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Part 4: 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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8. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

8.1 Introduction

This section presents an assessment of impacts for key environmental and social aspects identified in in Phase 1 of the Project. The impact assessment method is described in ***Chapter 5***. This section assesses the project's likely positive and negative direct and indirect impacts to physical (***Section 8.3***), biological (***Section 8.4***), social (***Section 8.5***) and unplanned events (***Section 8.6***) in the Project's area of influence. The outcomes of the assessment will inform the development of the ESMP (***Chapter 9***), which will be used to implement relevant management plans.

This section also identifies mitigation measures and any residual negative impacts that cannot be mitigated; explores opportunities for enhancement; identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions and specifies topics that do not require further attention; and examines global, transboundary, and cumulative impacts as appropriate.

8.2 Identification of Impacts

Following the determination of Area of Influence, a Scoping Matrix (***Table 8.1***) was used as a tool to support a methodological identification of potential interactions each Project activity may have on the range of resources/receptors within the AoI. This matrix was prepared in line with the gaps identified from the Phase 1 of the Study for consideration in this Supplemental ESIA.

It consists of, on one side of the matrix, a list of Project activities during the construction and operation phases which may give rise to significant impacts. These are set against a list of environmental and social resources/receptors within the AoI with potential to interact. Entries in the matrix cells are colored to indicate following potential impacts:

	Key
	Scoped in - Potentially significant impact requiring further assessment
	Scoped out - Potential interaction unlikely to be significant
	Positive impacts - An interaction with positive impact expected
	An interaction is not reasonably expected

Table 8.1: Scoping Matrix

Environmental and Social Receptors / Project Phase and Activities	**Environment**											**Social**								
	Air Quality	Noise and Vibration	Topography	Shadow Flicker	Geology & Soil	Ground and Surface Water	Landscape and Visual	Terrestrial Fauna and Flora	Aquatic Flora and Fauna	Protected Areas / Sensitive Species	Avifauna	Economic Opportunities	Economic Displacement and Livelihoods	Ethnic Groups	Local Amenity	Gender	Traffic and Transport	Occupational Health and Safety	Community Health, Safety and Security	Cultural Heritage
Pre-Construction																				
Workforce Mobilization and Presence																				
Land Preparation (site clearance, excavation and levelling), fencing, and civil works																				
Construction																				
Equipment and material transport and supply																				
Construction of turbine foundations, transmission line pylons, internal road, auxiliary works and turbine installation																				
Wastes, emissions and discharges generation, handling and disposal																				
Construction / operation of auxiliary facilities, i.e., concrete batching plant																				
Construction water usage																				
Commissioning and Operation																				
Workforce Presence																				

Environmental and Social Receptors / Project Phase and Activities	**Environment**											**Social**								
	Air Quality	Noise and Vibration	Topography	Shadow Flicker	Geology & Soil	Ground and Surface Water	Landscape and Visual	Terrestrial Fauna and Flora	Aquatic Flora and Fauna	Protected Areas / Sensitive Species	Avifauna	Economic Opportunities	Economic Displacement and Livelihoods	Ethnic Groups	Local Amenity	Gender	Traffic and Transport	Occupational Health and Safety	Community Health, Safety and Security	Cultural Heritage
WTG Operation		■		■				■	■	■	■		■				■	■	■	
WTG and Transmission line Inspection and Maintenance	▒	■		■													▒	■	■	
Waste, emissions and discharge generation, handling and disposal					▒	▒		▒	▒	▒									▒	
Unplanned Events																				
Leakage and spill incident					■	■	■							■	■			■		
Fire and Explosion						■	■	■	■	■								■	■	
Vehicle Collision																	■	■	■	
Blade throw																		■	■	
Transmission line snapping								■	■	■								■	■	
Natural Hazards (Flood and Landslide)					■	■	■	■	■	■		■	■			■	■	■	■	■

8.2.1 Scoped Out Impacts

The scoped out impacts and rationale are summarised in ***Table 8.2***.

Table 8.2: Scoped Out Impacts

Project Activity and Receptor	Rationale
Air emissions during operation and from routine maintenance	Impacts to ambient air quality will be from vehicle use from maintenance activities only. The Project will comply with good international industrial practise and impacts are not likely to be significance.
Waste generation and disposal during operation	Waste generation and disposal during operation will be from the small scale domestic wastes from the operational facilities and maintenance activities only
Land Acquisition and Physical Displacement – Local Communities and Livelihoods	The Project layout will involve the acquisition of land for access roads and transmission lines. However, siting has avoided villagers' houses, therefore there will not be physical displacement impact on villagers. Despite this, it is recognised that land acquisition may cause economic displacement as some agricultural land and forests will be cleared. Economic displacement is discussed as a separate impact in ***Section 8.5.2***. On this basis, the impact of physical displacement has been scoped out and will not be assessed further.

8.3 Physical Environment Impact Assessment

8.3.1 Scope of Physical Environment Impact Assessment

Potential impacts of the physical environment have been further assessed, including topography, geology and soil, climate change, air quality, noise, surface water quality, landscape values and visual amenity, and impact associated with shadow flicker. Details of the impact assessment are presented in the following sections.

8.3.2 Impacts on Topography

8.3.2.1 Potential Impacts

The Project is located in Dak Cheung District of Sekong Province and Sanxay District of Attapeu Province. These two districts have similar topographic features and weather conditions. The project area is mostly composed of the slopes of the hill and high mountainous areas, the elevation is ranging from about 1,000 to 1,600 m above sea level.

The construction activities that have the potential impact are wind turbine generator (WTG) foundation, access roads, transmission line, and other components. The construction of these project components requires levelling or cutting of the topography.

Other factors that can impact topography are the slope of the soil, rock condition, and improper land use situation.

In the operation phase, project facilities will have a permanent presence.

8.3.2.2 Existing Controls

The mitigation measures identified in the local EIA (EIA, 2020) include:

- Avoid carrying out earthwork during heavy rainfall, which will lead to erosion
- After completing construction work, earth filling and compacting must be performed;

- Conduct area clearance or cutting of trees in the Project footprint / Concession Area only;
- Define the operation area clearly by designing the use of road and temporary space for the installation of the WTG in each point in order to minimize the impact to the topography of the area;
- After the construction, conduct restoration of the area and return the landscape to the original condition as much as possible; and
- Assign staff to regularly conduct inspection and audit of the construction area.

8.3.2.3 Significance of Impacts

Methodology for Assessment of Impact Significance

The sensitivity criteria and impact magnitude criteria for topography has been provided in ***Table 8.3*** and ***Table 8.4*** respectively. The subsequent subsections will utilise these criteria to assess the impact of the Project activities to topographical changes.

Table 8.3: Sensitivity Assessment Criteria for Topography

Topography and Drainage Sensitivity	Criteria
Low	Flat topography
Medium	Undulating topography
High	Hilly area

Table 8.4: Criteria for Impact Magnitude for Assessment of Impacts on Topography

Magnitude	Criteria
Negligible	An imperceptible, barely or rarely perceptible change in topographical characteristics. The change may be short term.
Small	A subtle change in topography character over a wide area of a more noticeable change either over a restricted area or infrequently perceived. The change may be short term to long term and is reversible.
Medium	A noticeable change in topographic character, frequently perceived or continuous and over a wide area; or a clearly evident change over a restricted area that may be infrequently perceived. The change may be medium to long term and may not be reversible.
Large	A clearly evident, frequently perceived and continuous change in topographic characteristics affecting an extensive area. The change may be long term and would not be reversible.

Receptor Sensitivity and Impact Magnitude

Change in topography will occur on land occupied by the wind turbines and the associated facilities (e.g. substation, labour camp, site office, lay down area, crane hardstand, met masts etc.) as well as the internal access roads. Land that will temporarily be used for construction phase is anticipated to be around 60 ha for the labour camp, site office and lay down area. The temporarily used area will be reinstated after the constructional phase. The Project Development Area (excluding the transmission line) is approximately 70,828 hectares[90] however, the area impact to topography will be limited to the turbine base only and less than 1 ha per turbine. The impact magnitude is considered **Medium** given the presence of access roads, WTGs, and ancillary facilities.

[90] It should be noted that the Projects' concession area will be the land required to install and construct project facilities and ROW for related transmission line, which is around 1,050 ha.

The Project area is mostly composed of hills and high mountainous areas, the elevation ranges from around 1,000 to 1,200 m above sea level. The presence of the Project during the operation phase is considered long-term. Therefore, the receptor sensitivity is considered as **Medium**.

Impact Significance

The impact significance for topography has been assessed as **Moderate**.

8.3.2.4 Additional Mitigation, Management, and Monitoring Measures

The additional mitigations measures to minimize impacts include:

- Prepare and implement a Site Restoration Management Plan.
- Provide appropriate slope protection and drainage controls.

8.3.2.5 Residual Impact Significance

The residual impact significance will remain **Moderate** after implementing above mentioned mitigation, management, and monitoring measures.

Table 8.5: Impact on Topography (Construction and Operation Phases)

Significance of Impact					
Potential Impact	Potential impacts to topography, as a result of construction and operational activities and physical presence of the Project.				
Impact Nature	**Negative**	Positive	Neutral		
	Potential impacts to soil would be considered to be negative				
Impact Type	**Direct**	Indirect	Induced		
	Potential impacts would be direct impacts.				
Impact Duration	Temporary	Short-term	**Long-term**	**Permanent**	
	The construction phase of the Project are expected to be completed in 30 months, which would be considered long-term; however, the physical presence of the Project during operation phase is considered long-term.				
Impact Extent	**Local**	Regional	International		
Impact Scale	Potential impacts would be limited to the Project area and hence would be considered to be local.				
Frequency	Topographic during construction and operation is considered continuous.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	Based on the impact characteristics above, the impact magnitude is considered to be medium.				
Receptor Sensitivity	Low	**Medium**	High		
	Based on the receptor characteristics above, the receptor sensitivity is considered as medium.				
Impact Significance	Negligible	Minor	**Moderate**	Major	
	The combination of a Medium Receptor Sensitivity and Medium Impact Magnitude will result in an overall Moderate impact.				
Residual Impact Magnitude	Positive	Negligible	Small	**Medium**	
	Negligible	Minor	**Moderate**	Major	

Significance of Impact	
Residual Impact Significance	The residual negative impact will be of a 'Moderate significance during construction and operation.

8.3.3 Impacts on Geology and Soil

8.3.3.1 Potential Impacts

During the construction phase, the potential impacts from earthworks (clearing of vegetation and grading) include loss of soil stabilizing vegetation, soil erosion, and soil compaction that would affect the physical properties of soil.

In addition, the construction of WTG foundation requires drilling in an octagon shape with approximately 4.2 m depth and approximately 11-18 m width at each wind turbine location. Heavy machinery may cause minor vibration and disturbance to the surrounding area. Changes to soil structure may be caused by mechanical disturbance to the soil from these activities. Exposure of soil to rain and wind may in turn cause erosion and loss of topsoil. It is anticipated that the subsoil, which will be stripped and removed from the WTG foundation, transmission line route, and access road route, will be utilized for levelling/ backfilling.

The movement of heavy vehicles in the construction area will also result in soil compaction and damage to the soil structure. This compaction of the soil may potentially result in changed hydrological characteristics, such as reduced permeability and water infiltration to the soil, which could create additional surface run-off (and increase the flow velocity of this run-off), as well as reducing infiltration into subsurface aquifers.

Improper waste management practices can impact soil quality. Soil quality impacts are related with inappropriate dumping and inadequate storage/coverage during transport resulting in windblown litter. In addition, wastewater discharged and run-off would have the potential to result in localized soil contamination within and in the vicinity of the Project area.

During the operation phase, soil compaction and erosion may occur due to heavy vehicle movement, which will be occasionally required during maintenance work.

8.3.3.2 Existing Controls

The mitigation measures identified in the local EIA (EIA, 2020) include:

- In areas that are high risk for erosion; arrange earthwork in the dry season and avoid the rainy season, where possible;
- Undertake the earthwork within the Project footprint;
- The stockpiling of the construction materials must be kept at least 30 m from rivers and waterways;
- Ensure that the construction materials are stored in designated areas or in a secured place, and are not causing obstruction or located in areas of potential soil erosion;
- Construct a suitable drainage system specifically in areas of high potential soil erosion;
- Monitoring / auditing conducted to inspect erosion control measures;
- Avoid earthworks in existing forest areas as much as possible;
- Replantation to be conducted as soon as possible after completing the forest clearance or backfilling work;
- Avoid digging and removal of stockpiling of soil at the sides of the stream or canal in order to prevent sedimentation and erosion into the water sources;

- Conduct backfilling and compacting using heavy machinery to prevent the collapse of the soil as soon as possible after earthworks;
- Undertake erosion protection for WTG foundations and transmission towers that are located in a slope area.
- Undertake construction of a water drainage system at both sides of the access road to facilitate draining of water.

8.3.3.3 Significance of Impacts

Methodology for Assessment of Impact Significance

The sensitivity criteria and impact magnitude criteria for soil quality has been provided in ***Table 8.6*** and ***Table 8.7***, respectively. The subsequent subsections will utilise these criteria to assess the impact of the Project activities to soil quality.

Table 8.6: Sensitivity Assessment Criteria for Soil Quality (compaction, erosion and contamination)

Sensitivity Criteria	Contributing Criteria	
	Environment	Social
Soil quality related criteria as compaction, erosion and contamination and land use change	The extent to which the soil and its quality plays an ecosystem role in terms of supporting biodiversity. This includes its role in supporting a lifecycle stage.	The extent to which the soil and its quality provides a use (agricultural use) to the local communities and businesses, or is important in terms of national resource protection objectives, targets, and legislation.
Low	The soil quality does not support diverse habitat or populations and/or supports habitat or population of low quality	The soil quality has little or no role in provisioning of services as agricultural uses for the local community.
Medium	The soil quality supports diverse habitat or population of flora and fauna and supports habitats commonly available in the study area	The soil has local importance in terms of provisioning services as agricultural services but there is ample capacity and / or adequate opportunity for alternative sources of comparable quality i.e., ready availability across the study area.
High	The soil quality supports economically important or biologically unique species or provides essential habitat for such species.	The soil is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional level for provisioning services.

Table 8.7: Criteria for Impact Magnitude for Assessment of Impact to Soil

Magnitude Criteria	Negligible	Small	Medium	Large
Soil compaction and erosion	■ Qualitative-No perceptible or readily measurable change from baseline conditions ■ Scale - Localized area as Particular activity areas	■ Perceptible change from baseline conditions but likely to easily revert back to earlier stage with mitigation ■ Scale - Project site,	■ Clearly evident)e.g .perceptible and readily measurable (change from baseline conditions and/or likely take time to revert back to earlier stage with mitigation	■ Major)e.g . order of magnitude (change in comparison to baseline conditions and/or likely difficult or may not to revert back to earlier

Magnitude Criteria	Negligible	Small	Medium	Large
	■ Time-Short duration)few days (or one time as temporary	activity areas and immediate vicinity not impacting any sensitive receptor ■ Short term - Only during particular activities or phase of the project lifecycle as civil works or construction phase)few months(	■ Scale -Project site, activity areas and immediate vicinity impacting sensitive receptor/s ■ Long term - Spread across several phases of the project lifecycle)few years(	stage with mitigation ■ Scale - Regional or international; ■ Permanent change
Soil contamination	■ Well within standards	■ Well within standards	■ Exceeds Target Value but well within Interventional Value	■ Exceeds Interventional Value and needs intervention.

Receptor Sensitivity and Impact Magnitude

The receptor sensitivity has been assessed as **Medium** because of the importance of agriculture as a source of livelihood in the area, and a portion of land does support natural habitat.

Due to the localized area of construction within the Project area, the impact magnitude has been assessed to be **Small**.

Impact Significance

The overall impact significance on soil erosion and compaction has been assessed as **Minor.**

8.3.3.4 Additional Mitigation, Management, and Monitoring Measures

The additional mitigations measures to minimize impacts include:

- Prepare and implement and Spoil Management Plan and Soil Erosion and Sediment Control Management Plan prior to construction.
- A Waste Management Plan (WMP) for the Project should be developed and implemented. The WMP should include the following:

  - Good housekeeping practices for waste storage and handling referencing good international industry practice (GIIP);

  - A waste inventory developed in the planning stage, in discussion with the engineers, to establish the types of wastes (hazardous and non-hazardous) expected from the construction and to identify appropriate disposal routes;

  - Construction materials should be managed in a way to avoid over-ordering, poor storage and maintenance, mishandling as well as improper operation procedures;

  - Construction wastes should be separated into reusable items and materials to be disposed of or recycled whenever possible;

  - Waste suitable for reuse should be stored on site and reintroduced to the construction process as and when required;

- The WMP should identify disposal routes (including transport options and disposal sites) for all wastes generated during the construction phase;
- A hazardous waste management system covering waste classification (including hazardous chemical waste), separation, collection, storage, transfer and disposal should be set up and operated. The waste management system should comply with applicable regulation of the government, if any, or in its absence, GIIP;
- Hazardous waste should be stored in such a way as to prevent and control accidental release to the environment (e.g. secondary containment, sealed containers);
- Waste should be collected regularly by reputable waste collectors;
- Recyclables such as scrap steel, metals, plastics, and paper items should be collected for recycling wherever possible;
- Disposal of construction waste in or off the construction site should be prohibited;
- Chain of custody documents should be used for construction waste and hazardous waste to monitor disposal; and
- Waste segregation should be practiced at the labour camp with an emphasis placed on reducing, reusing and recycling of waste streams as appropriate.

- The access route for movement of heavy machinery will be designated to avoid the soil compaction in other areas.
- Conduct monitoring of Total Suspended Solids (TSS) at nearby water sources.
- Conduct pre-construction soil sampling at 5 locations to identify the potential presence of Persistent Organic Pollutants (POPs), which may include PCBs, dibenzofurans, and dioxins. If POPs are identified in the soil, the spoil will be treated as hazardous waste and will need to be managed and disposed of according to country requirements and Project hazardous waste management plan.

8.3.3.5 Residual Impact Significance

The residual impact significance will remain **Minor** after implementing above mentioned mitigation, management, and monitoring measures (***Table 8.8***).

Table 8.8: Soil Impacts from Soil Erosion and Compaction (Construction and Operational Phase)

Significance of Impact				
Potential Impact	Potential impacts on soil due to soil erosion and compaction, as a result of earthworks and use of heavy machinery.			
Impact Nature	**Negative**	Positive	Neutral	
	Potential impacts to soil would be considered to be negative.			
Impact Type	**Direct**	Indirect	Induced	
	Potential impacts would be direct impacts.			
Impact Duration	Temporary	Short-term	**Long-term**	**Permanent**
	The construction phase of the Project is expected to be completed in 30 months, which would be considered long-term and permanent for operation.			
Impact Extent	**Local**	Regional	International	
	Potential impacts would be limited to the Project area and hence would be considered to be local.			

Significance of Impact					
Impact Scale	Impact scale is considered localised and small.				
Frequency	Impacts to soil could occur intermittently during the construction phase.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Based on the impact characteristics above, the impact magnitude is considered to be small.				
Receptor Sensitivity	Low		**Medium**	High	
	Based on the receptor characteristics above, the receptor sensitivity is considered as medium.				
Impact Significance	Negligible	**Minor**	Moderate	Major	
	The combination of a Medium Receptor Sensitivity and Small Impact Magnitude will result in an overall Minor impact.				
Residual Impact Magnitude	Positive	Negligible	**Small**	Medium	
Residual Impact Significance	Negligible	**Minor**	Moderate	Major	
	Although the aforementioned mitigation measures are expected to help control the impact, the significance of residual impacts is expected to remain as Minor.				

8.3.4 Impacts on Air Quality

8.3.4.1 Potential Impacts

The ambient air quality is likely to be impacted by site development works. This includes site clearance, the removal of vegetation as well as earthwork and civil construction creating free flying fugitive dust/dust nuisance into the air, which could be hazardous for human health. Project activity potentially causing air emissions during the construction phase also includes transportation of personnel and material.

During the operation phase, passenger vehicles used by staff to travel to and from the Project is to be expected, air emissions generated from these vehicles are very minor and the number of vehicles is expected to be minimal. As such, no significant air quality impacts are expected during Project operation.

8.3.4.2 Existing Controls

The mitigation measures identified in the local EIA (EIA, 2020) include:

- Conduct air quality monitoring as per recommendations in the local ESIA (2020);
- Reduce the speed of vehicles: to mitigate the potential occurrence of dust from the transportation of construction materials to the project construction site, it is required to limit and control the speed of vehicles arriving to and leaving the affected villages at not exceeding 30 km/hour;
- The roads within the Project area should be paved. If the road isn't paved, it is required to regularly spray water at least two times per day, especially roads that pass through villages and access roads to the construction sites;
- In the construction area, areas located near the communities, it is required to build a 2 m height of fence around the site to reduce dust dispersion from soil digging, removing, dumping, and filling works if the construction site is within 500 m of communities;
- The construction contractor must regularly undertake maintenance of vehicles and heavy machinery of all types which are used in the construction of the project;

- Vehicles transporting construction materials must be properly covered, particularly the transportation of soil, sand, and gravel to the construction site;
- Have a wheel washing facility on exit from the site for vehicles to prevent the vehicles from carrying mud or sediment to outside construction site and communities; and
- Training should be organized and staff and workers to be prohibited from burning rubbish and wastes that will cause potential air pollution.

8.3.4.3 Significance of Impacts

Methodology for Assessment of Impact Significance

The sensitivity criteria and impact magnitude criteria for ambient air quality has been provided in ***Table 8.9*** and ***Table 8.10,*** respectively. The subsequent subsections will utilise these criteria to assess the impact of the Project activities to the ambient air quality.

Table 8.9: Sensitivity Assessment Criteria for Air Quality

Sensitivity Criteria	Contributing Criteria	
	Human Receptors	Ecological Receptors
Low	Locations where human exposure is transient.	Locally designated sites; and / or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team).
Medium	Few Receptors (settlements) within 1 km of project activity area as wind turbine, roads, batching plant etc.	Nationally designated sites.
High	Densely populated receptors (settlements) within 1 km of project activity area as wind turbine, roads, batching plants.	Internationally designated sites

Table 8.10: Criteria for Impact Magnitude for Assessment of Impact to Air Quality

Magnitude	Criteria
Negligible	Low levels of emissions/ dust generation due to Project activity Impact extent is local Temporary dust generation and emission from Projects
Small	Soil type with large grain size (e.g. sand) Impact extent is local Dust generation and emissions from Projects for short duration
Medium	Moderately dusty soil type (e.g. silt) Impact extent is local to regional Dust generation and emission from Projects for long duration
Large	Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size) Impact extent is local to international Significant process emissions from Project for the entire Project cycle

Receptor Sensitivity and Impact Magnitude

The receptor sensitivity has been assessed as **Medium** due to the presence of sensitive receptors (settlements) within 1 km of the site. The impact magnitude is considered to be **Medium**.

Impact Significance

The overall impact significance on air quality from land preparation and civil works, and transportation of personnel and material has been assessed as **Moderate,** respectively.

8.3.4.4 Additional Mitigation, Management, and Monitoring Measures

The additional mitigations measures to minimize impacts include:

- Prepare and Implement and Air Quality Management Plan prior to construction.
- Prioritise materials to be supplied by local suppliers (Laos suppliers);
- Water sprays should be applied at land preparation area, access roads and any other exposed surfaces which could be source of dust are to be watered;
- Construction material at the storage area will be covered to minimize dust dispersion during construction;
- No cleared vegetation to be burnt. Cleared vegetation will either be composed or reused for stabilization purposes;
- Vehicles transporting materials within or outside the construction site will not to be overloaded;
- Vehicle engines need to be properly maintained to ensure minimization in vehicular emissions;
- Use of modern equipment and vehicles meeting appropriate emissions standards, and regular preventative maintenance; and
- Minimizing stockpiling by coordinating excavations, spreading, and regrading and compaction activities.

8.3.4.5 Residual Impact Significance

With the implementation of both the embedded control as well as the suggested additional mitigation measures, uplifted fugitive dust dispersion emission of gases from vehicles can be limited and controlled. As a result, the residual negative impact associated with decreased air quality will be of a **Minor** significance (***Table 8.11***). Impacts during operation are not considered to be significant during Scoping and have been scoped out of the assessment.

Table 8.11: Air Quality Impacts (Construction Phase)

Significance of Impact				
Impact	Fugitive dust emission causing degradation in ambient air quality			
Impact Nature	**Negative**	Positive	Neutral	
	Potential impacts to air quality would be considered to be negative			
Impact Type	**Direct**	Indirect	Induced	
	Impacts to air quality would be direct impacts through mainly uplifting of fugitive dust during land preparation and civil works.			
Impact Duration	**Temporary**	Short-term	**Long-term**	Permanent
	The construction phase of the Project is expected to be completed in 30 months, which would be considered long-term. The impact to air quality due to land preparation and civil work is expected to be transient.			
Impact Extent	**Local**	Regional	International	
	The impact will only be localized within the Area of Influence of the Project.			
Impact Scale	Impact scale is considered localized and small.			

Significance of Impact					
Frequency	Impacts to air quality could occur intermittently during the construction phase.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	**Large**
	Based on the characteristic above, the impact is likely to be medium				
Receptor Sensitivity	Low		**Medium**	High	
	The location of the nearest sensitive receptor (i.e. village houses are less than 1 km away from the construction site).				
Impact Significance	Negligible	Minor	**Moderate**	Major	
	The combination of a Medium Resource Sensitivity and Medium Impact Magnitude will result in a Moderate impact significance.				
Residual Impact Magnitude	Positive	Negligible	**Small**	Medium	
Residual Impact Significance	Negligible	**Minor**	Moderate	Major	
	Upon considering the mitigation measure, the residual impact is assessed to be Minor.				

8.3.5 Impacts on Noise

This section describes the methodology and findings of the noise assessment forming part of the Environmental and Social Impact Assessment (ESIA). Detailed in this report are the main aspects of the proposed Project, the construction of the project, the wind farm noise assessment criteria and the predicted noise levels at all potentially affected receptors within the potential area of influence of the wind farm.

As the methodologies for assessing noise impacts will vary between construction and operational phases, these have been separated for the purposes of this assessment.

8.3.5.1 Construction Phase

Potential Impacts

During the construction phase, a range of works and activities will be required at various locations within the area. Those with the potential to generate significant noise emissions include:

- Site preparation, construction and installation works associated with each of the proposed wind turbines.
- Site preparation and building construction works associated any permanent facilities.
- Construction and installation of the internal electrical network (between turbines) and any associated transmission lines.
- Use of specialised (e.g. concrete batching plants) or unforeseen wind farm construction equipment, or activities that are to be undertaken.

Existing Controls

- Conduct noise monitoring as per the recommendations in the local EIA report (2020).
- During construction of the Project good-practice, construction noise mitigation and management measures should be implemented to reduce noise levels and minimise any impacts as far as practicable. A range of mitigation and management measures are available and those that are considered feasible, reasonable, and practical to implement the specific tasks should be considered, for example:

- Avoid unnecessary noise due to idling diesel engines and fast engine speeds when lower speeds are sufficient;
- Ensure all machines used on the site are in good condition, with particular emphasis on exhaust silencers, covers on engines and transmissions and squeaking or rattling components. Excessively noisy machines should be repaired or removed from the site; and/or
- Ensure that all plant, equipment, and vehicles movements are optimised in a forward direction to avoid triggering motion alarms that are typically required when these items are used in reverse.

Significance of Impacts

Methodology for Assessment of Impact Significance

A quantitative noise modelling assessment has not been conducted for construction; however, these works and activities (or similar activities) are expected to generate noise levels that would potentially generate impacts. This is typical of many construction works associated with major developments. Elevated levels will not represent a constant or long-term emission that would be experienced by the community throughout the project's construction schedule, or for the operational life of the wind farm. Construction noise levels would only be experienced for limited periods of time when works are occurring at select locations; they would often not be experienced for full daytime, evening or night time periods. Any impacts associated with these works would be temporary and will not represent a permanent impact on the community and the surrounding environment.

Some noise from construction sites is inevitable, such that good construction management practices usually focus on minimising noise impacts, rather than only on achieving numeric noise levels. Good-practice construction noise management and noise mitigation techniques may be required for construction of the Project to reduce noise levels as far as practicable. These would need to be considered and then implemented, where necessary.

The sensitivity criteria and impact magnitude criteria for ambient noise has been provided in ***Table 8.12*** and ***Table 8.13***, respectively.

Table 8.12: Criteria for Impact Magnitude for Assessment of Impact to Noise Level

Magnitude	Criteria
Negligible	■ Predicted noise levels are at or less than 3 dB (A) above the relevant limits / thresholds ■ Human exposure is transient within 500 m of project site ■ No designated sites and/or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team) within 500 m of project site ■ Impact extent is local ■ Temporary exposure
Small	■ Predicted noise levels are 3 to less than 5 dB (A) above the relevant limits / thresholds ■ Receptors include industrial, retail, or transient receptors within 500 m of project site ■ Locally designated sites; and/or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team) within 500 m of project site. ■ Impact extent is local ■ Short-term exposure
Medium	■ Predicted noise levels are between 5 and 10 dB (A) above the relevant limits / thresholds ■ Receptors include residential and recreational space' within 500 m of project site ■ Nationally designated sites and/or areas of specific ecological interest within 500 m of project site ■ Impact extent is local to regional ■ Long-term exposure

Magnitude	Criteria
Large	■ Predicted noise levels are at or more than 10 dB (A) above the relevant limits / thresholds ■ Receptors include educational/ religious/ medical facilities within 500 m of project site ■ Internationally designated sites and/or areas of specific ecological interest within 500 m of project site ■ Impact extent is local to international ■ Permanent exposure

Table 8.13: Noise Receptor Sensitivity

Category	Designation / Importance / Vulnerability
High	Existing ambient noise is already under stress and/ or public health is very sensitive to change (children, schools).
Medium	Existing noise quality conditions already shows some signs of stress and/ or supports ecological resources that could be sensitive to change in noise quality (protected species, migratory birds, protected areas).
Low	Existing noise quality condition is good and the ecological resources that it supports are not sensitive to a change in noise quality.

Receptor Sensitivity and Impact Magnitude

Given the above, the receptor sensitivity is classified as **Medium** and the construction noise will be **Medium** magnitude.

Impact Significance

The impact significance from construction in classified as **Moderate**.

Additional Mitigation, Management, and Monitoring Measures

Based on the findings of the qualitative construction noise assessment noise mitigation will be adopted as follows:

- During the construction design, choose appropriate machines for each task and adopt efficient work practices to minimise the total construction period and the number of noise sources on the site. Select the quietest item of plant available where options that suit the design permit.
- High noise-generating construction works and activities should be limited to the daytime period (7 AM to 10 PM; as per WBG EHS definition of daytime and night-time), and work should be avoided on Sundays or public holidays if possible. In the case that Project activities necessarily have to be conducted during night-time period, the Project will consult with village heads for approval.
- Any works that are required during the night-time period (10 PM to 7 AM) should be justified and task-specific noise mitigation and management measures should be implemented to reduce noise impacts to acceptable levels. These additional measures should consider the potential for sleep disturbance impacts that could occur during the night-time period due to “peak” or “maximum” noise level events e.g. metal on metal contact, or general clangs and bangs. In the case that Project activities necessarily have to be conducted during night-time period, the Project will consult with village heads for approval
- Works associated with transmission line and access road construction often require activities in closer proximity to receptors that are not affected by construction works at wind turbines or permanent facilities. In these circumstances, task-specific noise mitigation and management

measures should be implemented (when works are close to receptors) to reduce noise impacts to acceptable levels.

- Construction road traffic and heavy vehicle movements have the potential to generate high "peak" or "maximum" noise level events and these should be limited during the night-time period and avoided if possible. Where possible, significant noise-generating vehicle movements should be limited to the daytime period. Where it is not possible for this to occur drivers should be instructed to arrive and depart as quietly as possible. Whilst on-site and in close proximity to receptors the drivers should be instructed to implement good-practice noise management measures to reduce peak noise levels and minimise any impacts as far as practicable. During the works, instruct drivers to travel directly to site and avoid any extended periods of engine idling at or near residential areas, especially at night.
- If any validated noise complaints are received, the problem source and any potential noise-reducing measures should be identified and evaluated for implementation during the works. If the noise complaint cannot be validated, no further mitigation or management measures are required.

No further recommendations for construction noise mitigation and management measures to those established by the findings of this assessment, and documented in this report, are provided or warranted for the Project. The Project personnel should, however, remain aware of the potential for nuisance, or an unacceptable impact on amenity, to occur due to construction noise, continue to plan for and then manage construction works accordingly.

Residual Impact Significance

Based on the findings discussed above suitable recommendations, which can be considered and potentially implemented on-site, are provided in next section of this report. Construction noise levels would be reduced to Minor (***Table 8.14***).

Table 8.14: Noise Impact Assessment (Construction)

Significance of Impact					
Impact	Construction noise from equipment and vehicle use.				
Impact Nature	**Negative**	Positive	Neutral		
	Potential impacts to ambient noise would be considered to be negative				
Impact Type	**Direct**	Indirect	Induced		
	Impacts to ambient noise would be direct impacts mainly from installation and vehicle use.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	The construction phase of the Project is expected to be completed in 30 months, which would be considered long-term.				
Impact Extent	**Local**	Regional	International		
	The impact will only be localized within the Area of Influence of the Project.				
Impact Scale	Impact scale is considered localized and small.				
Frequency	Impacts to ambient noise would occur intermittently during the construction phase.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	**Large**
	Based on the characteristic above, the impact is likely to be medium				
Receptor Sensitivity	Low	**Medium**	High		
	The location of the nearest sensitive receptor (i.e. village houses are less than 1 km away from the construction site).				

Significance of Impact				
Impact Significance	Negligible	Minor	**Moderate**	Major
	The combination of a Medium Resource Sensitivity and Medium Impact Magnitude will result in a Moderate impact significance.			
Residual Impact Magnitude	Positive	Negligible	**Small**	Medium
Residual Impact Significance	Negligible	**Minor**	Moderate	Major
	Upon considering the mitigation measure, the residual impact is assessed to be Minor.			

8.3.5.2 Operation Phase

Potential Impacts

Nuisance, or an unacceptable level of noise amenity, may arise from operational activities associated with new wind farm sites. This potential for noise issues to arise is associated with emissions from significant noise generating sources/assets such as wind turbine generators. The purpose of this assessment is to address these potential noise issues by predicting and assessing wind farm operational noise levels from the Project at nearby sensitive receptors.

Significance of Impacts

Methodology for Assessment of Impact Significance

The noise limits of the Monsoon Wind Farm Project have been based on the requirements of national Lao Regulations and the ADB requirements, which refer to the World Bank Group International Finance Corporation Environmental, Health, and Safety (EHS) Guidelines and other relevant documentation. The IFC General EHS Guideline noise guidelines are also referenced in the IFC wind energy guidance, which are 55 dB LAeq, 1 hour during the day (07.00 to 22.00) and 45 dB LAeq, 1 hour at night (22.00 to 07.00). National Lao noise regulations define the noise limit of 70 dB LAeq for a period of 24 hours. A summary of the national and international noise regulations is presented in ***Table 8.15***.

The noise limit at each of the receivers around the project is defined as the existing background noise level + 3 dB, or the base limit for each receiver type. Therefore, the limit which gives the higher noise criterion of the two discussed above has been adopted in this study. However, as mentioned in ***Chapter 7***, the measured noise levels did not provide a clear correlation between wind speed and the background noise levels on R1 and R4. For those receptors, a conservative approach has been adopted, where only the IFC noise limits for day and night have been used.

Table 8.15: LAO National Regulation vs IFC Guidelines

	LAO National regulation	IFC Guidelines
Period	24 hours	Day/Night
Absolute Limit	70 dB(A)	55/45 dB(A)

When assessing the significance of an impact for the noise assessment, the process is slightly different to most other topics in this ESIA. The significance of an impact is derived from the impact magnitude, but takes account of other factors such as duration and the design detail of the noise sensitive property, for example if the construction will take place during a very short period of time, the significance of the potential impacts may be downgraded.

The sensitivity of the receptor is taken account of when calculating the impact magnitude as the criteria take into account the receptor's sensitivity to noise. For example, receptors sensitive to noise during the daytime only are assessed using criteria that consider the impact of noise on daytime activities, whilst those rated as sensitive during the night time are assessed using criteria that consider the impact of noise on sleep disturbance. The significance of noise effects is set out below in ***Table 8.16***.

Table 8.16: Magnitude and Significance of Noise Effects

Exceedance of criteria, dBA	Magnitude of predicted impact	Other relevant factors	Resulting Significance of effect
5 or more below the criteria	Negligible	Factors which may influence significance of effects, e.g. duration of construction activity	Insignificant
> 5 below, up to the criteria	Small		Minor
Up to 5 dB above the criteria	Medium		Moderate
> 5 above the criteria	Large		Major

The classification of significance refers to not-significant, minor, moderate and major. Impacts rated as Moderate or Major should be mitigated where practicable, feasible and reasonable with proportionately more emphasis on the Major items. Mitigation may not fully eliminate an impact, but would be expected to reduce its severity.

Receptor Sensitivity

In addition to the 4 locations (R1-R4) where background noise data were collected, for modelling purposes, additional 90 receptors have been taken into consideration (***Table 8.17***), which are considered potentially impacted by the noise produced from the operation of the project. The location of the additional receptors is presented in ***Figure 8.1***.

Figure 8.1: Additional Receptors

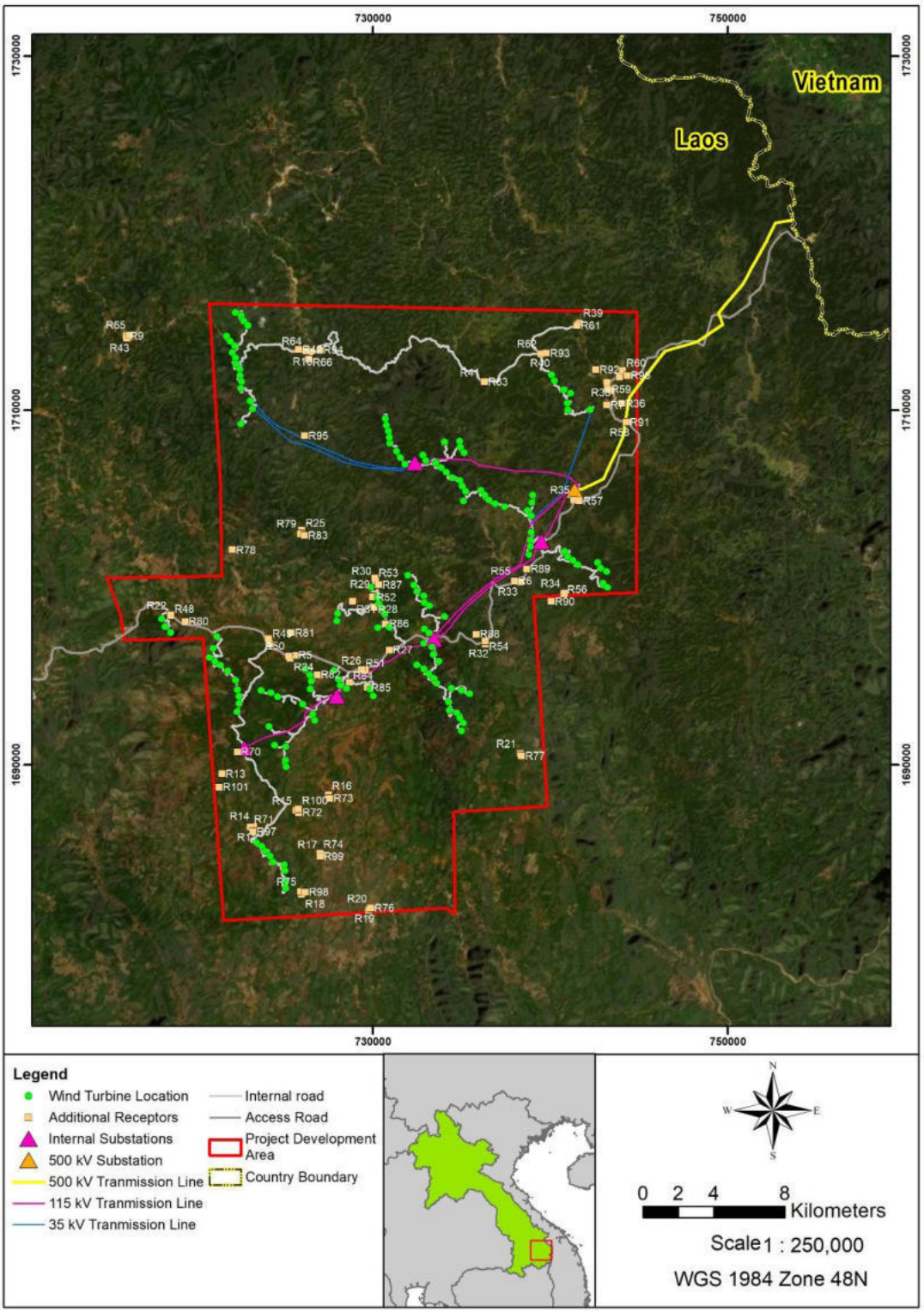


Table 8.17: Additional Receptors

Receptor	Description	UTM 48N WGS84 m	
		Easting	Northing
R5	Xiengluang Health Center	725582	1696196
R6	Dak Dor Health Center	737964	1700374
R7	Hospital Of Dak Cheung District	743174	1710307
R9	Dak Jom Health Center	716066	1714186
R10	B. Prao Health Center	726450	1713303
R11	Dak Samor Health Center	723246	1686465
R12	NamNgonnuea Health Center	729752	1681773
R13	Dak Nong Primary School	721478	1689492
R14	Dak Samor Primary School	723266	1686539
R15	Dak Yok Primary School	725648	1687406
R16	Dak Dor Primary School	727486	1688327
R17	Dak Sied Primary School	727086	1684927
R18	Dak Xuem Primary School	725942	1682695
R19	NamNgonnuea High School	729964	1681880
R20	NamNgonnuea Primary School	729876	1681895
R21	Dak Padou Primary School	738291	1690621
R22	Dak Tiem Primary & Lower Secondary School	718590	1698430
R23	Dak Seng Primary School	724169	1696811
R24	Xiengluang Primary & High School	725312	1696012
R25	Dak Sieng A Primary School	725967	1703255
R26	Dak Terb Primary School 01	729561	1695330
R27	Dak Terb Primary School 02	730912	1696489
R28	Dak Yang Primary School 01	730056	1698865
R29	Dak Yang Primary School 02	730052	1699638
R30	Dak Yen Primary School 01	730138	1700380
R31	Dak Yen Primary School 02	728846	1699210
R32	Trongmueang Primary School	736311	1696824
R33	Dak Dor Primary & High School	738320	1700330
R34	Dak Den Primary School	740791	1699669
R35	Dak Rant Primary School	741310	1704942
R36	Dak Bong Primary School	744012	1710378
R37	Dak Cheung Primary School	743419	1711116
R38	Dak Cheung Lower Secondary School	743186	1711556

Receptor	Description	UTM 48N WGS84 m	
		Easting	Northing
R39	Dak Pum Primary School	741628	1714935
R40	Tongxieng Primary School	739472	1713231
R41	Dak Lern Primary School	736246	1711574
R42	B. Prao & Dakkung Primary School	725795	1713437
R43	Dak Jom Primary & Lower Secondary School	716104	1714067
R44	NgonDone Primary & High School	743876	1711861
R48	Dak Tiem village	718585	1698466
R49	Dak Xeng village	724116	1697095
R50	Xiengluang village	725240	1696154
R51	Dak Terb village	729357	1695390
R52	Dak Yang village	729970	1699494
R53	Dak Yen village	730101	1700539
R54	Trongmueang village	736317	1696970
R55	Dak Dor village	737986	1700380
R56	Dak Den village	740747	1699625
R57	Dak Rant village	741622	1704882
R58	Dak Bong village	744383	1709315
R59	Dak Cheung village	743203	1711192
R60	Ngon Done village	744053	1712262
R61	Dak Pum village	741494	1714790
R62	Tongxieng village	739465	1713201
R63	Daklern village	736267	1711615
R64	B. Prao village	726198	1713335
R65	Dak Jom village	716267	1714262
R66	Dak Kung village	726377	1712905
R70	Dak Nong village	722344	1690728
R71	Dak Samor village	723078	1686508
R72	Dak Yok village	725807	1687306
R73	Dak Dor village	727562	1688115
R74	Dak Sied village	726995	1684992
R75	Dak Xuem village	725900	1682832
R76	Nam Ngonnuea village	729866	1681908
R77	Dak Padou village	738360	1690511
R78	Xiengmai village	722057	1702122

Receptor	Description	UTM 48N WGS84 m	
		Easting	Northing
R79	Sieng A village	725900	1703033
R80	Dak Tiem Cemetery	719405	1698097
R81	Dak Seng Cemetery	725386	1697432
R82	Xiengluang Cemetery	726850	1695092
R83	Dak Sieng A Cemetery	726124	1702946
R84	Dak Terb Cemetery 01	728659	1694665
R85	Dak Terb Cemetery 02	729680	1694344
R86	Dak Yang Cemetery	730690	1697966
R87	Dak Yen Cemetery	730314	1700144
R88	Trongmueang Cemetery	735809	1697377
R89	Dak Dor Cemetery	738663	1701034
R90	Dakden Cemetery	740032	1699213
R91	Dak Bong Cemetery	744263	1709336
R92	Dak Cheung Cemetery	742562	1712294
R93	Tongxieng Cemetery	739767	1713228
R94	B. Prao Cemetery	726996	1713402
R95	Dakkung Cemetery	726140	1708564
R96	NgonDone Cemetery	744319	1711973
R97	Dak Samor Cemetery	723219	1686240
R98	Dak Xuem Cemetery	726164	1682829
R99	Dak Sied Cemetery	727018	1684832
R100	Dak Yok Cemetery	725779	1687500
R101	Dak Nong Cemetery	721325	1688742

Methodology

Noise Prediction Method

The noise model used in this study to predict wind farm noise levels at sensitive receptors is based on ISO 9613-2:1996[91] as implemented in the SoundPlan computer noise model. The model predicts noise level through spherical spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding. The further advice provided by the UK IOA which is referenced in the IFC wind farm guidance has also been adopted. SoundPlan 8.0 is one of the most recognised noise prediction tool, used extensively in road, railway and industry noise modelling.

The industrial model is comprehensive and allows:

- modelling of sound power sources in third of octave;

[91] International Organization for Standardization (1996). ISO 9613-2:1996 *Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation.* https://www.iso.org/obp/ui/#iso:std:iso:9613:-2:ed-1:v1:en

- modelling of noise sources as point, line or area sources;
- 2D and 3D directivity of sources;
- 3D topography;
- noise sources ranking;
- use of various noise model standards (ISO, Concawe, Nordic, etc.);
- screening and meteorological effects
- modelling of Wind Turbine.

This software applies the “ray tracing” method. Sources are simulated as surfaces, lines or points: each source propagates sound waves. The resulting acoustic field depends on the absorptions and reflections characteristics of all existent obstacles between the source and the receptor.

Every ray carries a part of the acoustic energy of the sound source. The energy decreases along the way, as a result of the absorption of surfaces, geometrical divergence and atmospheric absorption.

The absorption of sound energy by air is related to the dispersion of energy caused by the collisions of air molecules among them. Every collision scatters one small part of the energy and causes more impacts.

In the area of interest, the acoustic field will be the result of the acoustic energies sum of “n” rays that reach the receiver. The levels in the whole area are indicated by iso-phones with equivalent steps, at a conventional height of 1.5 meters a.g.l. same height has been considered for receptors.

The mathematical model uses international standards for sound attenuation in the environment. In this study *ISO 9613 Acoustics – Attenuation of Sound During Propagation Outdoors – Part 2: General Method of Calculation* has been applied. This standard has many equations regulating the propagation and it allows calculating noise levels in the study area with a defined accuracy.

The aim of such methodology is to determine the equivalent continuous A- weighted sound pressure level, as described in ISO 1996/1-2-3, under meteorological conditions favourable to sound propagation from sources of known power emission.

Predicted L_{Aeq} noise levels were calculated based upon sound power levels determined in accordance with the recognised standard IEC-61400-11:2012[92] , where available, for the wind range of 3 m/s to 24 m/s.

Topographic and Environmental Variables

Soundplan software package allows 3D elevation data to be combined with ground regions, water, foliage, barriers, significant building structures etc. and receptor locations, to create a detailed and accurate representation of the wind farm and surrounding area.

- A 3D topography has been interpolated from NASA’s SRTM 1 Arcsec Cartography.
- A ground absorption factor of 0.6 was adopted across the entire modelled region, which represents an absorption factor for partly soft ground.
- In the scenario the whole set of known 3D buildings has been recreated.
- The scenario has been implemented also with forest to produce a linear absorption as for the ISO 9613
- Standard atmosphere variables have been implemented.

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

Noise Emission Sources

The Project will include the installation of 130 Goldwind GW165-4.0MW and 18 Goldwind GW155-4.5 MW WTGs with a hub height of 110 metres. The WTG specifications for the standard operation mode, have been provided by the client. ***Table 8.18*** and ***Table 8.19*** summarise the relevant turbine input data used for noise level prediction.

Table 8.18: Goldwind WTG Manufacturer Data

Make, Model, Power	GW155-4.5MW	GW165-4.0MW
Rotor Diameter (metres)	155	165
Hub Height (metres)	110	110
Cut-In Wind Speed (m/s)	2.5	2.5
Cut-Out Wind Speed (m/s)	24	26
Max. Sound Power Level (dBA)	109	111.2

Table 8.19: Sound Power Levels vs Wind Speed

Wind Speed at Hub Height (m/s)	Sound Power Level at Hub Height GW155-4.5MW (dBA)	Sound Power Level at Hub Height GW165-4.0MW (dBA)
6	102.2	105.3
7	105.5	108.6
8	108.1	111.2
9	109.0	111.2
10	109.0	111.2
11	109.0	111.2
12	109.0	111.2
13	109.0	111.2
14	109.0	111.2
15	109.0	111.2
16	109.0	111.2
17	109.0	111.2
18	109.0	111.2
19	109.0	111.2
20	109.0	111.2

The manufacturer did not provide sound power data for 3 to 5 m/s wind speed. The sound power level of the 6 m/s wind speed has been adopted for this missing range, for each type of WTG.

The reference spectrum in 1/3 of octave provided by the manufacturer is reported in ***Table 8.20***.

The sound power levels are presented for the highest overall sound power value used in the assessment that applies at 9 m/s wind speed and above. The sound power spectrum has been adjusted at lower wind speeds to represent the lower sound power values that are generated.

Table 8.20: Goldwind WTGs Sound Power Levels

Spectral Data – dBA in 1/3 Octave Bands		
1/3 Octave band Hz	**GW155**	**GW165**
20	64	60
25	68	67
31	72	73
40	77	78
50	82	82
63	86	86
80	89	89
100	92	91
125	95	94
160	97	95
200	98	97
250	99	99
315	100	100
400	100	101
500	100	102
630	99	102
800	98	102
1000	98	102
1250	97	101
1600	93	98
2000	90	96
2500	85	92
3150	80	86
4000	73	79
5000	66	69
6300	65	58
8000	64	46
10000	63	33
Overall Lw dB(A)	**109.0**	**111.2**

Impact Assessment

Noise level have been predicted at each of the four measurements site (R1-R4) for all the wind speeds involved in the assessment. For the receptors (R5-R46), noise levels have been predicted only for the wind speed range that results the greatest sound power level (9 m/s to cut off).

Since the national noise regulations are significantly higher than the IFC standards, this assessment focus on the IFC absolute criteria for day and night time and, just for R2 and R3, also to the background + 3dB criteria, whatever is higher for any wind speed class.

Predicted Wind Farm Operational Noise Levels

The predicted noise levels vs wind speeds at receptors R1-R4 are presented in ***Table 8.21***. Graphically this comparison is noticeable in ***Figure 8.2*** to ***Figure 8.5***.

Table 8.21: Predicted Operational Noise Levels (L_{Aeq}) vs IFC limits

Wind Speed		3	4	5	6	7	8	9	10
R1 (*)	Predicted Noise Level dB(A)	37	37	37	37	41	43	43	43
	IFC Day time limit dB(A)	55	55	55	55	55	55	55	55
	IFC Night time limit dB(A)	45	45	45	45	45	45	45	45
R2	Predicted Noise Level dB(A)	36	36	36	36	40	42	42	42
	IFC Day time limit dB(A)	55	55	55	55	55	55	55	55
	IFC Night time limit dB(A)	47	48	48	48	49	49	49	50
R3	Predicted Noise Level dB(A)	44	44	44	44	48	50	50	50
	IFC Day time limit dB(A)	55	55	55	55	55	55	55	55
	IFC Night time limit dB(A)	47	48	48	49	50	51	52	52
R4 (*)	Predicted Noise Level dB(A)	36	36	36	36	39	42	42	42
	IFC Day time limit dB(A)	55	55	55	55	55	55	55	55
	IFC Night time limit dB(A)	45	45	45	45	45	45	45	45

* Based on IFC absolute criteria considered

Figure 8.2: Predicted Noise Levels at R1 vs IFC Criteria

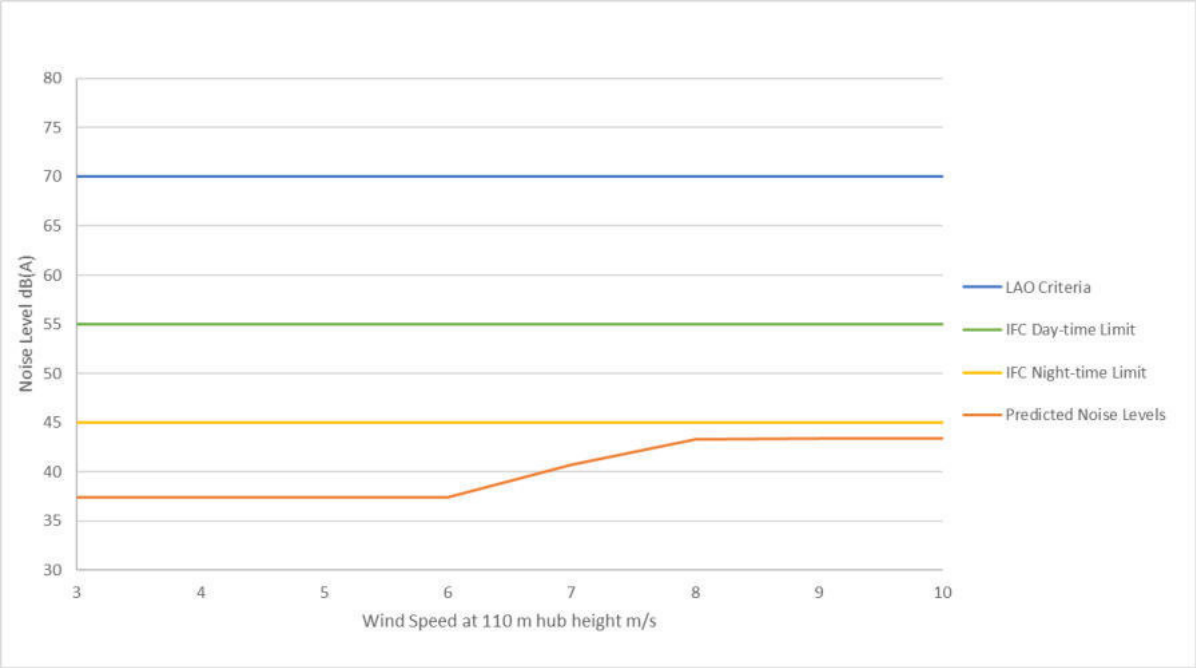


Figure 8.3: Predicted Noise Levels at R2 vs IFC Criteria

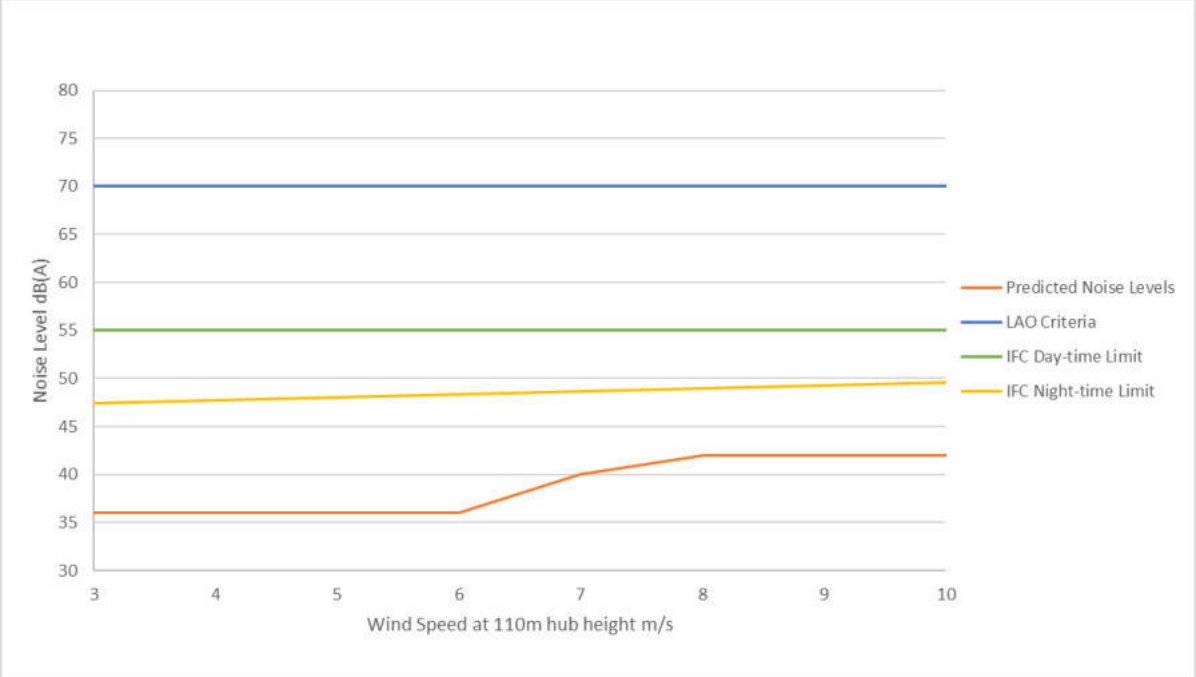


Figure 8.4: Predicted Noise Levels at R3 vs IFC Criteria

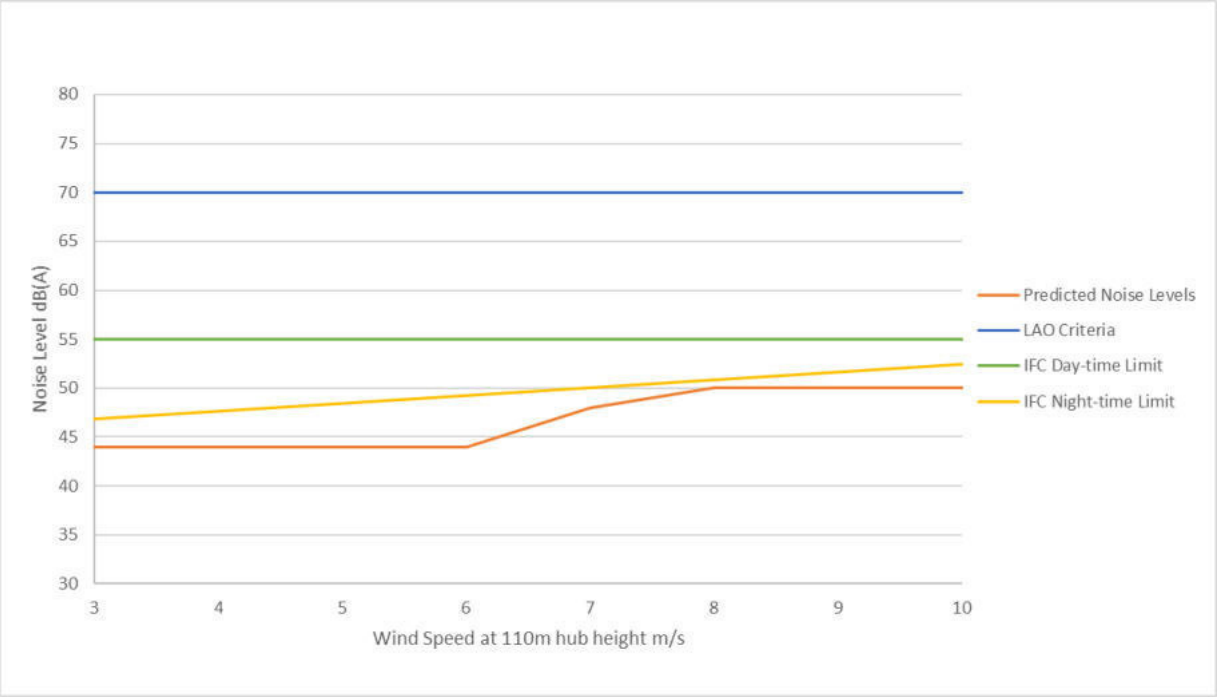
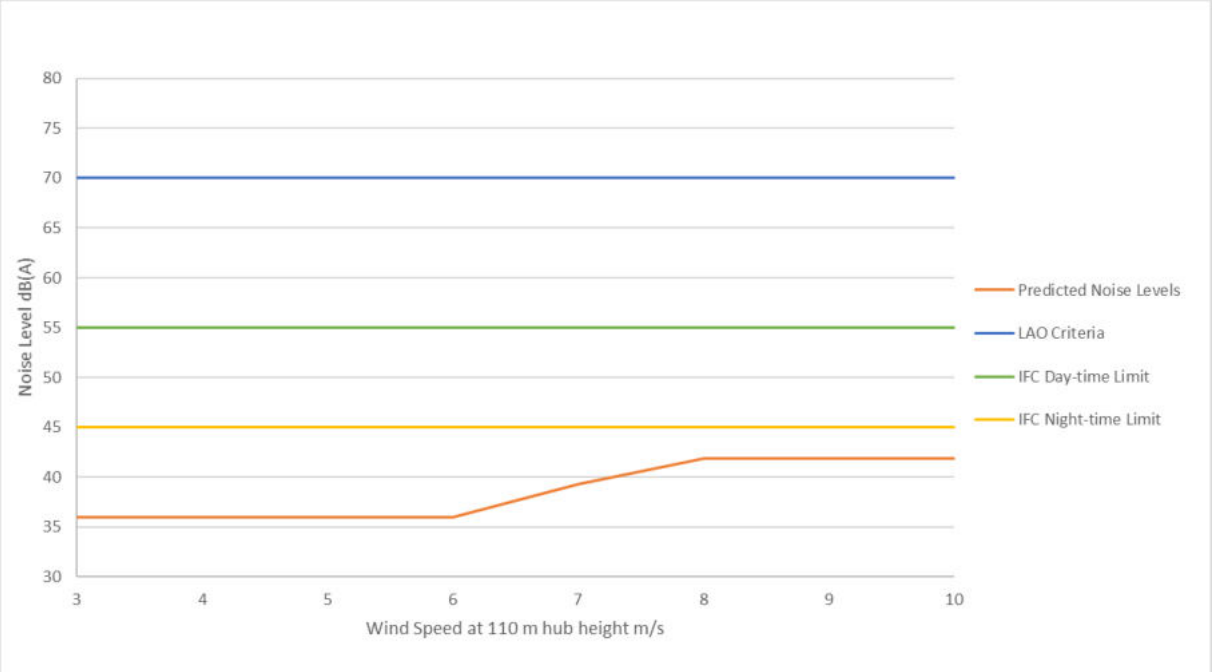


Figure 8.5: Predicted Noise Levels at R4 vs IFC Criteria



Predicted noise levels never exceed the criteria at any of the four receptors.

Predicted noise levels for wind speeds between 9 m/s to cut off for the receptors R5 to R46 are shown in ***Table 8.22*** presenting also a comparison with the IFC criteria. Predicted noise contours are presented in ***Figure 8.6.***

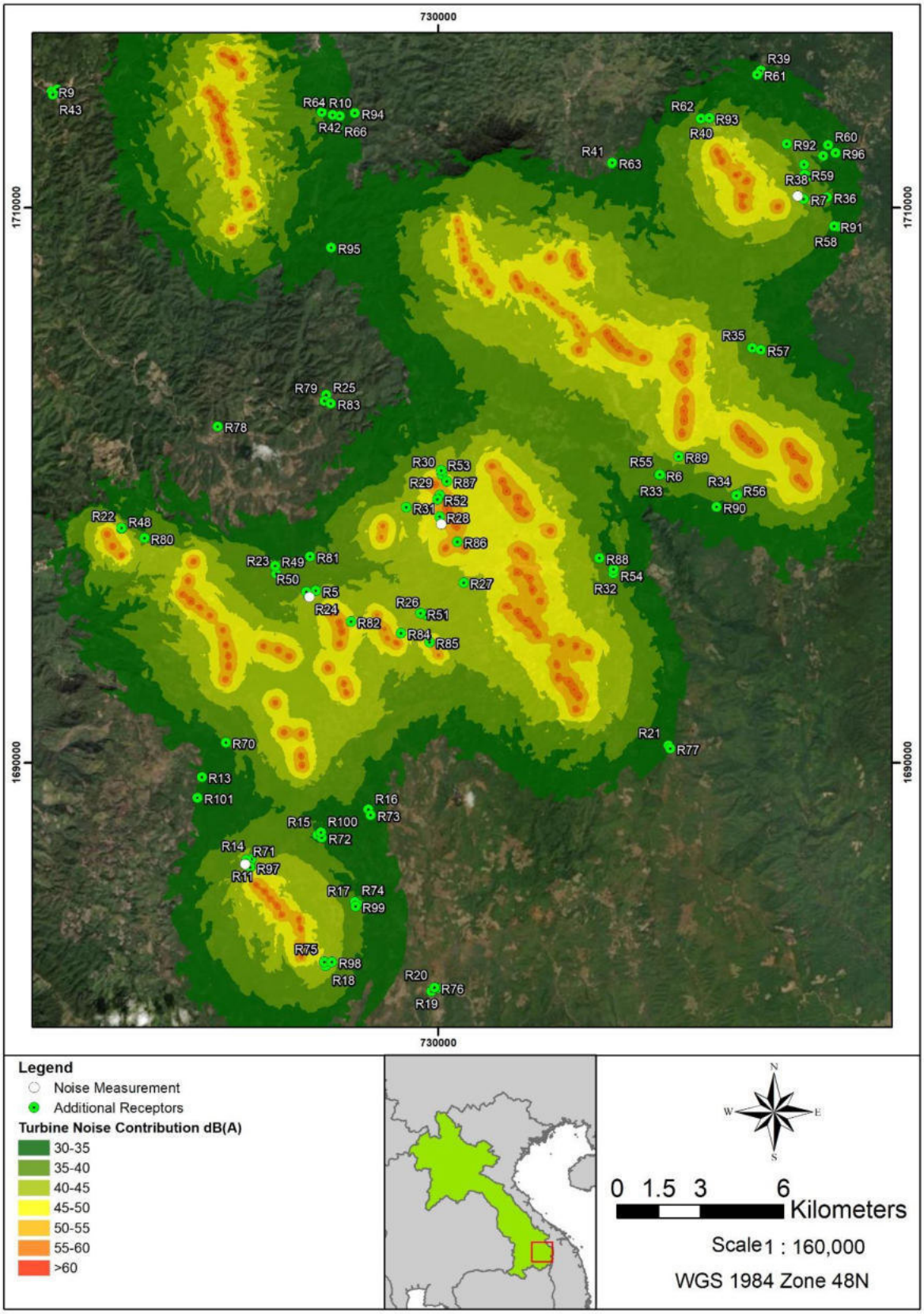
Table 8.22: Predicted Noise Levels

Receptor	Description	UTM 48N WGS84 m		IFC Limit dB(A)		Predicted noise level LeqA dB(A)
		Easting	Northing	Day-time	Night-time	
R5	Xiengluang Health Center	725582	1696196	55	45	43
R6	Dak Dor Health Center	737964	1700374	55	45	38
R7	Hospital Of Dak Cheung District	743174	1710307	55	45	40
R9	Dak Jom Health Center	716066	1714186	55	45	25
R10	B. Prao Health Center	726450	1713303	55	45	33
R11	Dak Samor Health Center	723246	1686465	55	45	38
R12	NamNgonnuea Health Center	729752	1681773	55	45	21
R13	Dak Nong Primary School	721478	1689492	55	45	32
R14	Dak Samor Primary School	723266	1686539	55	45	39
R15	Dak Yok Primary School	725648	1687406	55	45	35
R16	Dak Dor Primary School	727486	1688327	55	45	32
R17	Dak Sied Primary School	727086	1684927	55	45	37
R18	Dak Xuem Primary School	725942	1682695	55	45	43
R19	NamNgonnuea High School	729964	1681880	55	45	18
R20	NamNgonnuea Primary School	729876	1681895	55	45	18
R21	Dak Padou Primary School	738291	1690621	55	45	30
R22	Dak Tiem Primary & Lower Secondary School	718590	1698430	55	45	44
R23	Dak Seng Primary School	724169	1696811	55	45	38
R24	Xiengluang Primary & High School	725312	1696012	55	45	42
R25	Dak Sieng A Primary School	725967	1703255	55	45	22
R26	Dak Terb Primary School 01	729561	1695330	55	45	41
R27	Dak Terb Primary School 02	730912	1696489	55	45	43
R28	Dak Yang Primary School 01	730056	1698865	55	45	**51**
R29	Dak Yang Primary School 02	730052	1699638	55	45	**52**
R30	Dak Yen Primary School 01	730138	1700380	55	45	**47**
R31	Dak Yen Primary School 02	728846	1699210	55	45	44
R32	Trongmueang Primary School	736311	1696824	55	45	37
R33	Dak Dor Primary & High School	738320	1700330	55	45	37
R34	Dak Den Primary School	740791	1699669	55	45	37
R35	Dak Rant Primary School	741310	1704942	55	45	37
R36	Dak Bong Primary School	744012	1710378	55	45	36

Receptor	Description	UTM 48N WGS84 m		IFC Limit dB(A)		Predicted noise level LeqA dB(A)
		Easting	Northing	Day-time	Night-time	
R37	Dak Cheung Primary School	743419	1711116	55	45	37
R38	Dak Cheung Lower Secondary School	743186	1711556	55	45	38
R39	Dak Pum Primary School	741628	1714935	55	45	30
R40	Tongxieng Primary School	739472	1713231	55	45	38
R41	Dak Lern Primary School	736246	1711574	55	45	29
R42	B. Prao & Dakkung Primary School	725795	1713437	55	45	35
R43	Dak Jom Primary & Lower Secondary School	716104	1714067	55	45	21
R44	NgonDone Primary & High School	743876	1711861	55	45	35
R48	Dak Tiem village	718585	1698466	55	45	44
R49	Dak Xeng village	724116	1697095	55	45	38
R50	Xiengluang village	725240	1696154	55	45	40
R51	Dak Terb village	729357	1695390	55	45	42
R52	Dak Yang village	729970	1699494	55	45	**52**
R53	Dak Yen village	730101	1700539	55	45	**45**
R54	Trongmueang village	736317	1696970	55	45	38
R55	Dak Dor village	737986	1700380	55	45	37
R56	Dak Den village	740747	1699625	55	45	37
R57	Dak Rant village	741622	1704882	55	45	35
R58	Dak Bong village	744383	1709315	55	45	34
R59	Dak Cheung village	743203	1711192	55	45	37
R60	Ngon Done village	744053	1712262	55	45	33
R61	Dak Pum village	741494	1714790	55	45	30
R62	Tongxieng village	739465	1713201	55	45	38
R63	Daklern village	736267	1711615	55	45	29
R64	B. Prao village	726198	1713335	55	45	34
R65	Dak Jom village	716267	1714262	55	45	22
R66	Dak Kung village	726377	1712905	55	45	33
R70	Dak Nong village	722344	1690728	55	45	36
R71	Dak Samor village	723078	1686508	55	45	40
R72	Dak Yok village	725807	1687306	55	45	33
R73	Dak Dor village	727562	1688115	55	45	34
R74	Dak Sied village	726995	1684992	55	45	38

Receptor	Description	UTM 48N WGS84 m		IFC Limit dB(A)		Predicted noise level LeqA dB(A)
		Easting	Northing	Day-time	Night-time	
R75	Dak Xuem village	725900	1682832	55	45	44
R76	Nam Ngonnuea village	729866	1681908	55	45	18
R77	Dak Padou village	738360	1690511	55	45	31
R78	Xiengmai village	722057	1702122	55	45	18
R79	Sieng A village	725900	1703033	55	45	23
R80	Dak Tiem Cemetery	719405	1698097	55	45	39
R81	Dak Seng Cemetery	725386	1697432	55	45	35
R82	Xiengluang Cemetery	726850	1695092	55	45	**49**
R83	Dak Sieng A Cemetery	726124	1702946	55	45	22
R84	Dak Terb Cemetery 01	728659	1694665	55	45	**48**
R85	Dak Terb Cemetery 02	729680	1694344	55	45	**52**
R86	Dak Yang Cemetery	730690	1697966	55	45	**51**
R87	Dak Yen Cemetery	730314	1700144	55	45	**48**
R88	Trongmueang Cemetery	735809	1697377	55	45	38
R89	Dak Dor Cemetery	738663	1701034	55	45	43
R90	Dakden Cemetery	740032	1699213	55	45	34
R91	Dak Bong Cemetery	744263	1709336	55	45	34
R92	Dak Cheung Cemetery	742562	1712294	55	45	39
R93	Tongxieng Cemetery	739767	1713228	55	45	39
R94	B. Prao Cemetery	726996	1713402	55	45	29
R95	Dakkung Cemetery	726140	1708564	55	45	32
R96	NgonDone Cemetery	744319	1711973	55	45	33
R97	Dak Samor Cemetery	723219	1686240	55	45	41
R98	Dak Xuem Cemetery	726164	1682829	55	45	42
R99	Dak Sied Cemetery	727018	1684832	55	45	37
R100	Dak Yok Cemetery	725779	1687500	55	45	34
R101	Dak Nong Cemetery	721325	1688742	55	45	31

Figure 8.6: Predicted Noise Contours



The predicted noise levels comply with IFC daytime criteria at all receptors. For night time, predicted noise levels exceed the IFC criteria at receptors R28, R29, R30, R53, R82, R84, R85, R86 and R87. Receptors R82, R84, R85, R86 and R87 represent cemeteries and receptors R28, R29 and R30 represent schools. For these receptors, the assessment does not take into consideration the night time, since health centres, cemeteries and schools do not operate during night time.

The residential receptors, at which predicted noise levels exceed the night-time IFC criteria are R52 and R53.

Impact Magnitude

Table 8.23 presents the significance of impacts based on the predicted noise levels and the sensitivity of receptors. The table presents the receptors at which the predicted levels are up to 5 dB(A) below the criteria.

Table 8.23: Significance of Impacts

Receptor	Type of receptor	Time Period	Sensitivity	Magnitude	Significance of impact
R5	Health Centre	Night	Very High	Small	Minor
R28	School	Day	Very High	Small	Minor
R29	School	Day	Very High	Small	Minor
R48	Village	Night	High	Small	Minor
R51	Village	Night	High	Small	Minor
R52	Village	Day	High	Small	Minor
		Night	High	Large	Major
R53	Village	Night	Medium	Small	Moderate
R75	Village	Night	Medium	Small	Minor
R85	Cemetery	Day	Very High	Small	Minor
R86	Cemetery	Day	Very High	Small	Minor

Additional Mitigation, Management, and Monitoring Measures

Predicted noise levels due to the operation of the project are likely to have moderate to major impacts at, at residential receptors R52 and R53. Therefore, additional mitigation will be needed.

Table 8.24 presents the WTGs with the highest noise contribution to total noise levels at receptors where singnificant impacts have been predicted.

Table 8.24: Most relevant WTGs for Impacted Receptors

Receptor	Max Predicted Value dB(A)	IFC Night-time Limit dB(A)	Most relevant WTGs (ID from official layout)
R52	52	45	WH 141 WH 094 WH 095 WH 096
R53	45	45	WH 099

The recommendations proposed for reducing noise impacts during operation include:

- The WTGs in ***Table 8.24*** will need to be relocated at distances of more than 1 km from the current location for R52 and approximately 800 m from R53 in order to meet WBG standard limit.

The formula used is a combination for the simple open air propagation equation on 2 different distances is $L_{eq} = L_{rif} – 20 * Log10 (r/r_{rif})$. The calclations are provided in ***Table 8.25*** and ***Table 8.26***.

Table 8.25: Calculations and new Distances for Turbine Relocation (R52)

R52	Actual Lp	New Lp	Actual Distance (m)	New Distance (m)
W7094 - GW165	43,8	**36**	525	**1289**
W7095 - GW165	38,9	**36**	859	**1199**
W7096 - GW165	35,1	**35,1**	1212	**1212**
W7099 - GW165	43,9	**36**	519	**1217**
W7141 - GW165	49,3	**36**	283	**1309**
Total Leq	52	44,5		

Table 8.26: Calculations and new Distances for Turbine Relocation (R52)

R53	Actual Lp	New Lp	Actual Distance	New Distance
W7099 - GW165	43,1	40,5	572	772
Total Leq	45	44,0		

- If relocation of turbines is not feasible, The WTGs in ***Table 8.24*** will need to not operate during night time or operate on a different operational mode, at which sound power levels are lower than the ones presented in ***Table 8.19***.
- Noise monitoring should be conducted regularly, particularly during the night time, to check compliance with the noise criteria, and where exceedance are detected, additional mitigation measures should be implemented.

Residual Impact Significance

Noise impacts from the operation of the project can be effectively mitigated through good management practices and provision of well-established technical solutions, as per the above recommendations. The residual impact significance for R52 and R53 will be reduced to **Moderate** if the recommended additional mitigation and monitoring is applied. The residual impact significance at other receptors will remain **Minor**.

8.3.6 Impacts to Surface Water Quality

8.3.6.1 Potential Impacts

During the construction phase, water will be required for construction activity, such as during civil work, dust suppression, and domestic use. Potential impacts on surface water may arise from foundation work and civil construction, improper management of wastewater and accidental spills/leaks at storage area, which could lead to impact on contamination of surface water near by the Project site. It is estimated up to 1,400 workers will be working on-site during the construction phase of the Project. With an assumed sewage generation rate of 0.19 m^3 per worker per day [93], up to

([93]) EPD Hong Kong 2005. Technical Paper Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning. Available at: http://www.epd.gov.hk/epd/sites/default/files/epd/english/environmentinhk/water/guide_ref/files/gesf.pdf

about 266 m^3 of sanitary wastewater will be generated per day, mostly from the labour camp and site office. Mis-management of sewage and wastewaters would have the potential to result in contamination of surface waters, which may result in localized land/ecological contamination, impacts to health, odour nuisance and attraction of vermin.

In addition, if water is required for the Project from a nearby stream, this could impact local communities' availability of water resources. It is noted in ***Section 7.5.3.7,*** the villages in Dak Cheung District and Sanxay District mostly use the gravity-fed water systems, whereas rivers and streams are still used to a lesser extent for domestic water. However, ***Section 8.6.2.2*** notes that the overall hazard ratings for availability of water is considered to be 'Low' in the Project Area meaning that water availability is not a key concern in the area.

During the operation phase, water will be required for domestic use and drinking water for operational workforce at the project site. Improper management of wastewater from the Project and accidental spills/leaks at storage area, which could lead to impacts on quality of surface water near by the Project site.

8.3.6.2 Existing Controls

The mitigation measures identified in the local EIA (EIA, 2020) include:

- Conduct water quality monitoring as per the recommendations of the local EIA Report (2020);
- Control of sedimentation and water turbidity: The project must avoid undertaking construction and installation near water sources, where possible
- No washing vehicles of all types and construction equipment at rivers or streams in the project area;
- Toilets for workers should be provided. A proper wastewater treatment system should be installed and complies with the environmental engineering techniques and is located far from the river in order to avoid and reduce chemical contaminated water released into the river; and
- A drainage system should be installed and collected wastewater into the wastewater treatment system.

8.3.6.3 Significance of Impacts

Methodology for Assessment of Impact Significance

The sensitivity criteria and impact magnitude criteria for surface water quality has been provided in ***Table 8.27*** and ***Table 8.28,*** respectively. The subsequent subsections will utilise these criteria to assess the impact of the Project activities to surface water quality.

Table 8.27: Sensitivity Assessment Criteria for Water Resources (Surface water)

Sensitivity Criteria	Contributing Criteria	
	Environment	Social
Water Resources - Surface water and ground water (quality/quantity related criteria)	The extent to which the water resource plays an ecosystem or amenity role in terms of supporting biodiversity either directly or indirectly, particularly with respect to dependent ecosystems.	The extent to which the water resource provides or could provide a use (drinking water, agricultural uses, washing and other domestic or industrial, use as waterways) to the local communities and businesses, or is important in terms of national resource protection objectives, targets and legislation.
Low	The water resource does not support diverse aquatic habitat or populations,	The water resource has little or no role in terms of provisioning services as

Sensitivity Criteria	Contributing Criteria	
	Environment	Social
	or supports aquatic habitat or population that is of low quality.	agricultural water source, other domestic uses as washing, bathing, industrial use and waterways for the local community. The groundwater resource is not currently abstracted and used in the vicinity of the Project, but is of sufficient quality and yield to be used for that purpose in the future (and there is a reasonable potential for future use).
Medium	The water resource supports diverse populations of flora and / or fauna but available in the surface water bodies in the region.	The surface water resources have local importance in terms of provisioning services but there is ample capacity and / or adequate opportunity for alternative sources of comparable quality. The groundwater resource is an important water supply, and is currently used, but there is capacity and / or adequate opportunity for alternative sources of comparable quality.
High	The water resource supports economically important or biologically unique aquatic species or provides essential habitat for such species.	The surface water resources are wholly relied upon locally, with no suitable technically or economically feasible alternatives, it is important at a regional or transboundary watershed level for provisioning services. The groundwater resource is wholly relied upon locally, with no suitable technically or economically feasible alternatives. The development stage of groundwater is critical or over exploited.

Table 8.28: Criteria for Impact Magnitude for Assessment of Impact to Surface Water

Magnitude Criteria	Negligible	Small	Medium	Large
General Criteria	No perceptible or readily measurable change from baseline conditions.	Perceptible change from baseline conditions but likely to be within applicable norms and standards for mode of use.	Clearly evident (e.g. perceptible and readily measurable) change from baseline conditions and / or likely to approach and even occasionally exceed applicable norms and standards for mode of use.	Major changes in comparison to baseline conditions and / or likely to regularly or continually exceed applicable norms and standards for mode of use.
Surface Water	There is likely to be negligible or no consumption of surface water by the Project at any time	The Project will consume surface water, but the amounts abstracted are likely to be relatively small in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)	The Project will consume surface water, and the amounts abstracted are likely to be significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)	The Project will consume surface water, and the amounts abstracted are likely to be very significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)

Receptor Sensitivity and Impact Magnitude

The receptor sensitivity has been assessed as **Medium** as local communities are dependent on local watercourses for domestic use and agriculture. Also the water quality tested showed slightly elevated levels of coliform bacteria and COD; likely to be from human and animal feces in the Study Area entering watercourses.

Based on the impact characteristics, the impact magnitude is considered to be **Medium** during construction given that it is required for the duration of the construction period and that water use during construction will be sourced from nearby streams, and **Small** during operation (as only small scale operation and maintenance activities will occur).

The impact magnitude for water resource use is **medium** given the water availability variations in the dry season.

Impact Significance

The overall impact significance during construction phase and operation phase is assessed to be **Moderate** and **Minor,** respectively for water quality and **Moderate** for water resource use.

8.3.6.4 Additional Mitigation, Management, and Monitoring Measures

The additional mitigations measures to minimize impacts include:

- A Waste Management Plan will be prepared for the Project (as detailed in the topography impact assessment section);
- As groundwater or surface water will be utilised, the Project should prepare and implement a Water Use Plan. This plan must be communicated and agreed with the local people and with the District and Provincial Authorities;
- Conduct pre-construction surface water monitoring (5 sampling locations) in the same locations as surface water sampling for the baseline, but to identify and analyses presence of POPs;
- Construction workers will be given training about water conservation and encouraged for optimal use of water;
- Optimum use of water during sprinkling on roads for dust settlement, concrete mixing for WTG foundation, etc.;
- Regular inspection for identification of water leakages and preventing wastage of water from water tankers; and
- Recycling and reusing water to the extent possible.

8.3.6.5 Residual Impact Significance

The residual impact significance during construction phase and during operation phase is envisaged to be **Minor** and **Negligible**, upon application of mitigation, management, and monitoring measures for water quality and **Minor** residual for water resource use (***Table 8.29*** to ***Table 8.31***).

Table 8.29: Impacts to Surface Water Quality (Construction Phases)

Significance of Impact	
Potential Impact	Potential impacts on surface water due to: ■ Run-off from foundation work and civil construction; ■ improper management of wastewater; ■ Accidental spills/leaks at storage area and improper management of hazardous materials storage and handling.

Significance of Impact					
Impact Nature	**Negative**	Positive	Neutral		
	Potential impacts to surface water would be considered to be negative				
Impact Type	**Direct**	Indirect	Induced		
	Potential impacts would be direct impacts.				
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
	The construction phase of the Project is expected to be completed in 30 months, which would be considered long-term.				
Impact Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and hence would be considered to be local.				
Impact Scale	Impact scale is considered localized and small.				
Frequency	Impacts to surface water could occur intermittently during the construction phase.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	Based on the impact characteristics above, the impact magnitude is considered to be medium.				
Receptor Sensitivity	Low	**Medium**	High		
	The identified nearby canals are considered as medium.				
Impact Significance	Negligible	Minor	**Moderate**	Major	
	The combination of a Low Receptor Sensitivity and Medium Impact Magnitude will result in an overall Moderate impact.				
Residual Impact Magnitude	Positive	Negligible	**Small**	Medium	
Residual Magnitude Significance	Negligible	**Minor**	Moderate	Major	
	As a result, the mitigation measures, residual negative impact will be of a 'Minor' significance.				

Table 8.30: Impact on Surface Water Quality (Operation Phase)

Significance of Impact					
Potential Impact	Potential impacts on surface water due to: ■ Potential impacts on water quality from general operation activities; ■ Accidental spills/leaks at storage area and improper management of hazardous materials storage and handling.				
Impact Nature	**Negative**	Positive	Neutral		
	Potential impacts to surface water would be considered to be negative				
Impact Type	**Direct**	Indirect	Induced		
	Potential impacts would be direct impacts.				
Impact Duration	Temporary	Short-term	**Long-term**		
	The operation phase of the Project is considered long-term.				
Impact Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and hence would be considered to be local.				

Significance of Impact					
Impact Scale	Impact scale is considered localized and small.				
Frequency	Impacts to surface water could occur intermittently during the operation phase.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	Based on the impact characteristics above, the impact magnitude is considered to be small.				
Receptor Sensitivity	Low		**Medium**		High
	The identified nearby drainage canals are considered as medium.				
Impact Significance	Negligible	**Minor**	Moderate	Major	
	The combination of a Low Receptor Sensitivity and Small Impact Magnitude will result in an overall Minor impact.				
Residual Impact Magnitude	Positive	**Negligible**	Small	Medium	
Residual Magnitude Significance	**Negligible**	Minor	Moderate	Major	
	As a result, the mitigation measures, residual negative impact will be of a 'Negligible' significance.				

Table 8.31: Impact on Surface and groundwater Water Resource Competition (Construction and Operation Phase)

Significance of Impact					
Potential Impact	Potential impacts on surface water/groundwater resource competition due to: ■ Decreased water availability from the water resources of the area from construction and operation activities.				
Impact Nature	**Negative**	Positive	Neutral		
	Decreased water availability from the water resources of the area would be considered to be negative.				
Impact Type	**Direct**	Indirect	Induced		
	Potential impacts would be direct impacts.				
Impact Duration	Temporary	Short-term	**Long-term**		
	The construction and operation phase of the Project is considered long-term.				
Impact Extent	**Local**	Regional	International		
	Potential impacts would be limited to the Project area and hence would be considered to be local.				
Impact Scale	Impact scale is considered localized and small.				
Frequency	Impacts to surface water could occur intermittently during the construction and operation phase.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
	Based on water availability, the impact magnitude is considered to be medium.				
Receptor Sensitivity	Low		**Medium**		High
	The receptor sensitivity in the area is considered as medium due to rivers/streams plays local importance role in terms of provisioning services such as domestic use and drinking water.				
	Negligible	Minor	**Moderate**	Major	