) area is in the montane moss forest ecosystem; generally, tree roots are covered by moss. The composition of the forest is dominated by *Taxus sumatrana* and *Dacrycarpus imbricatus*. Common species found are *Weinmania* sp., *Liquidambar* sp. *Cinnamomum* sp., *Syzygium* sp., and Cihu (*Schima wallichii*). In the lower forest canopy are found *Lasianthus* sp., *Litsea* sp, *Acer laurinum*, *Symplocos* sp., and Proteaceae family species. Liana plants are rare, except *Rubus* sp. and *Lasianthus* sp., indicating the forest is still in good condition. On the forest floor were found *Sonnerila* sp., *Elatostemma* sp., *Impatiens* sp 3 which is also believed to be an endemic species not previously recorded.

4.2.4 Flora of Conservation Value

Information is limited for the flora of conservation value which occurs within the Bukit Jambul Gunung Patah Protection Forest. Surveys undertaken by Greencap and LIPI have identified at a species which are categorised as Endemic Species of Sumatra, namely *Taxus sumatrana*.

4.2.5 Birds

4.2.5.1 Habitat

In general, species of birds found were species in the main habitat forest, habitat edges of forests and plantations or shrubs and water bird species that can be found around the lake. Mountain bird species were dominant, and found at an altitude range of 1,500 – 2,500 m above sea level.

Communities build artificial lakes by damming rivers. These and artificial lakes built for hydropower plants become new habitats for birds. Some water birds were found in this location.

4.2.5.2 Species Composition

The study recorded 61 species of 28 families. Muscicapidae (flycatcher bird), Sylviidae (passerine birds) and Accipitridae (eagle bird) are bird families that were commonly recorded in the study area.

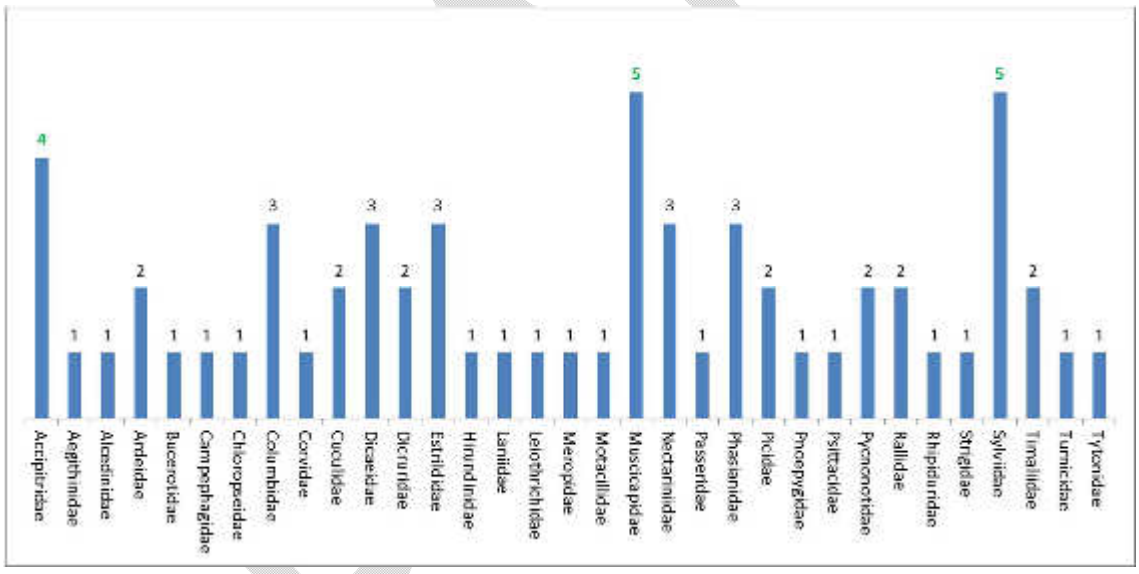


Figure 4-8 Number Species of Bird

Birds were identified through direct observation, vocal observation and camera traps. The species most commonly observed in the study area was the Ashy drogon and Indigo fletcher. These species were found in the wellpads and access roads surroundings. The results of the study on bird groups is presented in **Appendix V**.

Table 4-4 lists important bird species found during the study. A total of 15 species of birds were categorized as important based on the number of individuals in nature and the distribution range. Eight species include protected species of Indonesia, three endemic birds and three migratory birds.

Table 4-4 List of Important Bird Species

Family	Name		Status		Distribution
	English	Scientific name	GOI	IUCN	
Accipitridae	Oriental Honey-buzzard	*Pernis ptilorhynchus*	P	LC	Migratory
Accipitridae	Black Eagle	*Ictinaetus malayensis*	P	LC	
Alcedinidae	Collared Kingfisher	*Todirhamphus chloris*	P	LC	

Family	Name		Status		Distribution
	English	Scientific name	GOI	IUCN	
Nectariniidae	Plain Sunbird	*Anthreptes simplex*	P	LC	
Nectariniidae	Grey-breasted Spiderhunter	*Arachnothera affinis*	P	LC	
Nectariniidae	Olive-backed Sunbird	*Nectarinia jugularis*	P	LC	
Accipitridae	Crested Serpent-eagle	*Spilornis cheela*	P	LC	
Nectariniidae	Olive-backed Sunbird	*Nectarinia jugularis*	P	LC	
Estrildidae	Java Sparrow	*Padda oryzivora*	-	**VU**	
Phasianidae	Bronze-tailed Peacock-pheasant	*Polyplectron chalcurum*	-	NT	Endemic
Muscicapidae	Snowy-browed flycatcher	*Ficedula hyperythra sumatrana*	-	LC	Endemic
Phasianidae	Red-billed Partridge	*Arborophila rubrirostris*	-	LC	Endemic
Motacillidae	Gray Wagtail	*Motacilla cinerea*	-	LC	Migratory
Rallidae	Common Moorhen	*Gallinula chloropus*	-	LC	Migratory

Note: IUCN: LC = Least Concerned; GOI = Indonesia law under PP 7/1999: P = Protected

Four diurnal raptor species were found in the study area. The black eagle and crested serpent-eagle are species of diurnal raptor that were commonly found in the study area, and a nocturnal raptor (White-fronted scops-owl) was also identified. The survey also found groups of water birds in the artificial lake near the village, namely the Collared Kingfisher, Green-backed Heron and Common Moorhen.

4.2.6 Mammals

A total of 20 mammals were detected in the study area. Mammals were identified through footprints, camera traps, and sounds.

Table 4-5 lists terrestrial and arboreal mammal species recorded during the survey. Twelve of them are species that are protected by Indonesian law and two species are listed as Critical Endangered (**CR**) status in the IUCN Redlist Book. Four of them are endemic to the island of Sumatra.

In general, groups of arboreal mammals found on forest edges are the primates group, while some groups of chipmunks and squirrels were commonly found in the upper strata canopy within the forest areas.

The masked palm civet is a terrestrial mammal that was commonly found on the edge of the forest with plantations, as the feed sources are abundant in plantation areas. In addition, golden cats were found fairly wide spread in the study area. Three species of cat group (Felidae) were found during the study, two species captured by camera traps and one species was identified by footprint, namely the Sumatran tiger. Detailed species findings are listed in **Appendix III.**

Table 4-5 List of mammals in the study and project area

Name		Status		Distribution
English	Scientific name	GOI	IUCN	
Siamang	*Hylobates syndactylus*	P	EN	
Sumatran surili	*Presbytis melalophos*	P	EN	Endemic
Sunda pangolin	*Manis javanica*	P	CR	

Name		Status		Distribution
English	Scientific name	GOI	IUCN	
Dhole	*Cuon alpinus*	P	EN	
Sumatran tiger	*Panthera tigris sumatrae*	P	CR	Endemic
Wild boar	*Sus scrofa*		LC	
Red muntjac	*Muntiacus muntjak*	P	LC	
Sumatran mountain muntjac	*Muntiacus montanus*		DD	Endemic
Sumatran serow	*Capricornis sumatraensis*	P	VU	Endemic
Malayan tapir	*Tapirus indicus*	P	EN	
Malayan sun bear	*Helarctos malayanus*	P	VU	
Sambar deer	*Cervus unicolor*	P	VU	
Common palm civet	*Paradoxurus hermaphroditus*		LC	
Marbled cat	*Pardofelis marmorata*		VU	
Masked palm civet	*Paguma larvata*		LC	
Asian golden cat	*Catopuma temminckii*		NT	
Banded linsang	*Prionodon linsang*	P	LC	
Large treeshrew	*Tupaia tana*		LC	
Yellow throated marten	*Martes flavigula*		LC	
Malayan porcupine	*Hystrix brachyura*	P	LC	
Plantain Squirrel	*Callosciurus notatus*		LC	
Short-tailed Gymnure	*Hylomys suillus*		LC	
Indomalayan Maxomys	*Maxomys surifer*		LC	
Long tailed macaque	*Macaca fascicularis*		LC	

Note: IUCN: LC = Least Concerned, VU = Vulnerable, EN = Endangered, CR = Critical Endangered; GOI = Indonesia law under PP 7/1999: P = Protected; E = Endemic

4.2.6.1 Arboreal Mammals

4.2.6.1.1 Siamang (*Symphalangus syndactylus*) and Agile gibbon (*Hylobates agilis*)

In total, the survey covered a 20 km length which consisted of both line and natural foot trail walks. The habitats in the Project area are sub montane and montane forests. The lowest altitude is around 1,300 m and the highest about 2,000 m AMSL. With the maximum observation distance about 50 meters to either side, surveyors covered an area of 200 ha. During the survey, only Siamang were found and no agile gibbons could be detected nor heard. However, data collected mostly did not result from direct encounters with species, but through their vocalizations. The sources of vocalization were traced using triangulation. Only six groups were noted from direct encounters with the animals. The remaining 10 groups were detected from the territorial songs produced almost every morning.

The number of individuals in the groups encountered varied from 2 up to 5, consisting normally of an adult couple alone or with up to one adolescent and two juveniles. All six groups were encountered at high elevation, with five groups in montane habitat between 1,500 and 2,000 m AMSL. Only one group occupied territory in the sub-montane forest habitat with altitude below 1,500 meters AMSL. This is because most forest areas below 1,500 m AMSL have been converted to coffee plantations.

Appendix I shows direct encounters and vocalizations of siamang groups that were recorded. Six groups were obtained from line transects, occupying 200 ha. The average home range size for groups of siamang in this area was 33.4 ha, slightly larger than siamang groups studied in the Kuala Lompat forest, Malaysia, which utilize 32 ha of forest habitat (Chivers, 1984). The

availability of food trees particularly with fleshy fruit is reduced with increasing altitude. This was clearly shown by a study of habitat quality of two sympatric gibbons on montane habitat on the Malay Peninsula (Caldecott, 1980). Because of climate, soil, and drainage, the supply of fruit to agile gibbons decreases in abundance with elevation. This renders highland areas less favourable to agile gibbon than to siamang, which is less frugivorous (Raemakers, 1984). The only fleshy fruit bearing trees which are a dominant species in the study area are *Syzygium* spp. This is one of the explanations why the Agile gibbon (*Hylobates agilis*) could not be found in the study area.

O'Brien et.al (2004) found in Bukit Barisan Selatan National Park that Agile gibbon and Siamang density are negatively correlated, with the agile gibbon most abundant in mid-elevation forests (400 – 600 m AMSL) and Siamang most abundant in lowland (< 400 m AMSL) and sub-montane (1,000 – 1,500 m AMSL) forests. In this study, the agile gibbon (*Hylobates agilis*) was neither encountered nor heard by vocalization. Since the Project area consists of high elevation montane forest habitat, only a few groups of siamang exist.

Observers have discovered Siamang in the plantation near the forest edge. The coverage area was calculated based on the radius of the farthest distance between observer and source of vocalization which is estimated at 2 km length. There are 16 groups of siamang that have been documented within 48 km^2 forest area. Therefore, only 0.3 group/km^2 occur in the survey area. This number is much lower than the density of siamang in Gunung Tujuh (2,100 m AMSL) in Kerinci Seblat National Park, west Sumatra which is 2.7 groups/km^2 (Wood, et.al., 1996). The total number of tree stands with diameter more than 30 cm is less than 200 trees/ha. This number was obtained from 50 plots each 200 m^2 (range 2–7 trees/plot). In the last 10 years in south Sumatra of Barisan Montane range, illegal deforestation has increased up to the sub-montane forest habitat (1,000–1,400 m AMSL.). Currently, the forest in this region has been converted to coffee plantation and the encroachment went up to montane forest as seen in the map of Project area.

4.2.6.1.2 Sumatran Surili (*Presbytis melalophos*)

All leaf monkeys (*Presbytis melalophos*) encountered during the survey were in groups of 3 to 10 individuals. All encounters were situated in forest areas bordering coffee plantations. They inhabit peripheral forest at elevations 1,500 m to 1,700 m AMSL. In the Bukit Barisan Selatan Park which is situated in the southeast of the Project area, the Sumatran surili is abundant and occurred in forest habitats that have been converted into plantation. It occurs mainly in the lowlands, and its density is related to the existence of shrub, coffee, and forest patches (Nurcahyo, 2009).

In contrast, the density of Sumatran Surili based on this survey was only 2 groups/km^2. Further, it has been indicated by Nurcahyo (2009) that the Sumatran surili was not present in the proportion of forest with cover between 50 and 75%, but had an extremely high density in forest cover between 26 and 50% at more than 19 groups/km^2. Therefore, this species is hardly seen in the moist forest within the project area. The distribution of Sumatran Surili was found to be dispersed in the vicinity of Wellpads A and B, which are close to coffee plantations.

4.2.6.2 Large Mammals

Appendix II shows the list of species that have been found during the survey either captured by camera trap or indirectly through their sign of foot-prints. Several foot prints of prey animals have been identified and consists of Malayan tapir *(Tapirus indicus*), Red deer (*Muntiacus muntjak*), Serow (*Capricornis sumatrensis*), wild pig (*Sus scrofa*), Porcupine (*Hystrix brachyura*), and Sambar deer (*Cervus unicolor*). The prey species' foot prints are common in the well pad B area. The

greatest frequency of occurences of species foot prints were in the surrounds of Wellpad B whereas the least frequents were at Wellpad E which is near the Puyang Lake. This was calculated by using a formula which has been developed by Lancia et al. (1999). The most diverse foot prints of large mammals have been found in these forest surroundings in the altitude between 1,400 and 1,500 m AMSL with the Malayan tapir as the most frequent. The area was located near the village or plantation where the survey team found many active traps and snares targeted for prey animals.

Tiger foot-prints were found in the south of Wellpad B together with the Malayan Tapir, small cats, and Malayan Sunbear. Among the small cats which are captured by camera were the Asian Golden Cat (*Catopuma temminckii*) and the Marbled Cat (*Pardofelix marmorata).* Considering the existence of high varieties of prey species in these areas, it is assumed that the population of predator species including the Sumatran tiger and other cat species are living in a good quality forest habitat. Therefore, the most important management intervention is controlling the area from the threat of hunting pressure. This is a very crucial part of the management task in addition to the protection of the tiger itself. Hunting can drive big cat populations into rapid extinction only if it exceeds threshold levels set by habitat quality and reproductive potential of the species (Martin and de Maulenaer, 1988).

4.2.6.2.1 Sumatran Tiger (*Panthera tigris sumatrae*)

The vertical distribution of the Sumatran tiger ranges from sea level to 2,000 m AMSL (O'Brien et al. 2003) but on occasion they are found up to altitudes of more than 2,400 m AMSL (Linkie et al. 2003). There were 33 out of 38 forest patches of tiger habitat that have been evaluated and the project area includes one of the patches of forest that have not been evaluated yet (Wibisono and Pusparini, 2010). This study's results would be useful to fill in the gap of data of current tiger forest patches. Surveyors found evidence of Sumatran tiger existence in the vicinities of Wellpads B, C, and D.

The elevation of the study area is between 1,400 m and 2,500 m AMSL. Camera traps were deployed opportunistically in the forest. Wellpads where tigers were predicted to passwere on trails below ridgelines, trails near water, and passages between hills. During the survey, surveyors never directly encountered the tiger. However, prey animal signs such as footprints, as well as tiger prints were found in the forest surrounding Wellpad D with elevations of 1,800 m up to 2,000 m AMSL.

4.2.6.2.2 Sunda Pangolin (*Manis javanica*)

The survey has proved the existence of Sunda pangolin (*Manis javanica*) by camera trap, although the results of interviews with local residents indicate that they have never seen pangolin in the study area. The species was captured by camera trap on Wellpad D and Wellpad C.

Pangolin has been recorded in Bukit Barisan Selatan National Park at 900 m AMSL. (Wirdateti et al., 2013). It is a nocturnal species and specialist feeder foraging only on ants and termites. Major threats include loss and degradation of available habitat and also due to hunting for trade (Semiadi et al., 2009).

The finding of Sunda pangolin in the 1,910 m AMSL in the project area was the highest record in terms of altitude where the species has ever been found.

4.2.6.2.3 Dhole (*Cuon alpinus*)

The survey has proved the existence of Ajag or Dhole (*Cuon alpinus*) by camera trap. The species can be found primarily in lowland habitats up to 1,200 m AMSL.

Camera traps that were installed on Wellpad I and Wellpad D captured photographs of Dholes. On monitoring data, the Dhole was captured several times on different dates. It indicates the area is part of a main home-range of this species. The photographs show the species live on a solitary basis. Based on literature, Dholes live in the mountain and lowland forests; they commonly make nests in caves and holes. Two subspecies of dholes are endemic to Indonesia, inhabiting the islands of Sumatra and Java, namely *Cuon alpinus* javanicus and C. *alpinus* sumatrensis. Dholes typically live in groups consisting of 5 to 12 individuals, even up to 30 individuals. However, in certain situations, dholes can live in solitary conditions, as found in Gunung Leuser National Park (Aceh) and Way Kambas National Park (Lampung) as well as in the study area.

4.2.6.2.4 Malayan Sunbear (*Helarctos malayanus*)

Secondary evidence of the Malayan Sunbear was recorded during the field survey, such as scratches and footprints in the surrounding areas of Wellpad I, Wellpad B, Wellpad D and Puyang Lake area. Camera traps captured photographs of the Malayan Sunbear on Wellpad B, Wellpad D, Wellpad I and at forest edge habitats adjacent to plantations.

The Malayan Sun bear lives in the primary forest, secondary forest and occasionally in the plantation near the forest. This species can climb trees up to seven meters high for nesting.

They spread throughout tropical forests in Southeast Asia from Myanmar, South of China, Indochina, Sumatra and Borneo. This species has been listed by IUCN as vulnerable and has been included on the CITES list Appendix I since 1979.

4.2.6.2.5 Malayan Tapir (*Tapirus indicus*)

The Malayan Tapir is a nocturnal species (Holden et al. 2003; Novarino et al. 2005). The distribution of this species in Southeast Asia includes southern Myanmar, southern Thailand, the Malay Peninsula and Indonesia. **Figure 4-9** shows the distribution of Tapirs in Indonesia. In Indonesia the species can be found in Sumatra from the southern part of Toba Lake down to Lampung. There is only one record of Tapirs in the north area of Toba Lake, in Pangkalan Brandan (Meijard & van Strien 2003). However, this record did not get any additional support. Although the habitat in Aceh looks suitable for this species, it has never been seen in the area (Whitten et al. 1984). Usually, the species occupies lowland forest, however, it can be detected around elevations of 2,000 m AMSL in Gunung Tujuh, Kerinci National Park (Holden et al., 2003). It can be found in secondary forest habitat as well as plantations bordering the forest (Santiapilai & Ramono 1990; Novarino 2005; Maddox et al. 2007).

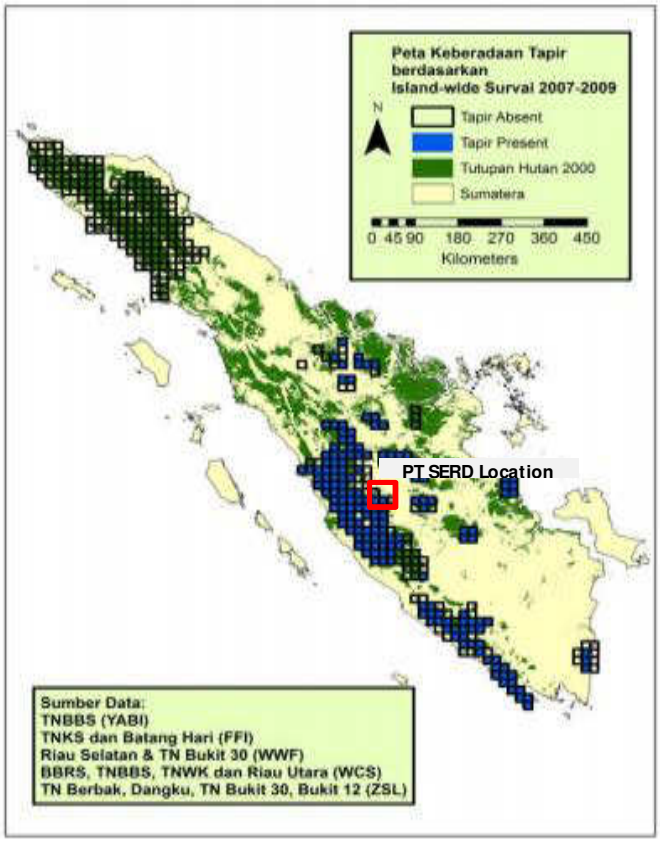


Figure 4-9 Distribution of *Tapirus indicus* (Pusparini et al. 2011)

The Malayan Tapir is one of the four Tapir species worldwide. In comparison to other Tapir species, the Malayan Tapir is the biggest. The IUCN considers the status of Malayan Tapir as Endangered (EN). In Indonesia, the Malayan Tapir is protected by Government of Indonesia Regulation's (PP) Number 7 Year 1999. In the Project location, the Tapir was found around Wellpad B and Wellpad I. Camera traps have captured the existence of this species in the Northern part of Wellpad I.

4.2.6.2.6 Sumatran Serow

The Malayan Tapir is one of the four Tapir species worldwide. In comparison to other Tapir species, the Malayan Tapir is the biggest. The IUCN considers the status of Malayan Tapir as Endangered (EN). In Indonesia, the Malayan Tapir is protected by the Government of Indonesia's Regulation (PP) Number 7 Year 1999. In the Project location, the Tapir was found around Wellpad B and Wellpad I. Camera traps have captured the existence of this species in the Northern part of Wellpad I.

4.2.7 Herpetofauna

4.2.7.1 Habitat

Herpetofauna have diverse habitat types ranging from agricultural to forested areas, but are typically located near water bodies such as rivers, lakes, or ponds in the forest floor.

River close Wellpad I

Cawang Tengah River

Figure 4-10 Water Body on Study Area

Characteristics of streams in the study area are rocky with shallow depths and clear water. Puyang Lake is a natural lake located in north Wellpad C with a distance of 2 km range.

4.2.7.2 Species Composition

Table 4-6 lists herpetofauna species found during the study. Surevy was recorded 14 of amphibian and 9 reptiles. Two species of frog were discovered on the forest floor, namely the Malayan Horned Frog and Hose's Frog. The rest, the species is collected on body water area. Two reptiles species with Vunerable conservation status are *Python reticulatus* and *Ophiophagus hannah*. The survey did not found endemic species and species protected under Indonesian regulations.

The Korinchi Frog is an endemic frog species found during the survey. This species is known only from a few localities (Barisan, Kerinci, Batang, Tarusan and Solok) in west Sumatra, Indonesia. The type locality is approximately around 1,200m ASL. It lives in montane forest, and the type specimen has unpigmented eggs, suggesting that the eggs are hidden in streams. The specimens collected recently in Solok were found along the banks of streams in forested habitat (www.iucnredlist.org, accessed 2016).

Table 4-6 List of herpetofauna in the study and project area by Transect and Observation Methods

No	Name		Status Conservation		
	English	Scientific name	GOI	IUCN	CITES
A	**Amphibian**				
1	Banded krait	*Bungarus fasciatus*	-	LC	-
2	Green Tree Frog	*Odorrana hosii*	-	LC	-
3	Malayan Horned Frog	*Megophrys nasuta*	-	LC	-
4		*Hylarana sp*	-	-	-
5	Asian Brackish Frog	*Rana cancrivora*	-	LC	-

No	Name		Status Conservation		
	English	Scientific name	GOI	IUCN	CITES
6	Asian Common Toad	*Bufo melanostictus*	-	LC	-
7	Gray Treefrog	*Hyla versicolor*	-	LC	-
8	Nicobar Island Frog	*Hylarana nicobariensis*	-	LC	-
9	Asian Brackish Frog	*Fejervarya cancrivora*	-	LC	-
10	Southern Big-headed Frog	*Limnonectes laticeps*	-	LC	-
11		*Rhacophorus pardalis*	-	LC	-
12	Hose's Frog	*Odorrana hosii*	-		-
13		*Philautus aurifasciatus*	-	LC	-
14	Malayan Horned Frog	*Megophrys nasuta*	-	LC	-
B	**Reptilia**				
1	Common Water Monitor	*Varanus salvator*	-	LC	II
2	Equatorial Spitting Cobra	*Naja sumatrana*	-	LC	II
3	Green Crested Lizard	*Broncochela cristatela*	-	LC	-
4	The reticulated python	*Python reticulatus*	-	VU	II
5	King Cobra	*Ophiophagus hannah*	-	VU	II
6	East Indian Brown Mabuya	*Mabouya multifasciata*	-	LC	II
7		*Acrochordus sp.*	-	-	-
8	Red-sided Keelback Water Snake	*xenochrophis trianguligerus*	-	LC	-
9	The white-lipped pit viper	*Trimeresurus albolabris*	-	LC	-

Note: IUCN: DD = Data Deficient; LC = Least Concerned, VU = Vulnerable; GOI = Indonesia law under PP 7/1999, P = Protected; CITES = Convention on International Trade in Endangered Species of Wildlife Forea Fauna, II = Appendix II

4.2.8 Fish

Aquatic biota sampling (nekton) was carried out at Cawang Tengah (shortcut) and near wellpad C. In Cawang Tengah, river condition dominates by rocky with depth 0.2 – 1.5 meter (**Figure 4-11, a**) and in river near Wellpad C dominate by sand (**Figure 4-11, b**).

(a) (b)

Source: primary data, 2016.

Figure 4-11 River Condition (a) Cawang Tengah and (b) Near Wellpad C

Result from the observation, the study only found the presence of fish in Cawang Tengah River. By using throw nets data collection method, study only found a species, namely Mahseer Fish (*Tor tambroides* Bleker 1854) or Cengkak/Semah (local name).

(a) (b)

Source: primary data, 2016.

Figure 4-12 Mahseer or Kings of the rivers (*Tor tambroides* Bleker 1854)

Range distribution Mahseer fish is Cina and South East Region Such as Thailand, Vietnam, Brunai, Malaysia and Indonesia. In Indonesia, distribution of this species occurs in Java, Borneo, and Sumatra. In Sumatra, Mahseer have large distribution in Lampung - Bengkulu (Wibowo et al., 2012), Pagaralam, Lahat, Empat Lawang and Muaraenim. Characteristic of this species inhabits river upstream with clear water conditions and high oxygen content. The species lives in large streams and rivers with moderate to swift flow.

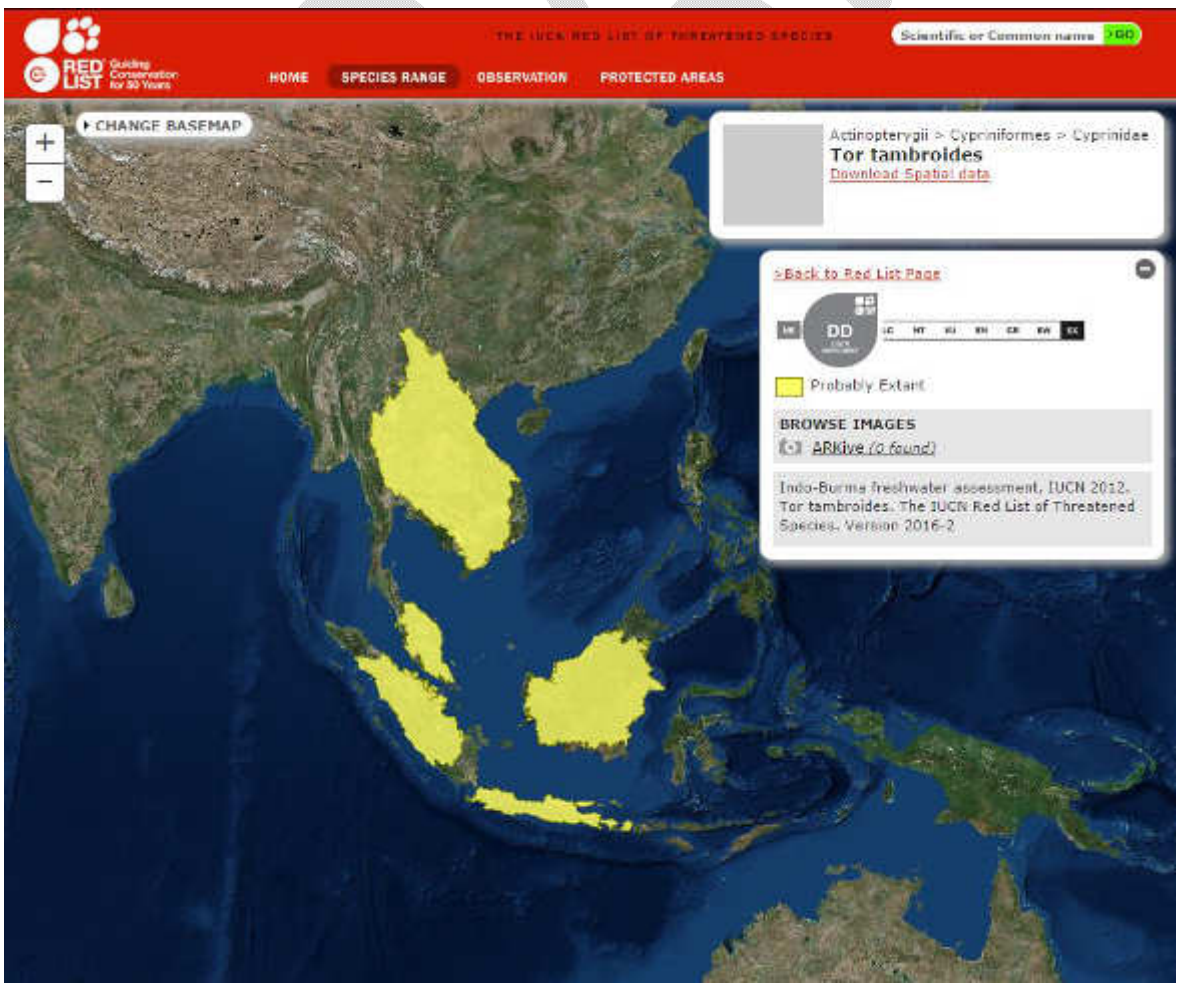


Figure 4-13 Range Distribution of Masheer Fish

Based on Indonesia Regulation for Endangered Species, Mahseer fish is not included as protected species. While refers to IUCN Red list category, this species has conservation status is Data Deficient (DD).

5 CRITICAL HABITAT ASSESSMENT

5.1 Background Information

Desktop reviews and this biodiversity study shows that some of the findings trigger critical habitat in accordance with GN55, IFC PS6, 2012. Critical habitat is a description of the most significant and highest priority areas of the planet for biodiversity conservation. It takes into account both global and national priority-setting systems and builds on the conservation biology principles of 'vulnerability' (degree of threat) and 'irreplaceability' (rarity or uniqueness) (Mott MacDonald, 2013). Critical habitat assessment is analysis of the significant area for biodiversity and conservation.

Critical habitat criteria are as follows and should form the basis of any critical habitat assessment:

- Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species at global and/or national level
- Criterion 2: Endemic and/or restricted-range species
- Criterion 3: Migratory and/or congregator species
- Criterion 4: Highly threatened and/or unique ecosystems
- Criterion 5: Key evolutionary processes

The determination of critical habitat however is not necessarily limited to these criteria. Other recognized high biodiversity values might also support a critical habitat designation, and the appropriateness of this decision would be evaluated on a case-by-case basis. Examples are as follows:

- Criterion 6: Legally Protected Areas in IUCN Categories I-II; and
- Criterion 7: Internationally Recognized Areas.

GN58-GN62 of IFCPS6 describes of gradient critical habitat. There are gradients of critical habitat or a continuum of degrees of biodiversity value associated with critical habitats based on the relative vulnerability (degree of threat) and irreplaceability (rarity or uniqueness) of the site.

5.2 Assessment of Critical Habitat

A Discrete Management Unit (DMU) is defined in paragraph GN65 of GN 6 (IFC; 2012) as “an area with a definable boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas”. The concept is central to the evaluation of critical habitat for Criteria 1 to 2, as the DMU is the geographical area within which a species population is assessed for significance against the thresholds and criteria used to determine if critical habitat is present.

Table 5-1 Critical Habitat Criteria

Criterion	Tier 1	Tier 2
Critically Endangered (CR)/ Endangered (EN) Species	(a) Habitat required sustaining ≥ 10 percent of the global population of a CR or EN species/subspecies where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species. (b) Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.	(c) Habitat that supports the regular occurrence of a single individual of a CR species and/or habitat containing regionally important concentrations of a Red-Listed EN species where that habitat could be considered a discrete management unit for that species/ subspecies. (d) Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species. (e) As appropriate, habitat containing nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing.
Endemic/ Restricted Range Species	(a) Habitat known to sustain ≥ 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species (e.g., a single-site endemic).	(b) Habitat known to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment.
Migratory/ Congregatory Species	(a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle where that habitat could be considered a discrete management unit for that species.	(b) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent but < 95 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment. (c) For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance. (d) For species with large but clumped distributions, a provisional threshold is set at ≥5 percent of the global population for both terrestrial and marine species. (e) Source sites that contribute ≥ 1 percent of the global population of recruits.

To determine whether the project is located in a critical habitat, a comprehensive literature review and consultation with stakeholders and biodiversity specialists has been undertaken. In addition, biodiversity surveys were undertaken as part of the ESIA and BAP for PT SERD Geothermal Project. The following potential critical habitat features are known or likely to be present in the DMU:

- Criterion 1: Critically Endangered (CR) and/or Endangered (EN) species at global and/or national level
- Criterion 2: Endemic and/or restricted-range species
- Criterion 4: Highly threatened and/or unique ecosystems
- Criterion 6: Legally Protected Areas in IUCN Categories I-II
- Criterion 7: Internationally Recognized Areas

DMU boundary is determined based on the landscape from legally protected areas and the Tiger Conservation Landscape. The project location in the landscape of Bukit Jambul Gunung Patah-Bepagut-Muara Duakisim protected forest is included in the protected area with IUCN categories V-VI. Total area of DMU is 218,600 hectares and shown in **Figure 5-1**.

A. Critically Endangered (CR) and/or Endangered (EN) species at global and/or national level; Endemic and/or restricted-range species; and Migratory and/or congregatory species

Critical Habitat Assessment for criterion 1, 2 and 3 is present on **Table 5-2**.

B. Highly threatened and/or unique ecosystems

DMU is part of the Bukit Barisan landscape. DMU is part of the Bukit Barisan Landscape which extends from Lampung province until Aceh. The mountain forest ecosystem is the ecosystem type that dominates in this landscape. Literature studies do not mention the existence of unique ecosystems in the DMU area.

Unique ecosystems cannot be found on PT project location. Therefore, criterion 4 is not applicable to the project site.

C. Legally Protected and Internationally Recognized Areas

The DMU and project area are shown to overlap with Indonesia Protection Forest (*Hutan Lindung*), protected area IUCN Category V-VI, TCL, and EBA. In addition, the primary forest located within the DMU is connected to BBSNP which is located about 15.7 km from the DMU and 27.3 km from the project area. Project area is located on Bukit Jambul Gunung Patah-Bepagut-Muara Duakisim protected forest included in protected area with IUCN categories V-VI.

The DMU is located on TCL class II. TCL is defined as an area where there is sufficient habitat for at least five tigers and tigers have been confirmed to occur in the last ten years. The TCL document classifies tiger landscapes into four classes based on their ecological and social potential for tiger conservation, and four priorities based on the desire to represent the best examples of tiger landscapes across habitat types and bioregions within a conservation portfolio (Table 2, Figure 6). Detailed information about the classification can be read in Dinnerstein et al (2006) and Sanderson et al. 2006).

It is however considered that the requirements in Paragraph 20 of the IFC PS6 (IFC, 2012a) is applicable to the PT SERD Geothermal Project and the critical habitat is triggered by internationally recognized and nationally protected areas. This is because Project is within Protection Forest and TCL class II.

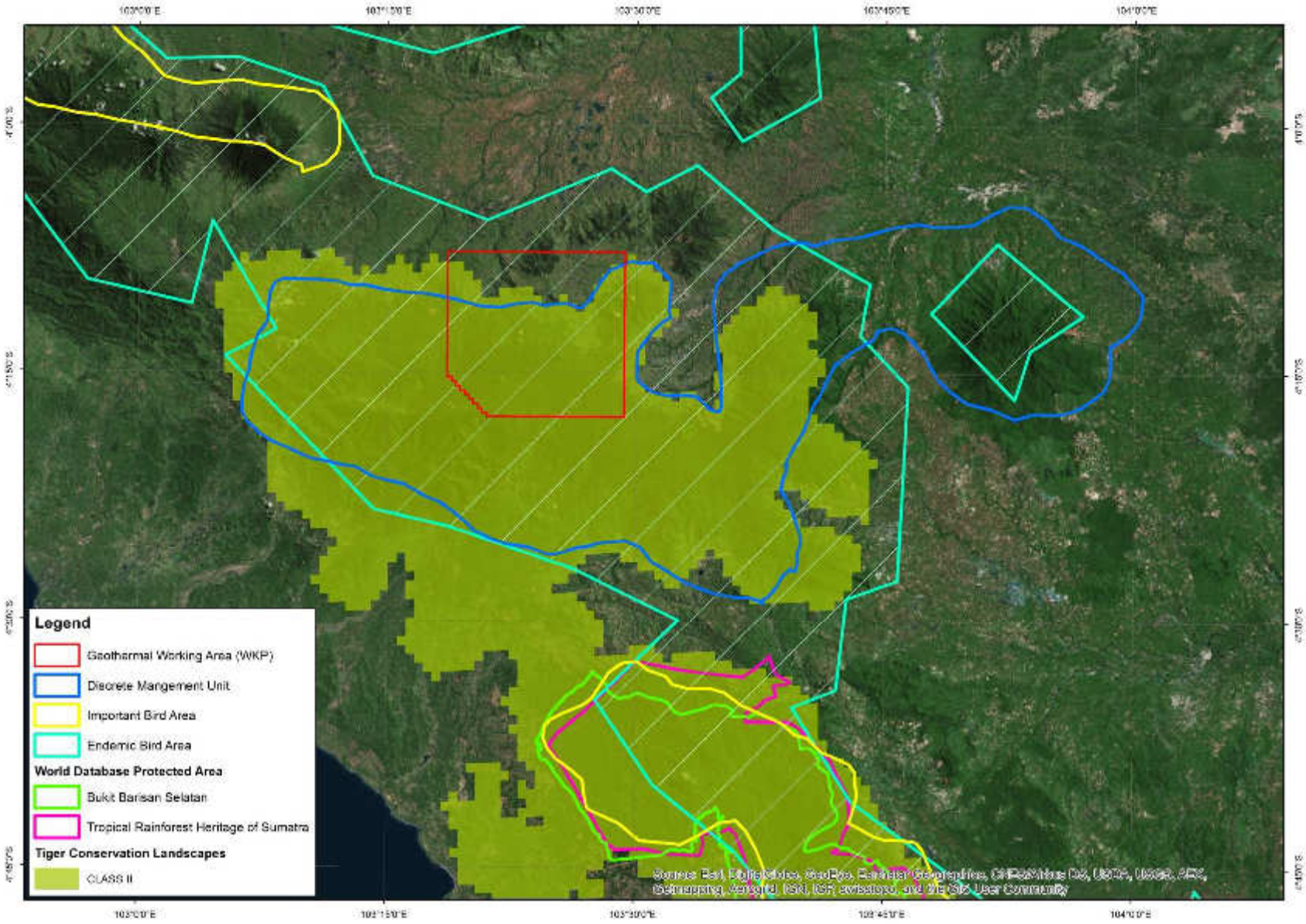


Figure 5-1 Project area and discrete management unit (DMU)

Table 5-2 Critical Habitat Assessment for Criteria 1, Criterion 2 and Criterion 3

No	Species	Distribution and Conservation Status	Description and Rationale	Criteria			Tier	
				1	2	3	1	2
Birds								
2	Sumatran ground-cuckoo (*Carpococcyx viridis*)	• IUCN Critically Endangered • Endemic of Sumatra island	**Relevance to study area:** Not recorded in project or study area. Detected in the DMU based on literature review. **Ecology:** Information noted on specimen labels reveals that it inhabits foothill and lower montane forest, with records from 300-1,400 m. **Population:** The population is estimated to number 50-249 mature individuals based on an assessment of known records, descriptions of abundance and range size. **Distribution:** This species is endemic to the island of Sumatra, Indonesia, where it is only known from eight specimens and a recent series of sightings, the majority of which have come from the Barisan Mountains in the southern half of the island (BirdLife International 2001). Survey did not record the existence on project area. Based on Literature review, DMU may suitable for regional important habitat concentration of protected species. Therefore, this species does meet the Tier 2 threshold for critical habitat and Endemic species in DMU.	√	√			√
3	Oriental pied bird (*Anthracoceros albirostris convexus*)	Indonesia protected species	**Relevance to study area:** Recorded in the area near wellpads L, M, N, and X oin August 2016. Species included in Bucerotidae family. Bucerotidae is a family of birds that are protected under Indonesian law. No information population of this species both nationally and globally, but has a very wide distribution. *Anthracoceros albirostris* is a widespread resident in northern South Asia, southern China, Indochina and western Indonesia. It is considered that the habitat characteristics and wide range distribution, the DMU area does not support nationally or globally important concentrations of this protected. Therefore, this species does not meet Tier 1 and Tier 2 threshold for critical habitat in the DMU.	√				√
4	Sumatran Cochoa (*Cochoa beccarii*)	Endemic of Sumatra island	**Relevance to study area:** Not recorded in project or study area. Detected in the DMU based on literature review. *Cochoa beccarii* is endemic to the island of Sumatra, Indonesia, where it is known from just four specimens and a few sight records (from five sites) along the Barisan Mts. However, observer coverage in likely areas across the remainder of the range has been extremely low. Little is known about its population status, but it appears to occur at low densities, in common with its congeners, and was considered very rare by collectors in the early 20th century. It is very unobtrusive, but is recorded regularly in suitable habitat once calls are known (N. Brickle in litt. 2007). It may be declining owing to loss of habitat in the lower portion of its altitudinal range, although the majority of populations should be relatively secure. Based on the EOO, DMU is suitable as regionally important habitat concentration for endemic species for Sumatra. Habitats in the DMU may support between 1 and 95% of the global population. Therefore, this species meets the Tier 2 threshold for critical habitat in the DMU.		√			√
6	Sumatran Laughingthrush (*Garrulax bicolor*)	Endemic of Sumatra island	**Relevance to study area:** Not recorded in project or study area. Detected in the DMU based on literature review. **Ecology:** This species is known from montane forest (with unsubstantiated reports of a lowland population in Berbak Game Reserve, Jambi). It lives in flocks in the middle and lower storeys of forest sometimes coming to the ground. **Population:** *Garrulax bicolor* was originally distributed along the length of the montane spine of Sumatra, Indonesia, from Aceh in the north to Lampung in the south (van Marle and Voous 1988), and was reportedly common. Recent evidence suggests that it has undergone a considerable decline. It is known to be present at a small number of sites scattered across Sumatra, including Bukit Barisan Selantan National Park, Danau Ranau (South Sumatra) (R. Thomas per C. R. Shepherd in litt. 2012), Batang Toru (North Sumatra) and Ulu Masen (Aceh) (N. Brickle in litt. 2007), and a single locality in Kerinci Seblat National Park (S. Högberg in litt. 2006), although recent surveys there have failed to find it (N. Brickle in litt. 2007). A small group of three birds was camera trapped in Batang Toru (G. Fredriksson per C. R. Shepherd in litt. 2012). It is frequently seen in local wild bird markets (e.g. in Jambi and Medan in 2007 [Shepherd 2007, N. Brickle in litt. 2007]), along with imported specimens of its sister species, the White-crested Laughingthrush G. leucolophus (Shepherd 2006, 2007). It is also frequently seen in the larger bird markets in Jakarta, Java (Shepherd 2007). Local traders and hunters report that it has become rarer (Shepherd 2007, 2011, N. Brickle in litt. 2007). Based on EOO and wide spread distribution, the DMU habitat is support less than 1% than global population. Therefore, this species does not meet the Tier 2 threshold for critical habitat in the DMU.		√			
7	Sumatran Babbler (*Trichastoma buettikoferi*)	Endemic of Sumatra island	**Relevance to study area:** Not recorded in project or study area. Detected in the DMU based on literature review. **Ecology:** It inhabits the undergrowth in primary forest, forest edge and degraded woodland, although will sometimes forage up vine-covered trees to the canopy, hunting insects (MacKinnon and Phillipps 1993, Verbelen 2009). **Population:** *Trichastoma buettikoferi* is endemic to Sumatra, Indonesia, where it has been described as an uncommon (van Marle and Voous 1988) and local resident throughout the mainland in lowlands and hills. This species occurs up to 800 m in the Gayo Highlands and 900 m in the Padang Highlands (van Marle and Voous 1988, MacKinnon and Phillipps 1993). Based on EOO, wide spread distribution and habitat diverse, the DMU habitat is support less than 1% than global population. Therefore, this species does not meet the Tier 2 threshold for critical habitat in the DMU.		√			
8	Shiny Whistling-thrush (*Myophonus melanurus*)	Endemic of Sumatra island	**Relevance to study area:** Recorded in the area near wellpads L, M, N, and X in August 2016. **Population:** There is no record that a lot about this species. This species is very common in the forest during the study, either directly or from the camera trap. The global		√			√

No	Species	Distribution and Conservation Status	Description and Rationale	Criteria			Tier	
				1	2	3	1	2
			population size has not been quantified, but the species is described as common (del Hoyo et al. 2005). Based on the EOO, This species is spread in the Bukit Barisan Mountains, from Lampung until Aceh. Based on EOO and distribution, the DMU habitat is support more than 1% than global population. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.					
9	Bronze-tailed Peacock-pheasant (*Polyplectron chalcurum*)	Endemic of Sumatra island	**Relevance to study area:** The survey noted the presence of this species is quite often on camera traps and widespread in the study area. Species is also detected in the DMU through literature review. **Population:** The global population size has not been quantified, but the species is reported to be fairly common in places (del Hoyo et al. 1994). EOO Data estimates this species is spreads in the Bukit Barisan mountain area ranging from Lampung until Aceh. Based on EOO and wide spread distribution, the DMU habitat is support more than 1% than global population. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.		√			√
10	Sumatran Trogon (*Apalharpactes mackloti*)	Endemic of Sumatra island	**Relevance to study area:** This species is found opportunistically in the study area. Species is detected in the DMU based on literature review. **Population:** The lack scientific publications and research of these species becomes obstacle to obtaining more detailed information. The global population size has not been quantified, but the species is described as uncommon (del Hoyo et al. 1999). Based on EOO, DMU area is estimated as species habitat. Based on EOO and spread distribution, the DMU habitat is support more than 1% than global population. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.		√			√
13	Crested Serpent Eagle *(Spilornis cheela)*	Indonesia Protected	**Relevance to study area:** Not recorded in project or study area. Detected in the DMU based on literature review. **Distribution:** This species has a very broad distribution. In Indonesia, this species was recorded throughout the island of Sumatra, Borneo and Java. Based on expert adjustment, It is considered that the habitats in the DMU do not support nationally important concentrations of this protected species. Therefore, this species does not meet the Tier 2 threshold for critical habitat in the DMU.	√				
14	Black Eagle *(Ictinaetus malayensis)*	Indonesia Protected	**Relevance to study area:** This species was frequently recorded during the biodiversity study. **Distribution:** This species has a very broad distribution. Nationally, this species can be found in almost all areas of Indonesia. It is considered that the habitats in the DMU do not support nationally important concentrations of this protected species. Therefore, this species does not meet the Tier 2 threshold for critical habitat in the DMU.	√				
15	Crested Honey Buzzard *(Pernis ptilorhynchus)*	• Indonesia Protected Migratory bird	Birds in the northern part of its range are migratory, arriving at breeding grounds in April and May and leaving again between August and October. Further south the species is sedentary (del Hoyo et al. 1994). It migrates by flapping as well as soaring, enabling it to cross expanses of water. Small groups generally form on migration, but otherwise the species is generally seen singly or in pairs (Ferguson-Lees and Christie 2001). It inhabits woodland of various climatic types, preferring broad-leaved forests; it is recorded up to 1,800 m (del Hoyo et al. 1994). Diet Bees and wasps (usually larvae) form the main part of its diet (del Hoyo et al. 1994). Breeding site The nest is built in the fork of a tree (del Hoyo *et al*. 1994). The species requires forest, although not necessarily old growth: it has been recorded to move back into irrigated forest plantations in Pakistan (del Hoyo *et al*. 1994). In Indonesia, there are no records for the habitat distribution or populations of these species. This species can be found on Sumatra, Java, and Kalimantan. In this study, this species was recorded in agriculture and forest areas. Based on expert judgment, DMU may sustain on a cyclical basis more than 1% and less than 95% of the global population, so this part of the DMU is likely to meet the critical habitat criteria for Tier 2.	√		√		√
16	Red-billed Partridge (*Arborophila rubrirostris*)	• Endemic to Sumatra Island	From the DMU landscape, **Table 4-6** is show the area of DMU approximately 1% of EOO area. The global population size has not been quantified, but the species is reported to be fairly common in places (del Hoyo et al. 1994). Based on expert judgement, this species is likely to meet the threshold under Tier 2 sub-criteria for restricted-range species (criterion 2), which means the habitats in the DMU may support between 1 and 95% of the global population.		√			√
	Mammals							
1	Sumatran Tiger (*Panthera tigris* ssp. *sumatrae*)	• IUCN Critical Endangered • Indonesia Protected	**Relevance to study area:** Footprints were recorded near wellpads B and D between October 2014 and January 2015, and ; faeces were recorded near wellpads L, M, N, and X in August 2016. **Ecology:** Tiger populations are mostly associated with prey availability, yet generally inhabit forested areas. **Population:** The tiger population was estimated at 400-500 in the first and second national tiger action plans (Govt of Indonesia 1994, 2007a), and at 342-509 in six major protected areas (estimates from Shepherd and Magnus 2004). However, incorporating more recent research, covering most of tiger estimated habitat (Sanderson et al. 2006) suggests the population could be higher. **Distribution:** The Sumatran Tiger occurs in about 58,321 km² of forested habitat in 12 potentially isolated Tiger Conservation Landscapes totaling 88,351 km² (Sanderson et al. 2006), with about 37,000 km² protected in ten national parks (Govt of Indonesia 2007).	√	√			√

No	Species	Distribution and Conservation Status	Description and Rationale	Criteria			Tier	
				1	2	3	1	2
			DMU is TCL class II, that's mean landscape that has sufficient habitat for 50 tigers, moderate levels of threat that can be mitigated in the next 10 years, and a basis for conservation that needs to be improved. The DMU habitat support more than 1% than global population but less than 95%. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.					
2	Sunda Pangolin (*Manis javanica*)	• IUCN Critical Endangered • Indonesia Protected	**Relevance to study area:** Recorded near wellpad D through camera trap between October 2014 and January 2015. **Ecology:** This species is found in primary and secondary forest, including lowland dipterocarp forest, and cultivated areas including gardens and oil palm and rubber plantations, including near human settlements (Azhar *et al.* 2013, Nowak 1999). **Population:** There is virtually no information available on population levels of any species of Asian pangolin and no comprehensive population estimates. This species is rarely observed, principally because of its increasing rarity, but also because it is secretive, elusive and primarily nocturnal. There is a paucity of research on population densities at local, national and global scales (WCMC et al. 1999, CITES 2000). **Distribution:** The species is widely distributed geographically, occurring across mainland and island Southeast East Asia, from southern China and Myanmar through lowland Lao PDR, much of Thailand, central and southern Viet Nam, Cambodia, to Peninsular Malaysia, to Sumatra, Java and adjacent islands (Indonesia) and to Borneo (Malaysia, Indonesia, Brunei) though the northern and western limits of its range are poorly known (Schlitter 2005, Wu *et al.* 2005). It has been recorded from sea level up to 1,700 m asl. The DMU habitat is support the regular occurrence of a single individual of a CR species. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.	√				√
3	Dhole (*Cuon alpinus*)	• IUCN Endangered • Indonesia Protected	**Relevance to study area:** Recorded near wellpads B and D through camera trap between October 2014 and January 2015. **Ecology:** The Dhole 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.). **Population:** The number of population is not known both at national level and at the project site. **Distribution:** Historically, Dholes occurred throughout both Sumatra and Java; however, their current distribution on both islands is fragmented and greatly reduced. On Sumatra, Dholes have recently been confirmed in several national parks along the Barisan Mountain range, ranging from the northern to southern parts of the island (e.g., Gunung Leuser, Kerinci Seblat and Bukit Barisan Selatan National Parks; FFI, WCS and WWF country programs unpubl. data). Home range of the species is wide and focused area is relatively small part of the landscape. Based on the distribution, The DMU is containing regionally important concentrations of national. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.	√				√
4	Sumatran Surili (*Presbytis melalophos*)	• IUCN Endangered • Indonesia Protected	**Relevance to study area:** Recorded near wellpad B and Lake Puyang through direct and vocal observation between October 2014 and January 2015. **Ecology:** Generally, these groups found in secondary forest and modified habitat. **Population:** This species is relatively common (Aimi and Bakar 1992) in its remaining and appropriate habitat, but its occurrence is very patchy and fragmented. **Distribution:** This species is endemic to Sumatra (Indonesia), where it is found south of the Wampu and Simpang Kiri Rivers (except for the eastern coastal forests), and on Pulau Pini in the Batu Archipelago (Groves 2001). Based on the distribution, The DMU is containing regionally important concentrations of national and DMU habitat is support no more than 1% than global population. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.	√				√
5	Siamang (*Symphalangus syndactylus)*	• IUCN Endangered • Indonesia Protected	**Relevance to study area:** Recorded near wellpad B and Lake Puyang through direct and vocal observation between October 2014 and January 2015. **Ecology:** This species lives in primary and secondary semi-deciduous and tropical evergreen forest. All levels of the canopy are used, although emergent trees are required for resting and sleeping. Siamangs occur at lower densities in secondary forest, but can persist in secondary areas. **Population:** In a study on this species in BBSNP, O'Brien et al. (2004) calculated an average group density of one group for every 2.23 km^2, with an average group size of 3.9, and a population estimate of 22,390 individuals. Based on **Distribution:** This species is found in Indonesia (Barisan Mountains of west-central Sumatra), Malaysia (mountains of the Malay Peninsula south of the Perak River), and a small area of southern peninsular Thailand (Chivers 1974; Khan, 1970; O'Brien *et al.* 2003; Treesucon and Tantithadapitak 1997). Based on the distribution, The DMU is containing regionally important concentrations of national and DMU habitat is support no more than 1% than global population. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.	√				√
6	Malayan sunbear (*Helarctos malayanus*)	• Indonesia protected species	**Relevance to study area:** Recorded near wellpads B, E, I, C, and D through camera trap and footprint between October 2014 and January 2015. **Ecology:** Sun bears rely on tropical forest habitat.	√				

No	Species	Distribution and Conservation Status	Description and Rationale	Criteria			Tier	
				1	2	3	1	2
			Population: Reliable estimates of sun bear populations are lacking. **Distribution:** Sun bears occur in mainland Southeast Asia as far west as Bangladesh and northeastern India (Chauhan 2006). The distribution is getting smaller and scientific records that indicate loss of habitat locally. DMU is significant importance to species that are wide-ranging. Therefore, this species does not meet Tier 1 and Tier 2 threshold for critical habitat in the DMU.					
7	Malayan tapir (*Tapirus indicus*)	• IUCN Endangered • Indonesia protected species	**Relevance to study area:** Recorded near wellpads B, E, I, C, and Lake Puyang through camera trap and footprint between October 2014 and January 2015. **Ecology:** *T. indicus* is restricted to tropical moist forest areas and occurs in both primary and secondary forest and wetland areas. **Population:** To date, there are no reliable population estimates for Sumatra, yet a decline is concluded to be definite. **Distribution:** *Tapirus indicus* occurs in southern and central parts of Sumatra (Indonesia), and on the Asian mainland in Peninsular Malaysia, Thailand (along the western border and on the Peninsula south to the Malaysian border, and in Huai Kha Khaeng Wildlife Sanctuary in the north), and Myanmar (south of latitude 18°N). Based on the distribution and EOO data, The DMU is containing regionally important concentrations of national. Therefore, this species does meet the Tier 1 threshold for critical habitat in the DMU.	√				√
8	Sambar deer (*Cervus unicolor*)	Indonesia protected species	**Relevance to study area:** Footprints recorded near wellpad I between October 2014 and January 2015 and near wellpads L, M, N, and X on August 2016. **Ecology:** Sambar deers were found in a wide range of natural habitats, yet exhibit low resilience toward human settlements. **Population:** Sambar was nearly six times as abundant in areas of BBSNP with low than with high human population density within 10 km of the park boundary, suggesting low resilience to human presence, presumably the effects of hunting, and reduced populations overall (O'Brien *et al.* 2003 in IUCN 2016). Sambar deer occurrences were also found to be connected to Sumatran tigers. There exists no accurate population estimate of tapirs in Sumatra, but it is anticipated to be below 400-500 adult individuals. **Distribution:** The Sambar deer occurs from the Indian subcontinent, to south China and Taiwan, then extending to the Sundaic Southeast Asia. It is considered that the habitat characteristics and wide range distribution, the DMU area does not support nationally or globally important concentrations of this protected. Therefore, this species does not meet Tier 1 and Tier 2 threshold for critical habitat in the DMU.	√				
9	Banded linsang (*Prionodon linsang*)	Indonesia protected species	**Relevance to study area:** Recorded near the plantation through camera trap. **Ecology:** Banded linsangs were recorded in primary and secondary forest and in human-inhabited areas. **Population:** The population status of Banded Linsang is poorly known. **Distribution:** Banded Linsang occurs in Sundaic South-east Asia. It is considered that the habitat characteristics and wide range distribution, the DMU area does not support nationally or globally important concentrations of this protected. Therefore, this species does not meet Tier 1 and Tier 2 threshold for critical habitat in the DMU.	√				
10	Malayan porcupine (*Hystrix brachyura*)	Indonesia protected species	**Relevance to study area:** Recorded near the plantation through camera trap. **Ecology:** It can be found in various forest habitats, and in scrubby, open areas close to forest. **Population:** It is common in suitable habitat. **Distribution:** Species range from the Indian subcontinent to central and southern China and Southeast Asia. It can be found from sea level to at least 1,300 m asl. It is considered that the habitat characteristics and wide range distribution, the DMU area does not support nationally or globally important concentrations of this protected. Therefore, this species does not meet Tier 1 and Tier 2 threshold for critical habitat in the DMU.	√				
11	Sumatran serow (*Capricornis sumatraensis*)	• IUCN Endangered • Indonesia protected species	**Relevance to study area:** Recorded near the plantation through footprint. **Ecology:** It inhabits steep mountain slopes between 200 and 3,000 m (van der Zon, 1979), covered by both primary and secondary forests. **Population:** No population estimates have been made in Indonesia. Although vulnerable to poaching and habitat destruction, serow appears to thrive well in some of the better protected areas such as Gunung Leuser National Park. **Distribution:** This species is found in Indonesia (Sumatra), Malaysia (Peninsular Malaya), Thailand (south of about 9°S latitude) (Grubb, 2005). In Indonesia (Sumatra), limited almost entirely to the volcanic mountain chain of the Barisan mountains which runs along the western spine of Sumatra from Aceh in the north to Lampung in the south. Based on the habitat characteristics, The DMU contains regionally important concentrations of national. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.	√				√
12	Agile gibbon (*Hylobates agilis*)	• IUCN Endangered • Indonesia protected species	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** This species occurs at highest densities in dipterocarp-dominated forests, but their known habitat ranges from swamp and lowland forests to hill, submontane, and montane forests (O'Brien *et al.* 2004). Additionally, populations in Bukit Barisan Selatan National Park in Sumatra do not seem to avoid forest edges near human	√				√

No	Species	Distribution and Conservation Status	Description and Rationale	Criteria			Tier	
				1	2	3	1	2
			habitations (O'Brien *et al*. 2004). **Population:** O'Brien *et al*. (2004) performed a population assessment in 2002 on agile gibbons in Bukit Barisan Selatan National Park, Sumatra, Indonesia. Using calling counts in both forest edge and interior habitats, and basing their estimate on forest cover area in the park, they calculated a population of 4,479 agile gibbons (CV = 30%) (O'Brien *et al*.2004). **Distribution:** This species is found in Sumatra (Indonesia) (southeast of Lake Toba and the Singkil River), Peninsular Malaysia (from the Mudah and Thepha Rivers in the north to the Perak and Kelanton Rivers in the south) and south Thailand (near the Malaysian border, east of the Thepha River watershed (Gittins 1978; Groves 2001; Marshall and Sugardjito 1986; W. Brockelman pers. comm.). Based on the distribution, The DMU is containing regionally important concentrations of national and DMU habitat is support no more than 1% than global population. Therefore, this species does meet the Tier 2 threshold for critical habitat in the DMU.					
13	Broad-nosed Sumatran Maxomys (*Maxomys inflatus*)	Endemic of Sumatra island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** It is a terrestrial species inhabiting tropical evergreen forest, at low to middle montane regions. **Population:** This species is common at the time of collection (Robinson and Kloss 1916), and perhaps even locally abundant. **Distribution:** This species is known only from the mountains of western Sumatra (Musser and Carleton 2005). The EOO is just about 77,000 km^2. Their habitat is generally not fragmented. This species fulfills the criterion of Tier 2 as the DMU represents approximately 3% of the species EOO.		√			√
14	Sumatran Mountain Muntjac (*Muntiacus montanus*)	Endemic of Sumatra island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** The species is presumably montane, which is reported to occur at between 1,430 and 2,225 m asl. They are also terrestrial. **Population:** In general there is not much known about the mountain muntjac except that their known EOO comprises approximately 30,000 km^2. **Distribution:** They are known to occupy the west part of Sumatra and has not been reported outside this area. Known localities include Sungai Kering (Kerinci Seblat National Park) and Sungai Kambang (Pesisir Selatan district of West Sumatra province). This species fulfills the criterion of Tier 2 as the DMU represents approximately 7% of the species EOO.		√			√
15	Sumatran Striped Rabbit (*Nesolagus netscheri*)	• Indonesian protected species • Endemic of Sumatra Island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** Most records of *Nesolagus netscheri* are from land being cleared for coffee or tea plantations, rabbits were noticed as the forest was cleared at elevations between 600 m and 1,600 m (Flux 1990). The preferred habitat of *N. netscheri* is montane forest with volcanic soil (Flux 1990). This species has low tolerance to human disturbance (Meijaard and Sugardjito 2005). **Population:** Population size and density are unknown for this species, though density is suspected to be naturally low (Flux 1990). It is a rarely seen species that has likely never been common in its range as there is little local knowledge of the species (Flux 1990). It is known from only seven locations (Flux 1990). **Distribution:** The species is endemic to the island of Sumatra, Indonesia (Hoffmann and Smith 2005). The majority of records are from west-central and southwest Sumatra, with one record from Gunung Leuser NP (Flux 1990). This species fulfills the criterion of both Tier 1 and Tier 2. The species itself reportedly only has seven localities globally (IUCN 2008), which by its own is already a criterion for Tier 1 based on IFC PS6. For Tier 2, the DMU represents approximately 15% of the species EOO.	√	√		√	√
	Reptiles							
1	Stripe-necked Reed Snake (*Calamaria margaritophora*)	Endemic of Sumatra island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** The species has been recorded living in leaf litter in lowland forest floor. It inhabits lowland dipterocarp forest. **Population:** Based on the representative specimens, the species is (or was) locally common in Bengkulu, but rare in the three other provinces of Sumatra. **Distribution:** The species is known from about a dozen specimens from four provinces in Sumatra: Ampat-Lavang, Kepahiang and Redjang in Bengkulu Province, Rimbo Pengdang and Solak Daras (West Sumatra). All the known records are from the 1940s. It lives up to 500-1,000 m. asl. This species fulfills the criterion of Tier 2 as the DMU represents approximately 1% of the species EOO.		√			√
2	Spatula-toothed Snake (*Iguanognathus werneri*)	Endemic of Sumatra island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** No habitat ecology data is known. **Population:** No population data is known. **Distribution:** The species has only been recorded in Sumatra, yet no exact locality is known. This species does not fulfill any Tier criteria. However, this species is deficient in data, thus more studies should be conducted.		√			
3	Sumatra Worm Snake	Endemic of Sumatra	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review.		√			

No	Species	Distribution and Conservation Status	Description and Rationale	Criteria			Tier	
				1	2	3	1	2
	(*Typhlops hypsobothrius*)	island	**Ecology:** No habitat ecology data is known. **Population:** No population data is known. **Distribution:** The species has only been recorded in Sumatra, yet no exact locality is known. This species does not fulfill any Tier criteria. However, this species is deficient in data, thus more studies should be conducted.					
	Amphibian							
1	*Rhacophorus bifasciatus*	Endemic of Sumatra island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** This species occurs in lowland and submontane forest, and presumably breeds in water, probably in streams. **Population:** It seems to be uncommon. **Distribution:** This species is known from Mount Kerinci, Barisan-Selatan, Bengkulu, Jambi and Aceh in Sumatra, Indonesia. It probably occurs more widely than current records suggest. This species fulfills the criterion of Tier 2 as the DMU represents approximately 27% of the species EOO.		√			√
	Flora							
1	*Rafflesia bengkuluensis*	Endemic of Sumatra island	**Relevance to study area:** Species not recorded during the study yet detected in the DMU through literature review. **Ecology:** Rafflesia bengkuluensis is one of several types of Rafflesia that live in the highland forests of Sumatra. LIPI was discovered in Bukit Jambul Gunung Patah Region. **Population:** It seems to be uncommon. **Distribution:** This species is endemic of Bengkulu region, indonesia. This species fulfills the criterion of Tier 1 as the DMU represents approximately more than 95% of the species EOO.		√		√	

5.3 Priority Biodiversity Features

Table 5-3 summarizes **Table 5-2** in order to explain the biodiversity features that meet the threshold for critical habitat in the DMU. The DMU qualifies as critical habitat based on the findings of the biodiversity study, literature review and expert justification.

Table 5-3 Biodiversity features which meet the threshold for critical habitat of DMU

Species	Status	CH Criteria
Birds		
Sumatran ground-cuckoo (*Carpococcyx viridis*)	• IUCN Critically Endangered • Endemic of Sumatra island	C1(1), C2(1)
Oriental pied bird (*Anthracoceros albirostris convexus*)	• Indonesia protected species	C1(2)
Sumatran Cochoa (*Cochoa beccarii*)	• Endemic of Sumatra island	C2(2)
Shiny Whistling-thrush (*Myophonus melanurus*)	• Endemic of Sumatra island	C2(2)
Bronze-tailed Peacock-pheasant (*Polyplectron chalcurum*)	• Endemic of Sumatra island	C2(2)
Sumatran Trogon (*Apalharpactes mackloti*)	• Endemic of Sumatra island	C2(2)
Crested Honey Buzzard *(Pernis ptilorhynchus)*	• Indonesia Protected • Migratory bird	C1(2), C2(3)
Red-billed Partridge (Arborophila rubrirostris)	• Endemic of Sumatra island	C2 (2)
Mammals		
Sumatran Tiger (*Panthera tigris* ssp. *sumatrae*)	• IUCN Critical Endangered • Indonesia Protected	C1(1), C2(1)
Sunda Pangolin (*Manis javanica*)	• IUCN Critical Endangered • Indonesia Protected	C1(2)
Dhole (*Cuon alpinus*)	• IUCN Endangered • Indonesia Protected	C1(2)
Sumatran Surili (*Presbytis melalophos*)	• IUCN Endangered • Indonesia Protected	C1(2)
Siamang (*Symphalangus syndactylus)*	• IUCN Endangered • Indonesia Protected	C1(2)
Malayan tapir (*Tapirus indicus*)	• IUCN Endangered • Indonesia protected species	C1 (2)
Sumatran serow (*Capricornis sumatraensis*)	• IUCN Endangered • Indonesia protected species	C1(2)
Agile gibbon (*Hylobates agilis*)	• IUCN Endangered • Indonesia protected species	C1(2)
Broad-nosed Sumatran Maxomys (*Maxomys inflatus*)	• Endemic of Sumatra island	C2 (2)
Sumatran Mountain Muntjac (*Muntiacus montanus*)	• Endemic of Sumatra island	C2 (2)
Sumatran Striped Rabbit (*Nesolagus netscheri*)	• Indonesian protected species • Endemic of Sumatra Island	C1 (2), C2 (1)
Reptiles		
Stripe-necked Reed Snake (*Calamaria margaritophora*)	• Endemic of Sumatra island	C2 (2)
Amphibians		
Rhacophorus bifasciatus	• Endemic of Sumatra island	C2 (2)

Species	Status	CH Criteria
Flora		
Rafflesia bengkuluensis	• Endemic of Sumatra island	C2 (1)

Notes: C1 = Criterion 1, C2 = Criterion 2, C3 = Criterion 3

5.4 Potential Biodiversity Features

The Biodiversity studies did not find all target species, but the results trends still address the potential species records in the DMU area. Therefore, **Table 5-2** can be changed dynamically if during the project period another key species that trigger critical habitat is discovered.

6 IMPACT ASSESSMENT AND MITIGATION

This chapter is a discussion of the potential impact of project activities on species and habitats. PT SERD Geothermal Project is located in critical habitat, but has a very small footprint area compared to the overall area of the DMU.

The location of a project within critical habitat does not mean that the project should not proceed. IFC PS6 2012 focusses on appropriate mitigation and offset actions, to ensure net gain to critical habitat in the country or region as a result of the presence of the project. Through application of the mitigation hierarchy and the implementation of the actions given in this BAP, it is considered likely that there will not be any measurable adverse residual impacts as a result of this project.

6.1 Critical Habitat Impact Assesment

To inform this assessment, the habitat areas to be affected by the Project have been calculated and the results are presented in **Table 6-2**. A habitat classification for the areas under the footprint of the Project has been prepared through interpretation of satellite imagery and ground-truthing and information from PT SERD.

The total area of the project footprint is 124 ha (including future WP-L, M, N and X) of which 115 ha overlaps with DMU of 218,600 ha. The project footprint is located in an edge area of the DMU and 106 ha of this DMU will be permanently used during the production stage, while the remaining 9 ha will be temporarily used.

Table 6-1 Habitat Loss based on PT SERD Geothermal Project

No	Habitat Type	Permanent Loss (Hectares)	Temporary Loss (Hectares)	Total (Hectares)	Percentage of DMU
1	Primary Forest	74	9	83	0.04
3	Secondary Forest	32	0	32	0.01
	Total	**106**	**9**	**115**	**0.05**

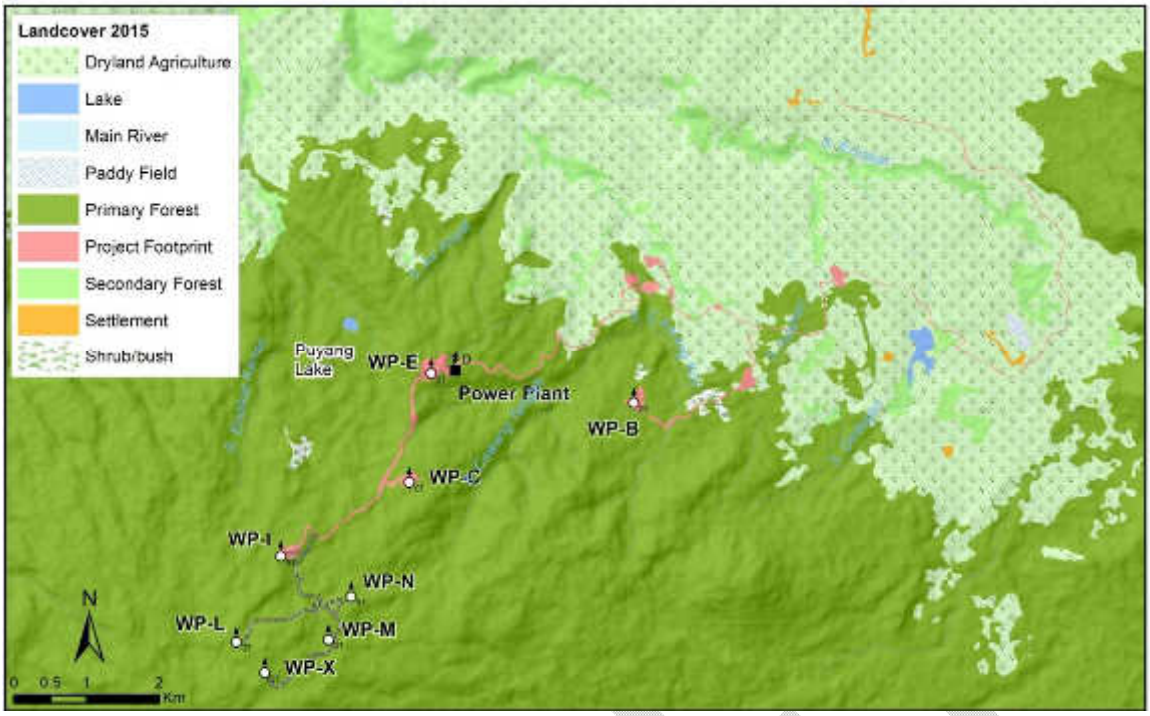


Figure 6-1 Habitat Map

6.2 Impact Evaluation - Species

Table 6-2 lists trigger species of critical habitats found within or surrounding the project location. The project location intersects core habitat though it is located on the edge of the area. Some of the species found, are sensitive species and generally use primary forests as their primary habitat.

Table 6-2 Biodiversity Features Which Meet the Threshold for Critical Habitat that Found Around Project Area

Species	Status	CH Criteria
Birds		
Sumatran ground-cuckoo (*Carpococcyx viridis*)	• IUCN Critically Endangered • Endemic of Sumatra island	C1 (1), C2 (1)
Oriental pied bird (*Anthracoceros albirostris convexus*)	• Indonesia protected species	C1(2)
Sumatran Cochoa (*Cochoa beccarii*)	• Endemic of Sumatra island	C2 (2)
Shiny Whistling-thrush (*Myophonus melanurus*)	• Endemic of Sumatra island	C2 (2)
Bronze-tailed Peacock-pheasant (*Polyplectron chalcurum*)	• Endemic of Sumatra island	C2 (2)
Sumatran Trogon (*Apalharpactes mackloti*)	• Endemic of Sumatra island	C2 (2)
Crested Honey Buzzard *(Pernis ptilorhynchus)*	• Indonesia Protected • Migratory bird	C1(2), C2(3)
Red-billed Partridge (Arborophila rubrirostris)	• Endemic of Sumatra island	C2 (2)
Mammals		
Sumatran Tiger (*Panthera tigris* ssp. *sumatrae*)	• IUCN Critical Endangered • Indonesia Protected	C1 (1), C2 (1)
Sunda Pangolin (*Manis javanica*)	• IUCN Critical Endangered	C1 (2)

Species	Status	CH Criteria
	• Indonesia Protected	
Dhole (*Cuon alpinus*)	• IUCN Endangered • Indonesia Protected	C1 (2)
Sumatran Surili (*Presbytis melalophos*)	• IUCN Endangered • Indonesia Protected	C1 (2)
Siamang (*Symphalangus syndactylus)*	• IUCN Endangered • Indonesia Protected	C1 (2)
Malayan tapir (*Tapirus indicus*)	• IUCN Endangered • Indonesia protected species	C1 (2)
Sumatran serow (*Capricornis sumatraensis*)	• IUCN Endangered • Indonesia protected species	C1(2)
Sumatran Mountain Muntjac (*Muntiacus montanus*)	• Endemic of Sumatra island	C2 (2)

6.3 Potential Biodiversity Features

The Biodiversity study did not record all potential target species in the project area; however, **Table 6-2** can be modified to accommodate key species that trigger critical habitat should they be discovered.

- There is no measureable (or likelihood of) adverse impact which could impair its high biodiversity value or the ability to function;
- The project is not anticipated to reduce the population of an endangered or critically endangered species or a loss of habitat such that the persistence of a representative host ecosystem by compromised; or
- Any lesser impacts are mitigated to achieve at least no net loss.

6.3.1 Evaluation of Impacts on Priority Species and Associated Habitats

Environmental Impact Analysis of the project activities is divided according to the stage in the AMDAL document. The qualitative analysis of impacts is based on expert judgement in accordance with the characteristics of the species and its habitat. In detail, impact prediction for critical habitat trigger species are presented in **Table 6-2**.

6.3.2 Evaluation of Impacts on Protected Areas

PT SERD Geothermal Project has impacts on legally protected areas, as the Project is located in theBukit Jambul Gunung Patah Protected Area. Nationally, the Bukit Jambul Gunung Patah area is categorized as Protection Forest (*Hutan Lindung*).

6.3.3 Evaluation of Impacts on Ecosystem Service

PT SERD Geothermal Project is unlikely to have any adverse impacts on any environmental services. This is because the project has minimal utilization of natural resources components such as water, and vegetation clearing for development as the Project area is very small compared with the DMU. The impact to environmental services is insignificant.

6.4 Impacts on Priority Habitats

Sub-montane and montane forest is located on ranges elevation 1500 – 2,000 m ASL. The differences of vegetation structure were found in the woods on the west side to the east side of Bukit Barisan, and between the south sides to the north side. Range canopy height of 35-45 m and 25-30 m is still common. Study has identified important habitat on surrounding study areas, such as Puyang Lake. The landscape of Puyang Lake area is predicted as refuges habitat, and has flat topography with a good forest condition. This habitat provides a good water source and feeding ground area for big mammals and primate groups. Survey recorded the existence of Siamang and Malayan Tapir.

6.5 Impacts on Priority Species

6.5.1 Plants

The study did not record presence of flora under important conservation status, such as restricted range distribution or threatened species. Flora species found in the survey areas are commonly found in other areas in sub-montane forest ecosystems.

6.5.2 Mammals

Eight species of threatened mammals that were found in the surrounding project footprint area are Sumatran Tiger (CR), Pangolin (CR), Dhole (EN), Malayan Tapir (EN), Sumatran Serow (EN), siamang gibbon (EN) and sumatran surili (EN). The potential impacts of project activities are:

- Exploration stage will have a significant impact, ie habitat loss and fragmentation on land clearing activities.
- Pre-construction stage of potential impact project is insignificant for species or habitat.
- Construction and operation stage will increase human activity, such as transportation and noise. The survey found some primate species that are semi-terrestrial species, e.g. Siamang and Sumatran Surili. Wildlife conflict could potentially occur in this stage as a wildlife accident.

6.5.3 Birds

Generally, project activities do not have significant impact on the bird groups. The impact on birds are mainly noise and habitat loss.

Some of the priority species groups that can adapt to disturbance are hornbills and raptors. Although migrant species were discovered in the study area, there was no habitat or landscape that has a large concentration of migrant species.

Birds are one of the targets of hunters. Although adjustment has no detailed discussion, the level of group hunting of birds is quite high. Potential indirect impact is potential poaching activity by the community.

The impact of land clearing is habitat loss. The major impacts will affect birds with sensitive characteristics and low adaptability, such as the Red-billed Partridge and Salvadori's Pheasant.

6.5.4 Amphibians and Reptiles

The study did not find any significant findings of herpeto-fauna groups. IUCN has not recorded any significant herpeto-fauna species in this location. Species that meet critical habitat and potential habitat of herpetofauna groups need to be preserved, such as rivers and lakes.

6.6 Summary of Impacts

Based on the review and impact assessment analysis of PT SERD Geothermal project, potential impacts for biodiversity and the habitat are:

- Land clearing, this activity is to prepare the land for the new wellpad and facilities. The direct impact of this activity is the loss of natural habitat in the form of Montane and sub-montane forest. Secondary impact of this activity is loss and fragmentation of fauna habitat.
- Noise is a main source of impact that has long-term impact. The species will be disturbed by noise derived from construction and operations activities.
- Land transportation activities will increase during construction and operation. Potential impact is wildlife conflict, particularly due to an incident. Priority species that will be affected are terrestrial and arboreal species that utilise the land for migration.
- Power plant and powerline operation. Potential impact towards wildlife conflict, particularly due to unlikely but possible incidents of electrical shock for arboreal mammals and bird. Priority species that will be affected are terrestrial and bird species that utilise the area for daily activity.

7 BIODIVERSITY ACTION PLAN

7.1 Overview

Where biodiversity values of importance to conservation are associated with a project site or its area of influence, the preparation of a BAP provides a useful means to focus on a project's mitigation and management strategy.

7.2 BAP Objectives

The BAP document addresses the management and mitigation of potential impacts caused by project activity to biodiversity and ecosystems. Significance of the geothermal project's impacts to biodiversity is expected to be minor or negligible with specific management measures. Minor or negligible means the negative impact will be localized in the footprint area. In terms of achieving no net loss and net gain of biodiversity values, the BAP is expected to contribute more positive impact to biodiversity and ecosystem. General objectives of the BAP are:

- Avoid, reduce, mitigate potential impacts of the Project
- Manage impacts caused by the Project, either directly or indirectly, particularly on endangered species and their habitats
- Develop cooperation with parties to manage the Project footprint landscape.

7.3 Summary of BAP Actions

The conservation actions have been established with the aim of achieving 'no net loss' to biodiversity in accordance with IFC PS6 (IFC, 2012a). IFC PS6 requires evidence that the mitigation hierarchy has been applied, that avoidance is prioritized, and that offsets are measurable and only applied as a last resort where residual impacts are unavoidable.

The conservation objectives and actions have been identified and developed based on:

- Legal, policy, regulatory and third party requirements;
- International and national standards, guidance, and best practice (e.g. ADB 2009; IFC, 2012a, 2012b; IPIECA, 2005)
- Inputs from priority species experts and the biodiversity study team.

A number of actions have been identified to achieve each objective, mitigate the impacts, and address biodiversity problems. Under each sub-plan, the objectives and actions relevant to impact avoidance and reduction are presented first, as they have high priority. The objectives and actions will involve further monitoring and research, biodiversity enhancement, and stakeholder engagement. The order of the actions generally follows the mitigation hierarchy, but this is not always possible as one action can be relevant to more than one category in the mitigation hierarchy.

Based on potential impacts and biodiversity issues on the Project landscape, a summary of conservation objectives for PT SERD's BAP follows. The below table showed the Summary of BAP Actions.

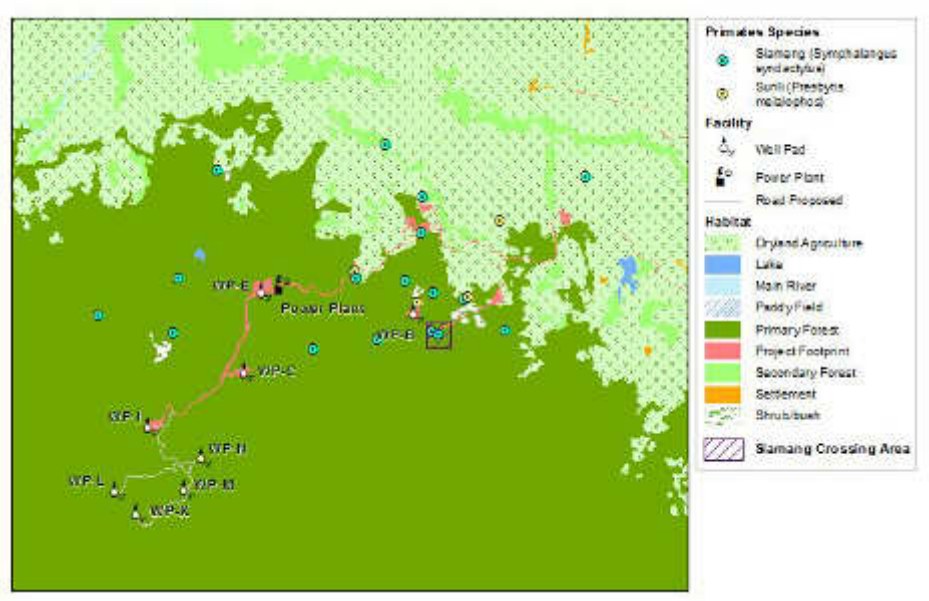
Table 7-1 Summary of BAP Actions

No	Action
1	Prevent and reduce mortability of wildlife on identified wildlife crossings
2	Conduct high conservation value species assessment before land clearing
3	Build Security Gate on project access road
4	Minimize noise and artificial lighting at night
5	Assess the need for the installation of an artificial crossing point on site access for endangered arboreal mammals crossing in Project area
6	Prepare long-term monitoring plan for endangered species in Project area
7	Prepare habitat maps for project site using aerial imagery
8	Conduct habitat rehabilitation with native vegetation in Project area
9	Cooperate with MoEF to help protect the Bukit Jambul Gunung Patah Protection Forest surrounding the Project area
10	Undertake habitat recreation in degraded forest areas outside the Project Area within the Bukit Jambul Gunung Patah Protection Forest Area.
11	Develop communication with multi-stakeholders for environmental management, such as local government, police, and customary leaders
12	Raise awareness of workers and employee staff of PT SERD on the importance of endangered species and relevant national laws
13	Raise awareness of local communities on the importance of endangered species and relevant national laws

7.4 BAP Actions

Action 1: Prevent and reduce mortability of wildlife on identified wildlife crossings

Target	:	To prevent accidental collision of site vehicles with wildlife on site roads.				
Indicator	:	• Site surveys are undertaken and monitoring system is established to identify wildlife crossings area; • Enforcement of speed limits along site roads to 30 km/h through staff training and road signs; • Introduction of speed calming measures; • Establishment of an incident reporting response system; • Establishment of a database to record number and type of wildlife injured or killed.				
Mitigation hierarchy:		Avoid	Reduce	Remedy	Offset	Additional actions
Start	:	During construction				

End:		For lifetime of Project
Frequency	:	On-going
Responsibility	:	• Site Manager (during construction) • Field Manager (post COD)
Consultees	:	Ecologist
Details	:	• PT SERD to identify wildlife crossing locations to identify higher risk crossing points along the access roads for which targeted mitigation should be implemented. This could include under- and over-passes. • Speed reduction measures are to be installed on wildlife crossing locations to warn road users. This will include speed limits and/or speed calming measures as well as training for all staff through induction briefings. • The implementation will be by the delegated site team staff. • Non-compliance will be reported to the Field Support Manager and appropriate disciplinary procedures applied in accordance with PT SERD policy. • An incident reporting mechanism will be introduced to record injured or killed wildlife including inclusion on a database.
Implementation	:	• Ecology survey on project footprint and surrounding area has been done by Greencap in October 2014 – January 2015 and August – October 2016. Study has identified crossing areas for arboreal mammals, which is Siamang. The below figure showed wildlife crossing locations.  **Figure 7-1 Wildlife Crossing Location** • PT SERD has determined that speed limit within the project road is 30 km/hr and reduce it to 20 km/hr at certain areas. Speed limit signs have been installed across the entire Project site.

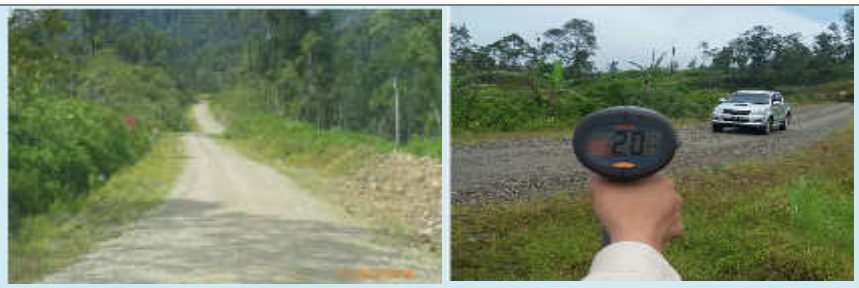


Figure 7-2 Speed Limit Sign on Access Road and Speed Check

- Company drivers receive internal defensive driving course that includes commentary driving. Drivers shall pass Company test to obtain a Company Driving license.

Figure 7-3 Internal Defensive Driving Course and Test

- Security and SHE conduct vehicle check and speed check for vehicles and motorcycles using radar speed gun.

Figure 7-4 Motorcycles Inspection

Action 2: Conduct high conservation value species assessment before land clearing

Target	:	Undertake biodiversity survey for mammal species of conservation value before construction of new wellpads.
Indicator	:	• Surveys to be undertaken prior to construction; • Findings to be communicated with site team; • Appropriate actions are taken where necessary to minimize impacts.
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	At least 2 weeks before start of construction
End:		End of construction.
Frequency	:	Before and at the end of contruction (short term) (See Action 6 for longterm monitoring plan)
Responsibility	:	SHE Manager
Consultees	:	Ecologist
Details	:	• The aims of this action are to : – Provide more detailed pre-construction biodiversity baseline data on mammals of conservation value in the new wellpads. – Inform changes or additions to the mitigation measures. • The target species for the surveys are mammals groups. • The survey is undertaken by experts.
Implementation	:	• The survey of biodiversity baseline data on mammals of conservation value in the new wellpads has been conducted during biodiversity survey by Greencap in August – October 2016. • Further observation will be conducted by site SHE staff before the start of construction to inform latest changes or additions to the mitigation measures.

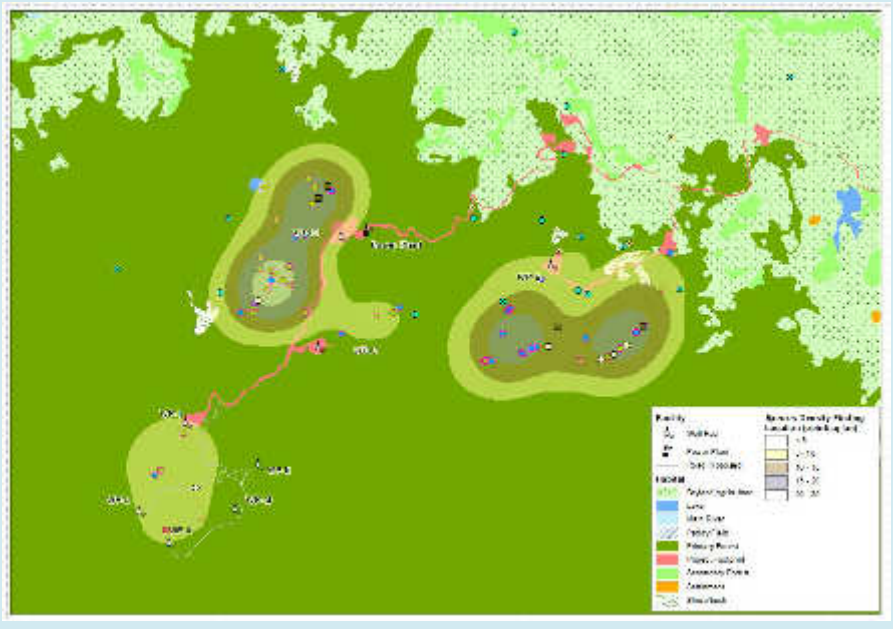


Figure 7-5 Distribution of Protected Species of Conservation Values

Action 3: Build Security Gate on project access road

Target	:	To control unauthorized persons entering the Project area and prevent people to enter the forest to undertake illegal activities such as logging and the hunting of Threatened and Protected species.
Indicator	:	• Construction of Security gates on project access road; • Restrict access to unauthorized people using site roads for logging and illegal hunting of Threatened and Protected species.
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	During construction
End:		Post construction (for access control)
Frequency	:	On-going
Responsibility	:	Security Manager
Consultees	:	-
Details	:	PT SERD will control the access road users by constructing Security gates; This will be adapted to specific areas of the site as some of the Project infrastructure has been constructed on existing roads. It will not be practical to prevent access on foot; however, where access will be restricted this will include either the exclusion of all vehicles and/or four-wheeled vehicles only.
Implementation	:	PT SERD constructed security gates at 2 locations i.e. (1) entrance to project area and (2) at near Shortcut Area. **Figure 7-6 Security Gates**

Action 4: Minimize noise and artificial lighting at night

Target	:	**To prevent disturbance to birds and arboreal mammal's species through noise or light pollution.**
Indicator	:	• Night working during construction and operation that can disturb wildlife is to be minimized where possible; • Direction of the lighting is to illuminate working areas only; • Light of operational areas only when personnel are present.
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	• During construction (night working); • Post construction (illumination of operational areas).
End:		For lifetime of Project
Frequency	:	On-going
Responsibility	:	• Site Manager (during construction) • Field Manager (post COD)
Consultees	:	Expert consultant.
Details	:	**Lighting** • Artificial lighting should be pointed away from forest or faced downwards so it will only illuminate the works areas to minimize disturbance to wildlife by light spill; • No night working that can disturb wildlife will be undertaken during construction or operation unless under exceptional circumstances (this does not include drilling activities at wellpads and powerplant activities). **Noise** Best practice noise reduction measures will be implemented during construction and operations will include: • Avoidance of unnecessary engine sounds and switching off of equipment when not required; • Vehicles and equipment will be properly maintained to meet the manufacturers' noise rating levels; • Limiting the use of particularly noisy plant equipment or vehicles where practicable.
Implementation	:	• PT SERD procedure requires that the condition of vehicle and motorbike shall comply with the regulations of the Government of

	Indonesia. This includes the use of standard muffler. • The implementation of this Action Plan will be monitored during construction and operations by Project, Subsurface, SHE, and Security members.

Action 5: Assess the need for the installation of an artificial crossing point on site access for endangered arboreal mammals crossing in Project area

Target	:	To maintain habitat connectivity along access roads to core forest habitat
Indicator	:	• Assess the need for the installation of an artificial crossing point (arboreal crossing bridge) for endangered arboreal mammals crossing access roads in the Project area; • Design and construct arboreal bridge to allow movement of arboreal species; • Monitoring and maintenance system for arboreal crossings.
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	Prior to construction of site access road to the new Wellpad F
End:		End of construction of site access roads.
Frequency	:	On-going
Responsibility	:	Project Manager and Site Support manager
Consultees	:	Ecologist, arboreal mammals expert
Details	:	• To assess the need for the installation of an artificial crossing point (arboreal crossing bridge) for endangered arboreal mammals crossing access roads in the Project area; • Consultation will be undertaken with ecological consultants and/or arboreal mammal's expert on the most appropriate design which also takes into consideration Project technical and safety requirements; • An appropriate monitoring and maintenance program will be introduced to ensure that the constructed crossing points / arboreal crossing bridge are retained in good functional condition. Inspections will take place at no less than six month intervals.
Implementation	:	• Speed reduction measures will be installed (see Action 1) to prevent incident with wildlife; • Further survey will be conducted to find fragmented habitat spots due to the construction of access roads and evaluate the efficiency and function of crossing point;

- When practicable, an artificial crossing point will be constructed.

Action 6: Prepare long-term monitoring plan for endangered species in Project area

Target	:	To update information on endangered species in the project area				
Indicator	:	Update database and information on endangered species in the project area.				
Mitigation hierarchy:		Avoid	Reduce	Remedy	Offset	Additional actions
Start	:	Before construction of the new access road to wellpad L, M, N and WP-X				
End:		For lifetime of Project				
Frequency	:	Surveys, reporting and mapping to be undertaken : • Before construction • 3 years after Operations commence • 3 years interval during Operations				
Responsibility	:	Corporate SHE Manager				
Consultees	:	Ecologist consultant, University, NGO, Species Expert				
Details	:	PT SERD will conduct regular monitoring of wildlife in project areas, for both flora and fauna. The surveys will be undertaken by biodiversity experts with assistance (including guides) from local villages. • Flora: presence of protected species, pioneer species, and invasive species either native or alien. • Fauna: presence, abundance and distribution of species with important conservation status and endemic species as a basis for habitat and population management.				
Implementation	:	A detailed biodiversity survey has been conducted in the Project footprint and surrounding area ("Study area") by Greencap for two periods (1) in October 2014 – January 2015 and (2) August - October 2016. Main findings highlighted by the experts are: • Nearly 61 species of 28 families' bird species were recorded in the PT SERD project area and adjacent forest. Of these, 8 are protected under Indonesian law, two migratory birds and three species are endemic to Sumatra. • Identification and mapping of habitat mammalia distribution, especially Siamang, and Sumatran surili. • Camera traps that were installed for 3 months each survey periods with total 15 locations on the surounding of project footprint (distance 1-2 km). The result of camera traps is show on **Appendix III**.				

	• Survey was recorded one fish on Cawang Tengah River, namely Mahseer Fish. This is has characteristic in habit on upstream river with flow and clear water. Thi is not protected or threaned species during survey.

Action 7: Prepare habitat maps for project site using aerial imagery

Target	:	• Obtain aerial imagery of the habitats of important species; • Prepare a detailed habitat map including biodiversity monitoring data.
Indicator	:	• Mapping to be completed prior to construction on wellpad L, M, N, X and powerplant; • Geographical information system database to be set-up to record biodiversity monitoring data; • Mapping to be updated following all biodiversity monitoring surveys.
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	June 2016
End:		For the duration of the short-term and long-term biodiversity monitoring.
Frequency	:	Database to be updated on annual basis.
Responsibility	:	Corporate SHE Manager
Consultees	:	Expert, University, NGO.
Details	:	• A habitat mapping database will be set-up following the pre-construction monitoring to store all biodiversity monitoring data. Habitat mapping is obtained using aerial imaginery (satellite or drone). • The results of the field survey and monitoring of biodiversity will be used to analyze more detailed and specific distribution of species or groups of flora and fauna. This will include sightings of wildlife by staff as well as during targeted surveys. • This action is part of the evaluation of management action and it can be undertaken on an annual basis. • The database will aim to share data between PT SERD, NGOs and ecologist.
Implementation	:	• Habitat mapping and database has been developed to store the biodiversity survey results carried out by Greencap in 2016. Habitat maps illustrated the distribution of the species. • Information of sightings of important species within and in the close proximity of the Project area will be documented in the database. • The habitat mapping database and biodiversity study results have been shared with relevant government members (Forestry and

	Environmental offices), university members, KSNP, NGOs, other experts, and an ADB representative during Biodiversity Public Consultation held in University of Andalas in Padang on 15 August 2016. Approximately forty participants attended the meeting.

Action 8: Conduct habitat rehabilitation with native vegetation in Project area

Target	:	Restoration of habitat present since development stage
Indicator	:	• The completion of restoration management plan; • Planting and ensure growth of planted species; • Monitoring of target species prior and following completion to determine no let loss and net gain of biodiversity.
Mitigation hierarchy:		Avoid | Reduce | **Remedy** | Offset | Additional actions
Start	:	Post construction of development stage
End:		• Temporarily used areas during construction i.e. around access roads, wellpads, and laydown areas will start to be rehabilitated within twelve months post construction; • Unused wellpad to be determined within twelve months following construction depending on requirement to use the well for monitoring purposes.
Frequency	:	• Planting over single period for each area; • Monitoring and management once every two months until planting is established.
Responsibility	:	Site Support Managerand Corporate SHE Manager
Consultees	:	University, consultant, experts
Details	:	• Approximately 9 ha of forested areas will temporarily be used during construction. These areas will be planted and managed following the completion of construction in 2020 to restore natural forest conditions to support species identified as BAP priority species. • The sites will also be incorporated into the short-term and long-term biodiversity monitoring and evaluation plan. • Consultation will be undertaken with relevant stakeholders in order to determine the composition and type of planting to be achieved. Implementation will then be undertaken by PT SERD and if needed will seek assistance from ecologist, and local villagers will be used to assist with the work as well as with future maintenance.
Implementation	:	Develop On-site Forest Restoration Plan by the end of construction period (2020).

Action 9: Cooperate with MoEF to help protect the Bukit Jambul Gunung Patah Protection Forest surrounding the Project area

Target	:	To prevent disturbance to Bukit Jambul Gunung Patah Protection Forest area, such as encroachment and poaching.
Indicator	:	• Installation of warning signs; • Report to authorities of any signs of illegal hunting and deforestation
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	Pre-development stage
End:	:	For lifetime of Project
Frequency	:	Continuous
Responsibility	:	Site Support Manager and Corporate Security Manager
Consultees	:	Forestry Agency, Sumatera Selatan Provence
Details	:	• Consult with Ministry of Environment and Forestry (MoEF) and/or Forestry Agency, Sumatera Selatan Provenceto develop support plan. • Implement applicable measures such as joint patrol.
Implementation	:	PT SERD will conduct discussion with Forestry Agency of Muara Enim in Semester 2 of 2017

Action 10: Undertake habitat recreation in degraded forest areas outside the Project Area within the Bukit Jambul Gunung Patah Protection Forest Area.

Target	:	To develop and implement a comprehensive biodiversity offset plan within the Project Area and adjacent Bukit Jambul Gunung Patah Protection Forest to achieve a net gain for priority habitats, species and ecosystem function; design off-set to complement local people's use of the forest and cultural values associated with biodiversity.PT SERD will evaluate the feasibility of the offsetting and/or alternative options at a later stage.
Indicator	:	• The preparation and implementation of a comprehensive biodiversity offset design, with habitat and species offsets.; • Monitoring of target species prior and following completion to ensure no net loss for natural habitat and net gain for critical habitat; • Establishment of long-term financial support arrangements for the implementation of biodiversity conservation measures.
Mitigation hierarchy:		Avoid | Reduce | Remedy | **Offset** | Additional actions
Start	:	1st Semester 2018
End:	:	For duration of site clearance
Frequency	:	On-going during periods of site clearance
Responsibility	:	Corporate External Relation Manager and Corporate SHE Manager
Consultees	:	MoEF, Sumatera Selatan Forestry Agency
Details	:	• Approximately 106 ha of forested areas will be permanently used during the operating period. In order to offset the permanent loss of habitats used for the project, new areas of forest will be recreated outside of the Project Area. • The offset plan will be designed using participatory process with related institution, and local people will be included in the design and implementation as far as possible. • Baseline and monitoring surveys should be undertaken to measure and evaluate the gains to priority species. Since the project area is located on Protection Forest category ("Hutan Lindung / HL"), regulation of Minister of Environment and Forestry (KLHK) no. P50 of 2016 regarding Guidelines for Forest Borrow Permit (IPPKH) of Forestry Area was to be referenced, 2 times of the size of permanently used area shall be acquired as offset area equating to no less than 212 ha or an equivalent set of biodiversity enhancement measures is to be implemented. BBOP Design Handbook (2012) will also be referenced for biodiversity enhancement measures.
Implementation	:	PT SERD will conduct discussion with related institution in 1st semester of 2018

Action 11: **Develop communication with multi-stakeholders for environmental management, such as local government, police, and customary leaders**

Target	:	To prevent and reduce illegal activity on project area and surroundings				
Indicator	:	Memorandum of Understanding (MoU) with local government and relevant institution.				
Mitigation hierarchy:		Avoid	Reduce	Remedy	Offset	Additional actions
Start	:	September 2017				
End:		Before construction				
Frequency	:	Continuous				
Responsibility	:	Corporate External Relation Manager & Corporate SHE Manager				
Consultees	:	Local Government, Police department				
Details	:	PT SERD will discuss with related institutions to establish cooperation program to protect and conserve the forest, such as local government, and MoEF.				
Implementation	:	1st Semester of 2017				

Action 12: Raise awareness of workers and employee staff of PT SERD on the importance of endangered species and relevant national laws

Target	:	• All construction and operation staff (including contractors) to be made aware of the importance of forest habitats, protected and threatened plants and animals within the Project Area, as well as details of the PT SERD site systems and regulations to protect biodiversity; • All staff to be made aware of personal obligations to comply with PT SERD biodiversity policy.
Indicator	:	• Number of staff and contractors reached through site induction and training (100%); • The erection and maintenance of information posters in the PT SERD site office; • Site guidelines and enforcement of regulations; • Infringements and incidents are recorded and monitored with corrective actions being taken.

Mitigation hierarchy:	Avoid	Reduce	Remedy	Offset	Additional actions

Start	:	1st Semester of 2017
End:		Throughout construction and operation.
Frequency	:	• Group training for existing staff and contractors in 1st quarter of 2017. • Wokers and employee staff induction : continuous during construction and operation
Responsibility	:	• Site Manager (during construction) • Field Manager (post COD)
Consultees	:	Experts
Details	:	• Socialization program was determined to be essential in promoting awareness of the importance of habitats of conservation value for compliance with Lenders' safeguards to demonstrate PT SERD's commitment toward 'no net loss' to biodiversity and 'net gain' in critical habitat. • All construction and operational staff will be informed about the areas supporting habitats and species of conservation value, why these features are important, and what activities are/are not permitted in these areas. This will include details of the PT SERD site systems and regulations to protect biodiversity as well as staff obligations. Staff will be made aware that PT SERD operates a no-tolerance policy on

		poaching. This includes all direct and indirect involvement; • Group sessions will be organized in order to train all existing staff and contractors working on the Project. The delivery method will be through a PowerPoint presentation followed by a discussion session. The content and delivery will be determined through consultation with SHE Manager and biodiversity experts/NGOs; • In addition to the training events as outlined above, awareness of the ecological issues affecting the Project and the conservation value of the KSNP forest will also be achieved through the placement of literature at the PT SERD site office; • Compliance with PT SERD environmental protection policy will be managed and monitored by the SHE Manager. This will include a procedure for reporting incidents by site staff. A recording and evaluation system will be established which will be reviewed no less than on a monthly basis. Corrective measures will be taken where necessary including appropriate actions for infringements
Implementation	:	• Identify number of employees to be inducted / trained. • Prepare material of presentation in 1st quarter of 2017 to raise awareness of the following: o National and international legislative requirements on biodiversity that the Project must comply with; o Importance of biodiversity and habitats and species of conservation value and sensitivities of the Project area; o Measures to be implemented and monitored on site during the construction phase; o Procedures to be followed in the event of non-compliance with the BAP; o Roles and responsibilities of each entity and personnel. • Set up training schedule • Conduct induction / training to target audience.

Action 13: Raise awareness of the local communities on the importance of endangered species and relevant national laws

Target	:	• To raise awareness of the local community on habitats, wildlife and plant species of conservation value within the KSNP forest; • Establish community based management plans; • Support conservation oriented livelihood initiatives.
Indicator	:	• Completion of socialization meetings with local villages in the Project Area; • Conservation management plan with local communities in the Project Area is established and implemented; • Conservation oriented livelihood initiatives with communities in the Project Area is developed and financially supported
Mitigation hierarchy:		Avoid | Reduce | Remedy | Offset | Additional actions
Start	:	1st semester of 2017
End:		End of construction
Frequency	:	At least one meeting with each village in Project Area
Responsibility	:	External Relations Manager, SHE Manager,and Site Support Manager
Consultees	:	MoEF, Forestry Agency of Sumatera Selatan Provenceand experts
Details	:	• Socialization through local community engagement will be carried out within the villages in the catchment of the Project. The aims of the events will be to: 1) Raise awareness of the conservation value of the protection forest; 2) Encourage local people not to hunt Threatened and Protected species in the forest or to clear areas by logging; 3) Communicate developments within the Project relevant to the local communities and to agree suitable actions (for example the use of site roads for access). • The programme will be developed in cooperation with PT SERD, localForestry Agency of Sumatera Selatan, and experts. • The delivery will be through presentations to local villages. • Long-term community based programmes including conservation orientated initiatives will be developed. In order to determine the most appropriate approach, analysis will be undertaken of existing socio-economic data as well through surveys and discussions with local villagers to determine the key drivers behind forest use. This will then be used to propose future strategies to reduce pressure on habitats and species of conservation value; in particular those identified as priority within this BAP.
Implementation	:	• PT SERD will conduct presentation to local communities in 2nd semester 2017.

7.5 Role and Responsibility

Additional information on the implementation and coordination of the BAP is provided in this section.

The KTPB, Project Manager, and SHE officer will have the overall responsibility to ensure an effective implementation of the protection and enhancement of biodiversity during construction of the Project. The responsibilities of the KTPB, Project Manager, and SHE Officer include but are not limited to:

- Inform, explain, and where necessary enforce the biodiversity legislations, policies, and lender requirements associated with the Project.
- Enforce the ban on hunting across the Project area, raise awareness of the importance of the ban among all employees.
- Undertake patrols across the Project area and oversee and provide guidance on activities that may affect the biodiversity features within the Project area.
- Undertake and arrange for the clear demarcation of, and signage to restrict entry to, ecologically sensitive areas.
- Provide advice to contractors regarding the ecological sensitivities within the Project area and region, and if necessary supervise contractors to ensure that they adhere to environmental requirements to avoid or minimize disturbance to habitats, flora, and fauna.
- Ensure the implementation of best practice guidelines on the prevention and management of invasive alien species.
- Develop working relations with local community groups, Forestry Agency of Sumatera Selatan, land-owners, land-managers, and business interests by maintaining close liaison with local individuals and communities.
- Provide advice to Project staff, as necessary, in relation to the conservation and management of wildlife areas.

7.6 Monitoring, Evaluation and Reporting

7.6.1 Monitoring during Construction

For the construction phase the monitoring activities will include:

- Daily monitoring of construction areas for leaks, spills, releases, improper waste disposal, and unexpected occurrences.
- Weekly monitoring of construction areas for general disturbance, and more intense when there are potential wildlife conflict findings.
- Monthly inspection of construction areas to monitor temporary working area size, number and extent of temporary access routes, construction vehicles used on specified access routes, levels of noise, and light disturbance.
- Monitoring of vegetation, endangered species, birds, mammals, reptiles, and amphibians before vegetation clearance.
- Monthly check of camera traps to monitor presence of terrestrial mammals, especially priority species during the biodiversity monitoring period.

- Monthly update and data compilation of the presence of endangered species in the Project area.
- Monitoring primate group populations in the Project area and update periodically.
- Weekly monitoring of wildlife incidents with associated facilities (transmission line route).
- Daily Monitoring of PT SERD access roads to secure them from poaching activity, in cooperation with Security department.

7.6.2 Post Construction Monitoring

Additional monitoring will check for evidence of bird and primate incidents related to power plant and associated facilities (transmission line). This monitoring will happen monthly for one year.

7.6.3 Reporting

- PT SERD will be responsible for the following: reporting non-compliance incidents, corrective actions, and inspection reports.
- PT SERD will report compliance with ecological mitigation requirements and BAP implementation to lenders and regulatory bodies (as appropriate).
- Annual post-construction monitoring reports and reports on the BAP implementation will be prepared and made available to appropriate parties.

7.6.4 Monitoring and Evaluation

The Project is unlikely to have any significant residual adverse impacts on the trigger features of critical habitat and therefore no biodiversity offsets are required. Nevertheless, IFC PS6 requires that for projects located in critical habitat (irrespective of impacts), a Biodiversity Monitoring and Evaluation Program (BMEP) is prepared and integrated into the client's management program (IFC, 2012a).

The aim of this BMEP is to monitor the natural landscape features, extent, quality, and spatial configuration of the habitats in relation to Project impacts.

The objectives of this BMEP are to:

- Undertake long-term monitoring to detect any significant changes in landscape.
- Design monitoring of species to estimate diversity and population.
- Analyze time series data and identify the reasons for any significant changes in consultation with specialists, local communities, and other stakeholders.

7.6.4.1 Monitoring Indicators

Biodiversity monitoring indicators need to be realistic, practical, simple, sensitive to anthropogenic impacts, dynamic (responsive to on-going changes), meaningful, and cost-effective to monitor (World Bank, 1998; EBI, 2009). The monitoring for the BMEP will be undertaken at several levels: Impacted Project area and priority species/populations around Project area.

7.6.4.1.1 Project Impacted Area Landscape

Project impacted area was defined as the project area within the DMU. Some parameters monitored are:

- Land cover and land use changes

- Habitat type changes related to biodiversity

Methodological approaches used involve remote sensing and spatial analysis. Land cover was obtained from interpretation of satellite images with guidance of ground truthed data. Land cover and land use change analysis use time series data.

Habitat analysis is defined with analyses of species location finding and literature review or botanist field survey data of characteristics of vegetation composition. Habitat mapping is developed by combining present land-cover and land use data with detailed vegetation information. In future, the BMEP will repeat the habitat classification every three years or habitat re-classification will also be conducted if there is a new project activity that requires forest opening or foreseen change to the habitat.

7.6.4.1.2 Species/ Population Level

Species or population levels are analyzed by monitoring time-series data. Baseline studies already identified distribution groups of Siamang, Sumatran Surili, and Agile Gibbon in the Project area. Monitoring data are updated with group numbers and populations of each group.

For bird's gorups, some endemic species and protected species are found in primary forest, secondary forest, and also in modified habitat, such as Red-billed Partridge, Salvadori's Pheasant, Changeable Hawk-eagle, Blyth's Hawk-Eagle , Wallace's Hawk-eagle, Crested Honey Buzzard, and Cream-striped Bulbul. Monitoring and estimation of population studies were performed at the edge of the forest directly adjacent to primary forest.

For flora, invasive species and pioneer species are monitored. Pioneer species is important species that can be used for rehabilitation and restoration. Monitoring of forest succession process in disturbed or secondary forests can be used for restoration activities.

The line transect method was used with a focus on obtaining data on populations of the primate groups, bird and flora. For terrestrial mammals, camera traps were used and findings were discussed with terrestrial species experts to identify individuals and population.

7.6.4.1.3 Biodiversity Offset

The Biodiversity Offset and Ecological Management Plan (BOEMP) outlines measures to be undertaken to offset the loss of habitats for priority species identified in Chapter 6.1. This includes areas of permanent habitat loss as well as those temporarily lost during construction where the on-site habitat restoration may be considered not sufficient to demonstrate no net loss for species affected (see section Habitat Change).

In order to provide a net positive gain for Critically Endangered, Endangered and endemic species and no net loss of other BAP species, offsite habitat recreation may be required. The full extent of the off-site recreation will be determined through consultation with the local government authorities and biodiversity experts. Factors affecting this process will include the condition and location of the habitats to be recreated (see Actions 9 and 10).

The design and implementation of the BOEMP will be detailed in an Off-Site Forest Recreation Plan which will be a stand-alone supplementary document to the BAP. The BOEMP will follow recognized guidance on offsetting, in particular that given by the Business and Biodiversity Offsets Programme (BBOP). The design of the process will be based on the Biodiversity Offset Design Handbook (BBOP, 2012). This comprises eight general steps which are outlined in **Table 7-2** below.

Steps 1 – 4 have already been addressed to some extent as part of the process undertaken for the ESIA and BAP. However, these steps will need to be formally reviewed as part of the BOEMP process. Following completion of the offset design, the implementation of the BOEMP will be undertaken based on the Biodiversity Offset Implementation Handbook (BBOP, 2009). This will address five key activities:

- Activity 1: A description of the offsetting activities and their location;
- Activity 2: The operation and management of the offsetting;
- Activity 3: The financing of the offsetting over the long-term;
- Activity 4: The monitoring and evaluation of the offsetting; and
- Activity 5: Launching the offset.

Table 7-2 Summary of steps in the offset design process

No	Step in offset design	Purpose
1	Review project scope and activities	To understand the purpose and scope of the development project and the main activities likely to take place throughout the different stages of its life cycle. Identify key decision 'windows' and suitable 'entry points' for integration of biodiversity offsets with project planning.
2	Review the legal framework and / or policy context for a biodiversity offset	To clarify any legal requirement to undertake an offset and understand the policy context within which a biodiversity offset would be designed and implemented. The policy context would cover government policies, financial or lending institutions' policies, as well as internal company policies.
3	Initiate a stakeholder participation process	To identify relevant stakeholders at an early stage and establish a process for their effective involvement in the design and implementation of any biodiversity offset.
4	Determine the need for an offset based on residual adverse effects	To confirm whether there are residual adverse effects on biodiversity remaining after appropriate application of the mitigation hierarchy, for which an offset is required and appropriate.
5	Choose methods to calculate loss / gain and quantify residual losses	To decide which methods and metrics will be used to demonstrate that 'no net loss' will be achieved through the biodiversity offset and to quantify the residual loss using these metrics.
6	Review potential offset locations and activities and assess the biodiversity gains which could be achieved at each	To identify potential offset locations and activities using appropriate biophysical and socioeconomic criteria, to compare them, and to select preferred options for more detailed offset planning.

No	Step in offset design	Purpose
7	Calculate offset gains and select appropriate offset locations and activities	To finalize the selection of offset locations and activities that should result in no net loss of biodiversity. Applying the same metrics and methods that were used to quantify losses due to the project, calculate the biodiversity gains that could be achieved by the shortlist of preferred offset options, check they offer adequate compensation to any communities affected so they benefit from both the project and the offset, and select final offset location(s) and activities.
8	Record the offset design and enter the offset implementation process	To record a description of the offset activities and location(s), including the final 'loss /gain' account which demonstrates how no net loss of biodiversity will be achieved, how stakeholders will be satisfied and how the offset will contribute to any national requirements and policies.

7.6.4.1.4 Evaluation

This monitoring will be periodically evaluated to determine its effectiveness in meeting the objectives, and identifying any necessary remediation.

The findings of the above monitoring program will be evaluated every years and the outcomes will be used to adapt the management and ongoing mitigation measures.

Management interventions will need to be identified when there is a negative trend in the areas of natural habitat and/or the connectivity of the habitats. The threshold for interventions will be when the area of any natural habitat has significantly decreased.

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Appendix I

Location Findings of Encounters and Vocalization Data of Siamang Groups (*Symphalangus syndactylus*)

Species	Location	Altitudes (meters AM SL)	Findings
Siamangs	S 04 ° 12'59.3" E 103 ° 23'27.3"	1,963	Direct detection
Siamangs	S 04º 12'49.3" E 103 ° 24'38.2"	1,691	Direct detection
Siamangs	S 04° 12'49.3" E 103 ° 24'41.7"	1,688	Direct detection
Siamangs	S 04 ° 12'30.1" E 103 ° 24'57.4"	1,714	Direct detection bordering coffee plantation.
Siamangs	S 04 ° 11'48.2" E 103 ° 24'24.4"	1,445	Direct detection
Siamangs	S 04 ° 11'28.7" E 103 ° 24'33.0"	1,375	Direct detection bordering coffee plantation.
Siamangs	S 04 ° 12'25.6" E 103 ° 24'39.2"	1,601	Vocalization
Siamangs	S 04 ° 12'18.5" E 103 ° 24'22.3"	1,575	Vocalization
Siamangs	S 04 ° 12'53.9" E 103 ° 24'05.3"	1,743	Vocalization
Siamangs	S 04 ° 11'08.4" E 103 ° 24'04.6"	1,317	Vocalization
Siamangs	S 04 ° 11'08.4" E 103 ° 24'04.6"	1,449	Vocalization
Siamangs	S 04 ° 12'49.5" E 103 ° 22'03.1"	1,987	Vocalization
Siamangs	S 04 ° 12'39.2" E 103 ° 21'18.4"	1,822	Vocalization
Siamangs	S 04 ° 12'17.0" E 103 ° 22'06.6"	1,671	Vocalization
Siamangs	S 04 ° 11'12.2" E 103 ° 22'30.2"	1,263	Vocalization
Siamangs	S 04 ° 12'48.5" E 103 ° 25'21.9"	1,650	Vocalization

Appendix II

Encounters of Terrestrial Mammals Group

Nama umum	Nama ilmiah	Status Konservasi			Endemik/ Migrasi	Lokasi							
		PP 7/ 1999	IUCN	CITES		*Wellpad* B	*Wellpad* E	*Wellpad* I	*Kebun*	*Wellpad* C	*Wellpad* D	Danau Puyang	*Wellpad* L, M, N, X
Mamalia													
Siamang	*Symphalangus syndactylus*		EN			D, V			T, D		D, V	D	
Surili	*Presbytis melalophos*	L	EN			D			V			D	
Tapir	*Tapirus indicus*	L	`	I		K	K	K		K		K, CT	F, K
Kijang kuning	*Muntiacus montanus*	L	LC			K, CT	K	CT					K
Kambing hutan Sumatera	*Capricornis sumatrensis*	L	VU	I		K							
Babi hutan	*Sus scrofa*		LC			K						K	
Landak	*Hystrix brachyura*	L	LC						CT				
Rusa sambar	*Cervus unicolor*		VU					K					K
Beruang madu	*Helarctos malayanus*	L	VU	I		K, CT	K	K	CT	K	K, CT		
Kucing emas Asia	*Catopuma temminckii*		NT	I					CT				
Kucing batu	*Pardofelix marmorata*		VU	I		CT		CT					CT
Ajag	*Cuan alpinus*		EN			CT			CT		CT		
Linsang	*Prionodon linsang*		LC	II									
Musang bulan	*Paguma larvata*		LC			CT			CT		CT		
Trenggiling	*Manis javanica*	L	CR	II							CT		
Musang leher kuning	*Martes flavigula*		LC							CT			
Tupai	Tupaiidae							CT					
Tupai tanah	*Tupaia tana*		LC						CT				
Harimau Sumatra	*Panthera tigris sumatrae*	L	EN	I		K					K		F
Kucing kuwuk	*Prionailurus bengalensis*	L	LC	II			K						
Luwak	*Paradoxurus*		LC				CT						

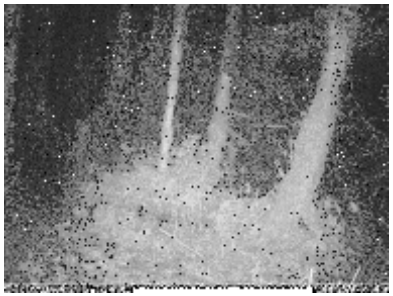
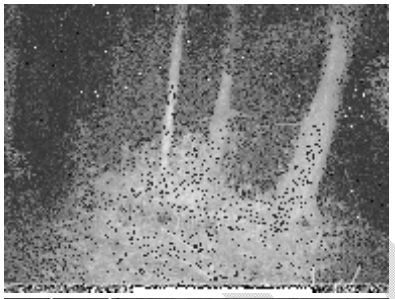
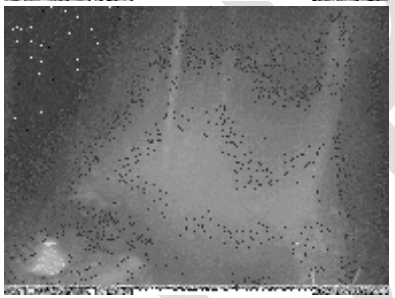
Nama umum	Nama ilmiah	Status Konservasi			Endemik/ Migrasi	Lokasi							
		PP 7/1999	IUCN	CITES		*Wellpad* B	*Wellpad* E	*Wellpad* I	*Kebun*	*Wellpad* C	*Wellpad* D	Danau Puyang	*Wellpad* L, M, N, X
	hermaphroditus												

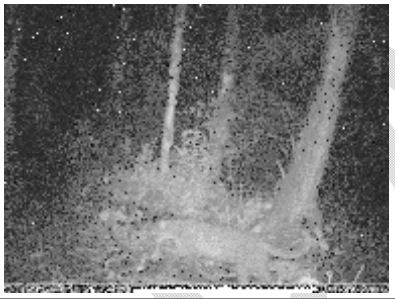
Note : PP 7/1999: L = Protected; IUCN: LC = *Least Concerned*, VU = *Vulnerable*, NT = *Near Threatened*, EN = *Endangered,* CR = *Critically Endangered*; CITES: I = Lampiran I, II = Lampiran II, III = Lampiran III; E = Endemic;

Location: D = Direct Encountered, V = Vocal, T = Traps, CT = *Camera trap*, K = Foot print, F = Faeces

Appendix III

Detailed Species Finding by Camera Trap

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
1	Wellpad D Route (**D1**)	Masked Palm Civet (*Paguma larvata*) Status: Least concern		24 October 2014/21.12 07 November 2014/15.15	S4.20011596°	E103.37811°	17 October 2014	29 January 2015
		Malayan sun bear (*Helarctos malayanus*) Status: Vulnerable	 	3 November 2014/00.37 9 November 2014/18.07 12 December 2014/05.23				

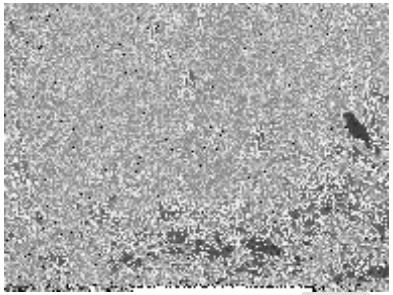
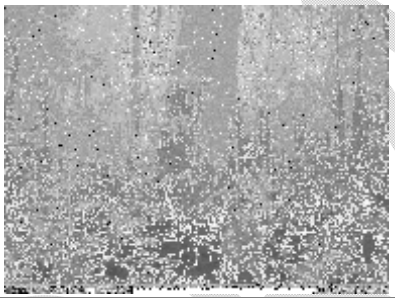
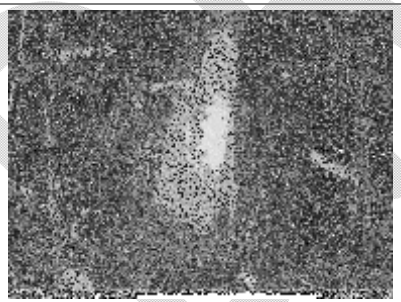
No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
		Dhole (*Cuon alpinus*) Status: Endangered		4 November 2014/13.15				
		Golden cat (*Catopuma temminckii*) Status: Near threatened		03 November 2014/21.56 23 December 2015/17.29 17 January 2015/08.52 25 January 2015/10.03				
		Sunda pangolin (*Manis javanica*) Status: Critical Endangered		22 November 2014/20.07				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
2	Adjacent of Plantation and Forest (PL1)	Malayan sun bear (*Helarctos malayanus*) Status: Vulnerable		22 October 2014/06.27 12 December 2014/16.00	S4.20713°	E103.41365°	21 October 2014	29 January 2015
		Banded Linsang (*Prionodon linsang*) Status: Least concern	 	31 October 2014/19.22 9 November 2014/04.43 19 November 2014/20.43 3 December 2014/21.26 13 December 2014/23.23 16 December 2014/21.38				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
		Bird	 	1 November 2014/06.46 27 November 2014/06.40 10 December 2014/16.24 11 December 2014/15.50 12 December 2014/15.26 13 December 2014/15.40 15 December 2014/08.21 20 December 2014/13.04 23 December 2014/07.19 24 December 2014/08.04 26 December 2014/12.42				
		Masked Palm Civet (*Paguma larvata*) Status: Least concern		3 November 2014/03.18 13 November 2014/01.42 17 December 2014/00.41 8 January 2015/12.39				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
		Golden cat (*Catopuma temminckii*) Status: Near threatened		6 November 2014/22.38				
		Malayan Porcupine (*Hystrix brachyura*) Status: Least concern		11 November 2014/22.25				
		Tupai tanah		21 November 2014/12.14				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
3	Wellpad I-1(I1)	Marbled Cat (*Pardofelis marmorata*) Status: Vulnerable		1 December 2014/10.51	S4.235978°	E103.3593°	13 October 2014	18 December 2014
		Muntjac (*Muntiacus muntjak*) Status: Least concern		23 October 2014/14.27				
		Tree shrew		25 October 2014/06.16				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
4	Wellpad I-2 (**I2**)	-	-	-	S4.242395°	E103.36629°	15 October 2014	29 January 2015
5	Wellpad B-2 (**B2**)	Bird 1		3 November 2014 / 06.39	S.2179057°	E103.41837°		29 January 2015
		Muntjac (*Muntiacus muntjak*) Status: Least concern		11 November 2014/16.23				
		Masked Palm Civet (*Paguma larvata*) Status: Least concern		26 November 2014/04.20				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
6	Wellpad B-1 (**B1**)	Malayan sun bear (*Helarctos malayanus*) Status: Vulnerable		16 October 2014/08.52 22 October 20014/08.25 23 October 2014/11.31 28 October 2014/20.46	S4.222144°	E103.3991°	17 October 2014	29 January 2015
		Marbled Cat (*Pardofelis marmorata*) Status: Vulnerable		13 November 2014/09.31 30 November 2014/13.15				
		Dhole (*Cuon alpinus*) Status: Endangered		15 November 2014/10.19 18 November 2014/08.06 17 December 2014/13.15				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
		Masked Palm Civet (*Paguma larvata*) Status: Least concern		20 November 2014/23.00				
7	Route to Punyang Lake (**P1**)				S4.2125184°	E103.37148°	16 October 2014	19 October 2014
8	Wellpad C (**C1**)	Bird		28 October 2014/17.01	S4.217328°	E103.38370°	20 October 2014	29 January 2015
		Yellow Throated Marten (*Martes flavigula*) Status: Least concern		10 November 2014/07.48				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
		Bird 3		20 October 2014/12.26 21 October 2014/06.42 22 October 2014/09.33 25 October 2014/07.51 25 October 2014/07.57 26 October 2014/07.03 26 October 2014/08.46 2 November 2014/09.12 2 November 2014/14.54 8 November 2014/07.01 10 November 2014/09.39 13 November 2013/13.33				
		Golden cat (*Catopuma temminckii*) Status: Near threatened		20 January 2015/03.11				
		Sunda pangolin (*Manis javanica*) Status: Critical Endangered		25 December 2015/18.46				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
9	Route to Puyang (**P2**)	Malayan Tapir Status: Endangered		7 January 2015/ 18.53	S4.21943°	E103.37085°	19 December 2014	29 January 2015
		Masked Palm Civet (*Paguma larvata*) Status: Least concern						
10	Wellpad E (**E1**)	Banded Linsang (*Prionodon linsang*) Status: Least concern		25 December 2015/ 02.31	S4.20702°	E103.38000°	19 December 2014	29 January 2015
		Masked Palm Civet (*Paguma larvata*) Status: Least concern		12 January 2015/ 02.53				

No	Location	Species	Picture	Date/ Time	Coordinate		Date	
					South	East	Start	Stop
11	Camera 1 (CT 1)	Sumatran Serow (*Capricornis sumatraensis*) Status: Vulnerable		8 August 2016	-4.24562	103.356	22 July 2016	8 September 2016
12	Camera Trap 2 (CT 2)				-4.24528	103.364		
13	Camera Trap 3 (CT 3)	Marble cat (*Pardofelis marmorata*)		23 July 2016 29 July 2016	-4.24259	103.369		
		Martes flavigula		23 August 2016				

Appendix IV

List of Flora Species

July 2014

Family	*Binomial*	*Local Name*	*Relative Abundance*
Rubiaceae	*Coffea*		+++
Malvaceae	*Durio spp.*	Durian	+
Mimosoideae	*Paraserianthes falcataria*	Sengon	+++
Verbenaceae	*Peronema canescens*	Sungkai	+++
Phyllanthaceae	*Aporosa microcalyx*		+
Theaceae	*Schima wallichii*		+
Gleicheniaceae	*Gleichenia linearis*	Resam	+++
Poaceae	*Imperata cylindrica*		+
Melastomataceae	*Melastoma malabathricum*	Senduduk	+++
Fabaceae	*Pithecellobium jiringa*	Jengkol	++
Lauraceae	*Litsea sp.*		++
Mimosoideae	*Mimosa pudica*		++
Verbenaceae	*Stachytarpheta indica*		++
Lycopodiaceae	*Lycopodium sp.*		++
Caesalpinionideae	*Cassia alata*		++
Myrtaceae	*Rhodomyrtus tomentosa*		+
Poaceae	*Bambusa sp.*		+++
Moraceae	*Artocarpus sp.*		++
Cyperaceae	*Cyperus sp.*		+++
Poaceae	*Saccharum spontaneum*		+
Apocynaceae	*Alstonia scholaris*		++
Euphorbiaceae	*Mallotus paniculatus*	Tutup putih	+
Lythraceae	*Lagerstromia sp.*		++
Anacardiaceae	*Semecarpus heterophylla*		+
Euphorbiaceae	*Macaranga sp.*		++
Malvaceae	*Hibiscus tiliaceus*		++
Moraceae	*Ficus benjamina*		+

Source: UKL UPL PT SERD (2014)

January 2015

Family	Binomial	Local Name	Plant Phase	Conservation Status	Location			
					Wellpad B	Wellpad E	Wellpad I	Plantation
Annonaceae	*Uvaria sp.*		Climber			√		
Apocynaceae	*Alyxia reinwardtii Blume*		Climber			√		
Aristolochiaceae	*Aristolochia sp.*		Climber		√			
Gesneriaceae	*Aeschynanthus radicans Jack*		Climber		√	√		
Nepenthaceae	*Nephenthes sp.*		Climber	Endemic		√		
Schizandraceae	*Schisandra elongata (Bl.) Hook.f.& Thoms*		Climber		√			
Smilacaceae	*Smilax leucophylla Blume*		Climber			√		
Aspleniaceae	*Asplenium sp.*		Fern		√			
Lomariopsidaceae	*Elaptoglossum blumeanum*		Fern		√			
Lycopodiaceae	*Lycopodium serratum*		Fern			√		
Plagiogyria Group	*Plagiogyria glauca*		Fern		√			
Polypodiaceae	*Belvisia revoluta*		Fern		√	√		
Polypodiaceae	*Pyrrosia sp.*		Fern		√			
Asteraceae	*Anaphalis longifolia (Bl.) DC.*		Herb		√			
Balanophoraceae	*Balanophora elongata Blume*		Herb		√			
Balsaminaceae	*Impatiens sp 1*		Herb	Endemic			√	
Balsaminaceae	*Impatiens sp 2*		Herb	Endemic	√			
Begoniaceae	*Begonia areolata Miq.*		Herb			√		
Begoniaceae	*Begonia isoptera Dryand.*		Herb		√			
Begoniaceae	*Begonia muricata Blume*		Herb		√			
Begoniaceae	*Begonia robusta Blume*		Herb		√			
Commelinaceae	*Commelina sp.*		Herb		√	√		
Gesneriaceae	*Cyrtandra sp 1*		Herb		√			
Gesneriaceae	*Cyrtandra sp 2*		Herb		√			
Gesneriaceae	*Cyrtandra sp 3*		Herb		√			

Family	Binomial	Local Name	Plant Phase	Conservation Status	Location			
					Wellpad B	Wellpad E	Wellpad I	Plantation
Hypoxidaceae	*Curculigo orchimoides Gaertn.*		Herb			√		
Melastomataceae	*Sonerila tenuifolia Blume*		Herb			√		
Polygonaceae	*Polygonum chinense L.*		Herb			√		
Rubiaceae	*Argostemma borragineum DC.*		Herb			√		
Rubiaceae	*Argostemma montanun Bl. ex DC.*		Herb			√		
Rubiaceae	*Argostemma uniflorum Bl. ex DC.*		Herb		√		√	
Rubiaceae	*Ophiorrhiza junghuniana Miq.*		Herb		√		√	
Rubiaceae	*Ophiorrhiza longiflora Blume*		Herb			√		
Urticaceae	*Elatostema sinuatum (Bl.) Hassk.*		Herb			√		
Urticaceae	*Elatostema strigosum (Bl.) Hassk.*		Herb		√			
Vittariaceae	*Antrophyum caliifolium*		Herb		√			
Vittariaceae	*Antrophyum latifolium*		Herb		√			
Zingiberaceae	*Etlingera sp.*		Herb		√			
Orchidaceae	*Macodes javanica (Bl.) Hook.f.*		Orchid		√			
Orchidaceae	*Macodes petola Lindl.*		Orchid			√		
Orchidaceae	*Cryptostylis arachnites Hassk.*		Orchid			√		
Orchidaceae	*Dendrobium mutabile (Bl.) Lindl.*		Orchid			√		
Orchidaceae	*Gendup*		Orchid		√	√	√	
Musaceae	*Musa acuminata Colla*	Pisang hutan	Other		√			
Arecaceae	*Caryota mitis Lour.*	Basao	Palm		√			
Arecaceae	*Pinanga sp.*		Palm		√	√		
Arecaceae	*Calamus spp.*		Rattan		√			
Araliaceae	*Trevesia sundaica Miq.*		Shrub		√			
Chloranthaceae	*Sarcandra glabra*		Shrub			√		
Ericaceae	*Gaultheria nummularioides D.Don*		Shrub		√			
Ericaceae	*Vaccinium varingiaefolium (Bl.) Miq.*		Shrub		√			
Ericaceae	*Rhododendron malayanum Jack*		Shrub		√			

Family	Binomial	Local Name	Plant Phase	Conservation Status	Location			
					Wellpad B	Wellpad E	Wellpad I	Plantation
Melastomataceae	*Medinilla speciosa (Reinw. ex Bl.) Blume*		Shrub			√		
Moraceae	*Ficus geophila*		Shrub		√			
Moraceae	*Ficus hirta Vahl*		Shrub			√		
Rosaceae	*Rubus lineatus Reinw. ex Blume*		Shrub				√	
Rosaceae	*Rubus rosaefolius J.E.Smith*		Shrub				√	
Rubiaceae	*Coffea arabica L.*		Shrub					√
Rubiaceae	*Lasianthus laevigata Blume*		Shrub		√	√		
Rubiaceae	*Lasianthus stercorarius Blume*		Shrub			√		
Rubiaceae	*Hypobathrum frutescens Blume*		Shrub			√		
Rubiaceae	*Pavetta montana Reinw. ex Blume*		Shrub			√		
Aceraceae	*Acer laurinum Hassk.*		Tree			√	√	
Actinidiaceae	*Saurauia sp 1*		Tree			√	√	
Actinidiaceae	*Saurauia sp 2*		Tree			√	√	
Aquifoliaceae	*Ilex pleiobrachiata Loes*		Tree			√	√	
Araliaceae	*Schefflera aromatica (Bl.) Harm.*		Tree			√		
Cunnoniaceae	*Weinmania blumei Planch.*		Tree			√	√	
Elaeocarpaceae	*Elaeocarpus griffithii A. Gray*		Tree			√		
Euphorbiaceae	*Macaranga sp.*	Sapot	Tree		√			
Fabaceae	*Albizia falcataria (L.) Forsberg*	Sengon	Tree					√
Fabaceae	*Erythrina subumbrans (Hassk.) Merr.*	Cangkring	Tree					√
Fabaceae	*Leucaena leucocephala (Lmk) De Wit*	Lamtoro	Tree					√
Fagaceae	*Lithocarpus spp.*	Pasang	Tree		√	√	√	
Fagaceae	*Quercus spp.*	Pasang	Tree			√	√	
Flacourtiaceae	*Casearia sp.*		Tree			√		
Icacinaceae	*Platea excelsa Blume*		Tree			√	√	
Lauraceae	*Actinodaphne procera Nees*		Tree			√	√	
Lauraceae	*Cryptocarya ferrea Blume*	Medang	Tree			√	√	

Family	Binomial	Local Name	Plant Phase	Conservation Status	Location			
					Wellpad B	Wellpad E	Wellpad I	Plantation
Lauraceae	*Cryptocarya sp 1*		Tree			√	√	
Lauraceae	*Cryptocarya sp 2*		Tree			√	√	
Lauraceae	*Cryptocarya sp 3*		Tree			√		
Lauraceae	*Lindera bibracteata (Bl.) Boerl.*		Tree			√		
Lauraceae	*Litsea cubeba (Lour.) Pers.*		Tree			√		
Lauraceae	*Litsea elliptica*		Tree			√		
Lauraceae	*Litsea montana*		Tree			√	√	
Lauraceae	*Litsea sp 1*		Tree			√		
Magnoliaceae	*Magnolia candolii Noteboom*	Cempaka	Tree		√			
Meliaceae	*Aglaia sp 1*	Beke elang	Tree			√	√	
Meliaceae	*Aglaia sp 2*		Tree			√		
Meliaceae	*Aglaia sp 3*		Tree			√		
Meliaceae	*Aglaia sp 4*		Tree		√			
Myristicaceae	*Myristica sp.*	Getah merah	Tree		√			
Myrsinaceae	*Rapanea hasseltii Metz*		Tree			√		
Myrtaceae	*Syzygium lineatum Merr.& Perry*		Tree			√	√	
Myrtaceae	*Syzygium sp 1*	Kayu kelat	Tree			√	√	
Myrtaceae	*Syzygium sp 2*		Tree			√		
Nyssaceae	*Nyssa javanica (Bl.) Wang*		Tree			√		
Oleaceae	*Chionanthus laxiflorus*		Tree			√	√	
Oleaceae	*Chionanthus montanus*		Tree			√	√	
Podocarpaceae	*Dacrycarpus imbricatus (Bl.) De Laub.*	Lengkedai	Tree			√	√	
Rhizophoraceae	*Gynothroches axillaris Blume*		Tree			√		
Rosaceae	*Prunus arborea (Bl.) Kalkman*		Tree			√	√	
Rosaceae	*Prunus gricea (C.Muell.) Kalkman*		Tree			√	√	

Family	Binomial	Local Name	Plant Phase	Conservation Status	Location			
					Wellpad B	Wellpad E	Wellpad I	Plantation
Rutaceae	*Euodia hemsleyi*		Tree			√		
Sabiaceae	*Meliosma sp 1*		Tree		√			
Sabiaceae	*Meliosma sp 2*		Tree			√		
Sapotaceae	*Gendup*	Balam	Tree		√			
Saxifragaceae	*Polyosma integrifolia Blume*	Marsawi	Tree				√	
Sterculiaceae	*Pterocymbium javanicum R.Br.*		Tree				√	
Taxacee	*Taxus sumatrana*		Tree	Endemic		√	√	
Theaceae	*Haemocharis integerima*	Cihu	Tree	Endemic		√	√	
Theaceae	*Ternstroemia sp*		Tree			√		
Cyatheaceae	*Cyathea sp 1*		Tree fern			√	√	
Cyatheaceae	*Cyathea sp 2*		Tree fern			√	√	

Source: Greencap (2015)

August 2016

FF1

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Tree								
Cyathaceae	*Cyathea* sp.				1,47	2,08	1,91	5,47
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing		CR	2,94	2,08	0,49	5,52
Fabaceae	*Caesalpinia* sp.				2,94	2,08	0,69	5,71
Fagaceae	*Lithocarpus* sp2				1,47	4,17	1,80	7,43
Fagaceae	*Lithocarpus* sp3				5,88	6,25	1,61	13,74
Fagaceae	*Quercus subsericea*	Kecing batu			1,47	2,08	1,38	4,93
Gymnospermae	*Gymnospermae* sp.				11,76	10,42	0,45	22,63
Lauraceae	*Actinodaphne borneensis*				1,47	2,08	0,97	4,53
Lauraceae	***Actinodaphne* sp.**				**1,47**	**2,08**	**24,31**	**27,87**
Lauraceae	*Alseodaphne* sp2				1,47	2,08	2,51	6,06
Lauraceae	*Cinnamomun parthenoxylon*	Selasihan			1,47	2,08	2,00	5,55
Lauraceae	*Criptocarya griffithiana*	Medang buaya			5,88	4,17	2,04	12,08
Lauraceae	*Cryptocarya* sp.				14,71	10,42	0,48	25,60
Lauraceae	*Litsea* sp2				1,47	2,08	3,36	6,91
Lecythidaceae	*Barringtonia* sp.	Kancil			7,35	4,17	3,05	14,57
Magnoliaceae	*Michelia alba*	Cempaka putih			2,94	2,08	14,16	19,19
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			1,47	2,08	0,69	4,24
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			1,47	2,08	3,08	6,64
Myrtaceae	*Syzygium* sp4	Jambu-jambuan			2,94	4,17	6,96	14,06
Myrtaceae	*Syzygium* sp5				1,47	2,08	0,66	4,21
Myrtaceae	*Syzygium tetraquetra*				4,41	2,08	1,86	8,35

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Pentaphylacaceae	*Adinandra dumosa*	Api-api			1,47	2,08	0,69	4,24
Phyllanthaceae	*Antidesma* sp1				1,47	2,08	5,90	9,45
Phyllanthaceae	*Antidesma* sp2				1,47	2,08	0,53	4,09
Primulaceae	*Ardisia* sp.				4,41	6,25	2,08	12,74
Sterculiaceae	*Scaphium macropodum*	Kembang semangkok		LC	8,82	8,33	2,21	19,37
	sp4				1,47	2,08	10,42	13,98
	sp5				1,47	2,08	1,34	4,90
	sp6				1,47	2,08	2,37	5,92
Tiang								
Anisophylleaceae	*Anisophyllea disticha*				9,52	5,88	8,46	23,86
Cyathaceae	***Cyathea* sp.**				**19,05**	**23,53**	**16,31**	**58,89**
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing		CR	4,76	5,88	5,78	16,43
Fabaceae	*Caesalpinia* sp.				4,76	5,88	3,91	14,55
Fagaceae	*Lithocarpus* sp2				4,76	5,88	7,14	17,79
Lauraceae	*Actinodaphne* sp.				14,29	11,76	16,30	42,35
Lauraceae	*Cryptocarya* sp.				9,52	11,76	10,28	31,57
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			4,76	5,88	4,34	14,99
Myrtaceae	*Syzygium tetraquetra*	Jambu-jambuan			14,29	5,88	15,83	36,00
Primulaceae	*Ardisia* sp.				4,76	5,88	5,04	15,68
Sterculiaceae	*Scaphium macropodum*	Kembang semangkok		LC	4,76	5,88	3,30	13,95
	sp4				4,76	5,88	3,30	13,95
Pancang								
Anisophylleaceae	***Anisophylla disticha***				**21,43**	**11,76**	**13,73**	**46,93**

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Cyathaceae	*Cyathea* sp.				3,57	5,88	16,14	25,59
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing		CR	7,14	5,88	7,56	20,58
Fagaceae	*Lithocarpus* sp3				3,57	5,88	3,90	13,35
Lauraceae	*Actinodaphne glomerata*	Huru dapung			3,57	5,88	0,59	10,04
Lauraceae	*Cryptocarya* sp.				7,14	5,88	7,03	20,05
Lecythidaceae	*Barringtonia* sp.	Kancil			3,57	5,88	0,97	10,43
Magnoliaceae	*Michelia alba*	Cempaka putih			3,57	5,88	4,81	14,27
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			10,71	5,88	23,42	40,02
Myrtaceae	*Syzygium tetraquetra*	Jambu-jambuan			17,86	11,76	10,43	40,06
Phyllantaceae	*Glochidion superbum*	Dalok			3,57	5,88	4,81	14,27
Phyllanthaceae	*Antidesma* sp1				10,71	17,65	5,14	33,50
Polygalaceae	*Xanthophyllum* sp.				3,57	5,88	1,46	10,91
Lantai Hutan								
Apocynaceae	*Hoya* sp.					0,48	1,54	2,02
Araceae	*Philodendron* sp.					0,24	1,54	1,78
Arecaceae	*Calamus* sp.					0,24	1,54	1,78
Aspleniaceae	*Asplenium* sp1					1,44	3,08	4,51
Aspleniaceae	*Asplenium* sp2					0,24	1,54	1,78
Athyriaceae	*Diplazium* sp.	Paku sayur				7,18	1,54	8,72
Begoniaceae	*Begonia* sp.	Begonia				3,59	4,62	8,20
Cyatheaceae	*Syathea* sp.					0,24	1,54	1,78
Cyperaceae	*Cyperus* sp.					0,48	1,54	2,02
Hydrocharitaceae	*Hydrilla* sp.					2,39	1,54	3,93
Hymenophyllaceae	*Trichomanes javanicum*	Pakis kartam				1,91	4,62	6,53
Lauraceae	*Cinnamomum* sp.					1,91	3,08	4,99

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Lauraceae	*Litsea* sp.					0,24	1,54	1,78
Lycopodiaceae	*Lycopodium serratum*					0,48	1,54	2,02
Lycopodiaceae	***Lycopodium* sp1**					**16,99**	**4,62**	**21,60**
Lycopodiaceae	*Lycopodium squarossum*					1,91	1,54	3,45
Melastomataceae	*Pternandra cordata*					0,48	1,54	2,02
Myrtaceae	*Syzygium* sp1	Jambu-jambuan				6,22	4,62	10,84
Myrtaceae	*Syzygium* sp2	Jambu-jambuan				1,44	3,08	4,51
Myrtaceae	*Syzygium* sp3	Jambu-jambuan				0,24	1,54	1,78
Nephrolepidaceae	*Nephrolephis* sp.					0,24	1,54	1,78
Pentaphylacaceae	*Adinandra* sp1					1,44	1,54	2,97
Pentaphylacaceae	*Adinandra* sp2					0,24	1,54	1,78
Phyllanthaceae	*Aporosa* sp1					0,48	1,54	2,02
Phyllanthaceae	*Aporosa* sp2					1,20	1,54	2,73
Piperaceae	*Piper* sp.					0,48	1,54	2,02
Proteaceae	*Helicia* sp.					1,44	3,08	4,51
Pteridaceae	*Adiantum caudatum*	Suplir				12,92	6,15	19,07
Rubiacae	*Adina* sp1					0,72	1,54	2,26
Rubiacae	*Adina* sp2					0,24	1,54	1,78
Rubiaceae	*Lasianthus* sp1					1,20	1,54	2,73
Rubiaceae	*Lasianthus* sp2					0,48	1,54	2,02
Rubiaceae	*Rubiaceae*					1,20	1,54	2,73
Selaginellaceae	*Selaginella* sp2					14,11	6,15	20,27
	Sp2					5,26	3,08	8,34
	Sp3					1,20	3,08	4,27
	Sp4					0,48	1,54	2,02

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
	Sp5					6,94	6,15	13,09
	Sp6					0,48	1,54	2,02
	Sp7					0,24	1,54	1,78
	Sp8					0,24	1,54	1,78
	Sp9					0,48	1,54	2,02

Source: ANDAL PT SERD (2016)

FF4

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

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

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			7,14	8,70	5,98	21,81
Rutaceae	*Acronychia porteri*		LC		3,57	4,35	2,06	9,98
	sp3				3,57	4,35	3,47	11,39
	sp4				3,57	4,35	5,79	13,70
Pancang								
Anisophylleaceae	*Anisophylla disticha*				9,09	10,00	12,34	31,43
Lauraceae	*Actinodaphne borneensis*				9,09	10,00	12,09	31,18
Lauraceae	*Cryptocarya* sp.				9,09	10,00	0,81	19,90
Lauraceae	*Criptocarya griffithiana*	Medang buaya			18,18	20,00	10,56	48,75
Lauraceae	*Litsea* sp2				9,09	10,00	0,81	19,90
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			9,09	10,00	2,01	21,10
Myrtaceae	*Syzygium tetraquetra*				9,09	10,00	3,22	22,31
Phyllanthaceae	*Antidesma* sp1				18,18	10,00	10,80	38,98
Rutaceae	***Acronychia porteri***				**9,09**	**10,00**	**47,36**	**66,45**
Lantai Hutan								
Arecaceae	*Calamus* sp.				4,15	8,06		12,21
Arecaceae	*Licuala* sp.				1,04	1,61		2,65
Aspleniaceae	*Asplenium nidus*	Paku sarang burung			0,52	1,61		2,13
Athyriaceae	*Diplazium* sp.	Paku sayur			11,92	8,06		19,98
Begoniaceae	***Begonia sp1***	**Begonia**			**28,50**	**8,06**		**36,56**
Begoniaceae	*Begonia* sp2	Begonia			2,59	3,23		5,82
Calophyllaceae	*Calophyllum* sp.				1,04	1,61		2,65
Cecropiaceae	*Myrianthus* sp.				0,52	1,61		2,13
Euphorbiaceae	*Macaranga tanarium*	Mara			1,55	3,23		4,78
Gesneriaceae	*Aeschynanthus radicans*	Tanaman lipstik			2,07	3,23		5,30

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Gesneriaceae	*Gesneriaceae*				1,04	3,23		4,26
Lamiaceae	*Vitex trifolia*	Legundi			0,52	1,61		2,13
Lauraceae	*Alseodaphne* sp.				0,52	1,61		2,13
Lauraceae	*Cryptocarya ferrea*	Huru kayu			0,52	1,61		2,13
Lauraceae	*Litsea* sp.				0,52	1,61		2,13
Lomariopsidaceae	*Nephrolepis* sp.	Paku pedang			0,52	1,61		2,13
Melastomataceae	*Pternandra* sp.				0,52	1,61		2,13
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			0,52	1,61		2,13
Orchidaceae	*Anoectochilus* sp.	Anggrek permata		II	0,52	1,61		2,13
Orchidaceae	*Bulbophyllum macranthum*	Anggrek dupa	LC	II	1,04	3,23		4,26
Orchidaceae	*Bulbophylum uniflorum*			II	0,52	1,61		2,13
Orchidaceae	*Calanthe triplicata*			II	0,52	1,61		2,13
Orchidaceae	Orchidaceae (sp2)			II	0,52	1,61		2,13
Phyllanthaceae	*Aporosa* sp1				5,70	8,06		13,76
Primulaceae	*Ardisia* sp.				0,52	1,61		2,13
Pteridaceae	*Adiantum* sp.	Suplir			17,62	8,06		25,68
Rosaceae	*Rubus rosifolius*	Rubus			0,52	1,61		2,13
Rubiacae	*Adina* sp.				1,04	1,61		2,65
Rubiacae	*Psychotria* sp.				2,07	4,84		6,91
Sapotaceae	*Payena* sp.				0,52	1,61		2,13
Selaginellaceae	*Selaginella* sp2	Paku rane			6,22	3,23		9,44
Theaceae	*Camellia* sp.				0,52	1,61		2,13
Vitaceae	*Leea indica*	Girang merah			1,04	1,61		2,65
Zingiberaceae	Zingiberaceae				2,59	1,61		4,20

Source: ANDAL PT SERD (2016)

FF6

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Pohon								
Anisophylleaceae	*Anisophyllea disticha*		LC		10.81	12.5	6.64	29.95
Cyatheaceae	*Cyathea* sp.				6.76	7.5	2.82	17.08
Dipterocarpaceae	*Dipterocarpus grandifloris*	Keruing	CR		4.05	5	1.82	10.87
Fabaceae	*Caesalpinia* sp.				2.7	5	11.88	19.58
Fagaceae	*Lithocarpus* sp.				1.35	2.5	1.13	4.98
Lauraceae	*Actinodaphne* sp.				4.05	5	1.34	10.39
Lauraceae	***Cryptocarya* sp.**				**25.68**	**12.5**	**18.44**	**56.62**
Lauraceae	Lauraceae 1				8.11	10	22.09	40.19
Lauraceae	Lauraceae 2				2.7	2.5	2.8	8
Lauraceae	*Cinnamomun parthenoxylon*	Selasihan			1.35	2.5	2.94	6.79
Lauraceae	*Alseodaphne* sp.				1.35	2.5	0.5	4.35
Lauraceae	Lauraceae 3				2.7	2.5	3.06	8.26
Lecythidaceae	*Barringtonia* sp.	Kancil			16.22	12.5	19.25	47.96
Myrtaceae	*Syzygium* sp1	Jambu-jambuan			4.05	5	1.32	10.38
Primulaceae	*Ardisia* sp.				2.7	5	1.47	9.17
Sterculiaceae	*Scaphium macropodum*	Kembang semangkok	LC		5.41	7.5	2.5	15.4
Tiang								
Anisophylleaceae	*Anisophyllea disticha*				10,34	9,09	10,56	30,00
Cyathaceae	*Cyathea* sp.				3,45	9,09	12,09	24,63
Lauraceae	*Actinodaphne* sp.				3,45	9,09	2,01	14,55
Lauraceae	***Cryptocarya* sp.**				**37,93**	**9,09**	**47,36**	**94,39**

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Myrtaceae	*Syzygium* sp2	Jambu-jambuan			10,34	9,09	12,34	31,77
Myrtaceae	*Eugenia* sp.				10,34	18,18	3,22	31,74
Polygalaceae	*Xanthophyllum* sp.				3,45	9,09	0,81	13,35
Rubiaceae	*Adina* sp.				17,24	9,09	10,80	37,13
Rubiaceae	*Randia* sp.				3,45	18,18	0,81	22,44
Pancang								
Anisophylleaceae	*Anisophyllea disticha*				9,09	10,00	12,34	31,43
Lauraceae	*Actinodaphne borneensis*				9,09	10,00	12,09	31,18
Lauraceae	*Cryptocarya* sp.				9,09	10,00	0,81	19,90
Lauraceae	*Criptocarya griffithiana*	Medang buaya			18,18	20,00	10,56	48,75
Lauraceae	*Litsea* sp2				9,09	10,00	0,81	19,90
Myrtaceae	*Syzygium* sp3	Jambu-jambuan			9,09	10,00	2,01	21,10
Myrtaceae	*Syzygium tetraquetra*	Jambu-jambuan			9,09	10,00	3,22	22,31
Phyllanthaceae	*Antidesma* sp1				18,18	10,00	10,80	38,98
Rutaceae	***Acronychia porteri***	**Ketiak**			**9,09**	**10,00**	**47,36**	**66,45**
Lantai Hutan								
Araceae	*Arisaema* sp	Kiacung			0,99	2,70		3,69
Aspleniaceae	*Asplenium* sp1	Paku-pakuan			6,93	5,41		12,34
Balsaminaceae	*Impatiens* sp				1,98	5,41		7,39
Begoniaceae	*Begonia* sp1	Begonia			14,85	5,41		20,26
Begoniaceae	*Begonia* sp2	Begonia			3,96	5,41		9,37
Cyathaceae	*Cyathea* sp.				8,91	5,41		14,32
Drypoteridaceae	***Dryopteris* sp.**	**Paku-pakuan**			**10,89**	**13,51**		**24,40**
Gesneriaceae	*Aeschynanthus radicans*	Tanaman lipstik			3,96	5,41		9,37
Lamiaceae	*Lamiaceae* sp1				2,97	5,41		8,38

Family	Binomial	Local Name	Conservation Status		Relative Density (%)	Relative Frequency (%)	Relative Density (%)	Important Value Indices
			IUCN	CITES				
Lomariopsidaceae	*Nephrolepis hirsutula*	Paku kinca			8,91	5,41		14,32
Lycopodiaceae	*Lycopodium* sp1	Paku kawat			9,90	8,11		18,01
Lycopodiaceae	*Lycopodium* sp2	Paku kawat			0,99	2,70		3,69
Myrtaceae	*Syzygium* sp1	Jambu-jambuan			0,99	2,70		3,69
Orchidaceae	*Bulbophyllum macranthum*	Anggrek dupa	LC	II	2,97	5,41		8,38
Orchidaceae	Orchidaceae (sp1)			II	0,99	2,70		3,69
Piperaceae	Piperaceae sp1				1,98	2,70		4,68
Rubiaceae	Rubiaceae sp1				1,98	2,70		4,68
Selaginellaceae	*Selaginella* sp1	Paku rane			11,88	2,70		14,58
Theaceae	*Camellia* sp.				1,98	5,41		7,39
Vitaceae	*Cissus* sp.				0,99	2,70		3,69
	Sp1 (tidak teridentifikasi)				0,99	2,70		3,69

Source: ANDAL PT (2016)

Appendix V

List of Bird Species

List of Bird Species was discovered on Study Area

Family	Name		Status		Distribution
	English	Scientific name	GOI	IUCN	
Accipitridae	Oriental Honey-buzzard	*Pernis ptilorhynchus*	P	LC	Migratory
Accipitridae	Black Eagle	*Ictinaetus malayensis*	P	LC	
Accipitridae	Changeable Hawk-eagle	*Nisaetus cirrhatus*	P	LC	
Accipitridae	Crested Serpent-eagle	*Spilornis cheela*	P	LC	
Alcedinidae	Collared Kingfisher	*Todirhamphus chloris*	P	LC	
Bucerotidae	Oriental pied hornbill	*Anthracoceros convexus*	P	LC	
Nectariniidae	Plain Sunbird	*Anthreptes simplex*	P	LC	
Nectariniidae	Grey-breasted Spiderhunter	*Arachnothera affinis*	P	LC	
Nectariniidae	Olive-backed Sunbird	*Nectarinia jugularis*	P	LC	
Estrildidae	Java Sparrow	*Padda oryzivora*	-	VU	
Phasianidae	Bronze-tailed Peacock-pheasant	*Polyplectron chalcurum*	-	NT	Endemic
Muscicapidae	Snowy-browed flycatcher	*Ficedula hyperythra sumatrana*	-	LC	Endemic
Phasianidae	Red-billed Partridge	*Arborophila rubrirostris*	-	LC	Endemic
Motacillidae	Gray Wagtail	*Motacilla cinerea*	-	LC	Migratory
Rallidae	Common Moorhen	*Gallinula chloropus*	-	LC	Migratory
Aegithinidae	Common Iora	*Aegithina tiphia*	-	LC	
Ardeidae	Green-backed Heron	*Butorides striata*	-	LC	
Ardeidae	Cinnamon Bittern	*Ixobrychus cinnamomeus*	-	LC	
Campephagidae	Sunda Minivet	*Pericrocotus miniatus*	-	LC	
Chloropseidae	Greater green leafbird	*Chloropsis sonnerati*	-	LC	
Columbidae	Zebra Dove	*Geopelia striata*	-	LC	
Columbidae	The spotted dove	*Streptopelia chinensis*	-	LC	
Columbidae	Wedge-tailed green pigeon	*Treron sphenurus korthalsi*	-	LC	
Corvidae	Grey Treepie	*Dendrocitta formosae*	-	LC	
Cuculidae	Plaintive Cuckoo	*Cacomantis merulinus*	-	LC	
Cuculidae	Lesser Coucal	*Centropus bengalensis*	-	LC	
Dicaeidae	Yellow-vented Flowerpecker	*Dicaeum chrysorrheum*	-	LC	
Dicaeidae	Scarlet-backed Flowerpecker	*Dicaeum cruentatum*	-	LC	
Dicaeidae	Orange-bellied flowerpecker	*Dicaeum trigonostigma*	-	LC	
Dicruridae	Ashy Drongo	*Dicrurus leucophaeus*	-	LC	
Dicruridae	Lesser Racket-tailed Drongo	*Dicrurus remifer*	-	LC	
Estrildidae	Javan Munia	*Lonchura leucogastroides*	-	LC	
Estrildidae	Scaly-breasted Munia	*Lonchura punctulata*	-	LC	
Hirundinidae	Pacific Swallow	*Hirundo tahitica*	-	LC	
Laniidae	Long-tailed Shrike	*Lanius schach*	-	LC	
Leiothrichidae	Chestnut-capped Laughingthrush	*Garrulax mitratus*	-	LC	
Meropidae	Blue-tailed Bee-eater	*Merops philippinus*	-	LC	
Muscicapidae	Oriental Magpie-robin	*Copsychus saularis*	-	LC	
Muscicapidae	Hill Blue-flycatcher	*Cyornis banyumas*	-	LC	
Muscicapidae	Asian Brown Flycatcher	*Muscicapa dauurica*	-	LC	
Muscicapidae	Shiny whistling thrush	*Myophonus melanurus*	-	LC	
Passeridae	Eurasian Tree Sparrow	*Passer montanus*	-	LC	
Phasianidae	Red Junglefowl	*Gallus gallus*	-	LC	
Picidae	Sunda Pygmy Woodpecker	*Picoides moluccensis*	-	LC	
Picidae	Orange-backed Woodpecker	*Reinwardtipicus validus*	-	LC	
Pnoepygidae	Pygmy wren-babbler	*Pnoepyga pusilla penida*	-	LC	

Family	Name		Status		Distribution
	English	Scientific name	GOI	IUCN	
Psittacidae	Blue-crowned Hanging-parrot	*Loriculus galgulus*	-	LC	
Pycnonotidae	Sooty-headed Bulbul	*Pycnonotus aurigaster*	-	LC	
Pycnonotidae	Yellow-vented Bulbul	*Pycnonotus goiavier*	-	LC	
Rallidae	White-breasted Waterhen	*Amaurornis phoenicurus*	-	LC	
Rhipiduridae	White-throated Fantail	*Rhipidura albicollis*	-	LC	
Strigidae	Collared Owlet	*Glaucidium brodiei*	-	LC	
Sylviidae	Dark-necked Tailorbird	*Orthotomus atrogularis*	-	LC	
Sylviidae	Ashy Tailorbird	*Orthotomus ruficeps*	-	LC	
Sylviidae	Rufous-tailed tailorbird	*Orthotomus sericeus*	-	LC	
Sylviidae	Inornate Warbler	*Phylloscopus inornatus*	-	LC	
Sylviidae	Perenjak gunung	*Prinia atrogularis*	-	LC	
Timaliidae	Horsfield's Babbler	*Malacocincla sepiaria*	-	LC	
Timaliidae	Grey-throated Babbler	*stachyris nigriceps*	-	LC	
Turnicidae	Barred Buttonquail	*Turnix suscitator*	-	LC	
Tytonidae	Common Barn-owl	*Tyto alba*	-	LC	

Geothermal Power Plant in Rantau Dedap in Lahat Regency, Muara Enim Regency and Pagar Alam City, South Sumatra Province

Critical Habitat Assessment

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DRAFT REPORT

Supreme Energy

Geothermal Power Plant Rantau Dedap in Lahat Regency, Muara Enim Regency and Pagar Alam City, South Sumatra Province,

Critical Habitat Assessment

March 2017

Reference: 0383026 CH Assessment SERD

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CONTENTS

1 INTRODUCTION

1.1 PURPOSE OF THE REPORT

This report outlines the results of the assessment of impacts to critical habitat relating to the PT Supreme Energy Rantau Dedap (SERD) Geothermal Project (the 'Project').

There is an existing body of work compiled as part of the Project that includes information relevant to the impact to biodiversity values. Specifically this includes the following documents:

- Environmental, Social and Health Impact Assessment (ESIA DRAFT FINAL) 250MW Rantau Dedap Geothermal Powerplant (Phase 1-92MW) South Sumatra, Indonesia, December 2016 (Greencap, 2017)
- Final Report of Study of Endangered Species at Rantau Dedap, PT Supreme Energy Rantau Dedap (SERD) Muara Enim Regency and Pagar Alam City, South Sumatra Province, February 2015 (Greencap, 2015); and
- Biodiversity Action Plan (Draft Final), PT Supreme Energy Rantau Dedap (PT SERD) Lahat Regency, Muara Enim Regency and Pagar Alam City, South Sumatra Province, November 2016 (Greencap, 2017).
- Critical Habitat Assessment Report (Draft Final), PT Supreme Energy Rantau Dedap (PT SERD) Lahat Regency, Muara Enim Regency and Pagar Alam City, South Sumatra Province, November 2016 (Greencap, 2017).

The primary purpose of this report is to document a assessment of impacts to biodiversity in accordance with Asian Development Bank (ADB) Safeguard Policy Statement (2009) and International Finance Corporation (IFC) Performance Standard (PS) 6, in particular Critical Habitat (According to Paragraphs 16-19 of the PS).

Section 3 summarises the baseline biodiversity values associated with the Project Footprint and Area of Influence (***Figure 1.1***).

The '*Project Area*' is defined as the direct disturbance footprint of the project infrastructure and is approximately 124.5ha[1]. It should be noted that a substantial portion of the footprint was cleared as part of the exploration activities that commenced in 2011/2012 and as such any footprint disturbance calculations are based on datasets prior to this time.

The Project '*Area of Influence*' (AoI) is defined as the area encompassed by a five kilometre (km) buffer from the Project Area and is approximately 25,823 ha. The buffer distance has been assigned in order to consider impacts that may occur in the Project Area surrounds. While a summary of baseline conditions is provided in this report the focus of *Section 3* is identification of

[1] Not including the transmission line.

the '*Priority Biodiversity Values*' in order to assess impacts to Critical Habitat. Priority biodiversity values are values that are considered candidates for consideration for Critical Habitat status.

*Section*s *0* and *6* document the impact assessment and application of the mitigation hierarchy in accordance with the ADB Safeguard Policy Statement and IFC PS6.

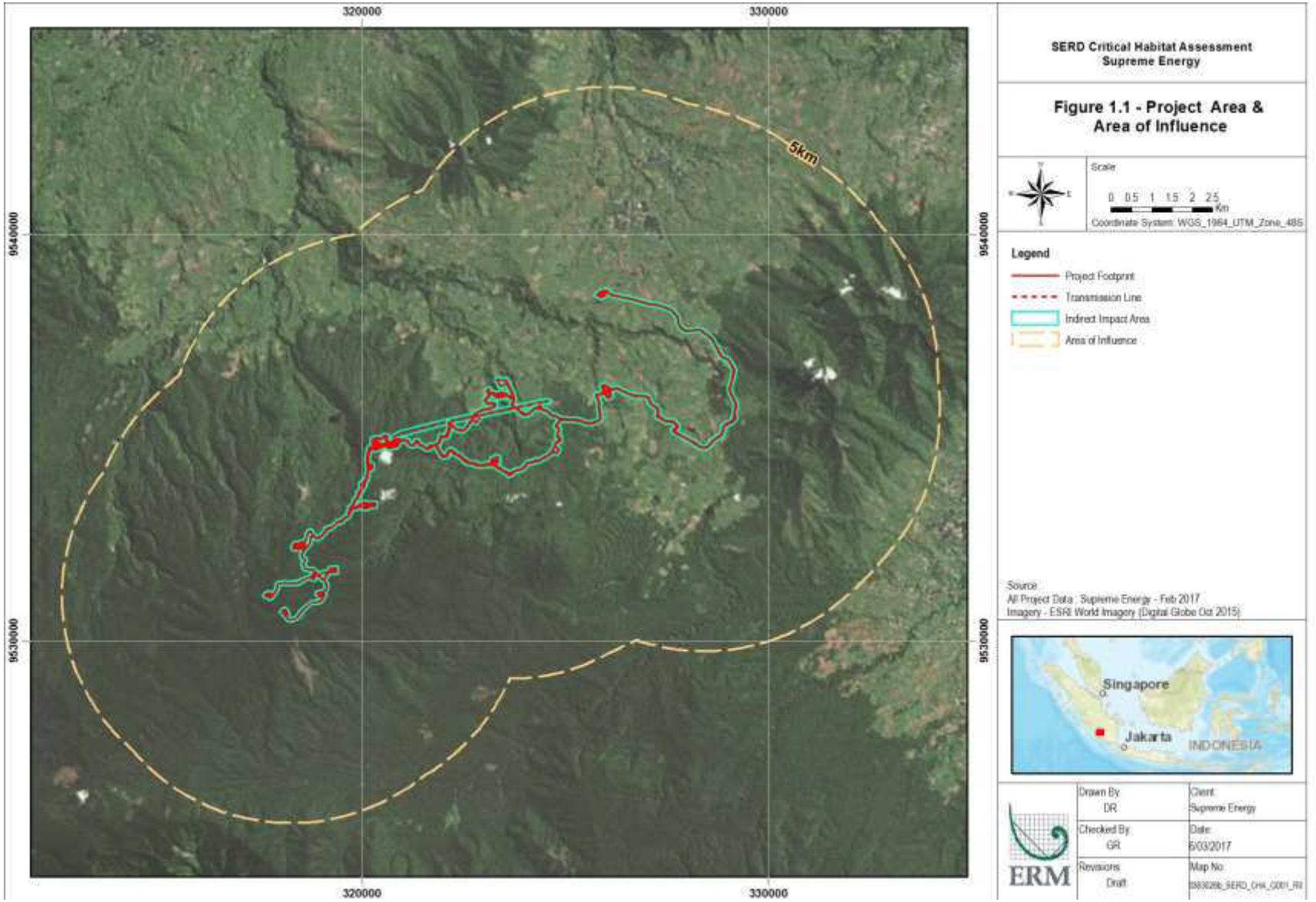
1.2 QUALIFICATIONS

The Project that has included a sequence of disturbance events to biodiversity values since exploration activities that commenced in January 2013. In order to identify the impact the biodiversity for the complete Project, data available regarding the values prior to this disturbance has been utilised where appropriate. This approach aims to develop an understanding of the baseline characteristics of the site prior to exploration such that impacts to habitats and ecosystems could be predicted retrospectively (when considering exploration activities).

The assessment of potential impacts related to terrestrial biodiversity in this Chapter is based on the environmental baseline data collected by Greencap and reported in draft documentation; desktop sources (as referenced); and judgements made based on available data, professional knowledge and previous experience of ERM from other projects within the vicinity.

From the data available from studies undertaken for other projects within Sumatra there is a high likelihood of endemic species occurring within the Project Area. Therefore there is a possibility that a number of endemic species may not have been recorded within the Project Area by previous studies. To overcome this gap, management measures have been developed to implement a precautionary approach a requirements to conduct pre-clearance surveys and assessments prior to the next phase of construction. This approach aims to detect conservation significant endemic flora prior to disturbance and allow for avoidance, translocation or seed harvest to be undertaken.

Figure 1.1 Project Area and Project Area of Influence



2 PROJECT DESCRIPTION

PT Supreme Energy Rantau Dedap (SERD) plans to develop a Geothermal Power plant project at the geothermal field in Rantau Dedap, South Sumatra ('the Project'). The concession is located approximately 91km south of Muara Enim, 225km to the southwest of Palembang, the capital city of South Sumatra Province and 100km southeast of Bengkulu, the capital of Bengkulu Province.

The development plans broadly comprise construction and operation of geothermal power units, construction of supporting infrastructures, and electricity distribution. These activities have potential to cause environmental impacts.

All activities of the development during construction and operation described below and the spatial areas impacted are defined as the Project Area for the purposes of this report. The Project Area is defined spatially in ***Figure 2.1***.

2.1 PROJECT HISTORY AND STAGING

Following award of the Rantau Dedap concession in December 2010 and grant of a Mining Area Licence in 2011, the exploration program commenced. Initially, the activities undertaken included topographic survey, civil engineering study, heat loss survey and geo-scientific interpretation, and these were completed in 2012.

In November 2012 the Project entered into a Power Purchase Agreement (PPA) with Perusahaan Listrik Negara, defining the contractual rights and obligations of the parties during exploration phase, construction phase and operation phase. At this stage, among other activities, land was acquired including approximately 91ha of Protected Forest Area and 10ha of other land, and access roads were built within the protected areas.

Civil and infrastructure work commenced in January 2013 and in February 2014 the exploratory drilling program began.

With the completion of the pre-feasibility and feasibility studies and then Front End Engineering Design (in 2016) the next stage of the Project will be the full development, including additional well drilling and construction of the steamfield, power plant, pipelines and other supporting infrastructure.

The Project life is expected to be 30 years though there may be opportunity to continue. Five years prior to the end of the Project life a decommissioning plan will be prepared to restore the area.

2.2 PROJECT CONFIGURATION

The main project components of the Rantau Dedap Geothermal Power Plant are described below and shown in ***Figure 2.1***.

2.2.1 *Production Wells, Injection Wells, and Wellpads*

The total estimated well requirement for operation of the full capacity 250MW power plant is 48 production wells (across eight wellpads). The 92MW Phase 1 dual flash power plant requires 16 production wells and four injection wells, situated on four to six wellpads. The completed exploration phase activities have developed four wellpads (and six wells).

Injection (or reinjection) wells are required to discharge brine and condensate back into the formation. The injection wells will be located downhill, at the existing Wellpad B and Wellpad E.

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

2.2.2 *Pipelines*

The pipeline network consists of an above-ground Steam Gathering System as well as the freshwater supply.

The pipeline route will follow existing roads or dedicated corridors to facilitate easier and lower-impact construction and maintenance. Cut and fill will be necessary in some pipeline sections to stabilise slopes and manage safe operation conditions.

Drainage channels will be built parallel to the pipelines in addition to inspection roads. At some sections, structures to cross roads, rivers, or other features are to be built.

2.2.3 *Soil Disposal*

There are two soil disposal areas located in the new well pad areas. Over excavated soil is expected only for the new roads to wellpads L and M. Other planned earthworks are equal cut and fill balances.

2.2.4 *Power Generation*

Steam and brine are separated from the flow from wells a separator stations. Brine will be reinjected into the formation, while the separated steam will then enter a scrubber to purify the steam from impurities such as silica.

The purified steam then enters a turbine where it drives the turbine shaft to produce mechanical energy and a generator converts this mechanical energy into 11kV electricity. This is then run through a step-up transformer unit and channelled to the GIS substation in the power plant area.

2.2.5 Switchyard and Transmission Line

The PT SERD switchyard is located within the power plant area. The interface between PT SERD and the PLN network is at the high voltage gantry of the switchyard, which is used for connection to the PLN transmission line.

The switchyard is the end point of connection at a voltage of 150 kV to the PLN transmission and distribution network. From this switchyard, a transmission line will be constructed. (Note: PT SERD are not seeking finance for the transmission line however it has been included here consider potential impacts of the Project whole).

The proposed transmission line within the project area is 12.4km and connects the power plant switchyard to the PLN 150 kV substation. The transmission line then extends out of the project area from the PLN substation to Lumut Balai substation where it connects to the regional grid. The length of this section of the transmission line is 26.7km. The total length of the transmission line is 39.1km.

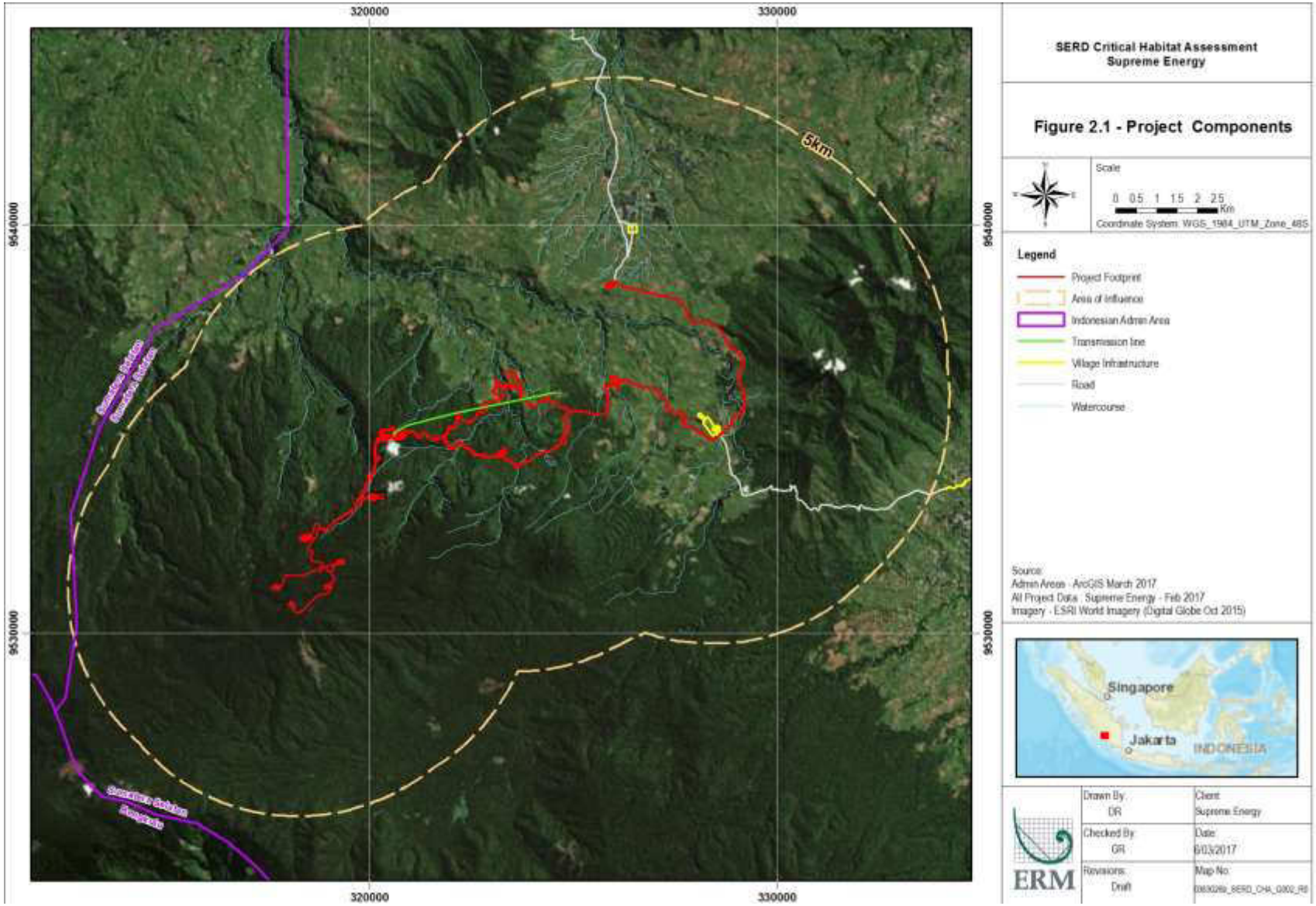
2.2.6 Access Roads

The total access road requirement is 52.5km. During the exploration activities 42.5km of access and connecting roads have been built with the additional 10km to be constructed in the next phase.

2.2.7 Additional Facilities

PT SERD will build facilities for a domestic water supply and treatment plant, waste water treatment, chemical storage, warehouse, workshop, firefighting system, open storage areas, project administration building and accommodation block.

Figure 2.1 Project Components



3 BASELINE BIODIVERSITY AND ECOSYSTEM SERVICES SUMMARY

3.1 BASELINE BIODIVERSITY VALUES

The Project site is largely located in the Muara Enim Solok Regency of South Sumatra, at the slopes and foothills of the Mount Patah range approximately 25 kilometres (km) to the southeast of the city of Pagar Alam (***Figure 3.1***). A small portion of the Project Area lies within the neighbouring Lahat Regency.

The Project is located within the Bukit Barisan highland, known for its rich biodiversity. There is a range of land uses in the region however the forested mountains of the Barisan Range dominate the wider landscape. The area is remote and relatively undeveloped with steep terrain. It is reported that most of the area has only walking trails or no access ways.

3.1.1 *Definition of Area of Influence*

ERM has defined the Area of Influence (AoI) of the Project as all contiguous forested habitats within 5km of the Project Area Boundary. This area has been defined based on the likely habitat utilisation of the species detected from previous surveys and for species likely to occur within the area. Some species may move beyond the AoI (such as for migration or breeding), however the defined AoI is likely to represent the area likely to be impacted by the Project.

3.1.2 *Biodiversity Survey and Assessment Summary*

3.1.2.1 *Surveys Undertaken*

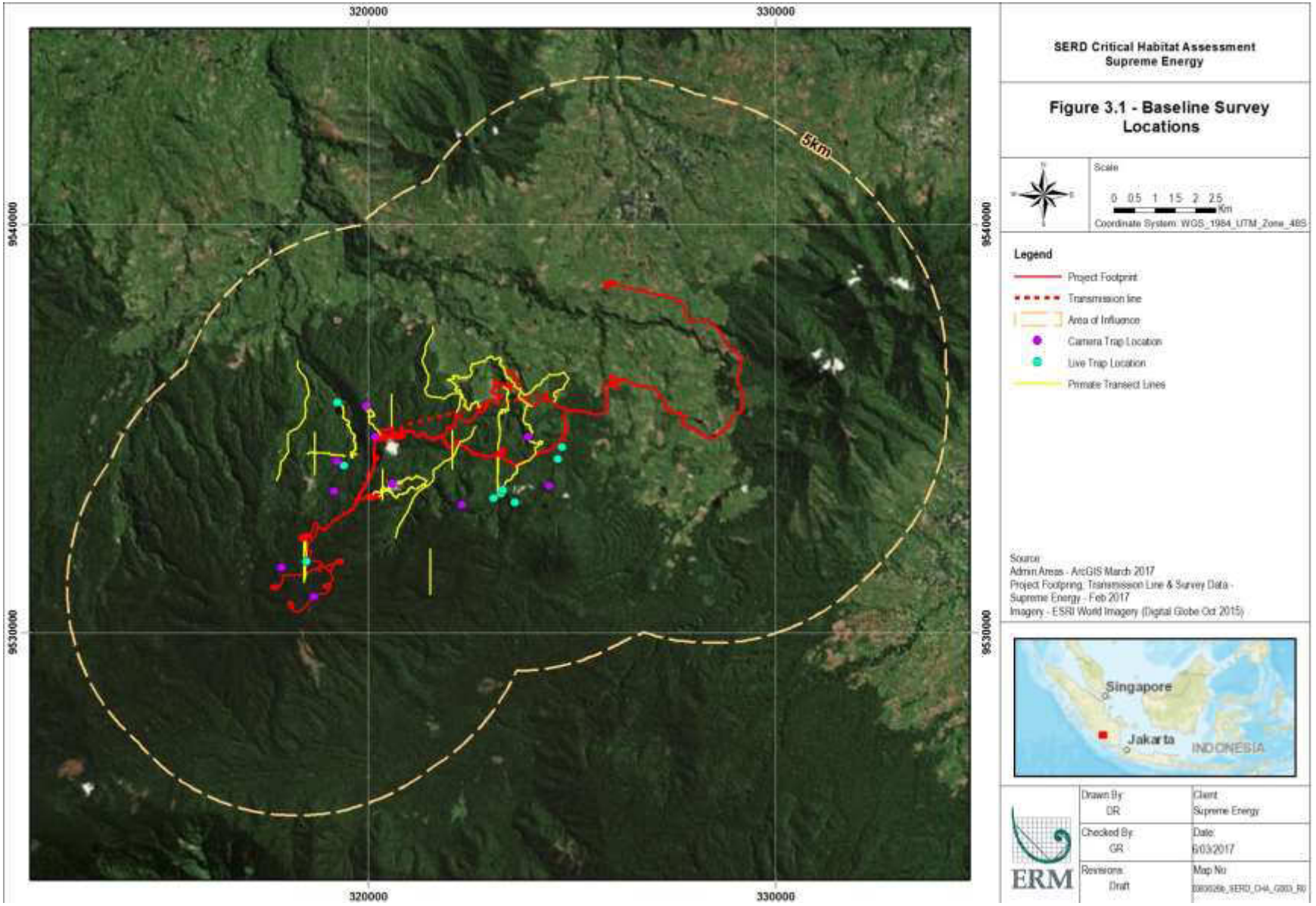
Greencap (2017) summarised the key field studies undertaken to describe the baseline biodiversity values associated with the Project. This included:

- Baseline Biodiversity Study in January 2014 – an assessment undertaken before the exploration stage where sampling locations focussed on capturing study of representative ecosystem types.
- Biodiversity Study September 2014 - January 2015 – an assessment undertaken during the exploration stage consisting of camera traps and rapid observation methods for the purpose of identification and mapping of endangered species in the Project Area and surrounds;
- Biodiversity Study July – October 2016 – an assessment undertaken after the exploration stage focussing on Well pad I, B and E. The study employed rapid assessment methods and camera traps. The survey consisted of flora plots at Well pads I, B and E to collect data on density and abundance of flora species of different strata. Mammal observations were completed along 1,000 m long, 50 m wide strip width line transects and supplemented by camera trapping, small animal trapping, mist netting, concentration counts and community interviews. Bird surveys were completed on transects (6:00 – 11:00) and adopting concentration counts. Camera traps and mist nets were used in combination with line

transects. The latter was also used for bird surveys. Reptiles and amphibians were detected using night visual encounters and line transects. In addition habitats were classified as natural and modified habitat using land cover information, remote sensing techniques and spatial analysis.

The locations of surveys undertaken by Greencap are shown in ***Figure 3.1***.

Figure 3.1 Baseline Survey Locations (Greencap, 2016)



3.1.2.2 *Consultation*

No specific consultation was undertaken by GreenCap in relation to biodiversity and ecosystem service values.

ERM undertook consultation in relation to the assessment and management of aquatic biodiversity values. This consultation was undertaken in March 2017 with:

- Dr Maurice Kottelat: freelance taxonomist specialised in biodiversity surveys of aquatic habitats and Chair of the committee on taxonomy for ichthyology of the International Commission on Zoological Nomenclature; and
- Dr Dewi Imelda Roesma: Biology Department, Faculty of Mathematics and Natural Sciences, Andalas University, Padang, West Sumatra, Indonesia

3.1.2.3 *Other Desktop Resources*

Key resources reviewed and utilised to describe the baseline biodiversity values have been referenced throughout this document. These sources in addition to spatial layers were reviewed to identify potentially relevant features in the absence of more detailed ground-truthed data.

3.1.3 Spatial Analysis

ERM undertook a spatial assessment using a Geographical Information System (GIS) clearing of vegetation within the AoI from Project related and non-project related activities from 2014 to the present (2016). Supreme advised that minor exploration activities occurred prior to work commencing on the project in 2010.

Land classes within each site were developed based on a review of existing baseline information, satellite imagery and field observations. An assessment of the distribution of Natural Habitat (as defined by ADB SPS) within the Project AoI was also undertaken to inform the impact assessment.

3.1.3.1 *Data sources*

The United States Geographical Service's (USGS) archive of Landsat satellite imagery was reviewed for the period from 2008 to the present (January 2017) to identify the best available imagery in annual time steps. The primary constraint on image quality is the presence of cloud. Cloud free images were identified for 2014, 2015 and 2016.

Only Landsat7 was available prior to 2014 and due to the functional issues with Landsat7, combined with persistent cloud results, a minimal area of imagery was identified that could have been analysed. The images selected and notes on the imagery selected are provided below in *Table 3.1*.

Table 3.1 Landsat Satellite Imagery Selected for Analysis

Image	Path	Row	Image Date	Notes	Satellite	Status
1	125	63	06-Aug-16	Cloud Present	Landsat8	Utilised - cloud masked
2	125	63	03-Jul-15	Largely Cloud free over AoI	Landsat8	Utilised
3	125	63	16-Jul-14	Largely Cloud free over AoI	Landsat8	Utilised

3.1.3.2 Land Clearing Assessment

A number of indices were tested for suitability to map bare ground in the AOI, including the Normalised Differential Vegetation Index (NDVI) and the Bare Ground Index (BGI), however it was found that the following index was most effective: Landsat8 (Band 4 – Band 2) / (Band 4 + Band 2); and Landsat5 andLandsat7 (Band 3 – Band 1) / (Band 3 + Band 1). Threshold values were set for each time step resulting in a binary image (cleared or not cleared). These images were corrected for cloud cover and converted to polygons for area calculations and mapping in GIS.

The total cleared area was calculated for 2014 as a baseline to define non-project related clearing. Subsequent area changes in clearing were calculated for each subsequent year. The cleared land was classified as: Project related clearing and Project induced clearing, being clearing not associated with direct project activities. It should be noted that clearing for project related activities commenced in April 2012.

Assessments of the imagery were made within the AoI and also within 1km of the Project area boundary. The 1km buffer from the Project area boundary was chosen in order to define an area that may have been made accessible from project related activities. Clearing within the 1km buffer is generally in a contiguous landscape with the Project Area and hence would likely be the area most impacted by project induced clearing during the period. Interpretation of the imagery indicates that clearing was occurring prior to the project related activities commencing (January 2013) as well as in areas that were geographically isolated from the Project Area but were within the AoI.

It should be noted that the clearing assessment is an estimation only and may still include clearing that was not induced by the project and therefore be an overestimate.

3.1.3.3 Natural Habitat Mapping

Natural and Modified habitat was mapped based on the extent of natural vegetation mapped in 2013. Image interpretation was combined with previously mapped Modified Habitat areas from 2013 and the combined cleared area mapping to generate Natural Habitat data set for 2016.

3.2 BASELINE BIODIVERSITY VALUES

3.2.1 Project Area Overview

The Project Area is part of the Bukit Besar highlands in South Sumatra, amidst an area dominated by volcanic mountains, namely Bukit Besar, Bukit Mutung and Mount Anak complex. The elevation of the Project Area ranges between 1,000 m and 2,600 m above sea level (asl). The land uses in the activity location are listed as coffee plantations, dryland agriculture and settlements. Forest ecosystems present within the Project Area include primary montane and primary and secondary submontane forests.

The Project ANDAL reports there are several waterbodies associated with the Project, in particular the Cawang River, Asahan River, Puyang Lake, Deduruk Lake and Endikat River. The riviers are tributaries of the Lematang River (97.5 km in length) and the Lematang Watershed (7,380 km^2).

Majority of the Project footprint overlaps with Protected Forest. The Project is located 27.3 km from Bukit Barisan Selatan National Park (BBSNP), which is a nationally protected (IUCN Category II) and globally recognised important habitat area (IBA and KBA).

3.2.2 Vegetation and Habitats

Vegetation within the Project Area is represented by coffee plantations, secondary submontane forest, primary submontane forest and primary montane forest. The montane and submontane forests were classified as highland montane and lowland montane respectively. A number of CITES-listed orchid species were found from these forests collectively however none of these were nationally protected or listed on the IUCN Red List. One Critically Endangered species, *Dipterocarpus sp.* was recorded within the Project Area.

The ANDAL Study conducted vegetation sampling from three locations in the Project Area. The first location, lowland montane forest and coffee plantations, featured a vegetation type dominated by *Actinodaphne* sp., *Cyathea* sp., *Anisophylla disticha* and *Lycopodium* sp.1. The second location featuring lowland montane forest was dominated by *Barringtonia* sp., *Michelia alba*, *Acronychia porter* and *Begonia* sp.1. The last location, featuring highland montane forest, was dominated by *Cryptocarya* sp., *Acronychia porter* and *Dryopteris* sp. (ESC, 2016).

Field studies conducted for the 2016 ANDAL report that the coffee plantation, lowland montane and highland montane forest habitats were suitable for a variety of mammal, herpetofauna and bird species. These include a number of IUCN-listed Critically Endangered species and endemic species.

Based on IUCN species profile information and results of field studies the primary and secondary forest is suitable habitat for a number of threatened species (flora and fauna) through provision of food and prey resources, nest

sites and forest space for seasonal, arboreal and terrestrial movement and protection from predators.

Details on the priority flora and fauna values associated with these habitats are outlined in *Section 3.4 Priority biodiversity and ecosystem service values*.

3.2.3 Land Clearing Assessment

3.2.3.1 Background land clearing in Sumatra

Deforestation in Sumatra has been high with nearly one-half of 1990 primary forests having been cleared or degraded by 2000. The primary causes of deforestation have been: agricultural expansion for palm oil, pulp and paper production; transmigration programs and associated clearance activities; illegal logging; and forest fires (Margano B et al 2012).

Margano has documented forest loss in Sumatra as: 7.54 Mha of primary forest loss during the period 1990–2010 (7.25 Mha was in a degraded state when cleared, and 0.28 Mha was in a primary state); and 2.31 Mha of primary forest was degraded. This clearing equates to approximately 0.377 Mha per annum during this period (7.54/20=0.377). The total land area assessed was 44.69 Mha.

Therefore the average forest loss per annum in Sumatra was 0.84% of the total land area assessed between 1990-2010 ([0.377/44.69] x [100/1]=0.84).

3.2.3.2 Land Clearing within the SERD Concession

PENDING following further assessment.

3.2.3.3 Land Classes Present

Landcover types have been mapped using GIS for the Project Area and AoI. The landcover assessment used data available from the Indonesian Department of Forestry and other data available from GreenCap. Each landcover type has been classed as Natural Habitat or Modified Habitat according to the definition of Natural Habitat within the ADB Sourcebook. The following land class types within the Project Area have been identified and described in *Table 3.1*.

Table 3.1 Land Classes within the Project Area

Land Class	Description
Plantation	These area areas used for plantations; in the context of the project, plantations are mostly used for coffee cultivation.
Semi-rural/Urban	These are areas where human settlements have been established or land cleared for buildings. This includes areas that have been cleared for the establishment of plant facilities.
Freshwater habitat	This habitat can be found within the rivers and streams within the Project Area.
Montane forests	This habitat is found within and around the Project Area.

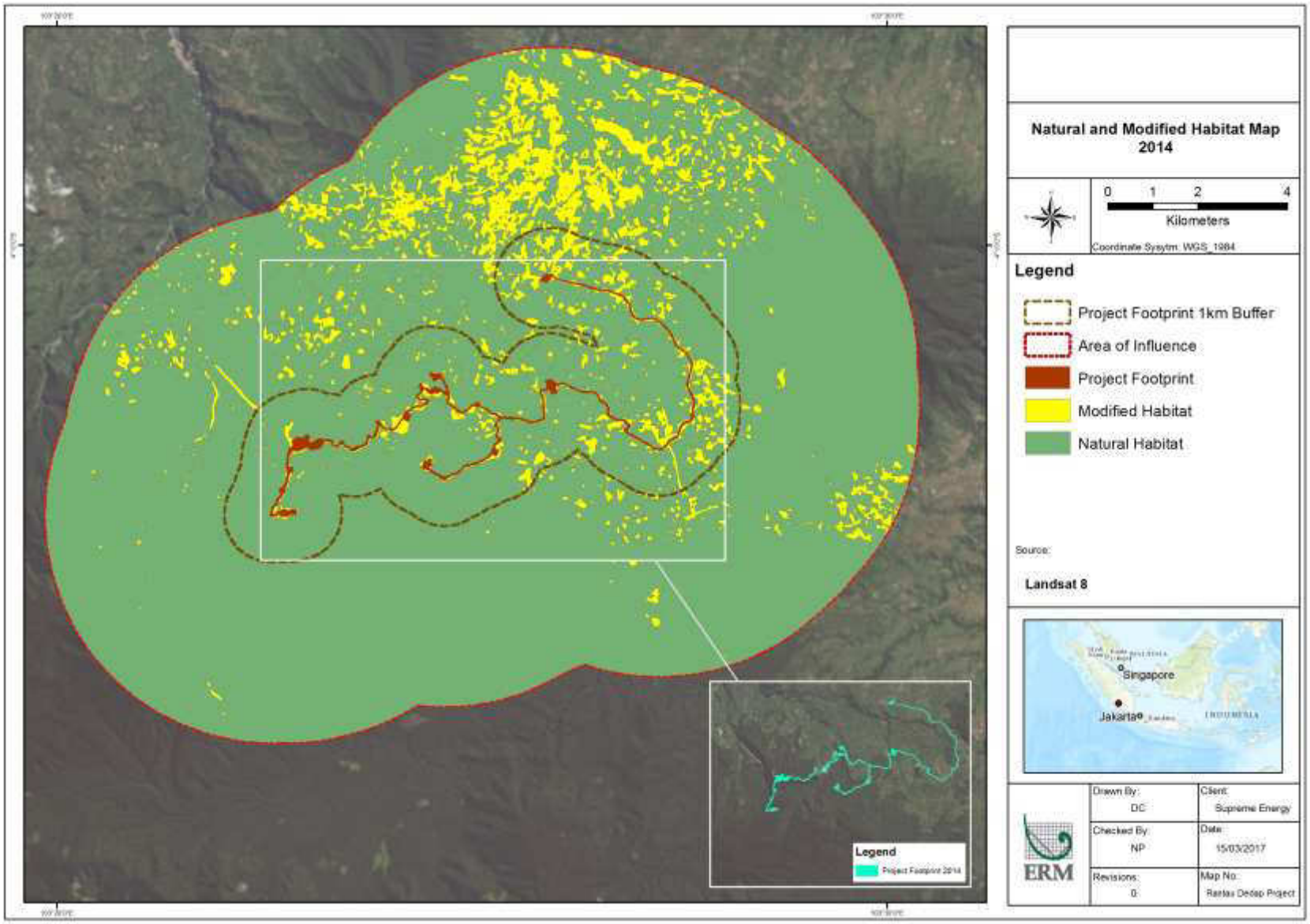
3.2.3.4 *Natural Habitat Mapping*

Given an understanding of the species assemblages within each habitat/land class, natural-modified habitat classifications have been assigned as shown in *Table 3.2*. The distribution of Natural Habitat and Modified Habitat in the Project Area is shown in *Figure 3.2*.

Table 3.2 Natural and Modified Habitats within the AOI, Project Concession and Project Area, Cement Plant

Land Class	IFC PS6 Habitat Classification	Justification
Plantation	Modified	These areas are cultivated and retain little of their natural ecological function.
Semi-rural/Urban	Modified	Contains human settlements. Retains little natural ecological function.
Freshwater habitat	Natural	Majority of freshwater habitats within the Project Area and AoI remain natural and possess their original ecological function.
Montane forests	Natural	Continues to support assemblage of CR and EN species, including large mammals. Expected to retain natural ecological function.

Figure 3.2 Natural and Modified Habitat Mapping



The Natural Habitat and Modified Habitat values areas are defined in ***Table 3.1***.

Table 3.1 Natural Habitat and Modified Habitat within the AoI

Year	Natural Habitat (Ha)	Modified Habitat (Ha)	Total Area (Ha)
2014	19810.66	2352.09	22162.75
2015 & 2016	21713.21	4110.22	25823.43

3.3 ECOSYSTEM SERVICES BASELINE VALUES

This Section assesses the likely impacts to Ecosystem Services that may occur as a result of the development of the Project. The purpose of the assessment is to identify:

- Priority Ecosystem Services in the Project area;
- Potential and existing impacts to Priority Ecosystem Services; and
- Outline measures to avoid, minimise and mitigate impacts to Priority Ecosystem Services.

Ecosystem services 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 Ecosystem Services typologies into a consistent classification scheme.

There are four categories of ecosystem services defined in Millennium Ecosystem Assessment as outlined in IFC Performance Standard 6:

- Provisioning Services; these services that can be extracted from ecosystem to support human needs. This term is more or less synonymous with the term " Ecosystem Goods" that was used in some prior classification schemes, including such tangible assets as fresh water, food, fiber, timber and medicinal plants,
- Regulating Services; the benefit obtained from an ecosystem's control of the natural environment, including of 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 diverse aspect of aesthetic, spiritual, recreational, and others cultural value,
- 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.

The IFC PSs require projects to assess and preserve the benefits from ecosystem services. The IFC also requires that the environmental and social risks and impacts identification process considers a project's dependence on ecosystem services. A fundamental component is to apply the mitigation hierarchy to determine measures to limit impacts on ecosystem services. ERM has utilized the World Resources Institute (WRI) Guidelines: *Weaving Ecosystem Service into Impact Assessment* to guide the approach used to assess ecosystem services in relation to the project.

Information used in this assessment is based on limited data contained in reports provided by SERD, discussions with the operator and secondary data. No specific ecosystem services surveys have been completed for the project in the AoI. Information on resource condition and trends is also not currently available.

3.3.1 Ecosystem Services Values identified within the AoI

No specific ecosystem services data is available for the Rantau Dedap facility.

Secondary data indicates that the population of Rantau Dedap is predominately Muslim and is a uniquely matriarchal society. Customary hunting of animals is not undertaken generally by local people (McKeay J 2013). Some local fishing does occur in local rivers to supplement protein in diets. The people are mainly farmers who cultivate rice and other crops in cleared forest land. Some local timber is sourced from the forests for construction purposes. Generally, water is sourced from local streams or wells. Some rituals and spiritual connection with natural areas has been recorded with the Rantau Dedap people, including burials and initiation.

A scoping exercise was undertaken to refine the list of Ecosystem Services identified in the WRI Guidelines to include only those services that were: identified as likely to occur in the study area; had human beneficiaries; and were potentially impacted by the Project. The results provide priority ecosystem services that are then carried forward to the impact assessment. The results of the scoping exercise are outlined in *Table 3.5* below.

Table 3.2 Results of Ecosystem Services Scoping

Service	Discussion	Scoped in?
Provisioning Services		
Food: wild-caught fish and shellfish	Local people likely to capture small amounts of wild fish in local rivers. SERD has reported that no fishing occurs where the water intake is located. Impacts likely to be minor due to small water extraction from local rivers and no water discharges. Note that specific mitigation for biodiversity has been recommended to conduct a water extraction study.	No
Food: wild meat	Local Muslim population do not generally hunt for wild meat. Some hunters from external villages may enter the forest for hunting.	No
Food: cultivated crops	Local people likely to clear forest for slash and burn agriculture. Restrictions on clearing within the Project AoI will reduce the area available for future clearing for cultivation.	Yes
Food: wild plants, nuts, mushrooms, fruit, honey	Local people likely to collect some forest derived foods. Alternative areas are likely available outside of the Project area.	No
Timber and wood products	Local people likely to harvest some trees for household use for construction. Alternative areas are likely available outside of the Project area.	No
Non- Timber Forest Products (NTFP)	Local people have limited collection of NTFP. Alternative areas are likely available outside of the Project area.	No
Freshwater	Local people derive water sources from wells and local rivers. Impacts from water extraction are likely to be minor from the project. Note that specific mitigation for biodiversity has been recommended to conduct a water extraction study.	Yes – To be determined
Irrigation water	Local people are use natural water sources for irrigation of crops. Impacts from water extraction are likely to be minor from the project.	No
Biochemical, natural medicines, pharmaceuticals	Local people are likely to gather some medicines from forest areas. Alternative areas are likely available outside of the Project area.	No
Animal trading	There is evidence in Western Sumatra of the trading of wild animals, such as song birds. There is no current data whether local people or people from outside of the Project area may enter for this purpose.	No
Regulating Services		
Fire regulation	Local forests are likely to play a role in regulating fire in the broader landscape both as a fire break and also to maintain moisture differentials during the dry season. Clearing for project related activities are unlikely to increase the fire risk.	No
Regulation of water timing and flows	Local rivers provide water during distinct seasons. Changes to water flows may impact on local people. Minor water extraction from the rivers is expected however it is not likely to be a significant impact.	No

Service	Discussion	Scoped in?
Water purification and waste treatment	Local forests and wetlands play a role in purifying water and treating waste. It is not expected that the project will have a significant impact on this service.	No
Pest/Disease regulation	Local biodiversity is likely to manage pest populations (such as insect impacts on crops). The impact is not considered to be significant.	No
Erosion regulation	Minor land slips are likely within the landscape from time to time. Clearing of forests may increase the risk of landslips. The impact is not considered to be significant.	No
Cultural Services		
Spiritual, religious or cultural value	Local people are likely to utilise the local forests for cultural reasons. The impact is not considered to be significant.	No
Traditional Practices	Local people are likely to utilise the local forests for traditional practices, including burials and initiations. Alternative areas are likely available outside of the Project area.	No
Supporting Services		
Recreation and tourism	The area is not currently known for its tourism value, however given the nearby National Park, tourism may play a role in the local economy in the future. Impacts on recreation and tourism within the AoI however are likely to be minimal.	No
Non-use value of biodiversity (e.g. existence, bequest value)	The unique matriarchal society of the local people means that bequest values are passed through the female side of families. However, it is not expected that the project will have a significant impact on this tradition.	No

3.4 PRIORITY BIODIVERSITY VALUES

Specific to biodiversity values this assessment considered two key guideline documents:

- Asian Development Bank (ADB) Policy Paper June 2009 Safeguard Policy Statement; and
- International Finance Corporation (IFC) Performance Standard (PS) 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources January 2012 and associated Guidance Note (January 2012).

The key features required for assessment by these guidelines include protected areas, natural and modified habitat, critical habitat, invasive species and ecosystem services. This section details these values based on the baseline information collated by Greencap (2016), available desktop sources and geospatial analysis.

3.4.1 Legally Protected and Internationally Recognised Areas

Protected areas associated with the Project Area are discussed in this section and shown in *Figure 3.5*.

3.4.1.1 Protected Areas

There are no IUCN category protected areas mapped within the Project Area. The desktop review identified the following Protected Areas within a 50 km radius of the Project Area:

- Bukit Barisan Selatan National Park (BBSNP), 39 km southeast (IUCN Category II);
- Gunmai Tebing Tinggi Wildlife Reserve, 25 km northwest (IUCN Category IV);
- Isau Isau Wildlife Reserve, 15 km northeast (IUCN Category IV);
- Bukit Rabang Grand Forest Park, 29 km west (IUCN Category VI); and
- Kaur Marine Area, 42 km southwest (IUCN Category VI).

3.4.1.2 World Heritage Areas (WHA)

There are no World Heritage Areas mapped within AoI or the Project Area.

3.4.1.3 Key Biodiversity Areas

There are no Key Biodiversity Areas mapped within AoI or the Project Area.

3.4.1.4 Alliance for Zero Extinction (AZE) Sites

There are no AZE sites mapped within AoI or the Project Area.

3.4.1.5 *RAMSAR Sites*

There are no RAMSAR sites mapped within the AoI or the Project Area.

3.4.1.6 *World Wildlife Fund EcoRegions*

The Project Area is located within the Sumatran Montane Rain Forests ecoregion. This type is recognised as part of the Global 200 ecoregions, those ecosystems represent the most outstanding and representative areas of biodiversity. (WWF, 2017)

The ecoregion is noted to represent the montane forests (>1000 m) along the Barisan Mountain Range. There are several large blocks of intact forest and numerous protected areas. Seven mammal and eight bird species are endemic to this ecoregion including mammals: North Sumatran leaf monkey (*Presbytis thamasi*), Sumatran flying squirrel (*Hylopetes winstoni*), Sumatran shrewlike mouse (*Mus crociduroides*), Sumatran mountain rat (*Rattus korinchi*), Sumatran mountain maxomys (*Maxomys hylomyoides*), Broad-nosed Sumatran maxomys (*Maxomys inflatus*) and Sumatran striped rabbit; and birds: Red-billed partridge (*Arborophila rubrirostris*), Salvadori's pheasant, Sumatran ground-cuckoo, Schneideri's pitta, Sumatran drongo (*Dicrurus sumatranus*) and Sumatran cochoa. (WWF, 2017)

Several other mammal species are found in the ecoregion including numerous primate species, siamang, dhole, Malayan sun bear, clouded leopard and Sumatran tiger. (WWF, 2017)

3.4.1.7 *Nationally Recognised Areas*

Specific to Indonesia forestry designations, all of the Project Area and the majority of the AoI is mapped by the Ministry of Forestry as Protected Area with approximately 124.5ha (+ 13 ha for the transmission line) within the Project Area (***Figure 3.3***).

The Project Area is entirely mapped as Indonesian Forest Moratorium Area.

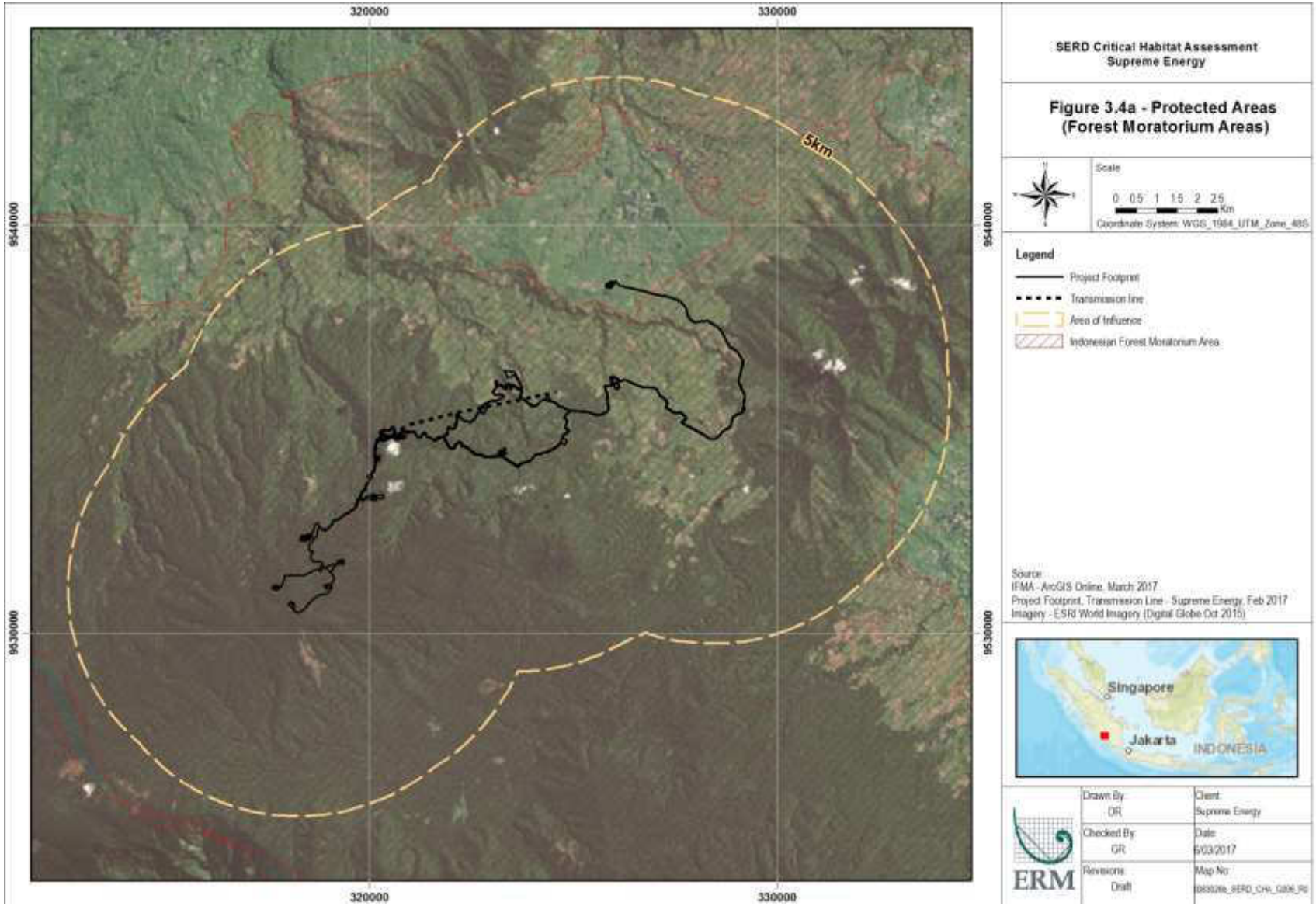
3.4.2 Natural Habitat and Modified Habitat

The spatial assessment Natural Habitat and Modified Habitat is based on the land class assessment undertaken for the Project Area and AoI. The areas are shown in ***Table 3.3*** below. ***Figure 3.3*** shows the distribution of Natural Habitat and Modified Habitat areas within the Project Area and AoI.

Table 3.3 Natural and Modified Habitat within the Project Area and Area of Influence

	Area of Influence		Project footprint	
	ha	%	ha	%
Natural Habitat	19810.66	89	0	0
Modified Habitat	2352.09	11	163.58	100
Total	22162.75		163.58	

Figure 3.2 Forest Moratorium Area



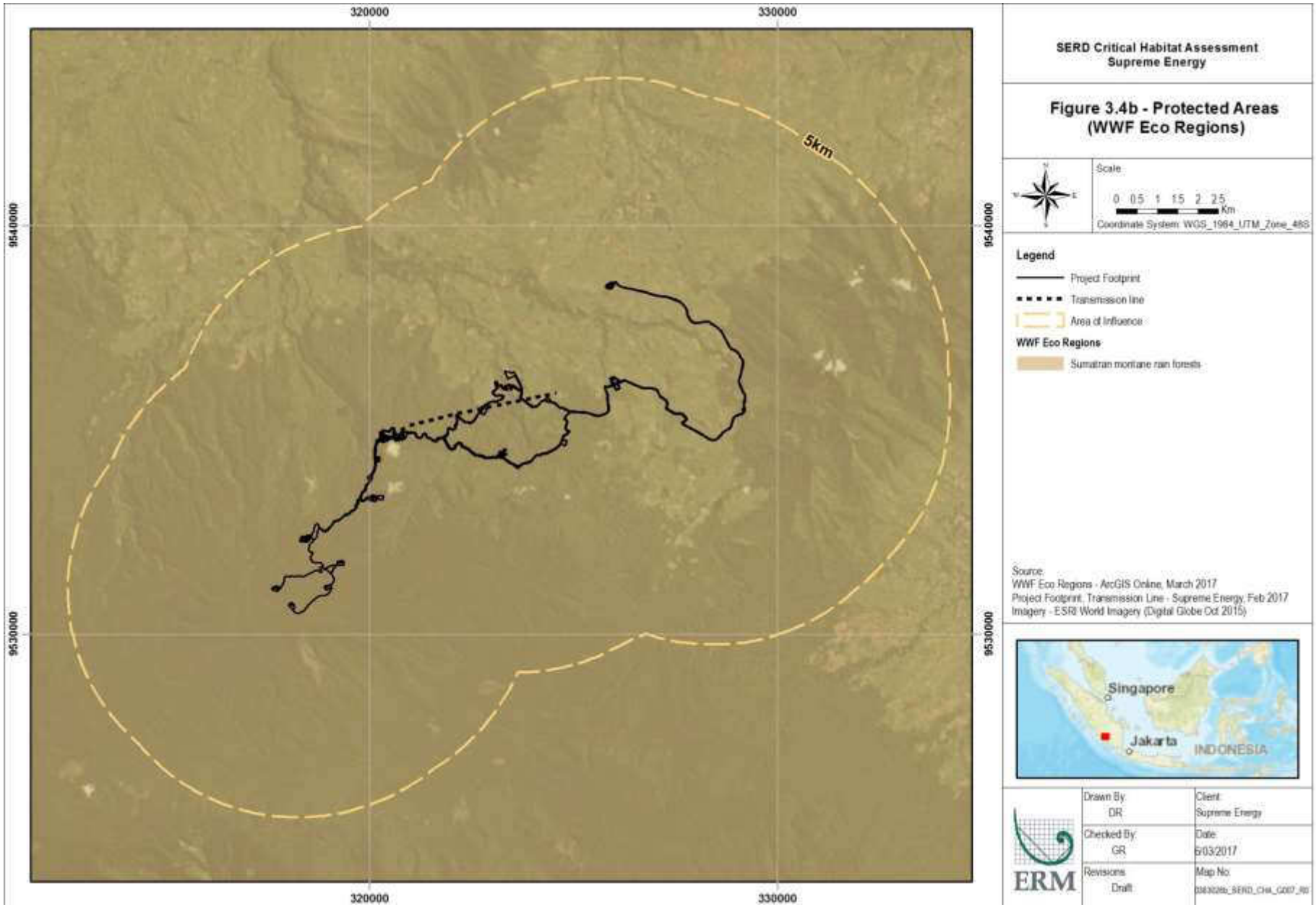
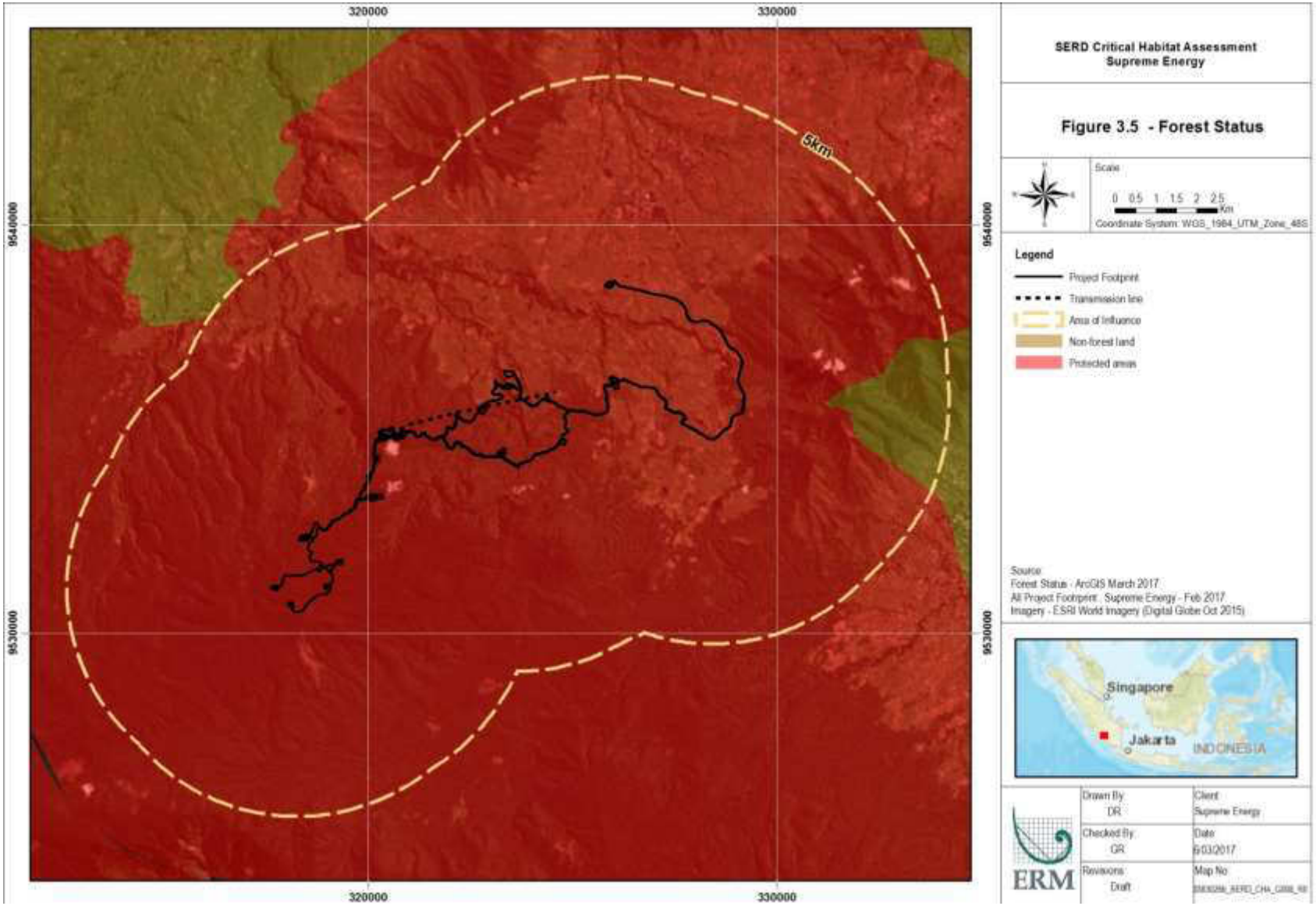

320000
330000
9540000
9530000
5km
SERD Critical Habitat Assessment
Supreme Energy
Figure 3.4b - Protected Areas
(WWF Eco Regions)
Scale
0 0.5 1 1.5 2 2.5
Km
Coordinate System: WGS_1984_UTM_Zone_48S
Legend
Project Footprint
Transmission line
Area of Influence
WWF Eco Regions
Sumatran montane rain forests
Source:
WWF Eco Regions - ArcGIS Online, March 2017
Project Footprint, Transmission Line - Supreme Energy, Feb 2017
Imagery - ESRI World Imagery (Digital Globe Oct 2015)
Singapore
Jakarta
INDONESIA
ERM
Drawn By:
DR
Client:
Supreme Energy
Checked By:
GR
Date:
6/03/2017
Revisions:
Draft
Map No:

Figure 3.3 Indonesia Forestry Type



3.4.3 Threatened Species

Threatened species are identified as those listed on the IUCN Red List of Threatened Species and where relevant species are afforded equivalent conservation protection nationally. The IUCN Red List of Threatened Species provides taxonomic, conservation status and distribution information on flora and fauna that have been evaluated using the IUCN Red List categories and criteria. The criteria identify three categories of threatened species:

- Critically Endangered (CR);
- Endangered (EN); and
- Vulnerable (VU).

Five (5) additional categories of flora and fauna are included in the IUCN Red List however species categorized as CR, EN and VU are considered to be at a heightened risk of extinction and are awarded an elevated level of consideration under the IFC Performance Standards.

Species identified as endemic, restricted range, migratory and/or congregatory according to the relevant IUCN species profiles are also listed in order to assess against the IFC PS6 Critical Habitat thresholds.

Where species have not yet been evaluated by IUCN the protection status has been considered. Species listed as Protected under Indonesian law (and not evaluated by IUCN) are also considered 'threatened species' for the purposes of this assessment.

Threatened species that were identified specific to the Area of Influence and Project Area are shown in ***Table 3.4*** below. Where record locations are available they are shown in and ***Figure 3.7*** and ***3.8***. Other threatened species identified through desktop review have been included as part of critical habitat assessment (*Section 3.4.5*).

Table 3.4 Threatened Species identified or likely to occur within the AoI

Scientific Name	Common Name	Type	IUCN Listing	Endemic	Migratory/ Congregatory	Source
Dipterocarpus grandifloris	-	Tree	CE			2016 Obs
Haemocharis integerrima	-	Tree		x		2015 Obs
Rafflesia bengkuluensis	-	Parasitic		x		Not recorded but identified with potential as part of baseline report
Apalharpactes mackloti	Sumatran trogon	Bird	LC	x		2016 Obs
Arborophila rubrirostris	Red-billed partridge	Bird	LC	x		2014 Obs and 2016 Obs, WWF Ecoregion species
Carpococcyx viridis	Sumatran ground-cuckoo	Bird	CE	x		WWF Ecoregion species
Cochoa beccarii	Sumatran cochoa	Bird	VU	x		WWF Ecoregion species
Dicrurus sumatranus	Sumatran drongo	Bird	NT	x		WWF Ecoregion species
Garrulax bicolor	Sumatran laughingthrush	Bird	EN	x		Not recorded but identified with potential as part of baseline report
Gallinula chloropus	Common moorhen	Bird	LC		x	2014 Obs
Hydrornis schneideri	Schneider's pitta	Bird	VU	x		WWF Ecoregion species
Lophura inornata	Salvadori's pheasant	Bird	NT	x		WWF Ecoregion species
Motacilla cinerea	Grey wagtail	Bird	LC		x	2014 Obs
Muscicapa dauurica	Asian brown flycatcher	Bird	LC		x	2014 Obs
Myophonus melanurus	Shiny whistling-thrush	Bird	LC	x		2016 Obs
Padda oryzivora	Java sparrow	Bird	VU			2014 Obs and 2016 Obs
Pericrocotus miniatus	Sunda minivet	Bird	LC	x		2014 Obs
Pernis ptilorhynchus	Oriental honey buzzard	Bird	LC		x	2014 Obs
Polyplectron chalcurum	Bronze-tailed peacock-pheasant	Bird	LC	x		2014 Obs and 2016 Obs
Trichastoma buettikoferi	Sumatran babbler	Bird	NT	x		Not recorded but identified with potential as part of baseline report
Arctictis binturong	Binturong	Mammal	VU			WWF Ecoregion species
Arctonyx hoevenii	Sumatran hog badger	Mammal	LC	x		2014 Obs
Capricornis sumatraensis	Sumatran serow	Mammal	VU			2016 Obs
Cuon alpinus	Dhole	Mammal	EN			2016 Obs, WWF Ecoregion species
Helarctos malayanus	Malayan sun bear	Mammal	VU			2016 Obs, WWF Ecoregion species
Hylobates agilis	Agile gibbon	Mammal	EN			Target species determined not to occur based on the field survey.
Hylopetes winstoni	Sumatran flying squirrel	Mammal	DD	x		WWF Ecoregion species

Scientific Name	Common Name	Type	IUCN Listing	Endemic	Migratory/ Congregatory	Source
Manis javanica	Malayan pangolin	Mammal	CE			2016 Obs, WWF Ecoregion species
Maxomys hylomyoides	Sumatran mountain maxomys	Mammal	DD	x		WWF Ecoregion species
Maxomys inflatus	Broad-nosed Sumatran maxomys	Mammal	VU	x		WWF Ecoregion species
Muntiacus montanus	Sumatran mountain muntjac	Mammal	DD	x		2016 Obs
Mus crociduroides	Sumatran shrewlike mouse	Mammal	DD	x		WWF Ecoregion species
Nesolagus netscheri	Sumatran striped rabbit	Mammal	VU	x		WWF Ecoregion species
Panthera tigris sumatrae	Sumatran tiger	Mammal	CE	x		2016 Obs, WWF Ecoregion species
Pardofelis marmorata	Marbled cat	Mammal	VU			2016 Obs
Presbytis melalophos	Sumatran surili	Mammal	EN	x		2014 Obs, WWF Ecoregion species
Pteromyscus pulverulentus	Smoky flying squirrel	Mammal	EN			Predicted to occur by threatened species report
Rattus korinchi	Sumatran mountain rat	Mammal	DD	x		WWF Ecoregion species
Rusa unicolor	Sambar	Mammal	VU			2016 Obs
Symphalangus syndactylus	Siamang	Mammal	EN			2016 Obs, WWF Ecoregion species
Tapirus indicus	Malayan tapir	Mammal	EN			2016 Obs, WWF Ecoregion species
Calamaria margaritophora	Stripe-necked reed snake	Reptile	DD	x		Not recorded but identified with potential as part of baseline report
Iguanognathus werneri	Spatula-toothed snake	Reptile	DD	x		Not recorded but identified with potential as part of baseline report
Ophiophagus hannah	King cobra	Reptile	VU			2014 Obs and 2016 Obs
Python reticulatus	Reticulated python	Reptile	VU			2014 Obs and 2016 Obs
Typhlops hypsobothrius	Sumatra worm snake	Reptile	DD	x		Not recorded but identified with potential as part of baseline report
Chalcorana crassiovis	Korinchi frog	Amphibian	DD	x		2016 Obs
Rhacophorus bifasciatus	-	Amphibian	NT	x		Not recorded but identified with potential as part of baseline report

CE = Critically Endangered; EN = Endangered; VU = Vulnerable; DD = Data Deficient; Mig = Migratory;

2014 Obs = Direct observations reported for biodiversity study (reported in Greencap, 2017); 2016 Obs = Direct observations reported for biodiversity study (reported in Greencap, 2017);

WWF Ecoregion species = key species noted for the Sumatran Montane Rain Forests Ecoregion.

3.4.4 Data Gaps in Existing Survey Data

From the data available from studies undertaken for other projects within Sumatra there is a high likelihood of endemic flora species occurring within the Project Area. Therefore there is a possibility that a number of endemic species may not have been recorded within the Project Area by previous studies.

To overcome this gap, management measures have been developed to implement a precautionary approach a requirements to conduct pre-clearance surveys and assessments prior to the next phase of construction. This approach aims to detect conservation significant endemic flora prior to disturbance and allow for avoidance, translocation or seed harvest to be undertaken.

Figure 3.7 Location of Critically Endangered Species records (Greencap, 2017)

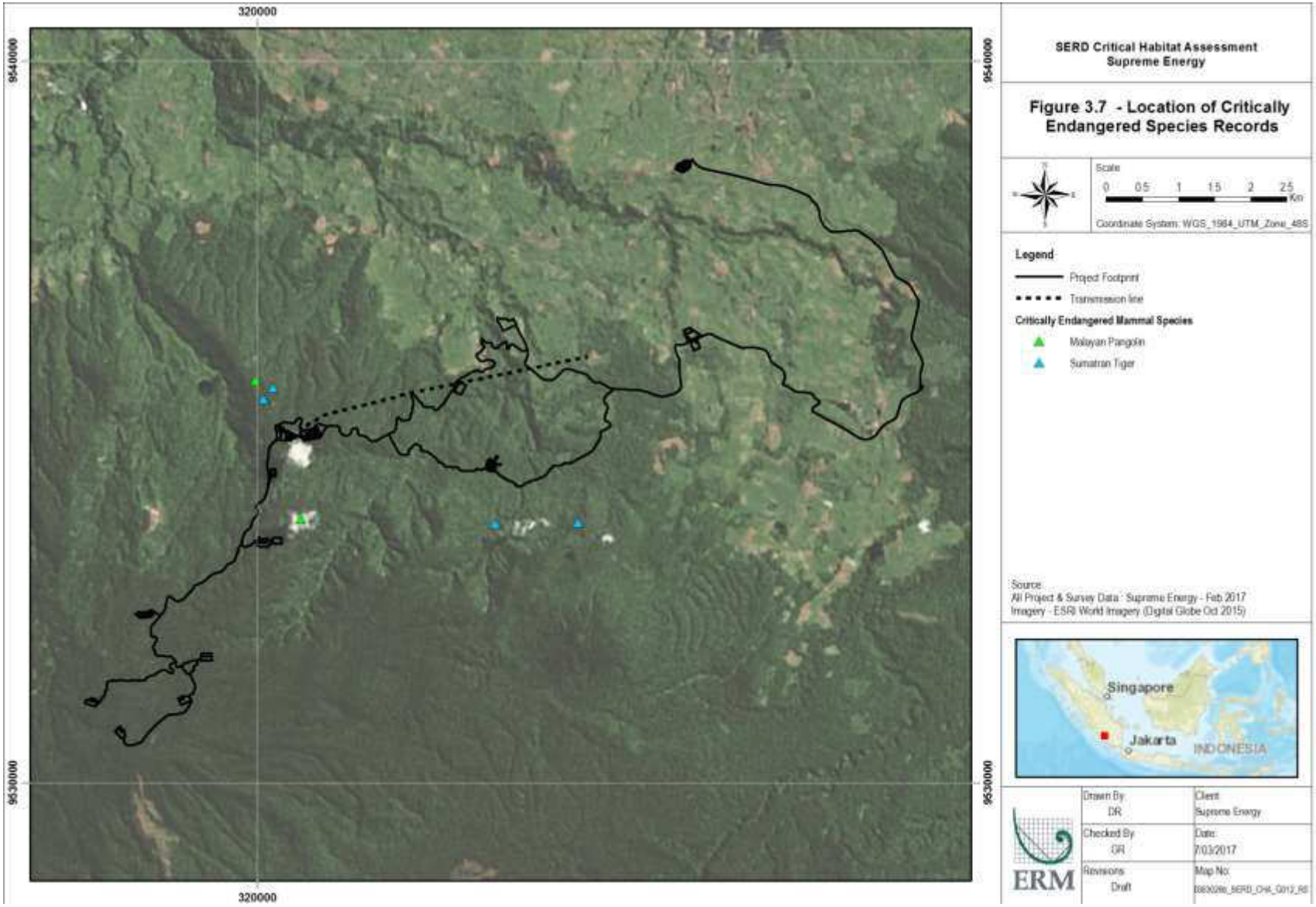


Figure 3.8 Location of Endangered Species records (Greencap, 2017)

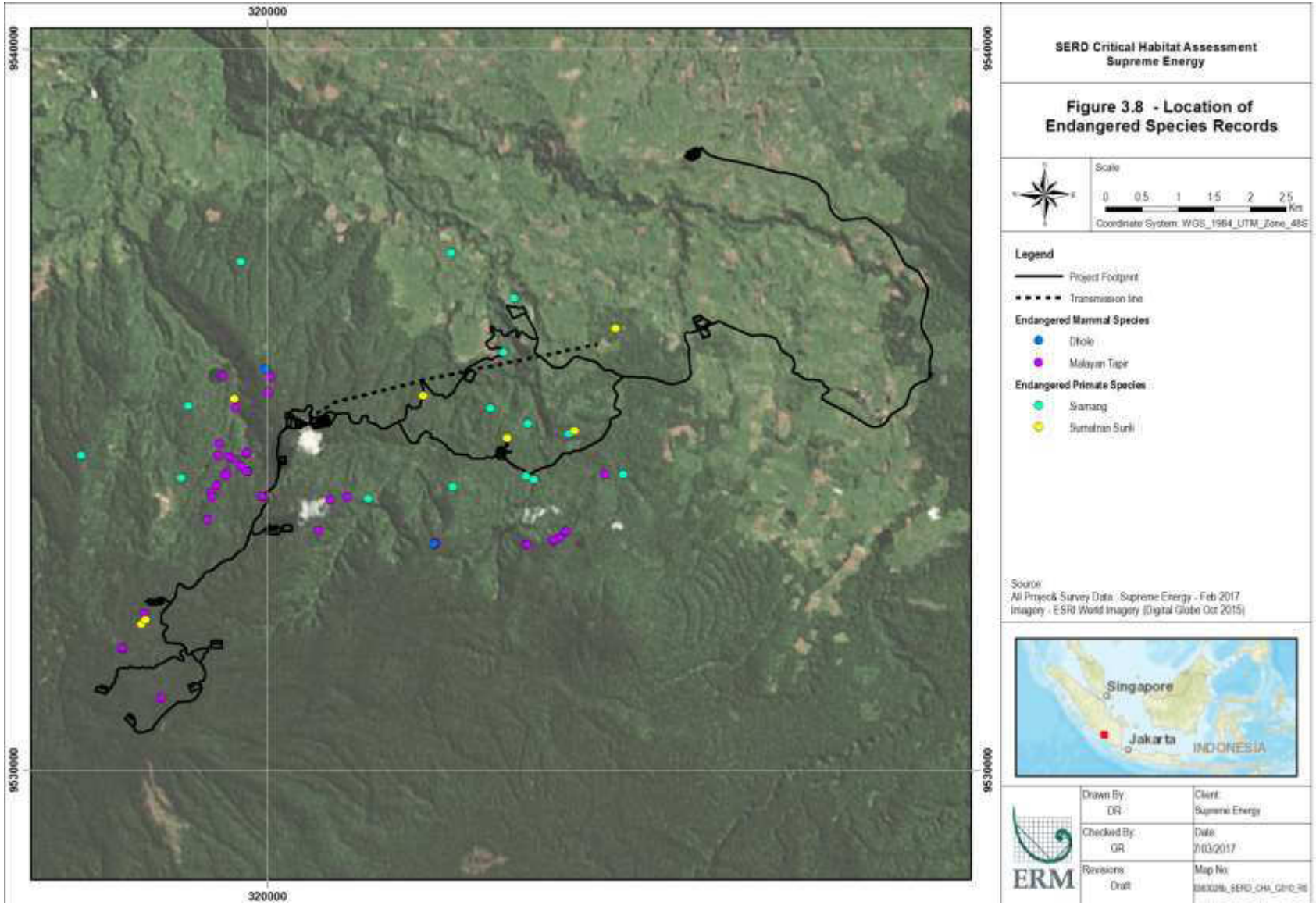
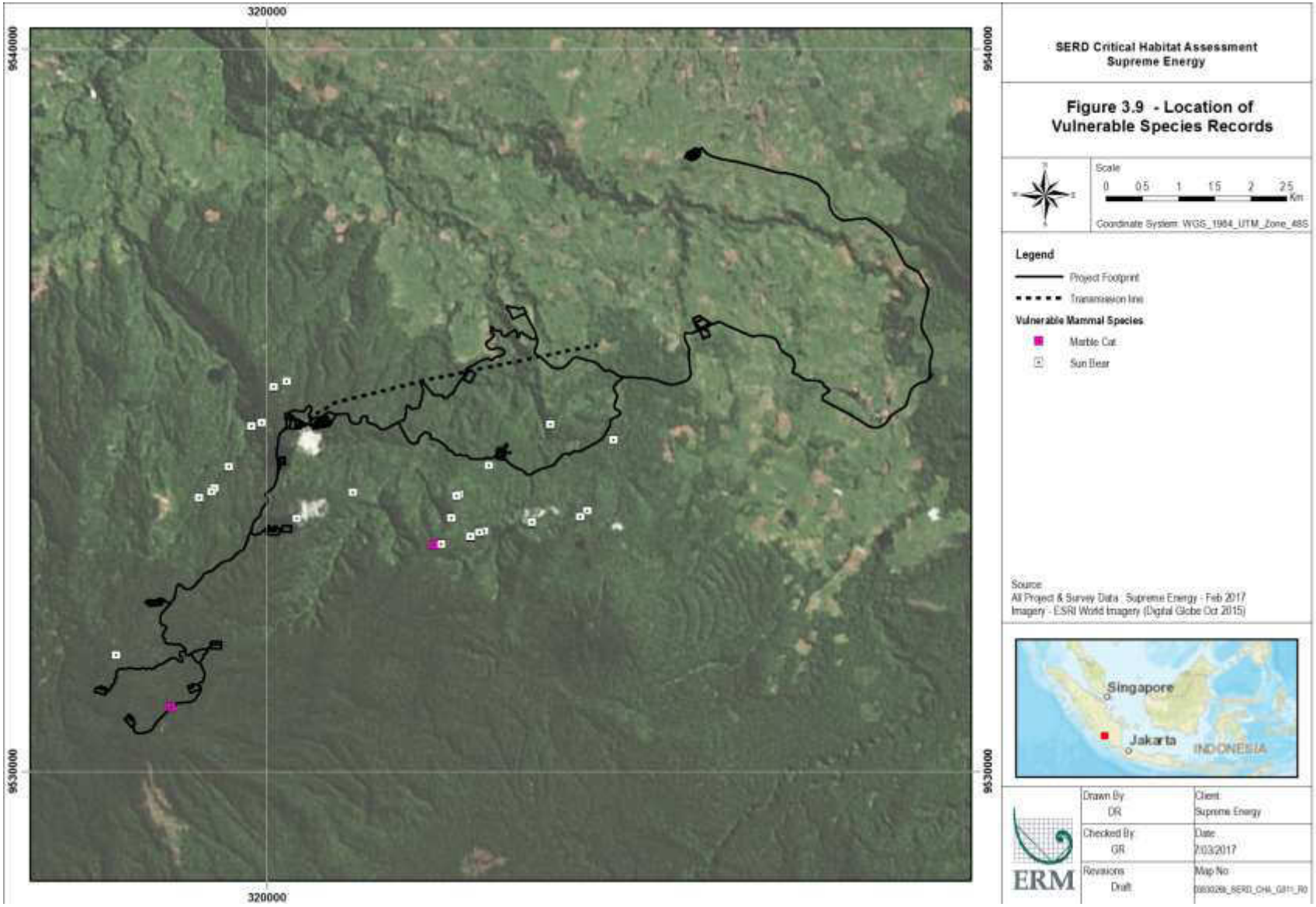


Figure 3.9 Location of Vulnerable Species records (Greencap, 2017)



3.4.5 Critical Habitat

3.4.5.1 Critical Habitat Triggers

Critical habitat is defined under both the ADB Safeguard Policy and IFC PS6.

Critical habitats are areas with: "high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes". In addition ADB Safeguard Policy includes areas having biodiversity of significant social, economic, or cultural importance to local communities as critical habitat. In this report this aspect will be collectively termed 'ecosystem services'.

Critical Habitat may not be limited to pristine or highly biodiverse areas but rather may include both modified habitat and natural habitats across the broader landscape that supports the biodiversity values that trigger the Critical Habitat criterion. Critical Habitats can therefore be a subset of both modified habitat and natural habitat.

Assessment for Critical Habitat is undertaken as a screening process against the criteria defined within IFC PS 6 Guidance Note. This involved GIS analysis and desk based data collection including a review of previous biodiversity studies.

Critical Habitat criteria are defined in PS6 Guidance Note 6 (GN6), Paragraphs GN69 to 97. ***Table 3.11*** provides detail of the qualifying requirements for Critical Habitat criteria 1 to 3 (ie thresholds), while details of the likely qualifying interests for Criterion 4 and 5 will be defined based on research and expert opinion.

Table 3.11 Criteria Habitat Criteria (IFC PS6 Guidance Note 2012)

Criteria	Tier 1[1]	Tier 2[1]
Criterion 1: Critically Endangered (CR) / Endangered (EN) species:	a) Habitat required to sustain ≥ 10 % of the global population of a CR or EN species /sub /species and where there known regular occurrences of the species and where habitat could be considered a discrete management unit for the species. b) Habitat with known, regular occurrences of CR or EN species where that	c) Habitat that supports the regular occurrence of a single individual of a CR species and/or habitat containing regionally- important concentrations of Red-listed EN species where that habitat could be considered as a discrete management unit for the species/subspecies. d) Habitat of significant importance to CR/EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the

Criteria	Tier 1[1]	Tier 2[1]
	habitat is one of 10 or fewer discrete management sites globally for that species.	long-term survivability of the species. e) As appropriate, habitat containing nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing.
Criterion 2: Habitat of significant importance to endemic and/or restricted-range species;	a) Habitat known to sustain ≥ 95 % of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species.	b) Habitat known to sustain ≥ 1 % but < 95 % of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment.
Criterion 3: Habitat supporting globally significant concentrations of migratory species and/or congregatory species;	(a) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 95 % of the global population of a migratory or congregatory species at any point of the species' lifecycle where that habitat could be considered a discrete management unit for that species.	(b) Habitat known to sustain, on a cyclical or otherwise regular basis, ≥ 1 % but < 95 % of the global population of a migratory or congregatory species at any point of the species' lifecycle and where that habitat could be considered a discrete management unit for that species, where data are available and/or based on expert judgment. (c) For birds, habitat that meets BirdLife International's Criterion A4 for congregations and/or Ramsar Criteria 5 or 6 for Identifying Wetlands of International Importance. (d) For species with large but clumped distributions, a provisional threshold is set at ≥ 5 % of the global population for both terrestrial and marine species. (e) Source sites that contribute ≥ 1 % of the global population of recruits.
Criterion 4: Highly threatened and/or unique ecosystems; and/or	Criterion 4 has no tiered system although recent publication (Keith et al, 2013) may introduce this. This criterion must include one of the following a) the ecosystem is at risk of significantly decreasing in area or quality; b) has a small spatial extent; and /or c) contains unique assemblages of species including assemblages or concentrations of biome-restricted species. Highly threatened or unique ecosystems are defined by a combination of factors which may include long-term trend, rarity, ecological condition, and threat.	
Criterion 5: Areas associated with key evolutionary processes	The criterion is defined by: a) the physical features of a landscape that might be associated with particular evolutionary processes; and/or b) subpopulations of species that are phylogenetically or morphogenetically 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.	

Note: [1] *No Tier system is in place for Criterion 4 and Criterion 5.*

With regard to Criterion 2, it should be noted that an endemic and restricted range species is defined by the IFC as one which possesses an extent of occurrence of 50,000 km² (C. Savy pers. comms). Plant species may qualify as endemic if has ≥95% of its global range inside the country or region of analysis.

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[2]. Therefore, Critical Habitat can be determined through a single criterion or where a habitat holds biodiversity meeting all five criteria. This approach is generally more cautious but is used more widely in conservation[3]. 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 (Tier considerations being secondary to this primary Critical Habitat determination). Second, each criterion is applied separately and not in combination, meaning that the scores are not cumulative.

3.4.5.2 Discrete Management Unit

As part of the process in carrying out a Critical Habitat assessment it is essential that the spatial boundaries relevant to the assessment are clearly determined and defined (IFC, 2012). IFC PS6 recommends defining a Discrete Management Unit (DMU) which delineates the area of habitat to be considered for the assessment within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas (IFC, 2012). A DMU may or may not have an actual management boundary (eg legally protected areas, World Heritage sites, KBAs, IBAs, community reserves) but could also be defined by some other sensible ecologically defined boundary (IFC, 2012).

Section 3.4.1.1 identifies that the AoI for the Project overlaps with a large tract of primary forest (and secondary forest) associated with Mount Patah. This area is considered to have potential to support a number of threatened and endemic species and given its association with the Project location is considered to be a management unit. In this instance the boundary of the DMU incorporates the mapped primary forest and secondary utilising land cover mapping sources.

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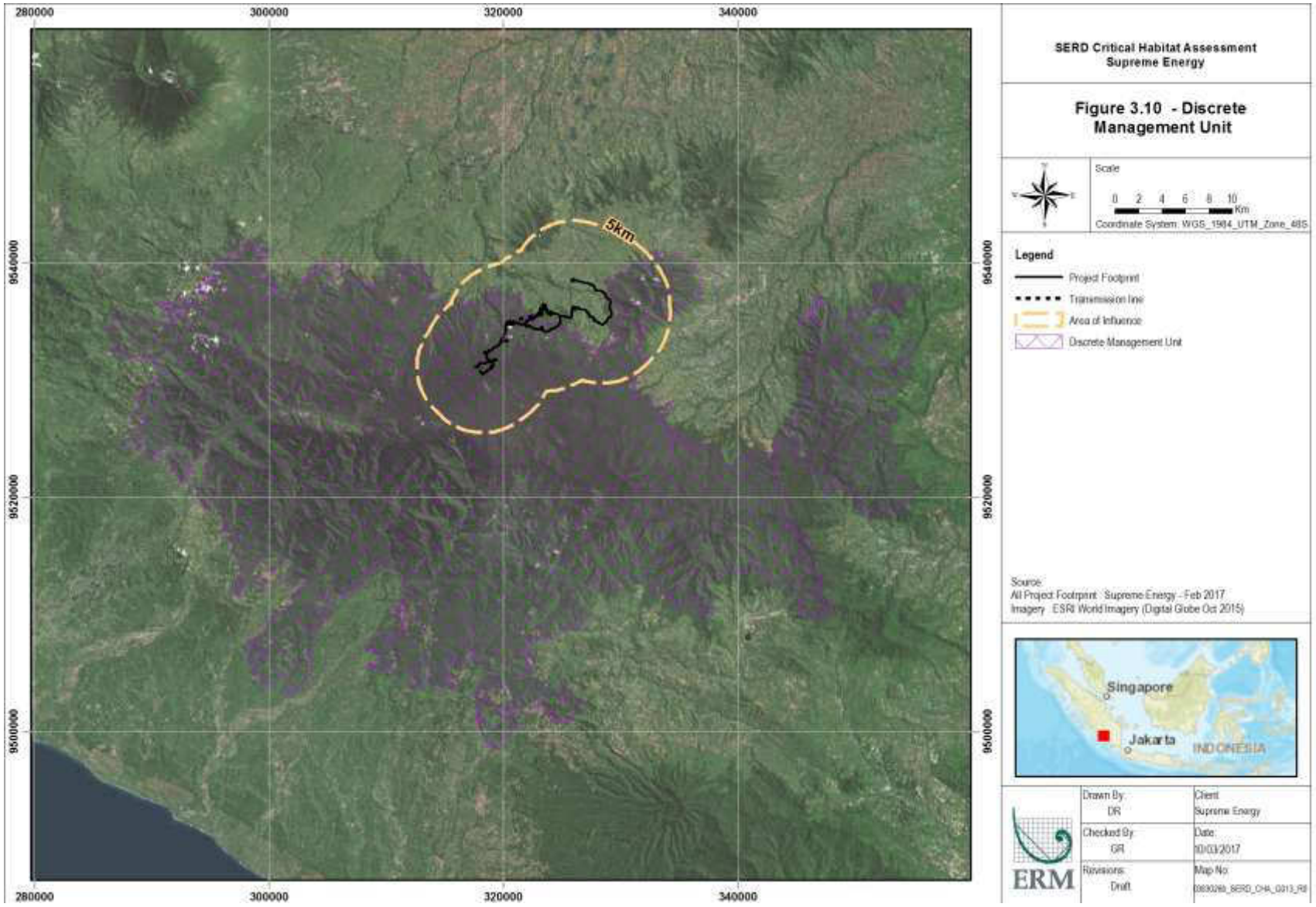
[2] The Biodiversity Consultancy (TBC) (2013) Getting through PS6: Critical Habitat and its requirements. Case Studies from Guinea and Mongolia. Whitmore, T.C. (1984) Tropical Rain Forests of the Far East. Oxford University Press. Second Edition.

[3] McDonald-Madden, E. Gordon, A. Wintle, B. Walker, S. Grantham, H. Carvalho, S. Bottrill, M. Joseph, L. Ponce, R. Stewart, R. & Possingham, H. P. (2009). "True" Conservation Progress. Science 323: 43-44.

Figure 3.9 Discrete Management Unit and AoI



3.4.5.3 Critical Habitat Candidate Species (Criteria 1-3)

For Criterion 1 to 3, this exercise considers if habitats from which candidate species are found in could qualify as Critical Habitat under the ADB Safeguard Policy and IFC PS6. Threatened species refer to species evaluated as CR or EN on IUCN status or have been conferred national protection status, are endemic or restricted range species, and are migratory or congregatory species (ADB, 2012). The evaluations were carried out in consideration of the threats facing these identified species and their habitat requirements.

Candidate species were identified from previous biodiversity studies and other relevant desktop information sources. The Critical Habitat candidates and assessment against thresholds are summarised in ***Table 3.12***.

The assessment identified the following species with Critical Habitat associated with the Project Area:

- *Rafflesia bengkuluensis* – Criterion 2, Tier 2;
- Malayan pangolin (*Manis javanica*) – Criterion 1, Tier 2;
- Broad-nosed Sumatran maxomys (*Maxomys inflatus*) – Criterion 2, Tier 2;
- Sumatran tiger (*Panthera tigris sumatrae*) – Criterion 1, Tier 1; Criterion 2, Tier 2;
- Sumatran surili (*Presbytis melalophos*) – Criterion 1, Tier 1 and 2;
- Siamang (*Symphalangus syndactylus*) – Criterion 1, Tier 2;
- Malayan tapir (*Tapirus indicus*) – Criterion 1, Tier 2; and
- *Rhacophorus bifasciatus* – Criterion 2, Tier 2.

Table 3.12 Candidate Critical Habitat Species (Criteria 1-3) and Assessment

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
Dipterocarpus sp.		CE	x			IUCN notes this species is possible extinct. The distribution is reported to include India, Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam from 0-600m asl. This species occurs in primary semi-evergreen and evergreen dipterocarp forest. The Project ESIA included reference to records of this species at a number of locations within the Project Area.	This species is considered possibly extinct. As part of the ESIA the species is reported as *Dipterocarpus grandifloras*, with common name Keruing. Keruing is a term used capturing the Dipterocarpus genus that covers 70 species spread across Southeast Asia. Simimarly the altitudinal range for the species is reported to be from 0 to 600m asl however the Project Area is located above 1400m asl. Further investigation of the reporting of this species would be required to confirm if it should be considered a Critical Habitat candidate.
Haemocharis integerrima				x		Occurs in undisturbed to slightly disturbed forests up to 100m. In secondary forest probably present as a pre-disturbance remnant. The distribution of the species is listed to include Sumatra, Java, Lesser Sunda Islands, Borneo (although only known from one collection) and Celebes.	The species information is not consistent with the requirement for a restricted range or endemic species, and as such is not considered a priority for critical habitat.
Rafflesia bengkuluensis				x		This species is a parasitic plant endemic to Sumatra. It was discovered in Bengkulu province (2006). Kaur Forest, Penangkulan River and Sakaian Mayan forest area are locations where habitat is known and the species is known (AnataraNews.com, 2016).	There is little reported regarding the extent of occurrence for this species. As a result the precautionary approach may apply and there is potential that the forest of the DMU sustains at least >1% but < 95% of the global population (Criterion 2, Tier 2b). It may also sustain >95% of the global population however there is a lack of species data to confirm this (Criterion 2, Tier 1a). **The Project Area is considered to contain Critical Habitat for this species.**
Apalharpactes mackloti	Sumatran trogon	LC		x		Species is native to Indonesia with an estimated extent of occurrence is listed by IUCN as	Given the extent of occurrence is >50,000km² it would not be considered a candidate for Critical Habitat under the

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						207,000km²	definition of endemic or restricted range.
Arborophila rubrirostris	Red-billed partridge	LC		x		Endemic to Indonesia. Estimated extent of occurrence is listed by IUCN as 192,000km²	Given the extent of occurrence is >50,000km² it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Carpococcyx viridis	Sumatran ground-cuckoo	CE	x	x		Species is only known from eight specimens and a recent series of sightings. It was un recorded since 1916 until an individual trapped in 1997 in Bukit Barisan Selatan NP (at 500m). Subsequent records include from NP and Wildlife Sanctuary to the north of the Project Area, a bird caught and additional sightings in Bukit Barisan Seletan NP. Habitat for the species, though poorly understood, is reported to occur in primary or little-disturbed forest with a relatively dense understorey. Specimen labels identify the species to inhabit foothill and lower montane forests from 300-1400 m asl. Threats to the species relate to deforestation and possibly susceptibility to bycatch through hunting. Endemic to Indonesia (Sumatra). Estimated extent of occurrence is listed by IUCN as 53,800km²	In the wider landscape there is 19810ha of natural habitat mapped (based on 2014 imagery) within the AoI. There is only a small number of sightings of the species, including a number of north and south of the Project Area in national parks. The DMU encompasses habitat consistent with known species preferences however there has been no evidence to date to suggest the species inhabits the DMU and as such no known regular occurrence of the species (Criterion 1, Tier 1a) or a regionally important concentration (Criterion 1, Tier 2c). The DMU is not linked to the national parks where the species is known via primary forest tracts. There may be fewer than 10 DMU sites for this species however while there are no known or regular occurrences of the species within the DMU Criterion 1, Tier 1b is not considered to apply. While the population distribution is not well understood, the loss of the 163 ha of potential habitat within the Project Area in the context of the DMU would not be considered likely to impact the long-term survivability of the species (Criterion 1, Tier 2d). Given there are no records of the species known from the DMU it is considered unlikely the DMU contains a nationally and/or regionally important concentration (Criterion 1, Tier 2e). Given the extent of occurrence is >50,000km² it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range (Criterion 2).

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
							The Project Area is not considered to contain Critical Habitat for this species.
Cochoa beccarii	Sumatran cochoa	VU		x		Endemic resident in Sumatra. Estimated extent of occurrence is listed by IUCN as 161,000km²	Given the extent of occurrence is >50,000km² it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Dicrurus sumatranus	Sumatran drongo	NT		x		Endemic resident in Sumatra. Estimated extent of occurrence is listed by IUCN as 658,000km²	Given the extent of occurrence is >50,000km² it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Garrulax bicolor	Sumatran laughingthrush	EN	x	x		The species is known from montane forest up to 2000m asl. There is recent considerable decline in the population with five locations where the species is known at present. One of the location includes Bukit Barisan NP and Lake Ranau to the south of the DMU. The largest extent of remaining habitat is in the Aceh Province where the species is still relatively widespread. Endemic resident in Sumatra. Estimated extent of occurrence is listed by IUCN as 218,000km². The species was not recorded during field survey.	The DMU encompasses habitat consistent with known species preferences however there has been no evidence to date to suggest the species inhabits the DMU and as such no known regular occurrence of the species (Criterion 1, Tier 1a) or a regionally important concentration (Criterion 1, Tier 2c). The DMU is not linked to the national parks where the species is known via primary forest tracts. There may be fewer than 10 DMU sites for this species however while there are no known or regular occurrences of the species within the DMU Criterion 1, Tier 1b is not considered to apply. While habitat exists, the loss of the 163 ha of potential habitat within the Project Area in the context of the DMU would not be considered likely to impact the long-term survivability of the species (Criterion 1, Tier 2d). Given there are no records of the species known from the DMU it is considered unlikely the DMU contains a nationally and/or regionally important concentration (Criterion 1, Tier 2e). Given the extent of occurrence is >50,000km² it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range (Criterion 2). The Project Area is not considered to contain Critical Habitat

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
							for this species.
Gallinula chloropus	Common moorhen	LC			x	The species inhabit freshwater wetlands, requiring easy access to open water. The mapped distribution identified the species as resident. The species has an extremely large range and an extremely large population. The species was recorded during biodiversity surveys in an artificial lake near the village (Greencap, 2015).	While the species is noted to be migratory, in Indonesia it is considered to be a resident and as a result the migratory/congregatory species criteria (Criterion 3) do not apply. The Project Area is not considered to trigger Critical Habitat for this species.
Hydrornis schneideri	Schneider's pitta	VU		x		Endemic resident in Sumatra. Estimated extent of occurrence is listed by IUCN as 165,000km^2	Given the extent of occurrence is >50,000km^2 it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Lophura inornata	Salvadori's pheasant	NT		x		Endemic to Sumatra. Estimated extent of occurrence is listed by IUCN as 229,000km^2	Given the extent of occurrence is >50,000km^2 it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Motacilla cinerea	Grey wagtail	LC			x	The habitat for the species is reported to be fast-flowing mountain streams and rivers with riffles and exposed rocks or shoals, often in forested areas. Also found in lowland watercourses, artificial waterfalls, weirs, millraces and lock gates. Outside of breeding season it inhabits a wider variety of habitats including farmyards, sewage farms, forest tracks and town centres. IUCN maps Indonesia as extant (non-breeding) distribution. The species has an extremely large range, extremely large population and is native to many countries. The species is a full migrant. The species was observed by Greencap during project surveys (Greencap, 2015).	Although the DMU is forested and may provide habitat it is considered unlikely to sustain ≥ 95 % of the global population (Criterion 3, Tier 1a) or ≥ 1 % but ≤ 95% (Criterion 3, Tier 2b) given the large range of the species in combination with an extremely large population. The DMU is not considered to meet the BirdLife International's criteria A4 or Ramsar criteria 5 or 6. This species is not a congregatory, waterbird or seabird species and there is no evidence to suggest the DMU is bottle neck site for migratory species (Criterion 3, Tier 2c). The species is not known to have a 'clumped' distribution and as such Criterion 3, Tier 2d is not considered to apply. Given that the species is not reported to breeding in Indonesia the DMU is highly unlikely to contribute ≥ 1 % of the global population of recruits (Criterion 3, Tier 2e). The Project Area is not considered to trigger Critical Habitat

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
							for this species.
Muscicapa dauurica	Asian brown flycatcher	LC			x	The species has an extremely large range and an extremely large population. It does not breed in Indonesia. The species is noted to be a common bird found in open woodland and cultivated areas. The species was recorded at Wellpad I during biodiversity surveys (Greencap, 2015).	These features are not uncommon in the disturbed areas of the lowland landscape locally and given that this species is a wide ranging species the survivability is unlikely to depend on the AoI. The AoI is not considered to sustain ≥ 95 % of the global population (Tier 1) given the large range in combination with large population. While habitat within the AoI may be suitable for the species it is not reported to breed in Indonesia. There is no evidence to suggest that the area would meet the BirdLife International criterion A4 or Ramsar Criteria 5 or 6. (Tier 2) The Project Area is not considered to trigger Critical Habitat for this species.
Myophonus melanurus	Shiny whistling-thrush	LC		x		Endemic to Indonesia. Estimated extent of occurrence 195,000km^2	Given the extent of occurrence is >50,000km^2 it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Pericrocotus miniatus	Sunda minivet	LC		x		Endemic to Indonesia. Estimated extent of occurrence 798,000km^2	Given the extent of occurrence is >50,000km^2 it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Pernis ptilorhynchus	Oriental honey buzzard	LC			x	Habitat for the species is noted as woodland, preferring broad-leaved forests up to 1,800 m. The species required forest although not necessarily old growth. Birds in the northern part of the range are noted to be migratory while further south the species is sedentary. Indonesia is in the southern part of the range and IUCN mapping shows Indonesia to support a resident population. The species has an extremely large range, very large population and is native to many countries. The species was observed by Greencap during	While the species is noted to be migratory, in Indonesia it is considered to be a resident and as a result the migratory/congregatory species criteria (Criterion 3) do not apply. The Project Area is not considered to trigger Critical Habitat for this species.

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						project surveys (Greencap, 2015).	
Polyplectron chalcurum	Bronze-tailed peacock-pheasant	LC		x		Endemic to Indonesia. Estimated extent of occurrence 197,000km^2	Given the extent of occurrence is >50,000km^2 it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Trichastoma buettikoferi	Sumatran babbler	NT		x		Endemic to Indonesia. Estimated extent of occurrence 533,000km^2	Given the extent of occurrence is >50,000km^2 it would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Arctonyx hoevenii	Sumatran hog badger	LC		x		The species is endemic to Sumatra. The IUCN listed notes it is listed as Least Concern as the geographic range for the species is far too large to warrant categorization as Near Threatened based on those grounds and implausible that the population is small enough or ay any steep decline to warrant categorization as Near Threatened based on population. The species is common in high montane zone of Kerinci Seblat NP as well as other areas. It has been recorded in Bukit Barisan NP. The species was recorded as widespread during biodiversity surveys (Greencap, 2017)	While an extent of occurrence is not calculated the IUCN listing notes the species has a large geographic range and a stable population that does not appear to be at risk. While the species is endemic to Sumatra, the extent of occurrence is not considered to be <50,000km^2 and as such would not be considered a candidate for Critical Habitat under the definition of endemic or restricted range.
Cuon alpinus	Dhole	EN	x			Species recently confirmed in several national parks along the Barisan Mountain range including Kerinci Seblat NP (to the north of the Project Area) and Bukit Barisan Selatan NP. IUCN lists over 10 areas where they have been confirmed in addition to listing distribution globally. The species is noted to be a habitat generalist occurring in a wide variety of habitat types including primary, secondary and degraded forms of forest. The species was recorded as part of Project	Highest populations of the species are noted in India, Thailand and Myanmar followed by Bhutan, Cambodia, China, Lao PDR, Malaysia and Nepal; and based on this the DMU habitat is not considered to sustain >10 % of the global population (Criterion 1, Tier 1a). While habitat within the DMU may be suitable for the species the area is not one of 10 sites globally with many sites noted globally for the species (Criterion 1, Tier 1b). There is no evidence to suggest there is an important concentration of the species within the DMU, including a nationally/regionally important concentration (Criterion 1,

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						biodiversity surveys (Greencap, 2015).	Tier 2c and Tier 2e). There is approximately 163 ha of the Project Area within the DMU that will be directly disturbed. It is not considered to be of sufficient extent to impact the long term survivability of the species (Criterion 1, Tier 2d). The Project Area is not considered to trigger Critical Habitat for this species.
Hylopetes winstoni	Sumatran flying squirrel	DD		x		The species is known from one type specimen only, recorded in the north of Sumatra. The taxonomic status requires evaluation and there is no information relating to population status or habitat preference.	There are currently no records of the species in the DMU and as such it is not known to sustain ≥ 95 % of the global population (Criterion 2. Tier 1a) or ≥ 1 % but ≤ 95% (Criterion 2, Tier 2b). As this species has only been recorded once in the north of Sumatra there is no evidence to suggest that the DMU or Project Area are important for the species. The Project Area is not considered to trigger Critical Habitat for this species.
Manis javanica	Malayan pangolin	CE	x			Habitat for the species is described as primary and secondary forest as well as cultivated areas (gardens, oil palm and rubber plantation), including near human settlements. While the species is found in a variety of habitats, primary forest is noted to support more individuals given a presence of greater number of older, larger trees with hollows suitable for sleeping and den sites as well as lower level of human activity. The species is widely distributed geographically. The IUCN listing profile notes a paucity of research on population density at local, national and global scales though notes populations in Singapore, Cardomom Mountains in Cambodia, Selangor and Negri Sembilan and Pasoh Forest Reserve and Kenyir Wildlife Corridor in Peninsula Malaysia, Sabah Sumatra, Java and Kalimantan.	Distribution data notes a wide geographic spread for the species and as such the DMU is unlikely to sustain >10 % of the global population and is not one of 10 or fewer discrete areas where the species is known (Criterion 1, Tier 1a and 1b). Primary forest habitats are noted to be preferred by the species and the Project captured photographs of the species at Wellpad D and Wellpad C. As a result the DMU would be considered to support a regular occurrence of an individual (Criterion 1, Tier 2c). While there is an overlap of the DMU with the Project Area, the direct disturbance of 163 ha of suitable habitat would not be expected to impact the long-term survivability of the species (Criterion 1, Tier 2d). There is insufficient data to confirm if the DMU habitat contains a nationally/regionally important concentration of the species so a precautionary approach may be suitable (Criterion 1, Tier 2e)

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						Home range size for the species has been estimated at 6.97 ha. The primary threat to the species is hunting and poaching. The species was recorded at 1,910m asl as part of Project biodiversity surveys (Greencap, 2015) and has been recorded in Bukit Barisan Selatan NP at 900m asl (Wirdateti *et al*, 2013 cited in Greencap, 2015).	**The Project Area is considered to contain Critical Habitat for this species.**
Maxomys hylomyoides	Sumatran mountain maxomys	DD		x		This species is reported to be found in primary upper montane or moss forest, and possibly sub alpine or shrubland vegetation. The range is poorly understood however it is noted to be found above 600-800m. There is no information to identify if the species can persist in disturbed or modified habitat. The species distribution is mapped only in two patches within the Kerinci Seblat NP. It is known present in the Kerinci Seblat NP and is noted may be found in other protected areas.	The species distribution is mapped only in two patches and not within the DMU. As a result with would be considered unlikely that the DMU sustains >95 % of the global population (Criterion 2, Tier 1a); and in the absence of any known records in the DMU unlikely to sustain >1 % but <95 % of the global population (Crierion 2, Tier 2b). The Project Area is not considered to trigger Critical Habitat for this species.
Maxomys inflatus	Broad-nosed Sumatran maxomys	VU		x		This species is believed to be confined to lower and mid-montane elevations, inhabiting tropical evergreen forest. The species distribution is mapped across the mountains of the length of western Sumatra incorporating the national parks to the north and the DMU. The species is known to be present in the Kerinci Seblat NP and has been recorded between 900 and 1500m asl.	The species distribution is mapped across the mountains of the length of western Sumatra including to the southern extent DMU. Based on this distribution it is unlikely that the DMU sustains >95 % of the global population (Criterion 2, Tier 1a) however there is potential that the DMU sustains >1 % but <95 % of the global population in the absence of any detailed population information (Criterion 2, Tier 1b). **The Project Area is considered to contain Critical Habitat for this species.**
Muntiacus montanus	Sumatran mountain	DD		x		The IUCN notes there is little acknowledgement of the species' potential existence, and thus work	Further work would be required to clarify the taxon of montanus upon which it would be expected the uncertainty

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
	muntjac					apparently continues to assume that only one muntjac species is present on Sumatra. The listing cites '*it is thus impossible to ascertain even the species' relative status and distribution let alone, habitat and altitude use, other aspects of ecology, levels of potential threats, and resilience to such threats*.' The distribution of the species is uncertain though current distribution mapping does not include the DMU. There is also uncertainty associated with altitudinal distribution though it appears it is a montane species. The species was not recorded during biodiversity surveys for the Project (Greencap, 2017).	regarding distribution and habitat preferences may become clearer. Given the species was not recorded during field survey and in the absence of other information this species will not be considered a critical habitat candidate in this instance.
Mus crociduroides	Sumatran shrewlike mouse	DD		x		The species is found in upper montane rainforest though elevation limits are not well defined. The type locality is Korinchi Peak at 3,050 m asl. The species is endemic to Sumatra however it is listed as data deficient as the limits of distribution geographically and attitudinally is not well known.	The mapped distribution of the species is restricted to an area associated with the Kerinci Seblat NP and does not include the DMU. As a result the habitat of the DMU is unlikely to sustain ≥ 95 % of the global population (Criterion 2, Tier 1a) or >1 % but <95 % of the global population (Criterion 2, Tier 2b). The Project Area is not considered to trigger Critical Habitat for this species.
Nesolagus netscheri	Sumatran striped rabbit	VU		x		Habitat preferences for the species are poorly understood however IUCN notes the population is restricted to elevations above 600m and below 1600m (based on data from seven known locations). Based on these preferences the extent of occurrence is estimated to be less than 20,000km^2. Most records of the species are from land being cleared for coffee or tea plantation though the preferred habitat is noted to be montane forest with volcanic soil, and the species has a low	There is uncertainty associated with a variety of species information for the Sumatran striped rabbit, in particular habitat requirements. In the context of critical habitat there is potential the DMU provides habitat for the species (in the absence of further detail on habitat preferences) though there are no known records of individuals in the DMU. The DMU overlaps the distribution of the species however mapping largely excludes the primary forest areas of the DMU (likely due to altitude). Most of the DMU is above 1600m and as a result it is considered unlikely

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						tolerance to human disturbance. There are camera trap recordings from Kerinci Seblat NP to the north of the Project Area and Bukit Barisan NP to the south of the Project Area.	that ≥ 95 % of the global population is within the DMU (Criterion 2, Tier 1a) or ≥ 1 % but ≤ 95% of the global population (Criterion 2, Tier 2b). The Project Area is not considered to trigger Critical Habitat for this species.
Panthera tigris sumatrae	Sumatran tiger	CE	x	x		The species is endemic to Sumatra. IUCN reported the species to occur in about 58,321 km² of forested habitat in 12 potentially isolated Tiger Conservation Landscapes totaling 88,351 km² with about 37,000 km² protected in ten national parks. A more recent publication from Wibisono and Pusparini (2010) found that the species was present in 27 habitat patches larger than 250 km², this was based on a questionnaire of 35 respondents including tiger conservationists, field biologists and government officials. The Bukit Balai Rejang Protection Forest (Bukit Balai Rejang South Tiger Conservation Landscape) was one of the forest patches evaluated where the species was confirmed to occur though population data is not reported. The tiger is adaptive to a wide range of habitats with sufficient prey and water being key as well as the presence of threats. They are found in primary forest, secondary forest, coastal forest, peat swamps and logging forest (Ministry of Forestry, 2007). Threats to the species include deforestation and degradation, hunting and trading, conflict and indirect pressures related to poverty (Ministry of Forestry, 2007).	There are no population estimates reported for the DMU though given known distribution and population data for other areas it is considered unlikely that the DMU sustains >10 % of the global population of the species (Criterion 1 - Tier 1a). Similarly the Wibisono and Pusparini study (2010) identified more than ten habitat areas so the Project DMU would not be considered one of 10 DMU globally for the species (Criterion 1 - Tier 1b). Forested habitats are noted to be preferred by the species and evidence of the species was detected at Wellpads B, C and D. In addition tiger prey species were detected in the Project Area. As a result the DMU would be considered to support a regular occurrence of an individual (Criterion 1, Tier 2c). While there is an overlap of the DMU with the Project Area, the direct disturbance of 163 ha of suitable habitat would not be expected to impact the long-term survivability of the species (Criterion 1, Tier 2d). There is insufficient data to confirm if the DMU habitat contains a nationally/regionally important concentration of the species so a precautionary approach may be suitable (Criterion 1, Tier 2e) Given the known forest patches where the species is reported it is unlikely that the DMU sustains >95 % of the global population however there is potential that the DMU sustains >1 % but <95 % of the global population. (Criterion 2, Tier 1 and 2).

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						Footprints of the species were recorded at Wellpads B, C and D (Greencap, 2015).	**The Project Area is considered to contain Critical Habitat for this species.**
Presbytis melalophos	Sumatran surili	EN	x	x		The species is endemic to Sumatra. The species is considered relatively common in its remaining and appropriate habitat however occurrences are very patchy and fragmented. It is known to occur in five protected areas, including Kerinci Seblat NP to the north of the Project Area and Bukit Barisan NP. Habitat is reported in disturbed and secondary forest areas, primary hill rainforest, shrub forest and plantations. The home range has been observed to be 14-29.5 ha. The Greencap surveys reported (2015) the species in forest areas bordering coffee plantations. The report noted that the density of the species calculated for the survey was only 2 groups/km^2 in contrast to the Bukit Barisan NP where it is recorded abundant. Greencap notes that the species is not present in forest with cover between 50 and 75%, and extremely high densities occur between 26 and 50%. The forest cover of the Project Area was reported by Greencap to remain at 75%.	The DMU includes suitable habitat and atleast one known population (recorded by Greencap). Although the species has been recorded within the Project Area, it is expected that the abundance is low. In the absence of more detailed data regarding the remainder of the DMU it cannot be ruled out that Tier 1 of Criterion 1 may apply, most likely Tier 1b. The DMU may be one of 10 or fewer DMU sites for the species globally noting the species is reported to occur in five NPs. Given its low abundance in the forest habitat at the Project and no additional population data there is no evidence to suggest that the DMU sustains >10 % of the global population (Criterion 1, Tier 1a). Specific to Criterion 1 Tier 2 threshold, the DMU has potential to provide habitat for a nationally/regionally important concentrations of the species (in the absence of utilization data) (Tier 2c and Tier 2e). Specific to the Project area there are records of the species close to the footprint, and this must be a consideration when understanding importance of the area given the relatively small home range of the species. While records suggest a population local to the Project Area, the direct disturbance of 163ha would not be expected to impact the long-term survivability of the species (Criterion 1, Tier 2d). Given the known forest patches where the species is reported it is unlikely that the DMU sustains >95 % of the global population and given its likely low abundance in the forest habitat unlikely to sustain >1 % but <95 % of the global population. (Criterion 2, Tier 1 and 2). **The Project Area is considered to contain Critical Habitat for**

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
							this species.
Pteromycus pulverulentus	Smoky flying squirrel	EN	x			The species is found in Brunei, Indonesia, Peninsular Malaysia and southern Thailand. Species lives in tree hollows of tall, undisturbed lowland primary forest (below 3000m asl). Two secure populations are noted in Sabah. The species was not recorded during biodiversity field surveys (Greencap, 2015)	The DMU may include suitable habitat though there are no known recorded of the species. The DMU may be one of 10 or fewer DMU sites however there is no evidence to suggest a known, regular occurrence for the species (Criterion 1, Tier 1b). Given there are no recorded in the DMU or nearby tracts is no evidence to suggest that the DMU sustains >10 % of the global population (Criterion 1, Tier 1a) or provides habitat for a nationally/regionally important concentrations of the species (Tier 2c and Tier 2e). In the event the DMU sustains a population of the species, the direct disturbance of XX ha would not be expected to impact the long-term survivability of the species (Criterion 1, Tier 2d). The Project Area is not considered to contain Critical Habitat for this species.
Rattus korinchi	Sumatran mountain rat	DD		x		This species is reported to be found in primary upper montane or moss forest. The population is not well known and the species is known from relatively few specimens. Records are known from Gunung Kerinci (to the northwest of the Project Area) and Gunung Talakmau in western Sumatra, and these are the two areas mapped as the species distribution. The mapped distribution does not include the DMU.	The mapped distribution of the species is restricted to an area associated with the Kerinci Seblat NP and Talakmau further north and does not include the DMU. As a result the habitat of the DMU is unlikely to sustain ≥ 95 % of the global population (Criterion 2, Tier 1a) or >1 % but <95 % of the global population (Criterion 2, Tier 2b). The Project Area is not considered to trigger Critical Habitat for this species.
Symphalangus syndactylus	Siamang	EN	x			The species is native to Indonesia (Sumatra), Malaysia (Peninsular Malaysia) and Thailand. In Indonesia this species is found in the Barisan Mountains of west-central Sumatra. The species is known from atleast nine protected areas in Indonesia, Thailand and Malaysia and Akrom (2012) notes species density estimates from	The DMU includes suitable habitat and atleast one known population (recorded by Greencap). The species has been recorded within the Project Area however it is expected that the abundance is low in comparison to other known areas where the species occurs. Given its low abundance in the forest habitat at the Project and no additional population data there is no evidence to suggest

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						additional locations. This species lives in primary and secondary semi-deciduous and tropical evergreen forest. Siamangs occur at lower densities in secondary forest, but can persist in secondary areas. They range from the lowlands up to 1500 m in elevation. Greencap (2015) reported records of the species in montane habitat between 1500m and 2000m. Based on the survey 16 groups were documented with a 0.3 group/km² density in the surveyed area. Greencap noted that the density is substantially lower than that measured in Kerinci Seblat NP of 2.7 groups/km² (Wood et al., 1996 cited in Greencap, 2015). In Burit Barisan NP average group density was reported to be one group for every 2.23km² with an average group size of 3.9. The population estimate of Bukit Barisan NP is 22,390 individuals.	that the DMU sustains >10 % of the global population (Criterion 1, Tier 1a). Similarly the literature identified more than ten habitat areas so the Project DMU would not be considered one of 10 DMU globally for the species (Criterion 1 - Tier 1b). Specific to Criterion 1 Tier 2 threshold, the DMU has potential to provide habitat for a nationally/regionally important concentrations of the species (in the absence of utilization data) (Tier 2c and Tier 2 e). While records suggest a population local to the Project Area, the direct disturbance of 163 ha would not be expected to impact the long-term survivability of the species (Criterion 1, Tier 2d). **The Project Area is considered to contain Critical Habitat for this species.**
Tapirus indicus	Malayan tapir	EN	x			This species is native to Indonesia (Sumatra), Malaysia, Myanmar and Thailand. In Sumatra this species occurs in the southern and central areas. Its populations are now highly fragmented within its former range. Linkie *et al*. 2013 (cited in IUCN species profile) recorded the species at 17 of 19 areas sampled using camera traps across Southeast Asia between 1997 and 2011. This species is restricted to tropical moist forest areas and occurs in both primary and secondary forest. It is predominantly found in the lowlands and the lower montane zones in some parts of the range.	The DMU includes suitable habitat for the species and there are known records. The mapped distribution of the species is fragmented and largely isolated to forest fragments (including existing protected areas) and does not include the DMU. Based on this there is no evidence to suggest that the DMU sustains >10 % of the global population (Criterion 1, Tier 1a). While habitat within the DMU is suitable for the species the habitat it is not one of 10 sites globally with many sites noted globally for the species (Criterion 1, Tier 1b). Specific to Criterion 1, Tier 2 thresholds the DMU has potential to provide habitat for a nationally/regionally important concentrations of the species (in the absence of utilization data) (Tier 2c and Tier 2e). While the DMU may contain a

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						The species was detected via camera trap near Wellpad B, C, E and I and Puyang Lake during the biodiversity surveys (Greencap, 2015)	population, the direct disturbance of approximately 163ha would not be expected to impact the long-term survivability of the species (Criterion 1, Tier 2d). **The Project Area is considered to contain Critical Habitat for this species.**
Calamaria margaritophora	Stripe-necked reed snake	DD		x		IUCN notes research is needed to establish if the species is present within the Kerinci Seblat NP as only recorded available are from the 1940s. Most known records are from just outside the border of Kerinci Seblat NP. The species is reported to occur between 500 and 1000m asl. The species was believed to be locally common in Bengkulu and rare in the three other Sumatran provinces. It is reported to inhabit lowland dipterocarp forest. The species was not recorded during biodiversity field surveys (Greencap, 2017)	Based on the literature it is considered unlikely this species occurs within the DMU (altitudinal distribution and location of previous records). Given the species was not recorded during field survey and in the absence of other information this species will not be considered a critical habitat candidate in this instance.
Iguanognathus werneri	Spatula-toothed snake	DD		x		Species known from one type specimen only collected in 1898 from an unknown location in Sumatra. There is no information regarding habitat and ecology of the species and research is required to establish the current distribution, habitats and threats. The species was not recorded during biodiversity field surveys (Greencap, 2017)	Given the species was not recorded during field survey and in the absence of other information this species will not be considered a critical habitat candidate in this instance.
Typhlops hypsobothrius	Sumatra worm snake	DD		x		Species known from two type specimens with the collections unavailable. There is no information regarding habitat and ecology of the species and research is required to	Given the species was not recorded during field survey and in the absence of other information this species will not be considered a critical habitat candidate in this instance.

Scientific Name	Common Name	IUCN Listing	Criterion 1	Criterion 2	Criterion 3	Species information*	CH rationale
						establish the current distribution, habitats and threats. The species was not recorded during biodiversity field surveys (Greencap, 2017)	
Chalcorana crassiovis	Korinchi frog	DD		x		The species is known from only a few localities including Barisan, Kerinci, Batang, Tarusan and Solok in west Sumatran. IUCN distribution mapping is restricted to an area over 350,000km to the north east of the DMU. There is an absence of information on extent of occurrence, status and ecological requirements. Greencap (2017) reports the species was found during the survey.	There is uncertainty associated regarding the habitat requirements for the species as well as its extent of occurrence. The IUCN distribution mapping does not include the Project Area or the DMU and as such further work should be undertaken to confirm the record reported by Greencap and as such the critical habitat.
Rhacophorus bifasciatus		NT		x		Species occurs in lowland and submontane forest, likely breeding in streams. Distribution of the species is mapped at six patches across Sumatra, one of which includes the DMU. The extent of occurrence while not calculated is noted to be 'not much greater than 20,000 km^2'. The species was not recorded during the biodiversity survey for the Project (Greencap, 2017)	While the species has not been recorded during field survey, there is suitable habitat and the Project Area is within the mapped distribution for the species. There is no population information specific to the species however given there are six other locations comprising the species distribution it is considered unlikely that the DMU sustains > 95% of the global population (Criterion 3, Tier 1a). That being the case there is potential that the DMU sustains >1% but <95% percent of the global population (Criterion 3, Tier 2b). **The Project Area is considered to contain Critical Habitat for this species.**

CE = Critically Endangered; EN = Endangered

*Species information sourced from IUCN Red List of Threatened Species profiles dated 1 and 2 February 2017 unless otherwise referenced.

Grey indicates species associated with potential Critical Habitat.

3.4.5.4 *Threatened and/or Unique Ecosystems (Criterion 4)*

Criterion 4 has no tiered system although recent publication (Keith et al, 2013) may introduce this. IFC PS6 describe this Criterion to be one of the following:

i. the ecosystem is at risk of significantly decreasing in area or quality;
ii. has a small spatial extent; and /or
iii. contains unique assemblages of species including assemblages or concentrations of biome-restricted species.

Highly threatened or unique ecosystems are defined by a combination of factors which may include long-term trend, rarity, ecological condition, and threat. Guidance in applying this Criterion suggests the use of an ecosystem map for the region that includes the Project site. Data used to create these maps typically includes vegetation mapping, land use mapping and consideration of other driving environmental factors such as climate, hydrology and landscape position.

Land cover mapping and natural and modified habitat mapping described Sections 3.2.2 and 3.2.4 have been considered in this instance to identify the ecosystems represented for the purposes of determining if they are highly threatened or unique.

The majority of the AoI is considered to be natural habitat, primarily primary forest and secondary forest. The other modified habitat land covers would not be considered unique, at risk or of small spatial extent. The forested habitat however would be considered part of the Sumatra montane rain forest type which is recognised as one of the Global 200 ecoregions. The Global 200 ecoregions are those ecosystems that represent the most outstanding and representative areas of biodiversity by WWF. This forest type contains far higher levels of mammal and bird endemism than lowland forests, as a result of longer periods of isolations and distinctive forest types. The current status of the ecoregion is described by WWF as 'relatively stable/intact'. It contains several large blocks of intact forest and includes numerous protected areas (covering 40% of the total ecoregion area) (WWF, 2017). Based on this the primary and secondary forest of the AoI is not considered to be an 'ecosystem at risk of significantly decreasing in area or quality' (Criterion 4i). Similarly, the spatial extent of Sumatra montane rain forest type is reported to be around 260,000 km^2 which is not considered to be small (Criterion 4ii) and in turn the area within the AoI is not considered to substantially contribute to the overall extent.

The DMU applied for the assessment of criteria 1 to 3 has been assessed to be Critical Habitat for a number of species and as such there may be a case for the presence of a unique assemblage of species, in particular considering the number of endemic species. When considering the ecosystems more locally, associated with the Project Area region, it would not be considered likely that the habitats in the region provide the niches that would not otherwise be represented within the other protected areas regionally (such as Bukit Barisan Selatan NP).

While the Project Area is within the Sumatra montane rain forest ecoregion its current status is not considered to be highly threatened. In addition to this the habitat of Project Area is of minor value to the wider ecoregion and unlikely to sustain highly threatened or unique ecosystems.

3.4.5.5 Key Evolutionary Processes (Criterion 5)

Criterion 5 has no tiered system though IFC PS6 describes this Criterion to be one of the following:

i. the 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
ii. subpopulations of species that are phylogenetically or morphogenetically 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.

There are no physical features within the AoI that are known to be associated with evolutionary processes. The criteria 1 to 3 assessment identified a number of endemic species that are associated with the defined DMU. The DMU may be considered to support a high level of endemism. When considering the habitat within the AoI, the natural habitat areas would not be considered to substantially contribute to the biological values of the DMU that sustain the endemic populations. Similarly, the species assessments did not identify any species subpopulations known to be phylogenetically or morphogenetically distinct to be relying the habitat of the AoI.

As a result it not considered likely that the Project Area and AoI would be considered important in the conservation of Key Evolutionary Processes.

3.4.6 Invasive Alien 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, socio-cultural, economic or environmental harm or harm to human health (FAO, 2013). Invasive species are naturalised species that reproduce often in large numbers and are able to spread over a large area, damaging native species (FAO, 2005). Invasive species have the capacity to exacerbate their role in ecosystem degradation through combination threats by habitat change, climate change, over-exploitation of ecosystem resources and pollution, which further enhances their threat to biodiversity and the human condition (Emerton and Howard, 2008).

The taxa or types of organisms that can become invasive are animals (vertebrates and invertebrates), plants and micro-organisms (including those

that are free-living as well as those that cause disease in plants, animals and people) (Emerton and Howard, 2008).

A desktop review of the Global Invasive Species Database (GISD, 2015) identified a list of species that are classified as invasive in Indonesia. The search identified 51 flora species and 39 fauna species that are considered invasive in Indonesia. The database does not specifically identify which part of Indonesia these species are known from and all these species have not been detected during baseline survey.

Of the species known in Indonesia four were recorded during baseline surveys or from other datasets (***Table 3.13***).

Table 3.13 Invasive species known from the Area of Influence (GISD, 2015)

Species/Common Name	Note
Imperata cylindrical Cogon grass	Formidable invasive grass. Displaces native plant and animal species and alters fire regimes. Dense swards create an intensely competitive environment for commercially important species.
Laucaena leucocephala Horse/wild tamarind	Weed of open, often coastal or riverine habitats, semi-natural and other disturbed or rural sites and occasionally agricultural land. Can form dense monospecific thickets which can replace native forest and in some areas threaten endemic species.
Macaca fascicularis Crab eating macaque	May impact biodiversity by eating eggs and chicks of threatened forest birds. Competes with native birds for resources such as native fruits. May play a role is dispersal of exotic plant species as well as carry potentially fatal human diseases.
Mimosa pigra Catclaw mimosa	Has the potential to harm a wide number and variety of different types of primary production. If large infestations occur over farmland, may threaten the health of pastoral industries by reducing the area of grazing land and the carrying capacity of the land. If livestock are reliant on natural water sources for drinking, their access to water may be blocked. May reduce water flow and increase silt levels, as it commonly colonises water course edges. Common along roadsides, mimosa may also increase the costs of maintaining power poles and cables used for electricity transmission. It may also decrease driver visibility, increasing the potential for traffic accidents.

3.4.7 Priority Ecosystem Services

Priority Ecosystem service identified from the screening assessment at *Section 3.3.1* is shown in ***Table 3.14*** below.

Table 3.14 Priority Ecosystem Services

Service	Discussion
Provisioning Services	
Food: cultivated crops	Local people likely to clear forest for slash and burn agriculture. This area of land available for future clearing has been restricted since 2009.
Freshwater	Local people are likely to use local streams for irrigation and non-potable uses. Extraction of water from the local waterways may reduce water availability for local people.

4 BIODIVERSITY IMPACT ASSESSMENT

4.1 ASSESSMENT METHODOLOGY

4.1.1 Approach

In accordance with IFC PS1 and PS6, the assessment process aims to predict and assess the Project's potential adverse impacts and risks to biodiversity values, in quantitative terms where possible. The objectives of the biodiversity impact assessment are to identify and quantify the potential Project impacts; design measures to avoid, minimise or mitigate potential adverse impacts; and identify likely residual impacts. To achieve this; a six step process was undertaken:

1. **Screening** to determine if the Project may pose a risk to biodiversity and in particular which the biodiversity features require study;
2. **Scoping** to determine which direct and indirect biological impacts are likely to be significant in order to determine the focus issues of the impact assessment;
3. **Baseline Studies** to define the Project's area of influence and describe the relevant biodiversity conditions likely to occur. This includes identifying modified and natural habitat areas and determining the presence of critical habitat in accordance with IFC PS6 definition;
4. **Impact Analysis** assesses the extent and complexity of potential adverse impacts considering the two parameters of habitat area (spatially) and threatened species individually;
5. **Mitigation Measures** are developed to avoid and minimise potential adverse impacts to biodiversity with a priority given to impacts on features with significant biodiversity values; and
6. **Residual Impacts** are determined and in the event significant residual impacts occur biodiversity offsets are considered.

A summary of the baseline conditions is provided in *Section 3*.

4.1.2 Scoping of Likely Impacts to Biodiversity Values

Table 4.1 broadly defines the types of threats to biodiversity values that have potential to occur as a result of a Project. These threats to biodiversity are derived from IFC PS6 and relate to the activities that are likely to occur during construction and post construction phases.

Table 4.1 Types of Threats to Biodiversity Values

Term	Description
Loss of habitat	Permanent loss of habitat or species due to permanent or temporary site activities.
Disturbance or displacement of	Disturbance to, or displacement/exclusion of a species from foraging habitat due to construction activities, and operational and

Term	Description
individuals - Light - Noise - vibration impacts	maintenance activities. Impacts from light, noise and vibration sources on surrounding habitats causing disturbance and displacement and changes in behaviour
Barrier creation	Creation of barriers to the movements of animals, especially fish, but also mammals, reptiles and amphibians and invertebrates and plants with limited powers of dispersal.
Fragmentation and edge effects	Fragmentation of habitat, or permanent /temporary severance of wildlife corridors between isolated habitats of importance for biodiversity. Impacts that occur when a habitat is exposed to a different adjacent habitat type or structure. These impacts can include increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species
Degradation of habitat - Dust - Water pollution - Invasive species	Disturbance or damage to adjacent habitat and species caused by changes in microclimate, vulnerability to predation and invasion and overall changes in conditions that can lead to a change in the community and its values for flora and fauna. This can include increased exposure to noise, light and dust. Introduction or spreading of alien species during the construction works.
Mortality – vehicle strike, hunting and poaching	Mortality of individual fauna species as a result of vehicle or machinery strike or falling debris during clearing activities. Mortality to individual fauna species as a result of worker influx and hunting/poaching of extant fauna

4.1.3 Screening of Key Project Activities/Aspects Relating to Potential Biodiversity Impacts

The nature of impacts to biodiversity can be described in terms of direct and indirect impacts; and permanent and temporary impacts. ***Table 4.2*** considers the construction and operation of each component of the Project and which threats to biodiversity categories may apply. This table is used in the resulting impact assessment.

Table 4.2 Screening of Key Project Activities/Aspects Relating to Potential Biodiversity Impacts

Activity/Aspect	Loss of habitat	Disturbance or displacement of flora/fauna	Barrier creation	Edge effects and fragmentation	Degradation of habitat	Mortality – vehicle strike hunting and poaching
General Exploration/Construction Activities						
Land clearing activities (Habitat removal)	■	■	■	■	■	■
Well drilling (Noise, vibration)		■				
Water extraction (Changes in aquatic habitats)	▒	■	■			▒
Movement of vehicles (Noise, dust, light and strike)		■		▒	▒	■
Storage of raw materials (Creation of new habitats/dust)					■	
Construction activities including building works, concrete works (Noise, vibration, dust)		■			▒	▒
Labor influx (Hunting and poaching of wildlife)					▒	■
Waste management (Creation of new habitats/foraging resources)		■			▒	
Stormwater runoff (Changes to aquatic habitats)					■	
General Operation Activities						
Movement of vehicles along haul roads and access roads (Vehicles strike/dust generation)				▒	▒	■
Operation of Power Plant (Noise, light and air emissions)		■			▒	
Waste management (Creation of new habitats/foraging resources)		■			▒	
Stormwater runoff (Changes to aquatic habitats)					■	
Maintenance activities (Noise, vibration and light)		■				▒
Land clearing activities (Induced clearing)	■				■	
Labour influx (Hunting and poaching of wildlife)						■

Notes:

■	Screened in to impact assessment
▒	Negligible impact possible, screened out
	No impact possible, screened out

4.2 BIODIVERSITY IMPACT ASSESSMENT

4.2.1 Impact Analysis

The significance of the impacts has been evaluated using a standardised approach based on ERM's Impact Assessment Standard. This Standard has been determined based on the requirements of IFC PS6. It is based on the relationship between the magnitude of impact and nature of receptor (sensitivity). Impacts to biodiversity are often discussed in terms of impacts to habitats and impacts to individual species or species groups. As such significance criteria are defined for both habitats and species. The Project impacts identified have been assessed for their significance according to the criteria provided in ***Table 4.3*** (for habitat areas) and ***Table 4.4*** (for specific species groups).

Table 4.3 Habitat Impact Assessment – Significance Criteria

Habitat Sensitivity/Value		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
Low	Habitats with no or local designation/ recognition; habitats of significance for species of Least Concern; habitats which are common and widespread within the region.	Negligible	Negligible	Minor	Moderate
Medium	Habitats within nationally designated or recognised areas; habitats of significant importance to globally Vulnerable, Near Threatened or Data Deficient species; habitats of significant importance for nationally restricted range species; habitats supporting nationally significant concentrations of migratory species and/or congregatory species; nationally threatened or unique ecosystems.	Negligible	Minor	Moderate	Major
High	Habitats within internationally designated or recognised areas; habitats of importance to globally Critically Endangered or Endangered species; habitats of 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.	Negligible	Moderate	Major	Critical

Magnitude of Effect Definition

Negligible	*Effect is within the normal range of variation*
Small	*Affects a small area of habitat, but without the loss of viability/function of the habitat*
Medium	*Affects a sufficient proportion of the habitat that the viability/function of part of the habitat or the entire habitat is reduced, but does not threaten the long-term viability of the habitat or species dependent on it.*
Large	*Affects the entire habitat or a significant proportion of the habitat to the extent that the viability/function of the entire habitat is reduced and the long-term viability of the habitat and the species dependent on it are threatened.*

Table 4.4 Species Impact Assessment – Significance Criteria

Species Sensitivity/Value		Magnitude of Effect			
		Negligible	**Small**	**Medium**	**Large**
Low	Species which are included on the IUCN Red List of Threatened Species as Least Concern (LC) (IUCN 2011).	Not significant	Not significant	Minor	Moderate
Medium	Species included on the IUCN Red List of Threatened Species as Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD) (IUCN 2011). Species protected under national legislation. Nationally restricted range species. Nationally important number of migratory or congregatory species.	Not significant	Minor	Moderate	Major
High	Species included on the IUCN Red List of Threatened Species as Critically Endangered (CR) or Endangered (EN) (IUCN 2011). 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 for bird species) less than 50,000 km². Internationally important numbers of migratory or congregatory species. Key evolutionary species.	Not significant	Moderate	Major	Critical

Magnitude of Effect Definition

Negligible	*Effect is within the normal range of variation.*
Small	*Affects a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself*
Medium	*Affects a sufficient proportion of a species population that it may bring about a substantial change in abundance and /or reduction in distribution over one or more generations, but does not threaten the long term viability of that population or any population dependent on it.*
Large	*Affects an entire population or species at sufficient scale to cause a substantial decline in abundance and/or change in distribution beyond with natural recruitment (reproduction, immigration from unaffected areas) may not return that population or species, or any population or species dependent upon it, to its former level within several generations, or when there is no possibility of recovery.*

4.3 BIODIVERSITY IMPACT TYPOLOGY

The scoping and screening of potential Project impacts identified a number of Project aspects and activities that have potential to biodiversity values (shown in ***Table 4.2***). Whilst the potential impacts relate to a combination of Project aspects/activities and biodiversity threats, they can be summarised into a number of key potential impacts according to the biodiversity threat type. These impacts can relate to habitat areas, specific species or both. These impact types include:

- Loss of habitat;
- Disturbance or displacement of individuals;
- Barrier creation;
- Fragmentation;
- Edge effects;
- Degradation of habitat;
- Mortality – vehicle strike, hunting and poaching.

These impact assessment types are further explored in relation to the biodiversity values identified within the Project Area and the specific Project activities/aspects in the following sections.

This section elaborates on the nature of impacts to biodiversity values at it relates to the characteristics of the Project Area as determined by assessing the impacts of the Project Description (*Section 2*). The information has been used to inform the evaluation of the significance of the impact in the impact assessment summary tables following each impact assessment type. Impact assessments have been undertaken for both Exploration/Construction Phase and Operation Phase.

4.4 EXPLORATION/CONSTRUCTION PHASE IMPACT ASSESSMENT

4.4.1 *Loss of Terrestrial Habitat*

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

The impact assessment summary for loss of habitat relating to the exploration/construction phase is outlined in ***Table 4.5***.

Table 4.5 **Impact Assessment Summary – Permanent and Temporary Loss of Habitat**

Impact	Permanent and temporary loss of habitat (terrestrial and aquatic) including transition of habitats from one habitat type to another				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the terrestrial and aquatic biodiversity is negative				
Impact Type	**Direct**	**Indirect**	Induced		
	Direct terrestrial habitat loss in the Project Footprint in areas within the footprint. Indirect effects occur (and discussed in sections to follow).				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	The loss of habitats within the footprint will be permanent.				
Impact Extent	**Local**	Regional	International		
	The extent of natural habitat to be permanently removed is 163 ha. This impact is considered to be a localised impact.				
Impact Scale	The Project footprint comprises 163 ha of natural habitat				
Frequency	Once construction is complete there will be no further habitat clearing required.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Considering the area of clearing of each habitat discussed above, the overall magnitude of this impact is **Small** during the exploration/construction phase.				
Receptor Sensitivity	Low	Medium	**High**		
	The primary forest habitat within the footprint provides habitat values for IUCN listed species, as such there sensitivity is considered to be **High**.				
Impact Significance	Negligible	Minor	**Moderate**	Major	Critical
	The significance of this impact is **Moderate**.				

4.4.2 Changes to aquatic habitat

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

Water extraction has the potential to change the amount of aquatic habitat available in the waterways where water will be sourced. Intensive aquatic biota sampling has not been undertaken as part of the baseline assessment however impacts to aquatic environmental are identified. If extracted at sufficient volume aquatic habitat can be reduced to an extent that fish and other biota communities are unviable. In addition a reduction in flow volume has potential to reduce quality of downstream habitat and interrupt fish migration triggers and pathways. Based on the Project description the volume of water to be extracted is well within the current reported river discharge however in the absence of more detailed study a precautionary approach is recommended and management measures are recommended to facilitate opportunity for adaptive management.

4.4.3 Disturbance and displacement of resident species

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

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

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

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

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

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

The impact assessment summary for disturbance and displacement during the construction phase is outlined in ***Table 4.6***.

Table 4.6 **Impact Assessment Summary – Light, noise and vibration**

Impact	Impact to species from light, noise and vibration from the exploration activities, and construction of access roads, well sites, transmission line, power station, water pipeline and other infrastructure			
Impact Nature	**Negative**	Positive	Neutral	
	The impact on the terrestrial and aquatic biodiversity is negative			
Impact Type	Direct	**Indirect**	Induced	
	The impact for fauna is indirect and has potential to induce individuals to move away from currently utilised habitat. In addition noise and vibration can interfere with communications of fauna, including breeding communication (calls).			
Impact	**Temporary**	Short-term	Long-term	Permanent

Duration	The impacts will be temporary, limited to during the activities required for infrastructure construction.				
Impact Extent	**Local**	Regional	International		
	The impact is expected to be localised for species that occupy habitats immediately adjacent to infrastructure components and activities.				
Impact Scale	It is anticipated that the scale of impact will be limited to terrestrial habitats near to Project components.				
Frequency	Construction occurs only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Considering this impact will be localised and temporary, the overall magnitude of this impact is **Small**.				
Receptor Sensitivity	Low	Medium	**High**		
	The primary forest habitat within the footprint provides habitat values for IUCN listed species, as such there sensitivity is considered to be **High**.				
Impact Significance	Negligible	Minor	**Moderate**	Major	Critical
	The significance of this impact is **Moderate**.				

4.4.4 Barrier to Terrestrial Fauna Movement

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

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

The impact assessment summary for the creation of barriers to fauna movement during the construction phase is outlined in ***Table 4.7***.

Table 4.7 Impact Assessment Summary – Barrier to Fauna Movement

Impact	Impact to fauna movement by the construction of linear infrastructure				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the terrestrial biodiversity is negative				
Impact Type	Direct	**Indirect**	Induced		
	This is an indirect impact to fauna groups in the local area				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	The infrastructure constructed will be a permanent feature as such the impact will be permanent.				
Impact Extent	**Local**	Regional	International		
	The impact is expected to relate to local fauna movements as opposed to regional or national scale corridor features.				

Impact Scale	It is anticipated that the scale of impact will be limited to areas along linear infrastructure components.				
Frequency	Construction occurs only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	While a barrier will be introduced opportunities for movement across the landscape will remain locally. As a result the overall magnitude of this impact is **Small**.				
Receptor Sensitivity	Low	Medium	**High**		
	The primary forest habitat within the footprint provides habitat values for IUCN listed species, as such there sensitivity is considered to be **High**.				
Impact Significance	Negligible	Minor	**Moderate**	Major	Critical
	The significance of this impact is **Moderate**.				

4.4.5 Fragmentation and Edge Effects

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

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

- Microclimate effects reported up to 40m from forest edge in tropical rainforest (Turner, 1996);
- Canopy cover effects up to 10m, snag abundance up to 13m, understory density up to 13m in tropical forest (Harper et al. 2005);
- Effects in light, temperature, humidity, gaps, weeds and pioneer species of up to 50-100m for linear clearings (no forest type defined)(Laurance et al. 2009);
- Altered floristic composition and disturbance indicators up to 20-45m in tropical rainforest (Goosen and Jago, no date);
- Edge effects to woody seedling density up to 10m and temperature and vapor pressure effects up to 50m in lowland tropical forest (Sizer and Tanner 1999); and

- Microclimate effects in tropical forest up to 20m (Ewers and Banks-Leite 2013).

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

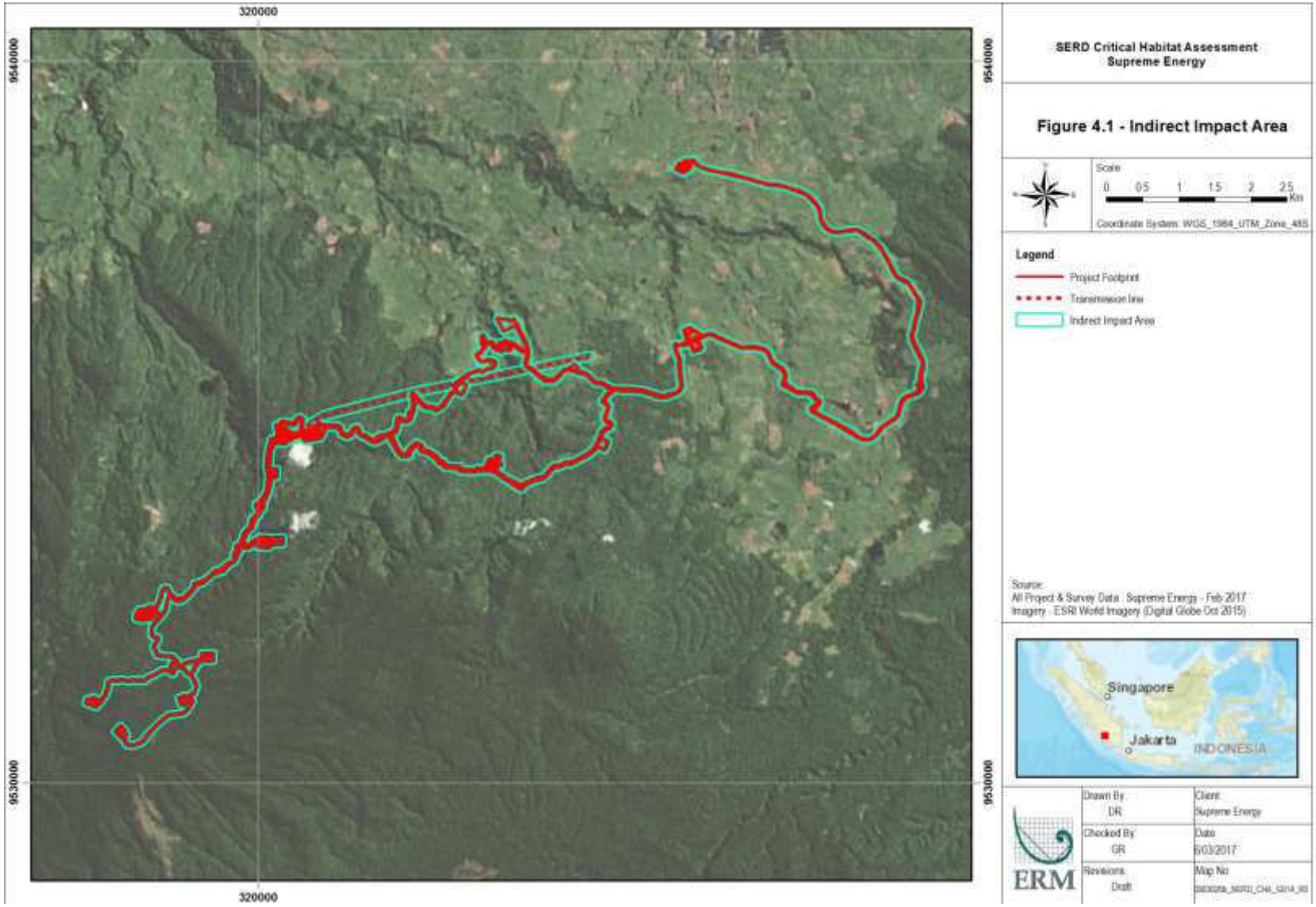
Fragmentation of habitats can occur where currently linked habitats are disconnected through the construction of Project components. Fragmentation reduces the continuity of habitat and hence the ability for fauna to move within and between habitat patches. The resulting impact can cause reductions in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

The impact assessment summary for impacts to habitats by edge effects during the exploration/construction phase is outlined in ***Table 4.8***.

Table 4.8 Impact Assessment Summary – Fragmentation and Edge effects

Impact	Impact to fauna movement from the construction of linear infrastructure				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the terrestrial biodiversity is negative				
Impact Type	Direct	**Indirect**	Induced		
	Indirect impact to flora and fauna species utilising the edge habitat areas.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Although construction will be short-term there will be a period of recovery for the edge habitat areas. Edge effects will be permanent however likely restricted to the dry season where dust on vegetation will persist.				
Impact Extent	**Local**	Regional	International		
	The impact is expected to be localised for habitats alongside linear infrastructure components, including roads.				
Impact Scale	It is anticipated that the scale of impact will be limited to areas along linear infrastructure components.				
Frequency	Construction occurs only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	While edge effects will occur, the impact will be localised and in the long-term most severe during dry weather conditions. The overall magnitude of this impact is **Small**.				
Receptor Sensitivity	Low	Medium	**High**		
	The primary forest habitat within the footprint provides habitat values for IUCN listed species, as such there sensitivity is considered to be **High**.				
Impact Significance	Negligible	Minor	**Moderate**	Major	Critical
	The significance of this impact is **Moderate**.				

Figure 4.1 Indirect Impact Area



4.4.6 Degradation of Habitats

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

Dust

During construction, land preparation has the potential to generate dust which may settle on vegetation adjacent to the construction area (including access roads). Excessive dust deposition on flora may act to suppress growth through limiting photosynthesis and the dusted foliage may also become unpalatable to foraging fauna. The construction activities will be temporary and dust generation is likely to be localised to active work areas. Rainfall will generally remove dust from foliage and this impact has been assessed for significance as part of the Edge Effects impact in *Section 4.4.5*.

Runoff

Land preparation will expose earth areas to be vulnerable to erosion (wind and/or runoff) until infrastructure construction or replanting is completed to stabilise the surface. The Project Area experience varied topography including steep slopes. Erosive processes transport sediment downstream depositing mobilized sediment downstream/downslope of habitats (both aquatic and terrestrial). This indirect impact has potential to degrade downstream habitat areas or change habitat characteristics, and as such influencing suitability for native flora and fauna communities. Runoff may flow into the local river systems which may provide habitat for conservation significant and commercially utilised fish species.

Release of Contaminants

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

Invasive Species

Invasive species (flora and fauna) have the potential to be introduced or spread throughout the Project Area through increased movement of people, vehicles, machinery, vegetation and soil. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some

native flora and fauna, including conservation significant species. Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native vegetation communities to re-establish. Invasive animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation.

Invasive species were detected within the Area of Influence and Project Area and will be considered as part of the impact analysis. The impact assessment summary for degradation of habitats during the construction phase is outlined in ***Table 4.9***.

Table 4.9 Impact Assessment Summary – Degradation of Habitats

Impact	Impact to habitats from degradation including runoff, release of contaminants and invasive species from the exploration/construction phase				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the terrestrial and aquatic biodiversity is negative				
Impact Type	**Direct**	**Indirect**	Induced		
	This impact has potential to be direct (eg. contamination due to accidental spill) or indirect (eg. introduced weeds reducing habitat suitability)				
Impact Duration	Temporary	Short-term	**Long-term**	**Permanent**	
	Although construction phase is short-term, resulting degradation has potential to be long-term or permanent.				
Impact Extent	**Local**	**Regional**	International		
	The impact is expected to be localised for habitats alongside linear infrastructure components and activities. If downstream environments are impacted the extent may be regional.				
Impact Scale	It is anticipated that the scale of impact will be limited to downstream areas and areas along linear infrastructure components.				
Frequency	Construction occurs only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Given there are currently invasive species known in the habitats of the Project Area magnitude of this impact is **Small**.				
Receptor Sensitivity	Low	Medium	**High**		
	The primary forest habitat within the footprint provides habitat values for IUCN listed species, as such there sensitivity is considered to be **High**.				
Impact Significance	Negligible	Minor	**Moderate**	Major	Critical
	The significance of this impact is **Moderate**.				

4.4.7 Fauna Mortality

Vehicle/Machinery Strike

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

It is likely that most individuals will disperse from construction activity locations into adjacent habitats as a result of noise and other disturbance

however some less mobile species may experience a localised reduction in abundance during this period, such as amphibians, reptiles and small mammals.

Hunting and Poaching

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

The impact assessment summary for impacts to species from fauna mortality during the construction phase is outlined in ***Table 4.10***.

Table 4.10 Impact Assessment Summary – Fauna Mortality

Impact	Impact to fauna from vehicle strike and hunting/poaching during the exploration/construction phase				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the terrestrial biodiversity is negative				
Impact Type	**Direct**	Indirect	Induced		
	Direct impact to terrestrial fauna.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	Although construction vehicle strike impacts will be temporary an increase in hunting and poaching may be a longer term impact for targeted species.				
Impact Extent	**Local**	Regional	International		
	It is anticipated that the scale of impact will largely be limited to the immediate Project vicinity, particularly along roads and near the workers camp.				
Impact Scale	It is anticipated that the scale of impact will largely be limited to the immediate Project vicinity, particularly along roads and near the workers camp.				
Frequency	Construction occurs only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Considering the magnitude of impacts the overall magnitude of this impact is **Small**.				
Receptor Sensitivity	Low	Medium	**High**		
	Terrestrial species likely impacted are considered to be a **High** sensitivity given the potential presence of Critical Habitat candidate species locally.				
Impact Significance	Negligible	Minor	**Moderate**	Major	Critical
	The significance of this impact is **Moderate**.				

4.5 OPERATION PHASE IMPACT ASSESSMENT

4.5.1 Loss of Habitat – Induced Clearing

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

To be advised once induced clearing assessment completed.

4.5.2 Disturbance and displacement of resident species

Disturbance and displacement of species during operation will be primarily caused by light and noise generated during operation and maintenance of the facilities. Light and noise impacts will have the same type of impacts to resident fauna as described in the impact assessment for the exploration/construction phase (as outlined above). Impacts will relate to both natural and modified habitats surrounding the Project infrastructure. Given the Project does not involve high noise generating activities (such as blasting) this impact is not expected to be substantial. The impact assessment summary for disturbance and displacement during the construction phase is outlined in ***Table 4.11***.

Table 4.11 Impact Assessment Summary – Disturbance and displacement of resident species

Impact	Impact to species from disturbance and displacement of resident species				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the terrestrial biodiversity is negative				
Impact Type	**Direct**	**Indirect**	Induced		
	Direct impact to terrestrial fauna.				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	The impact will be permanent and ongoing during operation				
Impact Extent	**Local**	Regional	International		
	The impact is expected to be localised for species that occupy habitats immediately adjacent to Project components and activities.				
Impact Scale	It is anticipated that the scale of impact will be limited to terrestrial habitats immediately adjacent to Project components.				
Frequency	The frequency of vehicle movements during operation will be reduced in comparison to construction. Similarly, lighting will be required only at operational facilities (ie not along access roads or transmission line).				
Impact Magnitude	Positive	**Negligible**	**Small**	Medium	Large
	The magnitude of this impact is expected to be Negligible to Small				
Receptor Sensitivity	Low	Medium	**High**		
	The primary forest habitat adjacent to the Project component includes habitat suitable for IUCN listed species, as such there sensitivity is considered to be **High**.				
Impact Significance	Negligible	**Minor**	**Moderate**	Major	Critical
	The significance of this impact is **Minor to Moderate**.				

4.5.3 Fragmentation and Edge Effects

Impacts from fragmentation and edge effects on resident species are likely to be similar to those described in the construction impact assessment (as discussed above). No new edges will be created as part of operational activities. The impact assessment in *Section 4.4.5* addresses this aspect.

4.5.4 Degradation of Habitats

Impacts relating to habitat degradation are likely to be similar to those described in the exploration/construction impact assessment (as discussed above). No new risk activities will be undertaken as part of operational activities. The impact assessment in *Section 0* addresses this aspect.

4.5.5 Fauna Mortality

Impacts relating to fauna mortality are those described in the exploration/construction impact assessment (as discussed above). No new risk activities will be undertaken as part of operational activities. The impact assessment in *Section 4.4.7* addresses this aspect.

4.5.6 Species Impacts

Species of conservation significance identified to occur or potentially occur within the Project Area have been assessed below based on the likely impact during construction and operation. The likely impacts to species are outlined in ***Table 4.12*** below. This list includes the identified species listed as CE, EN or VU on the IUCN Red List and species endemic to Sumatra. While Critical Habitat was not confirmed for these species impacts are identified such that measures can be developed to minimize the impact where possible.

Table 4.12 Assessment of Impacts to Threatened Species

Scientific Name / Common Name		IUCN	Endemic	Impacts
Dipterocarpus sp.		CE		Reduction of habitat from clearing during construction and operation. Removal of individuals during clearing.
Rafflesia bengkuluensis			✓	
Apalharpactes mackloti	Sumatran trogon	LC	✓	Reduction of habitat from clearing during construction and operation. Some bird species may be vulnerable to poaching for trade.
Arborophila rubrirostris	Red-billed partridge	LC	✓	
Carpococcyx viridis	Sumatran ground-cuckoo	CE	✓	
Cochoa beccarii	Sumatran cochoa	VU	✓	
Dicrurus sumatranus	Sumatran drongo	NT	✓	
Garrulax bicolor	Sumatran laughingthrush	EN	✓	
Hydrornis schneideri	Schneider's pitta	VU	✓	
Lophura inornata	Salvadori's pheasant	NT	✓	
Myophonus melanurus	Shiny whistling-thrush	LC	✓	
Padda oryzivora	Java sparrow	VU		
Pericrocotus miniatus	Sunda minivet	LC	✓	
Polyplectron chalcurum	Bronze-tailed peacock-pheasant	LC	✓	
Trichastoma buettikoferi	Sumatran babbler	LC	✓	
Arctictis binturong	Binturong	VU		Reduction of habitat from clearing during construction and operation. Potential impacts from hunting and poaching during construction and operation from labour influx during construction and operation.
Arctonyx hoevenii	Sumatran hog badger	LC	✓	
Capricornis sumatraensis	Sumatran serow	VU		
Cuon aplinus	Dhole	EN		
Helarctos malayanus	Malayan sun bear	VU		
Hylopetes winstoni	Sumatran flying squirrel	DD	✓	
Manis javanica	Malayan pangolin	CE		
Muntiacus montanus	Sumtrana mountain muntjac	DD	✓	
Tapirus indicus	Malayan tapir	EN		
Panthera tigris sumatrae	Sumatran tiger	CE	✓	
Pardofelis marmorata	Marbled cat	VU		
Presbytis melalophos	Sumatran surili	EN	✓	Reduction of habitat from clearing during construction and operation.

Scientific Name / Common Name		IUCN	Endemic	Impacts
				May avoid movement across linear barriers. Potential impacts from hunting and poaching during construction and operation from labour influx during construction and operation.
Symphalangus syndactylus	Siamang	EN		
Maxomys hylomyoides	Sumatran mountain maxomys	DD	✓	Reduction and degradation of habitat. Vulnerability to fauna mortality.
Maxomys inflatus	Broad-nosed Sumatran maxomys	VU	✓	
Mus crociduroides	Sumatran shrewlike mouse	DD	✓	
Nesolagus netscheri	Sumatran striped rabbit	VU	✓	
Pteromyscus pulverulentus	Smoky flying squirrel	EN		
Rattus korinchi	Sumatran mountain rat	DD	✓	
Rhacophorus bifasciatus		NT	✓	

4.6 ECOSYSTEM SERVICES IMPACT ASSESSMENT

Impacts were assessed based on the vulnerability of beneficiaries and the magnitude of potential or realised impacts, as described below.

4.6.1 Methods

4.6.1.1 *Assessing Level of Vulnerability*

Determination of the vulnerability of beneficiaries included consideration of the following questions:

- Are beneficiaries heavily dependent on a particular resource, with few alternatives available?
- Are resource shortages frequent and serious?
- Are key species or areas depended upon for goods or services legally protected and use is illegal?
- Are key resources controlled by an influential receptor and access is not guaranteed?
- Is there a low availability of alternatives for a number of important of Ecosystem Services?

Beneficiaries were considered vulnerable in the context of their immediate surroundings and were considered against existing pre-project baseline levels. Because of this there are always some vulnerable receptors within the receiving environment.

4.6.1.2 *Rating Magnitude of Impact*

Magnitude of social and health impacts is understood as a reflection of the 'size' of change caused by social impacts. Magnitude is a function of the extent, duration, scale, and frequency. Impacts on human receptors as a result of changes in Ecosystem Services were assessed according to the four magnitude criteria listed above and ranked from *negligible* to *large*.

4.6.1.3 *Evaluating Significance*

The significance of the impact was determined by combining the magnitude of predicted impact with the value of the receptor, to produce a significance rating from Negligible to Significant. The definitions of the criteria for vulnerability and magnitude, as well as the matrix for evaluating significance are provided in ***Tables 4.15*** below.

Table 4.15 Impact Assessment Matrix for Positive Impacts to Ecosystem Services

Positive impacts			Vulnerability of Receptors		
Magnitude of Impact	Negligible	Change remains within the range commonly experienced within the household or community	**Negligible**	**Negligible**	**Negligible**
	Low	Perceptible difference from baseline conditions. The impact results in an improvement in the availability or functionality of the Ecosystem Service across a small area and has implications for a small number of receptors. The change in the service is for a short duration or occurs with low frequency.	**Negligible**	**Minor**	**Moderate**
	Medium	Clearly evident difference from baseline conditions. The impact results in an improvement in the availability or functionality of the Ecosystem Service across a substantial area or number of people and is of medium duration or occasional frequency. Does not improve the long-term viability of the service.	**Minor**	**Moderate**	**Significant**
	Large	Change dominates over baseline conditions. The impact results in the improvement of all or a significant proportion of the availability or functionality of an Ecosystem Service and/or has implications for a large proportion or absolute number of receptors. The long-term viability of the service may potentially be improved.	**Moderate**	**Significant**	**Significant**
Vulnerability of Receptor Definitions		**Low** Low ability to take up on potential opportunities and realise positive sustained benefits			
		Medium Ability to partially capture potential opportunities and realise positive sustained benefits			
		High Able to capture potential benefits and utilise them for positive sustained benefits			

Table 4.16 Impact Assessment Matrix for Negative Impacts to Ecosystem Services

Negative impacts					
			Vulnerability of Receptors		
Magnitude of Impact	Negligible	Change remains within the range commonly experienced within the household or community.	**Negligible**	**Negligible**	**Negligible**
	Low	Perceptible difference from baseline conditions. The impact results in a reduction in the availability or functionality of the Ecosystem Service across a small area and has implications for a small number of receptors. The change in the service is for a short duration or occurs with low frequency.	**Negligible**	**Minor**	**Moderate**
	Medium	Clearly evident difference from baseline conditions. The impact results in a reduction in the availability or functionality of the Ecosystem Service across a substantial area or number of people and is of medium duration or occasional frequency. Does not threaten the long-term viability of the service.	**Minor**	**Moderate**	**Significant**
	Large	Change dominates over baseline conditions. The impact results in the loss of all or a significant proportion of the availability or functionality of an Ecosystem Service and/or has implications for a large proportion or absolute number of receptors. The long-term viability of the service is threatened.	**Moderate**	**Significant**	**Significant**
Vulnerability of Receptor Definitions		**Low:** Minimal areas of vulnerabilities; consequently with a high ability to adapt to changes brought by the project.			
		Medium: Few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the project			
		High: Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the project.			

4.6.2 *Results*

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

4.6.2.1 *Food: cultivated crops*

Local people clear forested areas for the creation of fields to cultivate crops. This practice is undertaken on a rotational seasonal basis. Induced clearing has occurred within 1km of the Project Area due to increased access allowed by the construction of roads. The Project has restricted clearing activities within the AoI since 2009 to reduce impacts on biodiversity values. This will subsequently reduce land available for clearing by local people. Whilst this reduction in access will have biodiversity benefits, local people will have a reduction in area available to clear and use for cultivated crops.

The impact assessment summary for food: cultivated crops during the construction and operation phase are outlined in ***Table 4.13***.

Table 4.13 Impact Assessment Summary – Availability of land for clearing to produce cultivated crops

Impact	Impact to the availability of land for clearing to produce cultivated crops				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the ecosystem service is negative				
Impact Type	**Direct**	**Indirect**	Induced		
	Direct impact to local people from reduction of land available for clearing and cultivation				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	The impact will be permanent and ongoing during operation				
Impact Extent	**Local**	Regional	International		
	The impact is expected to be localised for local people that occupy land immediately adjacent to Project components and activities.				
Impact Scale	It is anticipated that the scale of impact will be limited to local people immediately adjacent to Project components.				
Frequency	Not applicable				
Impact Magnitude	Positive	**Negligible**	**Small**	Medium	Large
	The magnitude of this impact is expected to be Negligible to Small				
Receptor Sensitivity	Low	**Medium**	High		
	Local people will have access to existing cleared land, however they may identify land in other areas to conduct clearing to cultivate crops. Suitable alternative cropping areas are available within the vicinity of the Project.				
Impact Significance	Negligible	**Minor**	Moderate	Major	Critical
	The significance of this impact is **Minor**.				

4.6.3 *Freshwater*

Local people are reported to use freshwater from local waterways for irrigation, potable and non-potable uses. Water extraction is proposed to occur that will reduce the amount of water available all year. The resource loss will

be predominately in the dry season each year. The amount of water extraction is estimated to be small.

The impact assessment summary for food: cultivated crops during the construction and operation phase are outlined in ***Table 4.13***.

Table 4.14 Impact Assessment Summary – Impact to freshwater availability from water extracted from local waterways

Impact	Impact to freshwater availability from water extracted from local waterways				
Impact Nature	**Negative**	Positive	Neutral		
	The impact on the ecosystem service is negative				
Impact Type	**Direct**	**Indirect**	Induced		
	Direct impact to local people from reduction of water available for irrigation and domestic use.				
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
	The impact will be permanent and ongoing during operation				
Impact Extent	**Local**	Regional	International		
	The impact is expected to be localised for local people that use water from local streams impacted by the water extraction.				
Impact Scale	It is anticipated that the scale of impact will be limited to local people immediately adjacent to Project components.				
Frequency	Not applicable				
Impact Magnitude	Positive	**Negligible**	**Small**	Medium	Large
	The magnitude of this impact is expected to be Negligible to Small				
Receptor Sensitivity	Low	**Medium**	High		
	Local people will have access to water from the streams. It is estimated that the impact will be minor as the water extraction is small.				
Impact Significance	Negligible	**Minor**	Moderate	Major	Critical
	The significance of this impact is **Minor**.				

5 MITIGATION MEASURES, MANAGEMENT AND MONITORING

The mitigation hierarchy aims to minimize impacts on biodiversity and should be applied sequentially to: avoid, minimize and where residual impacts remain compensate/offset.

IFC Performance Standard 1 (IFC, 2012a) highlights that options to 'minimize' are variable and include abate, rectify, repair and/or restore.

A key aspect of managing impacts to biodiversity is the implementation of an adaptive management approach. This approach is designed to provide opportunity for measures to be reviewed and changed (if and where necessary) such that environmental outcomes can be improved and ineffective measures can be identified and rectified in an appropriate timeframe. All parties involved in the construction and operation phases, (e.g. PT SERD, Contractors and Specialists) have a role to play in suggesting modifications to the Project EMP and Biodiversity Action Plan (BAP). The overall responsibility for managing change to the management of biodiversity values (and the BAP) will rest with PT SERD's SSM. The steps for managing change to the BAP include:

1. Identify and describe unanticipated impacts, ineffective mitigation or changes in the Project construction or operation that require updates to the BAP.
2. Suggest mitigation to manage the identified issues with the Corporate SHE Manager. Concerns/issues could, for example, be highlighted on an ongoing basis through stakeholder engagements with PT SERD or during routine fauna & flora monitoring surveys.
3. Review and update the BAP.

Specific measures to be incorporated into the BAP and Project EMP are provided in this section.

5.1 EXPLORATION/CONSTRUCTION PHASE

Disturbance to habitat in modified and natural habitat areas during exploration/construction has the potential to impact the local biodiversity and habitats including habitats for conservation significant species. Mitigation measures can be implemented to manage the disturbance during construction such that biodiversity values are not significantly impacted or impacts are reduced by the application of the mitigation hierarchy (avoid, minimize, mitigate and compensate through offsets).

Management measures specific to managing the natural environment will be incorporated into Project specific management plans and a Biodiversity Action Plan (BAP). These general environmental management measures will assist in

reducing the potential for degradation of habitat, behavior disturbance, fauna mortality and edge for native species.

In addition to the general measures for the management of potential impacts to the natural environment, measures specific to managing potential impacts to the identified priority biodiversity values are also considered. The recommended mitigation and management measures during the construction phase are shown in ***Table 5.1***.

Table 5.1 Mitigation and Management Measures, Exploration/Construction Phase

Nature of Impact	Overview of Measures
Loss of habitat	• The design and layout plan will be prepared to minimise tree cutting and Protected Area disturbance where possible. SERD shall be directly responsible for dissemination to its staff and workers of all rules, regulations and information concerning these restrictions, as well as the punishment that can expected if any staff or worker or other person associated with the Project violate rules and regulations; • Strict rules against logging outside the approved construction areas and against wildlife hunting and poaching will be imposed on all Project staff, workers, and all contractors and personnel engaged in or associated with the Project, with penalties levied for anyone caught carrying and using fire arms, or using animal snares and traps, including fines and dismissal, and prosecution under the relevant laws; • The planned clearance area for the construction works shall be clearly identified and marked using spray paint or marking tape to avoid accidental clearing. Site team are to be briefed prior to works in each area to highlight the areas to be avoided; • Following clearing of any vegetation an inspection will be undertaken to confirm no additional clearing was undertaken. Clearing outside the marked area is to be reported to the SSM and Construction Manager such that adaptive measures can be developed and implemented; • Native seed will be collected prior to vegetation clearing. Seedlings will be cultivated and propagated and maintained for a defined period for use in forest restoration activities; • A site nursery will be established to cultivate native species for use in forest restoration activities. Native seed stock and saplings will be obtained from within the Project Area and/or similar habitats and/or from other nurseries; • An offset plan will be developed to compensate for the habitat lost as a result of the Project clearing activities; • All clearing activities are to be undertaken using a Habitat Clearance Protocol supervised by an appropriately trained ecologist; • In natural habitat areas to be cleared, microhabitat features such as hollow logs will be relocated to adjacent natural habitat areas rather than being destroyed where possible; • Conduct ground-truth surveys at new well pad locations to confirm presence of any threatened or endemic flora species (in particular orchids) and signs of threatened fauna habitat. Outcomes to be communicated to site team so avoidance measures can be implemented where appropriate or other measures (for example translocation, seed harvest) can be implemented. Expert input may be required; • All construction personnel will undertake biodiversity awareness training prior to commencement of construction.
Changes to aquatic habitat	• Prior to water extraction feasibility assessment should be undertaken that considers suitability of the specific extraction site as well as volume to be extracted. Extraction rates may need to be altered depending on seasonal conditions and flow rates in order to maintain sufficient base flow and reliant ecosystems; • Monitoring of aquatic habitats will be undertaken throughout water extraction period to identify if extraction rates are too great to maintain ecosystem functioning. This may require input from a specialist; • A management plan will be developed and implemented specific to the aquatic environment and the extraction; • The extraction pipe will be suitably designed to avoid drawing fish into the pipe leading to mortality.
Disturbance and displacement	• Construction vehicles and machinery will be maintained in accordance with industry standard to minimise unnecessary noise generation; • Arrangement of transportation schedules will aim to avoid peak hours of road usage to minimise heavy traffic through habitat areas;

Nature of Impact	Overview of Measures
	• Traffic signs will be installed on all roads throughout construction areas depicting speed limits; • For construction areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible;
Barrier to movement	• The Project shall implement landscaping and re-vegetation after completion of construction in suitable areas to limit edge effects and vulnerability to weed invasion. This approach will reduce access road gaps where possible to minimise barrier influence; • Identify wildlife crossing locations to identify higher risk crossing points along access roads for which targeted mitigation should be designed and implemented; • Wildlife crossing areas are not to be directly lit (if safe to do so); • Prior to construction of access roads in natural habitat areas assess the need to install artificial crossing structures for endangered arboreal mammal species with input from species experts regarding most appropriate design and with regard for safety requirements; • Appropriate monitoring and maintenance specific to the constructed crossing points will be undertaken with inspections at no less than 6 month intervals; • Sediment and erosion control measures should be designed and maintained for all disturbed soil surfaces, including the road and spoil piles; • Where possible during access road construction maintain canopy trees to encourage canopy connectivity above the road; • Any in-stream works will be carried out in low-flow conditions where possible; • Throughout construction any road kill or fauna crossing sightings will be reported to the Project owner representative in the event a corridor pathways hotspot is identified. Data analysis throughout the construction period should inform implementation of additional measures (such as go slow areas or fauna crossing structures) if required; • The transmission line and access roads will not be fenced;
Fragmentation and Edge effects	• Dust suppression techniques will be utilised during construction, to control the dispersion of dust created by clearing lands at the construction sites; • The Project shall implement landscaping and re-vegetation after completion of construction using native species where possible; • To avoid/minimize releasing sediment load into the surrounding waterways, erosion control measures will be implemented and maintained e.g. using silt fence and temporary re-vegetation to minimize sediment transport;
Degradation of habitat	• Flora and fauna will be monitored throughout the Project by experts with information collected used as a basis for habitat and population management; • All work places will be kept clean with waste disposed of appropriately; • Workers and visitors will be educated regarding appropriate waste disposal and prohibition of feeding wildlife; • Construction and domestic waste will be appropriately stored and disposed of to avoid attracting native and alien species to the construction and camp areas; • For areas in direct runoff path to a watercourse, sediment and erosion control devices will be installed and maintained until vegetation replanting can occur to stabilise disturbed soil surfaces; • Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licenced waste management contractors; • Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to limit noise and dust generation;

Nature of Impact	Overview of Measures
	• Construction materials and chemicals will be appropriately secured to avoid accidental release to the natural environment (wind and water erosion).
Light, Noise and Vibration	• Design of lighting will be directed away from vegetated areas and habitats; • Upward lighting will be avoided; • Lights will not be left on after construction hours; • No drilling will be undertaken at night time; • Workers will be trained in noise-reduction behaviours; • All machinery used should be compliant with relevant noise regulations
Fauna mortality	• Local community engagement will be undertaken to raise awareness of the conservation values of the habitats and to promote no hunting of threatened species; • Use of the access road should be restricted to construction vehicles only. Checkpoints should be used to manage access and inspect vehicles for wildlife. • Controls will be placed on domesticated animals permitted within the Project Area. • Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike. All drivers will receive driving training and will be required to pass a driving test; • Commitment will be made to raise awareness of values of natural habitat areas to construction work force and arrangements will be made for restriction of poaching and forest product collection; • Wildlife shepherding procedures to be implemented immediately prior to any vegetation clearing to allow fauna individuals to move to adjacent refuge habitat. Temporary fencing may be required around construction areas to limit fauna access; • A Wildlife Rescue Protocol will be established for implementation during all clearance activities. This will include actions to be undertaken for injured wildlife, communication processes to forestry officers of injured wildlife, recording procedures, and identification of management of change measures necessary to reduce risk of future events; • Establish an incident reporting mechanism, including database (map, record), to record injured or killed wildlife; • Access restriction should be applied to Project facilities for non-construction vehicles; • Access roads will be monitored daily for poaching activity; • Hunting wild animals will be strictly prohibited to apply for all staff; • Monitoring of construction areas will be undertaken monthly for signs of potential wildlife conflict, illegal logging or poaching.

5.2 OPERATION PHASE

Impacts relating to the operation phase are associated with vehicle movements, displacement/disturbance, potential for induced clearing, hunting and poaching exposure, and barrier to movement. Mitigation measures can be implemented to manage the disturbance during operation such that biodiversity values are not significantly impacted or impacts are reduced by the application of the mitigation hierarchy (avoid, minimise, mitigate and compensate through offsets).

Management measures specific to managing the natural environment will be incorporated into Project specific Operation management plans. The proposed mitigation and management measures proposed for the operation phase are outlined in ***Table 5.2***.

Table 5.2 Mitigation and Management Measures, Operation Phase

Nature of Impact	Overview of Measures
Habitat Loss – induced clearing	• A habitat mapping database will be established to store all biodiversity monitoring data including species sightings; • Regular patrols (atleast every month) of the Project boundary will be undertaken to identify any incursion by local people into the Project Area and surrounding forested area; • Regular drone flights will be undertaken, at least every year, to monitor vegetation clearance within the Project Area
Disturbance and displacement	• Operational vehicles will be maintained in accordance with industry standard to minimise unnecessary noise generation; • Traffic signs will be maintained on all roads depicting speed limits; • Access to facilities, including the access road should be restricted to operational vehicles only; • For operational areas requiring night-time lighting, lights will be used only where necessary and will be directed toward the subject area and away from habitat areas where possible; • Commitment will be made to raise awareness of the operator work force regarding flora and fauna values and make arrangements for restriction of poaching; • Surveys to identify locations of invasive species infestations will be undertaken and where necessary work with specialists will be undertaken to manage extent.
Degradation of habitat	• Flora and fauna will be monitored throughout the Project by experts with information collected used as a basis for habitat and population management; • All work places will be kept clean with waste disposed of appropriately; • Workers and visitors will be educated regarding appropriate waste disposal and prohibition of feeding wildlife; • Oil, chemical and solid waste will be stored, and handled and disposed of by appropriately licenced waste management contractors.
Light, Noise and Vibration	• Design of lighting will be directed away from vegetated areas and habitats; • Upward lighting will be avoided; • Lights will not be left on after hours when not required; • All machinery used should be compliant with relevant noise regulations
Fauna mortality	• Speed limits to maximum of 40 km/hr for construction vehicles will be enforced to minimise potential for fauna strike. All drivers will receive driving training and will be required to pass a driving test; • Commitment will be made to raise awareness of values of natural habitat areas to operator work force and arrangements will be made for restriction of poaching and forest product collection; • Access to Project Areas, including the access road should be restricted to operational vehicles only. Warning signs will be installed and patrols will be undertaken. Security gates will be installed and manned 24 hours per day; • Hunting wild animals will be strictly prohibited to apply for all staff.

5.3 PRIORITY BIODIVERSITY VALUES MANAGEMENT MEASURES

Priority Biodiversity Values are described in *Section 3.3*. In addition to protected areas the values are those species described as critical habitat candidates in IFC PS6. As required by IFC PS6, a Biodiversity Action Plan (BAP) is required for all Critical Habitat candidate species. ***Table 5.3*** outlines the proposed priority biodiversity value management measures.

Table 5.3 Priority Biodiversity Values Management Measures

Scientific Name / Common Name		IUCN	Recommended Mitigation and Management Measures
Dipterocarpus grandifloris		CE	• Habitat Clearance Protocol to include searches for individuals and consider localized avoidance, or if unable to avoid, consideration to of translocation or seed collection. • Degradation of habitat measures
Rafflesia bengkuluensis			
Apalharpactes mackloti	Sumatran trogon	LC	• Loss of habitat measures • Disturbance and displacement measures • Degradation of habitat measures • Fauna mortality measures
Arborophila rubrirostris	Red-billed partridge	LC	
Carpococcyx viridis	Sumatran ground-cuckoo	CE	
Cochoa beccarii	Sumatran cochoa	VU	
Dicrurus sumatranus	Sumatran drongo	NT	
Garrulax bicolor	Sumatran laughingthrush	EN	
Hydrornis schneideri	Schneider's pitta	VU	
Lophura inornata	Salvadori's pheasant	NT	
Myophonus melanurus	Shiny whistling-thrush	LC	
Padda oryzivora	Java sparrow	VU	
Pericrocotus miniatus	Sunda minivet	LC	
Polyplectron chalcurum	Bronze-tailed peacock-pheasant	LC	
Trichastoma buettikoferi	Sumatran babbler	LC	
Arctictis binturong	Binturong	VU	• Loss of habitat measures • Disturbance and displacement measures • Fauna mortality measures
Arctonyx hoevenii	Sumatran hog badger	LC	
Capricornis sumatraensis	Sumatran serow	VU	
Cuon aplinus	Dhole	EN	
Helarctos malayanus	Malayan sun bear	VU	
Hylopetes winstoni	Sumatran flying squirrel	DD	
Muntiacus montanus	Sumtrana mountain muntjac	DD	
Pardofelis marmorata	Marbled cat	VU	
Manis javanica	Malayan pangolin	CE	• Species specific measures required • Loss of habitat measures • Disturbance and displacement measures

Scientific Name / Common Name		IUCN	Recommended Mitigation and Management Measures
			• Degradation of habitat measures • Fauna mortality measures
Maxomys hylomyoides	Sumatran mountain maxomys	DD	• Degradation of habitat measures • Fauna mortality measures
Maxomys inflatus	Broad-nosed Sumatran maxomys	VU	
Mus crociduroides	Sumatran shrewlike mouse	DD	
Nesolagus netscheri	Sumatran striped rabbit	VU	
Rattus korinchi	Sumatran mountain rat	DD	
Panthera tigris sumatrae	Sumatran tiger	CE	• Loss of habitat measures • Disturbance and displacement measures • Degradation of habitat measures • Fauna mortality measures
Presbytis melalophos	Sumatran surili	EN	
Pteromyscus pulverulentus	Smoky flying squirrel	EN	
Symphalangus syndactylus	Siamang	EN	• Species specific measures required • Loss of habitat measures • Disturbance and displacement measures • Barrier to movement measures • Fragmentation and edge effects measures • Degradation of habitat measures • Fauna mortality measures
Rhacophorus bifasciatus		NT	• Degradation of habitat measures • Fauna mortality measures
Tapirus indicus	Malayan tapir	EN	• Species specific measures required • Loss of habitat measures • Disturbance and displacement measures • Degradation of habitat measures • Fauna mortality measures

6 ASSESSMENT OF NO-NET-LOSS

Mitigation and management approaches have been considered to avoid, minimize and mitigate potential impacts to biodiversity as a result of Project activities. In general, many of the indirect impacts to biodiversity values can be minimized, such as behavioral disturbances, degradation of habitats, edge effects and barriers to terrestrial fauna movement. The next step of the mitigation hierarchy necessitates consideration of biodiversity offsets for residual impacts.

ERM has undertaken a biodiversity offsets assessment based on the guidance contained in the Business and Biodiversity Offset Program (BBOP) resource documents:

- *Biodiversity Offset Design Handbook* (BBOP 2012a); and
- *Resource Paper: No Net Loss and Loss-Gain Calculations in Biodiversity Offsets* (BBOP 2012b).

The purpose of these offsets is to manage biodiversity values to offset the residual impacts on biodiversity values. For natural habitats, as required by IFC PS6, a no-net-loss goal has been applied.

6.1 RESIDUAL IMPACTS ON BIODIVERSITY VALUES

The residual impacts to biodiversity identified largely relate to unavoidable habitat loss within the footprint of the Project and edge effects. Direct disturbance to habitats will be minimized where possible however this impact assessment has identified an unavoidable loss of approximately 163ha of natural habitat will occur due to Project related activities. To achieve no-net-loss of biodiversity values, a biodiversity offset will be required to compensate for this loss of habitat.

The fauna species assessed will have a loss of habitat due to Project related activities, however it is not expected that this loss is significant. Mitigation measures have been designed to reduce impacts to species in relation to Project related activities. Monitoring of species within the AoI will be required to determine if populations of species are maintained.

Loss of flora species (particularly endemic flora species) however can be counted as a residual loss to biodiversity values. Specific mitigation measures have been designed to reduce impacts on flora species; however specific offsets will be required to achieve no-net-loss of biodiversity values for these species.

6.2 *PROPOSED OFFSET RULES*

ERM has used the following offset rules when defining the biodiversity offsets that apply to achieve a no-net-loss of biodiversity values within the concession:

1. No net loss should be achieved for all natural habitats. Net gain should be achieved for species whereby critical habitats are likely impacted
2. Offsets should be "like for like" where possible (trading is only allowed within the same land class type);
3. Environmental contributions for specific programs can be used to substitute for the direct management of biodiversity where measurable conservation outcomes can be demonstrated;
4. Incremental loss and fragmentation of biodiversity values should be avoided;
5. Management of offset sites can be used to improve biodiversity values however this should not take the place of actions that are already funded;
6. Areas with existing or potential land uses that are likely to be in conflict with biodiversity offsets will be avoided (mining, indigenous land claims);
7. Location of offsets in the landscape that facilitate connectivity with adjacent habitats will be of preference;
8. Large offset sites that are connected to existing protected areas will be of preference;
9. Sites that are similarly used by comparable ethnic groups sharing similar cultural values will be of preference; and
10. Fairness and equity should be applied with affected stakeholders; and
11. Offsets chosen should be permanent and ongoing.

6.3 *BIODIVERSITY OFFSET METRIC*

A biodiversity offset metric has been developed to determine the offsets required to offset residual impacts on biodiversity for the SERD Project. ERM have used the Habitat Hectare model (BBOP 2012a) to calculate the offset "quantum" required to compensate for the residual values lost.

This model captures the *type* (habitat and species), *amount* and *condition* of the habitat biodiversity values present on the impacted site and candidate offset sites. The basis of the analysis is calculating the change in condition (*loss*) at the impact site compared to the *gain* in condition at candidate offsets sites over time from management.

Offset metrics have been designed for the terrestrial biodiversity values using data on:

- Classification of habitat classes in the impact area (*Type*);
- Area of habitat classes from spatial analysis (*Amount*); and
- Land class condition assessment from field data (*Condition*).

Given that a candidate offset site has not been identified to offset the impacts of the Project, the range of Habitat Hectare values that would be required for an offset site has been determined. Two scenarios have been used to calculate the range of habitat hectares required based on area and condition values scores:

1. First scenario calculates the area required if the offset site is in benchmark condition; and
2. Second scenario considers the offset site to be in degraded condition for the habitat types assessed.

This analysis will provide the range of habitat hectare values and hence the maximum and minimum area required to achieve the offset for each habitat type

6.4 BIODIVERSITY OFFSET CALCULATIONS AND RESULTS

6.4.1 IMPACT SITE HABITAT HECTARE CALCULATIONS

Ecological "Gain" Period

To determine likely biodiversity gains available from managing tropical forests in Indonesia, ERM has undertaken a literature review. Research indicates that ecological restoration activities for Indonesian rainforests can take a significant time period to achieve improvements in forest ecological values, dependent on the initial state of the land or forest.

Research undertaken by Kettle (Kettle, 2009) indicates that ecological restoration in lowland dipterocarp forests is possible, even in severely degraded sites through careful establishment and maintenance planting.

As reported by the *Global Forest Expert Panel on Biodiversity, Forest Management and REDD+* (Parrotta J et al, 2012) there is a strong correlation between forest restoration, species diversity and improvements in the availability of ecosystem services. However, forest restoration is likely to result in differing forest outcomes based on the existing disturbance. Disturbed secondary forests are likely to return to similar species diversity and mix over time.

Budiharta et al (Budiharta 2014) asserts that restoration activities can provide habitat outcomes (as well as carbon storage through above-ground biomass accumulation) from degraded forest landscapes through active planting and management over a 30 to 50 year time period in relation to REDD+ projects in tropical forests in Indonesia.

However, Elliot et al (Elliot et al 2013) discusses that ecological forest restoration from a degraded to a mature state is likely to take a much greater time period to achieve in tropical forests in Indonesia (that is, over 100 years or more).

The literature also indicates that there is significant uncertainty over the success of restoring ecological function of degraded tropical landscapes (Parrotta J et al, 2012).

In summary, the literature does not provide a definitive time period to achieve improvements in habitat values from degraded forests. Indicative timeframes are available however and the "Habitat Condition" and "Offset Gain" scores outlined below have been derived using these estimated ecological restoration time periods based on this research.

It is acknowledged that due to the uncertainty regarding success (or otherwise) of forest restoration activities to enable ecological improvements (or gains) robust monitoring and evaluation of offset restoration projects will be necessary to determine the rate of success (or failure). The use of adaptive management processes is necessary to reduce risks of failure.

It should also be noted that available gains have not taken into account any background change of ecological values due to uncertainty over what these impacts are currently and would be in the future. It is assumed that the management interventions at an offset site would reduce direct human derived ecological change. Background change caused by natural factors and human induced climate change have not been considered in the estimated gain periods given the uncertainty of what impacts/benefits that these factors could have on ecological restoration activities.

Habitat Condition Scores

The Habitat Hectare baseline calculations are used to quantify the residual value of the impacted habitats. Areas of habitat types within the Project Area have been determined based on Habitat condition scores. These scores are used to set a baseline condition of the impact site against a habitat condition benchmark (set at a value of 1 or a greater than 100 year restoration period). The Habitat Hectare model relies on scores to define 'vegetation quality' being the degree to which the current vegetation differs from a 'benchmark' representing characteristics of a mature and apparently long-undisturbed stand of the same vegetation community. Essentially, this method attempts to assess how 'natural' a site is by comparing it to the same vegetation type in the absence of major ecosystem changes that have occurred (Parkes *et al.*, 2003).

Table 6.6.1 outlines the habitat class condition scores applied. These scores have been derived based on the definitions contained in IFC PS6 for "natural" and "modified" habitats and the definition of "degradation" of habitats (IFC, 2012). Impacted habitats are defined as those where little, if any natural biodiversity remaining.

The scores applied have been derived to reflect the relative difference (and hence ability to restore) the habitat over time.

Table 6.6.1 Habitat condition scores (A)

Condition	Definition	Value
Benchmark	Being habitats in a mature condition with only native origin vegetation, a diversity of species of a mature or senescent state; and no sign of human disturbance (such as the presence of waste, vegetation removal).	1
Natural	High condition is defined as habitat largely of native origin, and/or where human activity has not essentially modified the primary ecological functions and species composition. Some disturbance is likely present such as selective logging, vegetation removal, waste and minor introduction of invasive species.	0.8
Modified	Moderate condition habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition	0.6
Degraded	Degraded condition is defined as significant conversion or degradation of the habitat such as the diminution of the integrity of a habitat caused by a major and/or long-term change in land use; or (ii) a modification that substantially minimizes the habitat's ability to maintain viable populations of its native species.	0.2
Impacted	Impacted condition is defined as major conversion whereby little if any natural vegetation remains on the site caused by significant land use change.	0

Habitat Hectare Calculation Formula (Impact Site)

The following formula has been used to calculate the Habitat Hectares of the residual values of the impacted habitats:

Area of Habitat Type (A) x Habitat Type Condition (B) = Habitat Hectares

Results of Habitat Hectare Calculations for the Impact Site

The results of the calculations are outlined in ***Table 6.6.2***.

Table 6.6.2 Calculation of impact area habitat hectares

Landcover Class/Habitat Type	Habitat Type	Habitat Type Condition	Condition Score(A)	Habitat Type Area (B)*	Habitat Hectares (Impact Area)
Primary/secondary forest	NH	Natural	0.8	TBC	TBC

** NH – Natural Habitat MH – Modified Habitat CH – Critical Habitat*

6.4.2 CANDIDATE OFFSET SITE HABITAT HECTARE CALCULATIONS

The management of candidate offset sites enables biodiversity value "gains" and hence enables impacts to be offset (that is, compensate for losses). This is calculated based on the expected outcomes from positive interventions from management actions at the offset site to improve biodiversity values.

The gains in condition value are relative to the existing condition of the offset site. Sites with an existing "high" condition are likely to have an incrementally smaller improvement in biodiversity condition values through management over time. Sites with a lower baseline condition have a greater capacity to improve from conservation management over time.

Offset Gain Period

The time period chosen for management of the offset areas has been 30 years. This period has been chosen as this equates to the concession agreement period for the operation of the Project by the Government of the Republic of Indonesia.

Offset Gain Scores

Offset gain scores have been derived based on the relative gain in condition available from the Habitat Condition Scores over the offset gain period (refer to discussion on *Ecological Gain Period* above). The offset gain scores outlined have been derived based on the relative time frames to achieve ecological restoration and the available Offset Gain Period. For example, an offset site condition in "Natural" state (0.8) assumes that there is a 20% available improvement in condition to achieve a "Benchmark" condition (1.0). It is also assumed that offset management over time will have diminishing results, hence the multiplier reduces over time. In the case of Natural state vegetation, an 8.44% increase in value is estimated to be achieved in 10 years; 11.25% increase by 20 years; and a 15% increase is achievable in 30 years. After 30 years of management, the condition of Natural vegetation would be 95% of the condition of benchmark vegetation.

Averted loss also applies to habitat within benchmark condition whereby offset management actions avert or reduce background losses to biodiversity values. The averted loss value is set at 11.25% of benchmark value over 30 years.

The estimates of gain may vary in practice and require monitoring to determine if the estimation are accurate. Where significant variations occur in estimated value increases, additional management or increases in offset areas managed will need to be applied.

Table 6.3 outlines the values chosen to derive the Offset Gain scores.

Table 6.3 Offset gain score (C1)

Existing Site Condition	Base Condition Value	Gain (10 Years)	Gain (20 years)	Gain (30 years)
Benchmark	1	0.0633	0.0844	0.1125
Natural	0.8	0.0844	0.1125	0.15
Modified	0.6	0.1125	0.15	0.2
Degraded	0.2	0.15	0.2	0.275
Impacted	0	0.2	0.275	0.35

Habitat Hectare Calculation Formula (Offset site)

The formulae used to calculate the offset gains available from candidate offset areas are outlined below:

1. Calculation of Baseline Habitat Hectares:

   Candidate Offset Habitat Condition Score (A1) x Area of Habitat Type (B1) = Candidate Offset Habitat Hectares (W)

2. Calculation of Habitat Hectare Gains:

   [Candidate Offset Habitat Condition Score (A1) + Candidate Offset Habitat Condition Score (Gain) (C1)] x Area of Habitat Type (B1) = Candidate Offset Habitat Hectares Gain (X)

3. Calculation of Habitat Hectares:

   Candidate Offset Habitat Hectares Gain (X) - Candidate Offset Baseline Habitat Hectares (W) = Candidate Offset Habitat Hectares (Y)

Two scenarios have been determined to provide the range of areas required to offset the impacts on Habitats. The offset goal is to achieve the same number of Habitat Hectares impacted at the offset site.

Table 6.6.2 shows the areas of Habitat Hectares required to be offset.

The results of the analysis to identify the range of areas required to achieve the offset goal are outlined in ***Table 6.5*** below.

Table 6.5 ***Candidate Offset site Habitat Hectares***

Forest Type	Habitat Condition	Condition Score (A1)	Offset Gain Score (C1)	Habitat Type Area (B1)*	Habitat Hectare Offset Area (W)	Habitat Hectare Gain Value (X)	Habitat Hectare Candidate Offset Value (Y)
Primary/ secondary forest	Benchmark	1	0.1125	TBC			
	Natural	0.8	0.1500				
	Modified	0.6	0.2000				
	Degraded	0.2	0.2750				

From this analysis, the required range of areas of Primary/secondary Forest for difference condition classes to achieve a no-net-loss of biodiversity values for the habitat types impacted is shown in ***Table 6.6***.

Table 6.6 ***Areas of Required Offsets to Achieve No-Net-Loss***

Forest Type	Habitat Condition	Habitat Type Area (Hectares)
Primary/secondary	Benchmark	TBC

Forest Type	Habitat Condition	Habitat Type Area (Hectares)
Forest	Natural	
	Modified	
	Degraded	

6.4.3 *Calculation of Offset Site Habitat Hectares*

An assessment will be required to be undertaken of the proposed candidate offset site to determine the condition and hence available area to achieve a no-net-loss of biodiversity values. The chosen offset site is likely to contain a range of condition types and this will affect the final size of the offset site chosen. The chosen site will also need to consider compliance with the offset rules.

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Annex A

Endangered Species Report (Greencap 2015)

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