Draft Environmental and Social Impact Assessment Report (ESIA)

Project Number: 50330-001
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INO: Rantau Dedap Geothermal Power Project (Phase 2)

Volume IV:

Appendix 6a – Critical Habitat Assessment
Appendix 6b – Biodiversity Action Plan
Appendix 7 – Framework of Temporary Worker Accommodation Management Plan

Prepared by ESC for the Asian Development Bank

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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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.

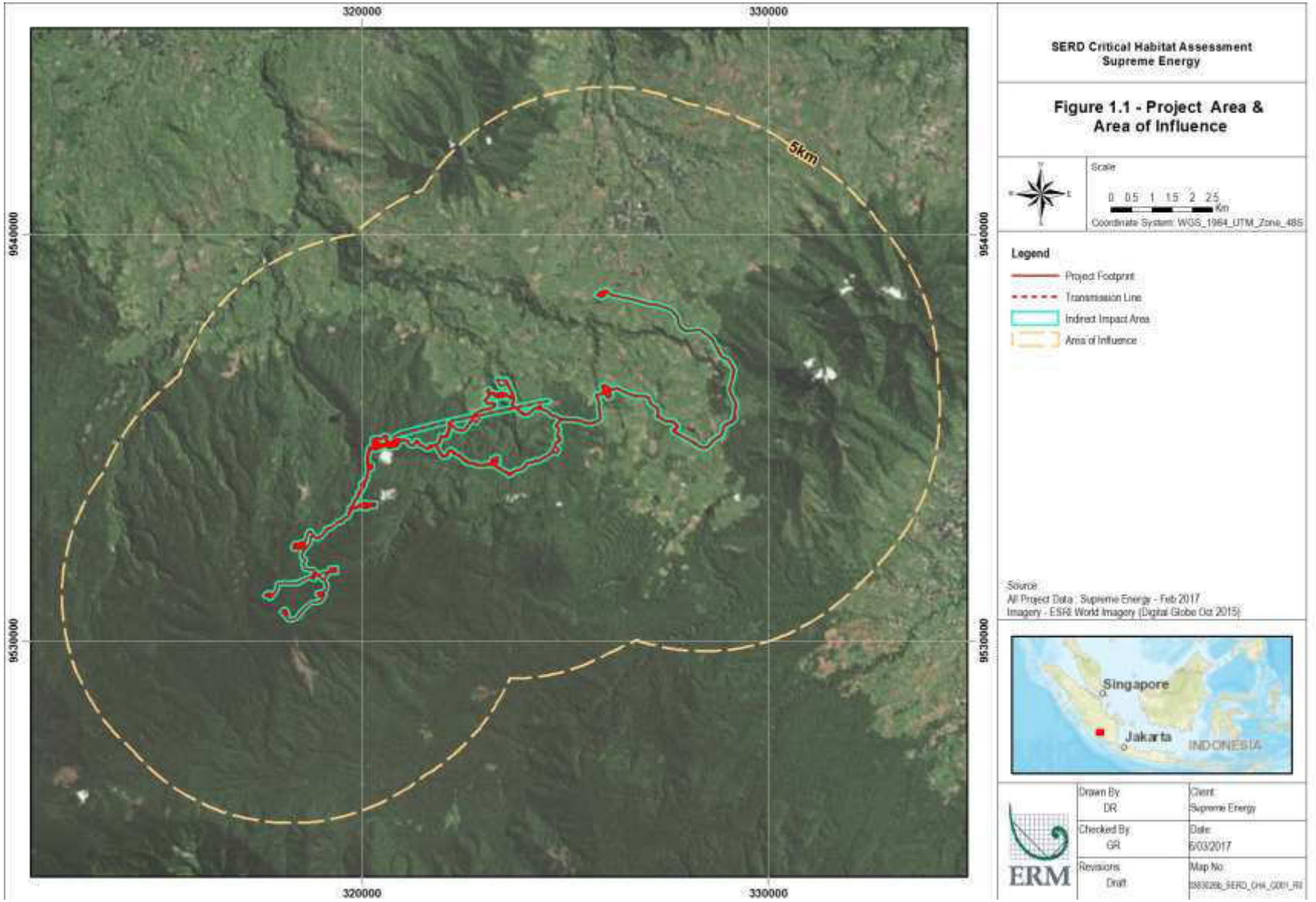
1.2 QUALIFICATIONS

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.

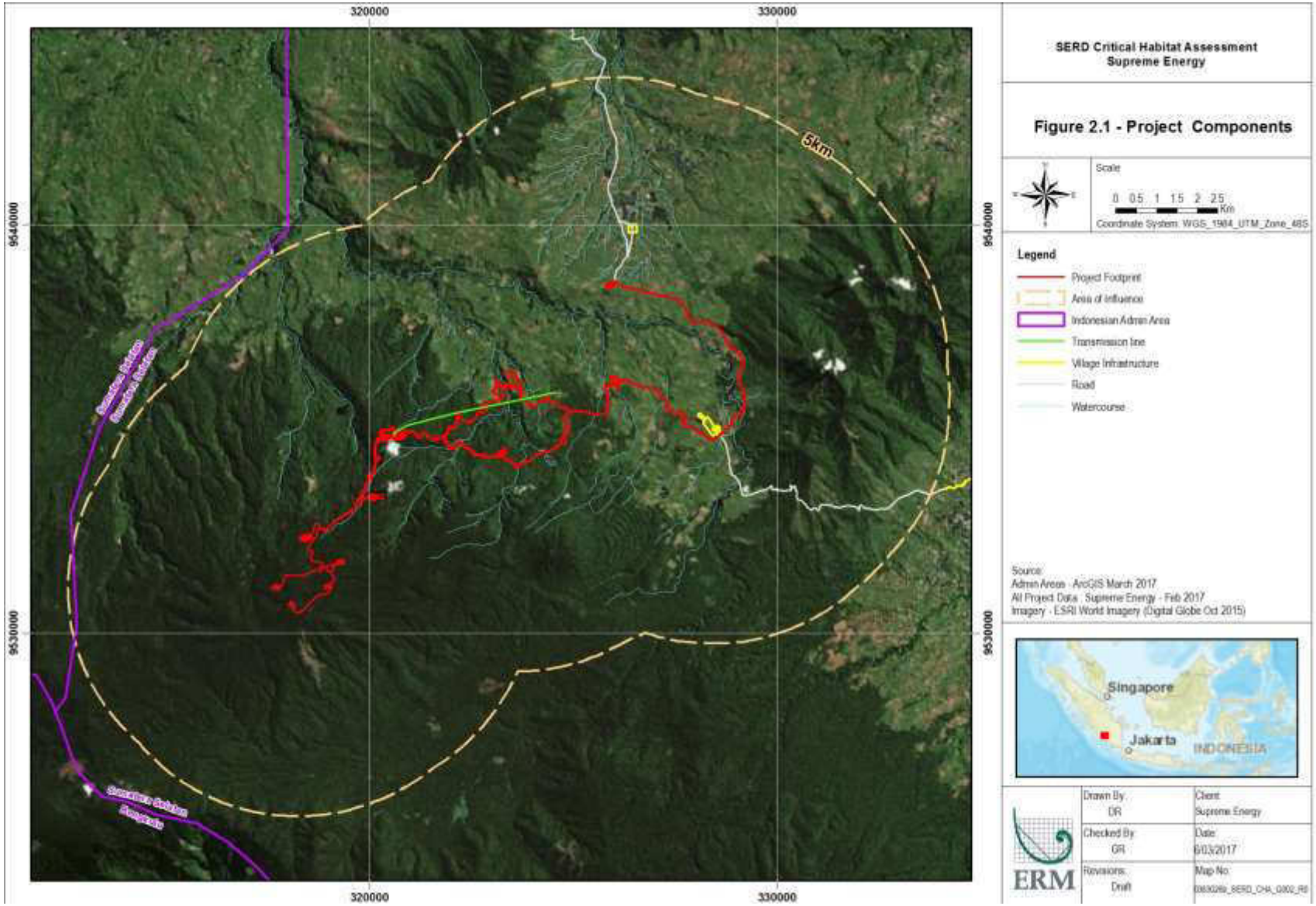
2.2.6 Access Roads

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*

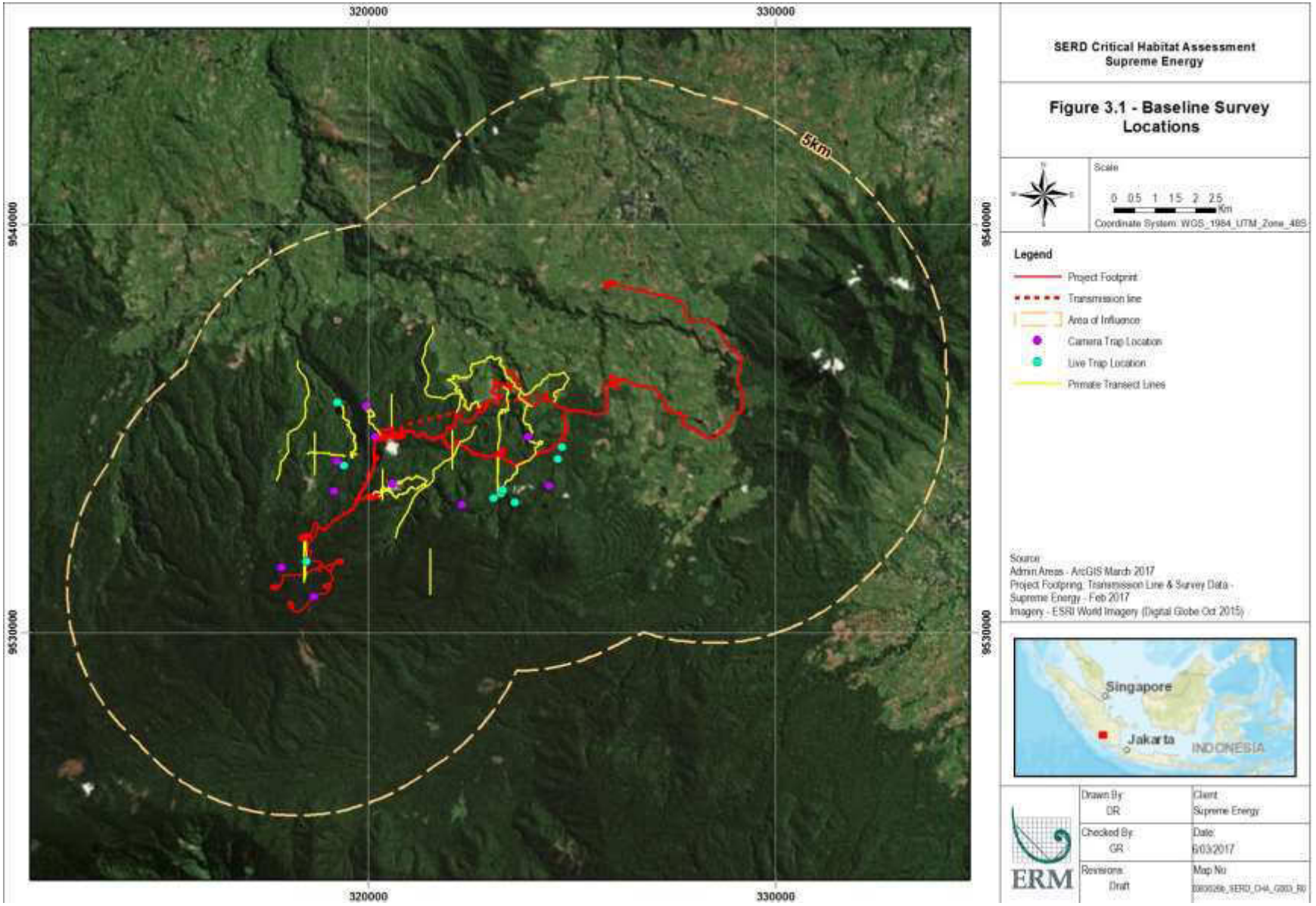
Greencap (2017) summarised the key field studies undertaken to describe the baseline biodiversity values associated with the Project. This included:

- 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.

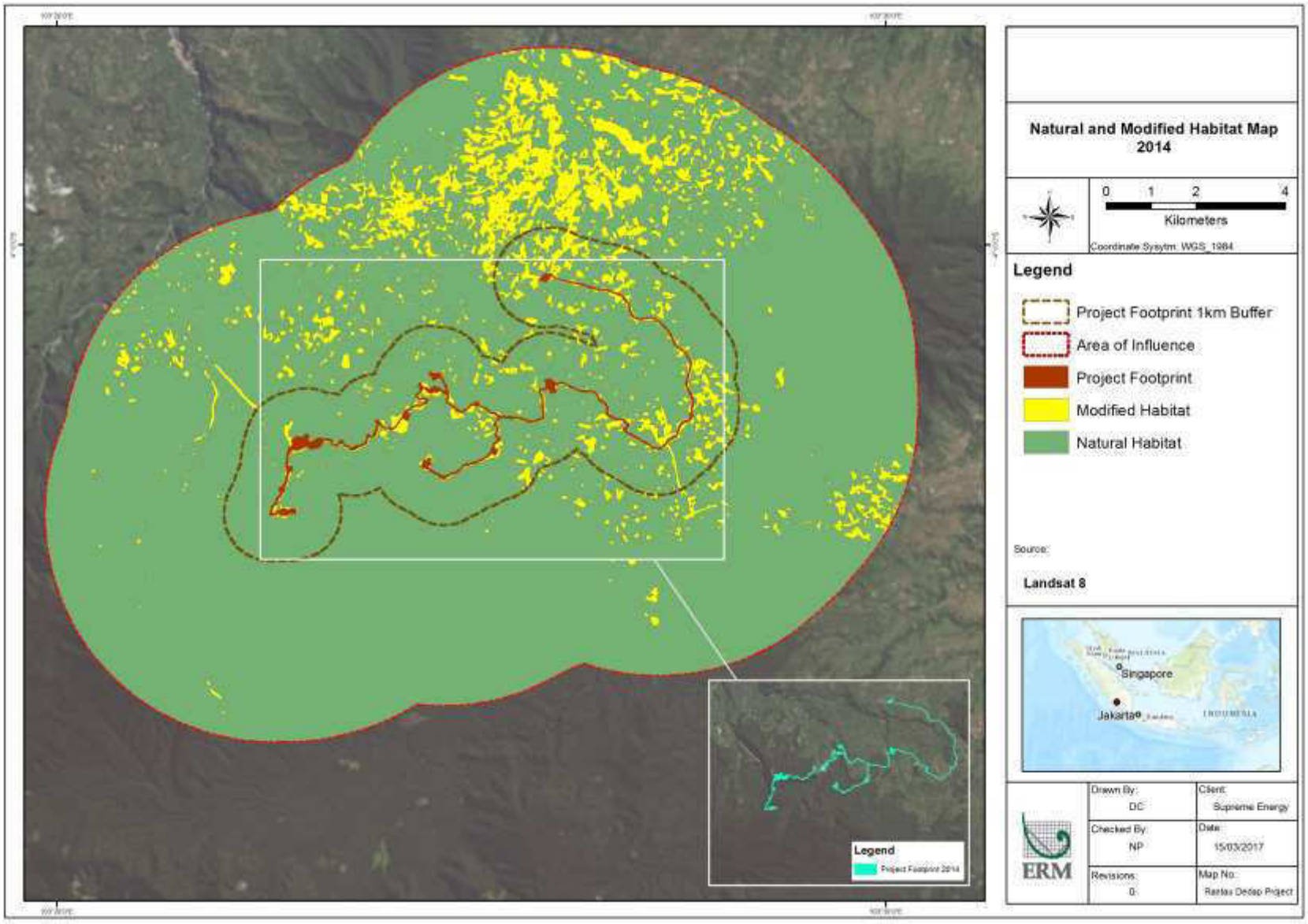
3.2.3.4 *Natural Habitat Mapping*

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.

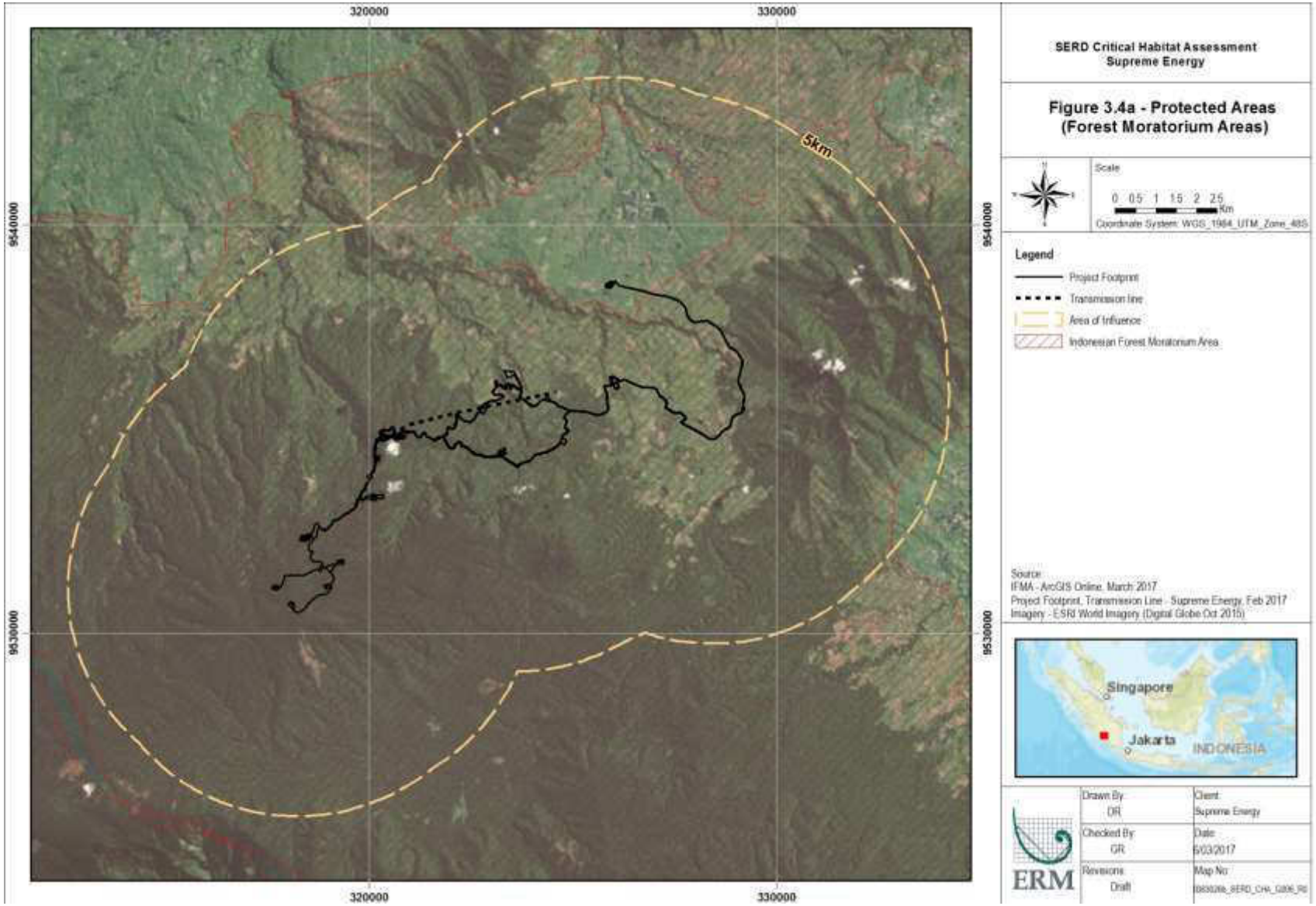
3.4.2 Natural Habitat and Modified Habitat

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



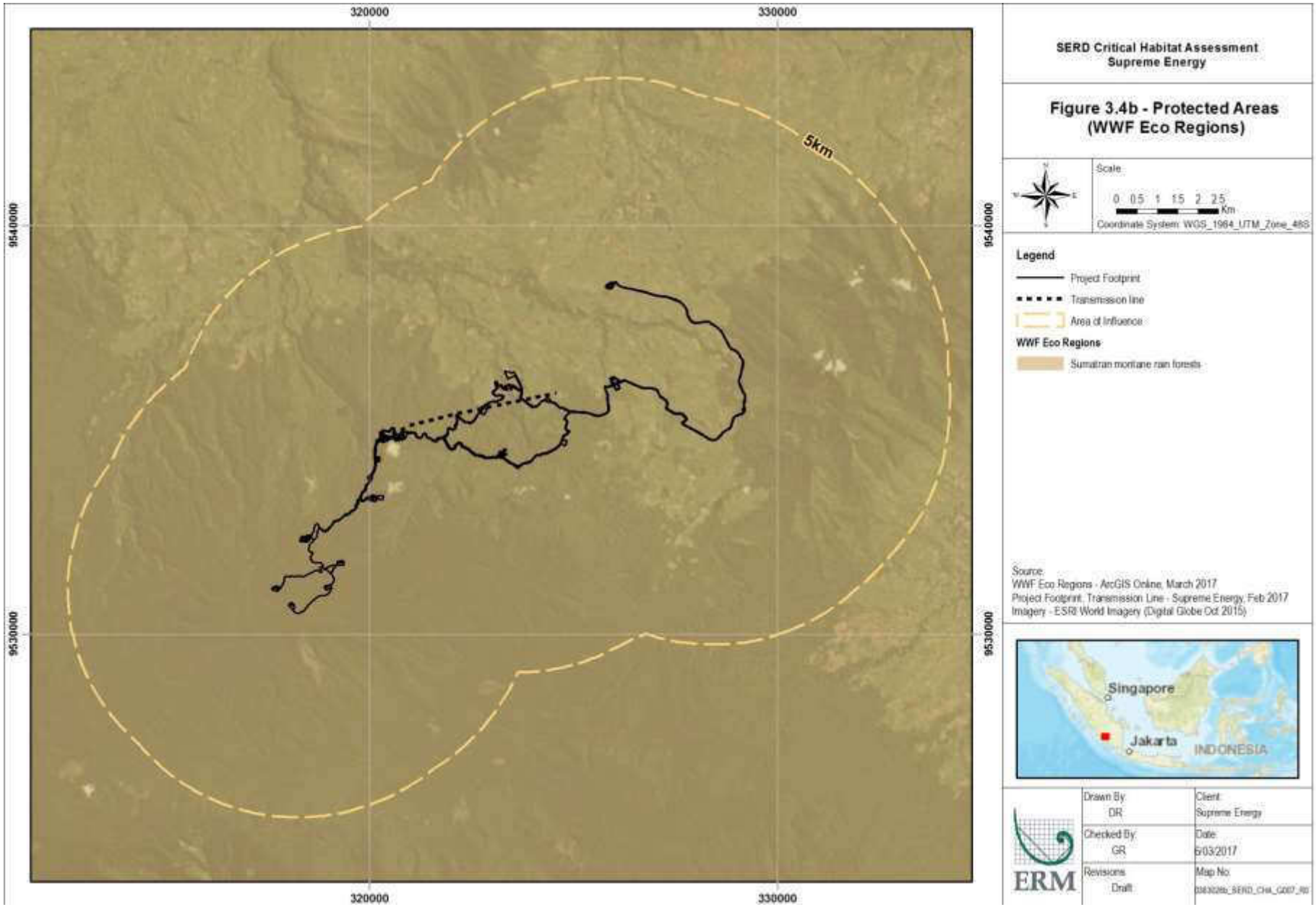
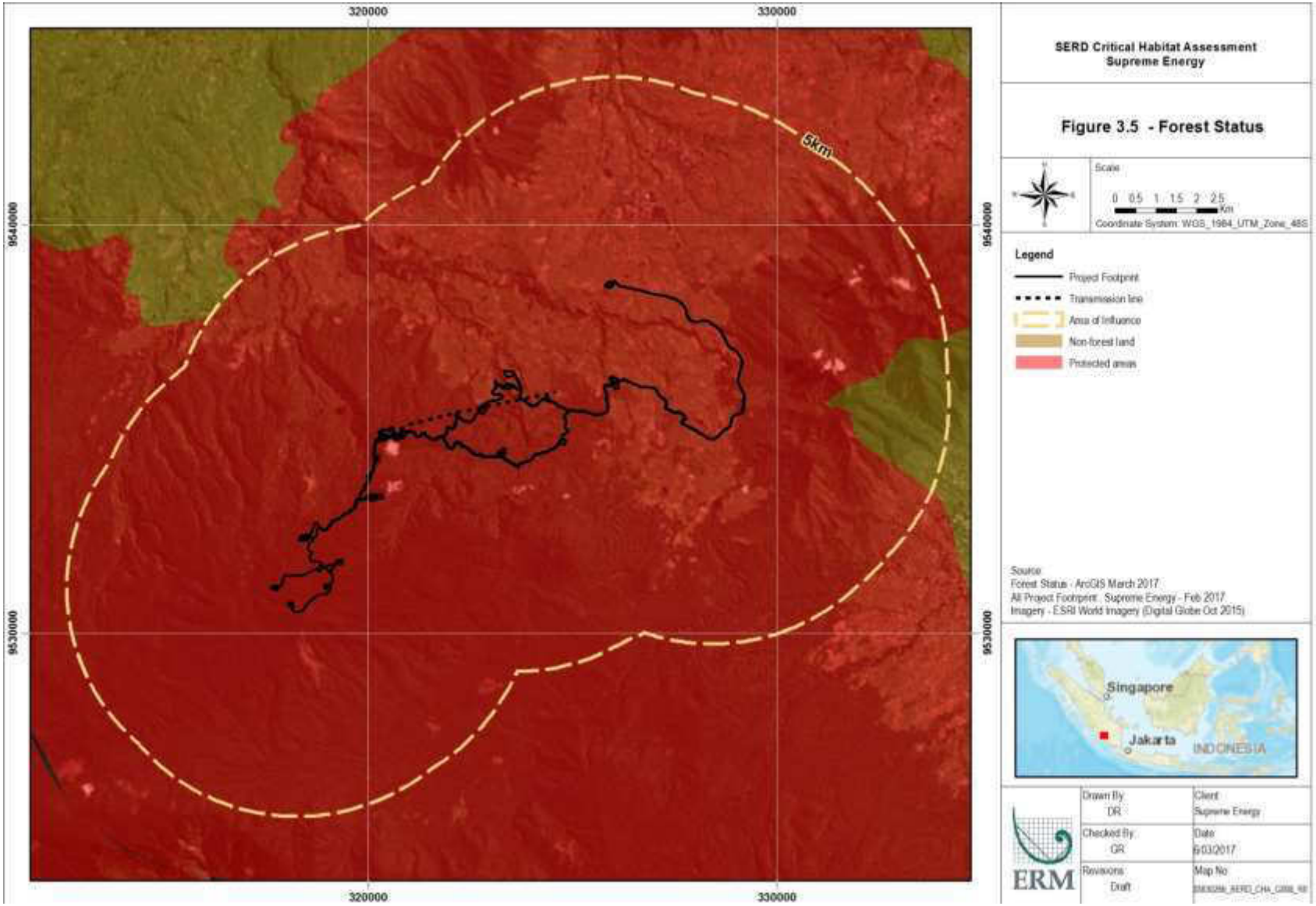

320000
330000
9540000
9530000
5km
SERD Critical Habitat Assessment
Supreme Energy
Figure 3.4b - Protected Areas
(WWF Eco Regions)
Scale
0 0.5 1 1.5 2 2.5
Km
Coordinate System: WGS_1984_UTM_Zone_48S
Legend
Project Footprint
Transmission line
Area of Influence
WWF Eco Regions
Sumatran montane rain forests
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)

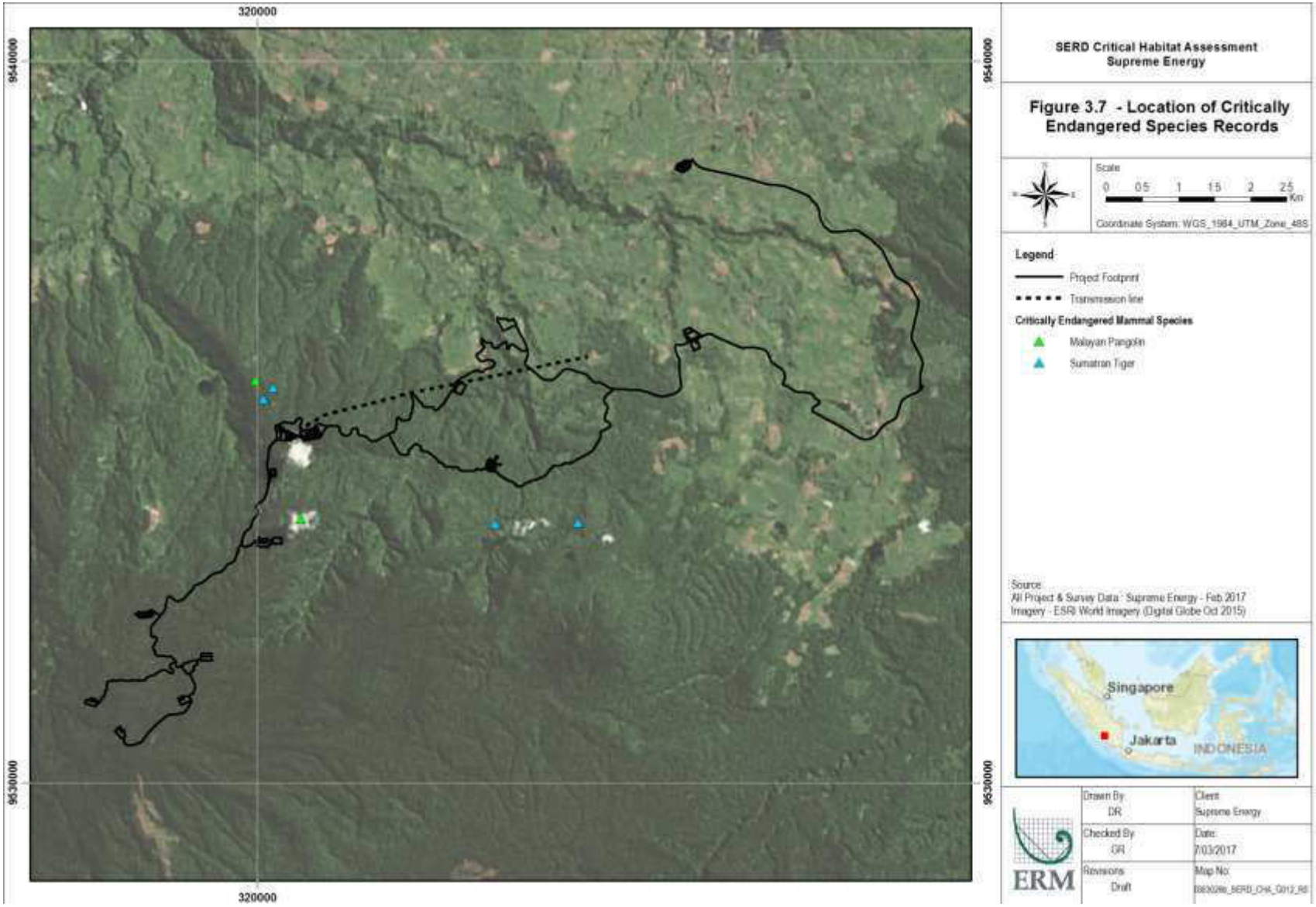


Figure 3.8 Location of Endangered Species records (Greencap, 2017)

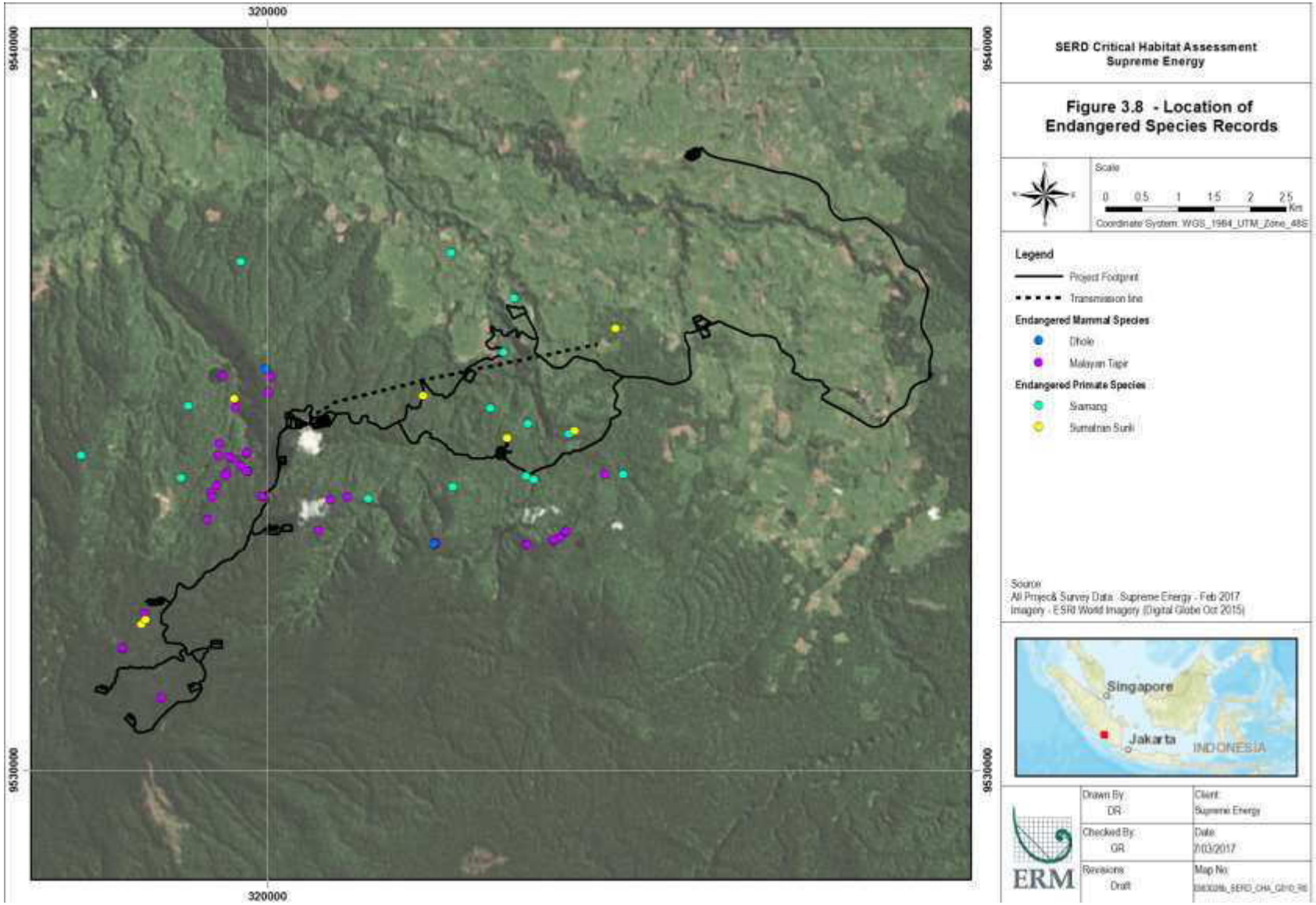
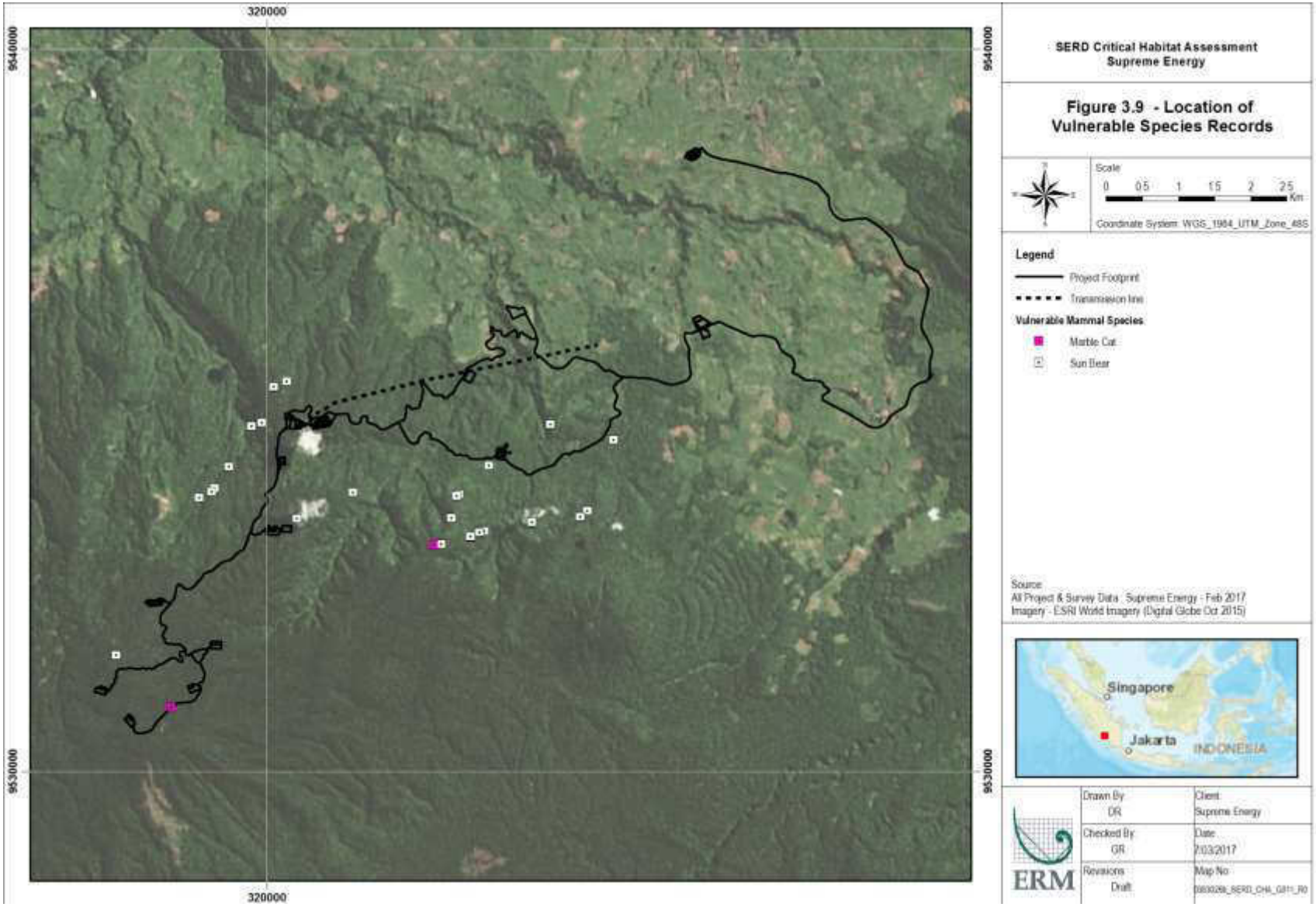


Figure 3.9 Location of Vulnerable Species records (Greencap, 2017)



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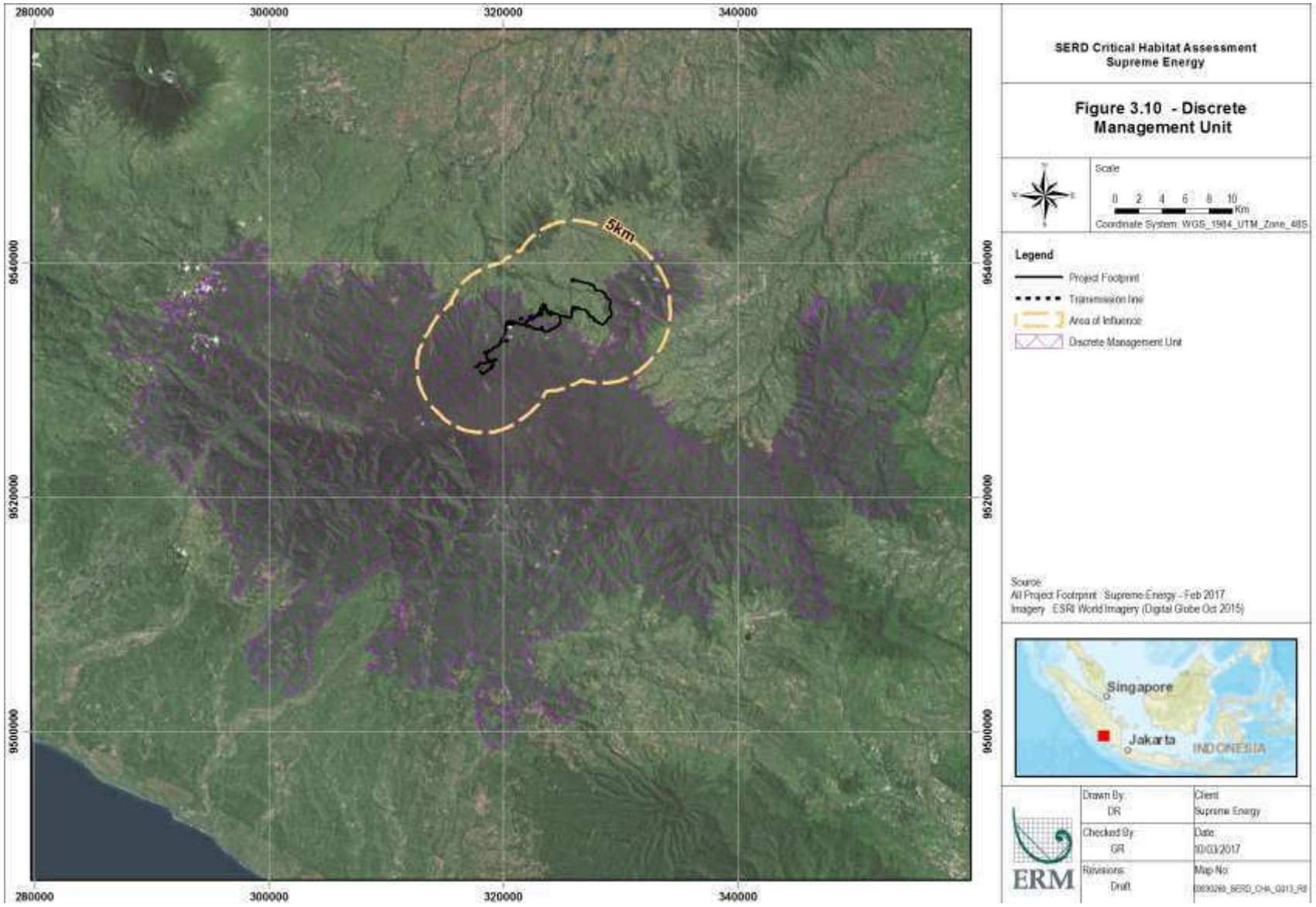
[2] The Biodiversity Consultancy (TBC) (2013) Getting through PS6: Critical Habitat and its requirements. Case Studies from Guinea and Mongolia. Whitmore, T.C. (1984) Tropical Rain Forests of the Far East. Oxford University Press. Second Edition.

[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.

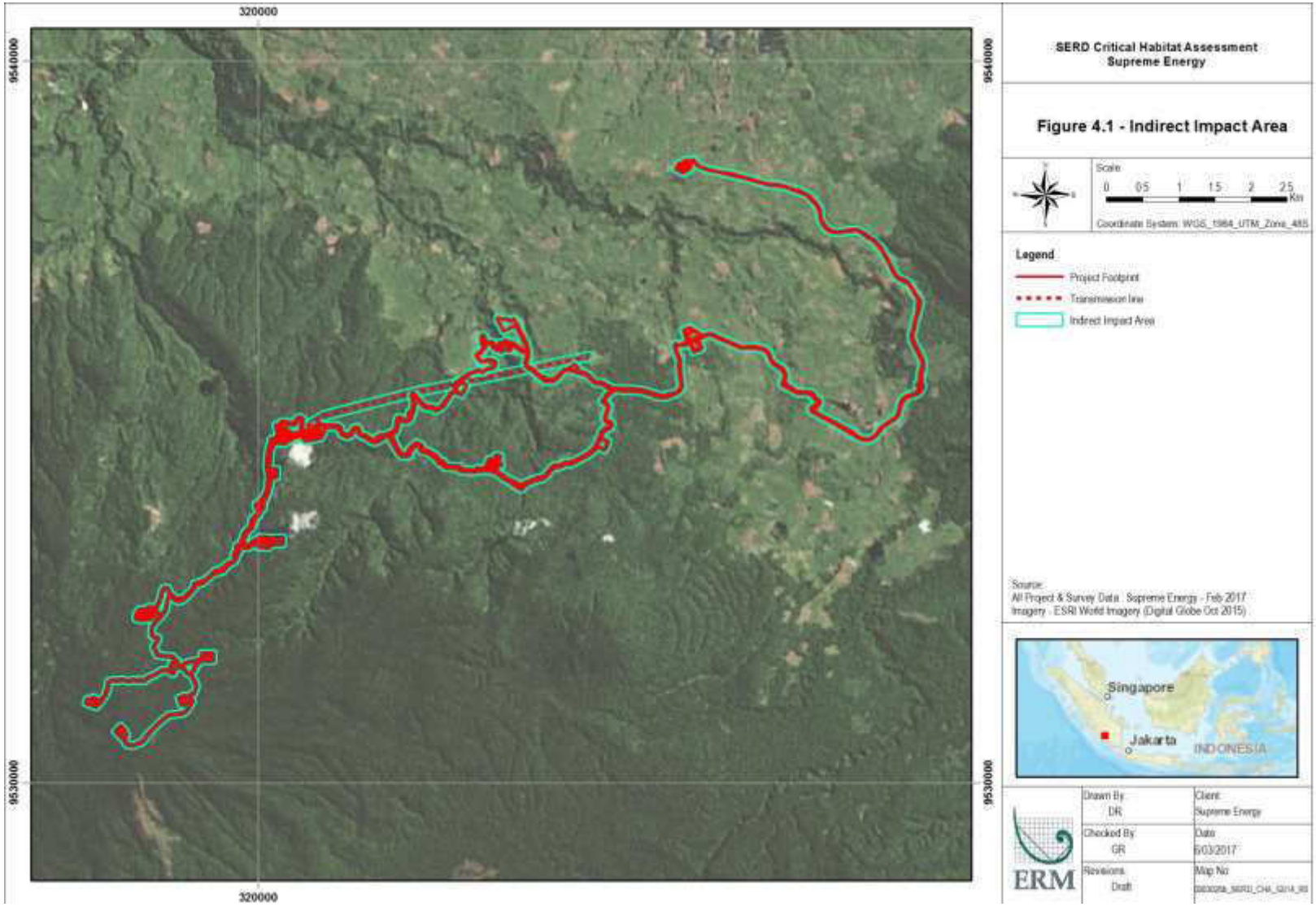
Fragmentation of habitats can occur where currently linked habitats are disconnected through the construction of Project components. Fragmentation reduces the continuity of habitat and hence the ability for fauna to move within and between habitat patches. The resulting impact can cause reductions in 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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PT SERD GEOTHERMAL PLANT BIODIVERSITY ACTION PLAN

S/N	Phase	Task	Aspect, Potential Impact /Issue	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring / Inspection / Spot Check Parameters				KPIs
							Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements	
1	Pre-Construction	General Planning & Management	All Environmental Aspects	Designate a Site Support Manager (SSM) with responsibility for implementation of the BAP, including oversight corrective action and BAP implementation auditing.	BOD (Board of Directors)	Appointment of Site Support Manager (SSM) that will supervise SHE activities at site prior to commence any work. SSM also acts as Geothermal Technical Head (KTPB) who is responsible for SHE management as regulatory requirement for geothermal operation.	Not applicable	Not applicable	Not applicable	Not applicable	SSM has been appointed in December 2016.
2	Pre-Construction	General Planning & Management	All Environmental Aspects	Implement adaptive management measures to review and change (if and where necessary) mitigation measures. 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 EMP. However, overall responsibility for the Management of Change to the BAP will rest with PT SERD's SSM. In addition, the PT SERD SSM shall carry out the Management of Change to the BAP in consultation with the relevant stakeholders. The steps for managing change to the BAP are: 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.	SSM (Site Support Manager), Construction Manager, and Corporate SHE Manager	Records of change management actions undertaken against each incident	Ongoing throughout construction and operation	Required mitigation outlined within this BAP	Required locations as outlined within this BAP	Minutes of any meetings conducted during construction and operation in relation to BAP implementation and corrective actions	Each Management of Change process to be addressed within 4 weeks of incident.
3	Pre-Construction	General Planning & Management	Fauna Mortality	Develop protocols for the management of injured wildlife, which will include: 1. Process of communication to forestry officers of injured wildlife. 2. Recording procedures for injured wildlife/ investigations. 3. Identification of management of change measures necessary to reduce the risk of future events.	Corporate SHE Manager	Corporate SHE Manager to ensure development of protocols	Not applicable	Not applicable	Not applicable	Not applicable	Each injured wildlife encounter to be resolved and closed within 3 days.
4	Pre-Construction	Incident Reporting	Fauna Mortality	Establish an incident reporting mechanism, including database (map, record), to record injured or killed wildlife.	Construction Phase: SSM Operation Phase: Field Manager	Establishment of an incident reporting reponse system and a database to record the number and type of injured/killed wildlife.	Not applicable	Not applicable	Not applicable	Not applicable	All wildlife injuries/mortality attributed to Project actions over Project lifespan is recorded.
5	Pre-Construction	Wildlife Crossing	Connectivity	PT SERD to identify wildlife crossing locations to identify higher risk crossing points along access roads for which targeted mitigation should be implemented. Ensure that there is no direct lighting of wildlife crossings.	Construction Phase: SSM Operation Phase: Field Manager	i) Corporate SHE Manager to ensure that study to identify the needs for temporary crossing is conducted. ii) If temporary crossing is needed, ensure it will be developed and that no light is directed onto the crossing. iii) Wildlife camera trap data / photo records to be collected and analysed monthly	Once during construction Wildlife camera traps will be used on a continuous basis within 1 year of crossing establishment.	Not applicable Wildlife camera trap data / photo records	Across locations identified for wildlife crossings. Deploy camera traps at at landing points and along the length of the wildlife crossing	Fauna monitoring reports Fauna monitoring reports	Identification of locations that need wildlife crossing along access road in 1st semester 2018. if the CH crossing is needed, the crossing will be designed and developed within 1 months after the identification. Use of wildlife crossing by any one of identified CH species triggers within 1 year of crossing establishment.
6	Pre-Construction	Clearance	Connectivity	Assess the need for the installation of artificial crossing (crossing bridge) for endangered arboreal mammals crossing in the Project area, with input from experts on the most appropriate design of arboreal crossing that takes into consideration technical and safety requirements. This requirement is to be confirmed prior to the construction of of site access roads to Wellpads L, M, N and X and injection brine pipeline route.	Corporate SHE Manager, SSM, and Construction Manager	Stakeholder minutes of meeting	Not applicable	Not applicable	Not applicable	Not applicable	See KPI for #3 above. Additional fauna (and flora) study is conducted prior to the construction of new roads to Wellpads L, M, N and X and injection brine pipeline route. Install artificial crossing by end of construction period (if required).
7	Pre-Construction	Clearance	Disturbance & Displacement of Wildlife	Conduct biodiversity surveys for mammal species and flora species of conservation value (including orchids) before construction of new wellpads. Findings are to be communicated with the site team and appropriate actions taken where necessary to minimise impacts.	Corporate SHE Manager Biodiversity experts	Survey reports	At least 2 weeks prior to clearance	Presence/absence, abundance, ecological observations, sex, maturity	At proposed sites for new wellpads	Survey report	Zero injured or dead wildlife attributed to land clearance.

S/N	Phase	Task	Aspect, Potential Impact /Issue	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring / Inspection / Spot Check Parameters				KPIs
							Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements	
8	Pre-Construction	Clearance	Disturbance & Displacement of Wildlife	Prior to the start of construction at each Project component, ensure that wildlife is shepherded from the Project area into adjacent refuge areas, and that temporary fencing/hoarding is erected around construction areas (if required) to limit access to fauna. Identified wildlife refuge areas during pre-construction and construction activities include: 1. Adjacent Protected Forest areas. Upon detection of any dead or injured animal, SSM and Construction Manager shall be notified and the action suspected to have caused the injury to be suspended. The SSM shall arrange suitably qualified persons to attend to the animal as soon as practicable. An incident should be logged via an incident reporting mechanism. Construction activities shall also proceed with greater caution in the event that any target terrestrial fauna (CH species triggers, in particular large mammals) are encountered within the construction site. Construction staff shall notify the SSM and Construction Manager.	SSM and Construction Manager Contractor	i) Visual inspections of hoarding erection ii) Wildlife shepherding surveys	Daily following erection of fencing/hoardings for each work package Survey in conjunction with shepherding activities Throughout construction and/ or operation (if possible)	Erected fencing/hoardings (as required) 1. Species requiring relocation within the Project component area. 2. Habitat features such as hollow trees, dens, nests and roosts. 3. Record all habitat features observed using a GPS. Large terrestrial CH trigger species such as Malayan Tapir	Work package boundaries Work package area to be cleared Refuge areas	Daily SHE Inspection Reports Wildlife shepherding records	Zero injured or dead wildlife attributed to land clearance.
9	Pre-Construction	Clearance	Disturbance & Displacement of Wildlife	All proposed clearance areas will be marked in the field prior to any vegetation being cleared. The marking can use spray paint or marking tape. A briefing is to occur with personnel to outlined the area proposed for clearing. An inspection is to occur following clearing to determine if clearing has been limited to the identified clearance area. Any clearing outside of the marked area is to be reported to the SSM and Construction Manager.	SSM and Construction Manager Contractor	Clearance briefing attendance records Inspection of cleared areas	During clearance activities	Areas marked for clearance	Work package area to be cleared	Daily EHS Inspection Reports	100% of clearance occurs within marked cleared area.
10	Pre-Construction	Clearance	Disturbance & Displacement of Wildlife	Prior to wildlife shepherding activities, undertake a briefing with all involved personnel so they are aware of their roles and responsibilities; measures to deal with injured wildlife; occupational health and safety requirements; and requirements regarding the prohibition of hunting/catching/taking of fauna and flora. This will include incident reporting measures to relevant forestry authorities and stakeholders, and the reporting of any individual suspected or caught with fauna and flora to the relevant authority. Random inspections of personnel arriving and leaving the Project area can be considered. Refresher training is to occur with new employees.	SSM, Construction Manager	Clearance briefing attendance records	Prior to clearance activities	Number of persons briefed and particulars	Not applicable	6-monthly EMP Implementation Reports	100% of contractors, workers and staff involved in land clearance briefed.
11	Pre-Construction	Clearance	Restoration	Establish a site nursery to cultivate native species on site for use in forest restoration activities. Native seed stock and saplings can be obtained from within the Project area and/or from similar habitat and/or from other nurseries.	SSM	Confirm the presence of site nursery Maintain an inventory of native species cultivated at the nursery.	Establishment of nursery Inventory to be established from inception of site nursery. It should be updated every time a new individual is added and a "stocktake" conducted bi-monthly.	Inventory to include date of arrival of individual to nursery, general location where individual was derived from. Location data can range from spatial coordinates to broader descriptions (eg near Village X or an area with similar habitat) depending on available resources for curation.	Designated nursery area Inventory can be maintained in a spreadsheet format.	6-monthly EMP Implementation Reports	Establishment of 1 on-site nursery prior to clearance phase.
12	Pre-Construction	Biodiversity Offset Planning	Biodiversity Offset	Approximately 163 ha of forested areas will be permanently cleared for the Project footprint. Offset area will be selected based on IFC PS and ADB requirement. A comprehensive biodiversity offset design, with habitat and species offsets in the suitable areas to be designed.	Corporate SHE Manager Experts	Biodiversity offset plan and commencement of offset project	Not applicable	Not applicable	Not applicable	Not applicable	Offset plan prepared within the construction period and discussion with related parties such as NGO, University, Forestry Agency or Forestry Research Agency in 1st semester of 2018.
13	Pre-Construction	Water management	Water extraction and flows	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.	Corporate SHE Manager Experts	Determine the extraction rates according to seasonal conditions and	To be determined following further assessment	To be determined following further assessment	To be determined following further assessment	To be determined following further assessment	To be determined following further assessment

S/N	Phase	Task	Aspect, Potential Impact /Issue	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring / Inspection / Spot Check Parameters				KPIs
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14	Construction	Clearance	Restoration	Collect native flora seed before land clearance. These seedlings to be cultivated and propagated in a nursery and maintained until 2020 when forest restoration activities commence at the site.	SSM	Confirm the presence of site nursery Maintain an inventory of native species cultivated at the nursery.	During clearance seed collection activities	Inventory to include date of arrival of individual to nursery, general location where individual was derived from. Location data can range from spatial coordinates to broader descriptions (eg near Village X or an area with similar habitat) depending on available resources for curation.	Designated nursery area Inventory can be maintained in a spreadsheet format.	6-monthly EMP Implementation Reports	Establishment of 1 on-site nursery prior to clearance phase.
15	Construction	Awareness Training	Disturbance & Displacement of Wildlife	Local community engagement will be carried out with villages in the Project catchment to (i) raise awareness of the conservation value of the Protection Forest's ecological function; (ii) encourage local people not to hunt threatened and protected species in the forest, or clear areas by logging; and This engagement programme will be developed by PT SERD, in consultation with, the local government, Forestry Agency, and customary leaders. Communities will be engaged formally once a year to communicate and consult on developments within the Project relevant to them. These meetings are to be formally minuted.	Corporate SHE Manager, SSM, and Corporate External Relations Manager	Minutes of meetings	Yearly	Not applicable	Not applicable	Not applicable	Meetings to be held for community members in villages around project area. All minutes of meetings to be documented.
16	Construction	Transportation	Fauna Mortality	Undertake daily monitoring of PT SERD access roads to secure them from poaching activity.	SSM, Field Security Supervisor, Field Relations, and Corporate External Relations Manager	Monitoring records	Daily	Signs of poaching activity	PT SERD access roads	To report to relevant authorities, including police department if necessary, and lodge an incident internally	Zero incidents of illegal poaching or tree felling by Company staff.
17	Construction Operation	Transportation	Fauna Mortality	Company drivers to receive internal defensive driving training that includes commentary driving. Drivers are required to pass PT SERD's driving test and obtain a company driving license before being authorised to drive on site.	SSM, SHE Supervisor, and Contractors	Log of personnel who have undertaken the driving test and documentation of registered drivers within PT SERD	Prior to commencement of construction works	Company drivers receiving training on defensive driving	All company drivers	Log of personnel who have successfully completed training	100% of all company drivers to possess PT SERD driving test license
18	Construction Operation	Transportation	Fauna Mortality	Security and/or SHE staff to conduct speed checks for vehicles using a radar speed gun. Non-compliance with the speed limit will be reported to the Site Support Manager and appropriate disciplinary procedures undertaken in accordance with PT SERD policy.	SSM, Security Supervisor, SHE Supervisor, and Contractors	Record of date of spot check occurrence and evidence of maintained speed log	Monthly spot checks	Speed of vehicle	Any point within the access road where speed limits are in place	Speed logs	Zero speeding incidents recorded. 100% of speeding incidents to receive appropriate disciplinary procedures within 1 week of offence.
19	Construction Operation	Lighting	Disturbance & Displacement of Wildlife	The following design elements for lighting within the Project area will be implemented: Lighting will be directed away from vegetated areas and habitats. Upward and directional lighting will be avoided. Lighting into unintended areas will be avoided. Where lighting is required to be installed for safety and security purposes, regulatory requirements or best practice for wildlife-friendly lighting design will be followed. During construction, lights will not be used outside of construction hours. During operations, general lighting usage will be consistent with the operating hours of each Project component. Outside of operating hours, low lux level and downcast lighting will be needed along pathways and roads at levels sufficient for safety reasons. Reduce the duration of nocturnal lighting sources by using a timer or movement based sensor system to turn off lights. Where permanent lights are employed, ensure that darker passages between lights exist for sensitive fauna to pass. Automatic dimming to reduce lighting intensity will also be considered. Avoid using lumination that has a high UV component to reduce impacts on insects. Avoid using broad spectrum lights. Installation of light fittings to reduce nocturnal light impacts on habitats in vegetated areas and habitats outside project area that are close to these night light sources	SSM, Construction Manager, and Field Manager	Light monitoring	At night, monthly during construction and operations	Light intensity (lux)	Vegetated areas and habitats that are close to these night light sources	Light monitoring records	100% compliance - no light spillage/ directed into forest
20	Construction Operation	General Planning & Management	Disturbance & Displacement of Wildlife	No night works that can disturb wildlife to be undertaken during construction or operation unless under exceptional circumstances (not inclusive of drilling activities at wellpads and powerplant activities).	SSM, Construction Manager, and Field Manager	Indication in construction schedule	Not applicable	Not applicable	Not applicable	Not applicable	100% compliance - no disruptive night works undertaken at night.

S/N	Phase	Task	Aspect, Potential Impact /Issue	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring / Inspection / Spot Check Parameters				KPIs
							Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements	
21	Construction Operation	Fauna & Flora Surveys	Monitoring	Conduct regular monitoring of flora and fauna in Project areas. The surveys will be undertaken by experts with assistance (including guides) from local villages. The information collected is to be used as a basis for habitat and population management.	Corporate SHE Manager	Updated species database of the Project area	Surveying, reporting and mapping to be undertaken (i) before construction; (ii) every 3 years after operations commence; and thereafter	Flora (seedlings, saplings, trees), mammals, birds, reptiles & amphibians, fish Flora: Presence of protected species, pioneer species, invasive species Fauna: Presence, abundance and distribution of species of	Project area using transects and vegetation plots where baseline surveys have been carried out.	Survey report	Not applicable
22	Construction Operation	Awareness Training	Disturbance & Displacement of Wildlife	All construction personnel and PT SERD staff will undertake biodiversity awareness training prior to commencement of construction to raise their awareness of the: (i) ecological sensitivity of the site, importance of forest habitats, protected and threatened plants and animals within the Project area; (ii) proper protocols to adopt when wildlife is encountered; (iii) need to be cautious when operating machinery to avoid injury/mortality to fauna; and (iv) PT SERD's no-tolerance policy on poaching that encompasses both direct and indirect involvement. This is applicable to both staff and contractors. All workers and visitors to be educated to ensure that all work places are kept clean and waste is not left in open areas. All workers will be prohibited from feeding animals. Refresher training will be provided at every year throughout construction and operation.	SSM, Construction Manager, Field Manager, and Corporate SHE Manager	Training Records	Prior to commencement of works and for all new workers Refresher training every year	Number of workers trained	Not applicable	Training records maintained	Zero incidents of hunting/poaching and wildlife injury/ mortality by PT SERD contractors and staff.
23	Construction Operation	Awareness Training	Disturbance & Displacement of Wildlife	Put up and maintain information posters and literature in the PT SERD site office to increase awareness of ecological issues affecting the Project and ecological function of protection forest in terms of both habitat provision and hydrology.	SSM, Construction Manager, Field Manager, and Corporate SHE Manager	Placement of posters and literature in the site office	Not applicable	Not applicable	Not applicable	Not applicable	Refresh posters and literature in site office a minimum of twice a year.
24	Construction Operation	Incident Reporting	Disturbance & Displacement of Wildlife	Compliance with PT SERD environmental protection policy will be managed and monitored by the SSM. This will include a procedure for reporting incidents by site staff. A recording and evaluation system will be established and reviewed on a monthly basis. Corrective measures will be taken where necessary including appropriate actions against infringements.	SSM, Construction Manager, Field Manager, and Corporate SHE Manager	Monitoring reports and records	Not applicable	Not applicable	Not applicable	Not applicable	100 % compliance with PT SERD environmental protection policy. 100 % of incidents reviewed by SHE team every month and corrective measures implemented within 2 weeks of review.
25	Construction	Fauna & Flora Surveys	Fauna Mortality	Monthly monitoring of construction areas for signs of potential wildlife conflict, illegal logging and poaching. Frequency of monitoring to increase if signs of these have been identified	SSM	Monitoring reports and records	Monthly, intensity to increase based on findings	Signs of wildlife conflict, illegal logging, poaching (e.g. new trails and roads into forest, dead wildlife)	Within Project area	Monitoring report	100% of all signs of potential wildlife conflict, illegal logging and poaching to be communicated to local forestry officers and relevant authorities within 3 days.
26	Construction	Awareness Training	Disturbance & Displacement of Wildlife	Workers to be trained in noise-reduction behaviours such as reducing the drop height of materials, and turning off equipment and vehicle engines when not in use.	SSM, SHE Supervisor, Construction Manager. Contractor and Field Manager	Training records	Not applicable	Presence of noisy behaviours	All worksite areas	Inspection report	100% of workers trained in noise-reduction behaviours.
27	Operation	Wildlife Crossing	Monitoring	An appropriate monitoring and maintenance programme will be introduced to ensure that the constructed crossing points/ arboreal crossing bridge is retained in good functional condition. Inspections will take place at no less than 6 month intervals. NGOs, ecologists and arboreal mammal experts to be engaged when undertaking this action.	SSM, Construction Manager, Field Manager.	Inspection records	Inspections to occur at six monthly intervals or less.	Bridge condition, vegetation structure at wildlife crossing points, signs of wildlife usage	At crossing points/ arboreal crossing bridges	Inspection record	Not applicable
28	Operation	Fauna & Flora Surveys	Monitoring	Data from camera trap surveys, transects and community monitoring to be used to measure long term population changes and trends for key species (such as the Sumatran Tiger, Malayan Tapir, Dhole, Pangolin and endemic birds). PT SERD will liaise with local authorities and experts to provide any relevant ecological monitoring data to integrate in the long term monitoring and with the other surrounding developments.	SSM and Corporate SHE Manager	Review of long term monitoring records	Every 3 years and intensity to change based on findings	Ecological monitoring data for key species, including CH trigger species	Project Area	Monitoring Records and Minutes of Meetings	Continued utilisation of Project area by CH trigger species over Project construction and operation.

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							Timing And Frequency Of Monitoring	Parameters	Location	Reporting Requirements	
29	Post-Construction Operation	Habitat Rehabilitation	Restoration	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 assistance will be sought from experts.	Corporate SHE Manager Experts	Minutes of meeting	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
30	Post-Construction Operation	Habitat Rehabilitation	Restoration	A community based forest restoration project may be developed to engage local communities to participate in forest restoration activities activities, such as weeding, replanting, maintenance and seedling propagation.	Corporate SHE Manager	Implementation of the community based forest restoration project	To be established within 6 months of commencement of Project operation and reviewed on a 12 monthly basis	Number of community members engaged	Within Project area and/or within Project vicinity (subject to permission from National Park)	Annual Implementation Report	50% of restoration workforce employed from local communities.
31	All Phases	General Planning & Management	Fauna Mortality	Install warning signs targeted at poachers and illegal loggers at the border of the buffer and interior of Gunung Patah Protection Forest. Conduct joint patrols with local authorities, Forestry and conservation Agency.	SSM and Security Supervisor	Installation of warning signs and attendance at joint patrols	Not applicable	Not applicable	Not applicable	Not applicable	Conduct a minimum of 12 joint patrols every year (average once a month).
32	All Phases	General Planning & Management	Fauna Mortality	Establish a communication system with the local forestry office and report to authorities immediately any signs of illegal hunting and deforestation, wildlife conflict and forest fires within the Protected Forest Area. Furnish this report with photographic documentation where possible and the date and time of observation. Incident also to be recorded via PT SERD's incident reporting mechanism.	SSM, Security Supervisor, and Field Relations Supervisor	Establishment of a communication system with reporting parameters	Not applicable	Not applicable	Not applicable	Not applicable	Each incident to be submitted to local forestry office within 3 days.
33	All Phases	Fauna & Flora Surveys	Monitoring / Engagement	Set up a habitat mapping database following the pre-construction monitoring work to store all biodiversity monitoring data. From this database: (i) Prepare habitat maps for the project site using aerial imagery obtained via satellite or drone. (ii) As part of the evaluation of management action, analyse results of field surveys, biodiversity monitoring, and opportunistic sightings to understand more detailed and specific distribution of species. The database is to be shared between PT SERD, related parties, and ecologists. It is to be updated annually or when major findings from surveys call for updates.	Corporate SHE Manager	Establishment of database	Not applicable	Not applicable	Not applicable	Not applicable	Database to be established within 1 year of construction commencement.
34	All Phases	Transportation	Fauna Mortality	Control access road users by constructing security gates to restrict access of vehicles. Security gates are to be manned by at least 1 security officer 24 hours per day who will record the particulars (name, address, village, vehicle registration number, personal identification number) of all vehicles who are allowed into the access road. As per PT SERD's security management system, an ID badge to be issued to visitors upon arrival and returned upon departure; company staff should already possess a Company ID Badge that must be displayed upon arrival. Visitors must also be accompanied by a company representative at all times. The security officers should be trained to identify behaviour associated with poachers and vehicle searches. The security gate should be equipped with 24 hour CCTV cameras. For people that have cleared and are utilising areas within the project concession, security to investigate if clearance is conducted in a legal manner. If yes, these individuals to be issued with a label (distinguished from staff), that grants them continued access into the site.	SSM and Security Supervisor	Proof of well-maintained access log Training records of security officers	Not applicable	Not applicable	Not applicable	Not applicable	Zero unregistered vehicles within PT SERD premises
35	All Phases	Transportation	Vegetation Clearance	Conduct regular patrols of at least every month of the project area to identify encroachment and burning/land clearing by residents. Patrols to be undertaken by PT SERD with involvement of the police and government staff. Where it is identified that local people have entered and undertaken illegal logging or poaching, work with local authorities to report and investigate the breach.	SSM, Security Supervisor, Field Relations, and Corporate External Relations Manager	Log of the results of regular patrols	During construction and operation	Regular patrols undertaken	Along the Project Area boundary and adjacent land	To report to relevant authorities, including police department if necessary, and lodge an incident internally	Zero incursion into Project Area.
36	All Phases	Transportation	Vegetation Clearance	Conduct regular drone flights at least every year to monitor clearance of vegetation within the project area. Where clearing activity is identified , it is to be investigated and infomration passed to local police and forestry department officials.	SSM and Corporate SHE Manager	Assessment of vegetation clearance within the project boundary	During construction and operation	Drone flight every 6 months	500m of the project footprint and/or within Project catchment area	To report to relevant authorities, including police department if necessary, and lodge an incident internally	Updated aerial map every year. Report all new clearance of vegetation within the project area.

S/N	Phase	Task	Aspect, Potential Impact /Issue	Required Mitigation	Responsible Person For Ensuring Action Implementation	Means Of Verification That Commitment Has Been Met	Monitoring / Inspection / Spot Check Parameters				KPIs
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37	Pre-Construction	Fauna & Flora Surveys	Invasive Species	Undertake surveys to identify locations where invasive species are particularly abundant and maintain an inventory. Where necessary, work with specialists to develop a plan to prevent invasive speices introduction and/or proliferation due to Project activities.	SSM and Corporate SHE Manager	Survey report and inventory development	Prior to construction of access road from Wellpad F to WP-F	Species, abundance, GPS location	Around worksite areas, in particular area where restoration is targeted to occur	Survey report	Map of invasive species aggregations prior to construction of access road to WP-L,M,N and X and injection brine pipeline route.
38	All Phases	General Planning & Management	Vegetation Clearance	Education of local people and restriction of clearing by local residents within the Project Area.	SSM and Corporate SHE Manager	Meeting records, including details such as village visited, number of people trained	Not applicable	Not applicable	Not applicable	Not applicable	Reduction in clearing incidents by local people 5 years from commencement of operation.
39	All Phases	General Planning & Management	Ecosystem Services	Conduct interviews with local people regarding their ecosystem service use within the Project Area and AoI.	SSM and Corporate SHE Manager	Meeting records	Not applicable	Not applicable	Not applicable	Not applicable	List of ecosystem services used by local residents, utilisation profile according to each village
40	All Phases	General Planning & Management	Vegetation Clearance	Monitor land clearing by local people. If land available for cultivation is reduced and impacts recorded to livelihoods, measures are to be assessed and undertaken to include alternatives.	SSM and Corporate SHE Manager	MoU Implementation Report	Monthly spot checks	Locations of land cleared Area of land cleared Individuals/ village responsible	Within Project Area	MoU Implementation Report	Reduction in clearing incidents by local people 5 years from commencement of operation.

Action items:

SN	Item	Responsibility	Additional Parties	Date to be completed	Frequency
1	Appoint a Site Support Manager to supervise SHE aspects at site	BOD	Not Applicable	December 2016	1 Time
2	Implement adaptive management measure	SSM	Not Applicable	March 2017	1 Time, Monthly monitoring
3	Develop protocols for the management of injured wildlife	Corporate SHE Manager	Not Applicable	March 2017	1 Time, Monthly monitoring
4	Establish an incident reporting mechanism	Corporate SHE Manager	Not Applicable	March 2017	1 Time, Monthly monitoring
4	Identification of Wildlife Crossing Points	PT SERD SHE Manager	NGOs, MoF	May 2017	1 Time, Monthly monitoring
5	Identify wildlife crossing points	SSM	experts	July 2017	1 Time
6	Assess the need for the installation of artificial crossing for endangered arboreal mammals	Corporate SHE Manager	experts	July 2017	1 Time
7	Conduct a flora and fauna survey prior to construction of wellpad	Corporate SHE Manager	experts	February 2017	1 Time
8	Wildlife shepherding activities	SSM	Contractors	March 2017	1 Time
7	Establish a site nursery to propogate native plants	PT SERD SHE Manager	Contractors	June 2017	Monthly monitoring
9	Ensure clearing has been limited to the identified area	Construction Manager	Contractors	March 2017	1 Time
9	Engage with NGOs, Universities on research activities	PT SERD SHE Manager	NGOs, MoF	February 2017	Bi-Yearly
10	Set up Habitat Mapping Database	PT SERD SHE Manager	Contractors	July 2017	1 Time
11	Contract specialist advice on forest restoration activities	PT SERD SHE Manager	Specialist wildlife consultant	March 2017	1 Time
12	Install warning signs regarding hunting and poaching	PT SERD SHE Manager	Contractors	March 2017	To be inspected weekly
13	Establish communication system with local forestry office/police	PT SERD SHE Manager	NGOs, MoF, Police	Apr-17	Bi-monthly
14	Conduct Biodiversity Awareness Training of All Staff	PT SERD SHE Manager	Contractors	March 2017	Bi-yearly
15	Install awareness posters in the SERD Offices on Biodiversity	PT SERD SHE Manager	Contractors	February 2017	To be inspected weekly
16	Conduct local community engagement activities	PT SERD SHE Manager	Local Community, NGO, MoF	March 2017	1 Time
17	Establishment of a grievance process	PT SERD SHE Manager	Local Community, NGO, MoF	March 2017	1 Time, Monthly monitoring
18	Prepare long-term community programs	PT SERD SHE Manager	Local Community, NGO, MoF	Sep-17	1 Time
19	Invasive species survey of Project Area	PT SERD SHE Manager	Specialist wildlife consultant	August 2017	Bi-yearly
10	Brief all involved personnel on wildlife shepherding activities	SSM, Construction Manager	Contractors	March 2017	1 Time
9	Mark area to be cleared	Construction Manager	Contractors	March 2017	1 Time
10	Prior to wildlife shepherding activities, undertake a briefing with all involved personnel	Construction Manager	Contractors	March 2017	1 Time
11	Establish a site nursery	SSM	Not Applicable	March 2017	1 Time
12	Develop a comprehensive Offsite Biodiversity Offset Design	Corporate SHE Manager	experts	end of 2019	1 Time
13	Conduct a water extraction pre-feasiblity assessment	Corporate SHE Manager	experts	end of 2019	1 Time
14	Collect native flora seed before land clearance	SSM	experts	March 2017	1 Time
15	Local community engagement to raise awareness of the conservation value of KSNP forest	SSM	experts	March 2017	Yearly
16	Undertake daily monitoring of PT SERD access roads to secure them from poaching activity	SSM	Not Applicable	March 2017	Daily
17	Company drivers to receive internal defensive driving training	SSM	Contractors	March 2017	Yearly
18	Conduct speed check	SSM	Not Applicable	March 2017	Monthly
19	Lighting management	Construction Manager	Contractors	March 2017	Monthly
20	Ensure night works will not disturb wildlife	Construction Manager	Contractors	March 2017	Daily
21	Conduct regular monitoring of flora and fauna in Project areas	Corporate SHE Manager	experts	March 2017	Every 3 years
22	All construction personnel and PT SERD staff will undertake biodiversity awareness training	Construction Manager	Contractors	March 2017	1 Time
23	Put up and maintain information posters and literature on ecological awareness	SSM	Not Applicable	March 2017	Every 6 months
24	Monitor compliance with PT SERD environmental protection policy	SSM	Not Applicable	March 2017	Monthly
25	Monitor construction areas for signs of potential wildlife conflict, illegal logging and poaching	SSM	Not Applicable	March 2017	Monthly
26	Workers to be trained in noise-reduction behaviours	SSM	Contractors	March 2017	1 Time
27	Crossing points/ arboreal crossing bridge is retained in good functional condition	Construction Manager	Not Applicable		Every 6 months
28	Measure long term population changes and trends for key species	Corporate SHE Manager	experts	end of 2019	Every 3 years
29	Consultation relevant stakeholders to determine the composition and type of planting to be achieved	Corporate SHE Manager	experts	end of 2019	1 Time
30	Develop a community based forest restoration project	Corporate SHE Manager	experts, local communities	end of construction	Yearly
31	Install warning signs regarding hunting and poaching at the border of the buffer area of the Protection Forest.	SSM	KSNP	March 2017	1 Time
32	Establish a communication system with the local forestry office and report illegal hunting / logging.	SSM	Forestry Office, Police	March 2017	Each incident
33	Develop and update habitat mapping database	Corporate SHE Manager	experts	March 2017	Yearly
34	Construct security gates to restrict access of vehicle	SSM	Not Applicable	March 2017	1 Time
35	Conduct regular patrols of the project boundary	SSM	Not Applicable	March 2017	Monthly
36	Conduct regular drone flight	Corporate SHE Manager	Not Applicable	March 2017	Yearly
37	Conduct invasive species survey of WP-L,M,N and X and injection brine pipeline route.	Corporate SHE Manager	experts	March 2017	Every 3 years

Estimated Budget (2016 USD Values) Year 1

S/N	Task	Rate ($USD Per Annum)	Consultant Requirement	Consultant Cost	Capital Equipment	Capital Equipment Cost	Estimated FTE	Labour Cost	Total
1	Appoint a Site Support Manager to supervise SHE aspects at site	7034,56			Office support	$ 1.000,00	1	$ 7.034,56	**$ 8.034,56**
2	Implement adaptive management measure	7034,56					0,0192	$ 135,28	**$ 135,28**
3	Develop protocols for the management of injured wildlife	7034,56					0,0385	$ 270,56	**$ 270,56**
4	Establish an incident reporting mechanism	7034,56					0,0192	$ 135,28	**$ 135,28**
5	Identify wildlife crossing points	7034,56					0,0577	$ 405,84	**$ 405,84**
6	Assess the need for the installation of artificial crossing for endangered arboreal mammals	7034,56	Biodiversity survey for arboreal crossing	$ 5.000,00			0,1538	$ 1.082,24	**$ 6.082,24**
7	Conduct a flora and fauna survey prior to construction of wellpad	7034,56	Biodiversity survey for mammal and flora species prior to new wellpad construction	$ 12.500,00			0,0769	$ 541,12	**$ 13.041,12**
8	Wildlife shepherding activities	7034,56					0,0192	$ 135,28	**$ 135,28**
9	Mark area to be cleared	7034,56					0,0192	$ 135,28	**$ 135,28**
10	Prior to wildlife shepherding activities, undertake a briefing with all involved personnel	7034,56					0,0192	$ 135,28	**$ 135,28**
11	Establish a site nursery	7034,56			Nursery	$ 5.000,00	1	$ 7.034,56	**$ 12.034,56**
12	Develop a comprehensive Offsite Biodiversity Offset Design	7034,56	Biodiversity Offset Plan	$ 20.000,00			0	$ -	**$ 20.000,00**
13	Conduct a water extractioon prefeasibility assessment	7034,56	Water extraction assessment	$15.000				$ -	**$ 15.000,00**
14	Collect native flora seed before land clearance	7034,56	Seed collection	$ 1.000,00			0,0769	$ 541,12	**$ 1.541,12**
15	Local community engagement to raise awareness of the conservation value of KSNP forest	7034,56	Local community	$ 10.000,00	OHP	$ 2.000,00	0,0577	$ 405,84	**$ 12.405,84**
16	Undertake daily monitoring of PT SERD access roads to secure them from poaching activity	7034,56					0,0769	$ 541,12	**$ 541,12**
17	Company drivers to receive internal defensive driving training	7034,56					0,0577	$ 405,84	**$ 405,84**
18	Conduct speed check	7034,56			Radar Speed Gun	$ 2.000,00	0,0769	$ 541,12	**$ 2.541,12**
19	Lighting management	7034,56					0,0769	$ 541,12	**$ 541,12**
20	Ensure night works will not disturb wildlife	7034,56					0	$ -	**$ -**
21	Conduct regular monitoring of flora and fauna in Project areas	7034,56	Yearly flora and fauna monitoring cost (2016 : USD27k by Greencap and USD7.5k/year)	$ 34.500,00	Camera Traps	$ 5.000,00	0	$ -	**$ 39.500,00**
22	All construction personnel and PT SERD staff will undertake biodiversity awareness training	7034,56					0,0769	$ 541,12	**$ 541,12**
23	Put up and maintain information posters and literature on ecological awareness	7034,56			Posters and literature	$ 2.000,00	0,0192	$ 135,28	**$ 2.135,28**
24	Monitor compliance with PT SERD environmental protection policy	7034,56					0,0192	$ 135,28	**$ 135,28**
25	Monitor construction areas for signs of potential wildlife conflict, illegal logging and poaching	7034,56					0,0192	$ 135,28	**$ 135,28**
26	Workers to be trained in noise-reduction behaviours	7034,56					0,0577	$ 405,84	**$ 405,84**
27	Crossing points/ arboreal crossing bridge is retained in good functional condition	7034,56					0,0192	$ 135,28	**$ 135,28**
28	Measure long term population changes and trends for key species	7034,56			Camera Traps	$ 5.000,00	0,0192	$ 135,28	**$ 5.135,28**
29	Consultation relevant stakeholders to determine the composition and type of planting to be achieved	7034,56	Stakeholders	$ 5.000,00			0,0192	$ 135,28	**$ 5.135,28**
30	Develop a community based forest restoration project	7034,56	Community forest restoration project	$ 10.000,00			0,0192	$ 135,28	**$ 10.135,28**
31	Install warning signs regarding hunting and poaching at the border of the buffer area of the Protection Fores	7034,56			Signs to discourage poaching and logging	$ 2.500,00	0,0577	$ 405,84	**$ 2.905,84**
32	Establish a communication system with the local forestry office and report illegal hunting / logging.	7034,56	See # 34				0,0192	$ 135,28	**$ 135,28**
33	Develop and update habitat mapping database	7034,56					0,0192	$ 135,28	**$ 135,28**
34	Construct security gates to restrict access of vehicle	7034,56			Gates, Office, CCTV	$ 45.000,00	0,0192	$ 135,28	**$ 45.135,28**
35	Conduct regular patrols of the project boundary	7034,56	Join patrol with police and government officials (along with #31)	$ 15.000,00			0,0577	$ 405,84	**$ 15.405,84**
36	Conduct regular drone flight	7034,56	UAV survey by consultant (2016)	$ 15.000,00	Drone	$ 6.000,00	0,0192	$ 135,28	**$ 21.135,28**
37	Conduct invasive species survey of WP-L,M,N and X and injection brine pipeline route.	7034,56					0,0192	$ 135,28	**$ 135,28**
				$ 143.000,00		**$ 75.500,00**	**3,3269**	**$ 23.403,44**	**$ 241.903,44**

Framework of Temporary Worker Accommodation Management Plan

The below presents a framework of the Temporary Workers Accommodation Management Plan to be elaborated and implemented by the major contractors during construction (see Schedule of Safety, Health and Environment, document number RD-EPC01-CCON-0216 Section 3.26.5 Worker's Accommodation).

SERD will review and approve the contractors' elaborated Temporary Worker Accommodation Management Plans for the construction phase of the Project.

Temporary Worker Accommodation Management Plans will be developed for all new construction accommodation camps prior to them being inhabited as per contract requirements.

These plans will be developed in accordance with international best practice guidance, as exemplified by "Workers' accommodation: Processes and standards, a guidance note by IFC and the EBRD" (2009) and follow a standard format addressing the following:

- Assessment of the need for workers' accommodation (availability of workforce, availability of existing housing; and assessment of impacts of workers' accommodation on communities including:
    - Specific impacts during the construction phase;
    - Community infrastructure;
    - Community services and facilities;
    - Local businesses and local employment;
    - Community health and safety;
    - Community cohesion;
    - Land acquisition and resettlement; and
    - Dismantling and reinstatement.

- Demonstrating how national and international best practice standards for workers' accommodation will be met in relation to:
    - General living facilities;
    - Room/dormitory facilities;
    - Sanitary and toilet facilities;
    - Canteen, cooking and laundry facilities;
    - Standards for nutrition and food safety;
    - Medical facilities; and
    - Leisure, social and telecommunication facilities;

- Description of the management and monitoring approach, structure, roles and responsibilities of the accommodation area in relation to:
    - Management and staff structure;
    - Charging fees for accommodation and services;
    - Health and safety on site;
    - Security of workers' accommodation;
    - Workers' rights, rules and regulations;
    - Consultation and grievance mechanisms; and
    - Management of community relations.