Draft Environment and Social Impact Assessment

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Lao PDR: Monsoon Wind Power Project
Part 2: Main Report

Prepared by Impact Energy Asia Development Limited (IEAD) for the Asian Development Bank.

Monsoon Wind Power Project, Sekong and Attapeu Provinces, Lao PDR

Environmental and Social Impact Assessment

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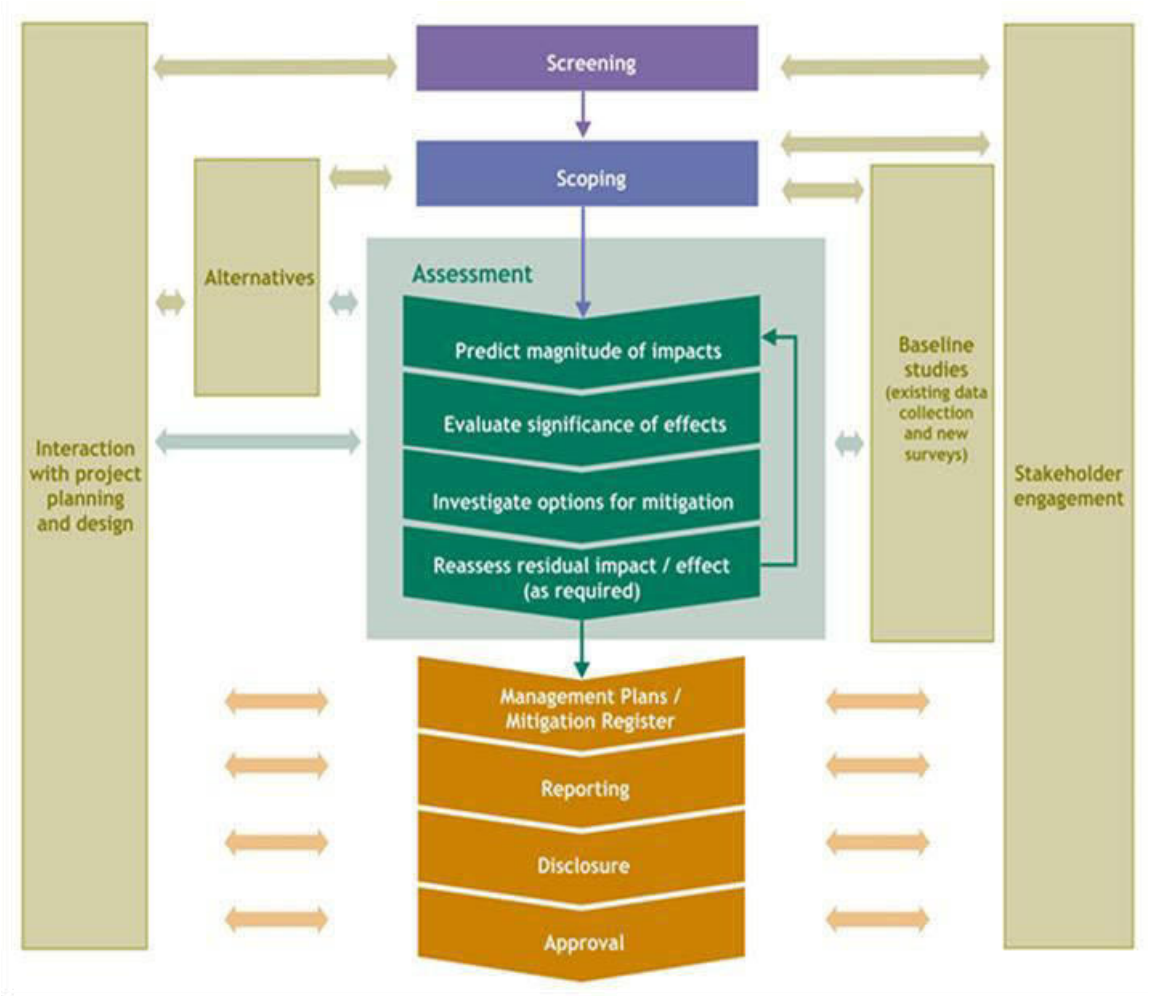
5. IMPACT ASSESSMENT METHODOLOGY

5.1 Introduction

This section presents the methodology used to conduct the Environmental and Social Impact Assessment (ESIA) for the Project. The Impact Assessment (IA) is undertaken following a systematic process that predicts and evaluates the impacts the Project could have on aspects of the physical, biological, social/ socio- economic and cultural environment, and identifies measures that the Project is planning to avoid, reduce, mitigate, offset or compensate for adverse impacts; and to enhance positive impacts where practicable.

The methodology has followed the approach illustrated in ***Figure 5.1***.

Figure 5.1: Overall Impact Assessment Approach



Source: ERM, 2019

This section also details the methodology used for the collection and analysis of primary and secondary data used in this report. Primary and secondary information from the Project Owner, government sources, non-governmental organisations (NGOs) and other Project-related stakeholders have been collected to support the preparation of this report.

5.2 Screening

The screening was conducted utilizing a high-level description of the Project and its associated facilities, including available information regarding the project design and existing environmental and

social conditions, applicable regulatory framework for the Project etc. in order to provide a summary of initial findings on potential project impacts and to guide development of the ESIA.

5.3 Scoping

Scoping has been undertaken to delineate the potential Area of Influence for the Project (and therefore the appropriate Study Area) and to identify potential interactions between the Project and resources/ receptors in the Area of Influence. It also helps in developing and selecting alternatives to proposed action and in identifying the issues to be considered in this ESIA. A scoping exercise was completed as part of the gap analysis undertaken by ERM.

5.4 Project Boundary and Area of Influence

In order to set out the scope of the Project features and activities, with particular reference to the aspects, which have the potential to impact the environment, a Project Description has been prepared. Details of the Project facilities' design characteristics, as well as planned and possible unplanned Project activities, are provided in ***Section 3*** of this ESIA Report. The Project Area of Influence (AoI) is also defined in ***Section 7*** of this ESIA Report.

5.5 Baseline Data Collection

To provide the context within which the impacts of the Project can be assessed, a description of physical, biological, social/socio-economic and cultural conditions that would be expected to prevail in the absence of the Project is presented. The baseline includes information on all resources/receptors that were identified during scoping as having the potential to be significantly affected by the Project.

The existing and additional environmental and social baseline conditions of the Project are reported in ***Section 7*** of this ESIA Report.

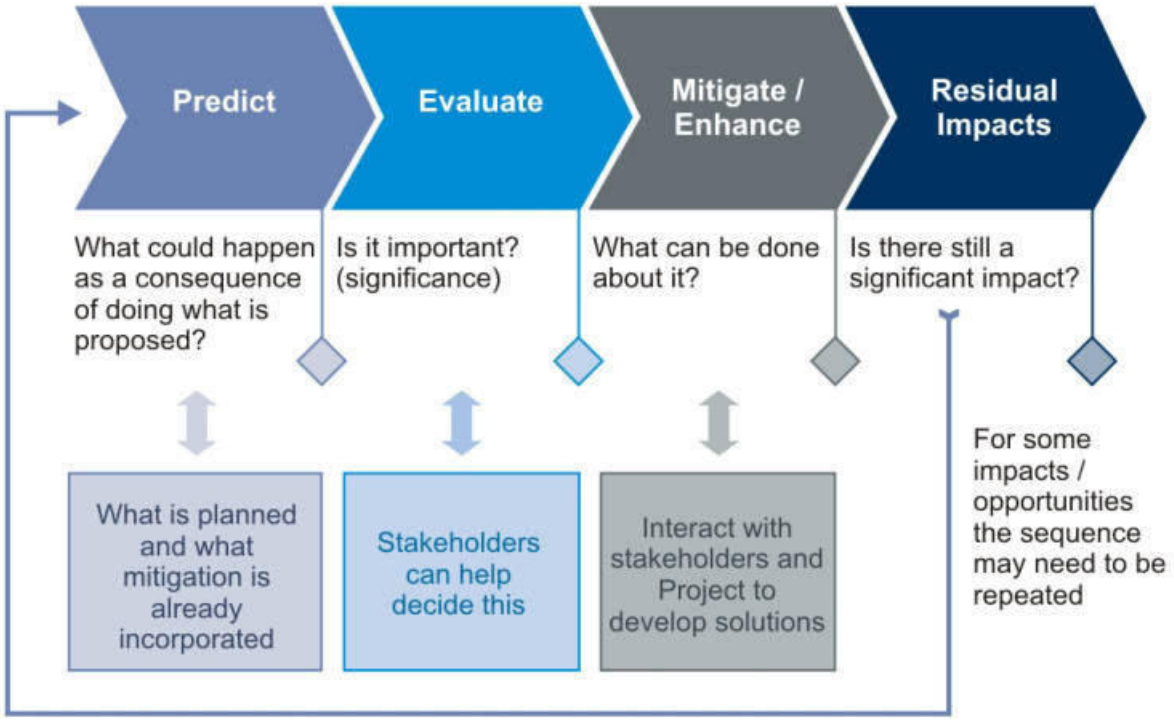
The baseline takes into account current conditions, as well as those changing conditions apparent in the Baseline and takes into consideration other developments within the Project area, which are underway or certain to be initiated in the near future. These developments are considered in the assessment of cumulative impacts and effects.

5.6 Impact Assessment Process

Impact identification and assessment starts with scoping and continues through the remainder of the ESIA Process. The principal ESIA steps are summarised in ***Figure 5.2*** and comprise:

- **Potential Impact Prediction**: to determine what could potentially happen to resources/receptors as a consequence of the Project and its associated activities;
- **Impact Evaluation**: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource/receptor;
- **Mitigation and Enhancement Measures**: to identify appropriate and justified measures to mitigate potential negative impacts and enhance potential positive impacts; and
- **Residual Impact Evaluation**: to evaluate the significance of potential impacts assuming effective implementation of mitigation and enhancement measures.

Figure 5.2: Overall Impact Assessment Process



Source: ERM, 2019

5.6.1 Impact Prediction

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified in Scoping, the impacts to the various resources/receptors are elaborated and evaluated. The diverse range of potential impacts considered in the ESIA process typically results in a wide range of prediction methods being used, including quantitative, semi-quantitative and qualitative techniques.

5.6.2 Impact Evaluation

Once the prediction of potential impacts is complete, each potential impact is described in terms of its various relevant characteristics (e.g., type, scale, duration, frequency, extent). The terminology and designations used to describe impact characteristics are shown in ***Table 5.1***.

Table 5.1: Impact Characteristics Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the potential impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The “reach” of the potential impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is potentially affected.	Temporary Short term Long term

Characteristic	Definition	Designations
Scale	The size of the potential impact (e.g., the size of the area with the potential to be damaged or impacted, the fraction of a resource that could potentially be lost or affected, etc.).	[no fixed designations; intended to be a numerical value or a qualitative description of "intensity"]
Frequency	A measure of the constancy or periodicity of the potential impact.	[no fixed designations; intended to be a numerical value or a qualitative description]

The definitions for the *type* designations are shown in ***Table 5.2***. Definitions for the other designations are resource/receptor-specific, and are discussed in the resource/receptor-specific impact assessment chapters presented later in this Report.

Table 5.2: Impact Type Definitions

Type	Definition
Direct	Potential impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Potential impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Potential impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (e.g., influx of workers resulting from the importation of a large Project workforce).

The above characteristics and definitions apply to planned and unplanned events. An additional characteristic that pertains only to unplanned events is *likelihood*. The *likelihood* of an unplanned event occurring is designated using a qualitative scale, as described in ***Table 5.3***.

Table 5.3: Definitions for Likelihood Designations

Likelihood	Definitions
Unlikely	The event is unlikely but may occur at some time during normal operating conditions
Possible	The event is likely to occur at some time during normal operating conditions
likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable)

Once impact characteristics are defined, the next step in the impact assessment phase is to assign each potential impact a 'magnitude'. Magnitude is typically a function of some combination (depending on the resource/receptor in question) of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood (for unplanned event).

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the potential impact. The magnitude designations themselves are universally consistent, but the definitions for these designations vary depending on the resource/receptor. The universal magnitude designations are:

- Positive;
- Negligible;

- Small;
- Medium; and
- Large.

In the case of a potential positive impact, no magnitude designation (aside from 'positive') is assigned. It is considered sufficient for the purpose of the ESIA to indicate that the Project is expected to result in a potential positive impact, without characterising the exact degree of positive change likely to occur.

In the case of potential impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised. However, the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation.

In addition to characterising the magnitude of impact, the other principal impact evaluation step is definition of the sensitivity/vulnerability/importance of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Other factors may also be considered, such as legal protection, government policy, stakeholder views and economic value. As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations vary on a resource/receptor basis.

The sensitivity/vulnerability/importance designations used herein for all resources/ receptors are:

- Low;
- Medium; and
- High.

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance can be assigned for each impact. Impact significance is designated using the matrix shown in ***Table 5.4***.

Table 5.4: Impact Significance

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

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor-specific considerations are factored into the assignment of magnitude and sensitivity/vulnerability/importance designations that enter into the matrix. ***Box 5.1*** provides a context for what the various impact significance ratings signify.

It is important to note that impact prediction and evaluation take into account any embedded controls (i.e., physical or procedural controls that are already planned as part of the Project design, regardless of the results of the ESIA Process). This avoids the situation where an impact is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls.

Box 5.1: Context of Impact Significances

An impact of **negligible** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of **minor** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/vulnerability/importance. In either case, the magnitude should be well within applicable standards.

An impact of **moderate** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its' effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of **major** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of ESIA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholder to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

5.6.3 Identification of Mitigation and Enhancement Measures

Once the significance of a potential impact has been characterised, the next step is to evaluate what mitigation and enhancement measures are warranted. For the purposes of this ESIA, ERM has adopted the following Mitigation Hierarchy:

- **Avoid at Source, Reduce at Source**: avoiding or reducing at source through the design of the Project (e.g., avoiding by siting or re-routing activity away from sensitive areas or reducing by restricting the working area or changing the time of the activity);
- **Abate on Site**: add something to the design to abate the impact (e.g., pollution control equipment, traffic controls, perimeter screening and landscaping);
- **Abate at Receptor**: if an impact cannot be abated on-site then control measures can be implemented off-site (e.g., noise barriers to reduce noise impact at a nearby residence or fencing to prevent animals straying onto the site);
- **Repair or Remedy**: some impacts involve unavoidable damage to a resource (e.g. agricultural land and forestry due to creating access, or materials storage areas) and these impacts can be addressed through repair, restoration or reinstatement measures; and
- **Compensate in Kind, Compensate Through Other Means**: where other mitigation approaches are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g., planting to replace damaged vegetation, financial compensation for damaged crops or providing community facilities for loss of fisheries access, recreation and amenity space).

The priority in mitigation is to first apply mitigation measures to the source of the potential impact (i.e., to avoid or reduce the magnitude of the potential impact from the associated Project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory

measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

5.6.4 Residual Impact Evaluation

Once mitigation and enhancement measures are declared, the next step in the ESIA Process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the implementation of the proposed mitigation and enhancement measures.

5.6.5 Cumulative Impact Assessment Process

According to IFC 2013, "Cumulative impacts (CI) are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones". According to the IFC (IFC 2013), the assessment and management of cumulative impacts is necessary when the Project and other developments under consideration could contribute to generating cumulative impacts on valued environmental and social component.

In order to gain an understanding of the projects overall contribution to impacts, a cumulative impact assessment (CIA) was undertaken. Whilst total cumulative impacts due to multiple projects within a given area should be identified within government-led spatial planning efforts, the Project owner needs to determine the degree to which it is contributing to these overall cumulative impacts. In this regard, the objectives of the CIA are twofold:

- Determine if the cumulative impacts caused by the Project and other existing or predictable future projects would threaten the sustainability of valuable environmental component (VEC) in the area; and
- Develop mitigation measures to prevent unacceptable conditions of VECs. The measures could include additional mitigation measures for Project and additional mitigation measures for other existing or predictable future projects in the area.

The ESIA and CIA are prepared based on similar logical framework, analytical process and tools. Unlike the ESIA that centers on the Project as a source of impacts, the CIA focuses on VECs under influence from different projects (***Figure 5.3***). In a CIA, the overall resulting condition of the VEC and its related viability are assessed.

This CIA closely follows the six (6) steps of the IFC Guidance (IFC 2013), as shown in ***Figure 5.4***.

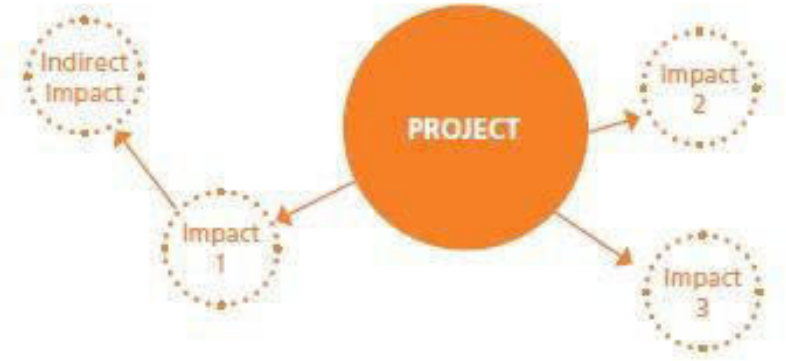
IFC Guidance takes into consideration the limitations that a private developer may face carrying out a CIA as part of an ESIA, or difficulties encountered in compiling such information. The limitations applicable to this CIA include:

- Incomplete information about other projects and activities (e.g. the information is not available in the public domain);
- Uncertainty with respect to the implementation of future projects; and

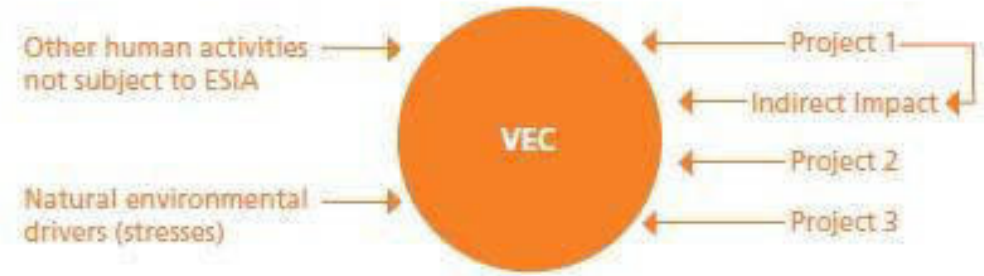
Difficulty in establishing thresholds or limits of acceptable change for VECs, and therefore the significance of cumulative impacts.

Figure 5.3: Comparing an ESIA and a CIA

ESIA: Project-Centered Perspective

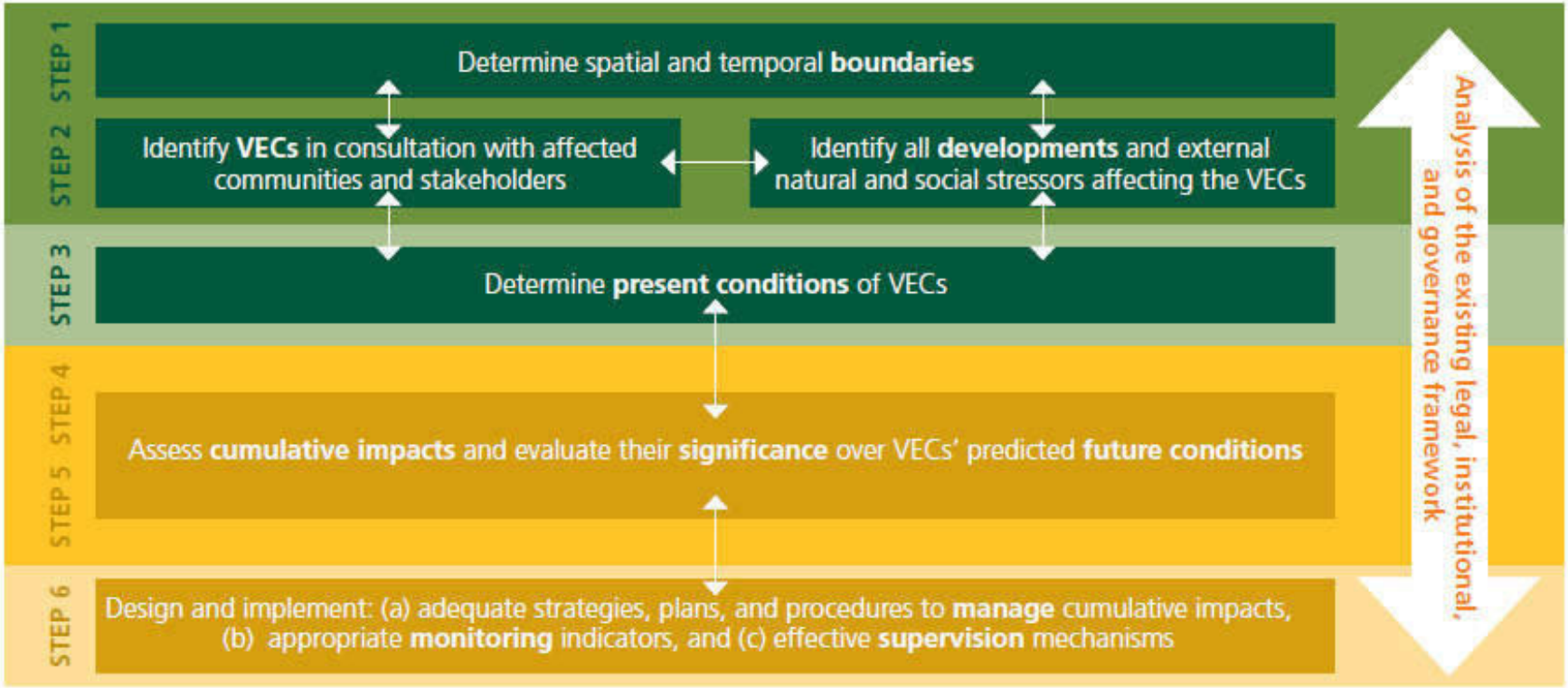


CIA: VEC-Centered Perspective



Source: IFC, 2013

Figure 5.4: Conceptual CIA Process



Source: IFC, 2013.

5.6.6 Management, Monitoring, and Audit

The final stage in the IA Process is the definition of the basic management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards/ guidelines; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

5.7 Risk Assessment for Unplanned Events

To evaluate potential impacts from unplanned events, a risk-based approach is used to define: 1) the most likely unplanned events leading to environmental, social and/or community health impacts; and 2) those unplanned events with the most significant potential environmental, social and/or community health impacts overall. Impact significance for unplanned events is therefore determined by evaluating the combination of likelihood and consequence.

5.7.1 Assess the Scale of Consequence

Indicative levels of consequence for potential impacts from unplanned events can be defined for the physical, biological, and social environment as provided in ***Table 5.5***.

Table 5.5: Indicative Levels of Consequence for Potential Impacts from Unplanned Events

	Incidental	Minor	Moderate	Major	Severe
Physical Environment	Impacts such as localised or short term effects or environmental media, meeting all environmental standards	Impacts such as widespread, short-term impacts to environmental media, meeting all environmental standards	Impacts such as widespread, long-term effects on environmental media, meeting all environmental standards	Impacts such as significant, widespread and persistent changes in environmental media OR Exceedance of environmental standards	Exceedance of environmental standards and fine/ prosecution
Biological Environment	Impacts such as localised or short term effects on habitat or species	Impacts such as localised, long term degradation of sensitive habitat or widespread, short-term impacts to habitat or species	Impacts such as localised but irreversible habitat loss or widespread, long-term effects on habitat or species	Impacts such as significant, widespread and persistent changes in habitat or species	Impacts such as persistent reduction in ecosystem function on a landscape scale or significant disruption of a sensitive species.
Social Environment	Slight, temporary, adverse impact on a few individuals	Temporary (<1 year), adverse impacts on community which are within international health standards	Adverse specific impacts on multiple individuals that can be restored in <1 year OR One or more injuries, not lost-work injuries.	Adverse long-term, multiple impacts at a community level, but restoration possible. OR One or more lost-work injuries to a member of the public including permanently disabling injuries.	Adverse long-term, varied and diverse impacts at a community level or higher – restoration unlikely. OR Fatalities of public.

5.7.2 Assess the Likelihood

For the purposes of assessment, the likelihood of an unplanned event occurring can be classified as follows:

1 - Remote, not known in the industry;

2 - Very unlikely, known of in the industry;

3 - Unlikely, may occur once or more in life of the Project;

4 - Likely, may occur once or twice per year;

5 - Expected, may occur more than twice per year.

5.7.3 Assess the Significance

The consequences and likelihood of potential unplanned events are combined to determine the overall impact significance using the risk matrix shown in ***Table 5.6***.

For potential impacts that are determined to have an impact significance of Moderate or Major, risk reduction measures are identified; these can include measures that reduce the likelihood of the event from occurring (i.e., preventive barriers), those that reduce the consequences on sensitive receptors/resources if the event were to occur (i.e. mitigation or recovery measures), and those that affect the likelihood and consequence.

Table 5.6: Risk Matrix for Potential Unplanned Events

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

6. STAKEHOLDER ENGAGEMENT

The section provides the stakeholder engagement and public consultation activities conducted during the EIA and Supplemental ESIA process until December 2021. It is also noted that these activities will be mentioned in a Stakeholder Engagement Plan (SEP).

6.1 Stakeholder Identification and Mapping

6.1.1 Stakeholder Identification

ADB defines 'stakeholders' as individuals or groups or institutions who can or are likely to (i) influence (promote, support, disrupt, or stop) the course of a program or project; and/or (ii) be affected (favourably or adversely) by the program or project.[17]

Stakeholder identification for the Project was initiated during preparation of the EIA and was further developed and refined during the ESIA process.

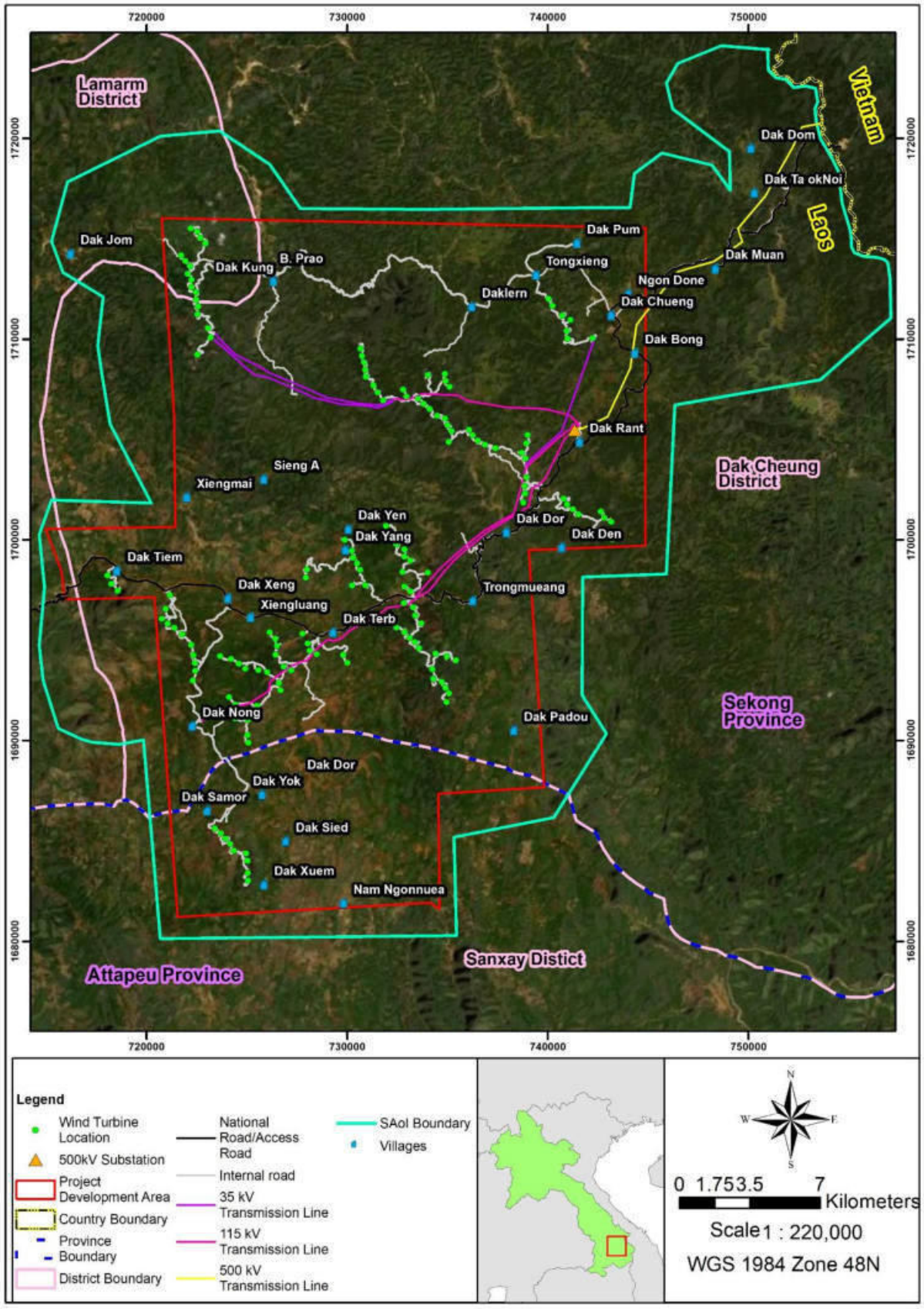
To aid the identification of stakeholders, the Project Social Area of Influence (PSAoI) was drawn taking into account areas of direct and indirect environmental and social influence (***Figure 6.1***). The following have been considered for the PSAoI:

- 27 villages located within the Project footprint (***Figure 6.1***).
- Villages located in surrounding areas of the Project footprint including but not limited to:
  - Dak Dom, Dak Ta-ok Noi, and Dak Muan villages as they will be affected by the Project 500 kv transmission line
  - Dak Jom village because their NTFPs collection area will be effected by the Project components.

The results of the preliminary stakeholder identification process are presented in ***Table 6.1***. The stakeholder mapping results are presented in ***Figure 6.2***. The stakeholder list as well as stakeholder analysis and mapping will continue to be revised according to the ongoing receipt of comments and input from stakeholders directed to the Project. This will be provided in the SEP.

[17] Guidance Note on Stakeholder Communication Strategy for Projects in South Asia

Figure 6.1: Social Area of Influence



Source: ERM/Innogreen, 2021

Table 6.1: Preliminary Identification of Project Stakeholders

Stakeholder Group	Interest and Role in the Project	Description and Relevant Stakeholders
Project Affected Persons (PAPs)		
Affected Population	Individuals, households and businesses that may be directly and indirectly impacted by construction and operation of the Project. The impacts may include: ■ Economic displacement (loss of agriculture land) due to Project land acquisition; ■ Noise and dust from construction activities; ■ Noise and shadow flicker impacts from the wind turbines; ■ Loss of forest resources; ■ Restricted access to natural resources and agricultural land; ■ Increased traffic risks and congestion; and ■ Increased demand on local infrastructure and public services due to influx of Project construction labours. Stakeholders may include, but are not limited to: ■ The villages, households, and individuals directly affected by Project construction and operation; ■ Individuals and households (including non-title holders) that will be directly affected by the land acquisition process for the Project. The Preliminary Land and Asset Survey conducted in November 2021 identified a total of 249 affected households, of which 136 are temporary affected and 110 are permanently affected; ■ People who make their livelihoods on land which will be directly affected by land acquisition of the Project; ■ Individuals and households that will have restricted access to natural resources due to the Project footprint. These stakeholders may include, for example, many in the villages who collect herbs, food, and firewood for livelihood; ■ People directly affected by the construction and operation of the ancillary facilities and workers' camps; ■ People directly affected by the construction and operation of the transmission line; ■ People directly affected by the construction and operation of the access road and internal roads; and	These include households in the following villages: **Dak Cheung District, Sekong Province** ■ 8 villages will be impacted by wind turbine facilities, transmission line facilities and access roads ○ Xiengluang, Dak Treb, Trongmueang, Dak Rant, Dak Kung, Sieng A, Dak Chueng, and Daklern ■ 6 villages will be impacted by wind turbine facilities and access roads ○ Dak Tiem, Dak Yang, Dak Yen, Dak Den, Dak Jom, and Tongxieng ■ 6 villages will be impacted by transmission line facilities ○ Dak Dor , Dak Muan, Dak Ta-ok Noi, Dak Dom, Dak Bong, and Ngon Don ■ 1 village will be impacted by access road only ○ Prao ■ 2 villages will be indirectly impacted ○ Dak Seng and Dak Pum **Sanxay District, Attapeu Province** ■ 4 villages will be impacted by wind farm facilities and access roads ○ Dak Samor, Dak Yok, Dak Xuem and Dak Padou ■ 1 village will be impacted by transmission line facilities and access roads ○ Dak Nong ■ 3 villages will be indirectly impacted ○ Dak Sied, Dak Dor and Nam Ngonneua ■ Individuals and households of nearby villages who may be make livelihood on affected lands and/or have restricted access to natural resources due to the Project footprint ■ Individuals and households who are located within and/or nearby to the PSAoI. These include: ○ Residents of Dak Cheung District, Sekong Province

Stakeholder Group	Interest and Role in the Project	Description and Relevant Stakeholders
	■ Those areas located within the Project's footprint or area of disturbance such as air or noise emission and shadow flicker.	○ Residents of Sanxay District, Attapeu Province
Cumulative Impacted Population	■ Individuals or groups located within the PSAoI, who many not be included in the affected population discussed above, however they may experience, for example, increased noise emissions, increased costs of living, and/or decreased forest resources due to the cumulative impact of neighbouring wind farm projects.	Individuals and organisations located within the Cumulative Area of Influence: ■ Residents of Dak Cheung District, Sekong Province ■ Residents of Sanxay District, Attapeu Province
Central, Provincial, District Government Agencies/Related Organisations		
Central and Provincial Government Agencies	■ Government agencies responsible for environmental approvals for the Project, and relevant Ministries responsible for making technical decisions and recommendations on the development of the project, ensuring that all technical, social, financial and legal requirements are strictly met. ■ Government agencies responsible for construction permits and licenses, land acquisition and resettlement, and other activities required for the Project development and operation.	**Key relevant agencies:** ■ Ministry of Natural Resources and Environment (MONRE). ■ Provincial Department of Natural Resources and Environment (PONRE) ■ Ministry of Energy and Mines ■ Ministry of Planning and Investment ■ Other relevant Ministries
District Administration Offices	■ Government agencies at the District level who are responsible for planning and implementation of the land acquisition and resettlement plan, construction licenses and permits. ■ Traditional leadership at district and village levels who represent the interest of the Potentially Affected People (PAPs) throughout Directly, Indirectly and Cumulatively Affected Population. ■ Have potential for the Project to utilise as an information disclosure channel.	Government offices at District level such as: ■ Dak Cheung District Administration Office ■ Sanxay District Administration Office ■ District Land Department ■ District Agriculture and Forestry Department ■ District Office of Natural Resources and Environment ■ Village leaders of the 31 directly affected villages (including 23 villages in Dakcheung District and 8 in Sanxay District)
Other Interested Parties		
NGOs and Community Groups	■ May have interest in the Project in the area of land acquisition and involuntary resettlement, environmental protection and human rights (such as cultural heritage, ethnic minorities/ indigenous peoples, biodiversity management, forced labour, etc.) ■ May be interested in the Project mitigation plan and development opportunities such as potential partners in the livelihood restoration programs, community health and safety awareness programs, etc.	■ Primarily community groups, but not limited to: ■ Youth Union ■ Lao Front for National Development ■ Lao Women Union ■ Lao Youths Revolutionary Union ■ World Wide Fund (WWF) ■ Human Rights Watch

Stakeholder Group	Interest and Role in the Project	Description and Relevant Stakeholders
Nearby Developments	■ Other developments in the Project's vicinity	■ 115 kV Transmission line of Nam Emoon Hydropower project. ■ Transmission line of Xekamarn 3 Hydropower ■ National road running from Dak Cheung District to Sanxay District ■ Mining projects
Educational and Training Institutions (Academia)	■ Those who may be interested in the Project mitigation plan and development opportunities, such as potential partners in the livelihood restoration programs, educational and training initiatives. ■ Have potential for the Project to utilise as an information disclosure channels.	■ Schools and training educations in in Sanxay District and Dak Cheung District ■ Ban Nam Ngon Neua
Health Institutions	■ Those who may be interested in the Project mitigation plan and development opportunities, such as potential partners in the livelihood restoration programs, community health and safety awareness programs, etc. ■ Have potential for the Project to utilise as an information disclosure channels.	■ Community Hospital of Dak Cheung District ■ Sanxay District Hospital ■ Xieng Luang Dispensary, Dak Dor Dispensary and Dak Run Dispensary in Dak Cheung District ■ Dak Samor Dispensary and Nam Ngon Neua Dispensary in Sanxay District
Elected Officials and Local Politicians	■ Interested in priority development project in their electorates. ■ Represent the interest of the PAPs.	■ Village heads of all 31 affected villages ■ District heads of Dakchueng and Sanxay Districts ■ Governor of Sekong and Attapeu Provinces
Local Services and Businesses	■ May be interested in the Project mitigation plan and development opportunities such as Project procurement programs, business training opportunities (i.e., accommodation providers, service providers).	■ Retail shops ■ Industrial factories such as rice mill, automobile repair shops, drinking water factory, ice-making factory and furniture factory
Media	■ May have an interest in the priority development projects in Lao PDR, particularly in the area of human rights – risks and impacts	■ Local media ■ Social media such as Facebook
Funding Partners/ Advisory Agencies	■ Provide funding for the costs associated with the technical advisory and program management of the Project. ■ Ensuring the Project manage environmental and social risks and impacts according to plans through a due diligence process.	■ Equator Principles Financial Institutions (EPFIs) ■ Asian Development Bank (ADB)
Foreign Government Multilateral Agencies	■ May be interested in the priority development projects, particularly in the area of human rights – risks and impacts.	■ Government of Vietnam ■ International Union for Conservation of Nature (IUCN)

Stakeholder Group	Interest and Role in the Project	Description and Relevant Stakeholders
		■ World Health Organisation (WHO) ■ International Labour Organization (ILO) ■ The United Nations Educational, Scientific and Cultural Organization (UNESCO)
Internal Stakeholders	■ Include but not limited to: supervision consultants, suppliers, Construction Contractors and Contractor's workforce, sub-contractors, etc. who take part in the planning approval, construction, and operation of the Project, who are responsible for fulfilling the contractual obligations to ensure overall success of the Project.	■ IEAD ■ EPC Contractor ■ Consultants ■

6.1.2 Stakeholder Mapping

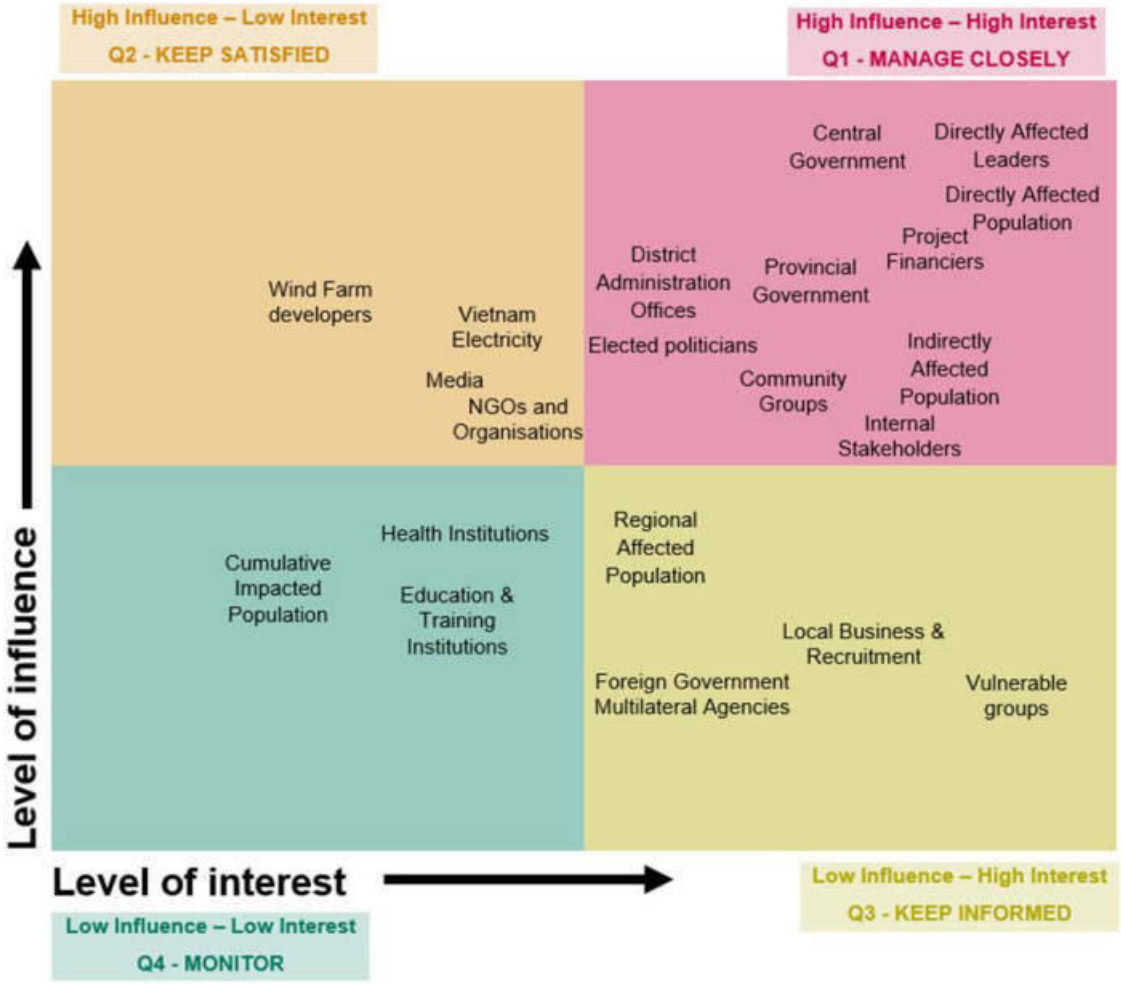
A stakeholder mapping exercise was undertaken to identify and prioritise the Project stakeholders as well as identify issues likely to be of concern to each of the different stakeholders. The matrix presented in ***Figure 6.2*** categorises stakeholders based on their interest in and influence over the Project.

- **Influence:** Refers to the power stakeholders have over a project, including the ability to affect or influence decisions and facilitate its implementation.
- **Interest:** Refers to the priority given by the company to considering and accommodating the stakeholder's needs and interests.

The outcome helps determine the level of engagement and the types of tools that will be used to consult with different stakeholders/stakeholder groups. The mapping exercise categorises stakeholders as follows:

- The stakeholders that appear in the top right quadrant (i.e. in Quadrant 1) are those that need to be managed closely (i.e. the stakeholders that need to be proactively engaged on a regular basis and engagement efforts should be focused on this group). This is because these are the stakeholders that are most interested in the Project and have the potential to influence its outcome (i.e. the ability of the Project to go ahead).
- The stakeholders that appear in Quadrant 2 and Quadrant 3 need to be kept informed – i.e. provided information and consulted on issues of interest to the stakeholders.
- Stakeholders in Quadrant 4 need to be monitored – i.e. informed of key Project aspects. It is important to track if their level of interest or influence changes.

Figure 6.2: Preliminary Stakeholder Mapping Results



Different stakeholder engagement strategies are employed based on the categorisation of the stakeholders; whereby stakeholders with higher levels of influence and interest will be engaged to a greater extent (***Table 6.2***).

Table 6.2: Stakeholder Engagement Strategies

Q4 - Monitor	Q3 - Keep Informed	Q2 - Keep Satisfied	Q1 - Manage Closely
■ Inform via public communications (for example through the Project website and press communications) ■ Respond to direct requests for further information and conduct engagement if the stakeholders ask to be consulted ■ Monitor for feedback.	■ Make use of interest by informing in low risk areas ■ Inform and consult in interest areas ■ Respond to direct requests for further information.	■ Keep engaged and consult regularly ■ Seek to obtain their support and technical guidance, where relevant ■ Be proactive in communication, provide information and seek views at regular intervals.	■ Inform and consult in interest areas by formal communications such as meetings, letters, written documents ■ Involve in governance and decision-making, as appropriate ■ Maintain ongoing engagement and work collaborative on areas of mutual interest.

The stakeholder list as well as stakeholder analysis and mapping will continue to be revised and incorporated into the SEP revisions according to the ongoing receipt of comments and input from local, national, and international stakeholders directed to the Project.

6.2 Local EIA Consultation

Stakeholder engagement activities were undertaken as part of the local EIA report preparation (as detailed in *Chapter 7— Public Consultation and Participation*). Stakeholder engagement activities aimed to inform and receive feedback on the Project, understand and explain the Project's potential social and environmental impacts, and provide updates on the progress.

Project affected people and relevant participants such as governmental organizations and relevant Ministries were included in the stakeholder engagement activities. Such activities included consultation meetings at the village level (November 2014 and September 2020), district level (May 2016), and a meeting with technical personnel prior to endorsement of the EIA (July 2018).

Local EIA stakeholder engagement is summarised in ***Table 6.3*** and are detailed in ***Appendix I*** of this ESIA Report.

Key stakeholder issues and concerns raised and feedback received during the consultation included:

- The Project should provide funding and assistance to improve water supply system (e.g. gravity-fed) to the villages and irrigation systems for rice paddies.
- The Project should help to improve the access road to the village and within village and the access roads to production land e.g. rice, coffee, and cassava plantations.
- The Project should provide funding and assistance to establish and improve school facilities, supplies and personnel.
- The Project should provide funding and assistance to establish and improve dispensary and healthcare centres in the villages.
- The Project should provide funding assistance to establish a village administrative office.
- People in the potentially affected villages should be able to benefit (i.e. have access to electricity generated by the Project).
- The Project should provide reasonable and fair compensation to those households affected by land acquisition.
- The Project should provide assistance to poor families in the affected villages. In addition, the Project should provide assistance for improvement of vocations in the villages and offer job opportunities for the village members to work on the Project.
- Request for the Project to provide financial support to the villages/ village fund/ monthly tax to the villages.

Table 6.3: Summary of Local EIA Stakeholder Engagement

Date	Objectives	Location	Participants	Outcomes
7-26 Sep 2020	Disseminate of information related to change of location and boundaries of wind turbine towers, benefits and potential impacts of the Project. In addition, conducted consultation at village level	18 villages located in the Project area	Direct and indirect PAPs	Consult with PAPs on the Project development and obtain opinions, suggestions and concerns of affected households and communities.
July 2018	Consultation Meeting at Technical Level to endorse the revised EIA report	Meeting room of the Provincial DONRE if Sekong Province	General Director of DONRE Policy, Deputy Director of Provincial DONRE of Sekong and Attapeu Provinces, and participants from other agencies of central, provincial and district levels, totaling to 63 participants	Consultation with related governmental agencies on technical aspects of the Project.
May 2016	Consultation at district level	District Administration Office of Dak Cheung District	Deputy Chief of Dak Cheung District and Sanxay District, Deputy Provincial of Department of Natural Resources and Environmental of Sekong Province and Attapeu provinces, and other participants, totaling to 70 persons	Consultation with district heads of the affected areas and obtain opinions, suggestions and concerns on the Project.
12-21 Nov 2014	Dissemination of information and consultation at village level	16 villages located in the Project area and nearby areas	Direct and indirect PAPs	Consult with PAPs on the Project development and obtain opinions, suggestions and concerns of affected households and communities.

Source: EIA dated September 2020

6.3 Supplementary ESIA Consultation and Disclosure

Consultation for the supplementary ESIA was conducted in November and December 2021 with a focus on:

- Disclosing updated Project information and development status to the 3 potentially affected communities and other stakeholders including the supplementary ESIA studies, the risks, impacts, and opportunities for the Project.
- Providing the affected communities and stakeholders with opportunities to express their views on Project risks, impacts, and mitigation measures.
- Soliciting stakeholders' ideas, opinions, and recommendations on various alternatives.
- Assessing the level of stakeholder interest and support for the Project and enable stakeholder views to be taken into account in Project design and environmental and social mitigation measures as well as development of benefits and opportunities.
- Undertaking extensive stakeholder engagement for land acquisition and resettlement

Consultation was planned to be carried out in a village meeting format that was appropriate to the cultural norm of the potentially affected communities. Consultation was also planned to be provided as part of focus group discussions (FGDs) with women, youth, and ethnic community members in the PAPs. However, due to the Covid-19 pandemic, government restrictions were imposed on the provinces where the Project is located, for the majority of the duration in the second half of 2021. As such, the Project was not able to undertake consultation and FGD activities. The local villagers were also hesitant to engage in group activities due to the risk of spreading Covid-19. The Project team was apprehensive of potential risks associated with the undertaking of the consultation plan, so a modification to the plan was implemented with an aim to fill the consultation gaps while respecting the needs to have a Covid-19-safe field operation during the pandemic.

Due to the Covid-19 restrictions, modification of the consultation plan consisted of:

- Consultation with individuals during the household socio-economic surveys and census of the affected population;
- Consultation during key informant interviews with village leaders, teachers, healthcare workers, religious leaders, and others;
- Consultation with representatives of women groups, youth groups, livelihood groups, ethnic minority groups; and
- A total of 345 people were consulted during the process through FGDs and Key Informant Interview (KIIs), in which 181 were women, 76 were ethnic group representatives and 75 were youth representatives.

A summary of supplementary ESIA consultation is provided in ***Table 6.4*** and further detailed in ***Appendix H and J*** of this ESIA Report.

Table 6.4: Summary of Supplemental ESIA Stakeholder Engagement

Date	Objectives	Participants	Location	Outcomes
06 Oct - 23 Nov 2021	■ Dissemination of information ■ Consultation at village level (through FGDs and KIIs) ■ Social baseline data collection through socio-economic HH survey and FGDs and KIIs	Direct and indirect PAPs	23 villages located in Dak Cheung District, Sekong Province	■ Collect socio-economic data to update the social baseline ■ Consult with PAPs on the Project development and obtain opinions, suggestions and concerns of affected households and communities.
	○ KIIs with local authorities	23 villages heads of the affected villages		
	○ FGDs with livelihood groups	69 farmers, livestock, laborers, NTFPs collection		
	○ FGD with women groups	82 women		
	○ FGD with ethnic groups	56 ethnic group representatives (41 Triang; 4 Katu; 9 Yae; and 2 Lao)		
	○ FGD with youth groups	57 youth		
	○ KIIs with healthcare personnel	9 healthcare personnel		
06 - 10 Dec 2021	■ Dissemination of information ■ Consultation at village level (through FGDs and KIIs) ■ Social baseline data collection through socio-economic HH survey and FGDs and KIIs	Direct and indirect PAPs	8 villages located in Sanxay District, Attapeu Province	■ Collect socio-economic data to update the social baseline ■ Consult with PAPs on the Project development and obtain opinions, suggestions and concerns of affected households and communities.
	○ KIIs with local authorities	8 villages heads of the affected villages		
	○ FGDs with livelihood groups	20 farmers, livestock, laborers and NTFPs collection		
	○ FGD with women groups	17 women		
	○ FGD with ethnic groups	20 ethnic group representatives (17 Triang and 3 Ar Luk)		
	○ FGD with youth groups	18 youth		
	○ KIIs with healthcare personnel	3 healthcare personnel		

Source: FGDs and KIIs undertaken by Innogreen in November and December 2021

Key stakeholder issues and concerns raised and feedback received during the consultation include are included in ***Table 6.5***.

Table 6.5: Key Stakeholder Concerns and Relevance for ESIA

Stakeholder Concern	Relevant ESIA Considerations
The Project should minimise impacts to sensitive receptors and houses and paddy field as much as possible.	The impact assessment including information on mitigation measures for the social receptors is provided in ***Section 8.5*** of the ESIA Report.
The Project development will impact the cultivation land, particularly rice paddy field as suitable land for rice cultivation is highly limited due to mountainous terrain of the region.	Impacts to livelihoods and land use, including rice paddies, is included in ***Section 8.5.3*** of the ESIA Report. This includes proposed mitigation measures.
The Project should ensure that there will be no encroachment into villagers' land.	Land and economic displacement is assessed in ***Section 8.5.3*** of the ESIA Report. This includes proposed mitigation measures. The Project will ensure all required processes for land acquisition are conducted in conjunction with relevant stakeholders.
Concern about nuisance from noise from wind turbines during operation.	Noise impacts (including from turbines) are assessed in ***Section 8.3.7*** of the ESIA Report. This includes proposed mitigation measures.
Concern about nuisance from shadow flicker and negative impacts on agricultural productivity.	Shadow flicker impacts are assessed in ***Section 8.3.10*** of the ESIA Report. This includes proposed mitigation measures.
Concern that the Project development may impact cemeteries of the village.	Impacts to cemeteries and other cultural heritage are assessed in ***Section 8.5.8*** of the ESIA Report. This includes proposed mitigation measures.
Some people expressed that they cannot articulate their concerns as they do not have sufficient information about the Project and its potential impacts	Information dissemination will be considered in the ESIA and SEP. A SEP will be prepared for the Project including future and on-going engagement required to ensure stakeholders are provided sufficient information on the potential impacts.
Concerns about unfair compensation for those impacted by land acquisition of the Project, and there will be no replacement land for cultivation and animal husbandry and therefore people will lose their main source of livelihood.	Impacts and processes for land acquisition are provided in ***Section 8.5.3*** of the ESIA Report. Note that this is based on preliminary land and asset registration undertaken by Innogreen in November and December 2021.
Concerns around safety of life and property and livestock of households nearby the wind towers and safety of those that conduct agricultural activities under the transmission line.	Impacts to community health and safety are assessed in ***Section 8.5.4*** of the ESIA Report. This includes proposed mitigation measures.
Prior to commencement of the Project construction, the village heads should be informed.	Village heads will be informed prior to construction, this commitment is included in ***Section 9*** (ESMP) of the ESIA Report.
The people in the affected villages were not sure if they can use electricity generated by the Project.	Reliable and affordable electricity will be provided to the affected villages. Priority will be given to the households affected by the Project's land acquisition, then poor households within the Project's affected communities, and finally the entire the affected villages if possible. Refer to ***Section 8.5.2*** for more details.
During construction and operation of the Project, there will be increased influx of workers and people from outside to the villages. There are concerns that these people may bring nuisances to the villages and increased risks of particularly of vulnerable populations (e.g. children, women) being trafficked.	Impacts from worker influx are assessed in ***Section 8.5.5*** of the ESIA Report. This includes proposed mitigation measures.

Stakeholder Concern	Relevant ESIA Considerations
Concerns about the Project's impact on landslides and impacts to forest resources as people are highly dependent on NTFPs collection from the forests.	Impacts from unplanned events (including those impacts as a consequence of natural hazards) are assessed in ***Section 8.6.3*** of the ESIA Report. This includes proposed mitigation measures. Impacts on communities livelihoods associated with NTFPs are assessed in ***Section 8.5.3*** of the ESIA Report. This includes proposed mitigation measures.

In addition to the main concerns from the people, the stakeholders engaged in FGDs and KIIs also provided suggestions to the Project which reflect communities' needs:

- The Project should provide support and assistance to improve agriculture and livestock to increase productivity.
- The Project to provide support to improve and enhance coffee plantations and coffee market linkage, coffee initiatives to promote coffee product development, factory and store for coffee products.
- The Project should provide electricity for those households that currently do not have access to the grid and public infrastructure (e.g. schools, healthcare centres) should also have access to electricity from the Project.
- The Project should help improve trading of agricultural products such as coffee, rice and fruits with the market and create road connection to the markets.
- The Project should provide assistance to improve health facilities.
- The Project should provide assistance to improve education such as build school facilities and provide school supplies.
- The Project should provide assistance to poor households.
- The Project should have programs to improve nutrition and food sufficiency of the villages.
- The Project should improve infrastructure in the villages including water supply system, irrigation and telephone signal.
- The Project should create new employment opportunities for the villages such as recruit local labours to work in the Project development.
- The Project should provide training opportunities for youth in the affected villages as this will help them in accessing job opportunities.

6.4 Local Perception and Understanding about the Project

The general opinions of stakeholders engaged in FGDs and KIIs show that the majority of the people agree with the development of the Project. This is because they perceive various benefits associated with the Project, particularly economic opportunities. They believe that the Project will create more job opportunities for the people in the villages, new developments that will come with Project development such as improved road connections and other facilities, the opportunity to increase tourism due to the wind farm being a new tourist attraction.

7. ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

7.1 Introduction

This chapter summarizes the existing physical (***Section 7.3***), biological (***Section 7.4***) and social (***Section 7.5***) conditions in the Area of Influence (AOI), focusing on the resources/receptors that may be impacted by the Project. Information in this chapter is based on studies undertaken by the local EIA (Innogreen & Greener Consultant, 2020), a desktop review of publicly available information, and the additional noise, landscape and visual, biodiversity, and social baseline studies undertaken in 2021 to 2022 by Innogreen, with ERM's guidance, during preparation of this ESIA.

7.2 Defining the Study Limits

7.2.1 Project Area

The Project area refers to the land that is used for Project facilities and activities across all project phases. This includes land being used on both a permanent and temporary basis. The full description of Project facilities and activities is presented in ***Section 3.3***, ***Section 3.6***, and summarised in ***Figure 7.1***. This includes the wind farm site boundary, the 22 km transmission line, and the access roads within the wind farm site boundary.

7.2.2 Area of Influence

Under the ADB SPS, the Area of Influence (AoI) encompasses:

"*(i) the primary project site(s) and related facilities that the borrower/client (including its contractors) develops or controls, such as power transmission corridors, pipelines, canals, tunnels, access roads, borrow pits and disposal areas, and construction camps;*

(ii) associated facilities that are not funded as part of the project (funding may be provided separately by the borrower/client or by third parties), and whose viability and existence depend exclusively on the project and whose goods or services are essential for successful operation of the project;

(iii) areas and communities potentially affected by cumulative impacts from further planned development of the project, other sources of similar impacts in the geographical area, any existing project or condition, and other project-related developments that are realistically defined at the time the assessment is undertaken;

(iv) areas and communities potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location."

This Project's AoI includes the following:

- The wind farm area (concession area), internal access roads, and transmission line route to the Vietnam border;
- The distribution of potential sensitive shadow flicker receptors, i.e. 13 clusters of properties/buildings across seven villages, based on a desktop analysis of local settings, and preliminary modelling of shadow flicker to understand potential receptor distribution in the vicinity of the wind turbines;
- The distribution of potential sensitive noise receptors within 2 km from any wind turbine, which has been selected based on good practice considerations[18];
- 23 villages in Dak Cheung district of Sekong province, and 8 villages in Sanxay district of Attapeu province affected by permanent land acquisition, permanent land use restrictions, temporary access agreements, and/or impacts to livelihoods and community health, safety and security;

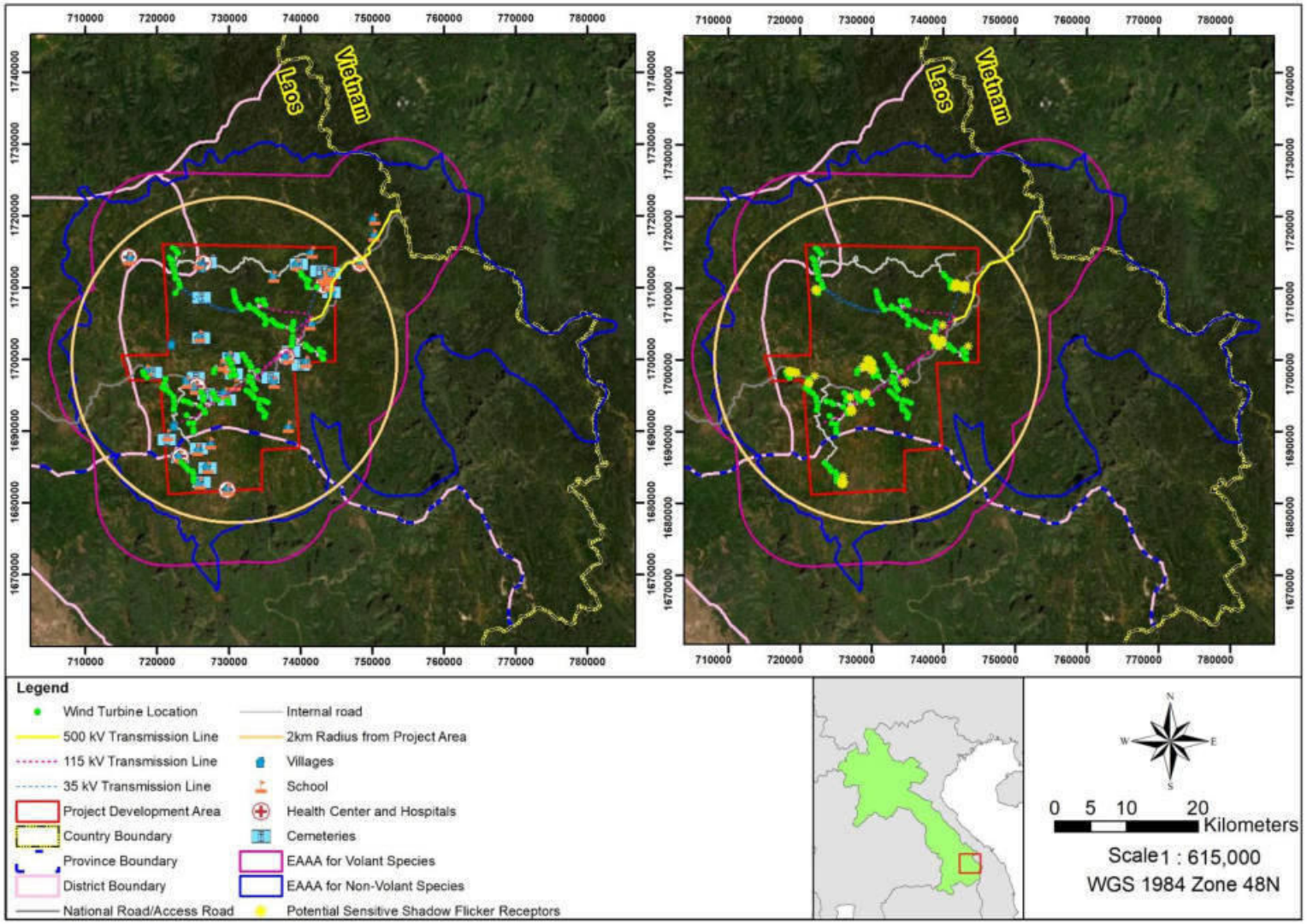
[18] Information provided in guidelines such as the World Bank Group's Environmental, Health and Safety (EHS) Guidelines for Wind Energy (IFC, 2015) was considered when delineating the Project's AoI.

- The administrative boundaries of Dak Cheung and Sanxay districts as representative of all areas that could be indirectly affected by changes in ecosystem services, community health, or linked to by local cultural heritage; and
- The Ecologically Appropriate Area of Analyses (EAAAs) which were delineated to account for species and/or ecosystems that regularly occur in the general area that may be affected by the Project. Two EAAAs were identified for volant (flying) species, and non-volant (non-flying) species, respectively. The approach taken to delineate the EAAA boundaries is presented in Section ***2*** of ***Appendix G***. The Project's AoI is presented in ***Figure 7.1***.

7.2.3 Study Area

The study area is defined to ensure that the baseline is adequately characterised to facilitate understanding of the potential interactions between the Project and resources/receptors within the AoI. The Project's study area encompasses both the Project area and AoI as described in ***Section 7.2.1*** and ***Section 7.2.2***, and are clearly defined for each resource/receptor in subsequent sections, ***Section 7.3***, ***Section 7.4*** and ***Section 7.5.***

Figure 7.1: The Project's Area of Influence (AoI)



7.3 Physical Environment Baseline

7.3.1 Introduction

This section provides an overview of the physical environment baseline conditions within the Project Study Area, including topography, geology and soil, climate and meteorology, air quality, noise, surface water quality, land cover, landscape values and visual amenity, and natural hazards.

Some information in this section is from baseline studies undertaken in 2021 by Innogreen, including noise (***Appendix B***), surface water (***Appendix C***), landscape values, and visual amenity (***Appendix D***).

Other information is based on studies undertaken from the local EIA, and published and publicly available information, including topography, geology and soil, climate and meteorology, air quality, wind speed monitoring, and natural hazards.

7.3.2 Topography

The Project is located in Dak Cheung District of Sekong Province and Sanxay District of Attapeu Province. Dak Cheung District is located in the eastern side of Sekong Province and has a total area of 2,732 km^2 (34.64% of the total provincial area), with the average elevation of approximately 1,200 m above sea level (the lowest point is 529 m and the highest point is 1,397 m above the sea level). Dak Cheung District is adjacent to Kaleum District in the north, Sanxay District of Attapeu Province in the south, Tai Yang and Nam Yang of Quang Nam Province and Dak Lai of Kon Tum Province of Vietnam in the east and, Lamarm District of Sekong Province in the west.

Generally, the topography comprises hills and high steep mountains (high mountainous area covers 95% and hill area covers 5%). The hills and mountains have complex features that are separated by numerous rivers and streams.

Sanxay District is located in the eastern side of Attapeu Province and has a total land area of 3.648 km^2. Sanxay District is adjacent to Dak Cheung District and Lamarm District of Sekong Province in the north, Phouvong District in the south, Dak Lai, Kon Tum Province of Vietnam in the east, and Saysettha District in the west. Sanxay District is divided into two types of areas, with 5% consisting of plain areas and 95% with high mountain areas. The elevation in this District ranges from 200 m to 1,600 m above sea level and has approximately 50% forest coverage of the total area.

The Project Area is mostly on the slopes of hills and high mountainous area, the elevation ranges from about 1,000 – 1,200 m above sea level (***Figure 7.2***).

Figure 7.2: Topography of the Project Area

7.3.3 Geology and Soil

According to the soil survey result and classification of agricultural and forest areas in Dak Cheung District, Sekong Province (2020), six soil groups and nine types of soil based on the original rocks, condition of the location, identified layer, and identified characteristics of the soils that is described as follows:

- The area is primarily composed of heavy clay, clay loam, and loamy sand.
- The depth of the soil layer is mostly comprised of very deep soil layer (D) > 100 cm from the soil surface, the moderately deep soil layer (M) between 75-100 cm, shallow soil layer (S) between 30-50 cm, and thin soil layer (T) between 50-75 cm from the soil surface.

Soil in Sanxay District of Attapeu Province is divided into six soil groups that is classified into 13 types of soil based on the original rocks, condition of the location, identified layer, and identified characteristics of the soils that is described as follows:

- The soil areas are primarily composed of clay loam, hard clay and loamy sand.

- The depth of the soil layer is mostly comprised of very deep soil layer (D) > 100 cm from the soil surface; next is the shallow soil layer between 30 and 50 cm and the smallest is the thin soil layer between 50 and 75 cm from the soil surface.

It is noted that soil sampling was not undertaken as part of the baseline because no significant soil impacts from Project activities were expected; however, soil monitoring is required to be conducted prior to construction commencement for the POPs (refer to ***Section 8.3.3*** and ***Section 9.8*** for pre-construction soil monitoring requirements).

7.3.4 Climate and Meteorology

The weather condition of Dak Cheung District and Sanxay District is mostly cold and with light drizzling rain over almost the entire year. The rainy season is between March and July, whereas the dry season runs from August to October. Over the past five years, a slight change in the temperature has been observed, with an increase of about 1-2 degrees Celsius (EIA, 2020).

7.3.4.1 Temperature

Based on meteorological data from Meteorology Station of Dak Cheung District – the nearest station to the Project, the average annual temperature in 2015 – 2019 is between 20.1 and 21.3 °C (***Table 7.1***). The maximum average temperature was 25.6°C in October 2016, and the minimum average temperature is 14.1 °C in January 2015. Dak Cheung District is situated in high mountain area and is influenced by the monsoon winds. This results in high water vapour and humidity.

Table 7.1: Average Temperature from the Meteorology Station

Year/Month	Average Temperature (°C)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**
2015	14.1	17.3	20.9	22.6	23.5	22.8	21.3	22.8	22.4	21.1	20.1	18.7	20.6
2016	18.6	16.5	20.6	24.0	23.1	22.8	22.4	22.5	22.7	25.6	19.9	16.6	21.3
2017	17.5	17.4	20.4	22.3	22.7	23.0	21.6	22.8	23.1	20.4	18.7	15.9	20.5
2018	16.7	16.8	19.1	21.4	22.7	22.0	21.3	21.1	22.7	20.1	19.8	18	20.1
2019	16.8	20.9	22.7	23.6	23.5	23.9	22.3	21.6	21.3	20.9	18.3	16.1	21.0
Min	**14.1**	**16.5**	**19.1**	**21.4**	**22.7**	**22.0**	**21.3**	**21.1**	**21.3**	**20.1**	**18.3**	**15.9**	**20.1**
Max	**18.6**	**20.9**	**22.7**	**24.0**	**23.5**	**23.9**	**22.4**	**22.8**	**23.1**	**25.6**	**20.1**	**18.7**	**21.3**

Source: Meteorology Station of Dak Cheung District

7.3.4.2 Rainfall

Based on rainfall data from the Meteorology Station of Dak Cheung District, the nearest station to the Project, the total annual rainfall from 2015-2019 ranged from 1,135-1,796 mm (***Table 7.2***).The maximum annual rainfall was 1,796 mm (in 2018) and the minimum annual rainfall was 1,135 mm (in 2015). The maximum rainfall recorded was 371.6 mm in September 2019. The minimum annual rainfall was 0 mm in March 2016 and February 2019. The months with the heaviest precipitation in 2015-2019 are May to November.

Table 7.2: Annual Rainfall from the Meteorology Station

Year/Month	Annual Rainfall (mm)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
2015	17.2	45.5	34.8	110.8	70.9	219.4	156.4	139.2	170.9	88.5	74.3	6.8	1,135

Year/Month	Annual Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2016	31.1	1.5	0	64.1	241.7	191.1	226.6	173.6	320.6	174.9	196	117.5	1,739
2017	53.4	29.7	40.3	62.8	160	83.2	296.5	71.8	120.9	200.3	306.1	64.4	1,489
2018	44	19.8	140.4	155.7	253	166.7	291.1	284.7	263.4	63.1	32.1	81.9	1,796
2019	30.3	0	57.9	142.8	275.2	128.2	140.4	361.4	371.6	110.9	89.5	14.1	1,722
Min	**17.2**	**0**	**0**	**62.8**	**70.9**	**83.2**	**140.4**	**71.8**	**120.9**	**63.1**	**32.1**	**6.8**	**1,135**
Max	**53.4**	**45.5**	**140.4**	**155.7**	**275.2**	**219.4**	**296.5**	**361.4**	**371.6**	**200.3**	**306.1**	**117.5**	**1,796**

Source: Meteorology Station of Dak Cheung District

7.3.4.3 Humidity

The Project is located in a mountainous area that is covered mostly with forests. The weather condition is influenced by tropical winds from Vietnam that result in high humidity during the morning and cloud cover during the evening, along with evaporation along the mountain ridges.

7.3.4.4 Wind Speed

Wind speed was measured by IEAD between 2012 and 2021. Wind measurement masts with a length of 110 m were installed and the data was recorded using Second Wind Nomad 2, Wind Sensor P2546A, and Vector w200P. The monthly wind speed and direction are shown in ***Table 7.3***. The average wind speed for 2012-2021 was 6.474 m/s, the maximum average wind speed was 11.069 m/s; recorded in December, and the minimum average wind speed was 4.099 m/s; recorded in May.

Table 7.3: Average Wind Speed Measurement in the Project Area for 2012-2019

Months	Wind speed at 110 m (m/s)	Direction (degree)
January	8.458	62.7
February	7.760	61.7
March	5.907	70.5
April	5.702	75.9
May	4.099	210.0
June	5.137	216.3
July	5.338	239.9
August	5.473	232.6
September	4.382	226.2
October	7.160	61.0
November	9.595	53.6
December	11.069	59.1
Average	**6.474**	**65.1**

Source: Impact Energy Asia Development Limited

7.3.5 Air Quality

Based on the local EIA (EIA, 2020), air quality surveys were undertaken for three continuous days from 17-19 September 2020 by Innogreen, in collaboration with Phanthamit Analytical Lab Co., Ltd. The sampling locations are as follows (and shown in ***Figure 7.3***):

- A1: Ban Xiengluang, Dak Cheung District, Sekong Province (72°43'87N, 16°96'54.1E (UTM WGS 1984 Zone 48N)); and
- A2: Ban Dak Run, Dak Cheung District, Sekong Province (741488N, 1704935E (UTM WGS 1984 Zone 48N)).

Two air monitoring locations have been selected given that the Project is located within remote areas and it is assumed that the air parameters (TSP, PM_{10}, PM_{2}.5, CO, SO_2, NO_2) will be relatively low and homogenous across the site. There is limited industrial or anthropogenic inputs in the AoI that would lead to variations in air quality. Based on the nature and scale of the Project, impacts from air emission are considered of low significance.

The parameters were based on the national environmental standards of 2017 that include particulate matter 2.5 microns in size (PM-2.5), particulate matter not exceeding 10 microns (PM-10), total suspended particulates (TSP), carbon monoxide (CO), sulphur dioxide ambient air (SO_2), and nitrogen dioxide ambient air (NO_2).

Air monitoring results from the local EIA (EIA, 2020) are presented in ***Table 7.4***. The air quality monitoring data showed that all parameters were within Laos regulations. This indicates that the ambient air quality within and around the Project area is in good condition.

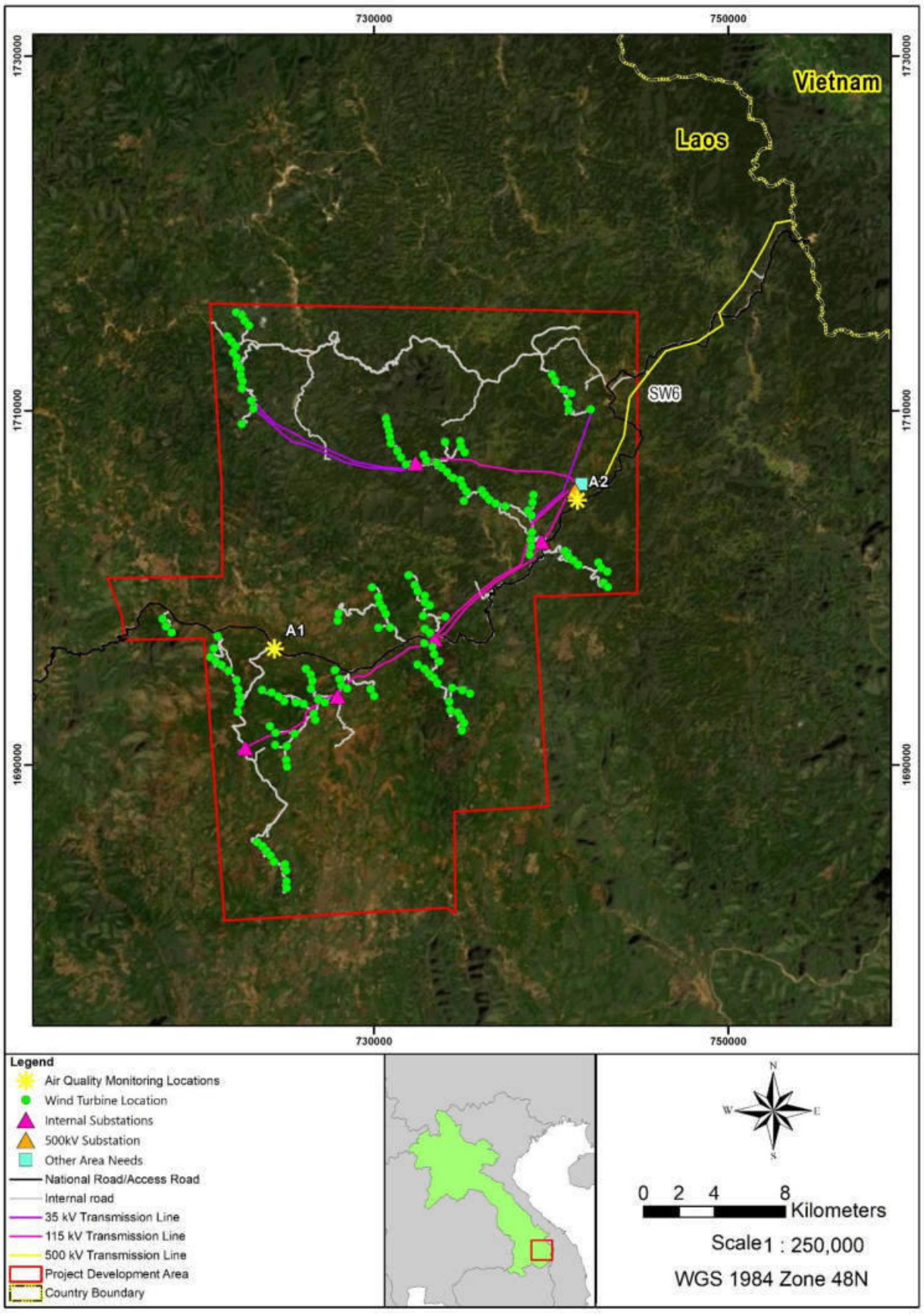
Table 7.4: Air Quality Monitoring Result

No.	Parameters	Unit	Monitoring Result						Standard[1/]
			A1: Ban Xiengluang			A2: Ban Dak Run			
			17/09/2021	18/09/2021	19/09/2021	21/09/2021	22/09/2021	23/09/2021	
1	PM-2.5	mg/m^3	ND	ND	ND	ND	ND	ND	0.05
2	PM-10	mg/m^3	0.005	ND	0.008	0.022	0.022	0.006	0.12
3	TSP	mg/m^3	0.012	0.006	0.007	0.024	0.026	0.022	0.33
4	CO 1 hr	ppm	0.01-0.09	0.02-0.09	0.01-0.07	0.07-0.19	0.20-0.39	0.17-0.29	30
	CO 8 hr (average)	ppm	0.055	0.06	0.04	0.15	0.31	0.21	9
5	SO_2 1 hr	ppm	0.000-0.007	0.000-0.007	0.000-0.007	0.000-0.011	0.001-0.006	0.002-0.010	0.13
	SO_2 24 hr (average)	ppm	0.003	0.003	0.003	0.004	0.003	0.005	0.05
6	NO_2 1 hr	ppm	0.001-0.01	0.001-0.008	0.001-0.009	0.000-0.002	0.000-0.002	0.000-0.009	0.11
	NO_2 24 hr (average)	ppm	0.005	0.003	0.004	0.000	0.000	0.004	0.02

Source: ESIA, Sept 2020

Note: [1/] General Air Quality Standard. National Environmental Standard (No 81 NA). 21 February 2017, ND = Not Detected (Limit of detection is 0.002 mg/m^3)

Figure 7.3: Air Sampling Locations



7.3.6 Noise

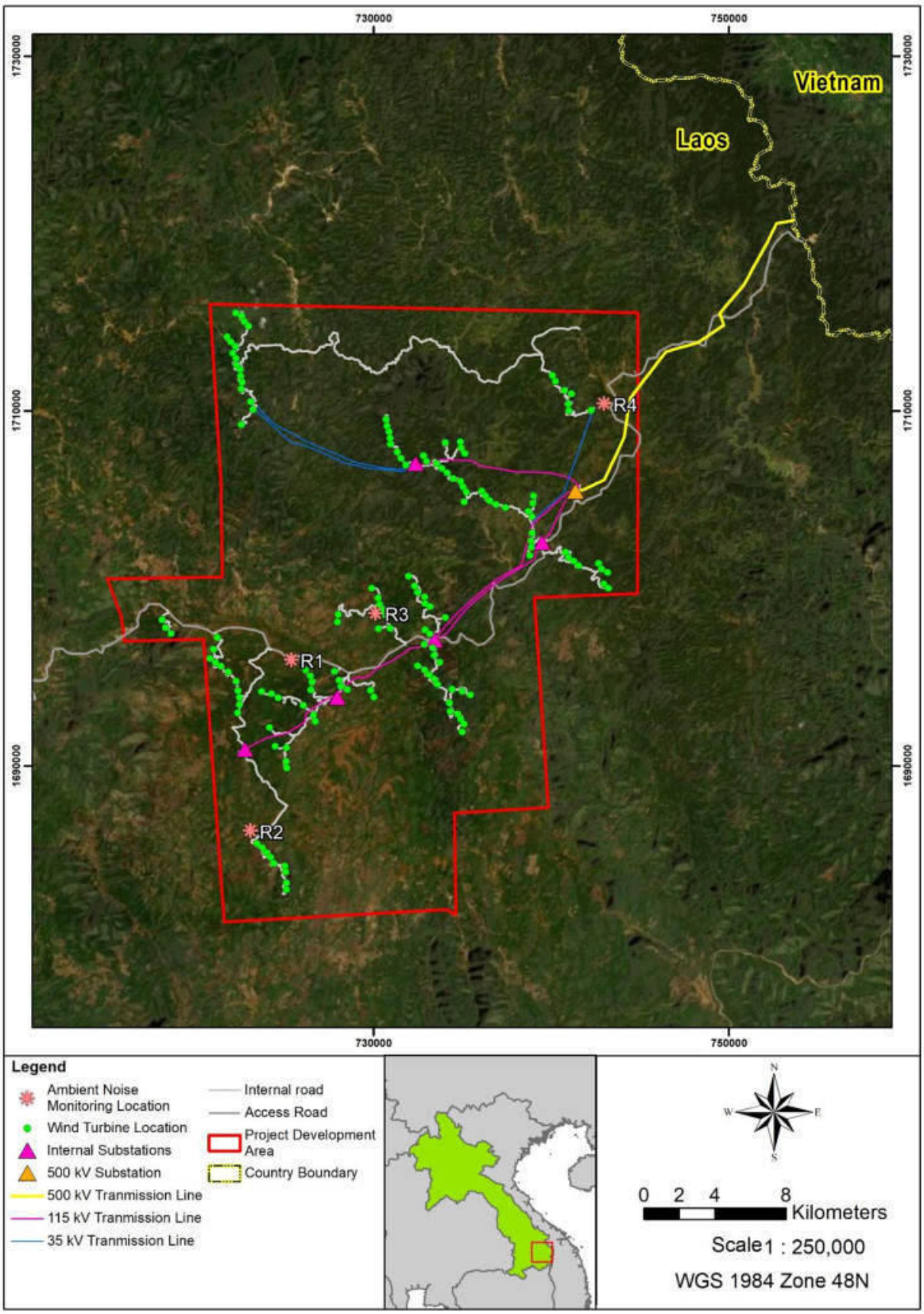
In order to establish wind farm noise limits, background noise monitoring is required to establish the pre-existing environment as a function of wind speed. As wind speed increases generally the background noise levels at most receptors also increases, as natural sources, such as the wind through the trees, begin to dominate. The variation of background noise with wind speed is usually quite site specific and related to various physical characteristics, such as topographic shielding and the extent and height of exposed vegetation.

Background noise measurements have been carried out by Innogreen at four representative monitoring locations in the vicinity of the Project site. The monitoring locations are described in ***Table 7.5*** and are illustrated in ***Figure 7.4***. Background noise measurements were carried out between August-November 2021 (13-16 Aug, 28-31 Oct, 1-2 Nov and 9-12 Aug).

Table 7.5: Noise Sampling Locations

Location	General location	Coordinates	Parameters	Monitoring Frequency and Duration
R1	Monitoring point located in the village c.1km northwest of wind turbine WH110	15°19'49.14"N 107° 5'55.88"E	■ L_{eq}1hr ■ L_{eq}24hr ■ L_{eq} ■ L_{max} ■ L_{min} ■ L_{10} ■ L_{90}	**Frequency**: Once **Duration:** Over 3 consecutive days
R2	Monitoring point located in the village, c.0.7km from access road, and c.2 km, northwest of wind turbine WH142	15°14'34.22"N 107° 4'38.49"E		
R3	Monitoring point located in the village c.0.2km northwest of wind turbine WH141	15°21'41.58"N 107° 8'34.73"E		
R4	Monitoring point located in the village c.1km southwest of wind turbine WH154	15°27'29.86"N 107°15'57.57"E		

Figure 7.4: Noise Monitoring Locations



7.3.6.1 Noise Monitoring Procedure

The noise monitoring procedure was undertaken in accordance with ISO 1996 -1:2003, which specifies that noise monitoring should be carried out using Type 1 sound level meter as per IFC standards[19]. A sound level meter 1.5 m above the ground and no closer than 3 m to any reflecting surface (e.g., wall) was deployed at each station. A portable weather station was positioned close to each sound level meter to simultaneously measure the wind speed (in a series of 10-minute intervals).

Noise levels were measured continuously for 72 hours with data logging every 10 minutes. Weather conditions (e.g., wind speeds), existing industrial condition and noise contribution from other noise sources at the monitoring locations were recorded and used for noise analysis. Field logs for all survey work, noting the date and time of the survey, equipment used, and a record of all activities and observations, calibration sheets, and noise monitoring raw data can be found in ***Appendix B***.

Regression analyses of the background noise data and the hub height wind speed data were carried out to determine a line of 'best fit' from the baseline noise measurements, from which the noise impact assessment criteria have been established as a function of wind speed.

7.3.6.2 Wind Speed Monitoring

The data was recorded in 10-minute intervals and this data was converted to provide the average wind speed at a nominal hub height of 110 m. The conversion applied an extrapolation based on a log law method, as set out in Section 2.1.5 of the Institute of Acoustics (IOA) Good Practise Guide (GPG) Supplementary Guidance Note 4: Wind shear[20]. The shear factors used in the calculation were extracted from the vertical speed profile wind model.

The IAO GPG describes the derivation of noise limits based on a 'standardized' wind speed at a height of 10 m. Wind turbine sound power levels in the past have been reported with reference to the 'standardized' wind speed at 10 m height. However, the 3rd Edition (2012) of IEC61400-11[3,21] mainly requires sound power levels to be stated in relation to the hub height wind speed. Additionally, recent standards and guidelines worldwide have eliminated the procedure of standardizing wind speeds to a 10 m height. As such, wind speed at a nominal hub-height of 110 m has been selected as the preferred reference wind speed for this analysis. This method simplifies any post-construction compliance measurements that are analyzed using data from the Project.

7.3.6.3 Noise Monitoring Results

Noise level (equivalent continuous sound pressure level with 'A' frequency weighting - LAeq) measured at the four (4) monitoring locations met the World Bank Group (WBG) Criteria which is more stringent than Lao National Ambient Noise Standard for most of the monitoring duration in the daytime (07:00 - 22:00). The exceeded noise level measured in the night-time (22:00-7:00) were likely due to interference of the local activities such as household activities, the movement of in-used vehicles, and animal (chicken, dogs, and buffalo). Noise monitoring results for each monitoring location are shown in ***Figure 7.5*** to ***Figure 7.8*** and discussed in detail below.

- **R1**: Day and night time noise levels are below the equivalent WBG noise standards. The main sources of noise were from road users (truck, car, and motorbike) as well as noise from community and farm animals.

[19] International Finance Corporation (2007). *Environmental, Health, and Safety (EHS) Guidelines*. World Bank Group. http://www.ifc.org/ehsguidelines

[20] Institute of Acoustics (2014). *A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise – Supplementary guidance note 4: Wind Shear*

[21] International Electrotechnical Commission (2012). IEC 61400-11 Edition 3.0 2012-11. *Wind turbines – Part 11: Acoustic noise measurement techniques*

- **R2**: Noise levels at this location exceeded the day time and night-time WBG criteria. During daytime noise levels vary, being mostly below the IFC criteria for daytime. The main sources of noise were from local communities / domestic noise, dogs, and music.
- **R3**: Noise levels during daytime at receptor R3 were on average below the WBG daytime criteria. During night-time, noise levels generally exceeded the WBG night-time criteria. The main sources of noise were from local communities / domestic noise, and farm animals.
- **R4**: During day and night time, measured noise levels at R4 are generally within the WBG night time noise criterion of 45 dB(A). R4 is an isolated receptor far from roads or many residential properties.

Figure 7.5: Noise Monitoring Result at R1

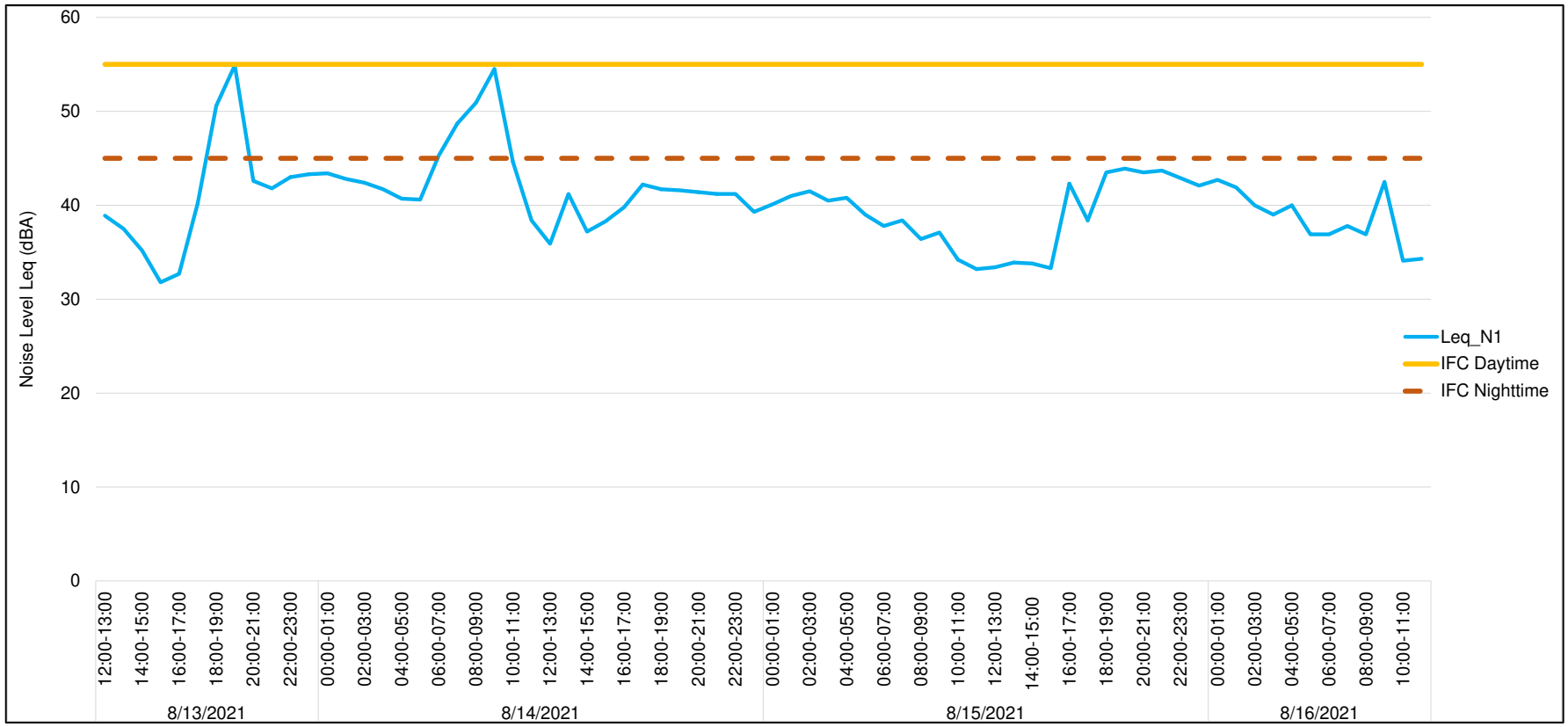


Figure 7.6: Noise Monitoring Result at R2

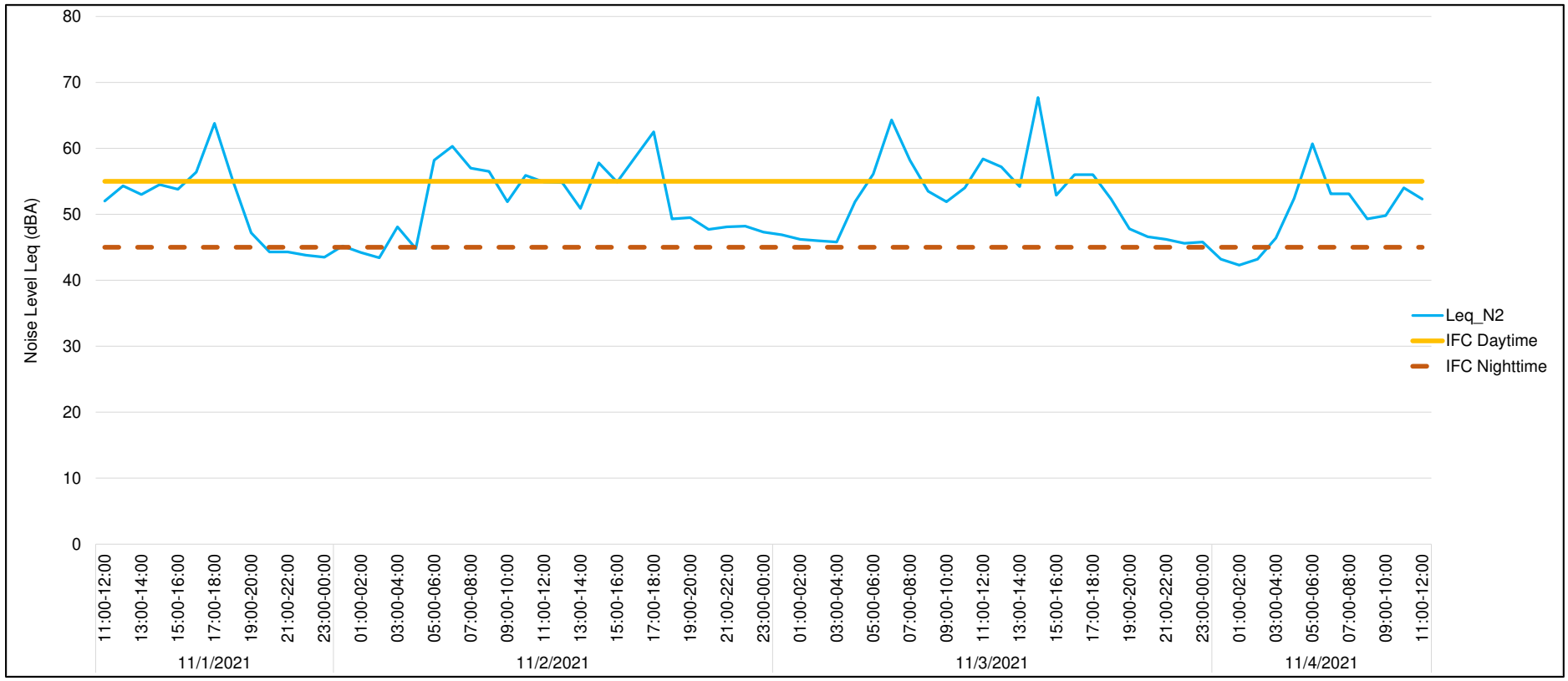


Figure 7.7: Noise Monitoring Result at R3

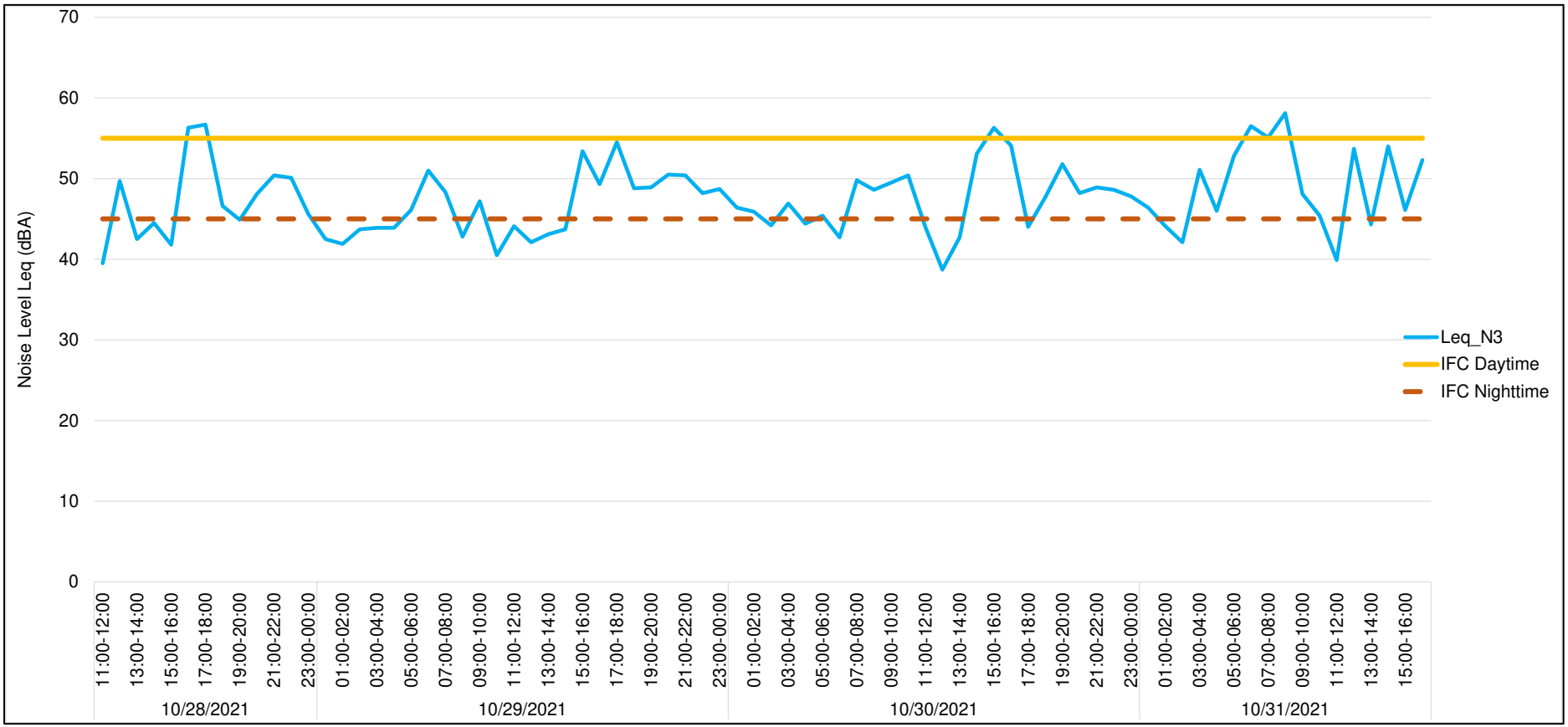
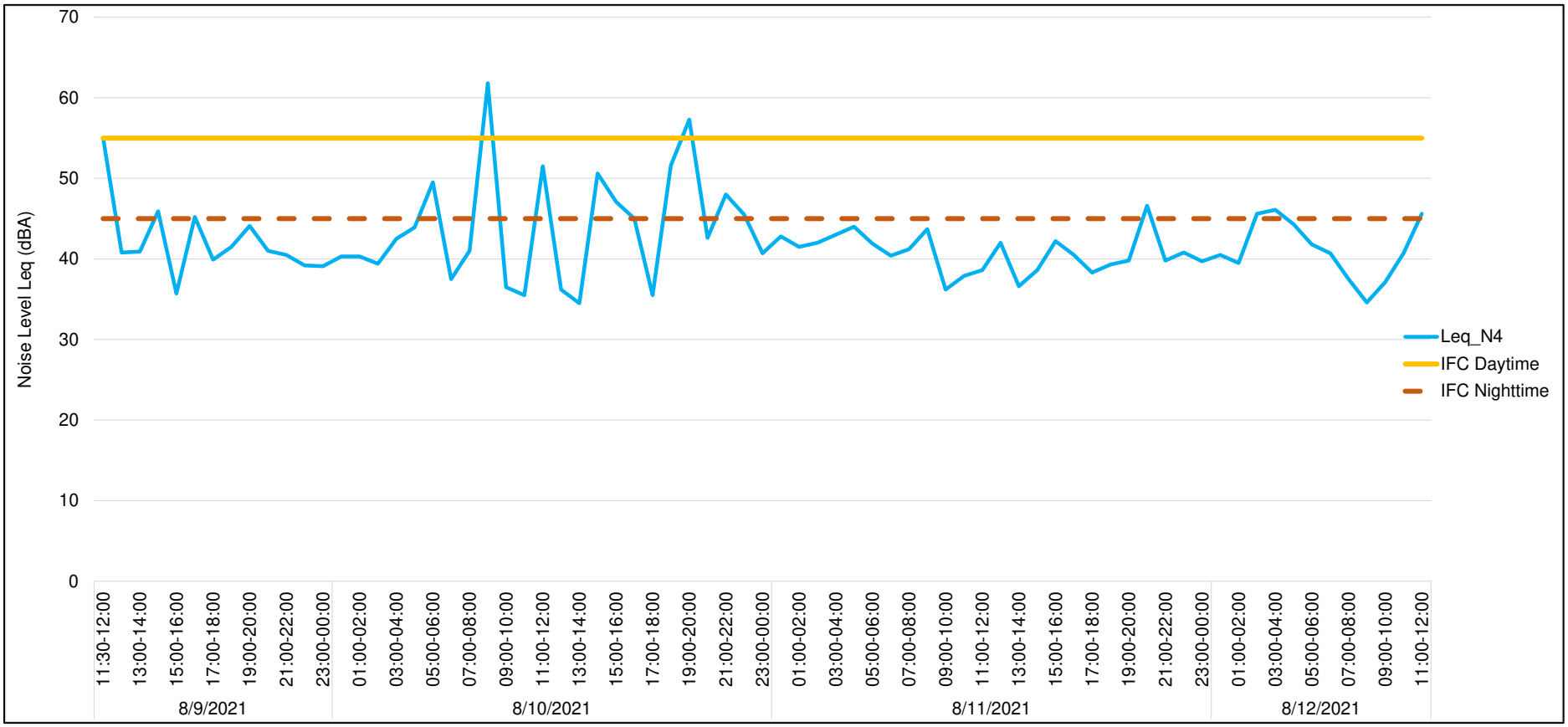


Figure 7.8: Noise Monitoring Result at R4



7.3.6.4 Background Noise Analysis

Limited rainfall was observed during the three day measurement period at each receptor. The noise data during rainfall over the 10-min intervals were excluded from the data analysis.

The existing acoustic environment is mainly driven by noise sources related to human activities, such as traffic or power generators, which probably lead to increased noise levels during night-time.

Despite the expectation, a weak correlation has been found between wind speed and noise level, meaning that some other factors were influencing the measurements.

Table 7.6 summarizes the total, excluded, remaining valid, day, and night 10-min periods for each location.

Table 7.6: Time Periods for Noise Measurements Occurred Every 10-Min

Location	Number of Points				
	Total	**Excluded**	**Remaining Valid**	**Day time**	**Night time**
R1	433	26	407	245	162
R2	439	0	439	277	162
R3	469	15	454	298	156
R4	433	21	412	255	159

The measured existing background noise levels based for the different wind speeds are presented in ***Table 7.7***.

Regression has been made for both 24 hours and the day/night period to accomplish both the requests of Lao PDR national criteria and WBG criteria.

Table 7.7: Background noise level at Monitoring Location

Location	Time period	Background Noise Level L90 (dBA) at 110m height wind speed (m/s)							
ID		**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
R1	24 hours	40	40	40	40	40	40	40	40
	Day-time	41	41	42	42	43	43	44	44
	Night-time[(1)]	40	40	40	39	39	38	38	38
R2	24 hours	45	45	45	45	45	45	45	45
	Day-time	46	47	47	48	49	49	50	50
	Night-time	44	45	45	45	46	46	46	47
R3	24 hours	43	44	45	46	47	48	49	50
	Day-time	42	44	45	46	47	48	49	50
	Night-time	44	45	45	46	47	48	49	49
R4	24 hours	39	39	39	39	40	40	40	41
	Day-time[(1)]	37	37	37	37	37	37	37	37
	Night-time	40	40	40	40	40	40	40	41

Notes:

[1] Weak regression

At most of the receptors a weak correlation has been found on receptors R1 and R4 between wind speed and noise levels. Background noise level typically increases with the increase of wind speed,

because of wind-induced noise generated around objects or vegetation (***Figure 7.9*** - ***Figure 7.12***). The line of best fit for the data set is determined using a linear trend line, which provides a correlation between wind speed and background noise level.

As the data do not provide a clear correlation between wind speed and measured noise level on R1 and R4; the absolute criteria of WBG has been considered for the assessment purpose in comparison with the predicted model noise.

Figure 7.9: Background Noise Measurements against Wind Speed for R1

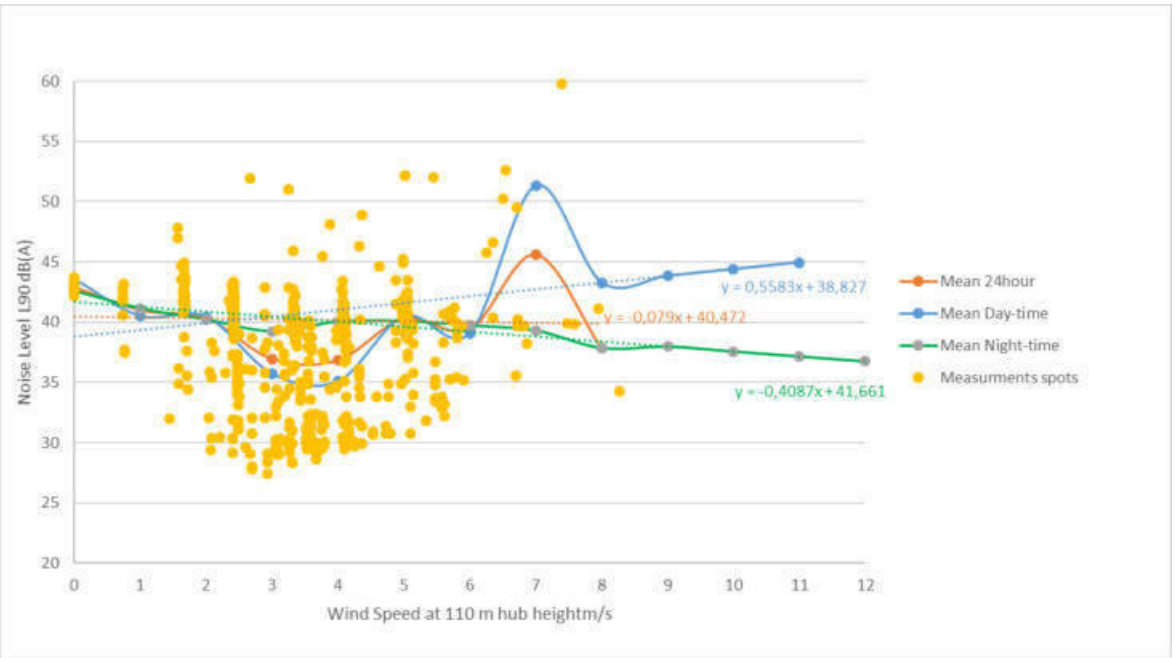


Figure 7.10: Background Noise Measurements against Wind Speed for R2

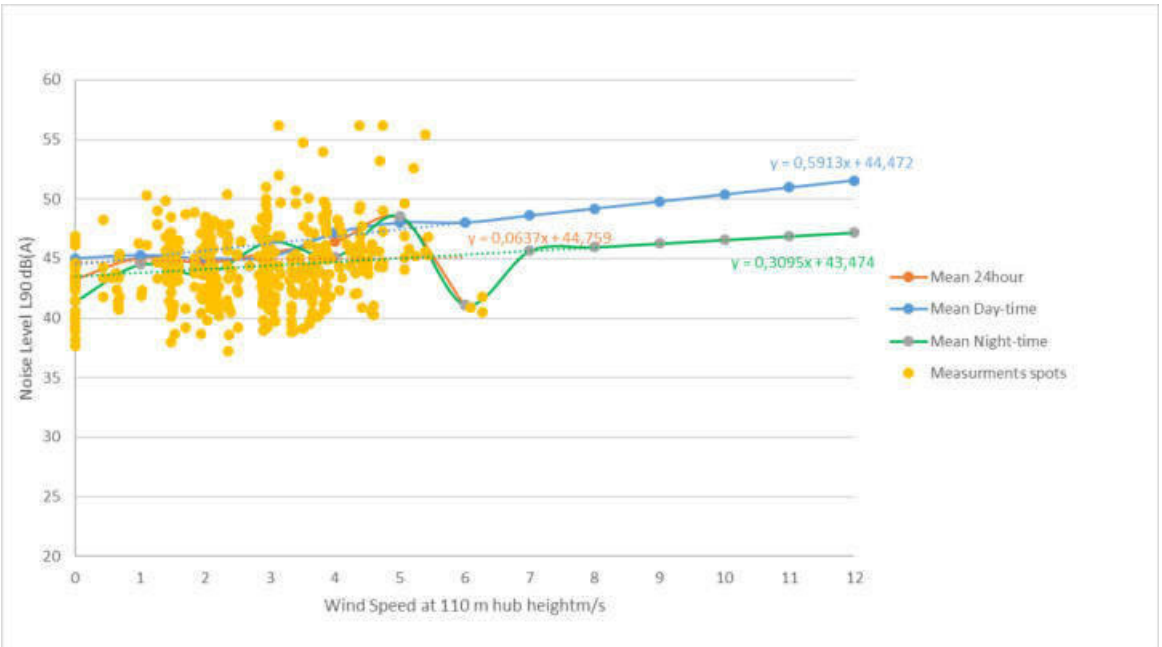


Figure 7.11: Background Noise Measurements against Wind Speed for R3

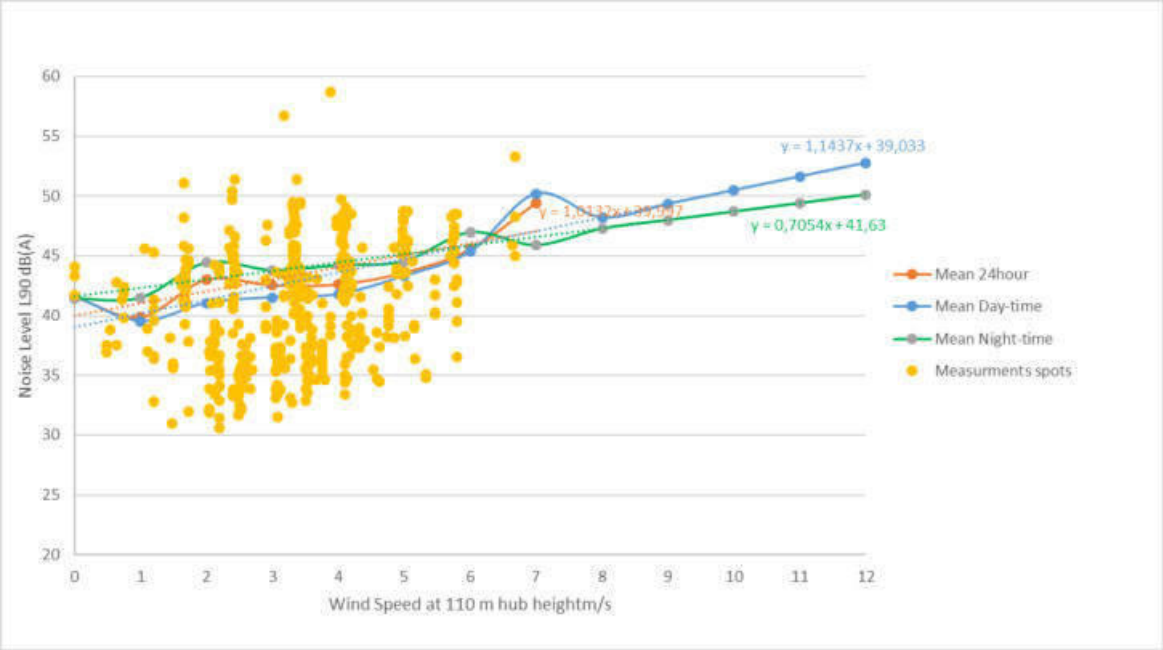
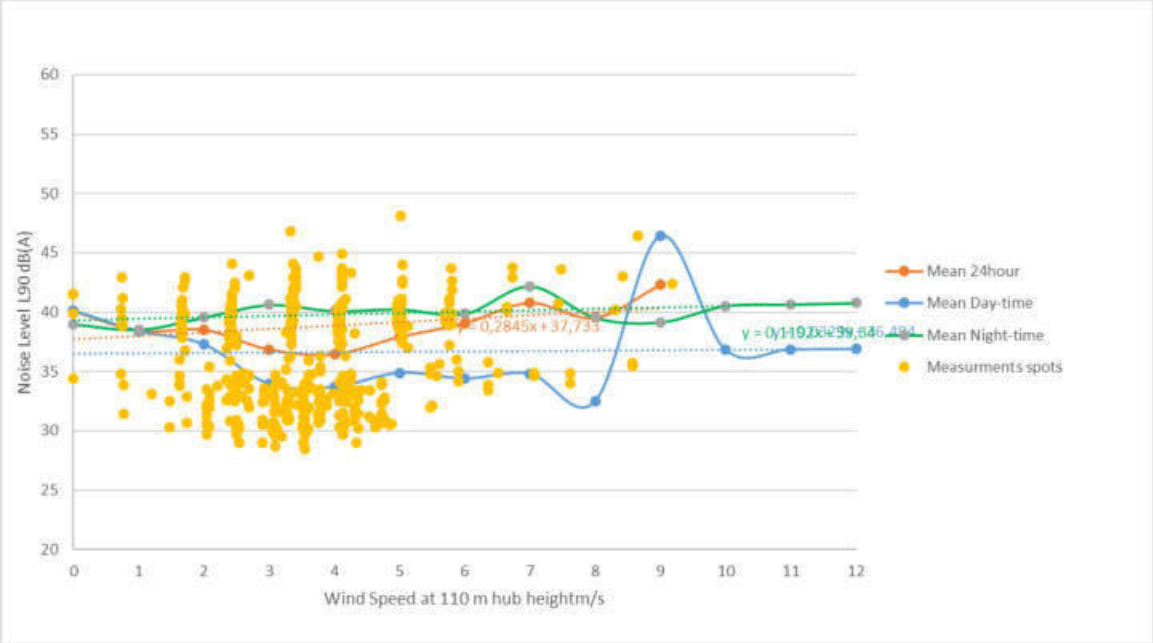


Figure 7.12: Background Noise Measurements against Wind Speed for R4



7.3.7 Surface Water Quality

7.3.7.1 Surface Water Monitoring – Reference from the local EIA

Baseline data collection for surface water was undertaken on 23 September 2020 by Innogreen, in collaboration with Phanthamit Analytical Lab Co., Ltd for the Based on the ESIA. The parameters were based on the National Environmental Standards No. 81/GOV, 2017.

The sampling locations included (as shown in ***Figure 7.13***):

- SW01: Houay Nam Ngon in Ban Nam Ngon, Sanxay District, Attapeu Province (73°10'03N, 16°84'39.9E (UTM WGS 1984 Zone 48°N));
- SW02: Houay Joon in Ban Dak Padou, Sanxay District, Attapeu Province (736057N, 1690997E (UTM WGS 1984 Zone 48N));
- SW03: Houay Preed in Ban Xiengluang, Dak Cheung District, Sekong Province (722427N, 1692294E (UTM WGS 1984 Zone 48N));
- SW04: Houay Air in Ban Sieng Mai, Dak Cheung District, Sekong Province (722309N, 1701964E (UTM WGS 1984 Zone 48N)); and
- SW05: Houay Nheung in Ban Dak Dor, Dak Cheung District, Sekong Province (738037N, 1700351E (UTM WGS 1984 Zone 48N));

Surface water monitoring results from the local EIA (EIA, 2020) are presented in ***Table 7.8***. The parameters of SW01, SW02, and SW05 were within Laos regulations. These monitoring locations are natural streams along the valley, covered with trees and some land area used for agricultural production, such as; cassava cultivation, upland crop cultivation along the slope of the mountain, and a small area is used for rice cultivation.

The parameters of SW03 and SW04 were mostly within the standards except for measurements of phenol (C_6H_6O). SW03 is in the area of Ban Xiengluang at Houay Preed, the boundary area connecting to Ban Dak Dor. The area near the stream consists of unstocked forest, agricultural land, and a fruit-tree plantation company. Phenol is an important industrial product that is used as a basic chemical in many kinds of products, primarily used in plastic synthesis and related materials, and as chemical in herbicide products. As such, the presence of the industry in the area may be the cause of the high value of Phenol in the water. SW04 is in the area of Ban Sieng Mai, Houay Air and has quite a large stream. There are villages located at the upper bank of the stream, including a rice field area, and cultivation area for crops. The area consists of natural high and steep rock mountains, which may contain minerals underground. There is frequent rainfall that causes water to flow over various sources that may cause the water contamination.

Figure 7.13: Surface Water Sampling Locations

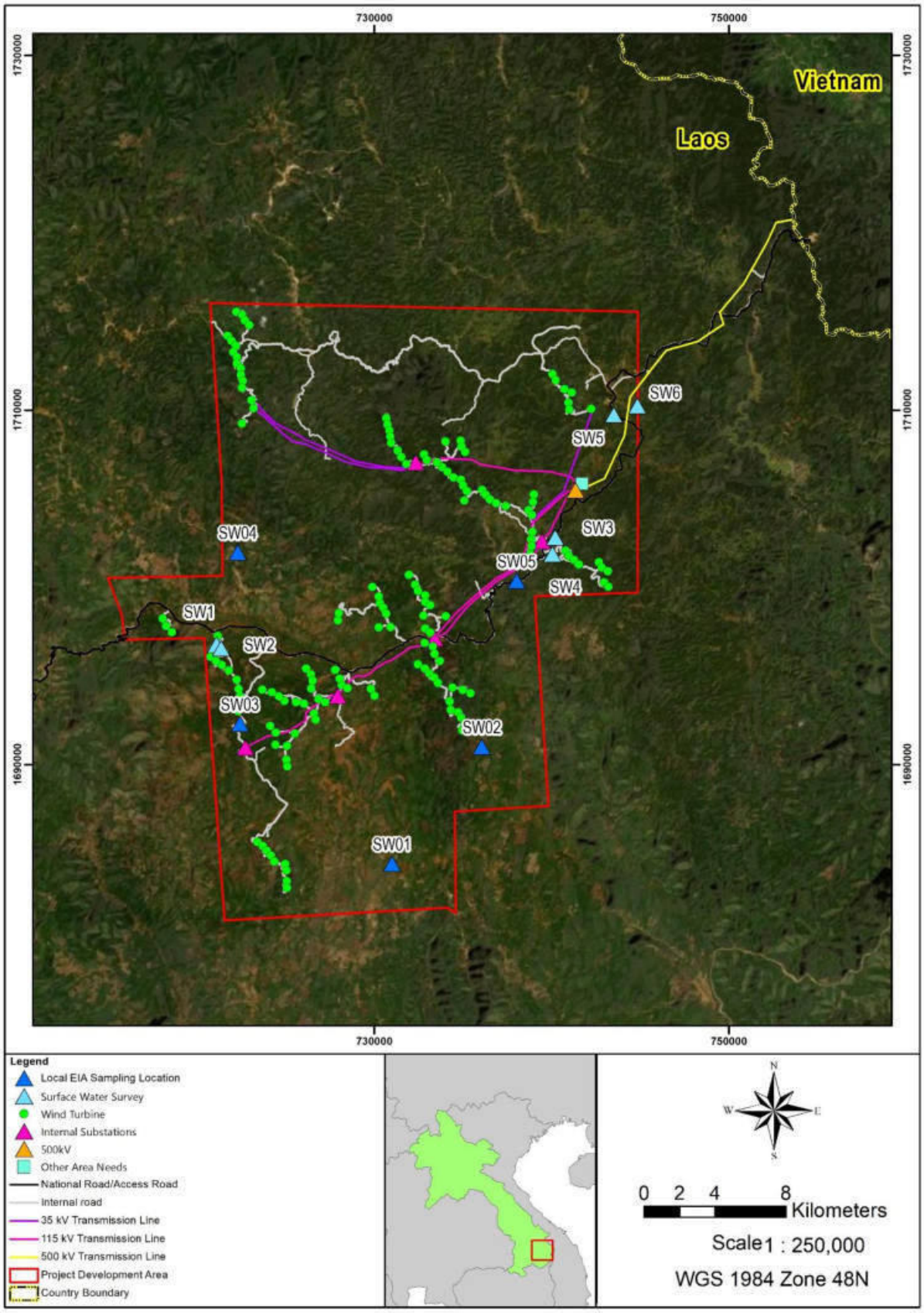


Table 7.8: Surface Water Monitoring Result

No.	Parameter	Unit	Surface Water Monitoring Result					Standard[1/]
			SW01	SW02	SW03	SW04	SW05	
			23/09/20 (10.45 am)	23/09/20 (02.25 pm)	23/09/20 (11.45 am)	23/09/20 (10.25 am)	23/09/20 (01.15 pm)	
			Village Name					
			Nam Ngon	Dak Padou	Xiengluang	Sieng Mai	Dak Dor	
			Stream Name					
			Nam Ngon	Houay Jool	Houay Preed	Houay Air	Houay Nheung	
1	Odor	-	Odourless	Odourless	Odourless	Odourless	Odourless	
2	Color (Field work)	-	Orange	Clear	Clear	Dark yellow	Grey	Colourless
3	Color	-	23.9	14	5.56	28.8	17.7	-
4	Water temperature	°C	21	23	20.8	20.5	24	-
5	pH	-	7.4	7.1	6.4	7.1	7.1	5.0-9.0
6	DO	mg/L	8.50	8.90	7.25	8.80	8.25	>4.0
7	Conductivity	ms/cm	18.8	22.8	9.90	21.6	24	≤2000
8	COD	mg/L	6.30	ND	ND	ND	1.89	7-10
9	TSS	mg/L	20	8.95	ND	34.4	11	≤40
10	As	mg/L	ND	<0.0020	ND	<0.0020	ND	0.01
11	Cd	mg/L	ND	ND	ND	ND	ND	0.003
12	Cu	mg/L	ND	ND	ND	ND	ND	1.5
13	Cr^{+6}	mg/L	ND	ND	ND	ND	ND	-
14	CN^-	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	0.07
15	Pb	mg/L	ND	ND	ND	ND	ND	0.01
16	Mn	mg/L	0.04	<0.03	<0.03	0.09	0.05	1.0

No.	Parameter	Unit	Surface Water Monitoring Result					Standard[1/]
			SW01	**SW02**	**SW03**	**SW04**	**SW05**	
			23/09/20 (10.45 am)	23/09/20 (02.25 pm)	23/09/20 (11.45 am)	23/09/20 (10.25 am)	23/09/20 (01.15 pm)	
			Village Name					
			Nam Ngon	Dak Padou	Xiengluang	Sieng Mai	Dak Dor	
			Stream Name					
			Nam Ngon	Houay Jool	Houay Preed	Houay Air	Houay Nheung	
17	Hg	mg/L	ND	ND	ND	ND	ND	0.001
18	Ni	mg/L	ND	ND	ND	ND	ND	0.1
19	NO_3-N	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	5.0
20	Phenol	mg/L	ND	ND	0.031	0.016	0.008	0.005
21	PO4	mg/L	<0.46	<0.46	<0.46	<0.46	<0.46	1
22	Zn	mg/L	ND	ND	ND	ND	ND	1.0
23	NH_3-N	mg/L	0.28	0.20	0.30	0.25	0.42	0.5
24	NH_4^+	mg/L	0.36	0.26	0.39	0.32	0.54	≤3

Source: ESIA, Sept 2020

Note: [1/] *National Environmental Standards, No. 81/GOV, 2017*
Underlined value: exceed the standard

ND = not detected.

7.3.7.2 Surface Water Monitoring – Supplementary Sampling

Surface water quality sampling was conducted on 12th August 2021 by Innogreen. Six (6) samples were taken in the Project area to analyze water quality parameters and compare against Laos Standards. An overview of the surveys and their results are presented in this section.

Surface Water Monitoring Locations

ERM recommended moving some of the original sampling locations proposed by Innogreen to a new location based on revisions to the site layout, identification of watercourses that have the potential to be impacted by the Project (e.g., turbines, site roads, watercourse crossings), and a set of comparable control sites, which are unlikely to be affected by any aspect of the development for the duration of the Project.

Surface water samples were collected at six (6) locations. A description for each of the sampling locations is shown in ***Table 7.9*** and the locations of each sampling site are shown in ***Figure 7.14.***

Given that the Project area has the potential presence of POPs in surface water and soil due to Agent Orange used during the Vietnam War, the Project will need to conduct pre-construction surface water monitoring (5 sampling locations) in the same locations, to identify and analyse the potential presence of POPs (refer to ***Section 8.3.6*** and ***Section 9.8*** of this report for water monitoring requirements).

Table 7.9: Supplementary Surface Water Sampling Locations

Sampling Station[1,2]		General location	Coordinates[3]	Parameters
No.	Type			
SW1	Control site, upstream of potentially affected site	Sampling point to be located upstream of site road that intersects river and connects wind turbines WH153 to WH133	15°20'16.64"N 107° 3'34.42"E	Observations: ■ Odour ■ Colour ■ Turbidity In-situ measurements: ■ pH ■ ORP (Oxidation Reduction Potential) ■ DO (Dissolved Oxygen) ■ Conductivity ■ Salinity ■ TDS (Total Dissolved Solids) ■ Water Temperature ■ Water depth Laboratory analysis: ■ Calcium ■ Magnesium ■ Sodium ■ Potassium ■ Total Hardness ($CaCO_3$) ■ Alkalinity ($CaCO_3$) ■ Sulfate
SW2	Potentially affected site	Sampling point to be located downstream of site road that intersects river and connects wind turbines WH153 to WH133	15°20'9.88"N 107° 3'43.34"E	
SW3	Control site, upstream of potentially affected site	Sampling point to be located upstream of site road that intersects river and connects to wind turbines WH056 toWH065.	15°23'27.09"N 107°14'16.41"E	
SW4	Potentially affected site	Sampling point to be located downstream of site road that intersects river and connects to wind turbines WH056 to WH065.	15°22'56.71"N 107°14'11.11"E	

Sampling Station[1,2]		General location	Coordinates[3]	Parameters
No.	Type			
SW5*	Potentially affected site	Sampling point to be located downstream from existing site road but upstream of transmission line development area	15°27'10.79"N 107°16'9.83"E	■ Chloride ■ Total Suspended Solids ■ Total Coliform Bacteria ■ Oil and Grease ■ Total Nitrogen ■ Total Phosphorus ■ Ortho-Phosphorus ■ Ammonia ■ Biological Oxygen Demand (BOD) ■ Chemical Oxygen Demand (COD) ■ Mercury ■ Cadmium ■ Arsenic ■ Iron ■ Aluminum ■ Manganese ■ Lead ■ Zinc ■ Copper ■ Nickel ■ Nitrate ■ Nitrite ■ Pesticides Other related measurements: ■ Ambient temperature
SW6	Control site, upstream of potentially affected site	Sampling point to be located downstream of both SW5 and transmission line development area	15°27'27.15"N 107°16'54.51"E	

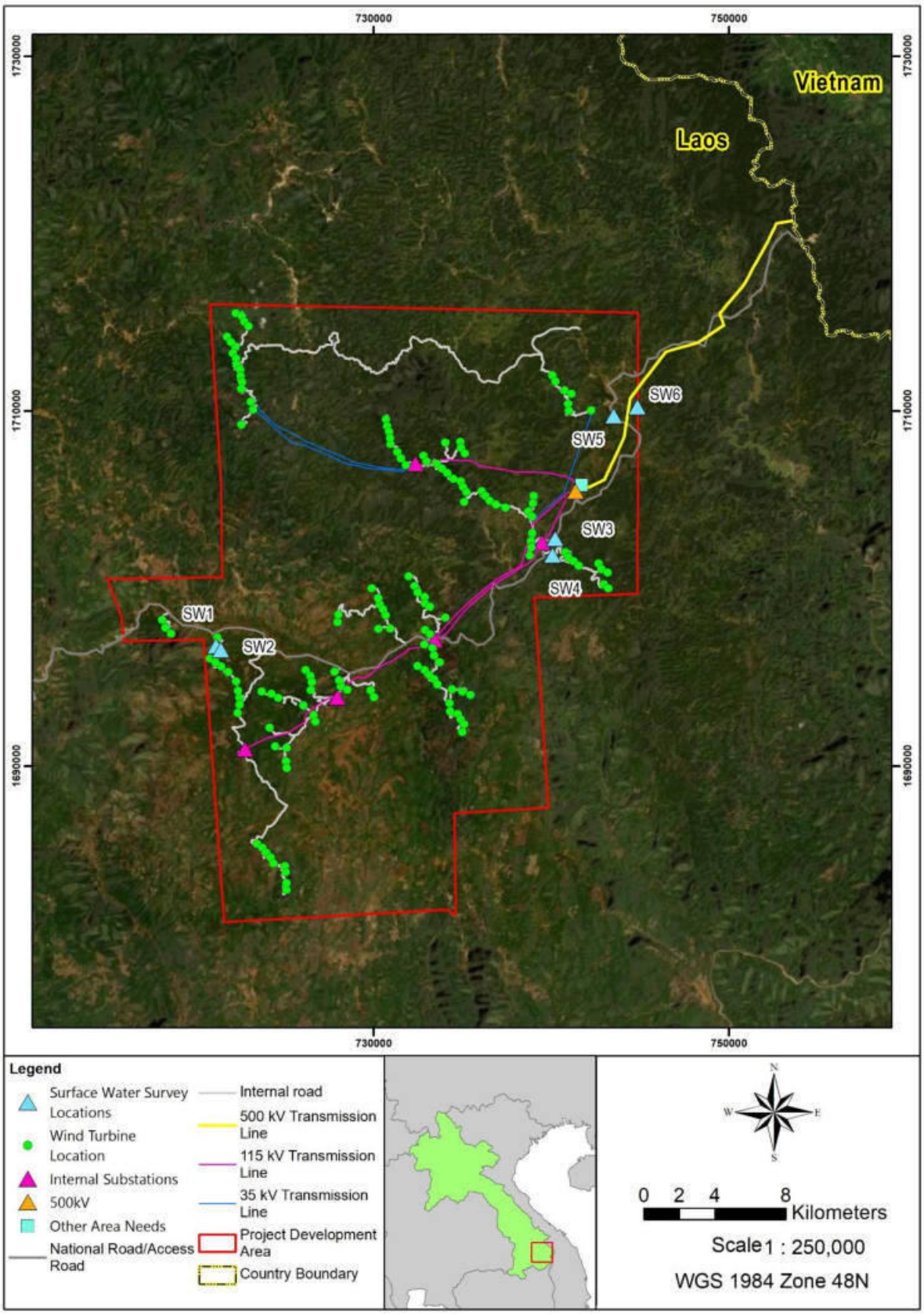
Notes:

[1] Sampling locations indicated with a star (*) were originally recommended by Innogreen.

[2] This does not include Quality Control (QC) samples such as blanks, and duplicates that should also be collected by Innogreen.

[3] Coordinates are given in WGS84 datum and provided as guidance only; exact locations should be taken on-site using a hand-held Global Positioning System (GPS).

Figure 7.14: Supplementary Surface Water Sampling Locations



Surface Water Monitoring Methodology

Surface water sampling was conducted on 12 August 2021. In-situ testing was conducted by Innogreen. Grab water samples were collected for physio-chemical, bacteriological, and pesticide tests onsite, and samples were sent for laboratory testing. The sampling was conducted in strict accordance with recognized standard procedures or referring to the recommendation of the United States Environmental Protection Agency (U.S. EPA).[22] Field logs for all survey work, noting the date and time of the survey, equipment used, and a record of all activities and observations, can be found in ***Appendix C***.

Surface Water Monitoring Results

The chemical oxygen demand (COD) measurement at SW03-5 ranged from 11.7-21.5 mg/L, which exceed the 5-7 mg/ L limit and Coliform Bacteria at SW03 is 11,000 MPN/100 mL which exceed 5,000 MPN/100 mL according to the National Environmental Standards No.81/MONRE 2017. All other parameters are found to be within the Lao standards. When the COD levels are higher, there is a greater demand for oxygen. This means that there is likely more oxidizable organic material in water with high COD levels. However, no corresponding decrease was observed in Dissolved Oxygen (DO) concentrations (which were above the 6 mg/L standard). The high coliform bacteria levels usually correspond to human or animal waste / sewage in water (as observed in SW03). The surface water analysis results are shown in ***Table 7.10*** (refer to **Appendix C** for more detailed results).

[22] United States Environmental Protection Agency (EPA), National Primary Drink Water Regulations & National Secondary Drinking Water Regulation.

Table 7.10: Surface Water Sampling Results

No.	Sampling point		SW01	SW02	SW03	SW04	SW05	SW06	National Environmental Standards No.81/MONRE 2017
	Date		12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	
	Time		17:40	17:05	14:45	15:30	14:00	15:50	
	Village		Daktiem	Daktiem	Dakrun	Dakrun	Dakbong	Dakbong	
	Observations	Unit							
1	Oder		Non	Non	Non	Non	Non	Non	
2	Color		Clear	Clear	Clear	Clear	Clear	Clear	
3	Turbidity		light	light	light	light	light	light	
	On Site Parameters								
1	Temperature	°c	22.4	22.3	22	21.4	26.4	26.4	-
2	pH		7.9	7.9	7.3	7.4	7.4	6.3	6 – 8
3	DO	mg/L	9.7	8.3	9.1	9.4	9	10.8	6.0
4	Conductivity	ms/cm	7	7.4	27.7	41	25	26.4	≤ 1000
5	Salinity	ppt	0	0	0.01	0.02	0.01	0.01	-
6	TDS	ppm	3.5	3.7	13.9	20.7	13.6	13.2	-
	Laboratory Analysis								
8	Ammonia	mg/L	ND	ND	ND	ND	ND	ND	-
9	BOD	mg/L	<1.00	ND	<1.00	ND	<1.00	ND	-
10	COD	mg/L	5.53	ND	*21.5*	*12.9*	*11.7*	ND	5 – 7
11	Chloride	mg/L	ND	ND	ND	ND	ND	ND	-

No.	Sampling point		SW01	SW02	SW03	SW04	SW05	SW06	National Environmental Standards No.81/MONRE 2017
	Date		12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	
	Time		17:40	17:05	14:45	15:30	14:00	15:50	
	Village		Daktiem	Daktiem	Dakrun	Dakrun	Dakbong	Dakbong	
12	Hardness	mg/L	<10.0	<10.0	10.9	17.6	11.4	10.9	-
13	Fe (Iron)	mg/L	0.3	0.13	0.33	0.15	ND	0.44	-
14	Alkalinity	mg/L	<10.0	<10.0	16.8	24	16.8	14.4	-
15	Nitrate	mg/L	ND	ND	ND	ND	ND	1.5	-
16	Nitrite	mg/L	ND	ND	ND	ND	ND	ND	-
17	Oil & Grease	mg/L	ND	ND	ND	ND	ND	ND	-
18	Sulfate	mg/L	<5.00	<5.00	<5.00	<5.00	<5.00	<5.00	-
19	TSS	mg/L	<2.50	3.70	7.2	6.2	6.1	7.1	≤ 25
20	Ortho Phosphate	mg/L	ND	ND	ND	ND	ND	ND	-
21	Coliform Bacteria	MPN/100mL	2,200	2,100	*11,000*	3,900	4,900	2,100	5,000
22	Phosphorus	mg/L	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	-
23	Total Nitrogen	mg/L	<5	<5	<5	<5	<5	<5	-
24	ORP	mV	-63.7	-40.8	0.4	26.1	24.7	27.6	-
25	Aluminium	mg/L	0.19	0.21	0.15	0.17	0.22	0.26	-
26	Arsenic	mg/L	ND	ND	ND	ND	ND	ND	0.01
27	Cadmium	mg/L	ND	ND	ND	ND	ND	ND	0.003
28	Calcium	mg/L	<1.00	<1.00	1.90	4.02	2.31	2.16	-

No.	Sampling point		SW01	SW02	SW03	SW04	SW05	SW06	National Environmental Standards No.81/MONRE 2017
	Date		12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	
	Time		17:40	17:05	14:45	15:30	14:00	15:50	
	Village		Daktiem	Daktiem	Dakrun	Dakrun	Dakbong	Dakbong	
29	Mercury	mg/L	ND	ND	ND	ND	ND	ND	0.001
30	Copper	mg/L	ND	ND	ND	ND	ND	ND	1.5
31	Lead	mg/L	ND	ND	ND	ND	ND	ND	0.01
32	Magnesium	mg/L	<1.00	<1.00	1.76	1.95	1.47	1.41	-
33	Sodium	mg/L	1.26	1.12	1.65	1.49	1.4	1.22	-
34	Potassium	mg/L	1.15	<1.00	<1.00	2.41	<1.00	1.03	-
35	Zine	mg/L	ND	<0.03	ND	ND	ND	ND	1
36	Manganese	mg/L	<0.03	0.2	0.1	0.03	<0.03	<0.03	1
37	Nickel	mg/L	ND	ND	ND	ND	ND	ND	0.1
	Pesticides Organochlorine Group								
38	Aldrin	µg/L	ND	ND	ND	ND	ND	ND	0.1
39	a-BHC	µg/L	ND	ND	ND	ND	ND	ND	0.02
40	a-Endosulfan	µg/L	ND	ND	ND	ND	ND	ND	-
41	ß-BHC	µg/L	ND	ND	ND	ND	ND	ND	-
42	Dicofol	µg/L	ND	ND	ND	ND	ND	ND	-
43	ß-Endosulfan	µg/L	ND	ND	ND	ND	ND	ND	-
44	Dieldrin	µg/L	ND	ND	ND	ND	ND	ND	0.1
45	cis-Chlordane	µg/L	ND	ND	ND	ND	ND	ND	-
46	Endosulfan Sulfate	µg/L	ND	ND	ND	ND	ND	ND	-
47	Endrin	µg/L	ND	ND	ND	ND	ND	ND	-

No.	Sampling point		SW01	SW02	SW03	SW04	SW05	SW06	National Environmental Standards No.81/MONRE 2017
	Date		12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	
	Time		17:40	17:05	14:45	15:30	14:00	15:50	
	Village		Daktiem	Daktiem	Dakrun	Dakrun	Dakbong	Dakbong	
48	Y-BHC	µg/L	ND	ND	ND	ND	ND	ND	-
49	HCB	µg/L	ND	ND	ND	ND	ND	ND	-
50	Heptachlor	µg/L	ND	ND	ND	ND	ND	ND	0.2
51	Heptachlor-exo-epoxide	µg/L	ND	ND	ND	ND	ND	ND	0.2
52	Methoxychlor	µg/L	ND	ND	ND	ND	ND	ND	-
53	o,p'-DDT	µg/L	ND	ND	ND	ND	ND	ND	-
54	o,p'-DDE	µg/L	ND	ND	ND	ND	ND	ND	-
55	o,p'-DDD	µg/L	ND	ND	ND	ND	ND	ND	-
56	p,p'-DDD	µg/L	ND	ND	ND	ND	ND	ND	-
57	p,p'-DDE	µg/L	ND	ND	ND	ND	ND	ND	-
58	p,p'-DDT	µg/L	ND	ND	ND	ND	ND	ND	-
59	Total DDT	µg/L	ND	ND	ND	ND	ND	ND	1
60	trans-Chlordane	µg/L	ND	ND	ND	ND	ND	ND	-
61	Anilofos	µg/L	ND	ND	ND	ND	ND	ND	-
62	Azinphos-ethyl	µg/L	ND	ND	ND	ND	ND	ND	-
63	Azinphos-methyl	µg/L	ND	ND	ND	ND	ND	ND	-
64	Chlorfenvinphos	µg/L	ND	ND	ND	ND	ND	ND	-
65	Diazinon	µg/L	ND	ND	ND	ND	ND	ND	-
66	Dichlorvos	µg/L	ND	ND	ND	ND	ND	ND	-
67	Dicrotophos	µg/L	ND	ND	ND	ND	ND	ND	-

No.	Sampling point		SW01	SW02	SW03	SW04	SW05	SW06	National Environmental Standards No.81/MONRE 2017
	Date		12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	
	Time		17:40	17:05	14:45	15:30	14:00	15:50	
	Village		Daktiem	Daktiem	Dakrun	Dakrun	Dakbong	Dakbong	
68	Dimethoate	µg/L	ND	ND	ND	ND	ND	ND	-
69	EPN	µg/L	ND	ND	ND	ND	ND	ND	-
70	Ethion	µg/L	ND	ND	ND	ND	ND	ND	-
71	Ethoprophos	µg/L	ND	ND	ND	ND	ND	ND	-
72	Etrimfos	µg/L	ND	ND	ND	ND	ND	ND	-
73	Fenitrothion	µg/L	ND	ND	ND	ND	ND	ND	-
74	Fenthion	µg/L	ND	ND	ND	ND	ND	ND	-
	Organophosphate Group								
75	Malathion	µg/L	ND	ND	ND	ND	ND	ND	-
76	Methamidophos	µg/L	ND	ND	ND	ND	ND	ND	-
77	Methidathion	µg/L	ND	ND	ND	ND	ND	ND	-
78	Mevinphos	µg/L	ND	ND	ND	ND	ND	ND	-
79	Monocrotophos	µg/L	ND	ND	ND	ND	ND	ND	-
80	Omethoate	µg/L	ND	ND	ND	ND	ND	ND	-
81	Parathion-methyl	µg/L	ND	ND	ND	ND	ND	ND	-
82	Phosalone	µg/L	ND	ND	ND	ND	ND	ND	-
83	Phosphamidon	µg/L	ND	ND	ND	ND	ND	ND	-
84	Pirimiphos-ethyl	µg/L	ND	ND	ND	ND	ND	ND	-
85	Pirimiphos-methyl	µg/L	ND	ND	ND	ND	ND	ND	-
86	Profenofos	µg/L	ND	ND	ND	ND	ND	ND	-

No.	Sampling point		SW01	SW02	SW03	SW04	SW05	SW06	National Environmental Standards No.81/MONRE 2017
	Date		12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	12/8/2021	
	Time		17:40	17:05	14:45	15:30	14:00	15:50	
	Village		Daktiem	Daktiem	Dakrun	Dakrun	Dakbong	Dakbong	
87	Prothiofos	µg/L	ND	ND	ND	ND	ND	ND	-
88	Terbufos	µg/L	ND	ND	ND	ND	ND	ND	-
89	Triazophos	µg/L	ND	ND	ND	ND	ND	ND	-

Source: Innogreen, 2021.

Note: Underlined values exceed the limit

7.3.8 Landscape Values and Visual Amenity

This section provides a summary of the existing environmental conditions within the Project study area.

The local environmental setting was determined through desktop analysis and photos from fieldwork (performed in October 2021) to gain a general understanding of the site visual context and landscape setting. The field survey landscape assessment sheet can be found in ***Appendix D***.

7.3.8.1 Landscape Baseline

The landscape is characterized by different components: topography, land use and potentially sensitive areas relating to landscape (e.g., cultural heritage sites), and according to the presence of common elements. Therefore, the proposed assessment has been developed according to the following tasks:

- Definition of the landscape study area;
- Description of the baseline landscape and topography in the study area;
- Mapping and description of Landscape Character Unit (LCUs);
- Landscape character; and
- Landscape value.

Study Area

The landscape study area of the Project was identified as a buffer of 25 km from each turbine to understand the wider landscape setting and context and where it is assumed that most of the potential impacts will occur.

Topography

The topography of Laos is largely mountainous, with the Annamite Range in the northeast and east and the Luang Prabang Range in the northwest, among other ranges typically characterized by steep terrain. Elevations are typically above 500 meters with narrow river valleys and low agricultural potential. This mountainous landscape extends across most of the north of the country, except for the plain of Vientiane and the Plain of Jars in the Xiangkhoang Plateau (EIA, 2020).

The southern "panhandle" of the country contains large level areas in Savannakhét and Champasak provinces that are well suited for extensive paddy rice cultivation and livestock raising. Much of Khammouan Province and the eastern part of southern provinces are mountainous. Together, the alluvial plains and terraces of the Mekong and its tributaries cover about 20% of the land area.

The landscape of the Project Area and topography are shown in ***Figure 7.15*** and ***Figure 7.16***, respectively.

Figure 7.15: Landscape Study Area

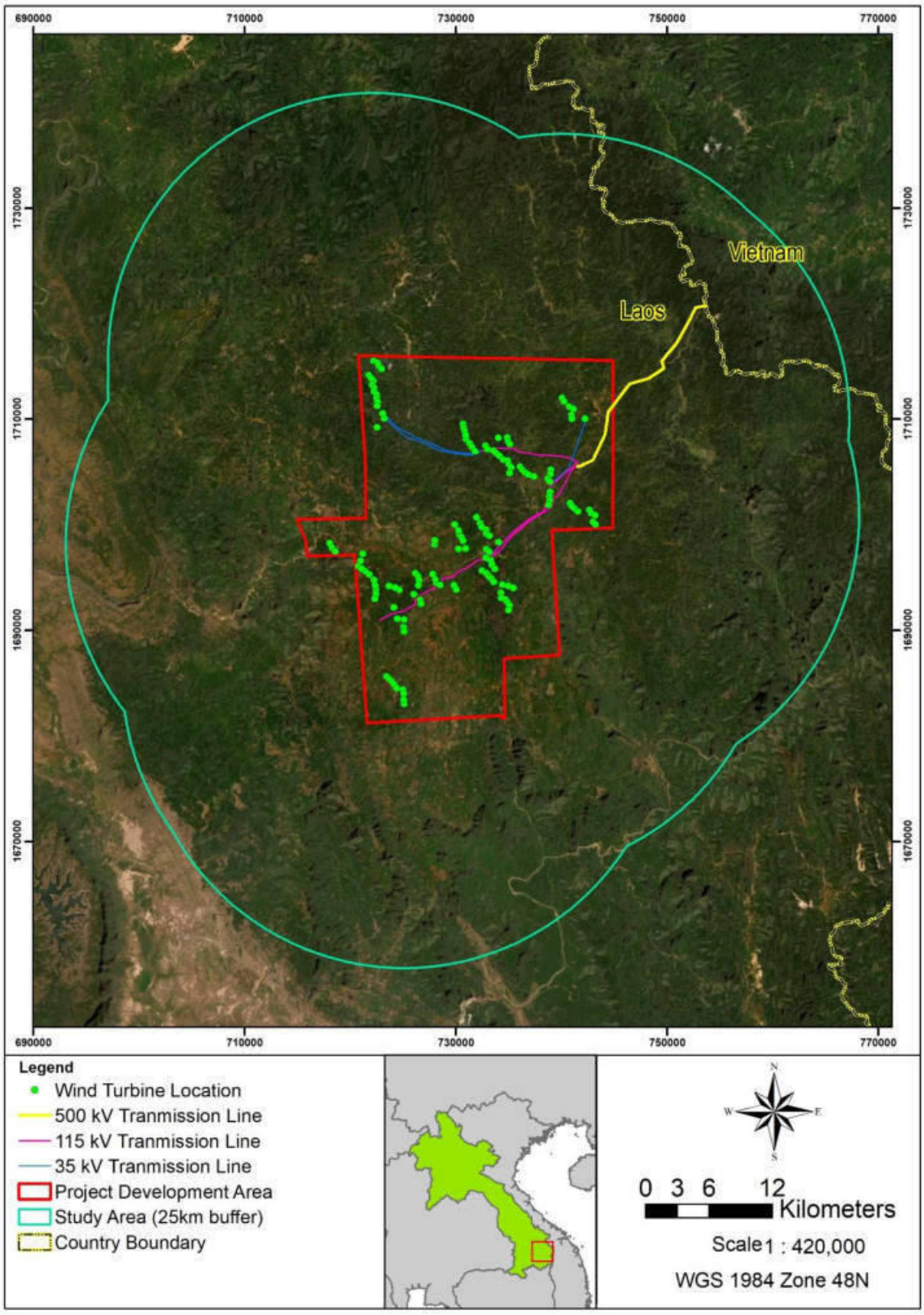
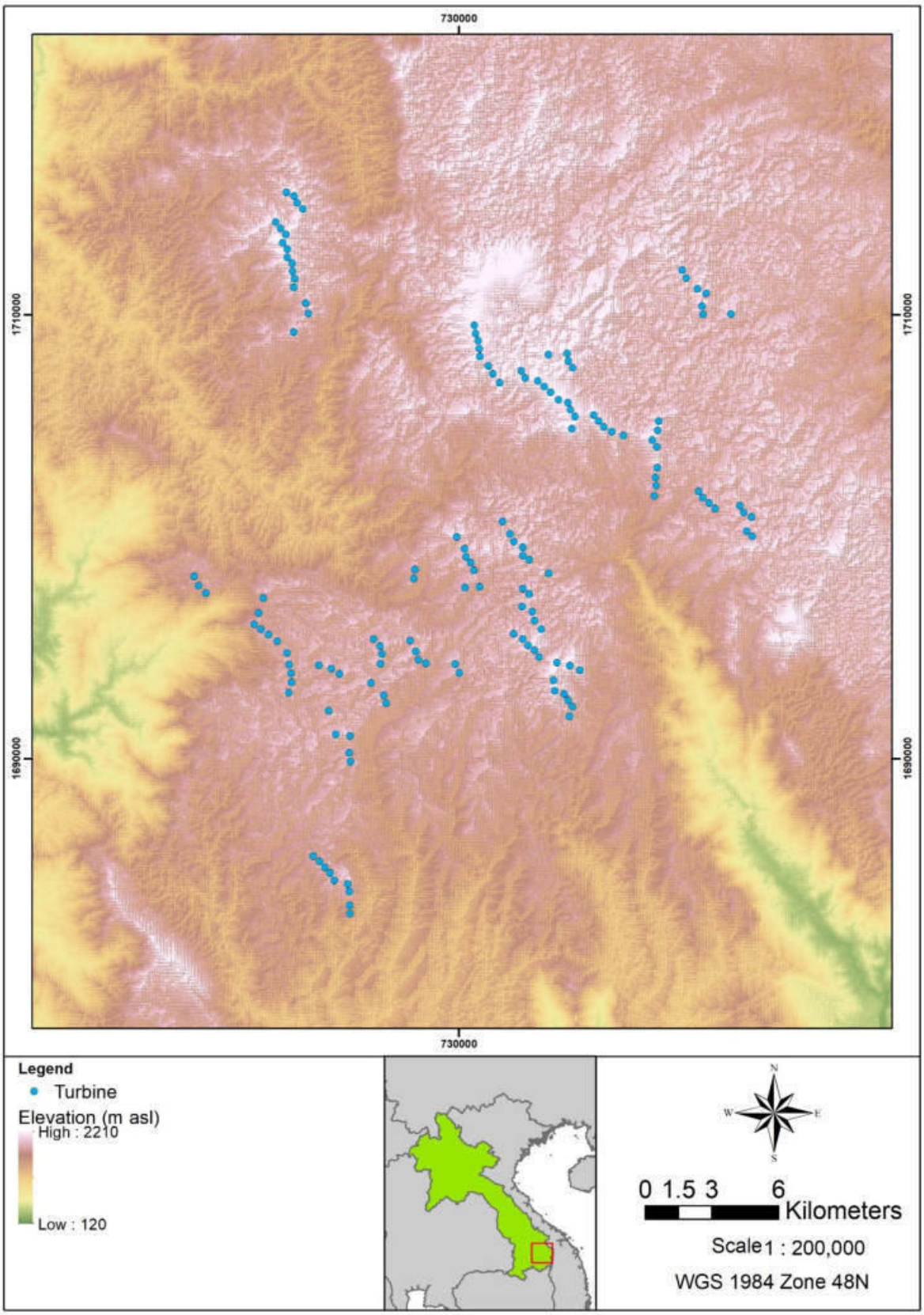


Figure 7.16: Topography of Project Area



Landscape Characteristic Unit (LCU)

The World Wildlife Fund (WWF) has classified areas into "*key ecoregions*" (***Figure 7.17***). Ecoregions are defined as large unit of land or water containing a geographically distinct assemblage of species, natural communities and environmental conditions[23]. Each ecoregion is characterized by distinct landscape characteristics.

The Project is located within a single ecoregion *Southern Annamites montane rain forests*. This area extends along the greater Annamite Range from central Vietnam and southwards to the Bolovans Plateau of Laos and the Central Highlands of Vietnam. It covers a region of high biodiversity. The terrain ranges from wet lowland forest to evergreen hardwood and conifer montane rain forest. Strong climatic gradients of rainfall and temperature are present within the ecoregion. There is a short dry season centred on January–February, but fog and dew are common throughout the year and support a lush forest.

It consists of a highly variable forest structure. At 600-900 m evergreen trees are present, dominated by species of Fagaceae, Myrtaceae, and Lauraceae, and above 900 m elevation montane hardwood forest are present that change their composition according to moisture and geological substrate. A number of significant endemic species are present, including *Pinus dalatensis* and *Pinus krempfii*.

Given the general homogeneity of the area where the Project will be located, a single Landscape Characteristic Unit (LCU) is proposed (***Figure 7.17***).

Factors affecting the sensitivity of change for landscapes are:

- Importance and rarity of special landscape elements;
- Ability of the landscape to accommodate change;
- Significance of the change in the local and regional context; and
- Maturity of the landscape.

Figure 7.18 provides photos from the site showing some of the main features of the landscape.

[23] https://www.worldwildlife.org/biomes

Figure 7.17: Landscape Characteristic Unit (LCU)

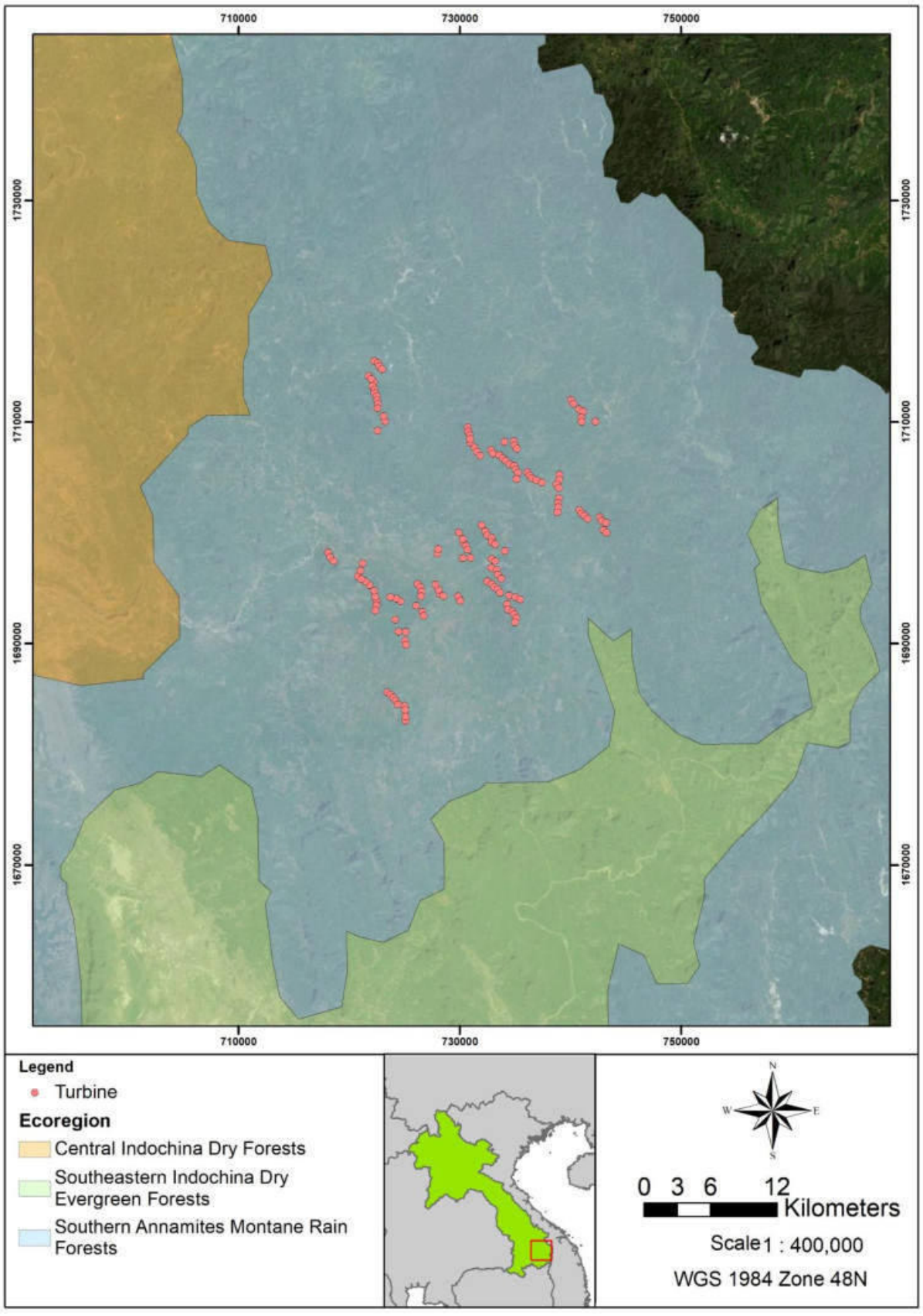


Figure 7.18: Photo of Nearby Landscape




Protected landscape

During the desktop baseline review, the following national and international protected areas have been considered:

- BirdLife International Important Bird Areas (IBA) and Endemic Bird Areas;
- International Union for Conservation of Nature (IUCN) Protected Areas;
- RAMSAR[24] Wetlands of International Importance;
- United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere (MAB) Reserves;
- World Heritage Sites; and
- World Commission on Protected Areas.

Based on the outcomes of the desktop review, the 25 km buffer of the Project Area intersects with two relevant protected areas, Dong Ampham (Laos) a National Protected Area, and Song Thanh (Vietnam) a nature reserve. These are shown in ***Figure 7.19***.

Dong Ampham

Dong Ampham National Biodiversity Conservation Area is a protected area which covers the northeastern part of Attapeu Province and southeastern part of Sekong Province in the southeast corner of Laos on the border with Vietnam.[25] The Dong Ampham IBA is also located within Dong Ampham Protected Area. The area is located 15 km from the wind turbine boundary and 25 km from the transmission line of the Project.

It consists of around 200,000 ha covered by a heavily forested area and it forms one of the National Biodiversity Conservation Areas of Laos. The area was established on 29 October 1993 and contains areas of lowland and tropical forests. Rivers flowing through the park include Xe Kaman River and Xe Xou River. The wetlands are home to populations of Siamese crocodiles and elephants, and large cats are known to inhabit the park.

Song Thanh

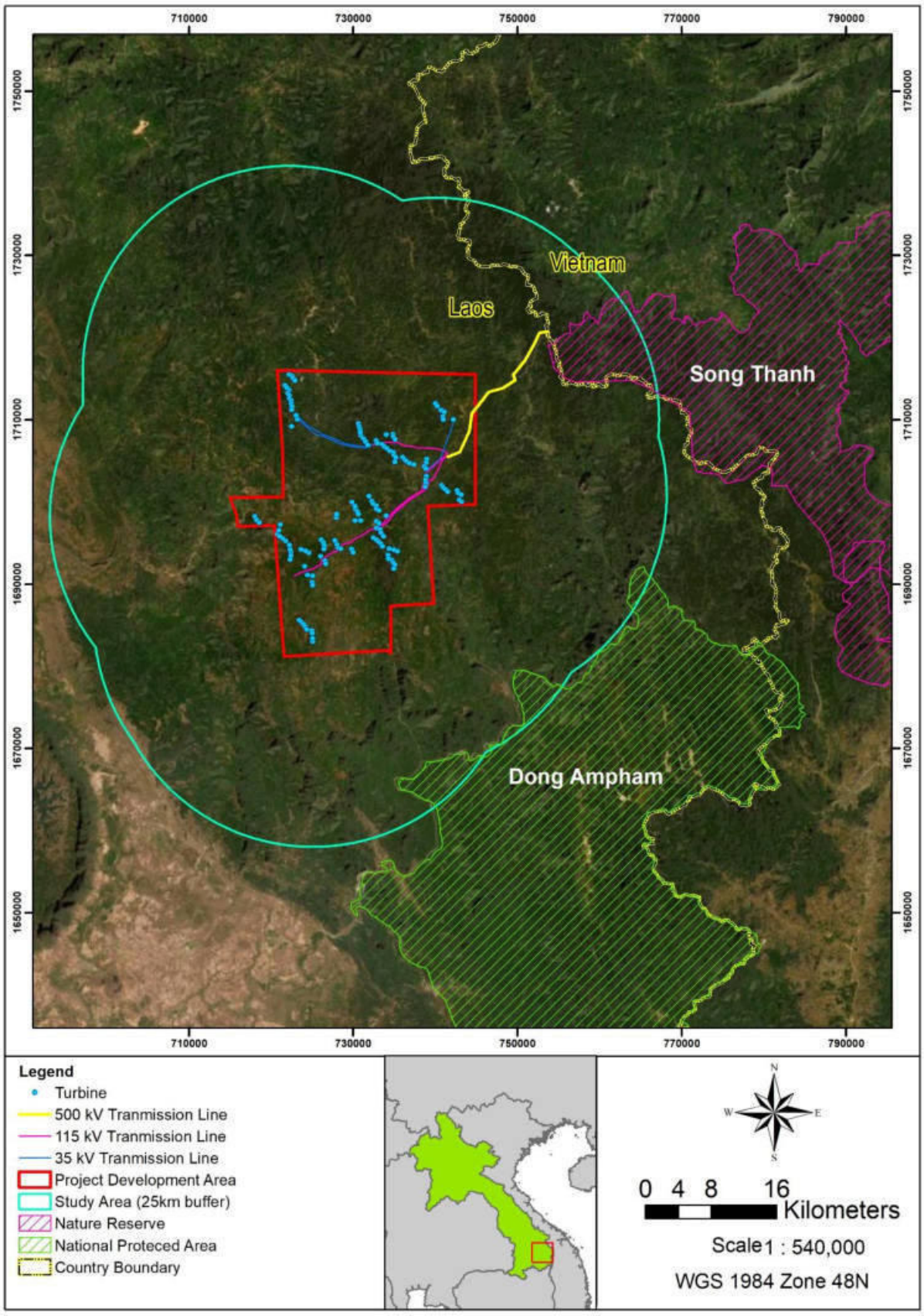
Song Thanh Nature Reserve is located in Southwest Quang Nam province with a total area of 76,964 ha and it was designated in October 2000. Song Thanh Nature Reserve is recognized as a Key Biodiversity Area (KBA) because of the importance of its mammal fauna, and is also a globally important conservation corridor. The area is located 11 km from the wind turbine boundary and right next to the transmission line of the Project.

Key species recorded include three mammals endemic to this landscape; Owston's civet *Chrotogale owstoni*, the Annamite striped rabbit *Nesolagus timminsi*, and the large-antlered muntjac *Muntiacus vuquangensis*. The last one is listed as Critically Endangered (IUCN, 2018) and it is one of the highest priority species in the Annamites.

[24] The Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat

[25] BirdLife International, http://datazone.birdlife.org/site/factsheet/dong-ampham-iba-laos

Figure 7.19: Protected Areas



7.3.8.2 Visual Baseline

Visual interferences may occur when new elements are introduced into a landscape or existing elements are altered or removed leading to a change in the way that stakeholders' perceive or experience landscape resources.

The proposed visual baseline has been developed according to the following tasks:

- Study area definition;
- View-shed analysis; and
- Viewpoint and sensitive receptor identification.

Study Area Definition and View-shed

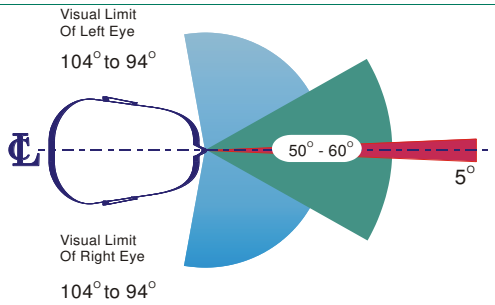
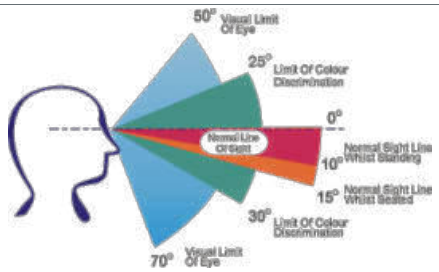
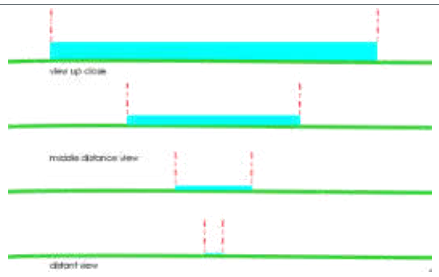
The visual study area is defined as the area within which the Project could be discernible by the human eye and could interfere with the main sensitivities identified in the local context.

To identify the study area, the Zone of Theoretical Visibility (ZTV) has been determined through computer analysis of topographical mapping to establish the theoretical distance from which the wind turbines could be visible in each direction.

The wind turbines are the major visual element of the proposed development and may visually impact the surrounding areas. As the viewer moves further away from these structures the visual impact decreases until it is no longer visible. However, before the point of non-visibility is reached, the wind turbines have reduced in scale such that they no longer have a significant visual impact.

Table 7.11 explains how a view-shed is defined and identified depending on the horizontal and vertical field of views.

Table 7.11: Field of View

Field of View	Diagram
A. Horizontal Field of View For most people, the horizontal central field of view covers an angle of between 50° to 60°. Within this angle, both eyes observe an object simultaneously but from a slightly different angle. This creates a central field of greater magnitude than that possible by each eye separately. This central horizontal field of view is termed the 'binocular field' (see green zone). Within this field images are sharp, depth perception occurs and color discrimination is possible. Research suggests that the visual impact of a project component will vary according to the proportion the binocular field it occupies. Project components that occupy 5%/2.5° or less of the horizontal central binocular field of vision are usually perceived as insignificant objects, whereas components that occupy 30° are considered to be visually dominating.	
B. Vertical Field of View The vertical central field of view has a similar set of parameters. The vertical binocular field is normally 25° above the vertical and 30° below the vertical. When project components exceed the 50° upper visual limit of the eye, they are considered to dominate the vertical central field of view. When project components occupy 0.5° they are not considered dominant, nor are they usually perceived as a significant change to the existing baseline condition when they are located within an anthropogenically modified landscape.	
C. Horizontal Versus Vertical Visibility Over Distance As a person moves further away from a project component, the visibility of the vertical dimension tends to reduce more significantly than the visibility of the horizontal dimension.	

The wind farm is comprised of a number of individual turbines of the same dimensions (110 m height for both 4.5MW and 4.0MW, and 155m diameter for 4.5MW and 165m for 4.0MW), with large separation distances between each individual turbine, about 300 m. When assessing the visual impact of the wind turbines, it is assumed that the largest horizontal component is the entire rotor, which would be a maximum of 165 m wide.

As shown in ***Table 7.12***, calculations suggest that the impact of a 165 m wide wind turbine rotor would reduce to be insignificant at about 3.8 km, as it would form less than 5% or 2.5° of the horizontal field of view (physical parameters are illustrated in ***Table 7.13***).

Table 7.12: Horizontal field of view

Horizontal Field of View	Impact	Distance from Observer to 165 m Turbine Rotor
<2.5° of view	The development will take up less than 5% of the central field of view. The development, unless particularly conspicuous against the background, will not intrude significantly into the view. The extent of the vertical angle will also affect the visual impact.	>3.8 km
2.5° – 30° of view	The development will usually have a moderate impact that may not be noticeable at the greatest distance of this range.	285 m to 3.8 km
>30° of view	Developments that fill more than 50% of the central field of vision will always be noticed and only sympathetic treatments will mitigate visual effects.	< 285 m

A similar analysis can be undertaken based upon the vertical field of view for human vision. Table 7.13 shows the relationship between impact and the proportion that the development occupies within the vertical line of sight.

Table 7.13: Vertical field of view

Vertical Line of Sight	Impact	Distance from Observer to a 192.5 m Turbine
< 0.5° of vertical angle	A thin line in the landscape.	>22 km
0.5° – 2.5° of vertical angle	The degree of visual intrusion will depend on the development's ability to blend in with the surroundings.	5.1 – 22 km
> 2.5° of vertical angle	Usually visible, however the degree of visual intrusion will depend on the width of the object and its placement within the landscape.	<5.1 km

Based on the above, it is reasonable that distances greater than 22 km would result in an insignificant magnitude of visual impact from the wind turbines, as a fully visible wind turbine would be an insignificant element within the landscape.

Generally, the more conservative or worse-case distances form the basis for the assessment of visual impacts. Therefore, for this Project the greater impacts would be associated with the vertical field of view and so it is proposed to extend the view shed to 25 km for the wind farm.

Arc Map 10.8 was used to determine the ZTV for the Project. The current visibility within the ZTV will vary depending on the presence of intervening local topography and other features, such as vegetation and buildings. The present view shed analysis has been based solely on topography and did not take into account the potential screening granted by the local vegetation patches, which would further reduce the actual view shed. Moreover, it should be highlighted that a typical view shed assessment does not take typical meteorological conditions into account that can result in changes to real visibility. For example, rainfall and other atmospheric conditions (e.g., sand transported by the wind) will alter the visibility of the Project. The diminution of visual clarity bought about by atmospheric conditions also increases with distance, and cloudy days can result in a natural attenuation of the visibility of the Project.

Three different view shed analyses were undertaken at different heights to provide a better understanding of the degree of visibility. These mapping outputs illustrate the number of wind turbines potentially visible from within the Study Area for the different turbine visibility elements.

Figure 7.20 and ***Table 7.14*** show the range of visibility options that have been mapped for turbines in the following GIS based analysis and ***Figure 7.21, Figure 7.22***, and ***Figure 7.23*** show the ZTV mapping.

Table 7.14: Mapping Turbine Visibility Elements

Zone	Extent That Wind Turbines Are Visible
Zone A	One or more wind turbines in their entirety
Zone B	The entire path of the blades of one or more wind turbines
Zone C	At least half of the path of one or more wind turbines
Zone D	Any part of the wind turbine blades of one or more wind turbines

Figure 7.20: Turbine Visibility Elements

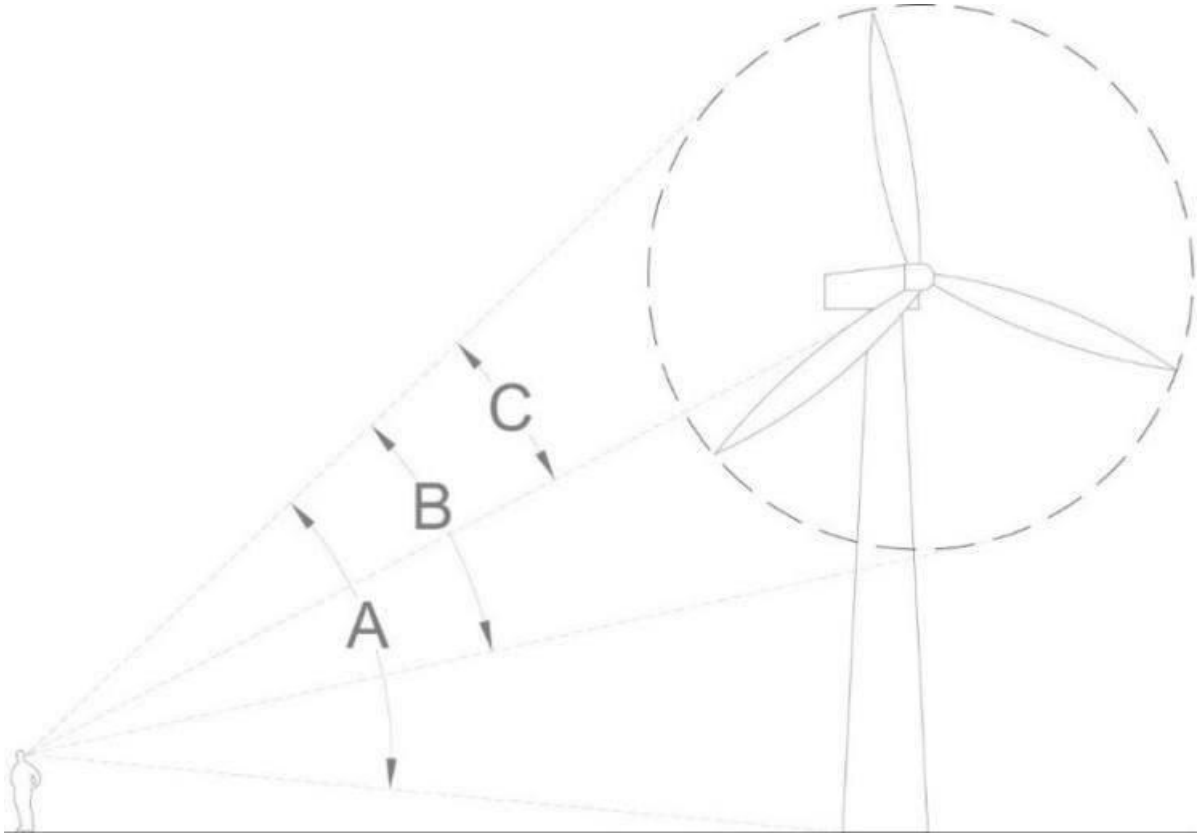


Figure 7.21: View shed Zone A: One or more wind turbines in their entirety

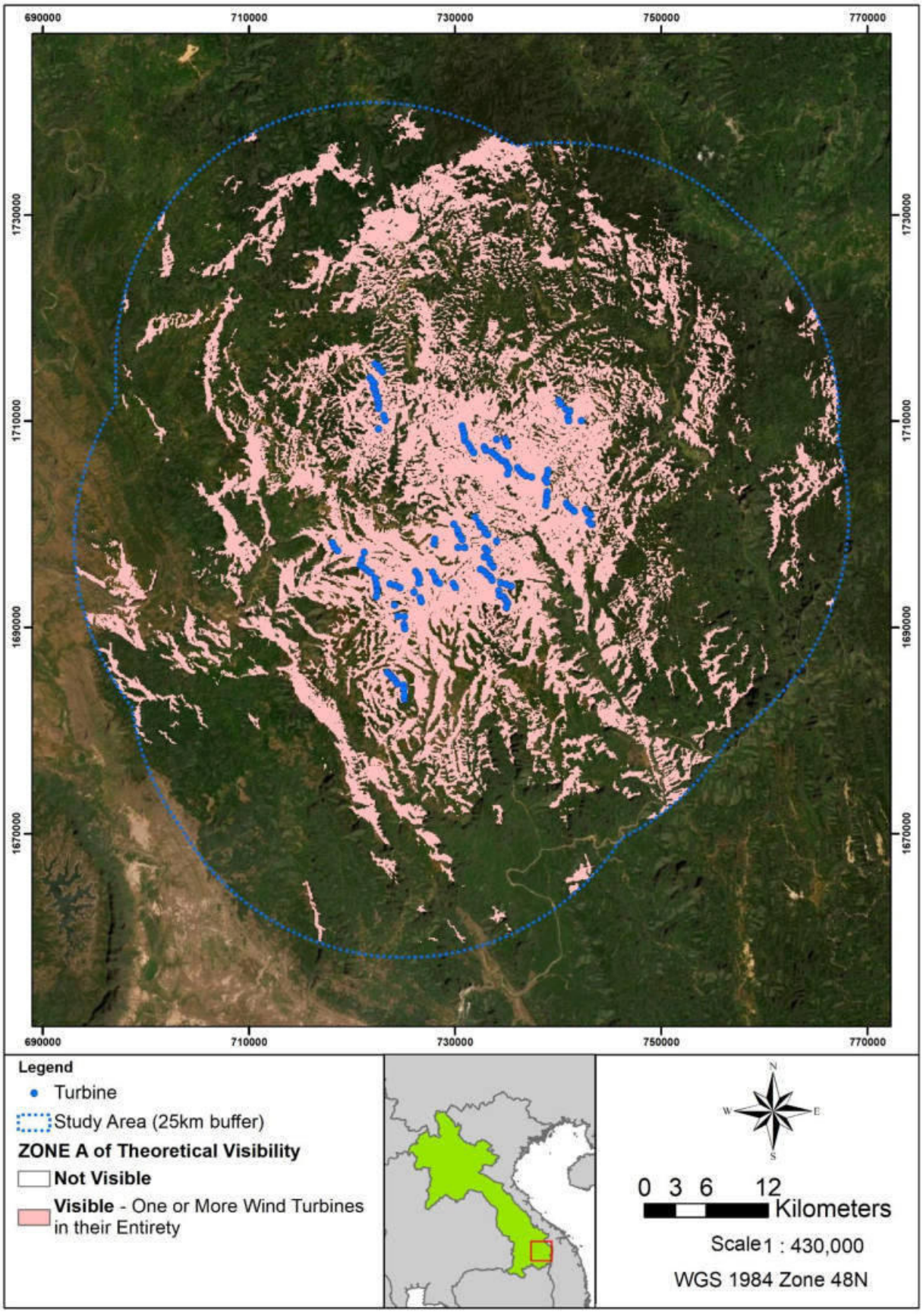


Figure 7.22: View shed Zone B: The entire path of the blades for one or more wind turbines

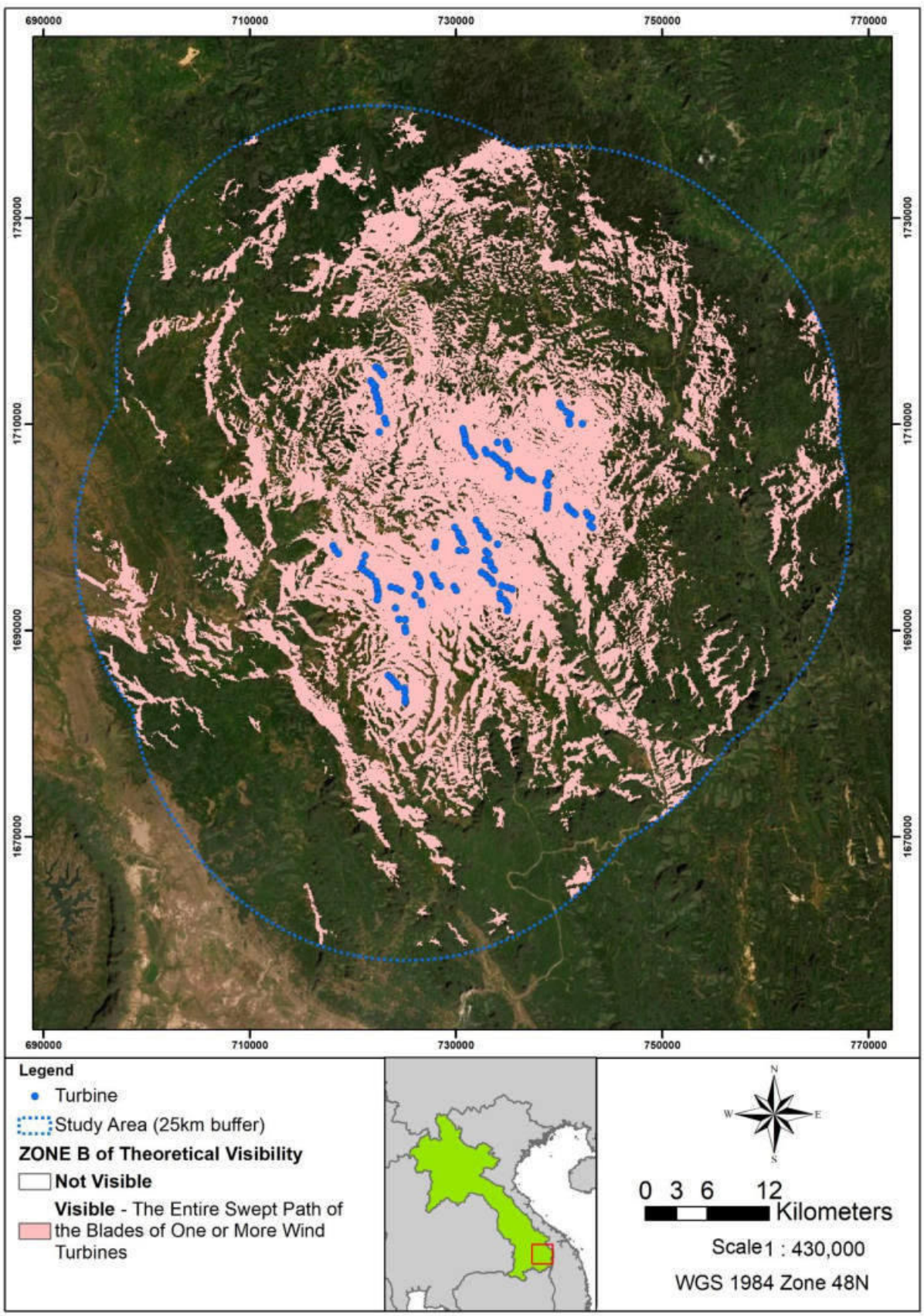
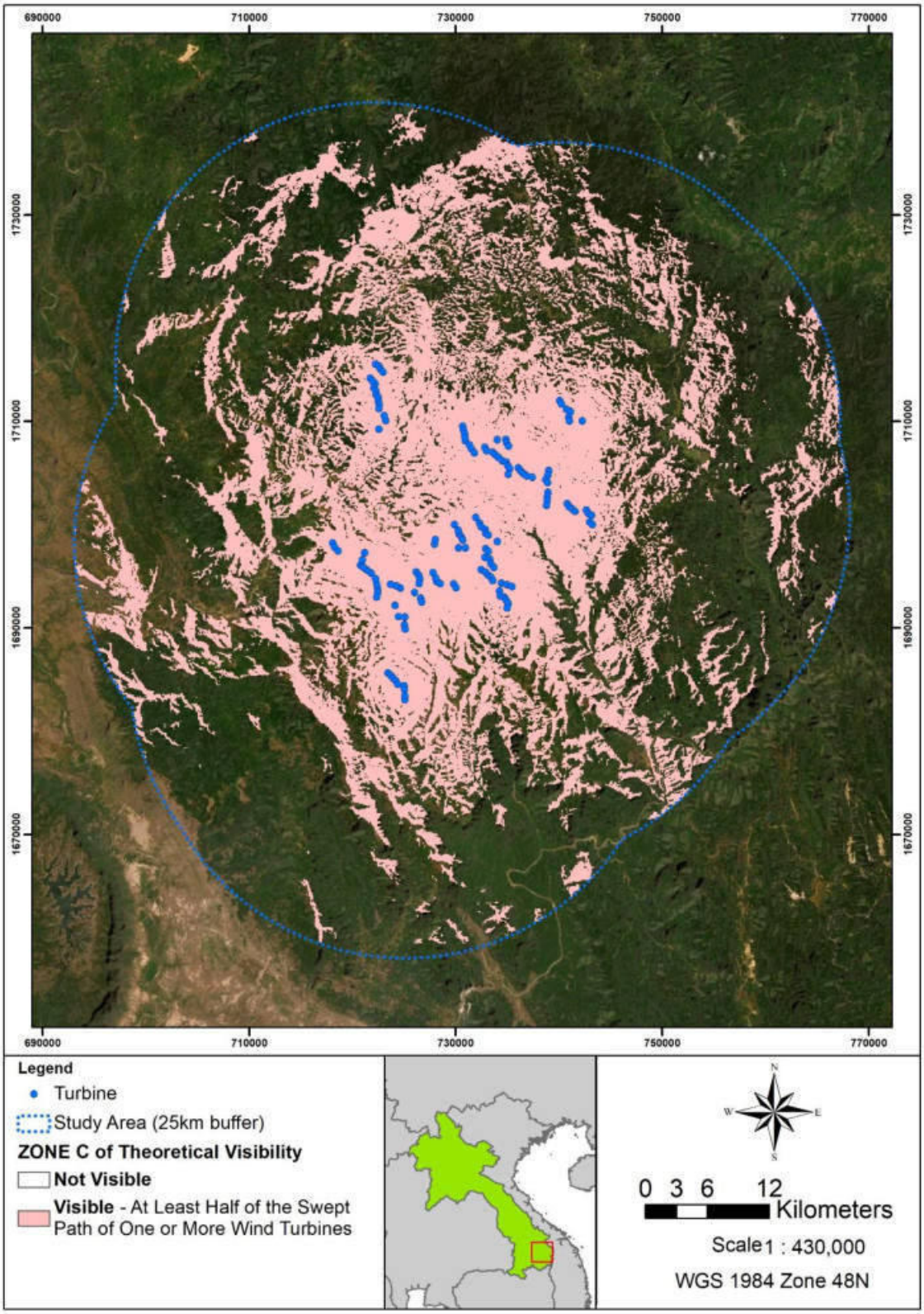


Figure 7.23: View shed Zone C: At least half of the path of one or more wind turbines



The results of the view shed assessment show that the visibility is strongly influenced by the morphology of the area. The roughness of the terrain makes the chance to see the wind turbines highly variable, both in their entirety and partially.

It should be emphasized that intervening vegetation is not included in this mapping and is likely to significantly reduce the visibility of wind turbines, in whole or in part, and therefore reduce the impact identified.

Regarding the potential visibility from local communities, wind turbines, either in whole or in part, will be visible from main residential areas, such as Ban Daktrab and Dakchueng. In addition, several settlements spread over the communes inside the Study Area, may be able to see the turbines.

7.3.8.3 Viewpoints Identification

In order to assess the visual baseline, 19 viewpoints have been identified within the Study Area, in order to be exhaustive of different landscape components. These viewpoints are referred to as Visual Sensitive Receptors (VSRs). They represent points within the view shed from where people will be able (or not) to see the Project, and where the quality of the landscape and visual resources of people could be affected by the presence of the Project.

It should be noted that, in order to screen the potential sensitive receptors, the following criteria have been used to assess the sensitivity of the VSRs:

- Value and quality of existing views;
- Type and estimated number of receiver population;
- Duration of frequency of view; and
- Degree of visibility.

Table 7.15 and ***Figure 7.24*** show the locations of the VSRs as representative of the general landscape character of the area, from locations within the Study Area varying in distance and elevation.

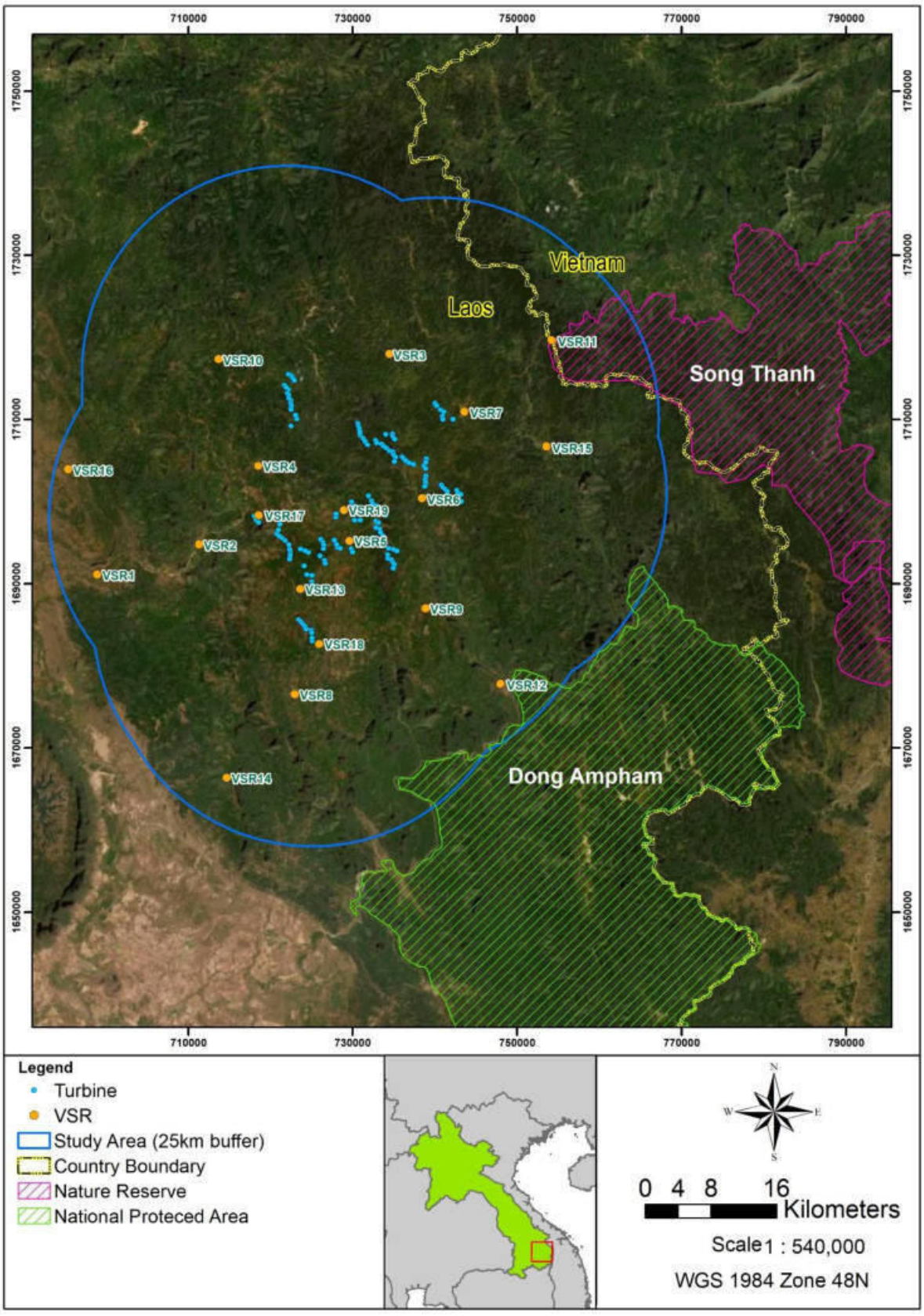
Table 7.15 provides the coordinates of the points and their distance from the closest turbine. The coordinates are expressed in WGS 1984/UTM Zone 48N (EPSG: 32648).

Table 7.15: Location of the proposed VSRs

VSR ID	X (East)	Y (South)	Type of Receptor
VSR01	698,867	1,691,144	Near village, along the road
VSR02	711,489	1,709,838	Near village
VSR03	710,714	1,694,729	Near village, along the road
VSR04	740,409	1,734,426	Near village
VSR05	706,005	1,720,205	Near village
VSR06	734,096	1,718,292	Near village
VSR07	723,632	1,726,066	Near village
VSR08	707,168	1,730,290	Near village
VSR09	718,416	1,704,511	Near village
VSR10	713,683	1,717,358	Near village – not accessible during the survey
VSR11	729,600	1,695,145	Near info centers and protected area, along the road and the national boundary
VSR12	729,412	1,705,295	Closed to protected area and lake
VSR13	738,352	1,700,353	Near village, along the road

VSR ID	X (East)	Y (South)	Type of Receptor
VSR14	714,606	1,666,434	Near village – not accessible during the survey
VSR15	727,631	1,734,549	Near village, close to the dam
VSR16	695,587	1,704,560	Mountain
VSR17	718,596	1,698,390	A school near the village
VSR18	725,898	1,682,732	Near village
VSR19	728,863	1,699,044	Near village

Figure 7.24: Location of the proposed VSRs



7.3.9 Natural Hazards

Based on the local ESIA (Sept 2020), natural disasters that are the most dangerous challenges to the Project development are floods, earthquakes, and landslides. The secondary data of natural disasters are summarized in the following points:

7.3.9.1 Floods

The topographic conditions of the Project area and nearby area is composed mostly of hills and high mountains, and there are no large rivers that will cause flooding in this area. And according to global flood data there is no historical flood event is recorded for the Project area.[26] [27]

In 2019 during August and September, Meteorology Station of Dak Cheung District recorded the maximum rainfall during the historical five (5) years (Table 7.2). In 2020 after two consecutive tropical storms lashed the region earlier September, Kaluem District (Jing, Songkhone, and Loy Villages) and Dakchung District (Darkdin Village) in Sekong province experienced the flooding of around 3,000 people were affected, and two people had lost their lives[28] .

7.3.9.2 Earthquakes

Lao PDR is located in the central part of the Indochina Peninsular between latitude: 13°54'- 22°30' N and longitude: 100°05' - 107°59' E, which is not located on an area of the tectonic plate boundaries. Consequently, it has low record of earthquake occurrences.

According to data from the Meteorological and Earthquake Network Division, Department of Meteorology and Hydrology, Ministry of Natural Resources and Environment (as summarised in the EIA, 2020), earthquake events have occurred in Lao PDR is in 2007 in Xayaboury Province. The latest earthquake occurrence was in 2019 in the area of Hongsa District of Xayaboury Province. For Sekong Province, Attapeu Province, and the proposed Project area, there is no record of an earthquake occurrence since ever record in the history.[29] However, the design of the turbines considers standards relevant for earthquakes.

There is no record of earthquake occurrence in the Project site or in Sekong and Attapeu provinces. However, the Project will be designed in accordance with standards so that the Project is capable of withstanding an earthquake.

7.3.9.3 Landslides

Rainfall is the main cause of landslides (soil erosion). Other factors are the slope of the soil, rock conditions and improper land use. Saravane and Sekong District are identified as highly susceptible to landslides according to UNDP Support National Hazard Profile in 2020. The climate impacts on rural roads are mainly related to flooding and landslides given some of the road in both Provinces are unpaved. Increasing incidence of landslides is being observed in the upper catchments of the Sedon and Sekong rivers, while increased flooding is being observed in the lower catchments and along the Mekong River.[30] The Project is at least 30 km distance to Sekong River.

[26] Global Flood Map, Laos Flood Map | Map of Potential Flooding in Laos (globalfloodmap.org)
[27] Reliefweb, UNOSAT Training activities (reliefweb.int)
[28] Reliefweb MDRLA007dfr.pdf (reliefweb.int)
[29] United States Geological Survey (USGS), https://earthquake.usgs.gov/
[30] UNDP, Project Document - Deliverable Description (undp.org)

7.4 Biological Environment Baseline

7.4.1 Introduction

This section provides an overview of the baseline conditions in the biodiversity baseline study area, i.e. the EAAAs as depicted on the map that appears in ***Figure 7.1***. Included is a description of the identified legally protected areas and areas with recognized high biodiversity values (***Section 7.4.2***), habitats and species that occur in this area, and the important biodiversity values associated with the Project area. Information was compiled and evaluated from desktop studies, field surveys, and consultation with key experts and other stakeholders, to support a comprehensive understanding of the biodiversity values that are present in the EAAAs.

Desktop studies considered global biodiversity datasets, as well as published and publicly available information. Key information sources included:

- The Integrated Biodiversity Assessment Tool (IBAT), which draws from:
  - The IUCN (International Union for Conservation of Nature) Red List of Threatened Species;
  - Key Biodiversity Area (KBA) database; and
  - The World Database on Protected Areas which encompass nationally and internationally recognised sites, including IUCN management categories I-VI, Ramsar Wetlands of International Importance (Ramsar site), and the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage sites.
- The IUCN Red List of Ecosystems.

Field data was collected to further inform the understanding of the important biodiversity values within the study area, and the findings are described in detail in ***Appendix F***. This included:

- A Rapid Ecological Assessment ("REA") (conducted between December 2020 and January 2021) to: (i) help ground truth the aerial habitat mapping, by identifying the main types of habitat and dominant vegetation at pre-selected survey points in each of the main turbine areas and transmission line; and (ii) provide an overview of the actual and likely species present, which in turn helps inform priority survey areas for the main wet and dry season follow up surveys;
- Monthly bird field survey campaigns across 12 months and covering all relevant seasons (December 2020 – November 2021);
- Five bat field survey campaigns, of which three campaigns were undertaken in the dry season (February and March 2021), and two campaigns were undertaken in the wet season (June and July 2021); and
- Two mammal, herpetofauna (reptiles and amphibians) and plant field survey campaigns in the wet season (July – August 2021), and dry season (November - December 2021) were undertaken based on the results of the REA [findings contained in the unpublished Biodiversity Assessment Report compiled by Phiapalath *et al.* (2022[31]].

To meet ADB SPS requirements, a Critical Habitat Assessment (CHA) was undertaken to identify the presence and extent of the important biodiversity values (i.e. natural habitat-associated values, critical habitat-qualifying values and other values of conservation and/or stakeholder concern) in the EAAA that could result in the categorization of the Project area as critical habitat. A summary of the approach and findings of the CHA is provided in ***Section 7.4.5,*** with the full details of the CHA presented in ***Appendix G***.

[31] Phiapalath, P., Khotpathoom, T. and Souladeth, P. (2022). Biodiversity Assessment of Monsoon Windfarm Power Project. Unpublished report compiled for Environmental Resources Management (ERM), Thailand. Final draft report, January 2022.

7.4.2 Legally Protected Areas and Areas with Recognized High Biodiversity Values

Legally Protected Areas ("PAs") include areas that are legally designated or officially proposed for biodiversity protection and conservation.

For this ESIA, areas with recognized high biodiversity values include KBAs, AZEs, UNESCO World Heritage sites, Ramsar site, and EBAs. These areas are defined as follows:

- **KBA**[32] - Key Biodiversity Areas are sites that contribute significantly to the global persistence of biodiversity and being applicable to terrestrial, freshwater, and marine ecosystems. Sites qualify as global KBAs if they meet one or more of eleven criteria, grouped into the following five categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes, and irreplaceability. KBAs typically include:
  - Important Bird and Biodiversity Areas ("IBA") identified by the BirdLife International Partnership;
  - Alliance for Zero Extinction sites ("AZE") containing 95% or more of the remaining population of one or more species listed as Endangered (EN) or Critically Endangered (CR) on the IUCN Red List;
  - KBAs identified through hotspot ecosystem profiles supported by the Critical Ecosystem Partnership Fund; and
  - A small number of other KBAs such as Important Plant Areas ("IPA"), and KBAs covering multiple taxonomic groups in freshwater, marine, and terrestrial systems.
- **UNESCO World Heritage site** – a site selected by UNESCO as having cultural, historic, scientific or other forms of significance. These areas are legally protected by international treaties and demarcated by UNESCO as protected zones.
- **Ramsar site** – wetlands of 'international importance' identified under the International Convention of Wetlands, called the Ramsar Convention, which is an intergovernmental treaty that provides the framework for the conservation and use of wetlands and their resources.
- **EBA** – Endemic Bird Areas are sites where the distribution of two or more restricted-range bird species is entirely included within the defined site boundary.

In accordance with ADB guidance areas with recognized high biodiversity values also included areas that have been voluntarily conserved by indigenous peoples and local communities through customary laws or other effective means.

One legally protected area, and six areas with recognised high biodiversity values overlap with, or are located within the EAAAs for volant and non-volant species, defined for the Project.

These are summarised in ***Table 7.16***, and shown on the map in ***Figure 7.25***.

[32] IUCN Species Survival Commission and IUCN. A Global Standard for the Identification of Key Biodiversity Areas - https://portals.iucn.org/union/sites/union/files/doc/a_global_standard_for_the_identification_of_key_biodiversity_areas_final_web.pdf

Table 7.16: Legally Protected Areas and Areas with Recognized High Biodiversity Values identified in the EAAAs

Name	Designation[1]	Overlap with the Project footprint?	Distance from EAAAs and direction	Details[2]
Dak Cheung **Plateau**	KBA, IBA	Yes	0 km (located within EAAA)	**Coordinates**: 15.356353, 107.135328 **IUCN Category**: - **Area Coverage**: 51 km^2 1. **Trigger species**: 2. Black-crowned Barwing (*Actinodura sodangorum*), VU (Vulnerable) 3. Asian Elephant (*Elephas maximus*), EN (Endangered) 4. Pygmy Slow Loris (*Nycticebus pygmaeus*), VU 5. Tiger (*Panthera tigris*), EN 6. Impressed Tortoise (*Manouria impressa*), VU
Ngoc Linh	KBA, IBA, AZE, PA	No	9.6 km (to north-east)	**Coordinates**: 15.324767, 107.725319 **IUCN Category**: IV **Area Coverage**: 297 km^2 **Trigger species**: *1. Brachytarsophrys intermedia*, VU 2. Thorny Tree Frog (*Gracixalus lumarius*), EN 3. Appleby' Leaf-litter Toad (*Leptobrachella applebyi*), EN *4. Leptobrachium banae*, VU 5. Chinese Edible Frog (*Quasipaa spinosa*), VU *6. Rhacophorus annamensis*, VU 7. Misty Moss Frog (*Theloderma nebulosum*), EN 8. Black-crowned Barwing (*Actinodura sodangorum*), NT (Near Threatened) 9. Golden-winged Laughingthrush (*Trochalopteron ngoclinhense*), EN 10. Dhole (*Cuon alpinus*), EN 11. Stump-tailed Macaque (*Macaca arctoides*), VU 12. Northern Pig-tailed Macaque (*Macaca leonina*), VU 13. Red-cheeked Gibbon (*Nomascus gabriellae*), DD (Data-Deficient) 14. Tiger (*Panthera tigris*), EN 15. Red-shanked Douc Langur (*Pygathrix nemaeus*), EN

Name	Designation[1]	Overlap with the Project footprint?	Distance from EAAAs and direction	Details[2]
				16. Poilane's Catkin Yew (*Amentotaxus poilanei*), VU 17. Eagle Wood (*Aquilaria crassna*), CR 18. Mann's Plum Yew (*Cephalotaxus mannii*), VU 19. *Cinnamomum balansae*, EN 20. *Dipterocarpus baudii*, CR (Critically Endangered) 21. *Knema saxat*ilis, VU 22. *Knema sessiflora*, VU 23. *Madhuca pasquieri*, VU 24. *Schefflera kontumensis*, EN
Phou Kathong	KBA, PA	No	2.8 km (to south-west)	**Coordinates**: 15.059711, 106.994783 **IUCN Category**: - **Area Coverage:** 1,080 km^2 **Trigger species:** **1.** Asian Elephant (*Elephas maximus*), EN
Phou Ahyon	KBA, IBA, AZE	No	6.5 km (to north)	**Coordinates**: 15.761714, 107.131703 **IUCN Category**: - **Area Coverage**: 339 km^2 **Trigger species**: 2. *Leptobrachium xanthops*, EN 3. Vietnamese Cutia (*Cutia legalleni*), NT 4. Indochinese Fulvetta (*Fulvetta danisi*), LC (Least Concern) 5. Black-hooded Laughingthrush (*Garrulax milleti*), LC 6. Necklaced Barbet, (*Psilopogon auricularis*), LC 7. Yellow-billed Nuthatch (*Sitta solangiae*), NT 8. Stump-tailed Macaque (*Macaca arctoides*), VU 9. Red-shanked Douc Langur (*Pygathrix nemaeus*), EN
Song Thanh	KBA, PA	No	10.6 km (to north-east)	**Coordinates:** 15.473311, 107.650292 **IUCN Category**: Not Reported **Area Coverage**: 890 km^2

Name	Designation[1]	Overlap with the Project footprint?	Distance from EAAAs and direction	Details[2]
				Trigger species: 10. Stump-tailed Macaque (*Macaca arctoides*), VU 11. Northern Pig-tailed Macaque (*Macaca leonina*), VU 12. Red-cheeked Gibbon (*Nomascus gabriellae*), EN 13. Pygmy Slow Loris (Nycticebus pygmaeus), VU 14. Tiger (*Panthera tigris*), EN 15. Red-shanked Douc Langur (*Pygathrix nemaeus*), EN 16. Eagle Wood (*Aquilaria crassna*), CR 17. *Dalbergia balansae*, VU 18. *Dipterocarpus grandiflorus*, CR 19. *Dipterocarpus retusus*, VU 20. *Dipterocarpus turbinatus*, CR 21. *Hopea hainanensis*, CR 22. *Hopea odorata*, VU 23. *Hopea siamensis*, CR 24. *Hydnocarpus annamensis*, VU 25. *Knema pierrei*, VU 26. *Knema saxatilis*, VU 27. *Madhuca pasquieri*, VU 28. White Seraya (*Parashorea stellata*), CR 29. Indochinese Box Turtle (*Cuora galbinifrons*), CR
Upper Xe Kaman	KBA, IBA	No	0 km (overlap within EAAA)	**Coordinates**: 15.083333, 107.283333 **IUCN Category**: - **Area Coverage**: 297 km^2 **Triggered species**: 30. Masked Finfoot (*Heliopais personatus*), EN

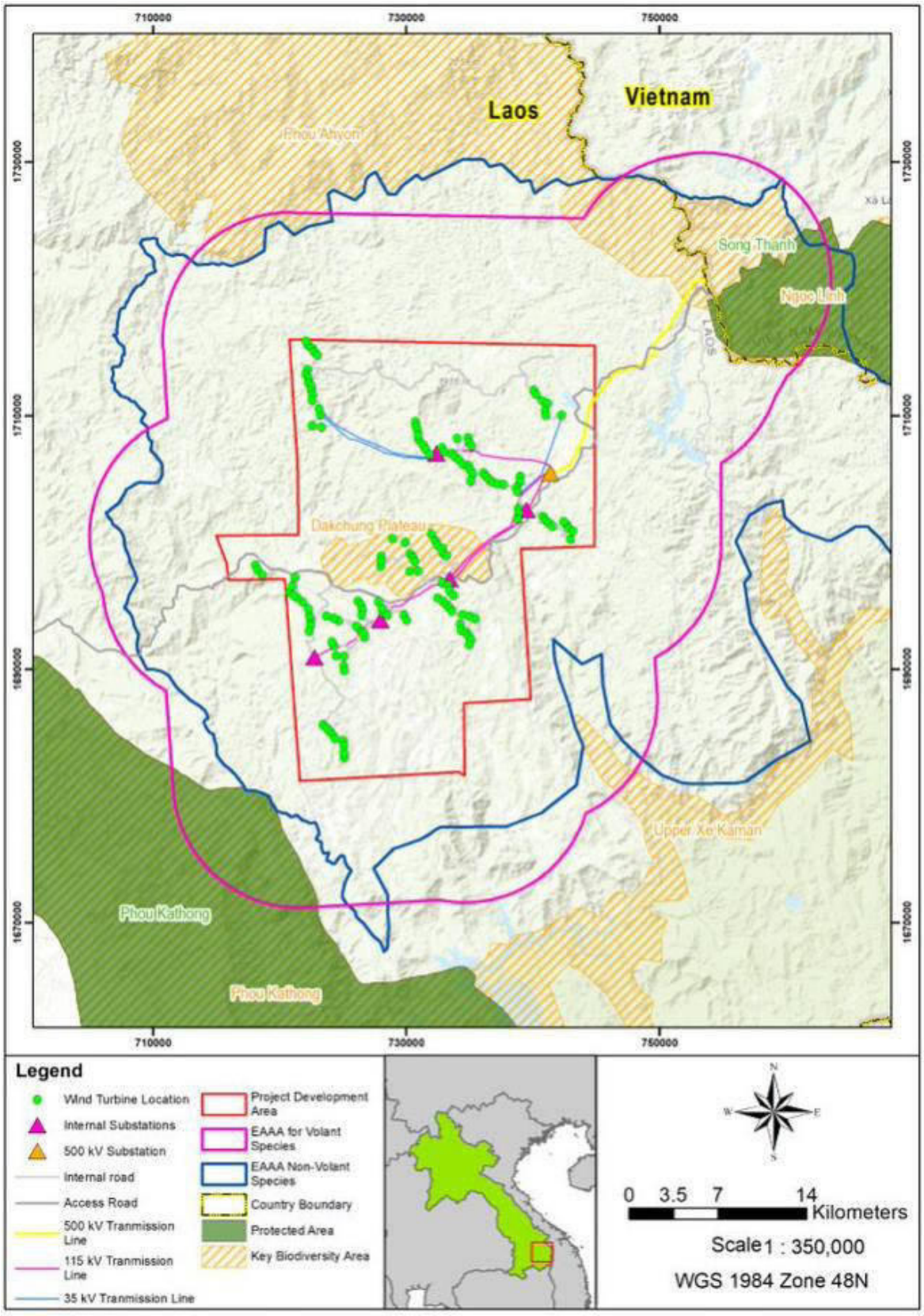
Key to table:

[1] KBA = Key Biodiversity Area, IBA = Important Bird Area, AZE = Alliance for Zero Extinction site, PA = Legally Protected Area

[2] CR = Critically Endangered, EN = Endangered; VU = Vulnerable; NT = Near Threatened; LC = Least Concern

Source of information: IBAT (2020)

Figure 7.25: Legally Protected Areas, and Areas with Recognized High Biodiversity Values within and overlapping the EAAAs



Source of information: ERM (2022).

7.4.3 Land Cover and Land Use

Several land cover and distinct land use types occur in the study area, including evergreen montane forest, wet evergreen forest, a mosaic of shifting cultivation, shrub land and grassland, waterbodies, and modified built-up areas.

Due to the high elevations and steep topography that characterises the ecoregion, the human population density is considered moderate, however anthropogenic impacts are pervasive in the form of regular burning to create open woodlands and shifting cultivation on the upper slopes. Wildlife poaching and excessive harvesting of forest products are also particularly threatening to the biodiversity of the region and according to the WWF, more than 75% of the ecoregion's natural habitat has been converted or degraded (WWF, 2021a).

A combination of remote sensing and field investigations (refer to the REA presented in ***Appendix F***) were used to identify the distribution of land cover types within the EAAAs. The full approach to identify and map land cover classes within the EAAAs is described in ***Section 2.5*** of **Appendix G**.

The land cover and land use classes present in the EAAAs are further described in ***Table 7.17***, and their extent and distribution is shown spatially on the map in ***Figure 7.26***.

Table 7.17: Land Class Descriptions and Areas

Land Cover / Land Use Type	Description	EAAA Land Cover	Project Footprint Land Cover (ha)
Montane Forest	Montane (evergreen) Forest represents the dominant land cover and evergreen forest type in the EAAAs. This forest type occurs in mountainous areas, at elevations of more than 1,000 m amsl (above mean sea level), receiving higher rainfall. These forests vary in structure and composition depending on geological substrate and moisture availability, best represented by species of Fagaceae and typically having tall forest canopies reaching up to about 30m height, with epiphytes and orchids forming a notable part of the biodiversity. The majority of the EAAAs are heavily degraded and fragmented due to access, farming and harvesting activities by local communities, with patches of better condition montane forest found in the north-eastern section of the EAAA, close to the Lao-Vietnam border and forming part of the Southern Annamite Mountain range n forest, and in the northern central and western sections of the Project area.	Approximately 30.4% of the EAAA for Non-Volant Species (81,262.1 ha) is comprised of this habitat type. Approximately 28.7% of the EAAA for Volant Species (69,712.4 ha) is comprised of this habitat type.	Approximately 42.8% of the Project Development Area (30,218.3 ha) is comprised of this habitat type.
Wet Evergreen Forest	Wet Evergreen Forest has a similar forest structure and composition as montane forest but receives less precipitation. This habitat type typically comprises mixed stands of	Approximately 10.4% of the EAAA for Non-Volant Species (27,732.1 ha) is	Whilst this habitat type is not present within the Project Development Area

Land Cover / Land Use Type	Description	EAAA Land Cover	Project Footprint Land Cover (ha)
	semi-evergreen forest / coniferous forest, with varying compositions of broad-leaved trees and *Pinus* species. Dominated by species of Fagaceae, Myrtaceae, and Lauraceae, with high overall species richness. Existing disturbance, particularly habitat fragmentation caused by access roads, is noted for these forest areas. This type has been mapped as occurring along the valley to the north-east close to the Lao-Vietnam border and overlapping the EAAAs.	comprised of this habitat type. Approximately 7% of the EAAA for Volant Species (17,040.8 ha) is comprised of this habitat type.	itself, the transmission line towards Vietnam includes an area of Wet Evergreen Forest. The final alignment of the transmission line is yet to be decided.
Agricultural-Shrub Land-Grassland Mosaic	Given the shifting agricultural pattern that characterises the study area, it was inherently difficult to classify many of the smaller, fragmented patches of open, transitional herbaceous and low-wooded vegetation amongst the broader contiguous forest communities. This habitat type has therefore been broadly mapped as a shrub land-grassland mosaic, comprised of the following sub-communities: ■ **Agricultural land** is used by local communities for rotational agricultural cropping, and to a lesser extent for commercial crop production such as coffee, sugarcane, and maize (ADB, 2016[33]; CEIC, 2021). Rice is cultivated in upland areas for mainly subsistence purposes (Alexander *et al.*, 2018). ■ **Shrub land** is scattered across the EAAAs where anthropogenic influences have modified the structural integrity of the area. This habitat type comprises small patches of vegetation that represent transitional evergreen/semi-evergreen forest-shrub areas that have been subject to degradation, forest regeneration and/or natural succession. ■ **Grassland** is typically a fire-adapted vegetation and habitat type found scattered throughout the EAAA, and in the southern and central sections of the Project area. Such land cover is often due to herbivore activity or fire on plateaus such as on the Dak Cheung Plateau. Large native trees are systematically	Approximately 58.7% of the EAAA for Non-Volant Species (156,798.4 ha) is comprised of this habitat type. Approximately 63.8% of the EAAA for Volant Species (154,916.5 ha) is comprised of this habitat type.	Approximately 56.3% of the Project Development Area (39,760.9 ha) is comprised of this habitat type.

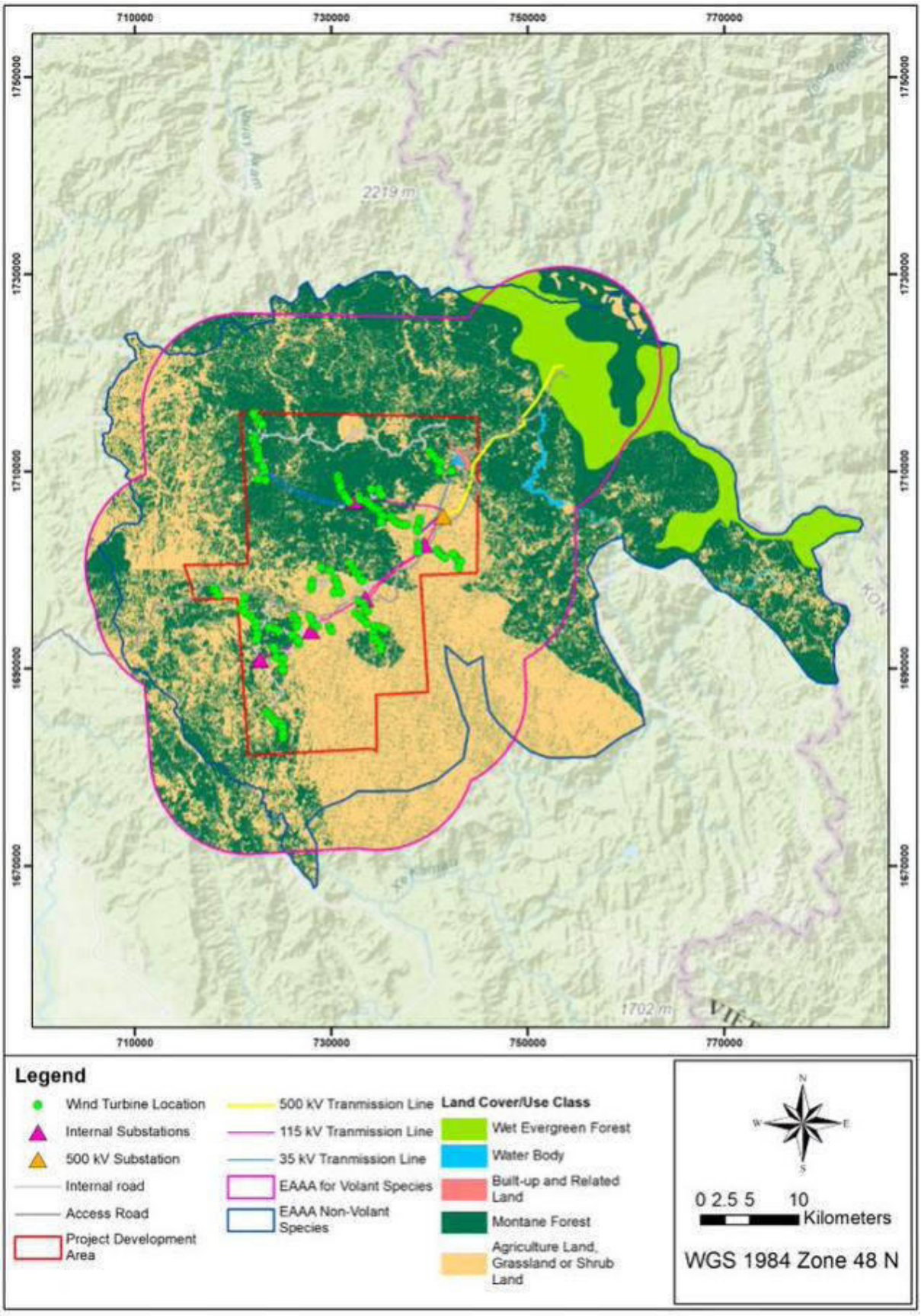
[33] Asian Development Bank: additional financing (2016). Proposed Administration of Grant. Lao People's Democratic Republic: Greater Mekong Subregion Biodiversity Corridors Project. Draft for submission to FIP Committee. Project Number: 40253. March 2016. Available online at: https://climateinvestmentfunds.org/sites/default/files/meeting-documents/fip-lao_pdr-004a-adb-protecting_forests_for_sustainable_ecosystem_services-annex12345678.pdf

Land Cover / Land Use Type	Description	EAAA Land Cover	Project Footprint Land Cover (ha)
	removed and key ecological processes are disrupted.		
Water Body	Rivers and streams occur at topographic low points in the landscape and along drainage lines throughout the Project area (Innogreen Engineering Co. Ltd. and Greener Consultant Co. Ltd, 2020), and wider EAAAs. Located within the Sekong River catchment area, this area is generally recognised for being ecologically unique due to the presence of unique habitats at high elevation and slopes (Meynell, 2014[34]). Of note, rivers and streams at Dak Cheung plateau appear to face relatively few impacts, except when in the vicinity of development works (Kottelat, 2011[35]).	Approximately 0.3% of the EAAA for Non-Volant Species (671.7 ha) is comprised of this habitat type. Approximately 0.3% of the EAAA for Volant Species (697.1 ha) is comprised of this habitat type.	Approximately 0.1% of the Project Development Area (79.5 ha) is comprised of this habitat type.
Built-up and Related Land	Artificial / man-made land use has removed most or all ecosystem attributes. Built-up land use in the Project area comprises residential buildings and basic infrastructure (e.g., roads, hospital, and school) (Innogreen Engineering Co., Ltd. and Greener Consultant Co., Ltd, 2020). These areas are located mainly in the north-east but smaller structures and roads are scattered throughout the landscape.	Approximately 0.2% of the EAAA for Non-Volant Species (491.8 ha) is comprised of this habitat type. Approximately 0.2% of the EAAA for Volant Species (590.6 ha) is comprised of this habitat type.	Approximately 0.8% of the Project Development Area (556.7 ha) is comprised of this habitat type.

[34] Meynell, P. (2014). The Sekong River in Viet Nam, Lao PDR: and Cambodia: An Information Sourcebook for Dialogue on River Flow Management. Bangkok, Thailand: IUCN. 139pp. Available online at: https://portals.iucn.org/library/sites/library/files/documents/2014-081.pdf

[35] Kottelat, M. (2011). Fishes of the Xe Kong drainage in Laos, especially from the Xe Kaman. Co0management of freshwater biodiversity in the Sekong Basin. October 2011. Available online at: https://wwfint.awsassets.panda.org/downloads/fishes_of_xe_kaman_2011.pdf

Figure 7.26: Land cover / land use in the EAAAs and Project area



Source of information: ERM (2022).

7.4.4 Birds

The sections below present a summary of the methodology and key findings of the bird field surveys undertaken for the Project. Further details are presented in ***Appendix F***.

7.4.4.1 Methodology

Detailed knowledge of bird distribution and flight activity is necessary in order to predict the potential effects of the wind farm on birds. Feedback from Multi-Lateral Agency ("MLA") consultation that took place between 22 August 2017 and 29 September 2017 identified bird surveys to international standards as survey priorities, with the peak bird migration season[36] being particularly important for survey. Bird Vantage Point ("VP") and transect surveys were therefore undertaken monthly from December 2020 – Nov 2021 (except for April and May 2021 when COVID-19 pandemic lockdown restrictions prevented surveys from taking place) to capture the annual seasonal variation expected at the Project area. ***Figure 7.27*** presents the locations of the bird VP and transect surveys undertaken.

Vantage Point Surveys

Given the extent of the Project area, it was not possible to undertake VP surveys for the entire wind farm. A sampling approach was therefore adopted that allows a representative proportion of the turbines in each of the main wind farm clusters to be surveyed. This approach enabled differences in species and collision risk between turbine clusters to be assessed, while providing for an overall collision risk determination across the entire windfarm. The data gathered used standard internationally recognised protocols based on Scottish Natural Heritage (now NatureScot) guidance[37,38].

Expert ornithologists tracked and mapped birds throughout the turbine area, recording species, numbers, and estimating flight height during timed watches at a total of fourteen VPs to collect data to quantify the flight activity levels and species distribution across the Project area. Twelve of the VPs were selected to provide a representative sample coverage of the habitats associated with the different turbine arrays, while the remaining two VPs were dedicated to monitoring flight activity associated with the proposed transmission line from the windfarm area to the Lao-Vietnam border (VPs 9 and 10). ***Table 7.18*** presents the VP locations with respect to turbine arrays and the transmission line.

Table 7.18: Vantage Point (VP) relationship to Turbine Arrays and the Transmission Line

Location	Vantage Points
East Central Arrays	1a, 3a, 2, 4
Southeast Array	5, 7a, 8
Ban Dakdonna Array	6, 11
Dak Cheung village Array	12

[36] The migration season in Southeast Asia generally begins in late September through into November, with a peak in October. Local bird experts have also indicated that in Laos, migration extends through to December.

[37] Scottish Natural Heritage August 2014. Recommended bird survey methods to inform impact assessment of onshore wind farms. Retrieved from https://www.nature.scot/sites/default/files/2018-06/Guidance%20Note%20-%20Recommended%20bird%20survey%20methods%20to%20inform%20impact%20assessment%20of%20onshore%20windfarms.pdf

[38] Scottish Natural Heritage. 2000. Wind farms and birds: Calculating a theoretical collision risk assuming no avoiding action. Retrieved from https://www.nature.scot/sites/default/files/2017-09/Guidance%20Note%20-%20Windfarms%20and%20birds%20-%20Calculating%20a%20theoretical%20collision%20risk%20assuming%20no%20avoiding%20action.pdf

Location	Vantage Points
Northwest Array	13
Southernmost array	14
Transmission line	9 & 10

The VP surveys recorded selected / target species comprising primarily migratory soaring birds, and included resident species of high conservation status (i.e. IUCN Red Data listed species, species of nationally-recognised high conservation concern within the country). Locally common resident bird species of Least Concern (LC) were not recorded during VP surveys. Birds that entered the windfarm boundary were tracked and their height estimated at 15 second intervals. Three bands based on the Project's turbine hub height and rotor length specifications were used to estimate flight height[39]:

1. **30 m or below**, allowing for the effect of downdraft and compensates for potential height estimation difficulties over undulating terrain;
2. **30 m to 150 m**, which was considered as the height at which there is a collision risk with turbine blades; and
3. **150 m or above**, which was considered as the area that is above the collision risk height.

VP surveys included 12 hours survey time per VP, per month. Total survey time at all VPs was estimated to be 120 hours, with the exception of VP 12, 13, and 14 which were added a month after surveys started in response to layout changes, and where survey time was 108 hours.

Transect Surveys

Transect surveys were conducted to record the variety of birds present in the Project area. Fourteen transect survey routes were selected based on the field surveyor's walking route from the nearest road to the VP. Surveys were undertaken twice in a day, during the morning and afternoon, prior to, and after each VP survey.

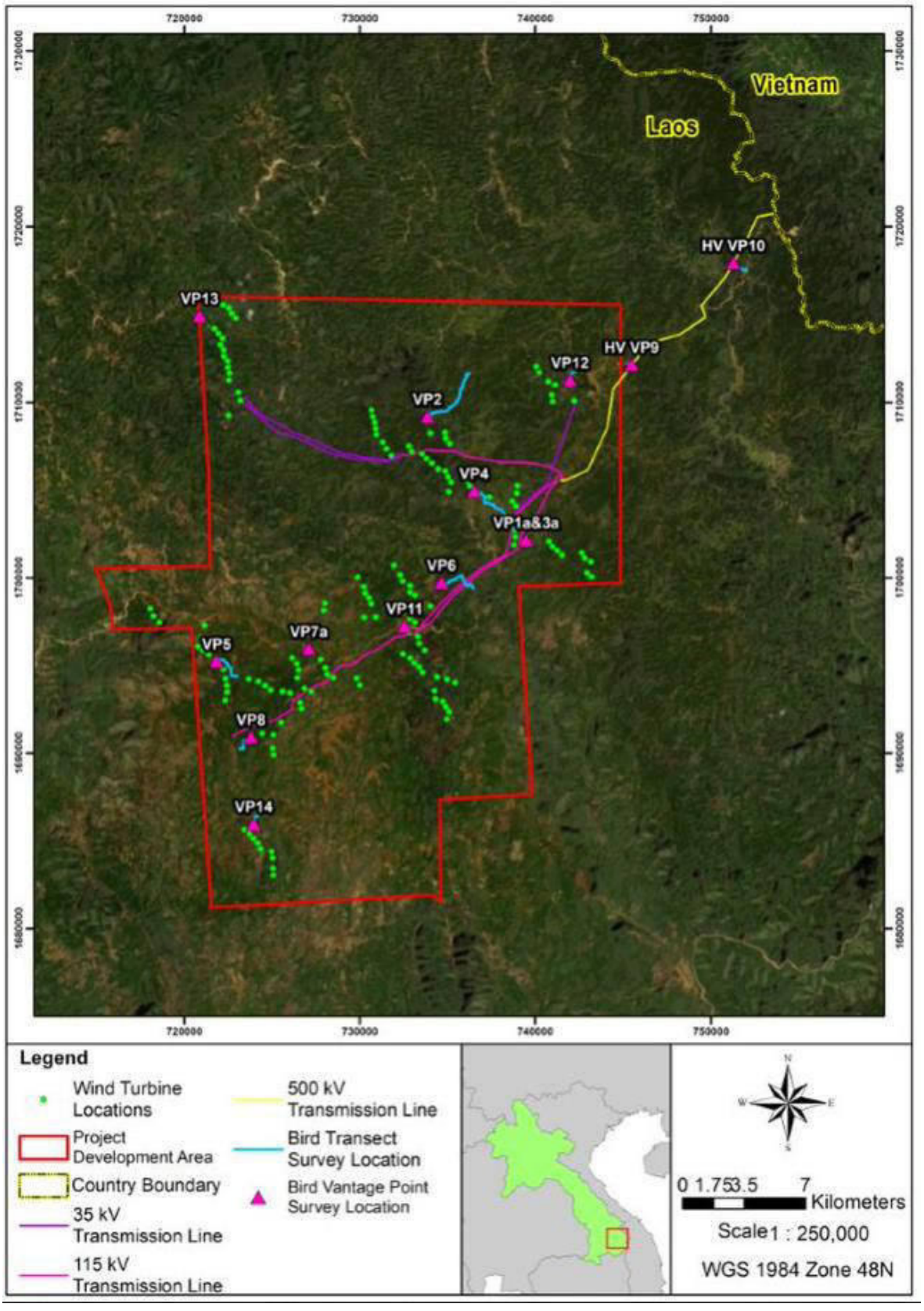
These transect surveys were designed to focus on identifying potential high priority species highlighted during expert consultation and an initial screening against the critical habitat criteria, which revealed that six endemic bird species are considered as potential high priority species (refer to ***Appendix G)***. These include:

- Chestnut-eared Laughing thrush (*Garrulax konkakinhensis*);
- Black-crowned Barwing (*Actinodura sodangorum*);
- Crested Argus (*Rheinardia ocellata*);
- Black-hooded Laughing thrush (*Garrulax millet*);
- Yellow-billed Nuthatch (*Sitta solangiae*); and
- Golden-winged Laughing thrush (*Garrulax ngoclinhensis*).

Given that these species are primarily understorey or ground dwellers that may be elusive, playback of recorded bird songs at intervals of 500m along each transect was also performed during the field surveys to increase the probability of encountering and confirming the presence of these particular species.

[39] Note that the turbine design and operational specifications were revised after commencing the bird VP surveys. Collision risk modelling calculations therefore factored in these changes where needed. This is described in further detail in ***Section 8.4*** of this ESIA.

Figure 7.27: Map showing VP and transect locations for the bird survey relative to planned WF infrastructure



7.4.4.2 Survey Findings

Vantage Point (VP) Survey Findings

The VP surveys recorded a total of 24 species (excluding three flights of two unspecified species). Of the species recorded, all were raptors with the exception of two heron species (Chinese Pond Heron, *Aredola bacchus* and Cinnamon Bittern, *Ixobrychus cinnamomeu*s), a wader (Red-wattled Lapwing, *Vanellus indicus*) and the Greater Hornbill, *Buceros bicornis*.

All but three of the species recorded were of LC (Least Concern) conservation/threat status, with two NT (Near Threatened) and one VU (Vulnerable) species recorded.

The majority of species are confirmed resident bird species (13), although eleven species are confirmed migrants. These proved to be broad-front migrants, which is unsurprising given that there are no IBAs designated for migratory and/or congregatory species identified within the EAAAs (refer to ***Section 7.4.9*** for further information).

Table 7.19 indicates the list of twenty-four species, and their total flight time at all heights and collision risk height, from December 2020 to November 2021.

Table 7.19: Bird species recorded during VP surveys with corresponding flight times at all heights / collision risk height

Bird Species Recorded *(conservation-important / RL species indicted in '**bold**')*		IUCN RL[1,2]	Resident/ Migratory	**Vantage Point (VP)** *(*species presence recorded indicated by an 'x')*																**Flight Time**	
Common Name	Scientific Name			1	2	3	4	5	6	7	8	9	10	11	12	13	14	1a & 3a	7a	Total (seconds)	Collision Risk height (m)
Besra	*Accipter virgatus*	LC	Altitudinal migrant	x		x	x		x		x		x	x						415	270
Black Baza	*Aviceda leuphotes*	LC	Migrant					x												120	30
Black Eagle	*Ictinaetus malaiensis*	LC	Resident	x	x	x	x	x	x	x		x	x	x	x	x		x	x	8 262	3 450
Black-winged Kite	*Elanus caeruleus*	LC	Resident				x											x		600	300
Changeable Hawk-eagle	*Nisaetus cirrhatus*	LC	Resident	x	x															72	0
Chinese Pond Heron	*Aredola bacchus*	LC	Migrant									x								90	0
Cinnamon Bittern	*Ixobrychus cinnamomeus*	LC	Migrant					x												120	0
Crested Goshawk	*Accipiter trivirgatus*	LC	Resident	x	x	x		x	x		x	x			x	x				1 506	465
Crested Serpent Eagle	*Spilornis cheela*	LC	Resident	x	x	x	x	x	x	x		x	x	x	x	x		x	x	5 105	975
Eastern Buzzard	*Buteo japonicas*	LC	Migrant															x		120	120
Eurasian Kestrel	*Falco tinnunculus*	LC	Migrant						x	x	x						x			610	90
Eurasian Sparrowhawk	*Accipiter nisus*	LC	Migrant					x			x						x			150	15
Great Hornbill	***Buceros bicornis***	**VU**	**Resident**										**x**							**135**	**15**
Grey-faced Buzzard	*Butastur indicus*	LC	Migrant		x	x	x	x	x	x						x	x			3 829	2 190
Japanese Sparrowhawk	*Accipiter gularis*	LC	Migrant			x	x													90	45

Bird Species Recorded *(conservation-important / RL species indicted in '**bold**')*		IUCN RL[1,2]	Resident/ Migratory	**Vantage Point (VP)** *(*species presence recorded indicated by an 'x')*																**Flight Time**	
Common Name	Scientific Name			1	2	3	4	5	6	7	8	9	10	11	12	13	14	1a & 3a	7a	Total (seconds)	Collision Risk height (m)
Jerdon's Baza	*Aviceda jerdoni*	LC	Resident	x			x	x	x			x	x			x				915	450
Mountain Hawk-Eagle	*Nisaetus nipalensis*	NT	Resident		x		x													300	120
Northern Goshawk	*Accipiter gentilis*	LC	Migrant											x						82	45
Oriental Hobby	*Falco severus*	LC	Resident	x				x	x		x			x			x	x		924	375
Oriental Honey Buzzard	***Pernis ptilorhynchus***	**LC**	**Resident**	**x**	**x**	**x**	**x**		**x**			**x**		**x**	**x**	**x**		**x**		**2 310**	**1 110**
Osprey	*Pandion haliaetus*	LC	Migrant												x					600	375
Red-wattled Lapwing	*Vanellus indicus*	LC	Resident							x										30	0
Rufous-bellied Eagle	***Lophotriorchis kienerii***	**NT**	**Resident**		**x**		**x**													**180**	**60**
Shikra	*Accipiter badius*	LC	Resident	x	x	x	x	x	x	x	x	x	x		x	x	x	x		1 288	180

Key to table:

VU = Vulnerable; NT = Near Threatened; LC = Least Concern

Transect Survey Key Findings

The transect surveys recorded a total of 256 bird species, the majority of which are of LC status species (249 species), with six species being NT and one VU species recorded.

Bird species with higher IUCN conservation status were identified as follows:

- Black-crowned Barwing, *Actinodura sodangorum* (NT),
- Blossom-headed Parakeet, *Psittacula roseata* (NT),
- Grey-headed Parakeet, *Psittacula finschii* (NT),
- Red-breasted Parakeet, *P. alexandri* (NT),
- Rufous-bellied Eagle, *Lophotriorchis kienerii* (NT),
- Wreathed Hornbill, *Rhyticeros undulates* (VU), and

Yellow-billed Nuthatch, *Sitta solangiae* (NT).

Of the six endemic bird species identified as potential high priority species of the Project, only the Black-crowned Barwing (*A. sodangorum)*, Crested Argus (*R. ocellata*)[40], and Yellow-billed Nuthatch (*S. solangiae*) were recorded during field surveys.

Table 7.20 lists the key species of conservation importance recorded during the transect surveys in alphabetical order.

For a comprehensive list of bird species recorded, the reader is referred to the baseline report contained in ***Appendix F***.

Table 7.20: Bird species of conservation importance recorded during transect surveys

S/N	Common Name	Scientific Name	Transect No.	Status	IUCN RL Status
1.	Black-crowned Barwing	*Actinodura sodangorum*	4	Resident	NT
2.	Blossom-headed Parakeet	*Psittacula roseata*	1a & 3a	Resident	NT
3.	Grey-headed Parakeet	*Psittacula finschii*	1a & 3a, 4	Resident	NT
4.	Red-breasted Parakeet	*Psittacula alexandri*	5	Resident	NT
5.	Rufous-bellied Eagle	*Lophotriorchis kienerii*	2, 4	Resident	NT
6.	Wreathed Hornbill	*Rhyticeros undulatus*	6	Resident	VU
7.	Yellow-billed Nuthatch	*Sitta solangiae*	10	Resident	NT

Key to table:

VU = Vulnerable; NT = Near Threatened

[40] The Crested Argus was recorded incidentally from survey block 1 on the Vietnam border during both the dry and wet season mammal, herpetofauna and plant assessment survey (Phiapalath. P. et al 2022).

7.4.5 Bats

7.4.5.1 Methodology

The baseline assessment for bats comprised a desktop review, followed by passive and active sampling for bats within the Project area. Both published and unpublished records of bats from southern Lao PDR (specifically from Saravan, Sekong, Champasak and Attapeu provinces) were reviewed prior to the field survey. Surveys across a total of five bat field survey campaigns were undertaken, which included three campaigns in the dry season (February and March 2021), and two campaigns in the wet season (June and July 2021).

Field survey methods included Key Informant Interviews ("KIIs"), roost surveys, live-sampling with harp traps and mist nets, and acoustic sampling using ultrasound detectors:

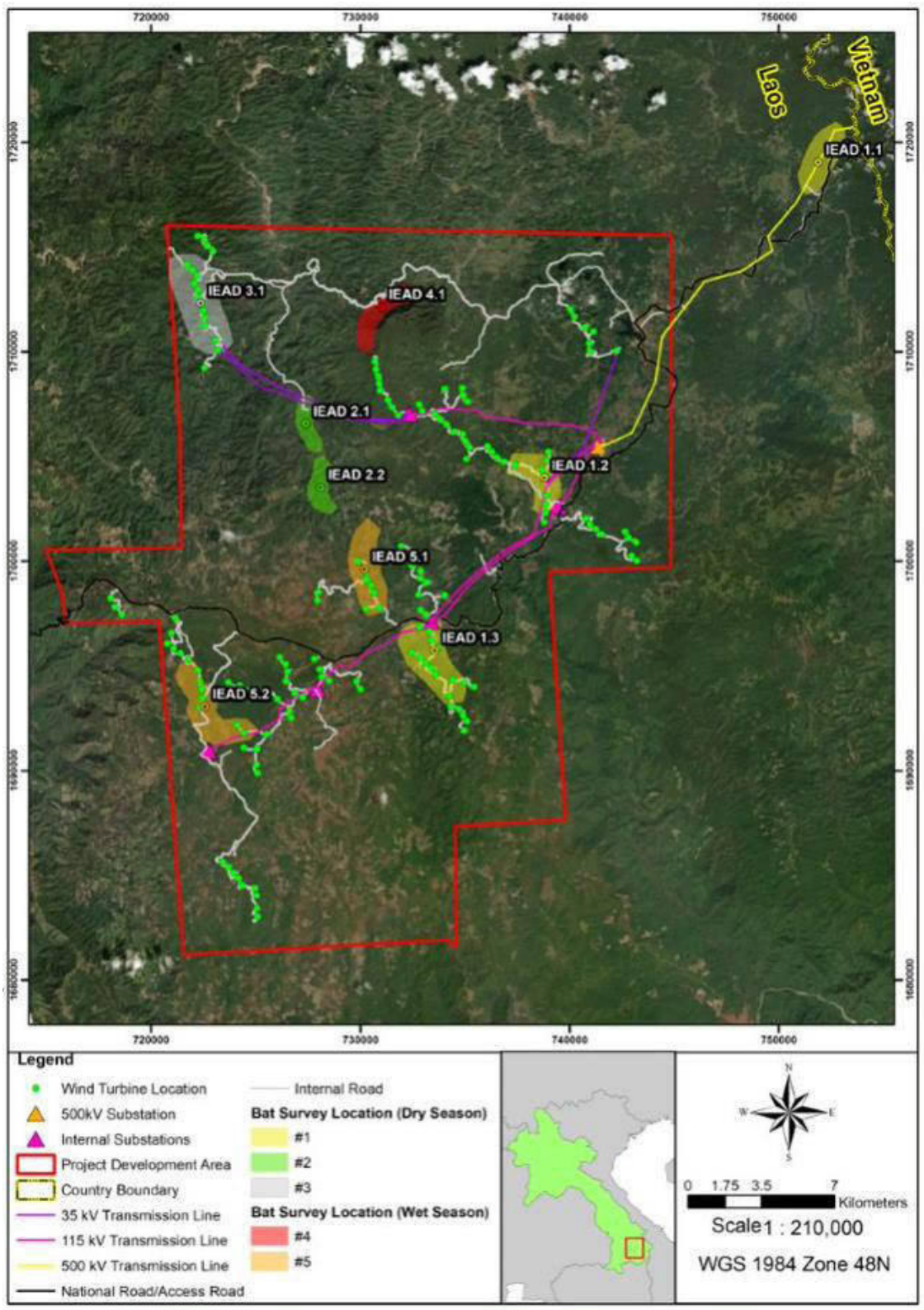
- KIIs were undertaken to determine location of significant bat colonies (> 100 individuals) within or in the vicinity of the Project area, with a specific focus on cave roosts and flying fox (*Pteropus* spp.) colonies. These were undertaken with 22 residents with a combined total of 625 years of local experience.
- Mist nets and harp traps were employed for live captures in 55 locations in the Project area, and five locations along the proposed transmission line route. All captured bats were measured, photographed, and identified in the field using the appropriate guides/monographs. They were subsequently released at the site and night of capture.
- Acoustic sampling using Song Meter 4 full spectrum (SM4) bat detectors (Wildlife Acoustics, USA) and 10 AudioMoth full spectrum (AM) bat detectors (Open Acoustic Devices, UK) were deployed each survey night to record insectivorous bat calls. SM4 detectors were deployed in a new location each night, while AMs were deployed at static locations to maximize coverage of representative habitats in each survey zone. Phonically distinct bat species were identified to the lowest possible taxonomic level possible based on the calls recorded.

Figure 7.28 that follows and ***Table 7.21*** presents the bat survey locations and itinerary for field surveys undertaken in the Project area.

Table 7.21: Itinerary for Bat Field Surveys

Survey Dates	Season	Sampling Nights	Survey Zone
3–7 February 2021	Dry season	4	Bat 1.1
7–11 February 2021		4	Bat 1.2
11–15 February 2021		4	Bat 1.3
23 February – 1 March 2021		6	Bat 2.1
1–7 March 2021		6	Bat 2.2
16–28 March 2021		12	Bat 3.1
17–29 June 2021	Wet season	12	Bat 4.1
14–20 July 2021		6	Bat 5.1
20–26 July 2021		6	Bat 5.2

Figure 7.28: Map showing the locations of bat surveys (wet and dry seasons) relative to planned WF infrastructure



Source of information: ERM (2022).

7.4.5.2 Survey Findings

Literature Review and Interview Findings

The literature review revealed that although a total of 56 bat species are known to the southern Lao PDR to date based on records (defined here as the Salavan, Champasak, Sekong and Attapeu provinces), only two species have been documented in Sekong Province (where >80% of the project area is located) prior to the survey.

All but four of the 56 species are currently recognised as species of Least Concern (LC) by the IUCN (2021), the exceptions being *Rhinolophus chaseni and Myotis ancricola,* (NE: Not Evaluated) and *Hypsugo dolichodon* and *Murina walstoni* (DD: Data Deficient).

Consistent with key informant interviews and observations throughout the survey, the review also revealed that limestone karst outcrops, significant cave bat roosts (>100 bats) and flying fox colonies are unlikely to occur in the Sekong portion of the project area.

Trapping and Acoustic Survey Findings

During the field surveys undertaken, a total of 468) bats representing 29 species, arranged in five families, were captured in live traps. An additional six species were recorded during the acoustic surveys conducted. All species are Least Concern (LC) in terms of conservation / threat status with the exception of *Rhinolophus francisi* (NE: Not Evaluated).

The findings included ten bat species which are the first records for southern Lao PDR, and two first country records for Lao PDR (see ***Table 7.22*** below).

For the comprehensive list of bat species recorded, the reader is referred to the baseline report contained in ***Appendix F***.

Table 7.22: New records for bat species in southern Lao PDR and Lao PDR

S/N	Common Name	Scientific Name	Capture Method	IUCN Red List Status	First Record for Southern Lao PDR	First Record for Lao PDR
1.	Horsfield's Fruit Bat	*Cyanopterus horsfieldii*	Trapping	LC	X	
2.	Blanford's Fruit Bat	*Sphaerias blanfordi*	Trapping	LC	X	
3.	Long-tongued Fruit Bat	*Macroglossus sobrinus*	Trapping	LC	X	
4.	Francis's Woolly Horseshoe Bat	*Rhinolophus francisi*	Trapping and Acoustic detecting	NE	X	X
5.	Thai Horseshoe Bat	*Rhinolophus siamensis*	Trapping and Acoustic detecting	LC	X	
6.	Wall-roosting Mouse-eared Bat	*Myotis muricola*	Trapping and Acoustic detecting	LC	X	
7.	Elery's Tube-nosed Bat	*Murina eleryi*	Trapping	LC	X	
8.	Fiona's Tube-nosed Bat	*Murina fionae*	Trapping	LC	X	

S/N	Common Name	Scientific Name	Capture Method	IUCN Red List Status	First Record for Southern Lao PDR	First Record for Lao PDR
9.	Formosan Golden Tube-nosed Bat	*Harpiola isodon*	Trapping	LC	X	X
10.	Lesser Hairy-winged Bat	*Harpiocephalus harpia*	Trapping	LC	X	

Key to table:

NE = Not Evaluated; LC = Least Concern

7.4.6 Land Mammals (non-volant species)

7.4.6.1 Methodology

Through interviews with the local villagers in the area, the survey team attained a good indication of the locations of opportune areas for encountering or observing signs of terrestrial (land) mammal activity. This informed the sampling design, with a focus on including key habitats in survey transects.

Transect surveys were conducted to record animals present in the Project area. These surveys took place in the morning, from 07:30 to 11:30 and in the afternoon to early evening from 13:30 to 17:30. Evidence such as tracks, calls, scat, scratch marks on trees, hollows, roosting sites, feeding sites were recorded. Spotlighting surveys were undertaken at night from 19:30. Key sites such as mineral licks, along stream channels and drainage lines, and beneath fruit trees were the focus of observations and all evidence found was photographed and collected where necessary. Listening posts were also conducted in the mornings from 05:30 to 08:00 to monitor gibbon activity by listening for their calls.

Camera traps (30 units) were deployed for a period of 5 months from late April to September 2021, resulting in a total of 3 233 trapping days. 20 camera trap units were installed in the Project area, with the remaining 10 units installed along the route of the Transmission Line to the north-east. Cameras were not installed systematically along a particular grid system, but rather at key locations where mammal activity was estimated to be significant and at an appropriate height to maximize the likelihood of recording priority small and larger mammal species.

7.4.6.2 Survey Findings

A total of 59 mammal species were reported as being potentially present in the Project area (based on the desktop survey and available species records), with 44 species confirmed through the field surveys conducted. The majority were directly confirmed in the field with evidence from the field assessment (both direct observations and indirect evidence of activity obtained from identifying tracks, droppings and feeding sites, and the results of camera trapping). Most of the mammal species identified were considered to have low populations in the area, with the exception of Pangolins and Chinese Serow.

A number of Globally Threatened mammal species have been identified for the Project area through the surveys conducted and through camera trap evidence. These species are listed in ***Table 7.23*** and include several CR (3 species), EN (5 species) and VU (7 species) species of small mammals (several primates, squirrel, otter, badger and pangolin) and with some larger mammal species also identified (such as bear and ungulates). This list of species in ***Table 7.23*** also includes species reportedly occurring in the area based on information obtained from villagers, however their presence was not confirmed with confidence through the survey work undertaken and based on expert opinion these species are unlikely to occur in the region.

The key species of conservation importance are primarily forest-dwelling species, associated with primary and secondary tropical and subtropical montane evergreen and semi-evergreen forests in broadleaf and mixed broadleaf-coniferous forest types (IUCN Red Data List: online at https://www.iucnredlist.org/). The exceptions in this case include the Chinese and Sunda Pangolin which occur in a wider range of habitats, including primary and secondary forests, broad-leaf and coniferous forests, shrub lands, grasslands and agricultural fields. Owston's Civet and Greater Hog Badger also typically utilize a variety of habitats and the Smooth-coated Otter requires a source of freshwater (rivers, streams, wetlands, etc.).

In Lao PDR, the Chinese Serow (*Capricornis milneedwardsii*, VU) is thought to be widely distributed in mountainous regions, although data on population size and trends is lacking. According to Thuc *et al*. (2014[41]), the species typically inhabits hilly or rugged mountainous areas with steep slopes and rocky outcrops, preferring secondary forests to primary forest and is likely to tolerate moderately degraded forest habitat.

As a result of forest habitat fragmentation, land claims for animal ranching, subsistence hunting and other human pressures, the land mammal group is considered to be under considerable threat in Laos PDR, possibly significantly higher than the other faunal groups (Phiapalath *et al.,* 2022). There is however evidence to suggest that some of the larger mammal species that have disappeared from the surrounding region may still occur within the protected 'Sacred Forest' of Phou Koungking identified, where these species can take refuge away from human pressures due to local beliefs and superstitions preventing ordinary access to this forest habitat (Phiapalath *et al.,* 2022). Refer also to the findings of the social survey for more information on the 'Sacred Forest' appearing in ***Chapter 8*** of the ESIA, specifically ***section 8.5.8*** 'Impact on Cultural Heritage').

Note that bat species (also mammals) have been discussed separately as a component of the volant (flying) species documented in ***section 7.4.5***.

For the comprehensive list of mammal species recorded, the reader is referred to the baseline biodiversity assessment report contained in ***Appendix F***.

[41] Thuc, P.D., Baxter, G., Smith, C. and Hieu, N. (2014). Population status of the Southwest China Serow *Capricornis milneedwardsii*: A case study in Cat Ba Archipelago, Vietnam. In Pacific Conservation Biology Vol 20 (4): 385-391. Available online for download at: https://www.researchgate.net/publication/265848893_Population_status_of_the_Southwest_China_Serow_Capricornis_milneedwardsii_A_case_study_in_Cat_Ba_Archipelago_Vietnam

Table 7.23: Conservation-important Mammals

Common Name	Scientific Name	IUCN Red List Status	Confirmed species (surveyed)	Credible accounts (villagers): *medium confidence*	Reported by villagers but presence unlikely: *low confidence*
Bengal Slow Loris	*Nycticebus bengalensis*	EN		X	
Pygmy Slow Loris	*Nycticebus pygmaeus*	EN		X	
Stump-tailed Macaque	*Macaca arctoides*	VU			X
Northern Pig-tailed Macaque	***Macaca leonina***	**VU**	**X**		
Northern Buff-cheeked gibbon	***Nomascus annamensis***	**EN**	**X**		
Indochinese Silvered Leaf Monkey	*Trachypithecus Germaini*	EN			X
Red-shanked Douc Langur	***Pygathrix nemaeus***	**CR**	**X**		
Annamite Striped Rabbit	*Negolagus timminsi*	EN		X	
Black Giant Squirrel	***Ratufa bicolor***	**NT**	**X**		
Chinese Pangolin	***Manis pentadactyla***	**CR**	**X**		
Sunda Pangolin	***Manis javanica***	**CR**	**X**		
Dhole	*Cuon alpinus*	EN			X
Binturong	*Arctictis Binturong*	VU			X
Owston's Civet	***Chrotogale owstoni***	**EN**	**X**		
Smooth-coated Otter	***Lutrogale perspicillata***	**VU**	**X**		
Asiatic Black Bear	***Ursus thibetanus***	**VU**	**X**		
Sun Bear	***Ursus malayanus***	**VU**	**X**		
Greater Hog Badger	***Arctonyx collaris***	**VU**	**X**		
Chinese Serow	***Capricornis milneedwardsii***	**VU**	**X**		
Sambar Deer	***Cervus unicolor***	**VU**	**X**		
Chinese Goral	*Naemorhedus greseus*	VU			X

Key to table:

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened

7.4.7 Herpetofauna

7.4.7.1 Methodology

Data collection was comprised of both field surveys and interviews with local villagers. Field surveys were conducted during both the day and night, with a focus on the wet season sampling when activity is considered highest. Daylight surveys were undertaken both in the morning, from 08:00 to 11:30, and the afternoon from 14:00 to 17:30 in the early evening. Attention was given to micro-habitats such as fallen logs, amongst leaf litter on the forest floor, trees, burrows, and tree hollows which in turn were situated around focal habitats such as waterbodies and wetlands. Nocturnal surveys utilised a direct encounter method and were conducted from 19:00 to 22:00. Unfamiliar species were captured for photographing, detailed identification, and DNA sampling.

7.4.7.2 Survey Findings

The numerous small streams in the Montane Forest habitats at altitudes exceeding 1000m amsl are likely to host some important and endemic herpetofauna species (i.e. amphibians and reptiles). A combined total of 71 species of herpetofauna (amphibians and reptiles) were recorded through field surveys conducted, of which 30 reptile species and 41 amphibian species were identified.

Several Globally Threatened species were recorded through the field surveys conducted, including:

- Red River Krait (*Bungarus slowinskii*, VU), a venomous species of snake endemic to mainland SE Asia (Laos and Vietnam);
- Impressed Tortoise (*Manouria impressa, EN),* a terrestrial forest-dwelling species and resident of SA Asia*;*
- Asiatic Softshell Turtle (*Amyda cartilaginea, VU),* a semi-aquatic species common to inland freshwater ecosystems*;*
- Chinese Softshell Turtle (*Pelodiscus sinensis, VU),* a semi-aquatic species common to inland freshwater ecosystems*;*
- Serrate Frilled Treefrog (*Kurixalus cf gryllus*, VU), a forest dwelling, semi-aquatic frog;
- Tiny Bubble-nest Frog (*Gracixalus supercornutus, NT),* a forest dwelling, semi-aquatic frog known from Lao PDR and Vietnam*;* and
- Truong Son Bug-eyed Frog (*Theloderma truongsonensis) (DD,* a poorly known forest dwelling species known from Vietnam and first recorded in Lao PDR in 2020

These are primarily forest-dwelling species, confined to secondary or primary evergreen forest in the mountainous regions of SE Asia, with several species (i.e. frogs and turtles) requiring freshwater habitats either to survive or complete their life-cycles (IUCN Red Data List: online at https://www.iucnredlist.org/) (refer also to ***Table 7.24***)

Local records were also documented for several additional EN and VU species of snake, tortoise and turtle, also listed in ***Table 7.24****,* although these species were not encountered during the field surveys undertaken. In addition, a number of endemic species were either encountered or identified through an examination of existing records.

Herpetofauna are considered to be one of the least-known or documented groups of vertebrates in Lao PDR, with several species records considered previously unknown to science. Four species identified during field surveys (not appearing on the IUCN RDL) are considered first records for Lao PDR (***Table 7.24***)., 2 reptile species were second records of Laos and 3 species have not been described yet and could possibly be new to science (*previously undiscovered potentially requiring further investigation*).

Table 7.24: Conservation-important Herpetofauna

Class	Common Name	Scientific Name	Evidence	IUCN Red List Status	Comments
REPTILES	**Red River Krait**	***Bungarus slowinskii***	**Field observation**	**VU**	
	King cobra	*Ophiophagus hannah*	Local record	VU	
	Indochinese Spitting Cobra	*Naja siamensis*	Local record	VU	
	Burmese Python	*Python bivittatus*	Local record	VU	
	Elongated Tortoise	*Indotestudo elongata*	Local record	EN	
	Impressed Tortoise	***Manouria impressa***	**Field observation**	**EN**	
	Keel Box Turtle	*Cuora mouhotii*	Local record	EN	
	Asiatic Softshell Turtle	***Amyda cartilaginea***	**Field observation**	**VU**	
	Chinese Softshell Turtle	***Pelodiscus sinensis***	**Field observation**	**VU**	
	-	***Acanthosaura prasina***	**Field observation**	**-**	First record for Lao PDR
AMPHIBIANS	**Serrate Frilled Treefrog**	***Kurixalus cf gryllus***	**Field observation**	**VU**	
	Tiny Bubble-nest Frog	***Gracixalus supercornutus***	**Field observation**	**NT**	
	-	***Rhacophorus sp.***	**Field observation**	**-**	First record for Lao PDR & possibly 'new species to science'
	Maoson Horned Toad	***Xenophrys cf maosonensis***	**Field observation**	**-**	**Yes**
	-	***Quasipaa sp.***	**Field observation**	**-**	**Yes**
	Spinyback Torrent Frog	***Amolops spinapectoralis***	**Field observation**	**LC**	First record for Lao PDR
	-	***Limnonectes poilani***	**Field observation**	**LC**	
	Firth's Litter Toad	***Leptobrachella firthi***	**Field observation**	**-**	
	Truongson Bug-eyed Frog-	***Theloderma truongsonensis***	**Field observation**	**DD**	

Key to table:
EN = Endangered; VU = Vulnerable; NT = Near Threatened; DD = Data Deficient; LC = Least Concern

For a comprehensive list of herpetofauna (reptiles and amphibians) recorded, the reader is referred to the baseline biodiversity assessment report contained in ***Appendix F***.

7.4.8 Flora

7.4.8.1 Methodology

To carry out vegetation surveys within the classified forest habitats, 30 sample plots (10mx10m quadrats) measuring 100m^2 were identified, with six plots sampled per Survey Block (5 survey blocks in total). Additional smaller plots were surveyed for tree saplings (5x5m quadrats, 25m^2), and for communities dominated by herbs and grasses, 2mx2m (4m^2) quadrats were used. The average elevation of these plots was 1,312m above sea level; ranging from 1,029m above sea level to 1,615m. Plant species were identified and listed, with their frequency of occurrence and densities assessed and species grouped according to their respective family, number of seedlings recorded, and undergrowth vegetation described (e.g. moss, herbs, ferns, etc.). Where possible and necessary, samples of fruit/leaves were collected where to aid in the identification of plants that could not be easily or readily identified in the field.

Some species that were found just adjacent to the relevant sample plots were also recorded to provide a comprehensive list of plants in the survey area. Non-tree species were counted to obtain a biodiversity baseline but excluded from the forest habitat analysis.

7.4.8.2 Survey Findings

Five survey blocks in total were sampled, with the vegetation communities and habitats encountered being primarily Wet Evergreen Forest at the lower altitude, with Montane Evergreen Forest occurring at higher altitudes (typically above 1000m amsl). Some of the forest communities were found to be degraded as a result of agricultural activities in the area.

Structurally, the forest communities were found to be relatively open, having little to no emergent layer in the sub-canopy, which was occupied instead by fallen trees, moss, rocks and lichens. Shrub layers were short and included younger trees, wild gingers and weeds. A relatively high tree density and canopy cover was encountered, with mean canopy height estimated to range from 14m to 35m from ground level and with a mean canopy cover of 85 - 90%. The forests sampled at lower elevations exhibited 3 layers of forest structure (canopy, understorey and shrub layer), with the higher elevation forests missing the emergent understorey layer)

A total of 626 plants, representing 538 species from 178 families were recorded, of which some 250 species of tree belonging to 58 families were recorded. The Rubiaceae, Lauraceae and Fagaceae, Annonaceae and Fabaceae were the dominant tree families sampled within the forest habitats, with 83 species recorded in total within the forest habitats sampled.

Two globally threatened species of flora were recorded, including:

- *Zingiber mellis* (EN), a rhizomatous herb common to higher-altitude, broad-leaved moist montane evergreen forest; and
- Soum dok-noi (*Pittosporum pauciflorum*, VU), a small tree / shrub species confined to areas of mixed montane forest (IUCN Red Data List: online at https://www.iucnredlist.org/).

In addition, the following 3 Near-Threatened (NT) species were recorded in the area:

- Phaya mai (*Nageia fleuyi*), a tree (conifer);
- Peak habai (*Pinus dalatensis var. bidoupensis),* a sub-montane and montane pine tree, endemic to Indonesia and China (IUCN Red Data List: online at https://www.iucnredlist.org/); and
- Kor langbian (*Quercus langnianesis*), an uncommon oak tree species.

Globally, these tree species have a relatively large distribution and are not yet considered as globally threatened species. That being said, despite limited information on population trends for these specie,

their respective habitats are under threat from agricultural activities, logging and wood harvesting activities which could potentially shift their threat status to VU in the future (IUCN Red Data List: online at https://www.iucnredlist.org/).

Findings of the flora survey are also considered significant to the scientific community, since 10 plant species were listed as rare or possibly new species to science and 29 first recoded plant records of Lao PDR.

Table 7.25: Conservation-important Plants

Family	Common Name	Scientific Name	IUCN Red List Status	Survey Block (1-5)
Podocarpaceae	Phaya mai	*Nageia fleury*	NT	2, 5
Pinaceae	Peak habai / Dalat pine	*Pinus dalatensis var. bidoupensis*	NT	2
Pittosporaceae	Soum dok-noi	*Pittosporum pauciflorum*	VU	4, 5
Fabaceae	Kor langbian)	*Quercus langbianensis*	NT	4
Zingiberaceae	-	*Zingiber mellis*	EN	3

Key to table:
EN = Endangered; VU = Vulnerable; NT = Near Threatened

For a comprehensive list of flora recorded, the reader is referred to the baseline biodiversity assessment report contained in ***Appendix F***.

7.4.9 Summary of the Critical Habitat Assessment

7.4.9.1 Introduction

A Critical Habitat Assessment ("CHA") was completed for the Project, in support of the Project's alignment with the applicable international standards, which include the Asian Development Bank's Safeguards Policy Statement ("ADB SPS"). The complete CHA is contained in ***Appendix G*** of the ESIA.

7.4.9.2 Critical Natural and Modified Habitats

The ADB SPS differentiates between three categories of land and water areas based on habitat condition and biodiversity value:

- **Natural habitat**: *includes areas where the biological communities are formed largely by native flora and fauna, and where human activity has not essentially modified the area's primary ecological functions (ADB SPS, 2009);*
- **Modified habitat**: *where the natural habitat has apparently been altered, often through the introduction of alien species of plants and animals (ADB SPS, 2009) and includes areas that may still contain a large proportion of native flora and flora, and/or where human activity has substantially modified an area's primary ecological functions and species composition (IFC PS6, 2019);* and
- **Critical habitat**: *is considered a subset of natural and modified habitat (identified irrespective of the condition of these areas) and encompasses areas with high biodiversity value associated with the presence of significant types of biodiversity (ADB SPS, 2009).*

7.4.9.3 Assessment Approach

The approach to the CHA was as follows:

- EAAAs (Ecologically Appropriate Assessment Areas) were identified and delineated for volant (flying) species, and non-volant (non-flying) species, respectively, to determine the spatial extent and scope of the CHA;
- Modified and natural habitats were identified / differentiated and mapped;
- A desk-based review of available information on the biodiversity features within the EAAA was undertaken to inform the CHA;
- The key findings of the baseline biodiversity surveys for fauna and flora were reviewed, with a key focus on species of conservation importance such as Red Data listed plants and animals recorded, with consultation with specialist to verify results;
- Biodiversity features identified as present or likely to occur within the volant and non-volant EAAAs were screened against the six qualifying criteria for 'critical habitat' provided in the ADB SPS and the ADB Environment Safeguards, 'A Good Practice Sourcebook' (aligned also with IFC PS6), including:
  - **Criterion 1** - *Habitat required for the survival of critically endangered or endangered species,*
  - ***Criterion 2*** - *Areas with special significance for endemic or restricted-range species,*
  - ***Criterion 3*** - *Sites that are critical for the survival of migratory species,*
  - ***Criterion 4*** - *Areas supporting globally significant concentrations or numbers of individuals of congregatory species,*
  - ***Criterion 5*** - *Areas with unique assemblages of species that are associated with key evolutionary processes or provide key ecosystem services,*
  - ***Criterion 6*** - *Areas with biodiversity that has significant social, cultural or economic importance to local communities, and*
  - *In addition, legally protected or officially proposed areas for protection.*

7.4.9.4 Findings of the CHA

The Project area has been described to be located in a mosaic of evergreen forest, shifting cultivation, shrub land and grassland, waterbodies, and built-up areas. In several areas, there has been extensive modification for agriculture and clearance of forests by local communities predominantly. The EAAAs assessed therefore contain both natural and modified habitat in terms of the ADB SPS definitions for these types:

- areas of natural habitat are concentrated in the northern and eastern sections and represent approximately 41% (109,665 ha) of the EAAA for non-volant species and 36% (86,753 ha) of the EAAA for volant species; and
- modified habitat (59-64% of EAAAs) is mostly found in the central and southern sections of the EAAAs, comprising primarily agricultural areas (currently or historically cultivated lands) that have been cleared and transformed through human activity and associated disturbance of the native vegetation and soils.

The EAAA's for volant and non-volant species associated with the Project both qualify as critical habitat in terms of criteria 1, 2 and 5, as key habitats were identified as supporting populations of CR/EN species, endemics and/or range-restricted species, and were also considered important in providing key ecosystem services. In addition, several Protected Areas (PAs) and Key Biodiversity Areas (KBAs) overlap with the EAAAs and are also considered critical habitat in terms of the ADB SPS (2009). This has been summarised below in ***Table 7.26.***

The two natural forest types, Montane Forest and Wet Evergreen Forest, are considered the most important ecosystems in the EAAAs in terms of providing key ecosystem services, and equally the most important habitats for supporting CR/EN species, endemics and range-restricted species.

Table 7.26: Summary of the Critical Habitat Assessment findings

ADB SPS qualifying criteria for Critical habitat	Qualifies as Critical habitat?	Relevant Habitat Types	Rationale
Criterion 1: Habitat required for the survival of critically endangered or endangered species.	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest ■ Natural / Modified Wet Evergeen Forest	■ Several fauna (mammals, reptiles, amphibians and birds) represented with CR or EN threat status. ■ 1 species of EN plant. ■ For modified forest habitats, fewer species are likely to represented than for natural areas but still some CR or EN species may utilise these habitats
Criterion 2: Areas with special significance for endemic or restricted-range species.	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest ■ Natural / Modified Wet Evergeen Forest	■ Several mammal and bird species are also endemic and/or range-restricted species. ■ Species potentially 'new to science' could be local endemics. ■ Fewer species are likely to represented in modified habitats than for natural areas but still some endemic and/or range-restricted species may utilise these habitats.
Criterion 3: Sites that are critical for the survival of migratory species.	No	n/a	■ The requirements / thresholds for these criteria have not been met in terms of the key species identified.
Criterion 4: Areas supporting globally significant concentrations or numbers of individuals of congregatory species.	No	n/a	
Criterion 5: Areas with unique assemblages of species that are associated with key evolutionary processes or provide key ecosystem services.	**Yes: volant and non-volant EAAAs**	■ Natural / Modified Montane Forest ■ Natural / Modified Wet Evergeen Forest	■ The broader landscape contains a number of KBAs specifically designated for endemic species, which overlap with or are located within the EAAAs. ■ There are also several species of plants and amphibians that were recorded during field surveys that may potentially be 'new to science'. ■ Given the potential for the forest ecosystems to provide key ecosystem services at both a local/regional and global scale, which are also

ADB SPS qualifying criteria for Critical habitat	Qualifies as Critical habitat?	Relevant Habitat Types	Rationale
			considered 'Priority ecosystem services' as per the definition provided in IFC PS6 for this criterion, the forest ecosystems are considered to qualify as critical habitat.
Criterion 6: Areas with biodiversity that has significant social, cultural or economic importance to local communities.	**No**	**n/a**	■ 'Sacred forest' areas appear to be associated principally with existing cemeteries, rather than the forest and biodiversity that just happen to be where these sites are located. Therefore, strictly speaking the associated forest does not qualify as critical habitat in terms criterion 6.
Additional: legally protected areas or areas officially proposed for protection (such as areas that meet the criteria of the World Conservation Union classification, the Ramsar List of Wetlands of International Importance, and the United Nations Educational, Scientific, and Cultural Organization's world natural heritage sites).	No	n/a	■ No project infrastructure is planned to be located within the legally protected area, and therefore the requirements under ADB SPS Safeguard 1, paragraph 30 do not apply

7.4.9.5 Implications of the CHA for the Project

Requirements in terms of natural habitat identified

There are a number of Project components that overlap with terrestrial and aquatic areas that are designated as 'natural habitat' and in these instances, the ADB SPS requires that the Project does not significantly convert or degrade areas of natural habitat, and mitigation measures are designed to achieve at least an overall no net loss of biodiversity.

Requirements in terms of critical habitat identified

Both the volant and non-volant EAAAs assessed qualify as comprising critical habitat, based on several of the ADB SPS critical habitat-qualifying criteria (as per ***Table 7.26***).

Where impacts do occur to identified 'critical habitats', the Project is required to fully exercise the mitigation hierarchy, and demonstrate an overall net gain of critical habitat-qualifying biodiversity associated with Project site. This is aligned with ADB SPS, paragraph 28 – "*No project activity will be implemented in areas of critical habitat unless the following requirements are met:*

i. There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.

ii. The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.