Environmental and Social Impact Assessment

Thanh Hai 1 Wind Power Project, Thanh Phu District, Ben Tre Province

ISO 9001:2015

Tan Hoan Cau Corporation JSC

20 May 2020

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The business of sustainability

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Environmental and Social Impact Assessment

Thanh Hai 1 Wind Power Project, Thanh Phu District, Ben Tre Province

Hai Pham
Operations Director

ERM Vietnam
3rd Floor, Saigon Finance Centre
09 Dinh Tien Hoang, Dakao Ward
District 1, Ho Chi Minh City
Vietnam

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Acronyms and Abbreviations

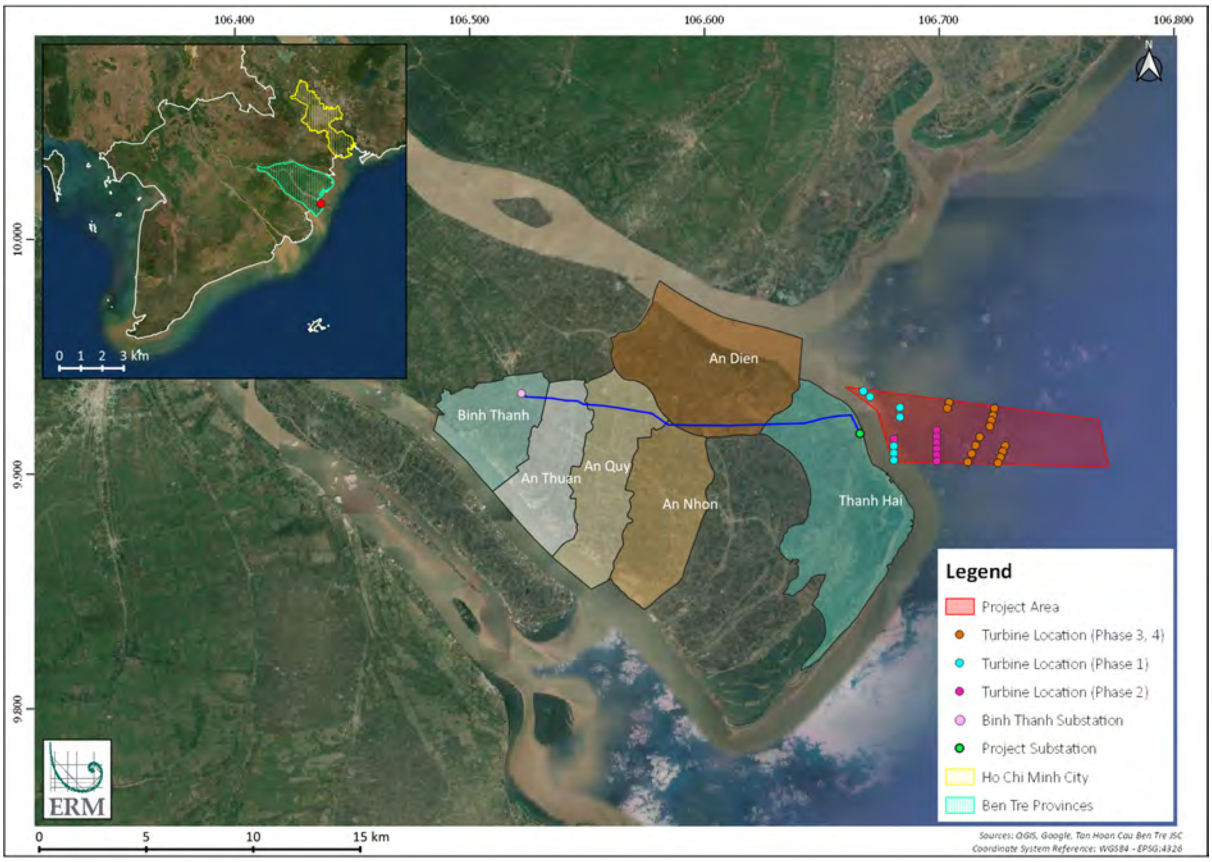
Name	Description
AoI	Area of Influence
ASEAN	Association of Southeast Asian Nations
BaU	Business as Usual
CH4	Methane
CMS	Central Monitoring System
CO2	Carbon Dioxide
CSR	Compensation, Support and Resettlement
DMS	Detailed Measurement Survey
DoNRE	Department of Natural Resources and Environment
DWT	Deadweight tonnage
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EPC	Engineering, Procurement, and Construction
EPFIs	Equator Principle Financial Institutions
EPs	Equator Principles
ERM	Environmental Resources Management
ESIA	Environmental and Social Impact Assessment
ESMP	Environment and Social Management Plan, Health and Safety
FGD	Focused Group Discussion
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIIP	Good International Industry Practice
Hz	hertz
IA	Impact Assessment
IFC	International Finance Corporation
IFC PS	International Finance Corporation – Performance Standard

IoL	Inventory of Loss
ISO	International Organisation for Standardisation
IUCN	International Union for Conservation of Nature
kg	kilogram
km	kilometre
kV	Kilovolt
LEP	Law on Environment Protection
m	metre
m/s	metre per second
m^2	square metre
MoNRE	Ministry of Natural Resources and Environment
MW	megawatt
N2O	Nitrous Oxide
NGO	Non-Governmental Organisation
NOx	Nitrogen Oxides
O&M	Operation and Maintenance
PAP	Project Affected People
PC	People’s Committee
PM	particulate matter
RE	Renewable Energy
rpm	revolutions per minute
SEA	Strategic Environmental Assessment
SOx	Sulphur Oxides
TL	Transmission line
TSP	Total suspended particles
US$	United States Dollar
VOC	Volatile Organic Compounds

WTG	Wind turbine generator
W/m^2	Watt per squared metre

EXCUTIVE SUMMARY

This Environmental and Social Impact Assessment (ESIA) presented an assessment of the potential environmental and social impacts associated with the development of Wind Power Plant No.5 at Thanh Hai Commune, Thanh Phu District, Ben Tre Province (see Figure below). The total capacity of the Wind Power Plant No. 5 was 110 MW included four phases. The first phase of Wind Power Plant No.5 Project, henceforth to be referred as "Thanh Hai 1 Wind Power Project" or "the Project", with capacity of 30MW, was scheduled to start generating electricity by 2020. Thanh Hai 1 Wind Power Project was a development of seven wind turbines with a capacity of each turbine was 4.5 MW, along with construction of the substation and transmission line infrastructure, as needed to accommodate all four Project phases.



The Project was aligned with the Wind Power Development Plan of Ben Tre Province in the period to 2020 with a vision to 2030, under Decision No. 2497/QD-BCT dated March 18, 2015 by the Ministry of Industry and Trade. The Tan Hoan Cau Ben Tre Joint Stock Company (the Client) was responsible for the Project's development and operation. The Client had prepared, submitted and sought approval of People's Committee of Ben Tre Province dated January 25 2019. The Project's construction was commenced in April 2019. In addition to the local EIA report, this Environmental and Social Impact Assessment (ESIA) developed to inform the Client of environmental and social risks that are relevant to the Project.

The purpose of this ESIA was to assess these risks of the Project based on the baseline data and impact assessment against the International Finance Corporation Performance Standards (IFC PS) and World Bank Group's Environmental, Health and Safety (EHS) Guidelines. The ESIA was prepared based on the local EIA, Feasibility Study, a desktop review of reliable sources, and additional baseline data collected from the socio-economic surveys of affected communities, noise monitoring within and around the Project area and terrestrial biodiversity surveys (including bird, bat, fauna and flora surveys). The results of the ESIA would inform the preparation of an Environmental and Social Management Plan (ESMP), which would guide the implementation of the Project.

The outcomes of the ESIA, including mitigation measures and monitoring, would be summarised in the Environmental and Social Management Plan (ESMP). The ESMP provided an overview of future environmental and social commitments of this Project.

A summary of the outcomes of the impact assessment for each environmental and social aspect identified in the Scoping Study were summarised in table below. A brief description of each aspect was provided hereafter.

Key Impacts	Applicable IFC PS	Phase	Significance of Impact	
			Before Mitigation	With Mitigation
Environmental Impacts				
Air quality	IFC PS3	Construction	Minor	Negligible
Noise Emissions	IFC PS3	Construction	Moderate	Minor
		Operation	Minor	Negligible
Sea water quality	IFC PS3	Construction	Moderate	Minor
Loss of terrestrial habitat	IFC PS6	Construction	Minor	Negligible
Loss of marine habitat	IFC PS6	Construction	Moderate	Minor
Disturbance of displacement impacts on terrestrial fauna species	IFC PS6	Construction	Moderate	Minor
Barrier creation, fragmentation and edge impacts on fauna movement - Terrestrial	IFC PS6	Construction	Negligible	Negligible
Barrier creation, fragmentation and edge impacts on fauna movement - Marine	IFC PS6	Construction	Moderate	Minor
Degradation of habitat	IFC PS6	Construction	Moderate	Minor
Mortality impacts – birds	IFC PS6	Operation	Moderate	Minor
Mortality impacts – bats	IFC PS6	Operation	Negligible	Negligible
Mortality impacts – marine mammals	IFC PS6	Operation	Moderate	Minor
Mortality impacts – other fauna	IFC PS6	Operation	Minor	Negligible
Shadow flicker impacts	IFC PS4	Operation	Negligible	Negligible
Visual impacts	IFC PS4	Operation	Minor	Negligible
Social Impacts				
Economic displacement from land acquisition	IFC PS5	Construction	Minor	Minor
Local economy from employment and business	IFC PS5	Both	Positive	N/A
Disturbance to cultivation, aquaculture and fishing activities	IFC PS5	Construction	Minor	Minor

Key Impacts	Applicable IFC PS	Phase	Significance of Impact	
			Before Mitigation	With Mitigation
Community Health due to the presence of migrant flux	IFC PS4	Construction	Minor	Minor
Community health and safety due to non-influx issues	IFC PS4	Construction	Minor	Minor
Traffic safety due to an increased transportation	IFC PS4	Construction	Moderate	Minor
General disturbance to local community	IFC PS4	Operation	Minor	Minor
Unplanned events				
Onshore leakage and spill	IFC PS4	Both	Minor	Negligible
Offshore leakage and spill	IFC PS4	Both	Moderate	Minor
Fire and explosion	IFC PS4 IFC PS3	Both	Negligible	Negligible
Vessel collision	IFC PS4	Both	Minor	Negligible
Blade failure	IFC PS4	Operation	Moderate	Minor

Overall, most of the impacts caused by the Project were expected to be either Minor or Negligible. Other impacts including noise emissions in the construction phase, mortality impacts on avifauna due to wind turbine collision in the operation phase, impacts on community health and safety and traffic safety and oil leakage and spill in the sea were assessed to be moderate and they were summarised below.

- Noise: the noise impacts during the construction phase was assessed to be moderate. Construction noise levels would be reduced to minor with the successful implementation of mitigation measures. Recommendations were designed to ensure that any residual impacts were minimised as far as practically achievable.
- Avifauna: the impacts on birds during the operation phase was considered to be moderate due to the presence of Critical Habitat trigger species: Nordmann's Greenshank and Spoon-billed Sandpiper. These bird species fly between 35 and 150 m in the air, posing a potential risk of wind turbine collision. Therefore, a collision risk assessment was recommended to identify the significance of the residual impact. Should the collision risk assessment indicated that a risk was present, development of a Bird Management Plan would be required to outline measures specific to bird species.
- Community health and safety: the Project was likely to employ approximately 200 workers at the peak time of the construction phase. Migrant construction workers were expected to stay offsite in either temporary worker accommodation or local boarding houses. This was predicted to result in potential conflict and tension due to the difference in culture and living style between two groups. Therefore, the impacts on the community health and safety were considered to be moderate during construction but they would be reduced to minor with the additional mitigation measures.
- Traffic safety: the Project was likely to use the existing roadways and waterways to transport equipment and materials. An increase in vehicles movement and transportation of large and heavy equipment would put more stresses on local roads. The significance of impacts on local traffic

during the construction phase was considered to be moderate. With the mitigation measures, the impacts were likely to be minor.

- Offshore leakage and spill: the Project's offshore components occupied a total area of approximately 2800 hectares. When it comes to oil spill or leakage, the nearshore area was at greater alarm due to the fast spreading of chemicals and difficulties in containing spreading and removal of contaminants. Marine fauna and species were highly sensitive to oil contamination. Consequently, the overall significance of impacts caused by oil leakage and spill was considered to be moderate. The impacts were expected to reduce to minor with the successful application of the mitigation measures.

Altogether, the construction and operation of the Project would have negative impacts of Minor to Moderate significance prior to mitigation. With implementation of the mitigation measures, the residual impacts were considered to be reduced Negligible to Minor.

To manage and mitigate such impacts, the ESMP had been prepared. The ESMP should be read with reference to this ESIA. As part of this report, a range of measures had been developed to reduce the overall impacts to acceptable levels and as low as reasonably practicable. The effective implementation of the ESMP and adherence with the IFC guidelines would assist in managing the environmental and social impacts to acceptable levels.

1. INTRODUCTION

1.1 Purpose of this Report

ERM Vietnam (ERM) was commissioned by Tan Hoan Cau Ben Tre Joint Stock Company (Tan Hoan Cau Ben Tre JSC) (hereinafter as “Tan Hoan Cau” or “Client”) to undertake an Environmental and Social Impact Assessment (ESIA) of the Thanh Hai 1 Wind Power Project (the Project). The purpose of the ESIA is to inform Tan Hoan Cau and their project partners of environmental and social impacts associated with the Project and in particular the extent to which the project aligns with the expectations of the International Finance Corporation (IFC) Performance Standards and associated World Bank Group Environmental, Health and Safety (EHS) Guidelines.

This Environmental and Social Impact Assessment (ESIA) presents an assessment of the potential environmental and social impacts associated with the proposed Wind Plant No.5 – Thanh Hai 1 Wind Power Project in Vietnam based on the agreed scope of baseline data collection and impact assessment methodology and will results in the preparation of an Environmental and Social Management Plan (ESMP).

1.2 Project Background

Tan Hoan Cau is developing Wind Power Plant No.5 Project with the capacity of 110MW which is divided into four phases. The first phase of Wind Power Plant No.5 Project, henceforth to be referred as “Thanh Hai 1 Wind Power Project” or “the Project”, with capacity of 30MW, is scheduled to start generating electricity by 2020. The total investment is approximately VND1.50 trillion (US$65 million). The Project is in line with the Wind Power Development Plan of Ben Tre Province in the period to 2020, with a vision to 2030 under Decision No. 2497/QD-BCT dated March 18, 2015 of the Ministry of Industry and Trade. Certificate of Investment Registration No. 2421475015 issued by the Department of Planning and Investment of Ben Tre Province on September 24, 2018 for Tan Hoan Cau Ben Tre Joint Stock Company to invest and develop the Wind Power Plant No.5 Project.

The Project is located at Thanh Hai Commune, Thanh Phu District, Ben Tre Province, Vietnam. Thanh Hai 1 Wind Power Project is a development of seven wind turbines with a capacity of 4.5 MW each. The Project’s location is presented in Figure 1.1.

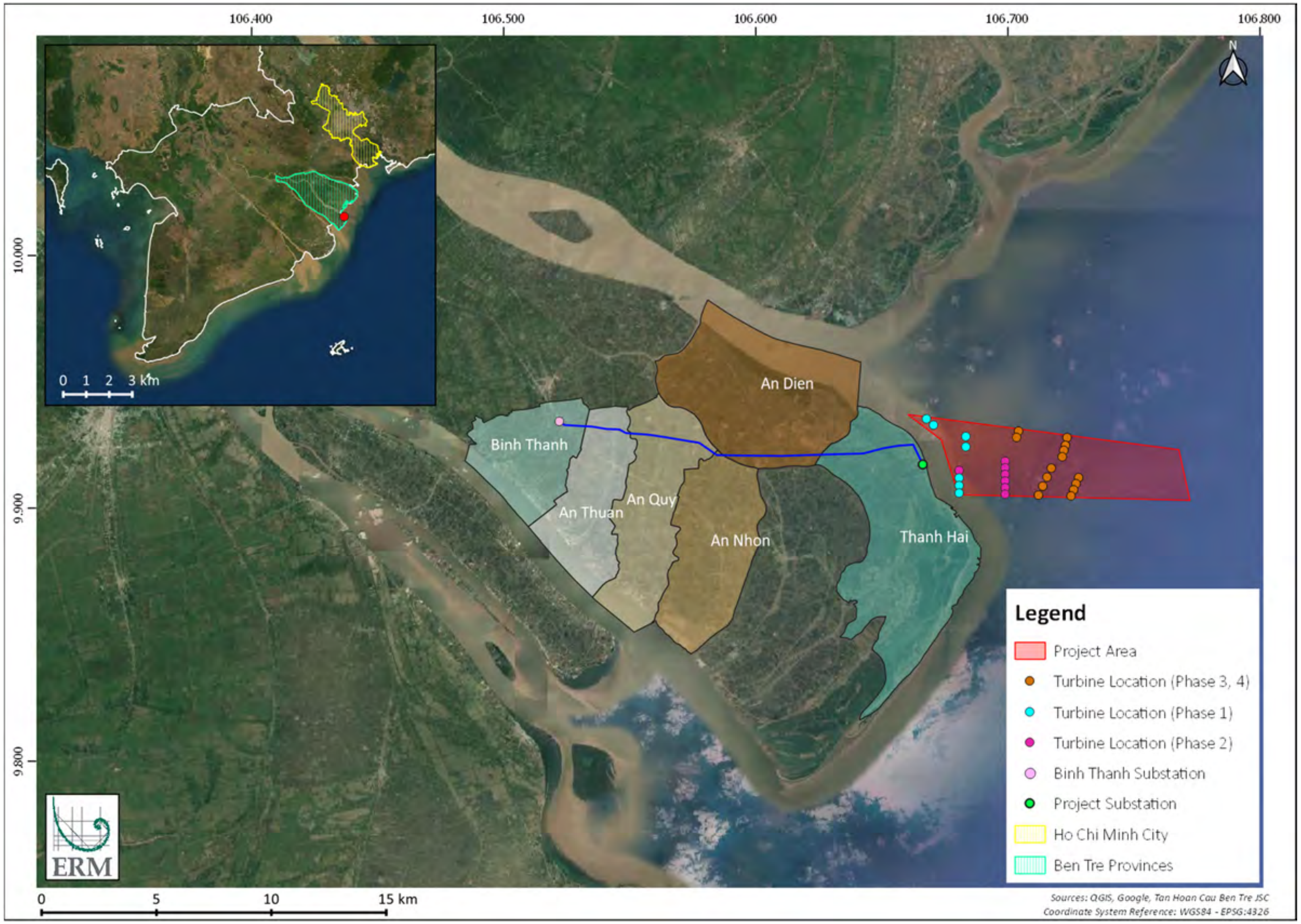


Figure 1.1 Project Location

As per national regulations on environmental management, the local EIA for the Project following Vietnamese National regulation on environmental protection has been prepared, submitted and obtained approval of People's Committee of Ben Tre Province dated January 25 2019. Center for Natural Resources and Environment Monitoring delivered consulting service and conducted survey for sampling and analysing samples within the scope of local EIA. The Project's construction was commenced in April 2019.

1.3 Limitation

The study undertaken in this ESIA was developed and structured based on available project information as provided by the Project developer (Client). The environmental and social impacts assessments were based on the documents made available, community consultation undertaken by ERM and primarily data collected from the site surveys.

At the time preparing this ESIA, project details of Phase 3 and Phase 4 are not available. Therefore, Cumulative Impact Assessment was conducted based on assumption of "worst-case" estimates and assumption of wind turbine data (i.e. type of turbine, hub height, rotor diameter, and separation distances between turbines …) shall be similar to turbines used in Phase 1.

2. PROJECT DESCRIPTION

During the Feasibility Study, the investor and consultants have conducted research and compared different options during basic design of the Project, In addition to the goal of reducing the cost of the project, an important criterion while selecting the location plan, substation and the direction of 110kV and 22kV transmission lines (TL) are to minimise land acquisition and impact of project's building to the local people lives.

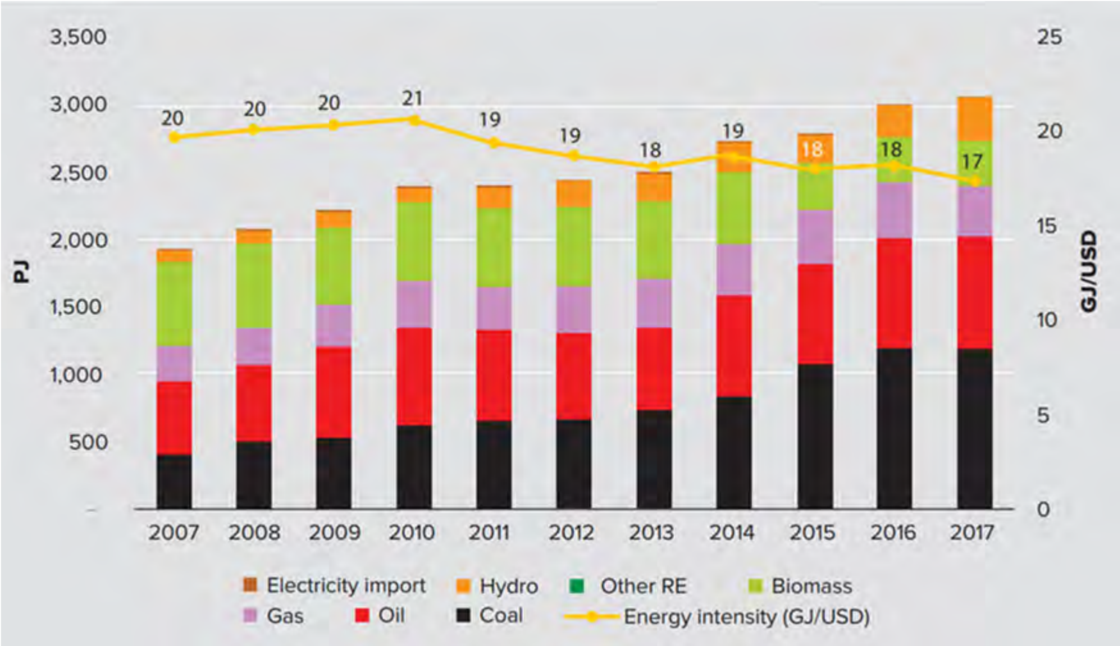
2.1 Project Alternative

The "IFC Performance Standard 1" (IFC, 2012) and the associated "IFC Guidance Note 1" (IFC, 2012) requires that the ESIA shall identify and analyse alternatives, including but not limited to project site location, design, technology and no project alternative (which assumes that the Project development does not happen). This section provides an analysis of certain alternatives to the Project development in relation to: (i) the Project site selection alternatives, (ii) the project design, (iii) the chosen technology and (iv) the "no project scenario".

2.1.1 No Project Scenarios

Vietnam has large reserves of primary energy resources, such as coal, oil, natural gas, and water for hydropower generation. It also has a high potential for renewable energy resources, such as biomass, solar, and wind. During the period 2007-2017, Vietnamese total primary energy supply (TPES[1]) grew at 4.7 % per annum. Hydropower experienced the highest growth at 14.5 % per annum, followed by coal at 11.3 % per annum. The share of coal increased from the third largest fuel source in 2007 to the largest in 2017. Meanwhile, the share of biomass fell from being the largest contributor in 2007 to the third largest in 2017. Oil, growing at the rate of 4.3 % per annum, is the second largest fuel source. Solar and wind have historically only contributed to a very small share in TPES. An overview of the progress of primary energy supply mix from 2007 to 2017 is presented in Figure 2.1.

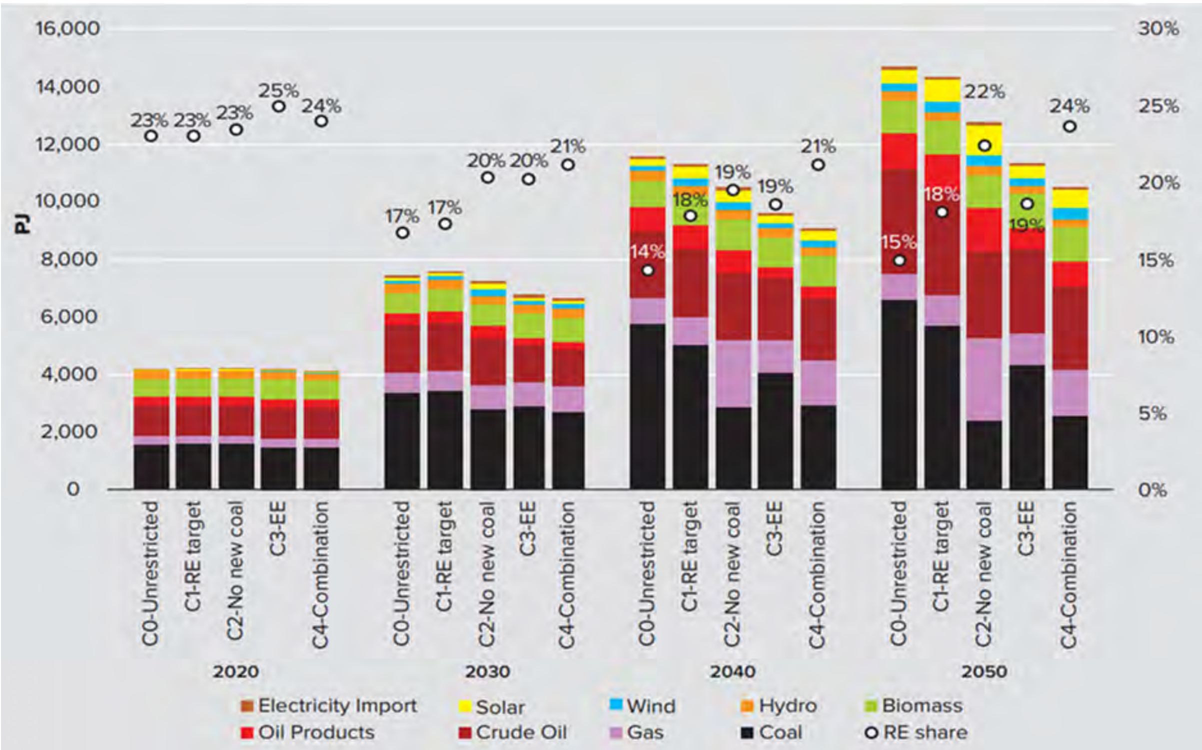
[1] Total primary energy supply describes the total input of primary energy to the energy system. TPES is the sum of production and imports subtracting exports and storage changes. Where primary energy is used to describe fuels, it is the energy available as thermal energy in the fuel. When solar and wind energy is converted to electricity, the electricity made from wind and solar counts as the primary energy for these sources.



Source: Vietnam Energy Outlook Report, 2019

Figure 2.1 Progress of primary energy supply between 2007 and 2017

Figure **2.2** shows the predicted power generation make-up of Vietnam by fuel type to 2050. While this shows a heavy reliance on coal fired power generation, it also shows the growth in supply by renewables such as hydropower to remain relatively stable over that period.

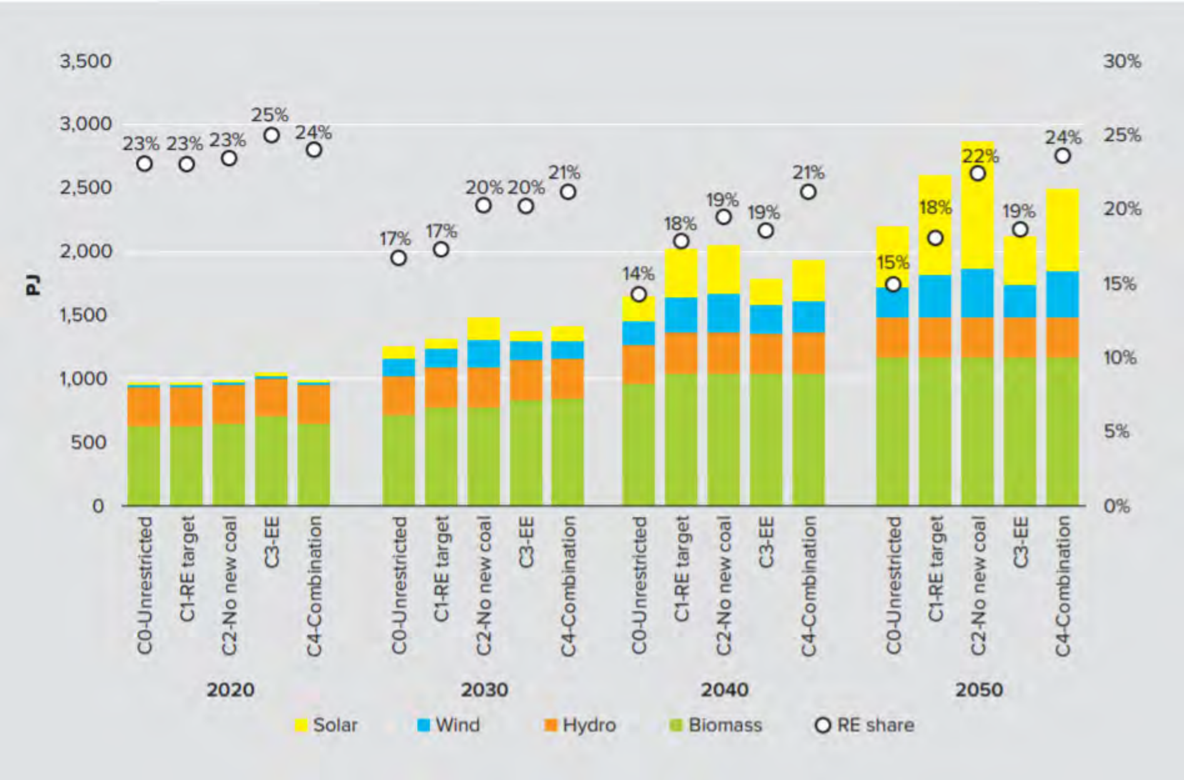


Source: Vietnam Energy Outlook Report, 2019

Figure 2.2 Total primary energy supply (TPES) and Renewable Energy share in TPES across analysed scenarios in the period 2020 – 2050.

The revised National Power Development Plan in the period 2011-2020 with the vision to 2030 and the Renewable Energy (RE) Development Strategy together set relatively concrete directions for the development of the power sector in the coming years. Regarding the primary energy mix per fuel type, coal still covers the major part but tends to be stable in the following years of the planning period at the proportion of 37.3 % in 2025 and 38.4 % in 2035. This is a result of applying low carbon policies to promote RE development. Hydro power experiences a significant reduction while gasoline and oil products cover over 20-22 % and natural gas accounts for about 11-13 % of the total primary energy.

The Energy Outlook Report (EOR) 2019 showed that the RE shares in TPES have a slightly decreasing trend in future years, primarily due to a large increase in fossil fuel consumption. With the proposed scenarios, the share of RE in the total primary energy supply could reach 21% in 2030, then increase to 24% in 2050. This ratio is remarkably higher than the one under the Business as Usual (BaU) scenario, but still fails to meet the required target in the RE Development Strategy (32% in 2030 and 44% in 2050)



Source: Vietnam Energy Outlook Report, 2019

Figure 2.3 Renewable energy sources and their share in TPES for all analysed scenarios[2]

[2] C0- Unrestricted: A theoretical scenarios not taking policy constraints into account, such as RE targets, restriction on coal – fired generation, successful Energy Efficiency penetration.

C1 RE target: A scenario where RE power sector targets in the REDs are fulfilled, without EE penetration.

C2 No new coal – C1 scenario with the addition of the constraint of no investment in new coal power plant after 2025

C3 Energy efficiency – C1 scenario with the addition of least – cost EE technology penetration rate of 50% in 2030 and 100% in 2050.

C4 Combination – The most ambitious scenario combining the three scenarios C1, C2 and C3.

Figure 2.3 has shown that wind and solar shares significantly increase across the scenarios, as they have low operation and maintenance costs and no fuel costs. Additional analysis in EOR2019 showed that with increasing wind and solar shares, the total energy system cost slightly increases while capital cost increases rapidly. Therefore, in the transition from conventional power production to wind and solar, it should be take consideration of access to capital cost, even considering the expectation that the investment costs of wind and solar will decrease drastically in the coming 30 years.

Financing of clean energy investments is a booming market, and not one that Vietnam is currently sharing in. After 2030, with the fossil fuels' increasing price tendency, the investment cost of fossil fuel power sources will increase due to stricter environmental standards while the power production cost of RE sources will fall as a result of technology improvement. As a result, RE could be able to compete with traditional power sources.

Should the Project not proceed, power supply would continue to be met by other sources, however as noted there is clearly a current and future reliance on fossil fuel generated power, particularly coal. In addition, should the project not move forward, the significant positive economic and environmental benefits would not be realized. Some benefits would be include the following:

- Producing clean energy that contributing energy security through development of local energy resources and decreasing dependency on traditional energy sources;
- The clean energy produced from renewable energy resources contributes to decrease global warming due to the fact that it produces no greenhouse gas emission and reduces some types of air pollution.
- During the construction and operation phase, the Project is expected to generate local employment opportunities. As such, this is expected, to a certain extent, to subsequently enhance the socio-economic conditions and standards of living of local community where the project will be developed.
- In the case of this Project, it is crucial to take consideration of positive environmental and social impacts incurred from the project development, against negative impacts that anticipated at the site-specific level. However, it could be concluded that the "no project" is not a preferable option.

2.1.2 Site location alternative

The Project site location alternative was not mentioned and analysed in Feasibility Report. According to Feasibility Report, the certain project site was selected due to some main reasons as follows:

- The selected sites have relatively good meteorological, topographical and geological conditions such as superior wind speed. Specifically, a wind resource measurement station set up within Thanh Hai Commune showed that the mean wind speed at a height of 74 m reached 6.4 m/s. The result was recorded in the period of 2012-2014.
- The selected site has available site plan and conditions for possible extent in the future, and limited volume of clearance and resettlement;
- The site locations are feasible for connecting the plant to national power system. The project's overhead 110kV transmission line will connect to an existing 110kV substation at Binh Thanh Commune;
- The sites were selected in the area with low population density; and
- The sites have been in line with local authority's development planning for the whole area and are concurred and supported by Ben Tre Province People's Committee under Decision No.1993/QĐ-UBND, dated September 21st, 2018.

2.1.3 Alternative of Wind turbine technology

During the Feasibility Study, the Project developer has approached different turbine technologies for the Project's development. With an estimated capacity of 30MW, the wind turbine technology was selected that generate the highest annual electricity output and highest capacity factor. According to

Feasibility Study Report, the wind turbine technologies that were considered and calculated annual electricity output are summarized in Table 2.1

Table 2.1 Wind turbine technology alternative for the Project Development

Technology	Capacity (MW)	Number of turbines	Hub height (m)	Diameter (m)	Annual Output(MWh)	Capacity factor (%)
Enercon	2MW	15	84.5	82	93,559	35.6
Envision	3MW	10	96	116	102,027	38.8
GE 2.5 -100	2.5 MW	12	80	100	100,557	35.4
GE 3.8 -137	3.8 MW	8	110	137	103,608	39.4
Siemens Gamesa G114	2.5 MW	12	90	114	102,724	39.1
Siemens Gamesa G132	3.3 MW	9	97	132	106,853	40.6
Siemens Gamesa SG145	**4.2 -4.5 MW**	**7**	**108**	**145**	**107,748**	**41.0**
Vestas V110	2,0 MW	15	80	110	93,726	35.6
Vestas V136	3.3 -3.6 MW	9	112	136	105,687	40.2
Vestas V150	4.0 -4.3 MW	7	105	150	106,432	40.5

Source: Project's Feasibility Study, 2018

At the time of preparing this ESIA, the Developer has selected turbine Siemens Gamesa 4.5 -145 for the Project. The technology was selected by some main reasons:

- The technology generate the highest annual electricity output and highest capacity factor;
- The technology is modern and globally applied;
- Turbines with high capacity can utilize to the maximum extent of project's area and wind condition in project site in order to generate high power production;
- Using high capacity turbines means the number of wind turbines will decrease, so capital cost, construction cost will reduced accordingly; and
- Less wind turbines to be used means impacts from construction phase on marine water quality, marine habitat as well as impacts from operation phase (e.g noise, shadow flicker, landscape, visual amenity, avifauna disturbance and mortality) can be reduced.

Throughout the ESIA, the assessment and modelling was conducted for the selected design, lay out and turbine's specification.

2.2 Project Location

The Project footprint is located in Thanh Hai Commune, Thanh Phu District, Ben Tre Province within the area of 2,800 ha which is about 53km Southeast of Ho Chi Minh City (Figure 1.1). The Project area is in the estuarine area which affected by the rising and falling tide with three sides adjacent to the sea and the last side. The Project onshore component comprises of 22/110kV substation, operation house, internal road and overhead 110kV transmission line that passes through Thanh Hai, Thanh Phong, Giao Thanh, An Nhon, An Quy, An Thuan and Binh Thanh commune. The area of project onshore component is about 24 ha.

Physical settings around the Project are described below:

- To the North: Co Chien River;
- To the East: Thanh Phong Commune, Thanh Phu District, Ben Tre Province;
- To the West: adjacent to the sea; and
- To the South: approximately 8 km from the Nexif Ben Tre Wind Power.

The locations of Project's wind turbines and Project area are presented in Table 2.2, Table 2.3 and Figure 1.1.

Table 2.2 Project's study area

Landmark	Coordinate (WGS 84)	
	Latitude (m)	Longitude (m)
1	9º54'19.06970"N	106º40'48.08658"E
2	9º55'37.37657"N	106º40'24.83619"E
3	9º56'13.83171"N	106º39'36.32022"E
4	9º55'22.42846"N	106º46'05.16767"E
5	9º54'10.77952"N	106º46'20.86603"E

Table 2.3 Project's wind turbine

No.	Turbines	Coordinate (WGS 84)	
		Latitude (m)	Longitude (m)
1	TB1	9°56'07.69"N	106°40'03.36"E
2	TB2	9°55'58.83"N	106°40'13.47"E
3	TB3	9°55'42.51"N	106°40'59.64"E
4	TB4	9°55'27.87"N	106°40'59.63"E
5	TB6	9°54'43.23"N	106°40'50.08"E
6	TB7	9°54'32.49"N	106°40'50.05"E
7	TB8	9°54'21.75"N	106°40'50.06"E

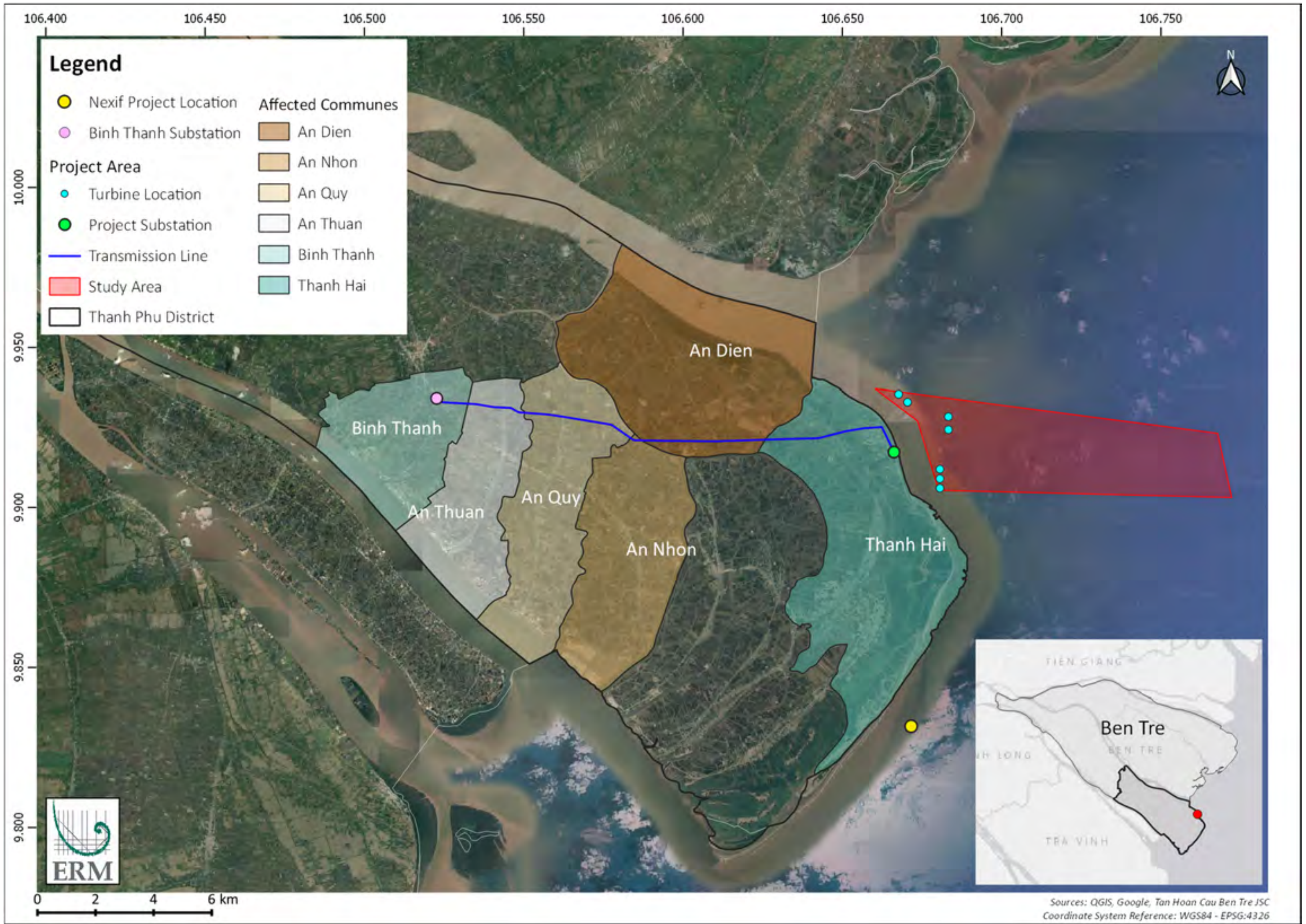


Figure 2.4 Locations of Project and Turbines

2.2.1 Wind turbine layout

Seven turbines is expected to be built on a coastal alluvial area, the sea floor is relatively flat, close to the mudflats. The permanent water area will be acquired for total 07 turbine's footprint and corridor of underwater transmission line is approximately 10.3 hectare and the shortest distance from each of them is roughly 450m as presented in Figure 2.5. The distance of the closest and farthest from turbines to clam ponds are approximately 1,100m and 2,250m respectively. The shortest and longest distance between turbines and shoreline are around 875m (TB8) and 2,100m (TB3) respectively.

At the time of this report was written, there were two cooperatives belong to Binh Minh Clam Cooperative and Thanh Loi Fishier Cooperative (Figure 2.6) and cultivated land (water melon, peanut, cassava, etc.) along the coast. Two cooperatives are in coastal area belonging to Thanh Hai commune which is among the project substation and turbines. There is a minor area of two cooperatives overlapped the wind turbine footprint but not significant.

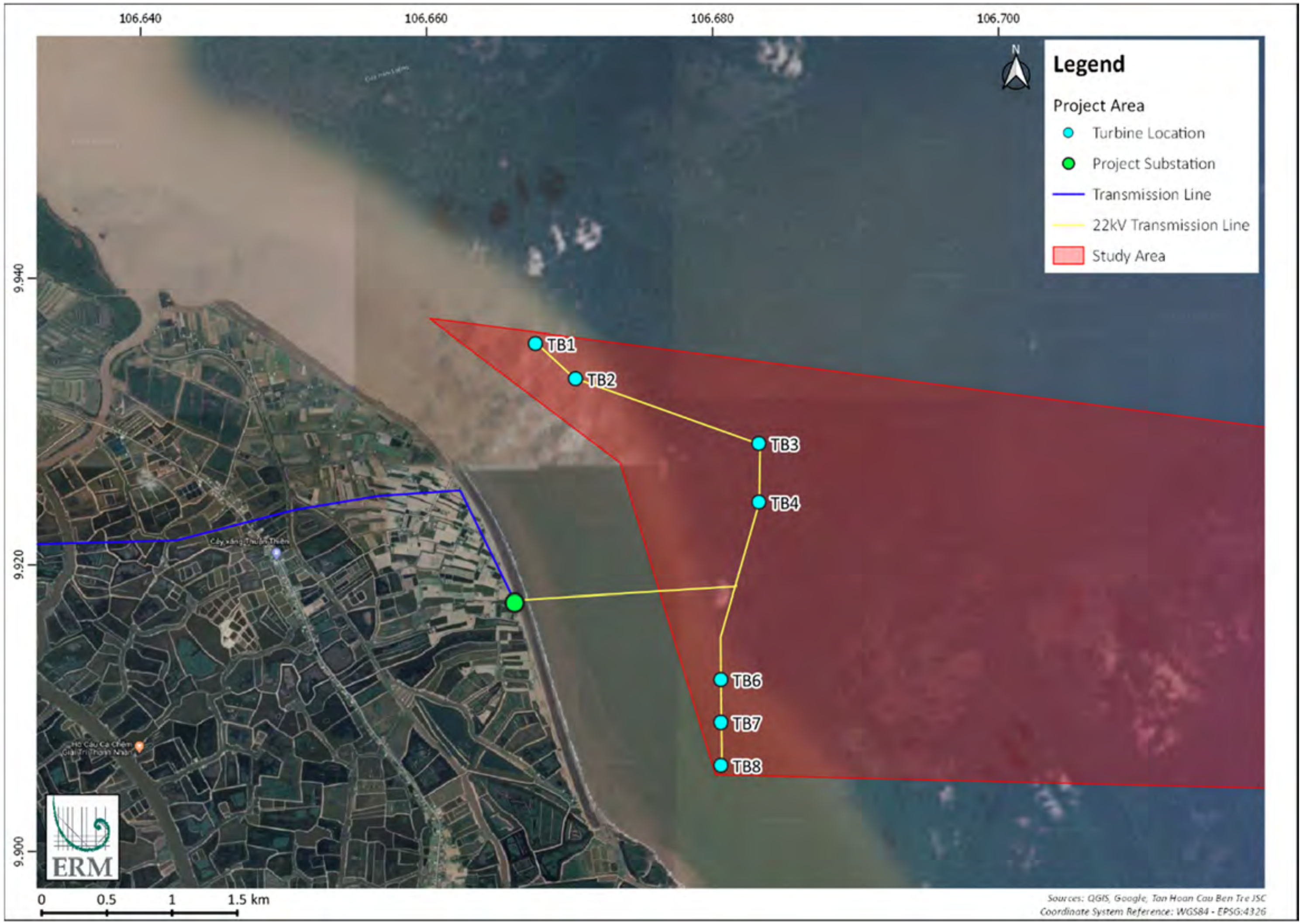


Figure 2.5 Wind Turbine Layout

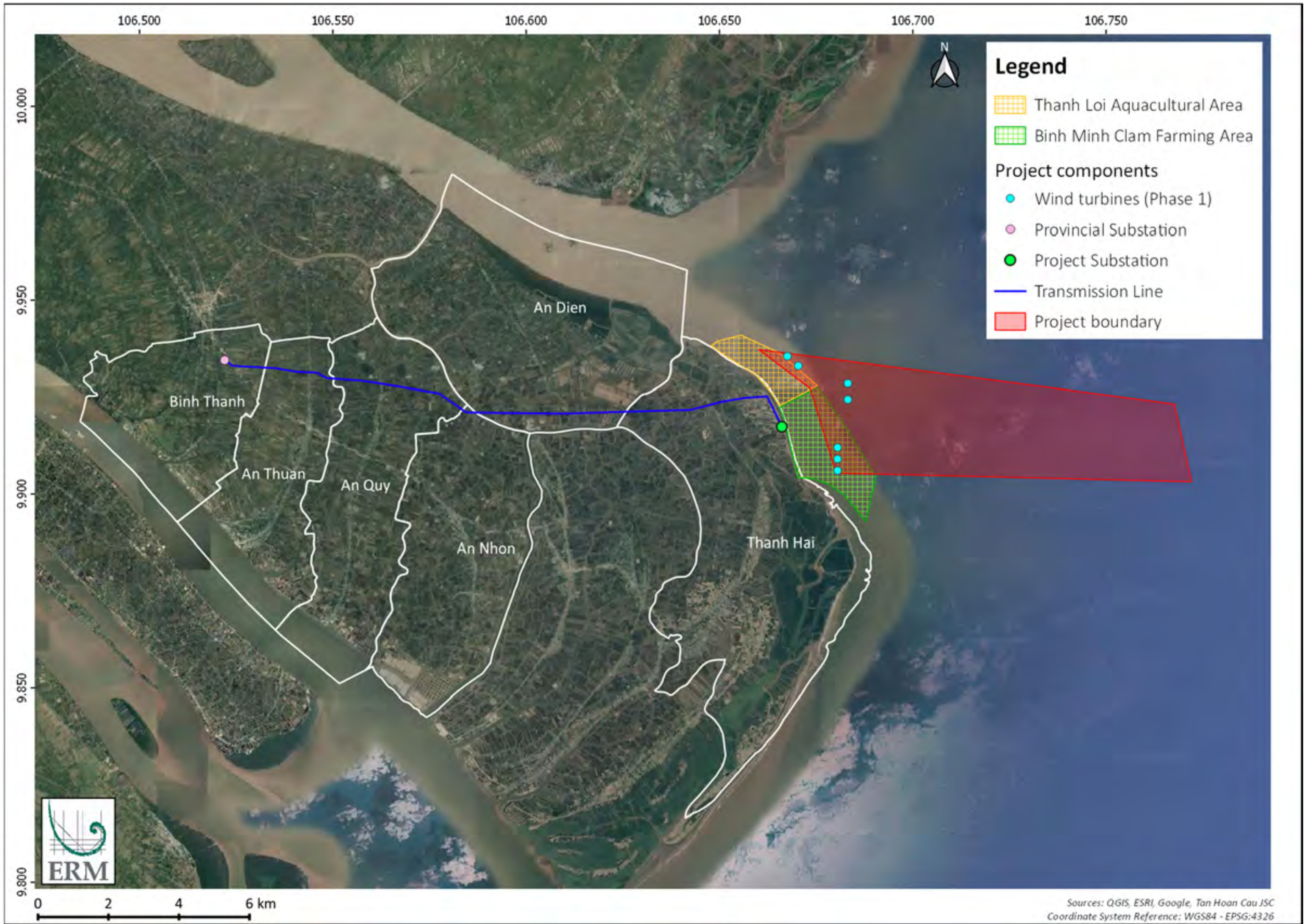


Figure 2.6 Cooperative Location in Thanh Hai Commune

2.2.2 Substation

The 22/110kV lift transformer station is being built in Thanh Hai Commune. This location is about 10km from Con Bung beach (also known as Thanh Phu beach or Thanh Hai beach). Figure 2.5 illustrates the location of project substation. Geographic location is as follows:

- The North border clam farming;
- The South border bare land;
- The East border shoreline, about 10km from the road to Con Bung beach; and
- The West border on cultivated land of people.

2.2.3 22kV Transmission line

The 27.34km submarine 22kV transmission line will be built that connect all turbines to collect electricity output from 0.69/22kV transformers and then connect to 22/110kV project's substation.

2.2.4 110kV Transmission line

The 18km 110kV transmission line will pass through mainly aquacultural farming area located in Thanh Hai, Thanh Phong, Giao Thanh, An Nhon, An Quy, An Thuan and Binh Thanh Commune (Figure 2.4) to the West of the Project and then connect to an existing 110kV Binh Thanh substation (Figure 2.7)

Figure 2.7 The connection area of 110kV Binh Thanh Substation

2.3 Project Schedule

The progress of Project development is shown in detail in the following Table 2.4.

Table 2.4 Project timeframe

No.	Timeframe	Works
1	September 2018 –October 2018	■ Set up and approve Feasibility Report
2	November 2018 – December 2018	■ Set up Technical Design and Drawings.
3	January 2019	■ Site Clearance and compensation ■ Bidding, Negotiation and EPC contract signing
4	April 2019 – March 2020	■ Set up Sale Contract. ■ Receiving equipment. ■ Construction of the system of roads. ■ Construction of the foundation of turbines ■ Construction of the substation, the operation house. ■ Construction of 22/110kV station and 110kV transmission line to connect the national grid.
5	– February 2019-October2020	■ Transport equipment to site ■ Installation of turbines ■ Construction of technical systems inside the operation house. ■ Trial for operation and put to operation

Source: Feasibility Study Report, 09 October 2018

2.4 Project Facilities and Components

A process flow diagram of the Project indicating main components is provided in Figure 2.8.

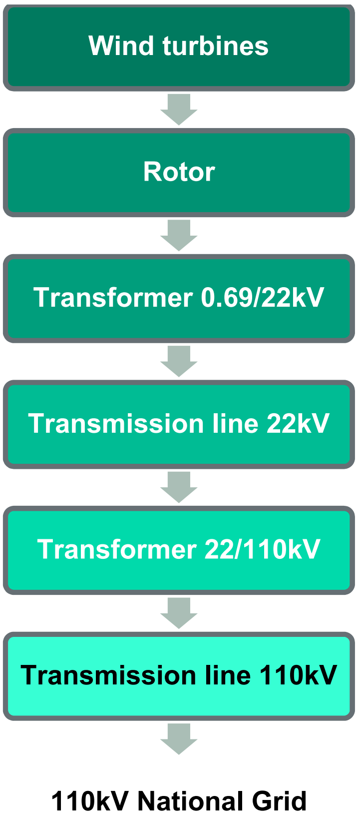


Figure 2.8 Project's process flow diagram

2.4.1 Wind turbine

There are seven wind turbines towers, one for each turbines. Wind turbines equipment is expected to be used from Siemens Gamesa SG145 4.2/4.5 (see Figure 2.9) with the following main components:

- Rotor
- Nacelle
- Tower

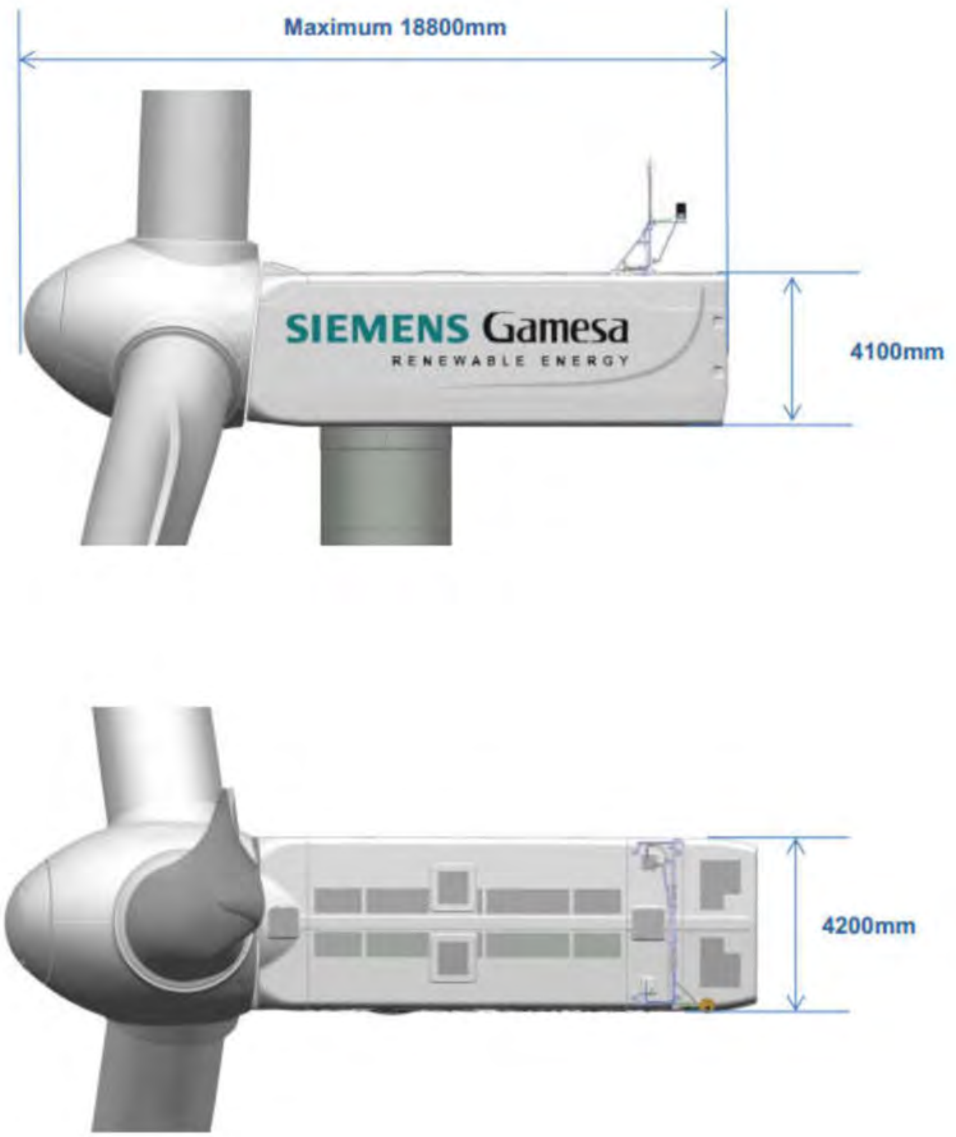


Figure 2.9 Siemens Gamesa SG145 4.5 MW

2.4.1.1 Rotor

Table 2.5 Specifications of Rotor

Specifications	
Turbine height (hub height)	107.5 m
Diameter	145 m

Specifications	
Area	16,513 m^2
Speed of rotation	10.77 rpm
Number of wings	3
Rotor start at wind speed	3 m/s
Wind speed reaches the rated capacity	11 m/s
Rotor stop when wind speed reaches	27 m/s

2.4.1.2 Generator

Table 2.6 Specifications of generator

Specifications	
The rated capacity	4,500 MW
3-phased output voltage	690 VAC
Frequency	50 Hz

Wind turbines operate on a simple principle. The energy in the wind turns three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity (3 phase, alternating current, 690 V). The transformers will increase the electricity to 22 kV, the transformers connect with each other through the medium voltage line 22 kV which then connects to the transformers 22/110 kV and to the grid of Binh Thanh (Thanh Phu) through the existing line.

2.4.2 22kV Transmission line

Each turbine will has an appropriate transformer to boost voltage 0.69/22kV, thus seven turbines will have seven transformer totally and corresponding to seven connection to 22kV transmission line. Though, for the purpose of saving investment cost, project will use three connection to 22kV transmission line. The specifications of 22kV transmission line is illustrated in Table 2.7

Table 2.7 Specifications of 22kV transmission line

Specifications	
Length	27.34 km
No. of circuits	7 (Pre-installed 3 circuits)
Cable	ACSR/Mz 240/39
Lightning rod	01 GSW-70 lightning protection cable, 01 lightning protection cable with OPGW-70 optical cable (24 fibre optic)

Specifications	
Insulation	Using vertical insulation for supporting columns and suspension insulation for hanging columns
Column	Using free-standing galvanised tower steel columns linked by bolts
Foundation	Using cast-in-place reinforced concrete foundation

2.4.3 110kV Transmission line

The 110kV transmission line will go through six communes in Thanh Phu District including Thanh Hai, An Dien, An Nhon, An Quy, An Thuan and Binh Thanh. Transmission line specification data is presented in Table 2.8, Table 2.9 and Figure 2.10 below.

Table 2.8 Specifications of 110kV transmission line

Specifications	
Length	18 km
No. of circuits	2
Cable	ACSR-300/39
Lightning rod	01 GSW-50 lightning protection cable, 01 lightning protection cable with OPGW-49 optical cable (12 fibre optic)
Insulation	Using the mounting interface according to IEC standards
Column	Using galvanised tower 2-circuit steel columns which is hot-dipped
Foundation	Using cast-in-place reinforced concrete foundation

Table 2.9 Transmission Line Parameters

			X [m]	Y [m]	Umax [kV]	I[A]	rA [mm]	dA [mm]	n	Ph-seq
Line 1	Circuit 1	L1	-2.5	16	123	610	10.8	0	1	1
		L2	-2.5	12	123	610	10.8	0	1	2
		L3	-2.5	8	123	610	10.8	0	1	3
		g.w.	-2.5	20	0	0	5.4	0	1	0
		g.w.	2.5	20	0	0	5.4	0	1	0
	Circuit 2	L3	2.5	8	123	610	10.8	0	1	3
		L2	2.5	12	123	610	10.8	0	1	2
		L1	2.5	16	123	610	10.8	0	1	1

X [m] – horizontal length from the middle of the line; Y [m] – height in which wires are suspended; Umax [kV] – maximum permissible line voltage; I [A] – maximum permissible line current (in case of bundle it is; determined for all wires); r_A [mm] – wire radius; d_A [mm] – distance between wires in bundle; n – number of wires in bundle; Ph-seq – phase sequence. 1 – L1, 2 – L2, 3 – L3, 0 – Ground Wire

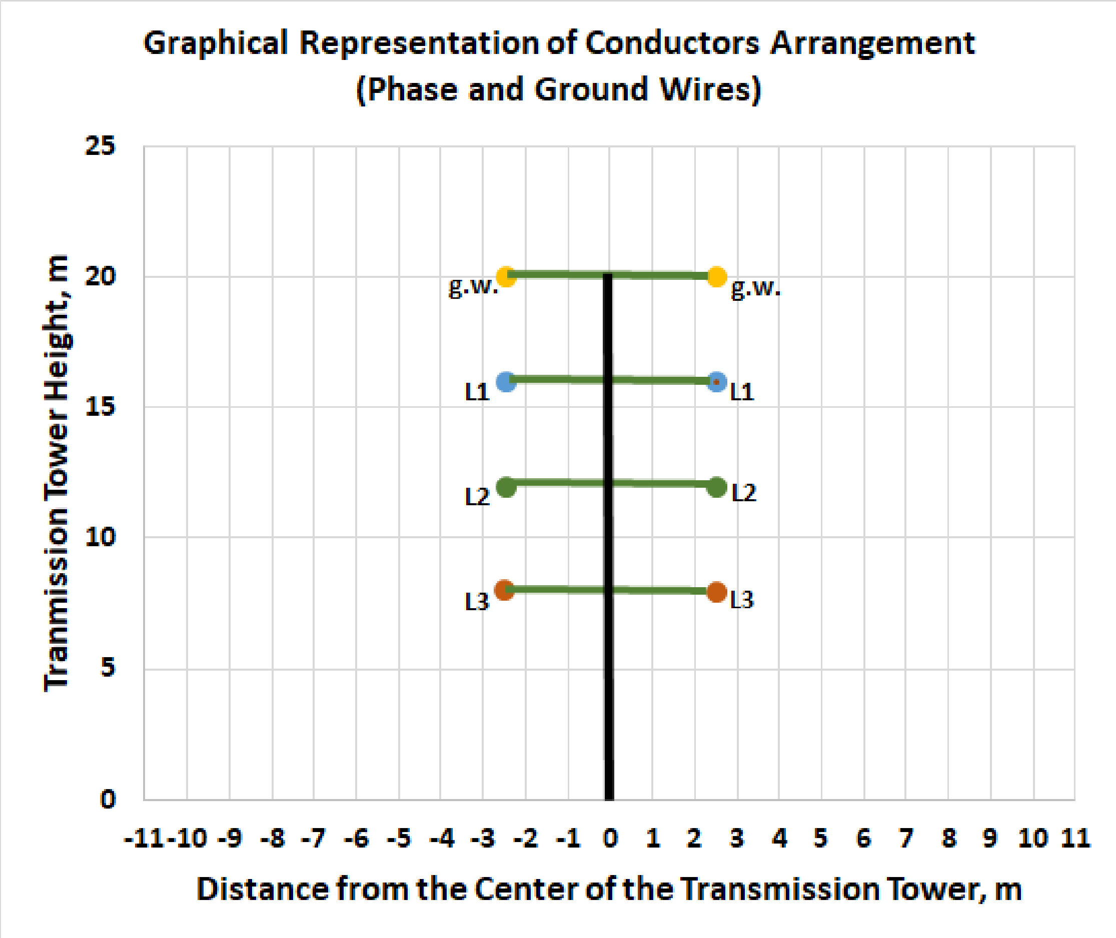


Figure 2.10 Schematic Representation of Transmission Tower with Power Lines Arrangement

2.4.4 Transmission parts

The transmission part will include the following parts:

- Gear;
- Coupling;
- Brake;
- Quick rotation axis connecting between gear and generator; and
- Generator

2.4.5 Substation

The 22/110kV Thanh Hai substation will be established for the purpose of collect and to raise the voltage then transmit to 110kV electrical grid of Ben Tre Province through 110kV. The 22/11kV Thanh Hai substation is a booster, which is half-exposed and requires to be observed manual. The area of substation is 11,160 m^2.

2.4.6 Other components

- Telecommunication and Supervisory Control and Data Acquisition (SCADA);
- Lightning protection system;
- Fire prevention system;
- Earthing system;
- Public lighting system; and
- Drainage system.

2.5 Project Activities

2.5.1 Pre-construction phase

The Pre-construction phase will include two main activities:

- Land acquisition for clearance. The project developer will coordinate with local authorities to measure and conduct inventory of loss, then develop the compensation plan; and
- Demining and UXO clearance by hiring a military unit with such capabilities for the construction area of the Project onshore components.

2.5.2 Construction phase

The Construction phase consists of construction of various Project components, as discussed in Section 2.4. These components can be categorised into three main construction activities, as follows:

- Construction of turbine foundation
- Installation of turbines
- Internal roads
- Construction of 22kV transmission line
- Construction of 22/110kV Substation and Operation house; and
- Construction of 110 kV transmission line

Details of the schedule of the above construction activities were presented in Section 2.3.

During construction, the EPC Contractor will apply best practice to reduce noise disturbance to nearby residents, and, where possible, e.g construction activities will be conducted during day time hours. There will be a designated area for EPC contractors to use such as construction laydown area for substation and T-line foundation which acquired 4.7 ha of permanent land; a temporary dumping area for fill material, worker camps and safety corridors for 110kV T-line which acquired 145.150 m^2 of temporary land.

2.5.2.1 Wind turbines layout construction

Based on Feasibility Study, wind turbine layout was identified optimal location by using Optimize module in Windpro application. For safety, the minimum distance among wind turbines is generally limited ranging from four or five times of rotor diameter and shielding performance of 90% or more.

Base on topography condition of project area, location of turbines were surveyed and rearranged to associate to existing condition, transportation routes and construction. The wind turbines layout is illustrated in Figure 2.5.

2.5.2.1.1 Turbine foundation

Turbine foundation will stabilize the normal activities of turbine component under the external condition (activities of turbines, wind, earthquake, etc.)

The specifications of the foundation depend mainly on:

- Location of wind turbines (geology, soil properties, etc.)
- Weather/ Climate Condition (wind)
- Kind of turbine (capacity, weight, height)

The turbine foundation is a high-strength reinforced concrete foundation on the pile foundation. The octagonal foundation has a height of 3m and width of 21.6m.

The 800Φ piles has the height of 50m which are piled into the seabed and each turbine requires 48 turbines. The piling layout is shown in Figure 2.11

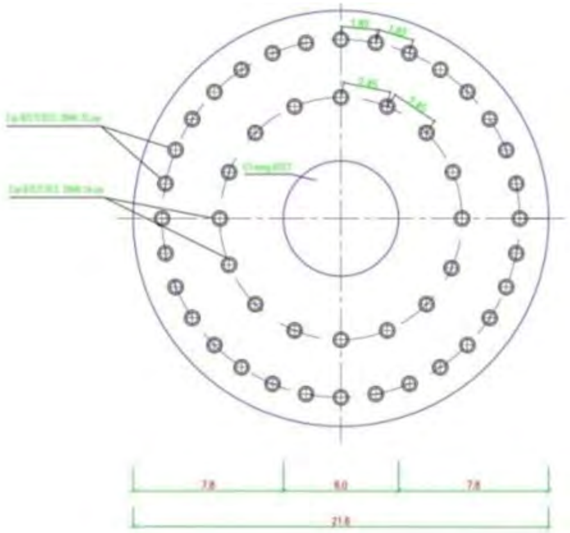


Figure 2.11 Piling layout

Establish embankments around turbine foundation: Establish embankments around turbine foundation, seal gaps by specialized glue and cover with canvas; Water treatment inside the foundation 24/24hour.

Figure 2.12 Cover around foundation with canvas

Steel structure of foundation is illustrated in Figure 2.13 and Figure 2.14

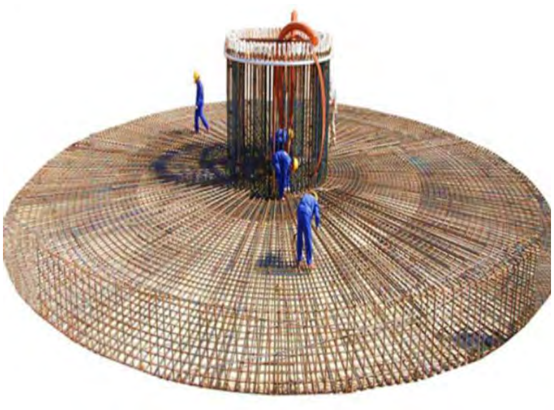


Figure 2.13 Steel structure of foundation

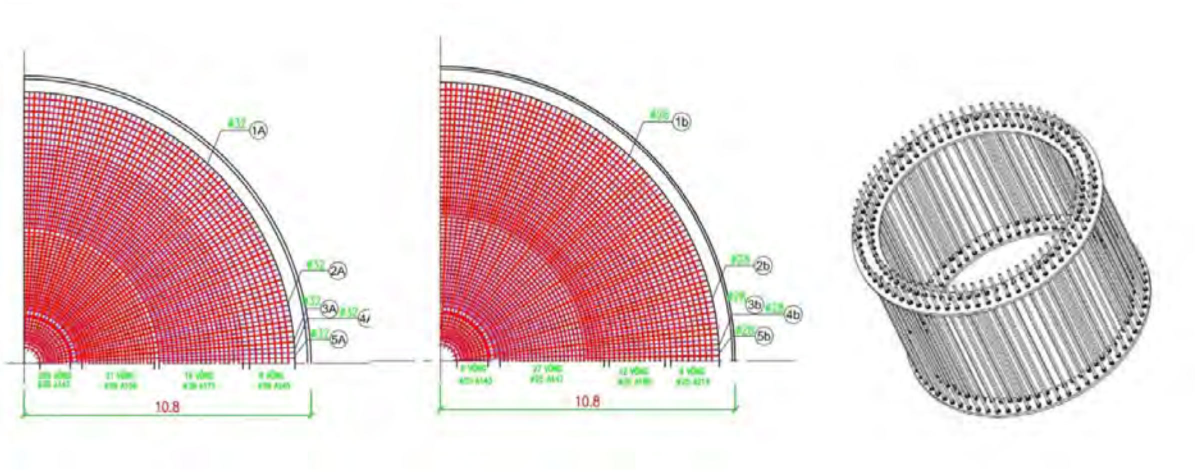


Figure 2.14 Steel structure (lower layer, upper layer, bulong)

- The lower layer uses concrete type M100 1x2, diameter of 22m, thickness of 20cm.
- The material for the foundation includes concrete type M400 0.5x2 stone:
    - Thick bottom has diameter of 19.3m, height of 1.15m;
    - Bevelled whose diameter decreased from 19.3m to 5.29m, height of 1.05m;
    - Reinforced concrete and macadam 0.5x2 M700 whose diameter of 5.29m and height of 0.465m

Bulong will be used to connect the turbine and foundation.

Figure 2.15 illustrates the basic structure of turbine foundation.

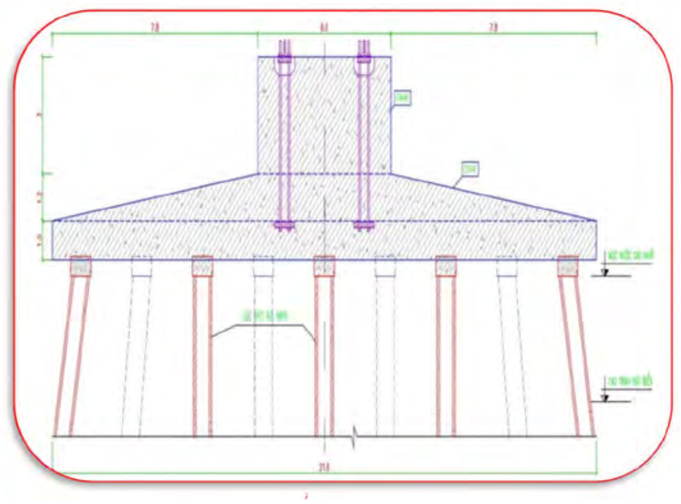


Figure 2.15 Turbine foundation

- Concreting approach:
    - Concrete is mixed at the batching plant with an electronic weighing system to ensure the exact quantity and quality of batches;

    - Concrete trucks are specialized types to ensure that concrete is not stratified, dehydrated or wasted in transportation;
    - Concrete trucks are transferred by barges to the location of turbine foundation.
    - At concrete is put into the foundation by concrete pumps truck;
    - Get concrete samples (directly from concrete trucks) to measure the slump of concrete and use this concrete sample as test samples before concreting (pouring concrete into pumps to pump up construction site);
    - Pumping concrete into the foundation by a pump.
    - Compact concrete by electric batons ensures that the concrete slurry mixture becomes solid, concrete does not exist pores, the outside surface is not porous and the concrete adheres to the reinforcement.
- Maintenance work:
    - Use jute sacks soaked in water to cover the surface of foundation to avoid quick evaporation of water causing cracks;
    - Concrete is moistened by watering during the curing and shock-proof period to ensure a curing process;
    - The maintenance of concrete is conducted continuously for 04 days from the date of pouring.

2.5.2.1.2 Turbine components

Besides the wind turbine foundations, the assembly of wind turbines include but not limited to:

- Transporting wind columns to installation location;
- Installing wind tower body on foundation;
- Installing nacelle on the tower,
- Installing hubs;
- Installing three propellers;
- Finalizing the connection of components; and
- Installing other mechanical equipment.

2.5.2.2 Substation and Operation house

The construction of substation and operation house includes but not limited to:

- Stone soil work:
    - Levelling;
    - Digging and covering soil
- Reinforcement, concrete construction and protection work;
- Assembly of columns and metal structures:
    - Producing & installing steel components
- Installation of electrical equipment:
    - Transformer;

  - Outdoor and indoor equipment

The area of operation house is 26mx38m, single storey house, bearing structure is reinforced concrete frame, and oblique roof of reinforced concrete, the top has waterproofing and gluing additives. The foundation of the house is a single reinforced concrete foundation.

2.5.2.3 Transmission lines

For the construction of transmission lines, these following activities are included but not limited to:

- Transmission tower's foundation:
  - Soil excavation;
  - Work on reinforced concrete foundation
- Measures to assemble columns;
- Installation of insulation and accessories;
- Strain rope and take deflection; and
- Grounding installation work

2.5.2.4 Main equipment's transportation

Most equipment in wind power plants in Vietnam in general and Thanh Hai 1 Wind Power Plant in particular are imported.

Turbines and equipment are imported from foreign firms. High-strength bolts with fatigue to connect the columns are also imported. Steel materials, cement and construction materials are normally purchased from agents of domestic suppliers and transported by road to the construction site.

Table 2.10 The Project's main equipment supply plan

No.	Work Items	Supply Plan
WIND TURBINE COMPONENTS		
1	Turbine, propeller and auxiliary equipment	Import
2	Column sections	Import/Domestic
3	Internal underground cables and auxiliary equipment	Import/Domestic
PART OF TRANSFORMERS		
1	Transformer	Import/Domestic
2	Cutting machine, disconnector	Import/Domestic
3	Protection control system and self-powered power supply	Import/Domestic
4	22kV network	Import/Domestic

Thanh Hai 1 Wind Power Plant plans to install nearshore turbines, so the transport plan is mainly carried out in the following 2 ways:

2.5.2.4.1 Road transport

Construction materials (such as sand, stone, steel, etc.) will be provided by local supplier and distributors and then transported by road via National Road 57 and district roads. For construction materials, it is understood that:

- Concrete for the construction of turbine foundation, will be purchased at local concrete mixing stations.
- Iron and steel will be purchased from local suppliers and machining at site.
- Stones and sand will be purchased from local granaries and sand.

Local suppliers are responsible for transporting and distributing materials to the construction site.

2.5.2.4.2 Maritime transport

Transport objects:

- Turbines, turbine support columns and imported equipment.
- Large/heavy construction equipment (cranes, concrete mixers ...).

There are two maritime transportation alternatives:

- PTSC Phu My Port: The capable of receiving large vessels is approximately 70,000 DWT. The port located in Duyen Hai District, Tra Vinh Province, about 13 km from National Road 57, and 55 km from Ho Chi Minh City. The route is about 90km from PTSC Phu My through Thi Vai Rvier and East Sea to Project area.
- Port of Duyen Hai Thermal Power Plant: The capable of receiving large vessels is approximately 50,000 DWT. The route is approximately 30 km frm Port of Duyen Hai Thermal Power Plant through East Sea to Project area.

■

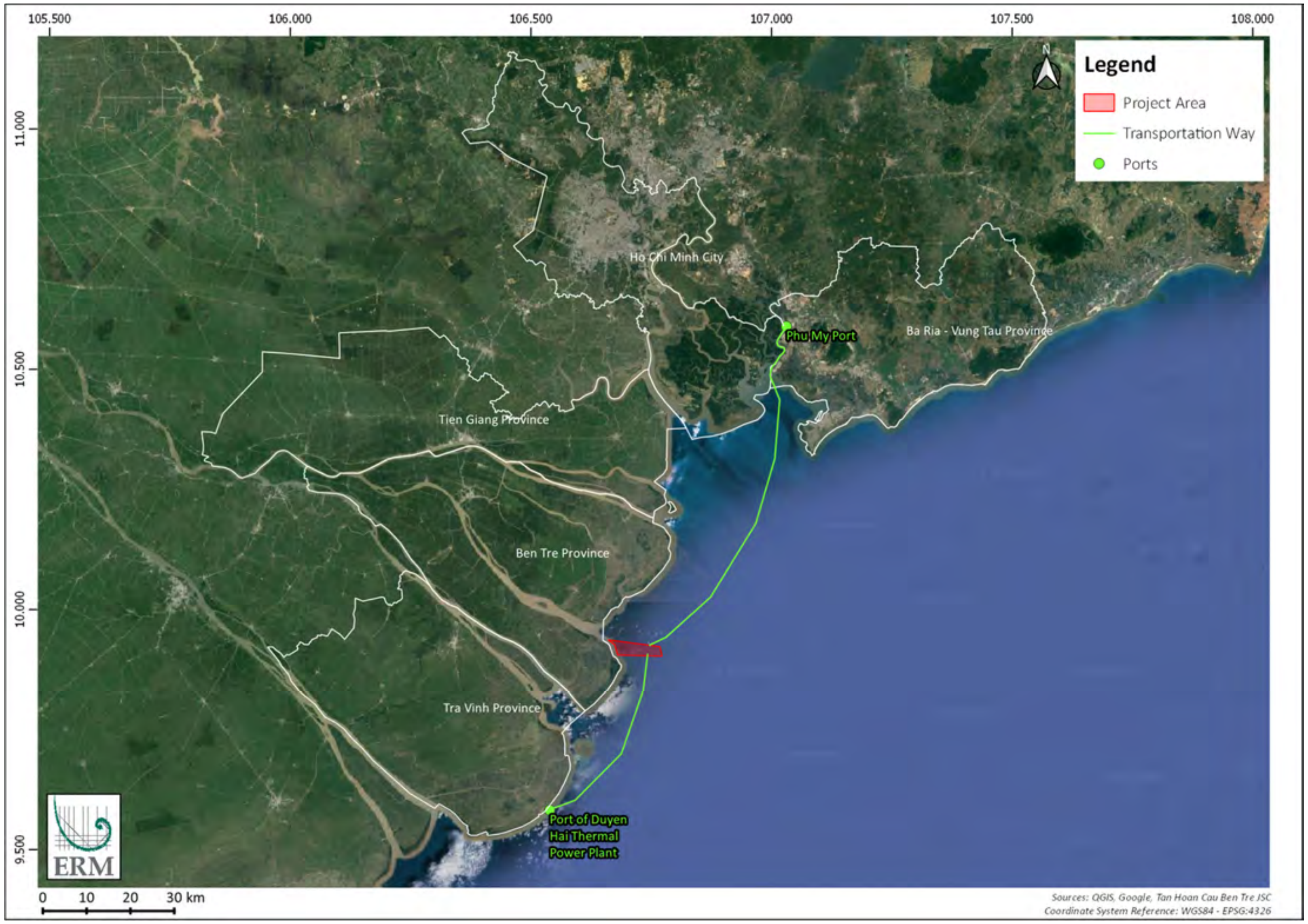


Figure 2.16 The transportation routes

The Project will use transportations below:

- Use one 5000-DWT barge to transport fully one pillar (full set) from Phu My Port to the construction site.
- Using five 1200–2000-DWT barges to transport objectives from Phu My port to the construction site.
- Using five tugs whose tonnage is 350-1500CV to pull the welding barge.

At the construction site, at high tide, the barge will be mobilized to the place of delivery and anchor. At low tide, the goods will be unloaded for installation.

2.5.2.5 Utilities required during construction

Location of the Project is about 46.5 km from Ben Tre city along national highway 57 and district roads. This area is located between the estuaries of Ham Luong and Co Chien rivers, which makes it very convenient for transporting materials and equipment by both road and waterway.

According to local regulatory EIA and FS, electricity for construction phase is expected to be taken from the national grid at project's area, using existing 22kV transmission line that connects to national grid as power source for construction activities of project's onshore component. Regarding power source for construction of project's offshore components, three-phase diesel generators of 0.4kV- 200kVA will be used and located close to turbine location.

Project construction only requires a small amount of water, which can therefore be taken from either groundwater sources or as treated water from Ham Luong River.

2.5.2.6 Waste management and storage

Table 2.11 Waste management

No	Phase	Waste type	Source	Estimated quantity	Method of disposal
	Non-hazardous waste				
1	Construction phase	Domestic wastewater	Labour activities	3.5m^3/day	
2		Wastewater	Plant/ machinery activities Concrete mixing process	~11m^3/day	80% wastewater which is from stone washing will be reused.
3		Domestic solid waste	Labour activities	~35kg/day	Waste will be collected by janitor and on site and landfilled.
4		Construction debris (excavated soil)	Construction of Wind Turbine Generators (WTGs), substations, storage yards, etc.	20-30kg/day - night	Excavated materials to be used for backfilling and levelling and other debris shall be used for road construction

No	Phase	Waste type	Source	Estimated quantity	Method of disposal
5		Sludge	Construction of WTGs, underwater transmission line		
6	Operation phase	Domestic solid waste	Labour activities	27.5kg/day	
7		Solid waste	Power Plant activities	30kg/day-night	
	Hazardous waste				
8	Construction phase	Used oil/waste oil and Oil contaminated rags	Diesel generators set, construction machinery	50-100kg/year	Project commits to comply with Circular No. 36/2015/TT-BTNMT of MoNRE, Decree No. 38/2015/ NĐ-CP on the management of hazardous waste.
9	Operation phase	Used oil/waste oil and Oil contaminated rags	Diesel generators set, construction machinery	~3-5kg/month	

Source: EIA, 2019

2.5.2.7 Employment and Accommodation

Prioritising the recruitment of local workers that can take care of their own accommodation in order to minimise domestic waste within the construction site.

- No. working day/year: 365 days
- No. of shift/day: 3 shifts/day
- No. of employees during the construction phase: approximately 200 persons
- No. of employees during the operation phase: 55 persons

2.5.3 Operation phase

Activities that will be carried out during the operation phase includes:

- Commissioning tests of the wind farm which usually involves inspection of the first wind turbines' operation, standard electrical tests and civil engineering quality and should be carried out within the first month after the project put into operation. Careful testing at this stage is extremely crucial to assess whether a good quality wind farm can be delivered and maintained. Generally, commissioning of an individual turbine can take more than two days with experienced staff.
- Routine inspection of all WTGs as per supplier's specifications;
- Schedule maintenance activities at each WTG location will be conducted as per the supplier's guidance of operation and maintenance;
- Operations and maintenance of ancillary facilities such as yards, stores, Central Monitoring System (CMS) building facilities;
- Inspection and maintenance of 0.69/22kV transformer, 22/110kV substation, overhead and submarine 22kV transmission lines; overhead 110kV transmission line;

The Annual Maintenance Schedule is performed every 6 months (except for the first month after the power plant is in operation), and may include the following maintenance:

- General inspection: visual inspection of corrosion, fracture, damage of all WTGs as per supplier specifications; inspection of water leakage or penetration, unusual noise, lightning protection element;
- Blades inspection of all WTGs;
- Pitch bearing inspection including leakage of oil, gears;
- Adjusting the angle of the blades (if any);
- Rotor inspection;
- Gear box inspection;
- Inspection of safety brake system;
- Generator inspection;
- Inspection of hydraulic system;
- Inspection of wind observation equipment;
- Inspection of power cables;
- Inspection of tower;

- Inspection of control system, transformer;
- Inspection of fire protection system, safety equipment, hygiene status.

Maintenance must be performed by a maintenance specialists (acknowledged about the factory and trained by the manufacturer). After maintenance completing, the maintenance technician will issue a Certificate of Maintenance to confirm the working conditions of factory meet requirement to continually operate.

2.5.4 Decommissioning phase

At the time of report, the Project has yet conducted any plan for the decommissioning phase. As such, this phase is out of scope for the ESIA.

3. ADMINISTRATIVE FRAMEWORK

3.1 Overview

There are two levels of governing provisions applicable to the Project. The first is the Vietnamese assessment and approvals process which must be followed to achieve regulator environmental approval. Secondly, as the proponent seeks to adhere to meeting international standards, the 2012 IFC Performance Standards 1-8 (IFC PS) and the World Bank Group EHS Guidelines are also applicable. The primary means of integrating the IFC PS and EHS expectations into the construction and operational phase of the Project is through the preparation of this ESIA.

The Project obtained approval for its regulatory Environmental Impact Assessment (EIA) dated January 25, 2019. However, the EIA does not address some aspects of international standards and expectations. Therefore, to integrate the IFC PS and EHS expectations into the construction and operation phases of the Project, this ESIA is prepared.

The regulatory EIA and ESIA processes and their relevance to the Project are described in detail below.

3.2 Regulatory Frameworks Affecting Projects in Vietnam

The various regulatory frameworks that will be adopted for this Project are detailed below.

3.2.1 Law on Environmental Protection

The Law on Environmental Protection (LEP) No. 55/2014/QH13, dated 23 June, 2014 is the main piece of environmental legislation currently in force in Vietnam. The law assigns national responsibility to environmental strategy, the drafting of regulations and standards and all monitoring to the Ministry of Natural Resources and Environment (MoNRE), and the Vietnam Environment Protection Agency (VEPA). Responsibility for implementation of environmental policy at the local level is assigned to the provincial assemblies through their Department of Natural Resources and Environment (DoNRE).

3.2.2 Environmental regulations/ standards

- Decree No. 38/2015/ND-CP dated April 24, 2015 on waste and scrap management;
- Decree No. 80/2014/ND-CP dated August 06, 2014 on the drainage and treatment of wastewater;
- Circular No. 36/2015/TT-BTNMT dated June 30, 2015 on hazardous waste management;
- 04/2015/TT-BXD Providing guidance on a number of articles of the government Decree No. 80/2014/ND-CP dated August 06, 2014 on drainage and wastewater treatment;
- Circular No. 08/2017/TT-BXD dated May 16, 2017 on construction waste management;
- QCVN 03-MT:2015/BTNMT - National Technical Regulation on the allowable limits of heavy metals in the soils;
- QCVN 05:2013/BTNMT - National Technical Regulation on Ambient Air Quality;
- QCVN 06:2009/BTNMT - National Technical Regulation on Hazardous Substances in Ambient Air;
- QCVN 07:2009/BTNMT - National Technical Regulation on Hazardous Waste Thresholds;
- QCVN 08-MT:2015/BTNMT - National Technical Regulation on Surface Water Quality;
- QCVN 09-MT:2015/BTNMT - National Technical Regulation on Ground water Quality;
- QCVN 14:2008/BTNMT - National Technical Regulation on Domestic Wastewater;
- QCVN 40:2011/BTNMT - National Technical Regulation on Industrial Wastewater;

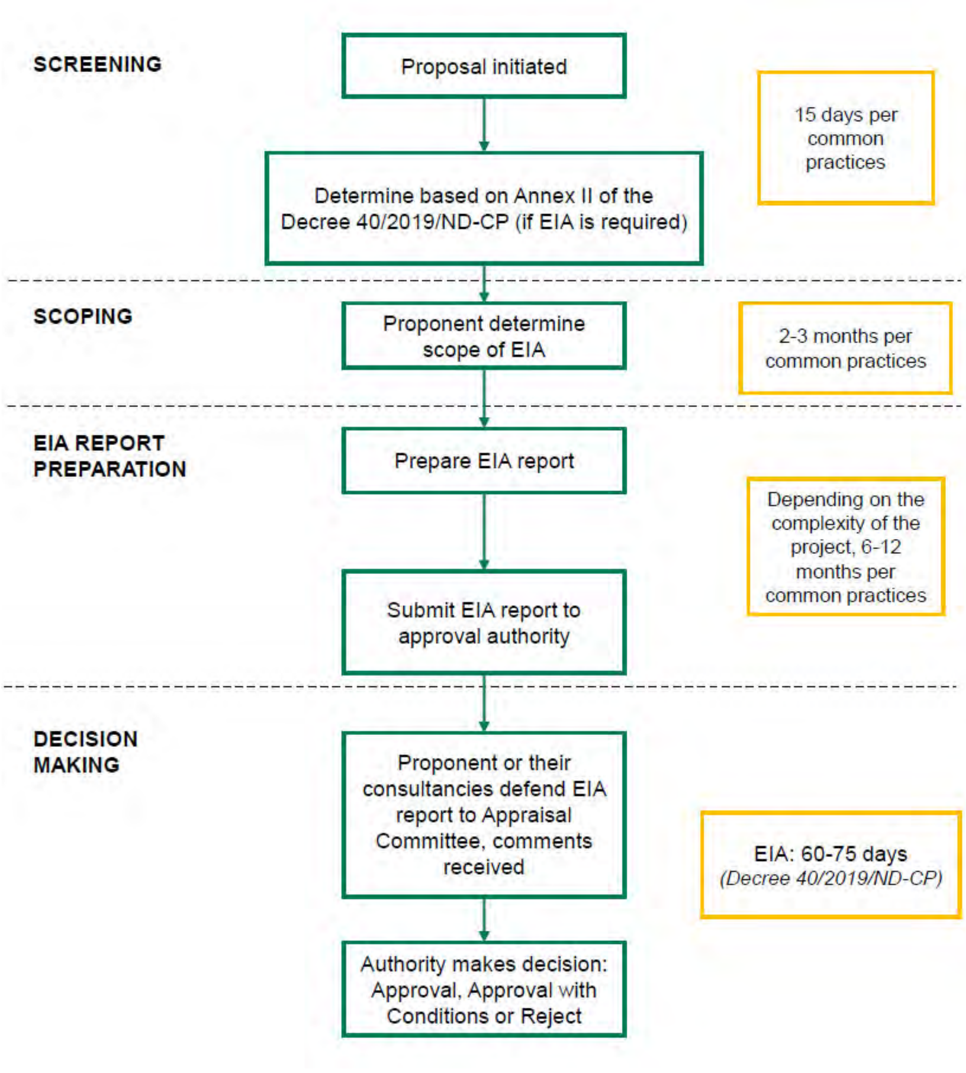
- QCVN 26:2010/BTNMT - National Technical Regulation on Noise.

3.2.3 Environmental Impact Assessment

The LEP states that all enterprises, as prescribed by the Government within the law, shall conduct a Strategic Environmental Assessment (SEA), an Environmental Impact Assessment (EIA) or Environmental Protection Plan (EPP) and obtain approval prior to the development and operation of a facility. The key EIA regulations are given below:

- LEP 2015;
- Decree No. 40/2019/ND-CP dated May 13, 2019 amending a number of articles of decrees that guiding the implementation of the Law on Environmental Protection;
- Decree No. 18/2015/ND-CP dated February 14, 2015 on environmental protection planning, SEA, EIA and EPP;
- Decree No. 19/2015/ND-CP dated February 14, 2015 detailing the implementation of a number of articles of the law on environmental protection;
- Circular No. 25/2019/TT-BTNMT dated 31 December, 2019 providing detailed regulations for Decree No.40/2019/ND-CP.

Vietnam's regulatory EIA process is shown in Figure 3.1 below.



Source: EIA, 2019

Figure 3.1 Structure of EIA process in Vietnam

3.2.3.1 Public Consultation

Under Decree No. 40/2019/ND-CP, public consultation is required to be conducted during EIA preparation. The Decree requires that project owners consult with People's Committees (PCs) of the communes, wards and towns located within proximity of the project area, as well as local organisations and the communities directly affected by the project. Information gleaned through research and community feedback mechanisms must be meaningfully considered in order to minimise the negative effects of the project on the natural environment, biodiversity and community health.

The PC of the commune where the project is expected to be located and organisations under direct impact of the project shall be consulted as per the following procedures:

- The project owner shall send EIA reports to the PC and organisations directly affected by the project, together with a written request for opinions;

- Within 15 working days from the date on which the EIA reports are received, the PC and organisations under the direct impact of the project shall send their response if they have concerns regarding the project.

Consultation with the community under the direct impact of the project shall be carried out in the form of community meeting co-chaired by the project owner and the relevant PC, together with the participation of representatives from the Vietnamese Fatherland Front of communes, socio-political organisations, socio-professional organisations, neighbourhoods and villages, and convened by the relevant PC. All opinions of delegates attending the meeting must be adequately and honestly recorded in the meeting minutes.

3.2.3.2 Information Disclosure

As required by the Decree No. 40/2019/ND-CP, the EIA shall be implemented with guidance of the Ministry of Natural Resources and Environment. The project proponent shall develop a plan to manage any environment affected by the project, based on the EIA report's recommendations, and have the plan available at the project site.

3.2.4 Law on Forestry 2017 and Law on Biodiversity 2008

The Law on Forestry 2017 regulates the rights and obligations of the forest owners'[3] organisations who are allocated forest in Vietnam for management. They must manage, protect, develop and use the forest sustainably in compliance with forest management regulations, provisions stated herein and other regulations required by relevant law. Those regulations stipulate that forest owners must:

- Comply with regulations on inspection of forest development;
- Return the forest that the State appropriates according to provisions stated herein;
- Conserve forest biodiversity, forest plants and animals;
- Ensure forest fire safety, prevent and eliminate forest pests;
- Facilitate management, inspection or actions against violations carried out by a competent state authority; and
- Fulfil financial obligations and other obligations.

3.2.5 National regulations on land acquisition, compensation, support and resettlement

The Land Law No. 45/2013/QH13, dated November 29, 2013 is the existing supreme legal regulation prescribing land use rights and land management in Vietnam, including those of land acquisition, compensation, support and resettlement.

3.2.5.1 National level regulations

- Law on Land No. 45/2013/QH13 (Land Law 2013);
- Decree No. 47/2014/ND-CP dated May 15, 2014 of the Government on regulating CSR Policies when land is acquired by the government;

[3] "forest owner" may be an organisation, household, individual or community that is allocated or leased out a forest by the State; allocated or leased out land for afforestation, forest regeneration or development; receives transfer of the forest, receives the forest as a gift or inherits the forest according to regulations of law

- Decree No. 43/2014/ND-CP dated May 15, 2014 of the Government detailing a number of articles of the Land Law 2013;
- Decree No. 44/2014/ND-CP dated May 15, 2014 of the Government prescribing Land Prices;
- Decree No. 01/2017/ND-CP dated January 06, 2017 of the Government on amendments to the Decrees on the implementation of the Land Law.
- Circular No. 30/2014/TT-BTNMT dated June 02, 2014 of MoNRE regulating documents on land allocation, land lease, land use change and land acquisition; and
- Circular No. 37/2014/TT-BTNMT dated June 30, 2014 of MoNRE detailing CSR policies when land is acquired by the government.

3.2.5.2 Provincial level regulations

- Decision No. 35/2014/QD-UBND dated December 19, 2014 on issuing the price list of land types in Ben Tre Province in the period of 2015-2019;
- Decision No. Decision No. 29/2019/QD-UBND dated August 12, 2019 on promulgating regulations on evaluation and classification of annual task completion levels for Departments, Boards, Branches and People's Committees of rural districts and cities.

A typical land compensation, support and resettlement process that complies with Vietnamese regulation includes the following main steps.

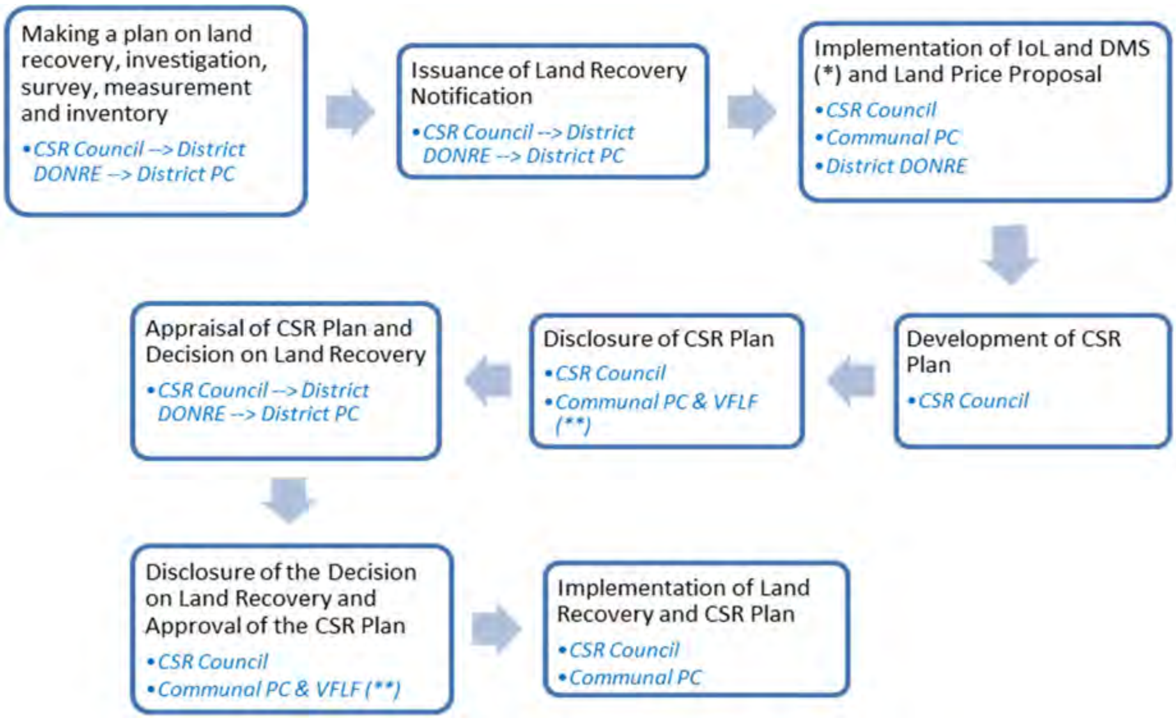


Figure 3.2 Land compensation, support and resettlement process required in Vietnam

Note: Inventory of Loss (IOL) and Detailed Measurement Survey (DMS) are conducted under the presence of members of the CSR Council and affected household's representative(s). IoL and DMS results will be disclosed to the Project affected persons (PAPs) for review and signature. All DMS results will be collected and sent back to the PC at provincial or district level who is tasked with the CSR process for signing and stamping.

3.2.6 National regulations on electricity

The Law on Electricity No. 28/2004/QH11 was approved by the National Assembly of the Socialist Republic of Vietnam at its 6th session on December 03, 2004, and Decree No. 14/2014/ND-CP dated February 26, 2014 stipulates in detail the implementation of The Law on Electricity, especially regarding electricity safety. Its key regulations are as follows:

- According to Article 12, for any 110kV lines outside cities and towns the distance from the highest point of the trees vertically to the height of the lowest conducting line at the state of maximum deflection must not be less than 3m. In any case where the trees are outside the safety corridor of overhead conducting lines and outside cities, towns, etc. the distance from any part of tree when the tree falls to any part of line must not be less than 1m. Rice, crops and plants must be planted at least 0.5m from the pole foundation and sleeper;
- According to Article 13, houses and constructional works are permitted to exist within the safety corridor of overhead conducting lines with voltage 110kV if they meet the following conditions: 1) Roof and walls must be made of non-combustible materials; 2) There must be no obstruction of the entry or exit of the house or works during testing, maintenance and replacement of parts of the high-voltage grid; 3) The distance from any part of the house or works to the nearest conducting line when the line is at the state of maximum deflection must not be less than 4m; 4) The electric field intensity must be less than 5kV/m at any point outside the house or works, and one meter from the ground and less than or equal to 1kV/m at any point inside the house and one meter from the ground.

Figure 3.3 Safety corridor required for 110kV transmission lines

Other regulations on electricity in Vietnam include:

- Circular No. 31/2014/TT-BCT dated October 02, 2014 regulating details on electrical safety;
- QCVN 25/2016/BYT – National Technical Regulation on Industrial Frequency Electromagnetic Fields – Permissible Exposure Level of Industrial Frequency Electromagnetic Fields in the Workplace; and
- QCVN 21:2016/BYT - National Technical Regulation on High Frequency Electromagnetic - Permissible Exposure Level of High Frequency Electromagnetic Intensity in the Workplace.

3.2.7 National regulations on grievances

Community grievances mechanisms in Vietnam are regulated by the Law on Grievance 2011. Generally, it stipulates that if a person has a grievance they must first submit it to local authorities at the lowest level (commune PC). If their grievance cannot be solved at that level, they are entitled to a second and third submission to authorities of higher administrative levels (i.e., district PC/Court and then provincial PC/ Court).

3.2.8 National regulations on Occupational Health and Safety (OHS)

Law No. 84/2015/QH13 on occupational safety and hygiene dated June 25, 2015, deals with occupational hygiene and safety assurance, policies and benefits for victims of occupational accidents and occupational diseases (hereinafter referred to as victims), the rights and obligations of organisations or individuals relating to occupational hygiene and safety, and the roles of regulatory agencies in occupational hygiene and safety.

In addition to this law, a number of Decrees, Circulars, Decisions and Standards have been issued relating to labour rights, health and safety. Decree No. 45/2013/ND-CP, dated May 10, 2013, provides provisions on the Labour Code on OHS. The employer has the responsibility to fully provide employees with the technical equipment required for labour safety and labour sanitation and to improve their working conditions wherever possible. The employee must follow regulations on labour safety, labour sanitation and the labour regulations of the business. All organisations and individuals associated with labour and production must observe national legislations on labour safety, labour sanitation and environmental protection.

3.2.9 National regulations on chemicals

Law No. 06/2007/QH12 sets national requirements on the classification, labelling, packaging, transportation, storage and use of chemicals. For any projects where chemicals listed in Appendix IV of Decree No. 113/2017/ND-CP are used onsite, the project owners are required to i) develop and implement chemical-related incident prevention and response plans and establish safety distances; or ii) develop and implement chemical-related incident prevention and response measures. A list of chemicals subject to conditional production or trading, chemicals restricted from production or trading, as well as banned chemicals were provided in Decree No. 77/2016/ND-CP and Decree No. 113/2017/ND-CP. Several circulars under these decrees guide project owners on labelling, packaging, storage and usage of chemicals. TCVN 5507:2002 stipulates the arrangements of hazardous chemical storage.

The Stockholm Convention was signed on 22/5/2001 and entered into force on 17/5/2004 with the aim of protecting human health and the environment from the risks of Persistent Organic Pollutants (POPs). Vietnam ratified the Stockholm Convention on 22/7/2002 and was the 14th party to the Convention. To implement the Stockholm Convention, Vietnam issued the National Implementation Plan for the Stockholm Convention, under Decision No. 184/2006/QD–TTg dated August 10, 2006 pertaining to safety management, minimisation and eventual elimination of POPs in Vietnam. The Decision meets both the requirements of the Stockholm Convention and Vietnam's goal of sustainable development.

3.2.10 National regulations on fire prevention and fire fighting

Law No. 27/2001/QH10 on Fire Prevention and Fighting mandates that every entity has responsibilities in fire prevention and firefighting and that the heads of agencies, organisations and households must support the organisation and regularly inspection of fire prevention and firefighting activities, within the ambit of their respective responsibilities. Fire prevention and firefighting plans for all developments listed in Annex IV of Decree No. 79/2014/ND-CP dated July 31, 2014 of the Government must be prepared, appraised, and approved by the relevant authorities before project construction. To have a fire prevention and firefighting plan approved, a dossier must be prepared and submitted to the Fire Police for appraisal and approval, as specified in Article 15 of Decree No. 79/2014/ND-CP.

3.2.11 Regulations on labour rights, health and safety

The main legislation in Vietnam relating to labour rights, health and safety is the Labour Code No. 10/2012/QH13 which was issued on 18 June, 2012 by the Vietnamese National Assembly. It stipulates that everyone has the right to work without discrimination based on sex, nationality, social background, beliefs or religion. Maltreatment of an employee and forced labour in any form are strictly forbidden. The government protects workers through its relevant legislation on employment, apprenticeship, labour contracts, collective labour accord, salary, work and break time, labour discipline, material liability, specific provisions for female workers, minors and other types of workers (elderly workers, disabled workers, highly-skilled professionals and technically-skilled workers, employees working for foreign organisations and individuals in Vietnam, foreigners working in Vietnam and Vietnamese employees working abroad, as well as other types of labour), social insurance, trade unions, and settlement of labour disputes.

3.3 International Regulatory Framework

The Applicable International Standards that will be adopted for this Project are as follows.

3.3.1 Equator Principles IV[4] (2019)

The Equator Principles (EPs) are the environmental and social risk management framework voluntarily adopted by 94 member financial institutions (Equator Principle Financial Institutions, EPFIs). They are primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. The Equator Principles were developed by private-sector banks and launched in June 2003. They were first revised in July 2006 and the latest update of the Principles which is known as EP IV, released on 18 November 2019. The effective date for EP IV on all mandated transactions will be 1 July 2020.

The EPs established voluntary principles for addressing environmental and social risks and issues in global project finance transactions, including adherence to IFC PS. The EPs are designed to serve as a benchmark for the financial industry to manage social and environmental risks in project financing. They apply to all new project financings with total project capital costs of USD $10 million or more, and across all industry sectors. The Principles (EPs 1 to 10) are:

- Principle 1: Review and Categorisation;
- Principle 2: Environmental and Social Assessment;
- Principle 3: Applicable Environmental and Social Standards;
- Principle 4: Environmental and Social Management System and Equator Principles Action Plan;
- Principle 5: Stakeholder Engagement;
- Principle 6: Grievance Mechanism;
- Principle 7: Independent Review;
- Principle 8: Covenants;
- Principle 9: Independent Monitoring and Reporting; and
- Principle 10: Reporting and Transparency.

Principle 1: Review and Categorisation. Under this principle, a Project is categorised to ensure that the required level of environmental and social due diligence is commensurate with the nature, scale and stage of the Project, and with the level of environmental and social risks and impacts. The CVX Project is a Category A project; this category applies to projects with potentially significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented.

Principle 2: Environmental and Social Assessment. All Category A Projects are required to conduct an assessment process to address the relevant environmental and social risks and impacts of the proposed Project. The potential adverse Human Rights impacts and climate change risks are expected to be included as a part of the assessment process. In addition, the United Nations Guiding Principles on Business and Human Rights (UNGPs) should be referred to when assessing Human Rights risks and impacts. A Climate Change Risk Assessment is required for all Category A Projects and will include consideration of relevant physical risk aligned with Climate Physical Risk and Climate Transition Risk categories of the Task Force on Climate-related Financial Disclosures (TCFD).

[4] https://equator-principles.com/wp-content/uploads/2019/11/The-Equator-Principles-November-2019.pdf

The EP4 notes that quantification of Scope 1[5] and Scope 2[6] emissions GHG emissions will be conducted in accordance with internationally recognised methodologies and good practice, for example, the GHG Protocol.

The EP IV notes that for all Projects, in all locations, when combined Scope 1 (direct) and Scope 2 (indirect) emissions are expected to exceed **100,000 t CO_2-e** annually, an alternatives analysis will be conducted to evaluate less GHG intensive alternatives.

In accordance with Annex A of the EP IV, the alternatives analysis (see Chapter 5 of the ESHIA) requires the evaluation of technically and financially feasible and cost-effective options available to reduce project-related GHG emissions during the design, construction and operation phases of the Project. For Scope 1 emissions, this analysis includes consideration of alternative fuel or energy sources if applicable.

Principle 3: Applicable Environmental and Social Standards. This principle requires that the Project complies with relevant host country laws, regulations and permits that pertain to environmental and social issues. The principle also brings into consideration compliance with the IFC PS on Environmental and Social Sustainability and the World Bank EHS Guidelines.

Principles 4 to 10 apply to all Category A Projects.

3.3.2 IFC's Performance Standards on Environmental and Social Sustainability (2012)

In April 2006, the IFC, a member of the World Bank Group, released a set of Performance Standards (PS) based upon the original World Bank Group Safeguard Policies, which recognised further the specific issues associated with private sector projects. The IFC PS have been broadened to include issues such as greenhouse gases, human rights, community health, and safety and security. A revised set of PS came into force on January 1, 2012. The complete list of IFC PS is provided Figure 3.4 and more details can be found on the IFC website[7].

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[5] Emissions are direct GHG emissions from the facilities owned or controlled within the physical Project boundary.

[6] Emissions are indirect GHG emissions associated with the off-site production of energy used by the project

[7] http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_External_Corporate_Site/IFC+Sustainability/Sustainability+Framework/Sustainability+Framework+-+2012/Performance+Standards+and+Guidance+Notes+2012/

Source: IFC, 2019

Figure 3.4 IFC Performance Standards

3.3.3 World Bank General EHS Guidelines (2007)

Supplementing the IFC PS are the General EHS Guidelines that were released in April 2007. The EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). They are categorised by environment, occupational and community health and safety, and construction and decommissioning. The General EHS Guidelines are designed to be used together with the relevant Industry Sector EHS Guidelines, which provide guidance to users on EHS issues within specific industry sectors.

3.3.4 World Bank EHS Guidelines for Electric Power Transmission and Distribution (2007)

The EHS Guidelines for Electric Power Transmission and Distribution include information relevant to power transmission between a generation facility and a substation located within an electricity grid, in addition to power distribution from a substation to consumers located in residential, commercial, and industrial areas.

The EHS Guidelines for Electric Power Transmission and Distribution are organised in the following sections:

- Section 1.0 — Industry-Specific Impacts and Management
- Section 2.0 — Performance Indicators and Monitoring
- Section 3.0 — References and Additional Sources
- Annex A — General Description of Industry Activities

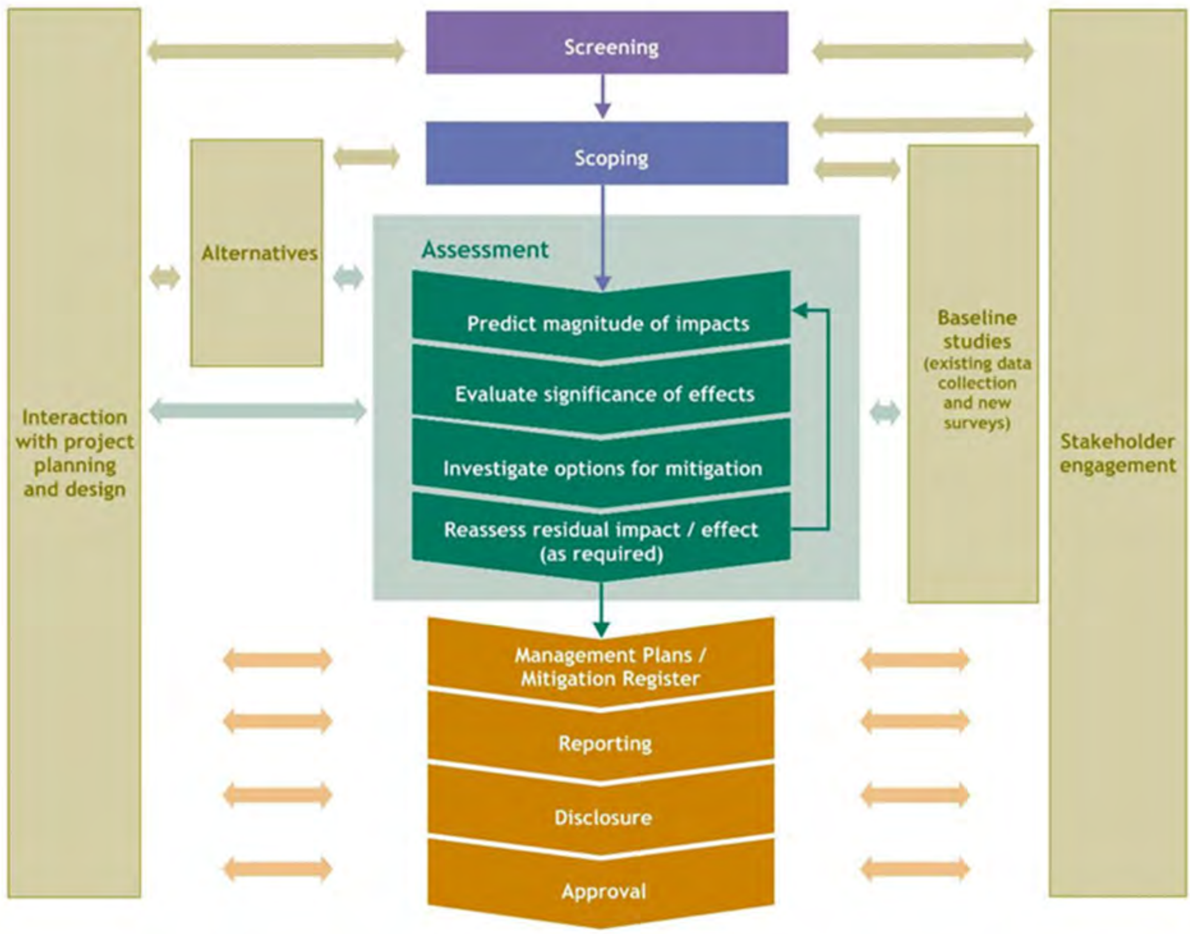
3.3.5 World Bank EHS Guidelines for Wind Energy

The EHS Guidelines for Wind Energy include information relevant to environmental, health, and safety aspects of onshore and offshore wind energy facilities. It should be applied to wind energy facilities from the earliest feasibility assessments, as well as from the time of the environmental impact assessment, and continue to be applied throughout the construction and operational phases.

4. IMPACT ASSESSMENT METHODOLOGY

4.1 Introduction

This section presents the methodology used to conduct this ESIA, which follows the approach illustrated in Figure 4.1. This ESIA has been undertaken following a systematic process that: evaluates the potential impacts the Project could have on aspects of the physical, biological, social/socio-economic and cultural environment; identifies preliminary measures that the Project will take to avoid, minimise/reduce, mitigate, offset or compensate for potential adverse impacts; and identifies measures to enhance potential positive impacts where possible.



Source: ERM, 2019

Figure 4.1 Process for producing an ESIA

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.

4.2 Screening

At the initial stage of this ESIA, preliminary information was provided to aid in the determination of what legal and other requirements should be applied to the Project. This step was completed utilising a high-level description of the Project and its associated facilities.

4.3 Scoping

Scoping has been undertaken to delineate the potential Area of Influence for the Project (and thus the appropriate Study Area), and to identify potential interactions between the Project and resources/receptors in the Area of Influence (i.e., identifying the potential impacts that could result from these interactions). It also helps in developing and selecting alternatives to proposed action and in identifying the issues to be considered in this ESIA.

Table 4.1 presents the resources/receptors considered in the scoping stage, together with the changes that might indicate a potential Project-related impact.

The content of this ESIA report has been prepared according to the output from the scoping process, which is further detailed in Chapter 5.

Table 4.1 Resources/receptors and potential impacts considered in scoping

Resources/receptors	Changes that may indicate potential impacts
Environmental	
Geology	Changes to geology, geomorphology, topography
Soil	Changes to physical and chemical properties and soil ecology
Surface water	Changes to physical, chemical or biological quality of rivers, lakes, and other surface water bodies. Introduction of exotic species; changes in habitat quality, abundance, diversity. Effluent discharge
Marine water	Changes to physical, chemical or biological quality of seas. Introduction of exotic species; changes in habitat quality, abundance, diversity. Effluent discharge
Groundwater	Contamination of shallow or deep groundwater resources. Change in groundwater resources
Sediments	Sea/River/waterbed morphology, physical and chemical properties, benthic organisms
Fisheries	Changes in fisheries productivity
Vegetation	Changes to vegetation population, health, species abundance and diversity, and impact on endangered and economic species. Food chain effects

Resources/receptors	Changes that may indicate potential impacts
Wildlife	Changes to wildlife assemblages, impact on endangered and economic species, food chain effects
Air	Emissions of NO_x, SO_x, PM, CO, VOC, greenhouse gases (CO_2, CH_4, and N_2O), ozone and TSP
Noise	Change in noise levels
Aesthetics	Physical presence of facilities, increased night time light
Waste	Generation of wastes – hazardous and non-hazardous
Social / Socio-economic	
Population and physical displacement	Changes in total population, gender ratio, age distribution. Physical displacement from residence as a result of Project land acquisition or activities.
Social and cultural structure	Disruption in local authority and governance structure, change in social behaviours, alterations to social and cultural networks, intra and inter-ethnic conflict.
Economy and employment	Changes in national/local economy, employment, standard of living, occupations.
Resource ownership and use	Temporary or permanent restriction for accessing or using land or water, changes in livelihood activities based on natural resources; changes in ownership of such resources.
Cultural resources	Physical disturbance of shrines, burial grounds, archaeological resources or other desecration or change in access to cultural resources, rituals or celebrations carried out in their premises.
Education and skills	Change in availability or quality of education or skills provision, supply and demand of certain skill sets, etc.
Infrastructure and public services	Improvement or pressure on existing urban/rural infrastructure or services including: transportation, power, water, sanitation, security, waste handling facilities, etc.
Community Health and Safety	
Environmental change	Potential degradation in air quality (eg NO_x, SO_x, VOC, CO, PM), contamination of surface water and potable ground water, increased vibration and noise, increased night time light beyond acceptable limits, changes to the visual environment.
Communicable and non-communicable diseases	Change in incidence and /or prevalence of communicable and non-communicable diseases or disease causing factors.
Vector borne diseases	Changes in the incidence and or prevalence of vector borne diseases, the density of these vectors and their breeding grounds.

4.4 Project Description

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 Chapter 2 of this ESIA Report.

4.5 Baseline Conditions

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 baseline characterisation is reported in Chapter 7 and Chapter 8 of this Report.

4.6 Stakeholder Engagement

An effective ESIA Process requires engagement with relevant stakeholders throughout the key stages. This assists in understanding stakeholder views on the Project and in identifying issues that should be taken into account in the prediction and evaluation of impacts.

Details of the Stakeholder Engagement activities undertaken for this Project to date are presented in Chapter 6 of this Report.

4.7 Impact Assessment (IA)

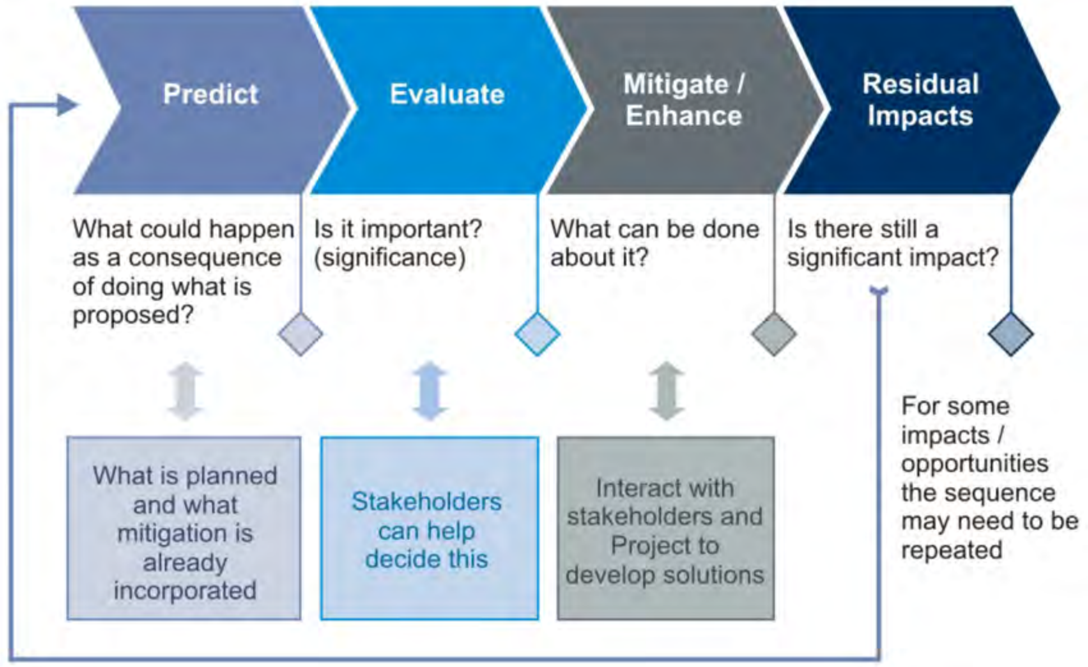
Impact identification and assessment starts with scoping and continues throughout the remainder of the ESIA Process. The main ESIA steps are summarised below and comprise of:

Potential Impact Identification: 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;

Management and Mitigation 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.



Source: ERM, 2019

Figure 4.2 IA process

4.8 Prediction of Impacts

Prediction of impacts is essentially an objective exercise to determine what is likely to happen to the environment as a consequence of the Project and its associated activities. From the potentially significant interactions identified during the Scoping phase, 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.

4.9 Evaluation of Impacts

Once the identification 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 4.2

Table 4.2 Impact characteristic terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the potential impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The “reach” of the potential impact (e.g., confined to a small area around the Project footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is potentially affected.	Temporary Short-term Long-term
Scale	The size of the potential impact (e.g. the size of the area with the potential to be damaged or impacted, the fraction of a resource that could potentially be lost or affected, etc.)	[no fixed designations; intended to be a numerical value or a qualitative description of “intensity”]
Frequency	A measure of the constancy or periodicity of the potential impact.	[no fixed designations; intended to be a numerical value or a qualitative description]

The definitions for the type designations are shown in Table 4.3. Definitions for the other designations are resource/receptor-specific, and are discussed in the resource/receptor-specific IA chapters presented later in this ESIA.

Table 4.3 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).

Type	Definition
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 camp followers 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 4.4.

Table 4.4 Definitions for likelihood designations

Likelihood	Definition
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 IA 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 to each impact. Impact significance is designated using the matrix shown in Table 4..

Table 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. The context for what the various impact significance ratings signify is presented in the box below.

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 helps avoid a situation where an impact is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls.

Context of Impact Significance

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 maybe 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.

4.10 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, work camps 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).

4.11 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 IA steps discussed above, considering the implementation of the proposed mitigation and enhancement measures.

4.12 Management, Monitoring and Audit

The final stage of the ESIA Process is defining 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; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted.

A Register of Commitments, which is a summary of all actions the Project Proponent has committed to executing, with respect to environmental/social/health performance for the Project, is also included as part of this Report. The Register of Commitments includes mitigation measures, compensatory measures and offsets, and management and monitoring activities.

5. ESIA SCREENING AND SCOPING

5.1 Screening Result

The requirements for whether an ESIA is required under IFC PS depends upon the nature and complexity of the Project and the prediction of impacts that are likely to occur. As discussed in Section 3.3.1these are embodied within EP – Review and Categorisation, and are categorised as Category A, Category B or Category C. Due to the scale of the Project and potential environmental and social impacts; this particular Project would likely be classified as a **Category B Project**. This is primarily determined on the basis of the following baseline information and that the potential limited adverse environmental and social impacts are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures. The rationale for selecting Category B for the Project includes:

- The closest wind turbines are more than 1km from the environmental and social receptors;
- Limited risk to households from noise, electromagnetic interference and resettlement/livelihood issues
- Residual risks are largely reversible and will be mitigated to ensure lower impacts to receptors
- The impacts are generally site-specific and impacts will be contained within the Project boundary

5.2 Scoping

Scoping has been undertaken to identify the potential Area of Influence for this Project (and thus the appropriate Study Area), to identify potential interactions between the Project and resources/receptors in the Area of Influence and the impacts that could result from these interactions, and to prioritize these impacts in terms of their likely significance.

This stage is intended to ensure that the ESIA focuses on those issues that are most important for design, decision-making and stakeholder interest.

The findings of the scoping exercise are reported in this Chapter. Table 5.1 presents the resources/receptors considered during scoping.

Table 5.1 Resources/receptors considered during scoping

Resources/Receptors	Impacts
Environmental	
Marine water	Changes to physical, chemical or biological quality of seawater
Terrestrial vegetation	Changes to vegetation population, health, species abundance and diversity and impact on endangered and economic species, food chain effects
Marine fauna	Disturbs marine fauna species
Avifauna species	Impacts on endangered and economic species, food chain effects
Air	Emissions of NO_x, SO_x, PM, CO.
Noise	Changes in noise level
Waste	Generation of wastes – hazardous and non-hazardous
Social / Socio-economic	

Resources/Receptors	Impacts
Social and cultural structure	Disruption in local authority and governance structure, change in social behaviours, alterations to social and cultural networks, intra and inter-ethnic conflict
Economy and employment	Change in national/local economy, employment, standard of living, occupations
Resource ownership and use	Temporary or permanent displacement from land or water based livelihood activities; changes in ownership of such resources
Cultural resources	Physical disturbance of shrines, burial grounds, archaeological resources or other desecration of the aforementioned cultural resources
Education and skills	Change in availability or quality of education or skills provision
Infrastructure and public services	Improvement or pressure on existing urban/rural infrastructure or services e.g. transportation, power, water, sanitation, waste handling facilities
Community Health	
Communicable and non-communicable diseases	Change in incidence and /or prevalence of communicable and non-communicable diseases or disease causing factors
Vector borne diseases	Changes in the incidence and or prevalence of vector borne diseases, the density of these vectors and their breeding grounds
Sexually Transmitted Diseases (STDs)	Changes in the incidence and /or prevalence of STDs and the factors that contribute to this (e.g. external workforce, transport routes)
Nutritional status	Changes to nutritional status and food security
Health care/recreational facilities	Changes in availability of and access to health care and recreational facilities including green space
Psychosocial /lifestyle factors	Drug use/abuse, prostitution, communal violence, crime, suicide and depression; changing expectations of quality of life

5.3 Scope of the Assessment

This ESIA covers the following project elements, which were described in detail in Section 5.2 of this chapter:

- WTG transportation and construction;
- WTG foundation establishment, WTG installation, WTG site access;
- Substation and transmission line;
- WTG operation, maintenance; and
- Supporting facilities such as the construction laydown area and office facilities.

5.4 The Project Area of Influence (AoI)

Under IFC PS1's definition, an AoI would include the physical boundary of the Project's activities as the core area, and a wider buffer zone covering access to the Project and any natural or community receptors which may be affected by the Project. It should be noted that the AoI for a particular resource/receptor may vary depending on the nature of the change caused by the Project activities and the type of effect being considered, but in each case it is defined as including the entire area likely to experience significant impacts. As such, the AoI will be discussed in terms of the specific environmental/ social aspects (e.g., biodiversity, social, noise) being impacted.

For this Project, the appropriate AoI has been identified to cover construction and operation phase of the Project facilities as discussed in Section 2.4 with the following areas:

- Project AoI of noise impact should be determined within 2,000m of any turbines;
- Project AoI of shadow flicker impact should be determined as 10 times of rotor diameters from each turbine location;
- Project AoI of blade throw should be determined as 1.5 times of turbine height (hub height and rotor radius); and
- Project AoI of biodiversity is the area within a 1,000m radius of the Project area to be assessed to define habitat values in the immediate project vicinity where species may regularly dwell

Area of Influence of the Project is presented in Figure 5.1

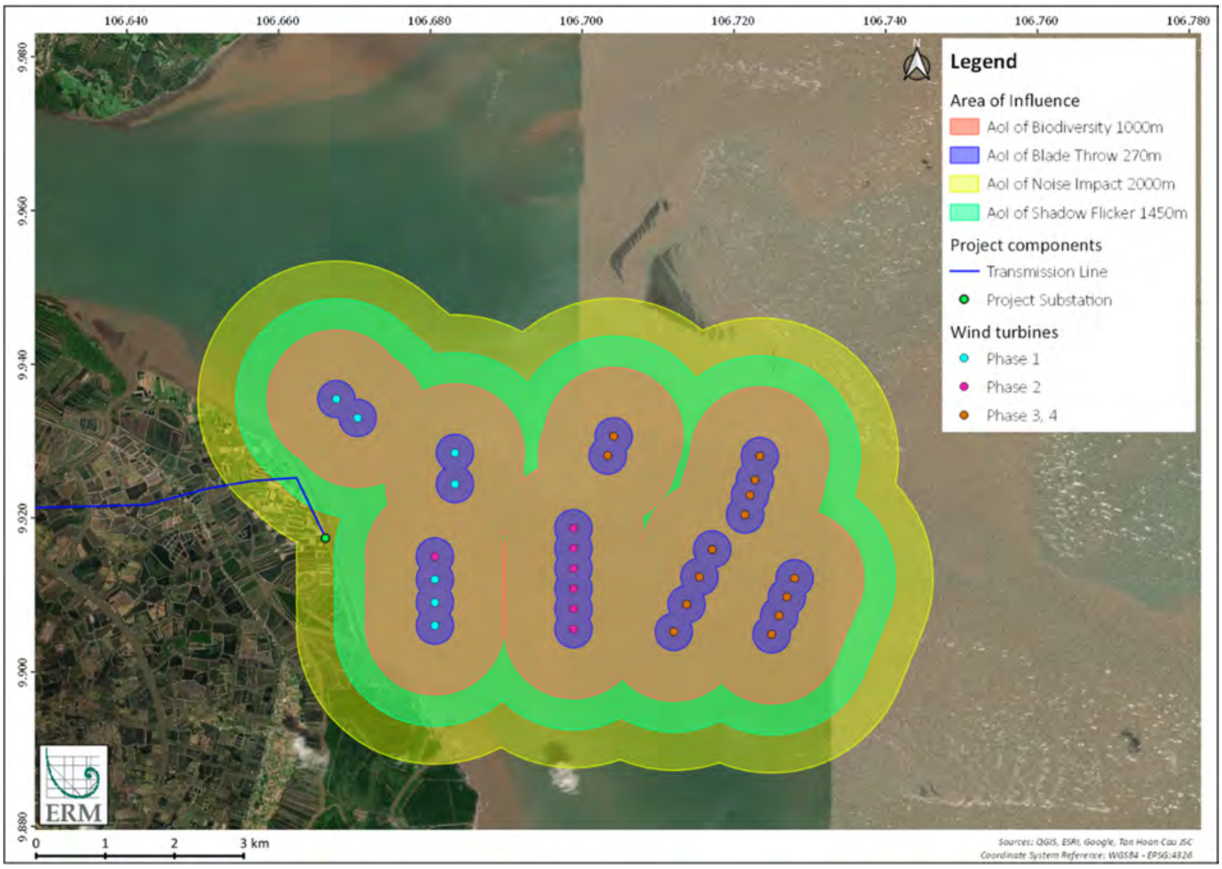


Figure 5.1 Project's Area of Influence

5.5 Scoping Matrix

Potential impacts have been identified through a systematic process whereby the features and activities (both planned and unplanned) associated with the pre-construction, construction, and operation of the Project have been considered with respect to their potential to interact with resources/receptors. Potential impacts have each been classified as one of three categories, listed as follows:

- **No interaction:** where the Project is unlikely to interact with the resource/receptor (e.g., wholly terrestrial projects may have no interaction with the marine environment);
- **Interaction likely, but not likely to be significant:** where there is likely to be an interaction, but the resultant impact is unlikely to change baseline conditions in an appreciable/detectable way; and
- **Significant interaction:** where there is likely to be an interaction, and the resultant impact has reasonable potential to cause a significant impact on the resource/receptor.

As a tool for conducting scoping, the various Project features and activities that could reasonably act as a source of impact were identified, and these have been listed down the vertical axis of a Potential Interactions Matrix. The resources/receptors relevant to the Baseline environment have been listed across the horizontal axis of the matrix. Each resulting cell on the Potential Interactions Matrix thus represents a potential interaction between a Project feature/activity and a resource/ receptor. The completed Potential Interactions Matrix is presented in Table 5.2.

Those cells that are coloured white are 'scoped out' of further consideration in the IA Process. Those interactions that are grey are also 'scoped out', but the IA report includes a discussion that presents the evidence base (e.g., past experience, documented data, etc.) used to justify the basis upon which this decision was made. Those interactions that are shaded black are retained for further consideration in the IA Process.

Table 5.2 Potential Interaction Matrix

PROJECT PHASES AND ACTIVITIES	Environmental Resources								Socio-Economic and Health Resources							
	Air Quality	Noise	Hydrology, soil and sediment and Erosion	Marine Water Quality	Freshwater Quality	Terrestrial Fauna and Flora	Marine Fauna	Avifauna	Infrastructure and Public Services	Fisheries	Land Use	Land and Marine Traffic	Tourism	Loss of Visual Amenity	Socio-Economy	Community Health and Safety
PRE-CONSTRUCTION PHASE																
Land acquisition																
CONSTRUCTION PHASE																
Nearshore activities																
Transportation of equipment, workers and materials	■	■										■				■
WTG installation and piling			■	■			■			■		■				
Vessel presence							■			■		■				

PROJECT PHASES AND ACTIVITIES	Environmental Resources								Socio-Economic and Health Resources							
	Air Quality	Noise	Hydrology, soil and sediment and Erosion	Marine Water Quality	Freshwater Quality	Terrestrial Fauna and Flora	Marine Fauna	Avifauna	Infrastructure and Public Services	Fisheries	Land Use	Land and Marine Traffic	Tourism	Loss of Visual Amenity	Socio-Economy	Community Health and Safety
Waste and wastewater management																
Hazardous materials storage and handling																
Labour influx																
Onshore activities																
Land clearance																
Construction activities																

PROJECT PHASES AND ACTIVITIES	Environmental Resources								Socio-Economic and Health Resources							
	Air Quality	Noise	Hydrology, soil and sediment and Erosion	Marine Water Quality	Freshwater Quality	Terrestrial Fauna and Flora	Marine Fauna	Avifauna	Infrastructure and Public Services	Fisheries	Land Use	Land and Marine Traffic	Tourism	Loss of Visual Amenity	Socio-Economy	Community Health and Safety
Transportation of equipment, workers and materials																
Waste and wastewater management																
Hazardous materials storage and handling																
Labour influx																
OPERATION PHASE																
WTG operation and inspection and maintenance																

PROJECT PHASES AND ACTIVITIES	Environmental Resources								Socio-Economic and Health Resources							
	Air Quality	Noise	Hydrology, soil and sediment and Erosion	Marine Water Quality	Freshwater Quality	Terrestrial Fauna and Flora	Marine Fauna	Avifauna	Infrastructure and Public Services	Fisheries	Land Use	Land and Marine Traffic	Tourism	Loss of Visual Amenity	Socio-Economy	Community Health and Safety
Waste, emissions and discharge generation, handling and disposal																
UNPLANNED EVENTS																
Spillage of fuel, oil, chemicals and hazardous materials																
Vehicle/vessel accident																
Blade throw																

6. STAKEHOLDER ENGAGEMENT

6.1 Stakeholder engagement during EIA Process

As required by Vietnam EIA regulations, on 01 November 2018, the Project organized multiple public consultation sessions for the draft local EIA report at affected areas where the Project is located following the below approach:

- Sending letters soliciting opinions regarding Project's potential environmental impacts from People's Committee (PC) of Thanh Hai Commune; and
- Arranging public consultation meeting at the Thanh Hai Commune PC' offices with participation of local authorities, socio-political professional organizations and affected communities surrounding the Project area.

The purposes of these public consultation sessions were to obtain gain (i) opinions on negative impacts by the Project to natural environment, socio-economy and community health, (ii) opinions on mitigation measures to reduce these impacts, (iii) recommendations of community to Project Owner.[8]

Detailed comments of local community and authorities together with feedbacks from Project Owner are provided in Table 6.1.

[8] Project's Environmental Impact Assessment Report, July 2019

Table 6.1 Opinions and Feedbacks during local EIA process

<table>
<tr><th colspan="2">Opinions of Stakeholders</th><th>Feedbacks from Project Owner</th></tr>
<tr><th>Thanh Hai Commune PCs</th><th>Community</th><th></th></tr>
<tr>
<td>■ On negative impacts of the project on the natural and socio-economic environment: Thanh Hai Commune PCs agree with the environmental impacts in stages such as site clearance, construction and activities relating to environmental aspects including air, soil, water that the project owner mentioned.
■ Regarding measures to impacts mitigation on the natural environment, socio-economic and public health of community: The project owner has introduced measures to minimize the impact on the phases.
Project Owner is recommended to:
■ The People's Committee requests the project owner to implement measures to overcome environmental incidents if any.
■ It is suggested that the project owner must regularly collaborate with the local management agencies in the construction process to minimize the negative impacts on the production of the people in the Commune.</td>
<td>■ Community worries about negative affect of project on clams and aquatic species in the sea because the clam farm located 2km from the coast.
■ The project owner shall consider the effect on the farming activities.
■ During the construction phase, transporation properly impacts on the routes of fishing boats and clam-keeping ships of the two cooperatives. The construction unit is requested to build a bridge to conduct site surveys so as not to affect clam fields.</td>
<td>■ The wind turbines are located offshore, about 2.7 km from the shore, thus it does not affect the two clam cooperatives, crop land and seafood fishing, does not affect the aquatic species in the project area. The project owner will consider the approriate location of the bridge so that it does not affect the clam field of the two cooperatives.
The Project Owner also has committed to the following measures:
■ Implement measures to control and minimize impacts during project implementation according to the stages mentioned.
■ Collaborate with local management and community in the project area during the project phases to minimize the environmental impact and the economic impact.</td>
</tr>
</table>

6.2 Stakeholder Engagement during ESIA Process

6.2.1 Meeting with Authorities

On 23, 24 and 26 September 2019, THCBT and the Project's consultant – ERM Vietnam Company Limited (ERM), have conducted five formal meetings with regulatory bodies from district and commune levels to:

- Follow-up the current socio-economic conditions and future socio-economic development plans of the Project area;
- Obtain their opinions and concerns on the development of the Project; and
- Inform and seek support from local authorities about a social survey for baseline data collection performed in September 2019.

The following authorities were involved in the meetings with THCBT and ERM:

1. Land Fund Development Center of Thanh Phu District;
2. People's Committee of Thanh Hai Commune;
3. People's Committee of An Dien Commune;
4. People's Committee of Binh Thanh Commune; and
5. People's Committee of An Thuan Commune

A summary of discussions, concerns, and recommendations generated in the course of Project's engagement with authorities during ESIA process is provided in Table 6.3 below. Corresponding minutes of meetings with detailed discussion as well as full lists of meeting participants are attached in Stakeholder Engagement Plan.

6.2.2 Engagement with local communities for Baseline Data and Perception

Simultaneously with authority meetings, the Project team and ERM organized multiple engagement activities at the local community level from 23, 24 and 26 September 2019 mainly to collect the updated socio-economic baseline data and local communities' opinions and concerns on the development of the Project. The consultations were in the form of focus group discussions and household surveys as discussed below.

Key informant interviews (KIIs)

The KIIs were conducted with People's Committees of the four communes as mentioned in Table 6.2. Meetings with the People's Committees of An Nhon and An Quy Communes have not been made due to the authorities' unavailability. The KIIs were semi-structured with major questions prepared in advance in the form of open-ended questions and a statistic data table. The questions concentrated on general information about the community, infrastructure, ethnicity, vulnerable groups, education, livelihoods and employment, health, cultural heritage and perceptions about the Project. Table 6.2 provides a list of authorities involved in the KIIs and the number of KIIs that took place.

Table 6.2 List of KII participants and number of KIIs

Province	District	Commune	Participants	Number of KIIs
Ben Tre	Thanh Phu	Thanh Hai	Representatives of the Commune PC	1
		An Dien	Representatives of the Commune PC	1
		An Thuan	Representatives of the Commune PC	1

Province	District	Commune	Participants	Number of KIIs
		Binh Thanh	Representatives of the Commune PC	1
		An Quy	Representatives of the Commune PC	1
Total				**5**

Household Surveys

In order to understand the socio-economic baseline including current livelihoods, income, health profile and the awareness and concerns of the affected communities about the Project, face-to-face interviews were undertaken for 203 households living in Thanh Hai, An Dien, An Nhon, An Quy, An Thuan and Binh Thanh Communes, Thanh Phu District. Primary data from the household surveys were used to form the socio-economic baseline section of the ESIA report and to propose livelihood restoration and community development plans of the Project.

Topic of engagement and feedback including concerns and suggestions from the KIIs and Houshold survey are summarised in Table 6.3

Table 6.3 Summary of Stakeholder Engagement Activities during ESIA Process

Interviewed Group	Organizations	Topics covered in the interview meetings
Commune authority	PCs of: ■ An Dien ■ An Thuan ■ Binh Thanh ■ Thanh Hai	■ Update the authority with Project development progress; ■ Obtain to-date socio-economic data/information including infrastructure and public services development of the Commune, health, livelihoods and employment of the people in the Commune; and ■ Gain feedback/perceptions on the Project development. ■ Gain feedback/perceptions of the process of land acquisition and site clearance for the components of the Project.
Associations	Cooperative Head Fishery Association Head	The questionnaire of the KII interview was designed to collect the following: ■ The history and organizational structure; ■ Operation and business activities; ■ Financial situation; ■ Future-oriented development; and ■ Awareness on the development of the Project and its engagement activities.
Household	Thanh Hai, An Dien, An Nhon, An Quy, An Thuan and Binh Thanh	The questionnaire of the household interview was designed to collect the following: ■ Family status and demographics;

Interviewed Group	Organizations	Topics covered in the interview meetings
	Communes, Thanh Phu District	■ Vulnerable status (i.e. who by virtue of gender, ethnicity, age, physical or mental disability, economic disadvantage, or social status that may be more adversely affected by the Project development); ■ Livelihoods and employment (i.e. their livelihoods/employment); ■ Household income and expenditure; ■ Housing and land (i.e. land use and land tenure); ■ Education background (i.e. education level of members in the surveyed households); ■ Health status/profile and health care practice; ■ Access to and availability of public facilities (i.e. electricity, water supply, etc.); and ■ Awareness on the development of the Project and its engagement activities.

6.2.3 Concerns from Interviewed Authorities and Household

The perceptions of local authorities and households regarding environmental, health, social and economic issues relating to the Project collected from the aforementioned engagement activities are summarized in Table 6.4

Table 6.4 Opinions from Stakeholder Engagement during ESIA Process

Opinions	Thanh Phu LFDC	An Dien Commune		An Thuan Commune		Binh Thanh Commune		Thanh Hai Commune	
		PC	Community	PC	Community	PC	Community	PC	Community
Environment									
■ Agree with the project's presence and development	✓	✓	✓	✓	✓		✓		✓
■ Adverse impact to local environment, marine biodiversity, and seawater during construction and operation phases					✓			✓	✓
■ Impact to quality of groundwater resources									
■ No concern						✓			
Health									
■ Impact to people's health due to water contamination caused by Project's activities									
■ No concern	✓	✓		✓		✓			
Social, economic, cultural issues									

Opinions	Thanh Phu LFDC	An Dien Commune		An Thuan Commune		Binh Thanh Commune		Thanh Hai Commune	
		PC	Community	PC	Community	PC	Community	PC	Community
■ Prioritization of local employment, service, training and financial support to boost local benefits and community welfare	✓			✓				✓	✓
■ Developing local infrastructure system	✓								
■ Concerns on land acquisition compensation, livelihood transition issues and support for affected people and organizations	✓	✓		✓		✓		✓	✓
■ Concern on potential impact to existing agriculture and aquaculture farming activities of local people and organizations				✓				✓	✓
Technical issues									
■ No concern	✓	✓		✓		✓		✓	✓

6.2.4 Recommendation from Interviewed Authorities and Households

The key topics arising from the above meetings were in relation to queries regarding how the Project would benefit local communities in terms of employment opportunities and trainings for affected people; how it would affect aquaculture farming habitats; and how the development would affect the environment. During the engagement, Project team emphasized that the ESIA process had been looking at all potential effects of the Project on environmental and social aspects; the results of stakeholder engagement activities would be used to influence the design of the project and mitigation measures would be recommended to minimize any potentially negative effects. Summary of recommendations from interviewed parties is outlined in Table 6.5 below; further details are provided in the Stakeholder Engagement Plan.

Table 6.5 Recommendations from Stakeholder Engagement during ESIA Process

	Thanh Phu LFDC	Communes PC	Community
Environment			
■ Comply with all relevant regulatory requirements on environmental protection to minimize potential environmental issues during Project's construction and operations phases		✓	✓
Health			
■ No recommendation	✓	✓	✓
Social, economic, cultural issues			
■ Priorities local recruitment and vocational training program to support local improvement		✓	✓
■ Conduct social management programs in relation to land acquisition to support project affected people		✓	✓
■ Ensure security and safety during construction;		✓	
■ Engage relevant stakeholders to increase awareness of Project's development plan, construction schedule and potential impacts in a timely manner		✓	✓
Technical issues			
■ Manage activities of operation phase to ensure it does not affect local environment		✓	

7. ENVIRONMENTAL BASELINE

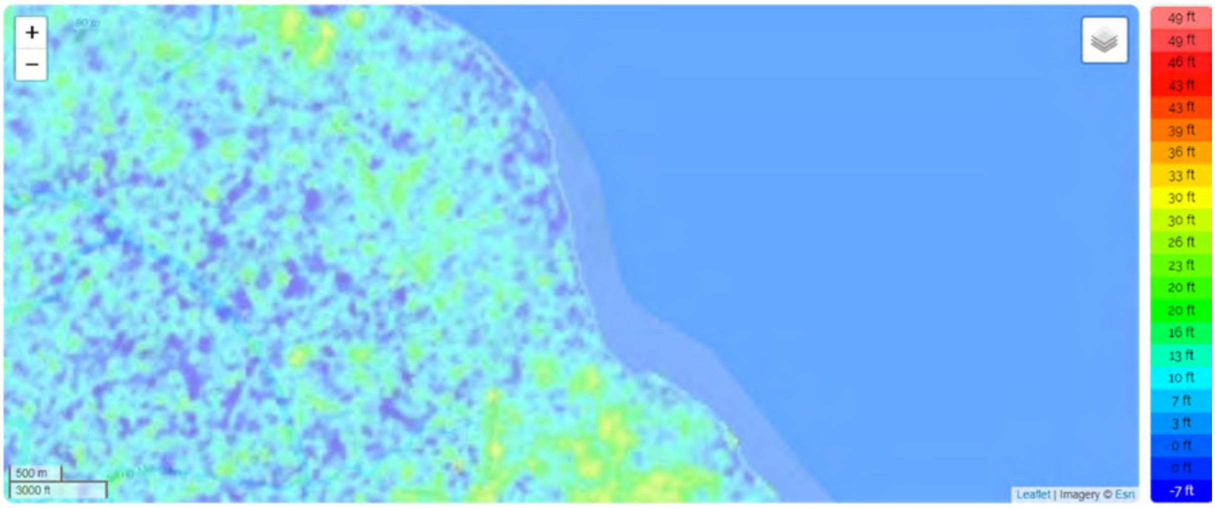
7.1 Introduction

This section provides a detailed description of the of the Project area's environmental baseline. To establish the environmental baseline, data is collected for each environmental factor. For this chapter, environmental data was collected from desktop analysis from scientific reports or collected through different primary sampling methods.

The environmental factors which data was collected during the conduct of local EIA and presented in this chapter include: ambient air quality, water quality, soil and sediment. Whilst noise and biodiversity were conducted by ERM in order to meet applicable international standards and requirements. The baseline data is the primary means of assessing the environmental impact of the proposed Project on the receiving environment. The physical environmental baseline data was obtained during September and October of 2018 by local EIA consultant.

7.2 Topography

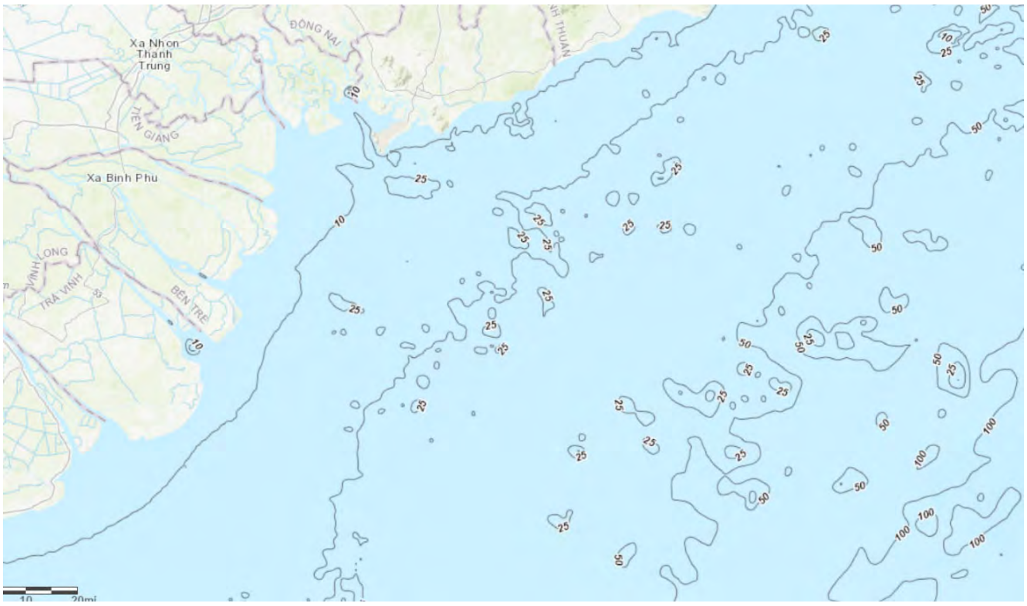
Ben Tre province is located in the Mekong Delta River region having an average elevation 0.5 – 1.0 m above sea level. However, with the lower elevation in the South, drainage is difficult to implement leading to prolonged flooding.



Source: Topographic-map.com

Figure 7.1 Elevation map for Thanh Hai commune

The proposed Project is located mainly offshore. Marine topography is quite flat. Continental shelf from Thanh Hai commune is approximately 12 km length in the East with the estimated bathymetric value is 10 m.



Source: GEBCO 2019 Bathymetric Contour

Figure 7.2 Bathymetric map in the East Sea

7.3 Geology

Geologic properties within project, substation, and transmission line (22 kV and 110 kV) area is up to 50m in depth. Stratigraphic structure includes 4 – 6 layers (EIA, 2019) in which majority has 3 types of soil:

- Type 1: clayey loam layer having weak physico-mechanical properties is 1.5 – 5.0 m thick; distribute on ground surface;
- Type 2: medium and fine sand layer is from 5 up to 20 m thick; and
- Type 3: hard clay layer is 3 – 15 m thick. The sand and clay layers both are distributed alternatively. From a depth of 30 m or lower is sand layer.

From the ground surface to the survey depth of 50.1 m, the ground of the construction comprises 6 soil layers:

- Layer 1: clayey loam with 4.8 m average thick is a weak soil layer. Unfavorable for construction.
- Layer 2: soft plastic sandy clay with 2.5 m average thick is a weak soil layer. Unfavorable for construction.
- Layer 3: loose, fine sand is 9.5 m average thick. This layer has physico-mechanical properties which are unfavorable for construction.
- Layer 4: medium hard to hard clay appears from a depth of 17.2 m with 10 m average thick. This soil layer is favorable for construction.
- Layer 5: friable to firm sand with 15.7 m average thick is a good soil layer which is favorable for construction.
- Layer 6: hard to very hard clay appears from a depth of 42.9 m with 7.2 m thick as survey. This soil layer is favorable for construction.

7.4 Hydrology

In order to analyse the meteorological, hydrological and oceanographic characteristics for the Project area and final field design, the following hydrological and meteorological stations were chosen for secondary data collation. These stations were selected as they meet the criteria of being: relevant to the project and project area, monitored data over a long period of time and complied with the standards of a Grade I station[9]:

- Ba Tri meteorological station (approximately 22 km from Project area);
- Vung Tau meteorological station (approximately 78 km from Project area);
- Ben Trai hydrological station (approximately 10.5 km from Project area); and
- Tan Thuy (An Thuan) hydrological station (approximately 7.5 km from Project area)

7.4.1 Tidal characteristics[10]

7.4.1.1 River

The Project area is located in Ben Tre Province, one of the provinces that got water supply from the complex yet crucial Mekong Delta. The Project area laid on the coastline connecting Vung Tau to Mui Ca Mau, in the south of Vietnam. This area is affected by an irregular semidiurnal tidal regime.

Tide magnitude along this part of the coast has a recorded range of 2.0 m to 4.0 m, the highest tide magnitude area in Vietnam. The highest tides occur during October and November, while the lowest tides occur during July and August.

Tidal regime is not the only aspect that needs to be considered for this report; in addition, certain factors such as wind, storms, water flow, local rain, evaporation and permeability can have an effect on water level fluctuation.

7.4.1.2 Coastal area

In this area, the sea level can rise by 30 cm during the Northeast (from October to late March or early April) and 50 cm during Southwest monsoon (from April to September) seasons compared to windless days. Moreover, depending on the storm level and location, storm surges can see the sea level rise between 50 cm and 110 cm in this area.

Water flow in the Mekong Delta can also have a significant influence on the Southern coastal region’s sea level. During major floods, the sea level can rise between 15 cm and 30 cm on average; during minor floods it can potentially rise 10 cm to 25 cm.

7.4.2 Water level

7.4.2.1 River

Ben Tre Province is covered with a network of rivers and canals in all districts and towns which make the waterway transportation is the favourable and accessible mean of transport within the community and other adjacent provinces. There are four major tributaries of the Mekong Delta (My Tho, Ba Lai, Ham Luong and Co Chien) which are also the main water supply sources for Ben Tre Province. The Project site locates in Thanh Phu District in which lies between Co Chien and Ham Luong river mouths.

The data used to assess the water level was recorded by two hydrological stations: Ben Trai and Tan Thuy (An Thuan) located in Co Chien and Ham Luong rivers, respectively as shown in Table 7.1 below. The water level data was recorded between 1998 and 2017.

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[9] Grade I meteorological station transmits SYNOP 8 times a day at hour: 01, 04, 07, 10, 13, 16, 19 and 22; CLIM montly at 19h30’ on the last day of the month and CLIMAT once a month at hour 20 on the last day of the month.

[10] Sources: ICOE Marine Engineering Institute

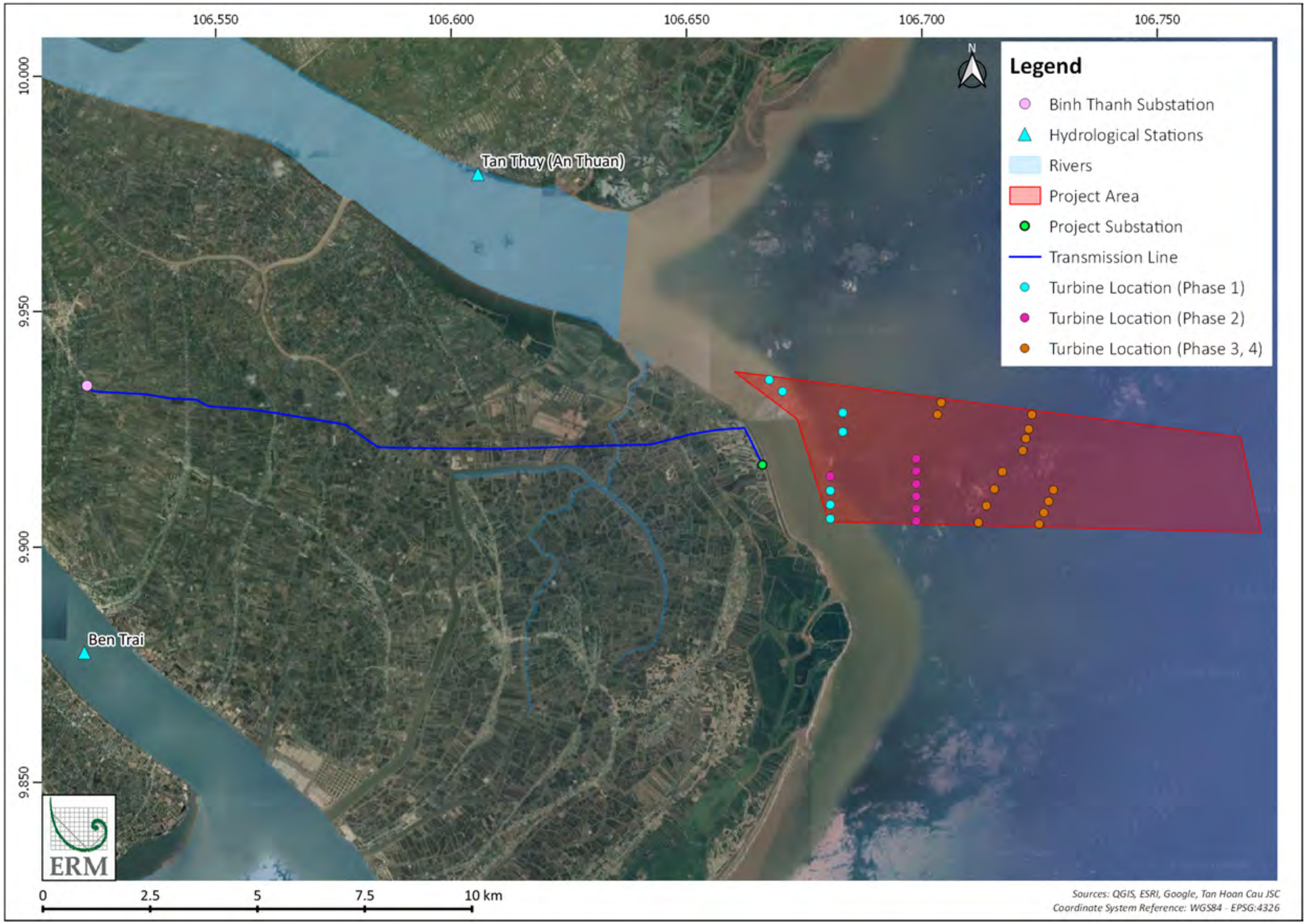


Figure 7.3 Location of nearby hydrological stations

Table 7.1 Water level at Ben Trai and Tan Thuy hydrological stations (1998-2017) (cm)

Station		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Ben Trai	Avg	25.0	17.1	10.7	1.4	-8.0	-17.1	-17.0	-12.8	-1.1	24.8	34.3	33.9	7.6
	Max	174.0	172.0	173.0	152.0	139.0	129.0	134.0	150.0	169.0	188.0	187.0	187.0	188.0
	Min	-206.0	-208.0	-196.0	-203.0	-232.0	-238.0	-243.0	-234.0	-206.0	-207.0	-205.0	-215.0	-243.0
Tan Thuy (An Thu an)	Avg	27.1	19.7	13.0	3.7	-6.6	-17.4	-18.4	-15.1	-4.9	21.8	33.7	34.5	7.6
	Max	171.0	170.0	171.0	162.0	143.0	135.0	131.0	151.0	168.0	188.0	184.0	183.0	188.0
	Min	-199.0	-193.0	-188.0	-198.0	-217.0	-227.0	-232.0	-233.0	-209.0	-207.0	-192.0	-198.0	-233.0

The elevation of water level at Ben Trai and Tan Thuy hydrological stations is compared with National elevation level.

7.4.2.2 Coastal area

It should be noted that the dry season takes place between December to April and the wet season lasts from May until November. The wind is typically strongest in December and January, measuring around level 4 or 5 on the Beaufort scale, and typically weakest in February and March. April is the interim period. Table 7.2 shows the maximum wave heights recorded by Vung Tau meteorological station, which is located about 71.5km northeast of the Project area.

Table 7.2 Maximum wave heights recorded by Vung Tau Meteorological Station (cm)

P(%)	0.5	1	2	4	5	10	20	25	50	75
Hs_max	480	428	374	327	307	256	206	190	152	115

Table 7.3 presents the seawater salinity levels recorded at the Vung Tau meteorological station between 1985 and 2010, when measured at a frequency of four times per day (at 1AM, 7AM, 1PM and 7PM).

Table 7.3 Seawater salinity levels at Vung Tau meteorological station (1985 – 2010) (‰)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Avg	32	32.6	32.6	32.1	30.9	30.2	29.6	28.6	28.4	28.9	30.2	31.2	20.6
Max	34.3	34.7	34.5	35.5	34.4	33.6	32.6	33.2	32.7	32.6	32.9	33.7	35.5
Min	22.4	26.8	26.8	26.1	20.2	18.4	17.6	19.2	15.5	15.6	19.0	20.7	15.5

Ben Tre Province is supplied by freshwater annually from the Mekong Delta through Tien river branch. The water flow in the area has been influenced by two different seasons:

- Dry season (from November to April): Tien river is distributed roughly 52% of the freshwater from upstream. The flow rates at Co Chien river mouth is 710.4 m^3/s and at Ham Luong river mouth is 828 m^3/s;
- Wet season (from May to October): Tien river accounts for approximately 52% of the total freshwater volume from both Tien and Hau rivers. The flow rates at Co Chien and Ham Luong river mouths reach approximately 2,880 m^3/s and 3,360 m^3/s respectively.

In case of there are upstream constructions that regulate water in both seasons, this will contribute to the salinization of further downstream with such reported flow rates above. However, water level will be rising to help the waterway transportation and also ensure freshwater supply is sufficient.

Ben Tre Province has relatively flat terrain, below the average sea level. Rivers are strongly influenced by tidal regime. Many rivers and canals are practically large, the width of estuaries are approximately two to three kilometres. In dry season, freshwater salinity is abnormally high, saltwater intrusion happens in all areas of the Province, causing widespread freshwater shortage.

Additionally, the water source near coastal mudflats, in which the Project is located, is completely became brackish water.

7.5 Climate and Meteorology

7.5.1 Wind

7.5.1.1 Wind Regime

The Ben Tre Province is influenced by the northeast monsoon season from December to April and the southwest monsoon from May to November. The average wind speed ranges from 2.4 m/s to 4.5 m/s in northeast monsoon and from 2.2 m/s to 4.2 m/s during southwest monsoon season. The highest wind speed has been recorded in Ben Tre can be reached at 30.8 m/s which relatively high compares with other regions in Mekong Delta. The wind direction changes between these monsoon seasons in November and May create two distinctive periods. The northeast monsoon season is generally dry, while the southwest monsoon season is typically wet.

The Project's meteorology mast was installed in 2018 in Thanh Hai Commune (Figure 7.4). Monthly average wind speed at the Project's meteorology mast was presented in Table 7.4.

Table 7.4 Monthly average wind speed at the project's meteorology mast (Unit: m/s)

Month / Height	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
76m(Ch1)	7.6	6.9	6.6	6.4	5.9	6.6	6.6	6.1	6.3	5.8	6.0	6.3	6.4
74m(Ch2)	7.4	6.6	6.3	6.2	5.7	6.2	6.3	5.8	6.0	5.5	5.8	6.1	6.2
60m(Ch3)	7.2	6.5	6.1	6.2	5.7	5.8	5.9	5.5	5.6	4.9	5.1	5.6	5.8
12m(Ch4)	5.2	4.7	4.3	4.2	3.7	4.6	4.7	4.4	4.7	3.7	3.9	4.5	4.4

Note: Ch1: Channel 1
Ch2: Channel 2
Ch3: Channel 3
Ch4: Channel 4

Source: EIA, 2019

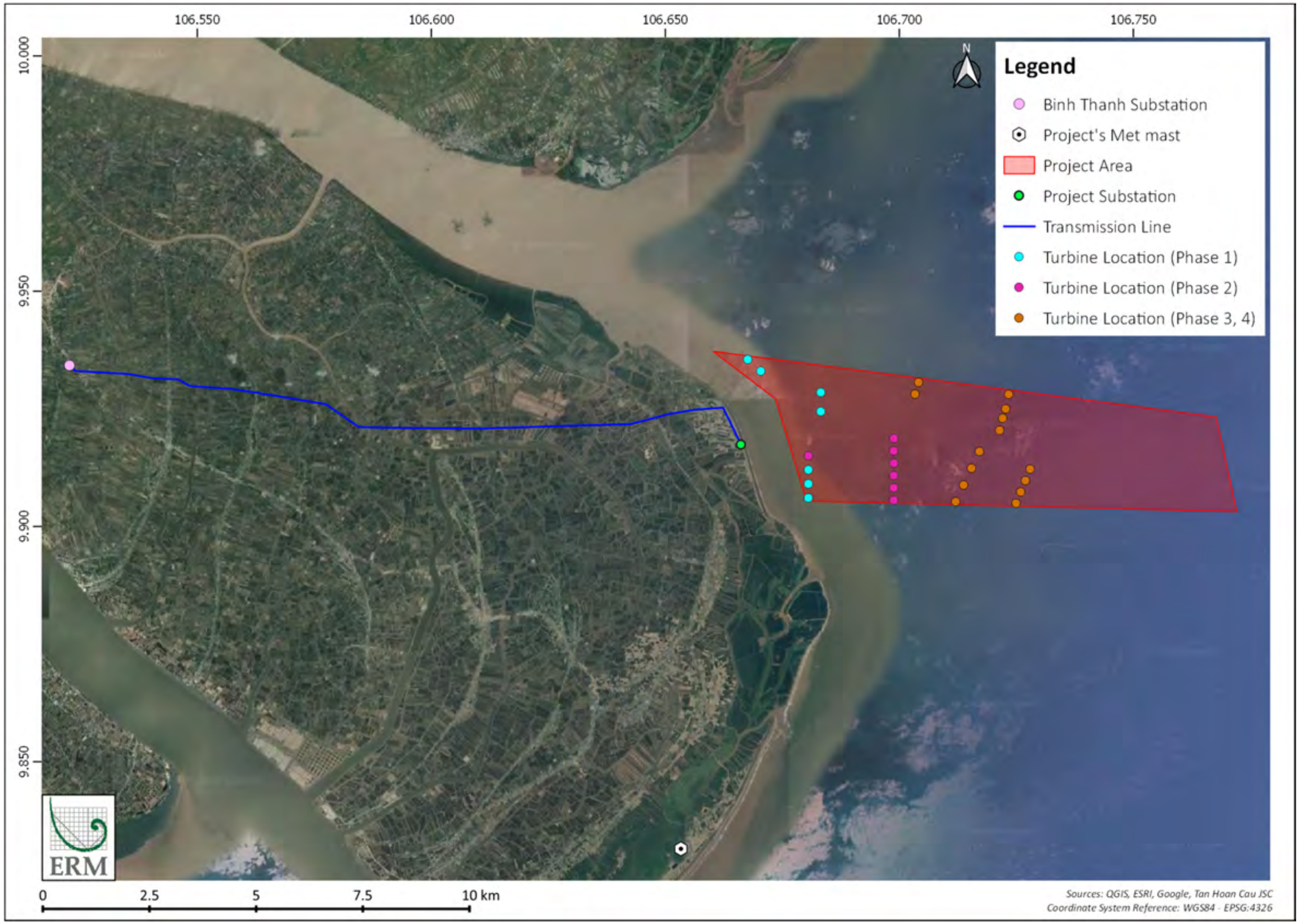
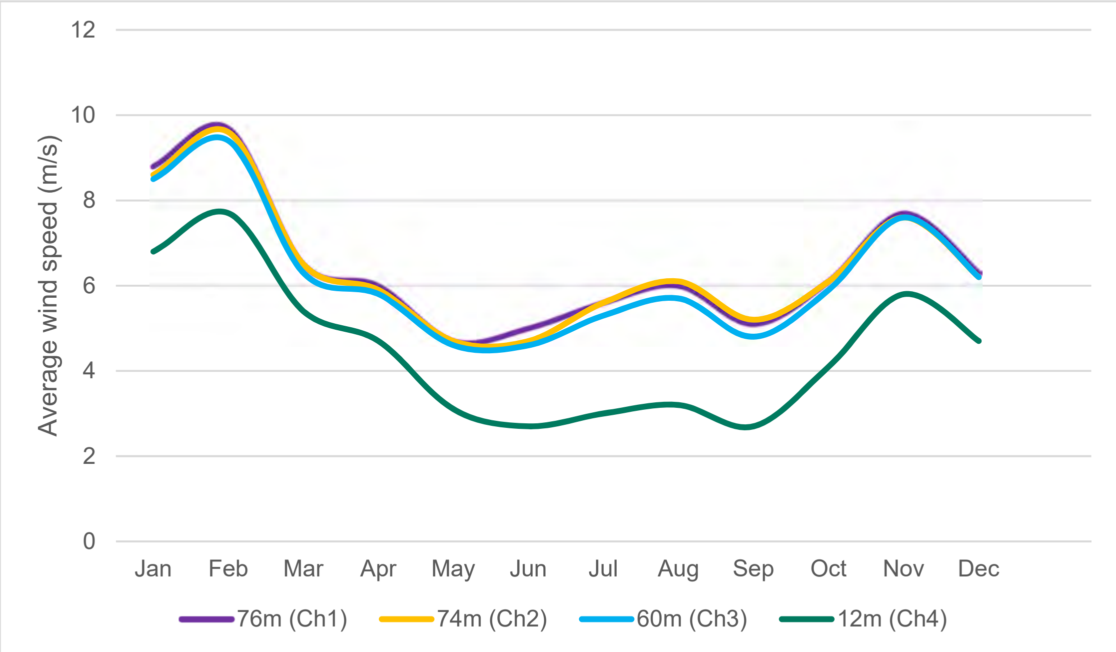


Figure 7.4 Location of Project's meteorology mast



Source: EIA, 2019

Figure 7.5 Graph of changes in monthly average wind speed at altitudes

The curves showing the average monthly wind speeds at various altitudes in the Project area are consistent with one another throughout the year. Wind speeds during dry season (November to April) are greater than wind speeds during wet season (May to October), and are at their maximum between January and February. This is because in terms of the pressure structure, the pressure gradient during dry is larger than it is during wet.

7.5.2 Air Temperature

The air temperature in Ben Tre Province varies depending on seasons and fluctuates during the day. There are days that the mornings and afternoons are hot, while the temperature drops and creates the night times and early mornings dew. There is not much difference in heat between months of the year. In 2017, the highest average air temperature reached 29.1°C in April and the lowest temperature stopped at 26.5°C in February. Table 7.5 presented the average temperature has been recorded throughout the years from 2012 to 2017.

Table 7.5 Average air temperature in Ben Tre (2012-2017) (Unit: °C)

	2012	2013	2014	2015	2016	2017
Average	27.5	27.3	27.1	27.5	27.7	27.5
January	26.1	25.7	24.1	24.8	27.2	26.7
February	26.8	26.8	25.2	25.0	26.7	26.5
March	28.1	27.9	27.3	27.3	27.4	27.6

	2012	2013	2014	2015	2016	2017
April	28.6	29.1	29.0	29.0	29.5	29.1
May	28.3	29.2	29.2	29.7	29.6	28.4
June	28.1	27.8	27.6	28.1	27.8	28.2
July	27.4	27.4	27.3	28.2	27.8	27.2
August	27.9	27.2	27.1	28.4	27.8	27.3
September	26.3	26.9	27.1	26.4	27.4	27.9
October	27.3	27.0	27.1	27.4	26.8	27.9
November	28.0	27.2	27.8	28.3	27.8	27.4
December	27.3	25.2	26.5	27.3	26.3	27.3

Source: Ben Tre Province's statistics book, 2017

7.5.3 Air Humidity

Due reduced precipitation occurring between December and April, humidity levels relatively low at 77 % in March 2017. However as the wet season approaches, humidity levels rise up to 88 percent in August 2017. Table 7.6 shows the annual average humidity levels recorded in Ben Tre from 2012 to 2017.

Table 7.6 Relatively average of air humidity in Ben Tre Province (2012- 2017) (%)

	2012	2013	2014	2015	2016	2017
Average	82	83	89	87	83	84
January	79	80	78	90	76	81
February	78	76	78	89	74	80
March	78	78	77	88	74	77
April	79	80	82	87	77	78
May	84	81	92	89	82	86
June	84	87	96	93	89	86
July	86	85	87	94	89	87
August	84	87	95	93	90	88
September	90	88	95	91	88	87
October	84	87	95	81	91	87

	2012	2013	2014	2015	2016	2017
November	81	85	93	77	85	86
December	80	81	94	75	86	81

Source: Ben Tre Province's statistics book, 2017

7.5.4 Rain

Climate characteristics in Ben Tre Province form two distinct seasons: the rainy season, which usually starts in May and ends in October, and the dry season from November to April. Rainfall during the rainy season accounts for approximately 90% of the total annual rainfall. In general, the rain in the area is typically tropical showers (rain comes and ends quickly), usually a rain lasts no more than 3 hours but the intensity of rain is quite high. Months from July to October are the months with high rainfall, while chances of rain in January and February are relatively low. The total number of rainy days in a year is 152 days.

Table 7.7 Average annual rainfall in Ben Tre Province (2012-2017) (Unit: mm)

	2012	2013	2014	2015	2016	2017
Average	**1,486**	**1,307**	**1,461**	**995**	**1,674**	**1,444**
January	-	81	6	21	-	15
February	7	2	-	-	-	49
March	41	-	-	-	-	0,2
April	77	51	37	8	-	31
May	205	160	77	39	229	187
June	171	159	293	164	209	120
July	250	79	227	11	331	172
August	103	194	279	131	128	221
September	417	183	260	295	342	256
October	172	290	99	176	227	249
November	33	91	90	14	112	65
December	10	17	94	37	96	78

Source: Ben Tre Province's statistics book, 2017

7.6 Ambient Air Quality

For the assessment of ambient quality, air samples were taken at three different onshore locations along the coastline of the Project's area. These sample points are described in Table 7.8 and shown in Figure 7.6 below.

When determining the ambient air quality for impact assessment, the following National Technical Regulation is considered and complied with QCVN 05:2013/BTNMT – National Technical Regulation on Ambient Air Quality. Samples were taken and analysed with the results presented in Table 7.8.

According to the analysed results, all samples for sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and dust concentration (TSP) were under the thresholds' limits for these characteristics. Whereas, carbon oxide (CO) and ozone concentration were unable to be determined. However, detection limit of the sampling method for such factors was lower than regulatory standards. Therefore, the results from CO and ozone concentration were still within the acceptable limit.

Table 7.8 Results of monitoring and analysis of air quality in the Project area

No.	Notation	WGS84		Wind speed (m/s)	CO (mg/m^3)*	SO_2 (mg/m^3)	NO_2 (mg/m^3)	O_3 (g/m^3)**	TSP
		Lat	Long						
1	KK-01	9.936069	106.647325	3.71	ND	0.025	0.022	ND	0.06
2	KK-02	9.926056	106.662199	3.90	ND	0.029	0.025	ND	0.07
3	KK-03	9.910897	106.667658	3.98	ND	0.027	0.021	ND	0.06
QCVN 05:2013/BTNMT				***-***	***30***	***0.35***	***0.2***	***0.2***	***0.3***

Note:
** Method detection limit (MDL) = 2.5 mg/m^3*
*** MDL = 0.02 mg/m^3*
ND: Not detected
-: Not specified

Source: EIA, 2019

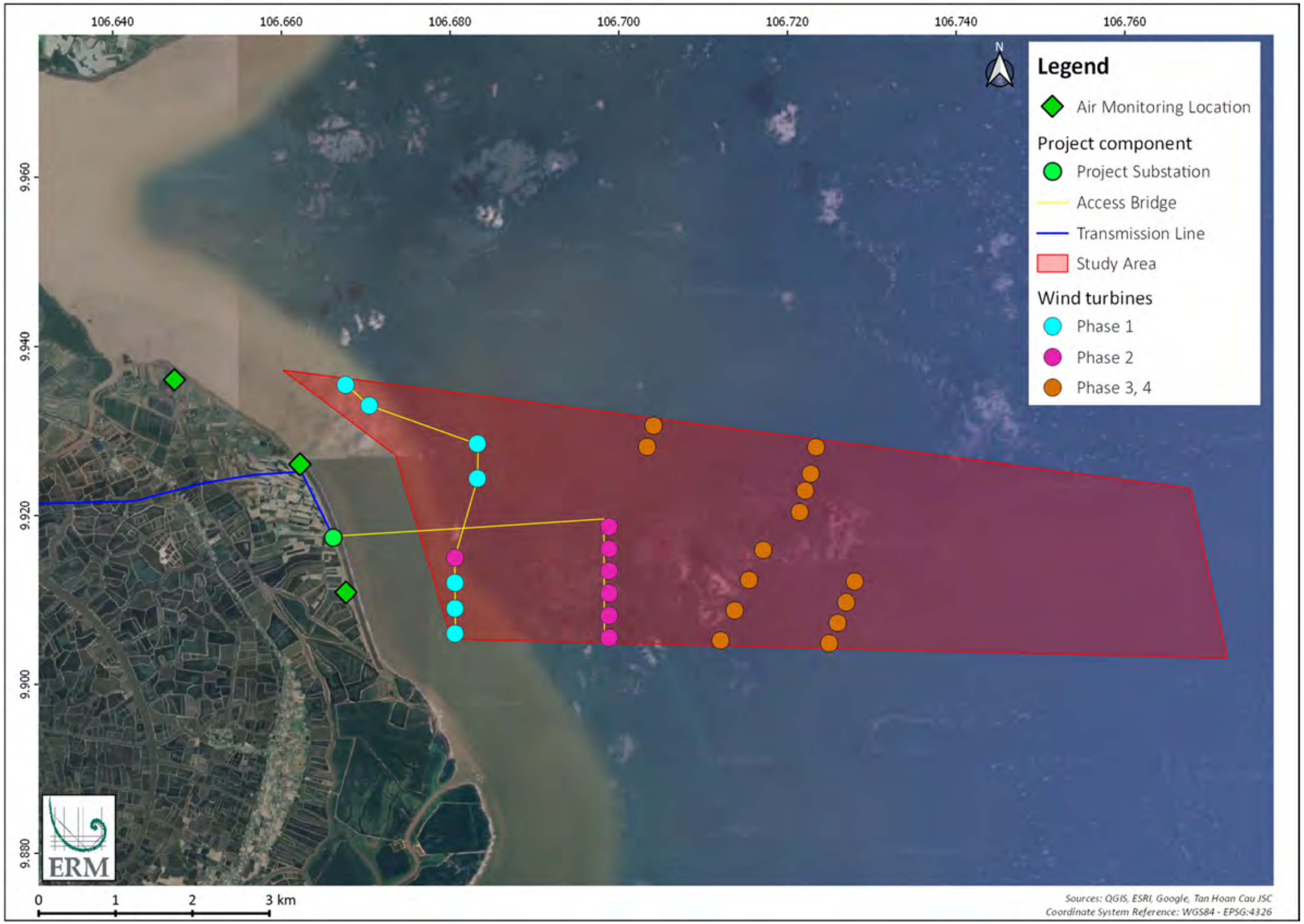


Figure 7.6 Air monitoring location

7.7 Noise

In order to establish noise limits, background monitoring is required to establish the pre-existing noise environment as a function of wind speed. As wind speed increases the existing levels at most receptors generally also increase as natural sources such as wind in 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.

The relative proximity of some receiver locations to one another and their similar wind exposure and surrounding environment meant that background noise monitoring could be conducted at one representative location and that data can be considered indicative of other similar locations.

Background noise measurements have been carried out by the University of Hochiminh City Institute for Environment and Resources at three representative onshore monitoring locations in the vicinity of the Project site. Details of the noise measurement methodology, measurement equipment can be found in the "*Noise Levels in Thanh Hai, Thanh Phu District, Ben Tre Province*" report.

The background noise measurements at each monitoring location were conducted for a period of 48 hours at 10-minute intervals. The measured background noise data were supplemented with synchronous wind speed data measured at the microphone position. The measured wind speed data at microphone height have been converted to wind speed at hub height for used in the regression analysis. A regression analysis of the background noise data and the converted hub height wind speed data were used to determine a line of 'best fit' from which the noise limit is established.

7.7.1 Measurement Locations

Background noise measurements were carried out between 23 and 29 September 2019 at the three locations described in Table 7.9 and then identified in Figure 7.7 to Figure 7.9 below.

Table 7.9 Background noise measurement locations

Location ID	UTM[1] WGS84 North Zone 48 (metres)		Comment
	Easting	Northing	
N1 or NML01	682139	1097656	▪ Far away about 30m in the Southern direction is village road, 90m far away in the Northeast is sea dyke. ▪ There are about 8 households within a radius of 150m from the noise measurement site. Residents go to bed rather early, about 8PM. Two nearest households are 25m to the southwest and 35m to the north. ▪ The weather was dominant with strong Southeast or Northeast wind and nearly no rain. However, this site is quite closed windy from under 1.8m due to the high embankment. The noise team set the height of the wind meter at approximately 1.5 m (the height of the sound level meter). ▪ The farmer visits to their Jícama once a day for spraying water and removing grass. ▪ In general, the main sources of noise at the first monitoring site are wind, roaster, vehicles and sea waves.
N2 or NML02	682419	1096834	▪ About 50m away from the West is a small village road, 230m to the Northeast is the Con Loi beach. Residents living in this area are not crowded, with about 5 households within a radius of 150m from the noise measurement site. The nearest household is 20m to the southwest.

Location ID	UTM[1] WGS84 North Zone 48 (metres)		Comment
	Easting	Northing	
			■ This nearest household is quite ventilated and nearly un-shielded. Therefore, wind speed was very strong and noisy, especially at night. ■ One household, 120 meters away from the noise measurement site, played karaoke from 17:25 to 18:50 on September 24, 2019. Occasionally, goose of a nearby house make noise (noise level is up to 62dBA). ■ The determined sources of noise in this measuring site were winds, waves, goose and vehicles.
N3 or NML03	683312	1094928	■ There is a village road leading to the sea, 30 meters northwest of the measuring point. When the sea level rises, it is impossible to move along the beach from the northwest, people have to go through this road. Motorbikes traveling through this road are mainly of clam catchers or members of the Binh Minh Fisheries Cooperative. It is easy to realize that at the third site the wind was not as strong as at the second site but the sound of sea waves could be heard clearly at this site. ■ There is not any household around the third measuring site, except for the shrimp farmer's hut. 340m northwest from the monitoring site is the housing and office of Binh Minh Fisheries cooperative. ■ The measuring area has two large dogs and four puppies. There is a herd of more than 20 goats in the barn 85 meters from the measuring point. Every morning they are released to go out to eat and nearly 5PM return to the barn. ■ 150m to the East and 200m to the Southeast are boundaries of protection forest (mangrove trees) ■ The sources of noise in the third site were goats, sea waves, dogs, and vehicles.

Universal Trans Mercator = UTM.
Source: "Noise Levels in Thanh Hai, Thanh Phu District, Ben Tre Province" report.

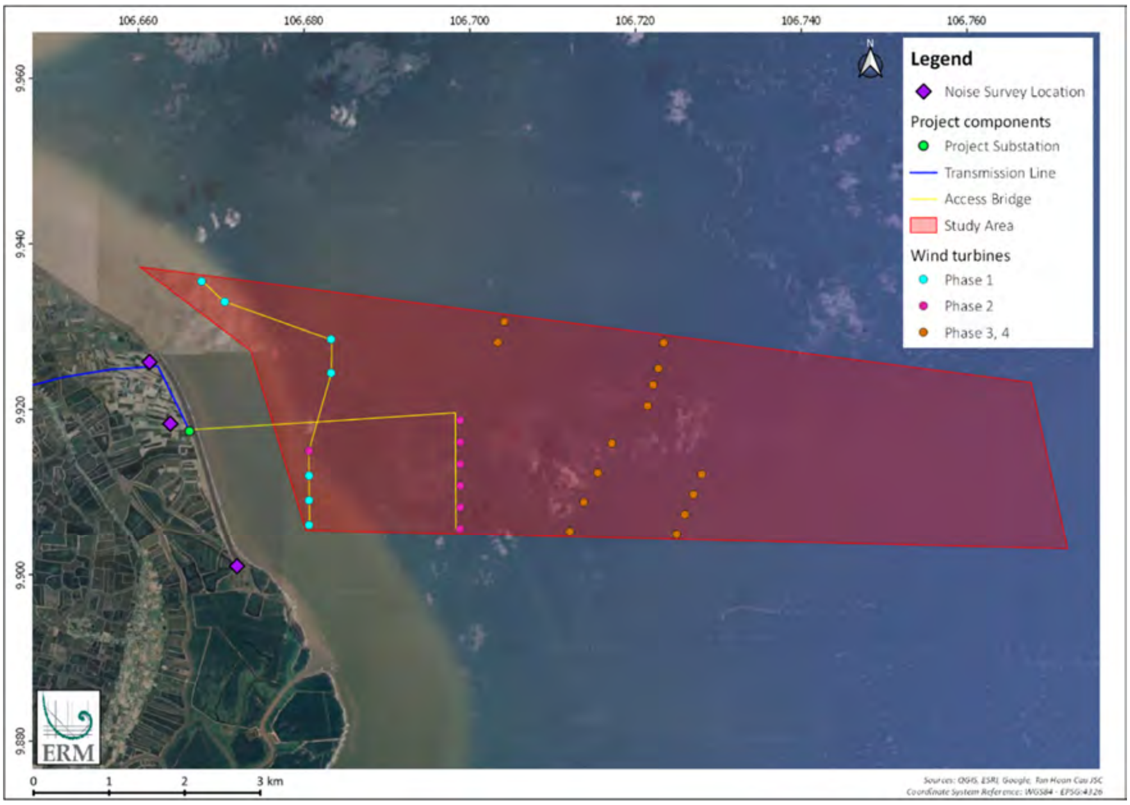


Figure 7.7 **Geography of Thanh Hai communes Thanh Phu district, Ben Tre province**

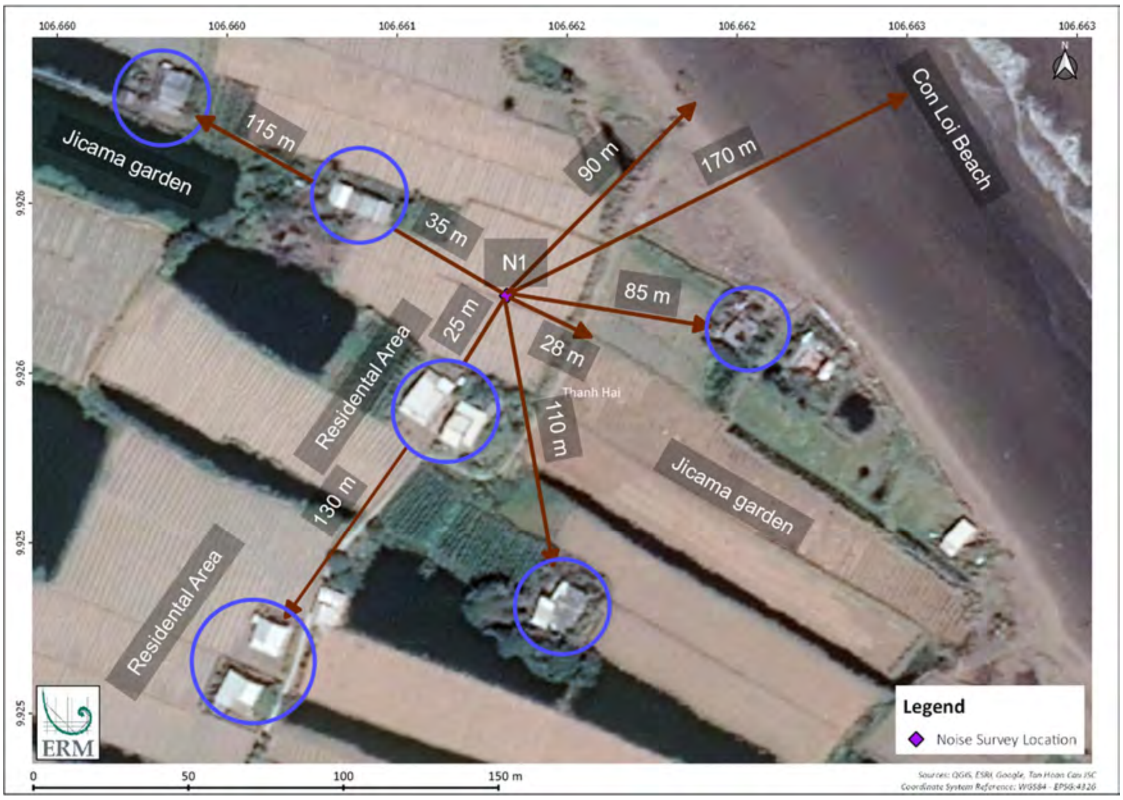


Figure 7.8 **The first noise monitoring site in Thanh Hai commune, Thanh Phu district, Ben Tre province from Sep 25 to Sep 27, 2019**

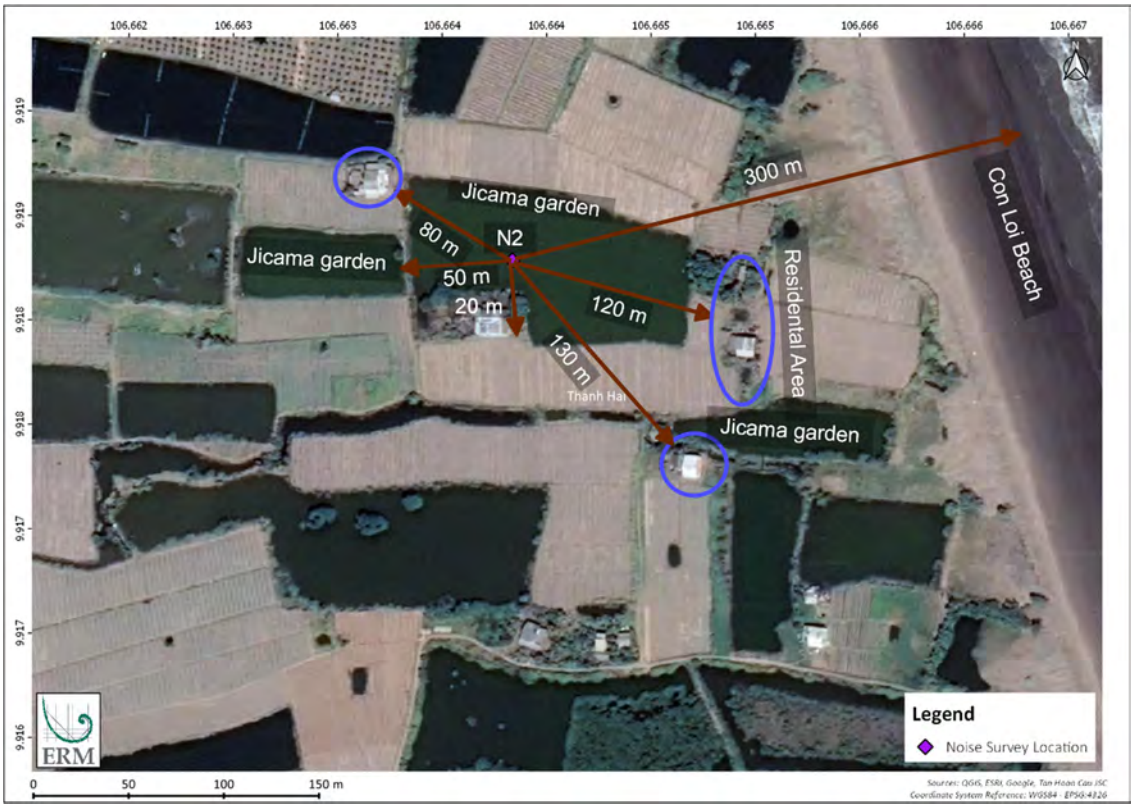


Figure 7.9 **The second noise monitoring site at Thanh Hai commune, Thanh Phu district, Ben Tre province (from Sep 23 to Sep 25, 2019)**

7.7.2 Background Noise Plot and Regression Analysis

7.7.2.1 Monitoring Overview

As stated in the "*Noise Levels in Thanh Hai, Thanh Phu District, Ben Tre Province*" report, monitoring was carried out using the methodology specified in the Environmental Noise Survey according to ISO 1996-2:2007. This included measuring the following parameters:

- Leq: Equivalent continuous sound level (A-weighted sound level).
- Lmax, Lmin: Maximum, minimum A-weighted sound level.
- L90: 90 percentile noise level.
- L10: 10 percentile noise level.
- L1: 1 percentile noise level.

Measuring equipment was mounted on a tripod with the height of approximately from 1.2 to 1.5 m. The tripod was placed at sampling point to its distance to surrounding walls were over 3.5 m (as in accordance with ISO 1996 – 2:2007). Windscreen was also used to reduce the effects of windy weather.

The equipment used was a 3M Sound Pro (DL 2-1/1) Sound Level Meter with the following features:

- ANSI and IEC standards compliant
- Class/ Type 2
- A, C and Z (flat) frequency weighting
- Fast, slow, and IEC impulse time response
- Selectable thresholds 10 dB – 140 dB

- 3, 4, 5, 6 dB exchange rates
- SD memory card slot
- Time history data logging with 1 second to 60 minute intervals
- Full (1/1) octave band real-time analysis

The 3M Sound Pro DL 2/1-1 conforms to legal requirements for quantity measurements ANSI and IEC standards. Its unit supports real-time octave band analysis in the range from 16 Hz to 16 kHz. Logged data is automatically saved to the instrument's memory card.

Calibration of this device was carried out using an external sound calibrator – Sound Calibrator 0554.0009 (Sound-calibration) at 94 dB and 104dB at 1KHz. Sound level meter equipment was calibrated before and after each sampling point. Calibration uncertainty ranged within ± 0.2 dBA.

7.7.2.2 Regression Analysis

Background noise is typically expected to increase as wind speed increases, as a result of wind induced noise generated around objects or vegetation. Because of this a regression analysis is required to establish a line of best fit for the data.

The measured background noise levels (L_{A90}) are plotted against the wind speed at hub height of 106.5 metres to obtain a background versus wind speed characteristic. As wind speeds at each noise measurement location were measured at microphone height (1.5 metres), the measured wind speeds have been converted to hub height (106.5 metres) high wind speeds using the equation presented below using a roughness of 0.0024 at all three locations. The equation is:

$$\frac{V_S}{V_Z} = \frac{\ln\left(\frac{z_{ref}}{z_{o,ref}}\right) X \ln\left(\frac{H}{z_o}\right)}{\ln\left(\frac{H}{z_{o,ref)}}\right) X \ln\left(\frac{z}{z_o}\right)}$$

The line of best fit for the data set was determined using a "power" trend line. Correlation coefficients (R2) ranged from approximately 0.14 to 0.67. Lower correlation coefficients occur where background noise levels are not determined by local wind-driven sources. The data recorded at all three locations is acceptable for use but reduced correlation (wind speed versus time) may occur for a multitude of reasons including:

- Lack of nearby foliage.
- Other dominant sources, waves crashing, traffic, insects, frogs etc.
- Atmospheric conditions of high stability or ground level detachment.

The resultant regression analysis for all three locations (NML01 to 03) is presented in Figure 7.10 to Figure 7.12.

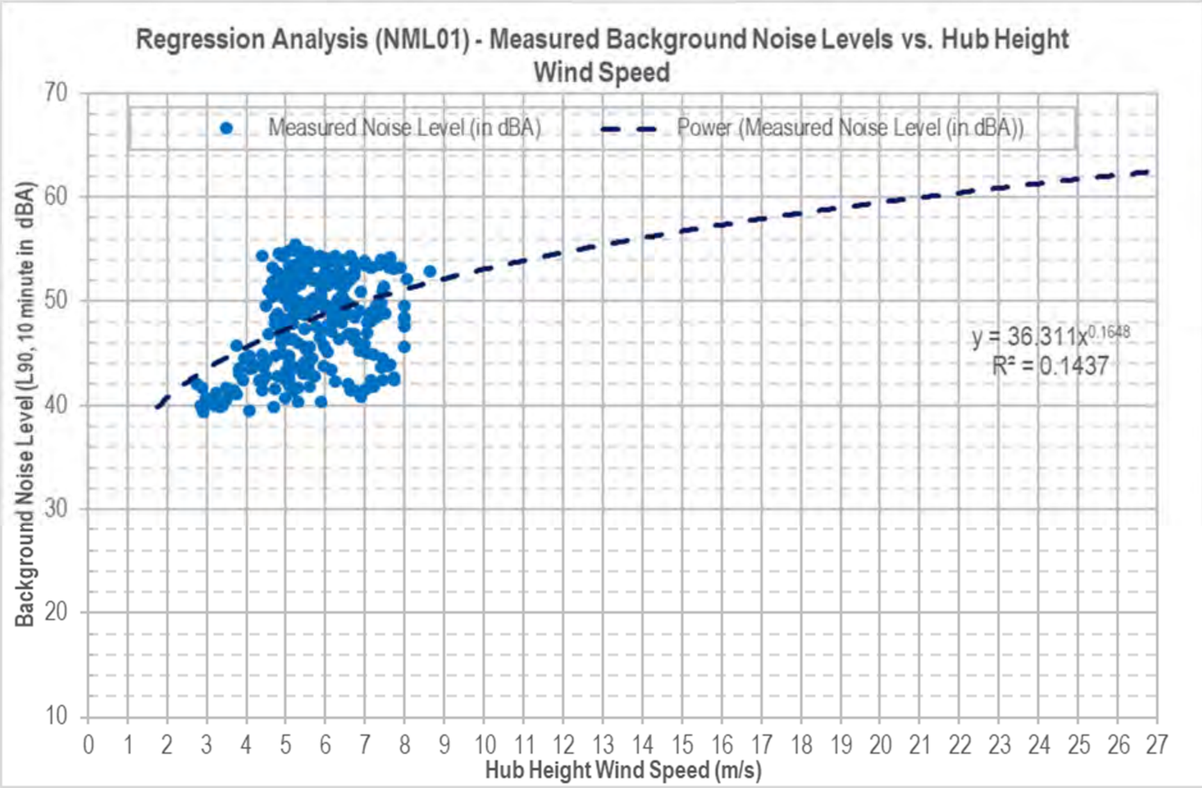


Figure 7.10 Regression Analysis (wind speed versus noise) for NML01

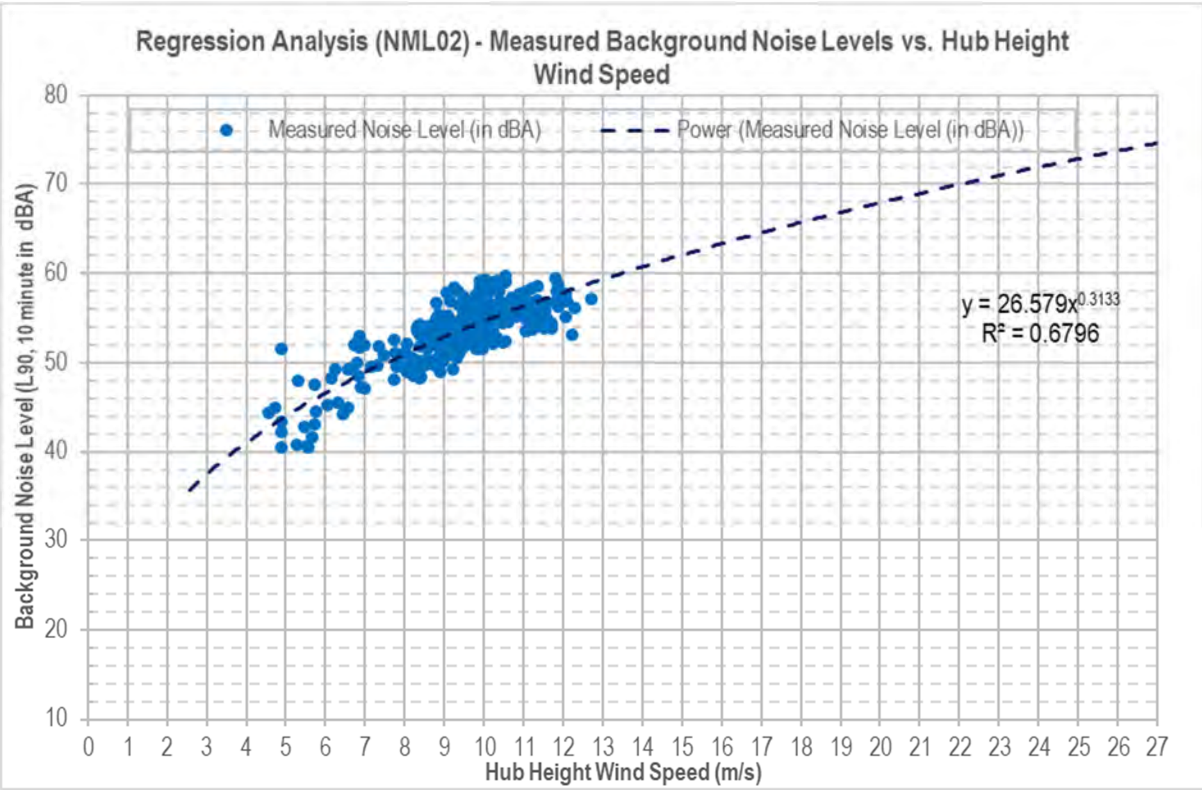


Figure 7.11 Regression Analysis (wind speed versus noise) for NML02

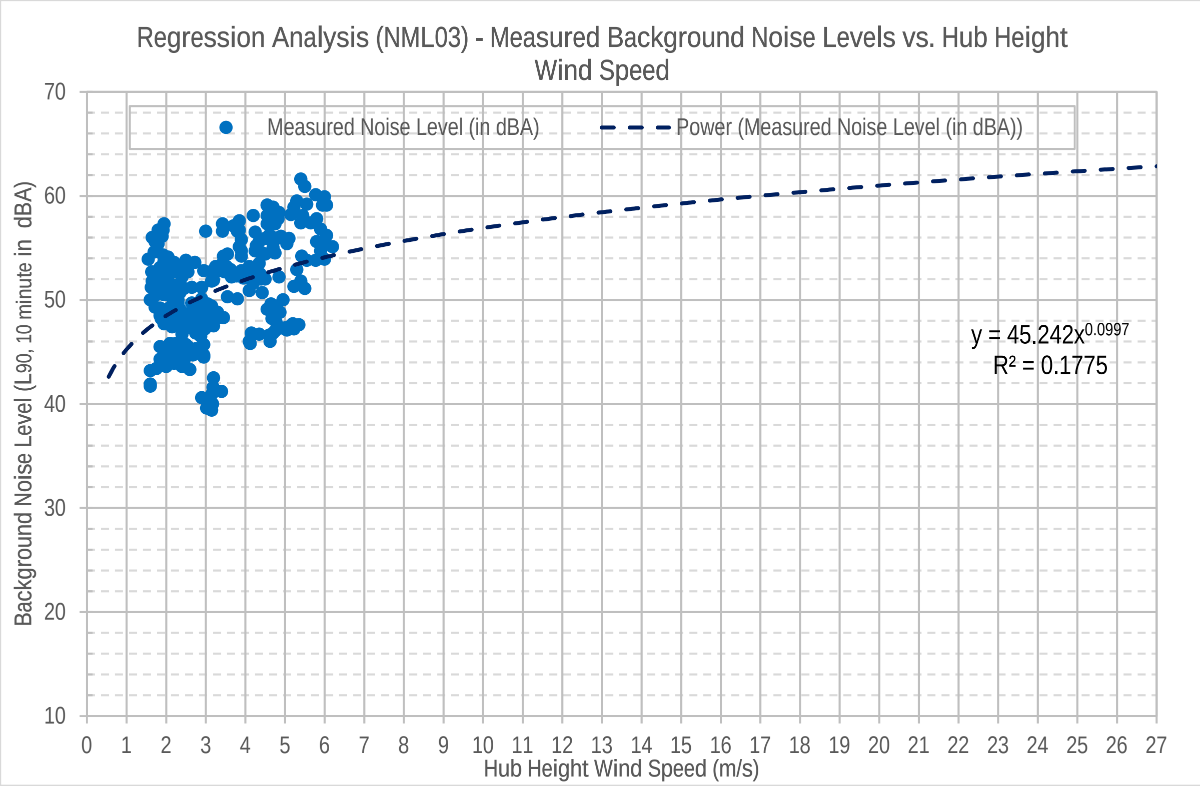


Figure 7.12 Regression Analysis (wind speed versus noise) for NML03

7.7.3 Compliance Limits

Wind farm noise compliance limits for receptors have been derived based on the background noise plot and the limits defined in the ETSU-R-97 “The Assessment & Rating of Noise from Wind Farms” document referenced in the IFC which is 45 dBA or the background noise plus 5 dBA, whichever is the greater. Based on this assumption, the plots showing the background noise and compliance limit curves against hub height wind speed for each measurement location are presented in Figure 7.13, Figure 7.14 and Figure 7.15 below.

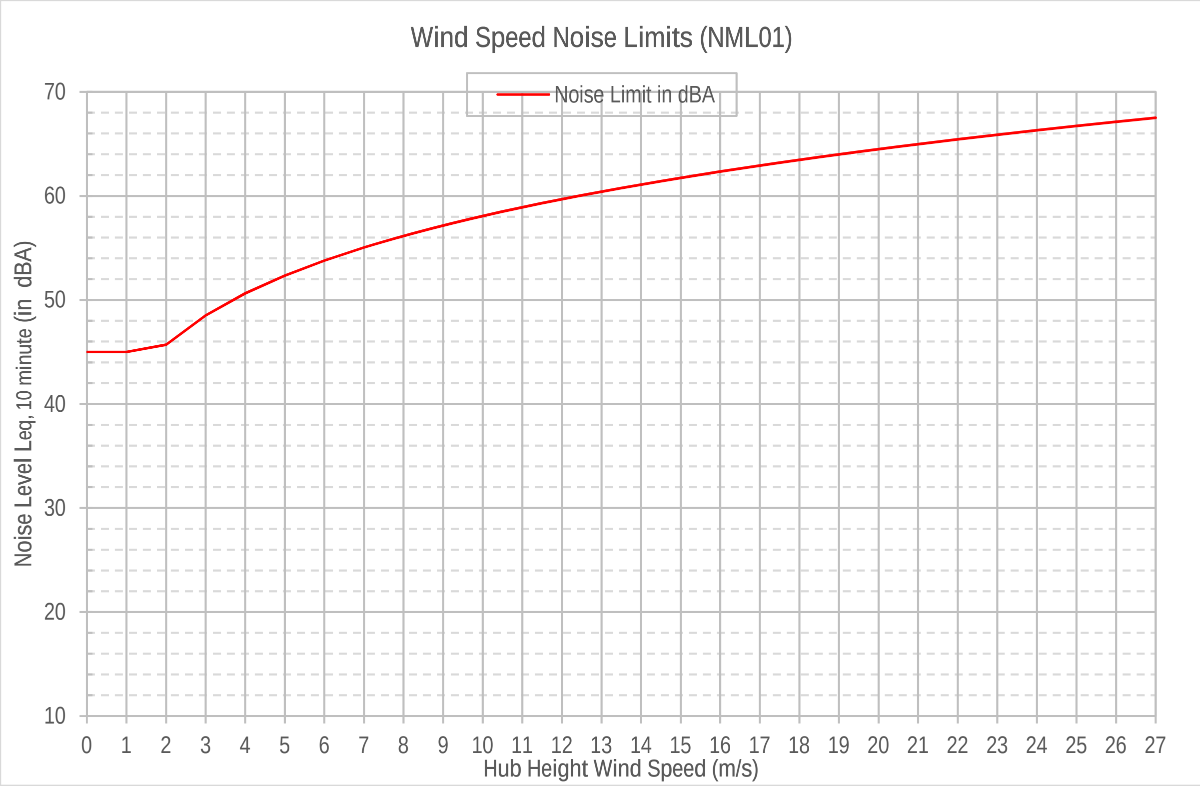


Figure 7.13 Wind Farm Noise Limits (Integer Wind Speeds) NML01

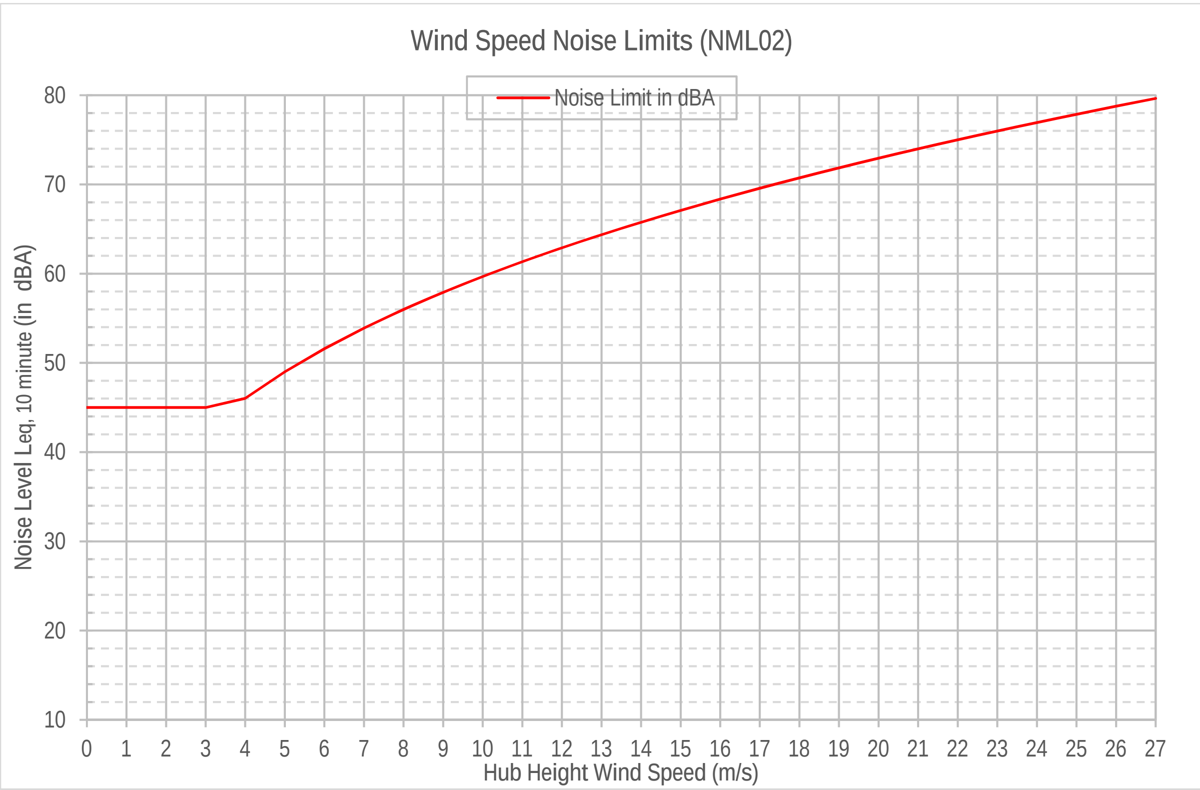


Figure 7.14 Wind Farm Noise Limits (Integer Wind Speeds) NML02

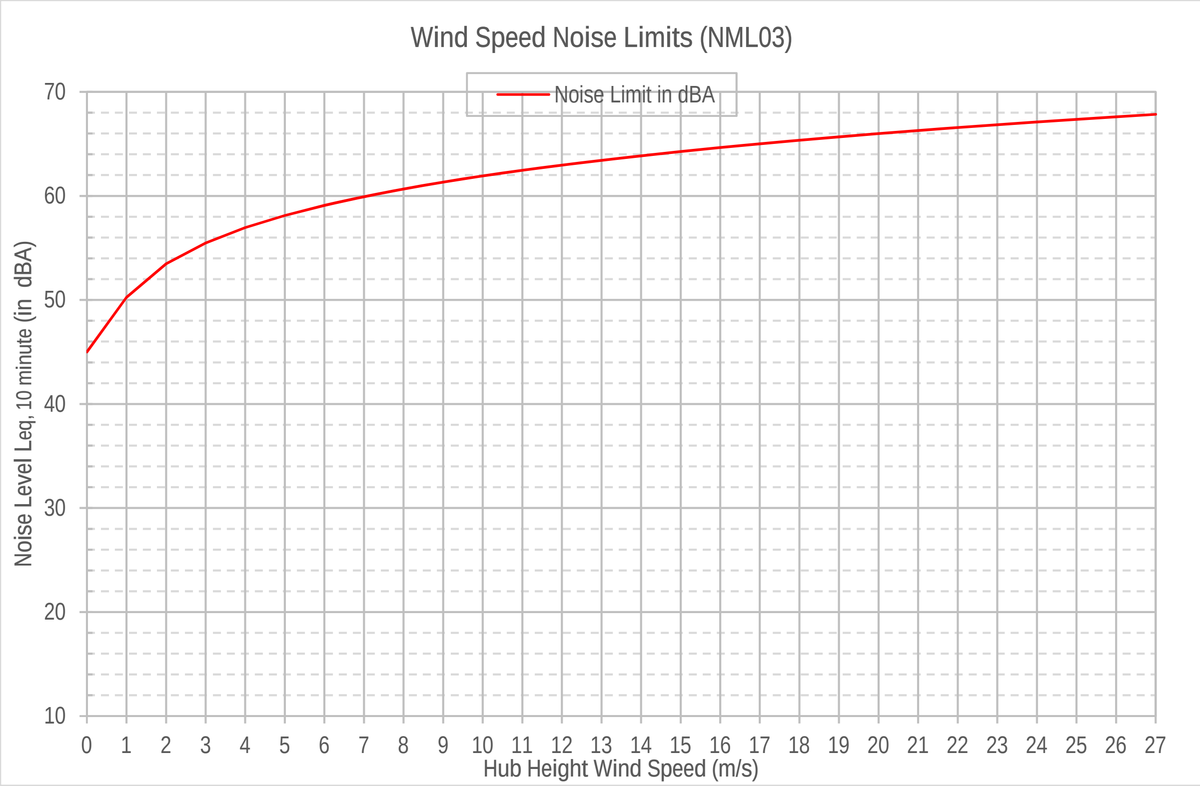


Figure 7.15 Wind Farm Noise Limits (Integer Wind Speeds) NML03

7.8 Water Quality

7.8.1 Coastal water

Three coastal water samples were taken and analysed for six parameters in accordance with QCVN 10-MT:2015/BTNMT – National Technical Regulation on Sea Water Quality within the area in which the Project's offshore components will be installed. The coastal water samples' locations are shown in Figure 7.16 with the results of sampling program presented in Table 7.10.

Based on the laboratory results, the total content of suspended solids, microbiological criterias and iron concentration were relatively high in all samples, exceeding the permitted regulations. At the sampling locations NBVB-01 and NBVB-02, ammonium concentration was above its thresholds limit. The exceedance is mostly caused from alluvial deposits during the rainy season. The exceedances relating to Coliforms at NBVB-02 is a result of contaminated surface and ground water entering the ocean.

Table 7.10 Results of monitoring and analysing coastal water quality in the Project area

No	Parameter	Unit	NBVB-01 (9.941686, 106.664733)	NBVB-02 (9.928239, 106.672594)	NBVB-03 (9.912933, 106.682581)	QCVN 10-MT:2015/ BTNMT
1	pH	-	6.58	6.61	6.62	**6.5-8.5**
2	TSS	mg/l	253	446	319	**50**
3	Fe	mg/l	5.42	6.18	6.91	**0.5**
4	NH_4^+	mg/l	0.13	0.12	0.09	**0.1**
5	Total oil & grease*	mg/l	ND	ND	ND	**0.5**
6	Coliform	MPN/ 100ml	750	1,500	930	**1000**

Note:
** MDL = 0.3 g/m³*
ND: Not detected
-: Not specified

Source: EIA, 2019

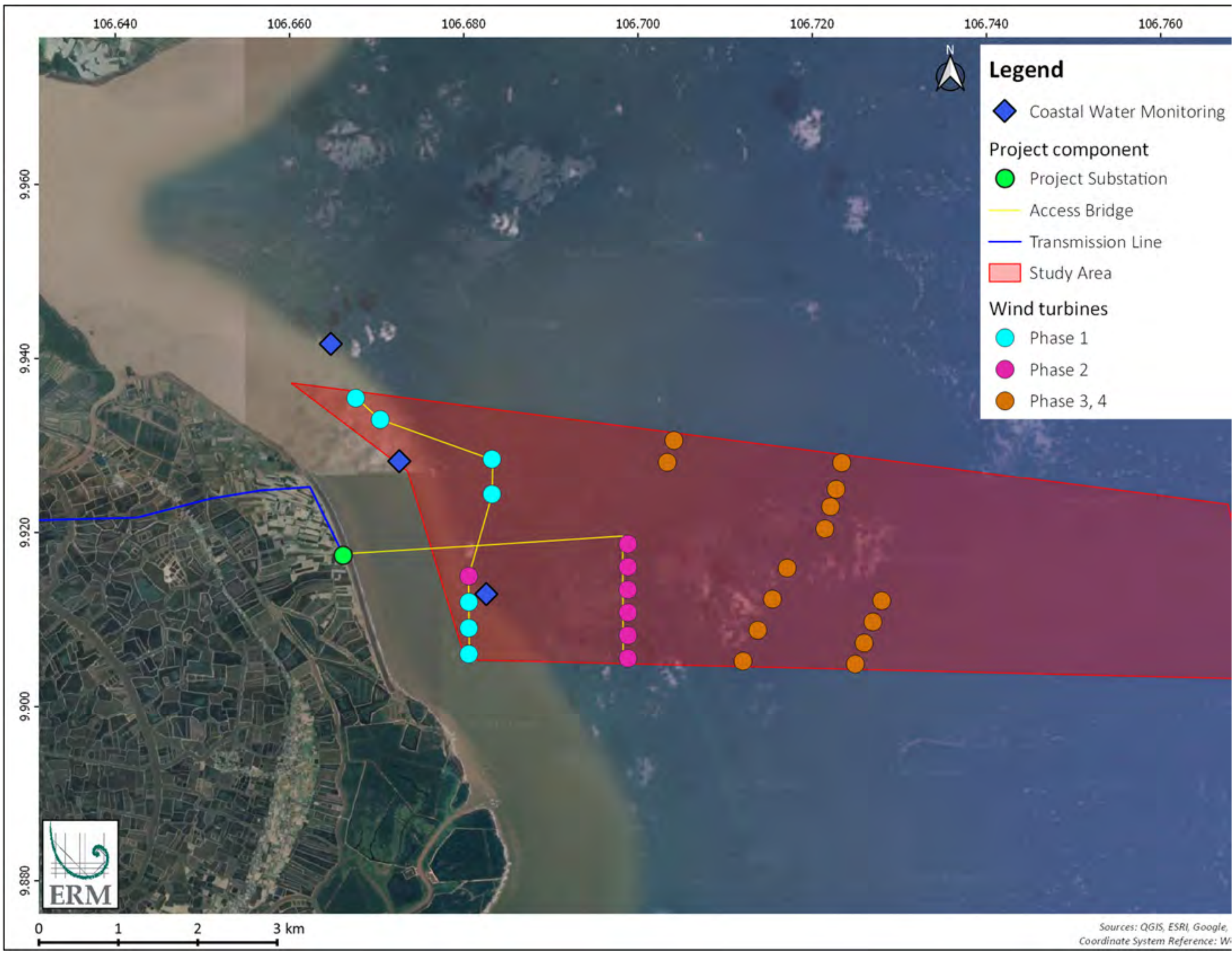


Figure 7.16 Coastal water monitoring location

7.8.2 Surface water

To determine the environmental baseline for surface water, five surface water samples were taken and analysed for 14 parameters. These samples were taken and analysed in accordance with QCVN 08-MT:2015/BTNMT – National Technical Regulation on Surface Water Quality, against the B2 standard. The B2 standard was selected as the water quality requirements are lower as it applies to waterways that are to be used for transportation and other purposes. The locations where surface water samples were taken are presented in Figure 7.17.

The laboratory results from this sampling program as presented below in Table 7.11. It can be seen that the majority of samples were under the allowable limits of QCVN 08-MT: 2015/BTNMT (column B2). It should be noted, the regional surface water quality was generally good and at the time of sampling and there was no evidence of pollution.

However, amonium concentration was slightly higher at the location NM-01 than the standard due to effluent from aquculture activities discharge.

Table 7.11 Results of monitoring and analysing surface water quality in the Project area

No	Parameter	Unit	NM-01 (9.928406, 106.6576)	NM-02 (9.918433, 106.6652)	NM-03 (9.9143, 106.6636)	NM-04 (9.911122, 106.6654)	NM-05 (9.903239, 106.67)	QCVN 08-MT:2015/ BTNMT - B2 column
1	pH	-	7.3	7.1	7.7	7.8	7.7	**5.5-9.0**
2	DO	mg/l	6.22	6.41	6.61	6.44	6.67	**>2**
3	TSS	mg/l	45	60	41	66	62	**100**
4	NH_4^+	mg/l	0.91	0.87	0.80	0.88	0.82	**0.9**
5	CN^-	mg/l	0.004	0.003	0.003	0.003	0.003	**0.05**
6	As	mg/l	0.001	0.004	0	0	0.003	**0.1**
7	Cd	mg/l	0.00006	0.00002	0.00007	0.00005	0.00002	**0.01**
8	Pb	mg/l	0.0012	0.0015	0.0010	0.0013	0.0015	**0.05**
9	Cr (VI)	mg/l	0.04	0.045	0.03	0.028	0.01	**0.05**
10	Cu	mg/l	0.1	0.2	0.15	0.17	0.11	**1**
11	Zn	mg/l	0.45	0.57	0.55	0.42	0.59	**2**
12	Hg	mg/l	0.00003	0.00002	0.00004	0.00004	0.0001	**0.02**
13	Total oil & grease*	mg/l	0.91	0.89	0.88	0.80	0.86	**1**
14	Coliform	MPN/ 100ml	75	83	77	92	68	**200**

Source: EIA, 2019

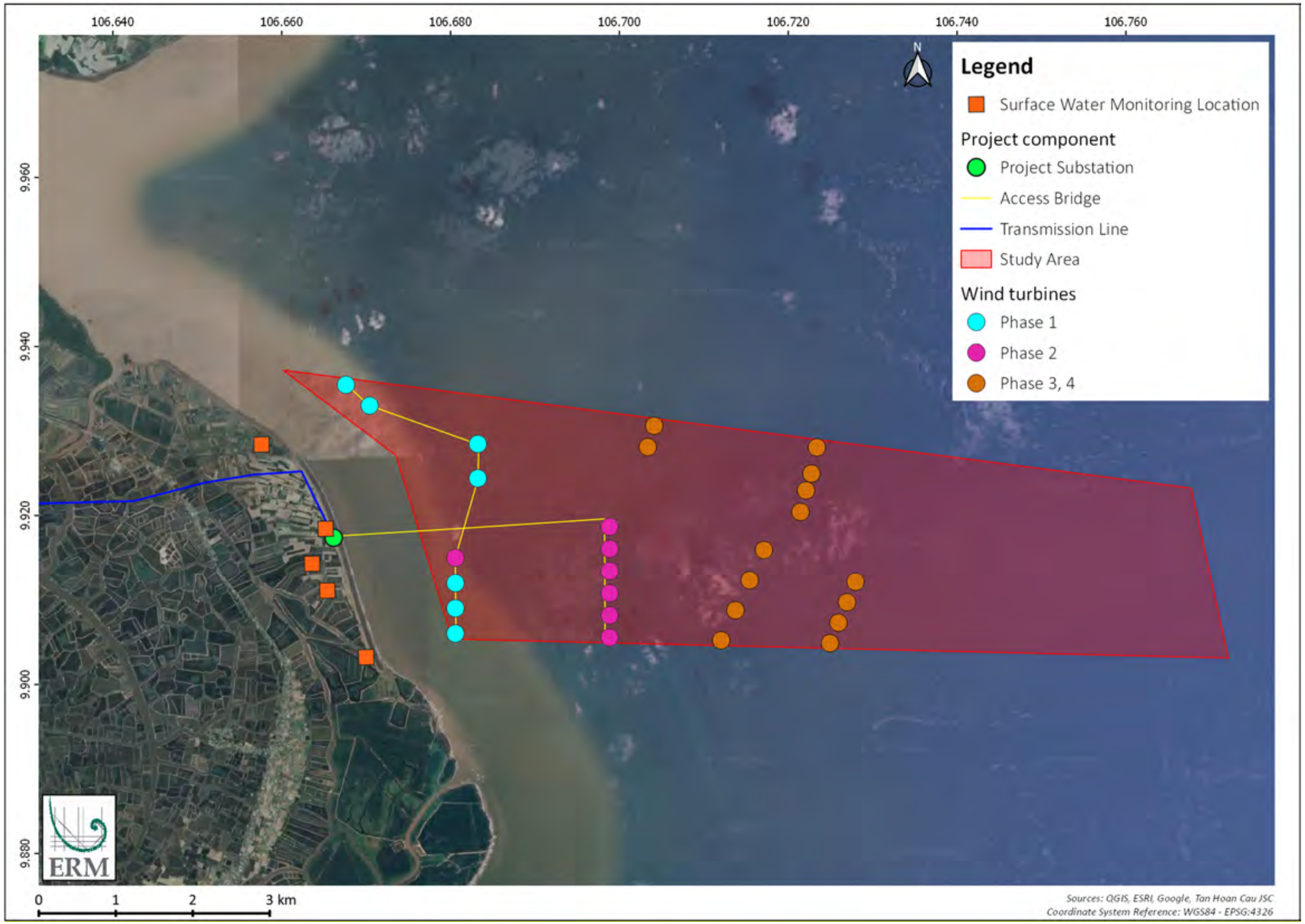


Figure 7.17 Surface water monitoring location

7.8.3 Groundwater

In accordance with QCVN 09:MT-2015/BTNMT – National Technical Regulation on Underground Water Quality, wells across the Project area were identified and determine as to their suitability to provide an accurate assessment of the ground water quality upstream, across and downstream of the project area.

Five groundwater sampling locations were identified. The locations where the samples were taken are described in Table 7.12 and presented Figure 7.18. Each sample was analysed against 13 groundwater parameters. The laboratory results for each well and each parameter are presented in Table 7.12 and the key findings described below.

The result show that the all of samples were under the thresholds allowed by QCVN 09-MT:2015/BTNMT which indicate the groundwater in the area had decent quality.

Table 7.12 Results of monitoring and analysing groundwater quality in the Project area

No	Parameter	Unit	NN-01 (9.926069, 106.6554)	NN-02 (9.923775, 106.6602)	NN-03 (9.920269, 106.6618)	NN-04 (9.910525, 106.6615)	NN-05 (9.902808, 106.6609)	QCVN 09-MT:2015/ BTNMT
1	pH	-	7.2	6.9	6.9	7.3	7.1	**5.5-8.5**
2	DO	mg/l	0	0.2	0.1	0	0	**>4**
3	TSS	mg/l	10	9	7	4	8	**1500**
4	NH_4^+	mg/l	0.75	0.66	0.70	0.82	0.81	**1**
5	CN^-	mg/l	0.0015	0.0013	0.0011	0.0012	0.0011	**0.01**
6	As	mg/l	0.0002	0.0003	0.0001	0.0001	0	**0.05**
7	Cd	mg/l	0.000013	0.000012	0.000012	0.000011	0.000010	**0.005**
8	Pb	mg/l	0.002	0.0013	0.0025	0.0011	0.0010	**0.01**
9	Cr (VI)	mg/l	0.033	0.031	0.029	0.029	0.030	**0.05**
10	Cu	mg/l	0.0029	0.0058	0.0021	0.0034	0.0046	**1**
11	Zn	mg/l	0.0085	0.0036	0.007	0.0072	0.0074	**3**
12	Hg	mg/l	0.000011	0.000015	0.000011	0.000013	0.000012	**0.001**
13	Coliform	MPN/ 100ml	0	0	0	0	0	**3**

Source: EIA, 2019

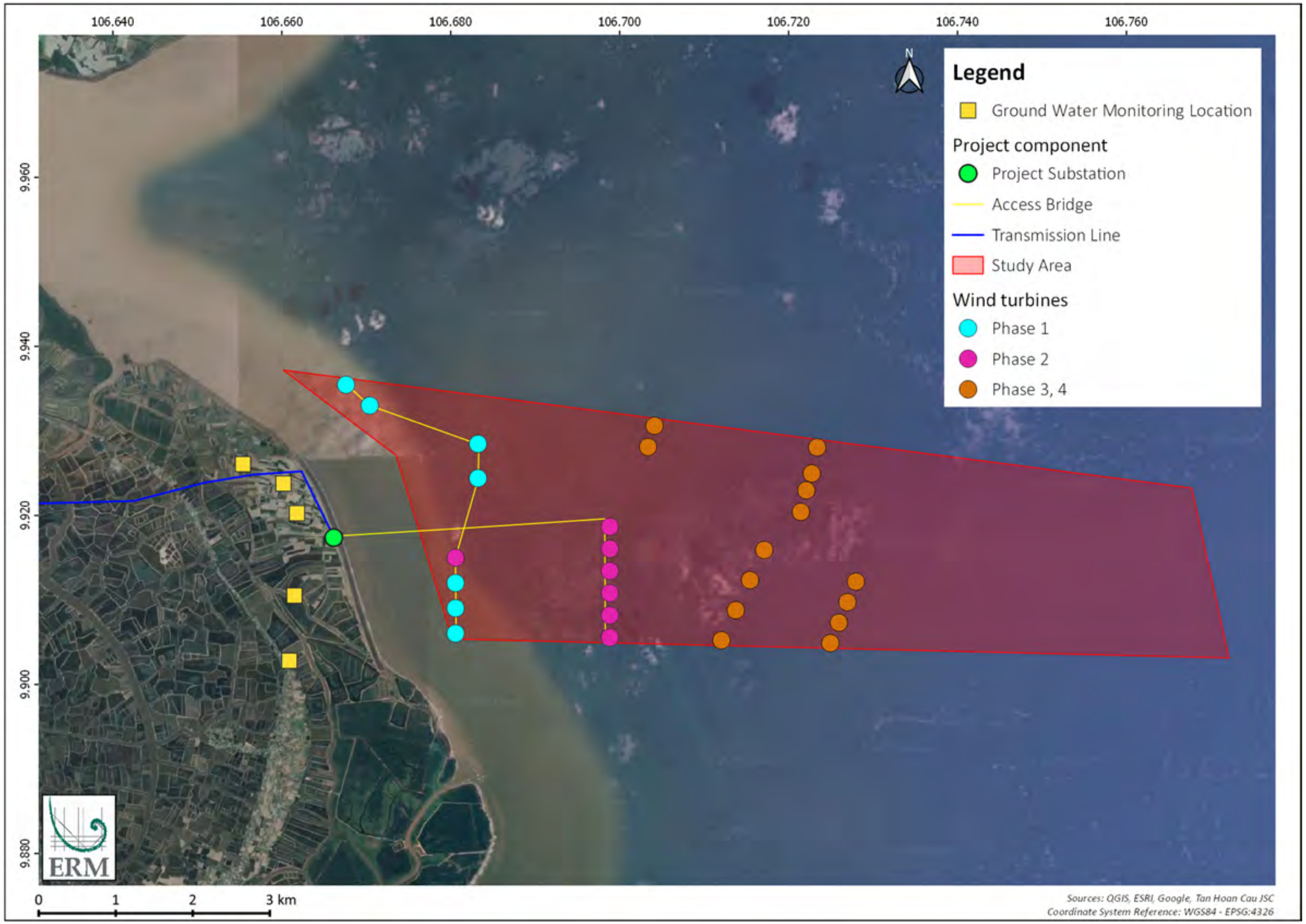


Figure 7.18 Groundwater monitoring location

7.9 Soil Quality and Sediment

7.9.1 Soil Quality

Soil samples were taken at locations where the Project's onshore components and its auxiliary project components will be constructed. Five soil samples were analysed and compared with six parameters that apply to soil samples of residential land, in accordance with QCVN 03-MT:2015/BTNMT - National Technical Regulation on Permissible Limits of Heavy Metals in Soil. The sampling locations are described in Figure 7.19.

The sampling results are presented in Table 7.13 and these result indicate that no systemic pollution was identified across the project area. However, isolated soil contamination may identified during more detailed land survey or construction activities.

Table 7.13 Results of monitoring and analysing soil quality in the Project area

No	Parameter	Unit	D-01 (9.928781, 106.6579)	D-02 (9.9185, 106.6651)	D-03 (9.913589, 106.6652)	D-04 (9.911275, 106.6655)	D-05 (9.903306, 106.67)	QCVN 03-MT:2015/ BTNMT
1	As	mg/kg	3.23	5.6	5.4	3.85	3.42	**15**
2	Fe	mg/kg	0	0	0	0	0	**-**
3	Pb	mg/kg	3.11	4.34	3.26	3.19	5.13	**70**
4	Zn	mg/kg	73.07	66.13	74.05	73.13	70.63	**200**
5	Hg	mg/kg	0	0	0	0	0	**-**
6	Cu	mg/kg	38.87	39.23	39.97	38.65	38.55	**100**

Source: EIA, 2019

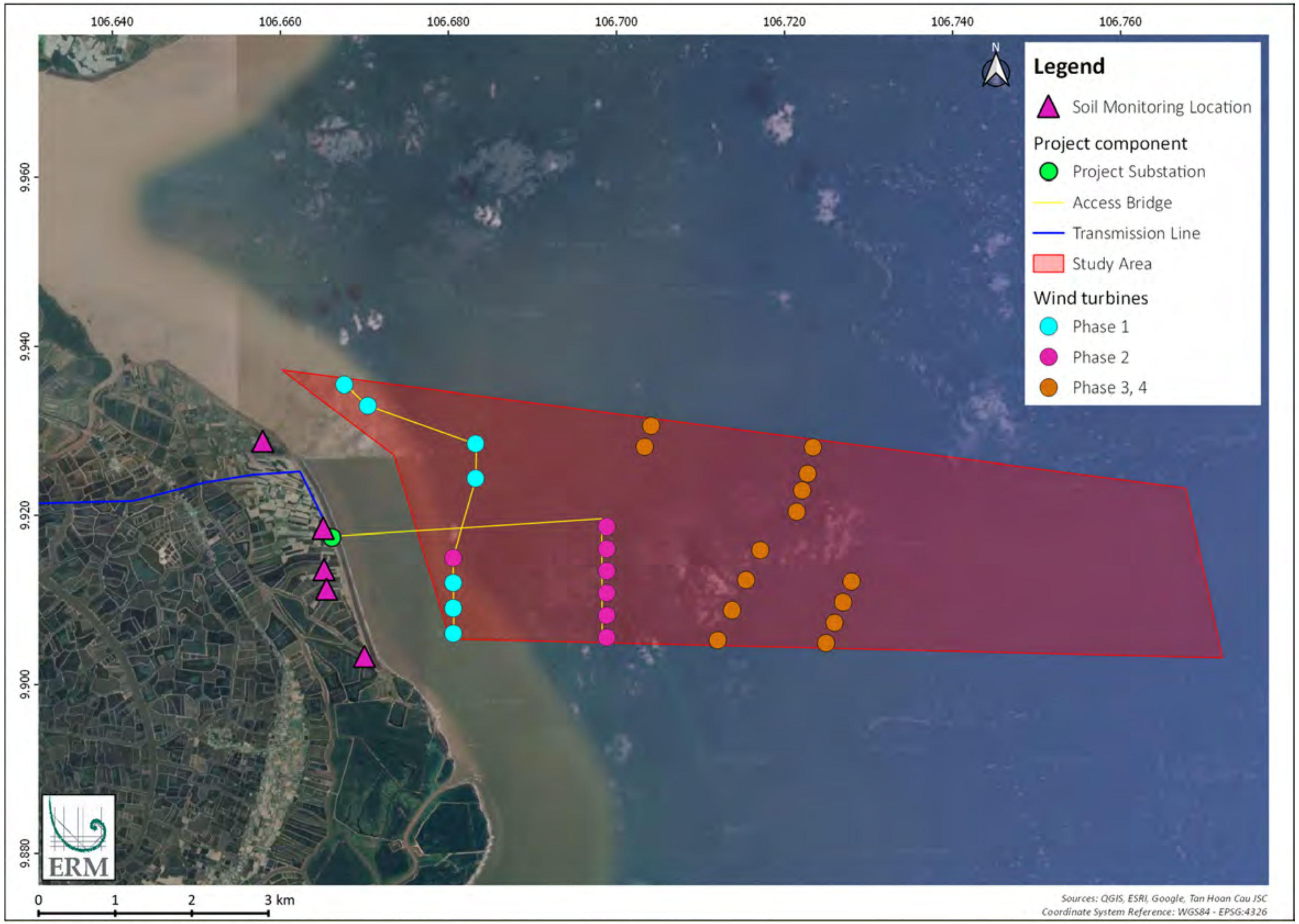


Figure 7.19 Soil monitoring location

7.9.2 Sediment

Only freshwater sediment samples were taken in the Project area during the local EIA phase. These sediment samples were analysed against eight parameters as required by QCVN 43:2012/BTNMT - National Technical Regulation on Sediment Quality.

The sampling locations and laboratory results are presented in Figure 7.20 and Table 7.14 respectively. These results indicate that freshwater sediment in the Project area appears not to be contaminated by heavy metals or hydrocarbons and compiles with the parameter limits imposed by QCVN 43:2012/BTNMT - National Technical Regulation on Sediment Quality.

Table 7.14 Results of monitoring and analysing sediment quality in the Project area

No	Parameter	Unit	TT-01 (9.928406, 106.6576)	TT-02 (9.918433, 106.6652)	TT-03 (9.9143, 106.6636)	TT-04 (9.911122, 106.6654)	TT-05 (9.903239, 106.67)	QCVN 43-MT:2012/ BTNMT
								Freshwater
1	As	mg/kg	4.47	3.23	4.90	5.40	5.51	**17**
2	Cd	mg/kg	0.057	0.037	0.06	0.023	0..37	**3.5**
3	Pb	mg/kg	10.08	9.23	10.87	9.03	6.17	**91.3**
4	Zn	mg/kg	228.13	241.13	191.97	178.3	170.13	**315**
5	Hg	mg/kg	0.0021	0.0017	0.0019	0.0022	0.0017	**0.5**
6	Cr	mg/kg	15	15	13	11	11	**90**
7	Cu	mg/kg	28.63	29.23	28.30	19.83	25.43	**197**
8	Total HC	mg/kg	77	77	75	73	73	**100**

Source: EIA, 2019

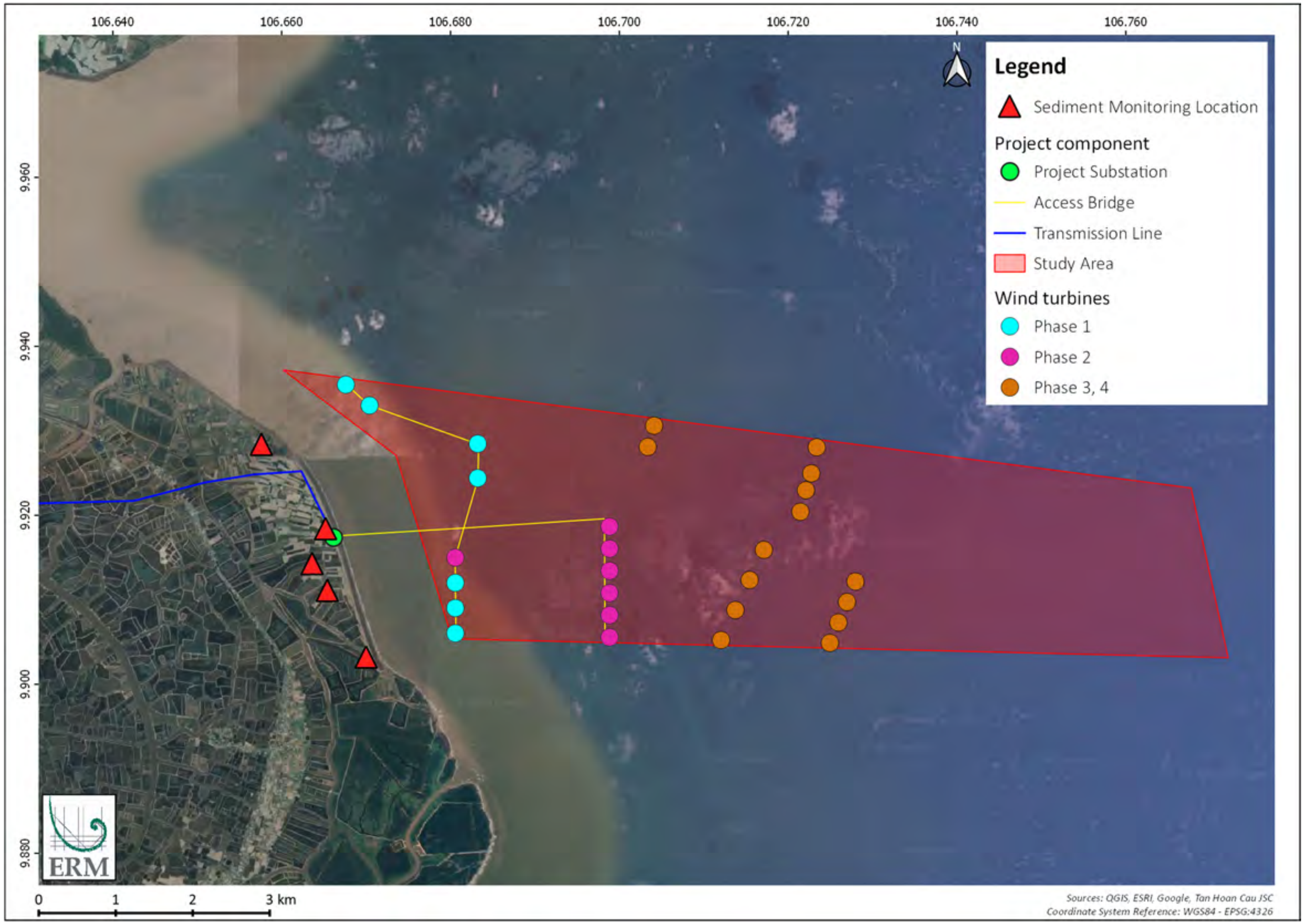


Figure 7.20 Sediment monitoring location

7.10 Biodiversity

The biodiversity section provides an overview of protected areas, critical, natural and modified habitats, conservation significant species, terrestrial and marine biodiversity in the region, with a focus on the Project Area. The information presented in this section is primarily derived from a desktop review of relevant publications and online resources, biodiversity surveys conducted and the IBAT (Integrated Biodiversity Assessment Tool).

7.10.1 Background Assessment

This section summarises information from several databases and online data sources on biodiversity values within the landscape to determine predicted biodiversity values associated with the Project Area.

The following definition of areas have been used:

- The Project Area is defined as the development boundaries located in the terrestrial and marine zones. It is the footprint of disturbance required for the Project (Figure 7.21)
- The Study Area encompasses a 50 km buffer of the Project and has been used to identify biodiversity habitats and values for consideration (Figure 7.21);
- The Project Area of Influence (AoI) is the region in a 1km radius from the Project Area and has been assessed to define habitat values in the immediate project vicinity where species may regularly occur (Figure 7.21); and
- Where a species is identified to have or is likely to have a regular occurrence in the Project AoI, the Ecologically Appropriate Area (EAA) has been defined as required under IFC PS6 for that species. The EAA is used to identify the presence of critical habitat for that species (through application of the IFC PS6 critical habitat thresholds outlined in the IFC PS6 Guidance Note (IFC, 2019)) (Section 7.8.4).

The desktop review considered online sources, literature and environmental studies undertaken within the Study Area. Key sources include:

- NGO webpages and databases including those belonging to the World Wildlife Fund (WWF);
- Alliance for Zero Extinction (AZE);
- BirdLife International;
- Global Biodiversity Information Facility (GBIF);
- International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (the 'IUCN Red List') and their profiles;
- IUCN Red List of Ecosystems; and
- Integrated Biodiversity Assessment Tool (IBAT) IFC/WB ESS6 Risk Report (dated 25 September 2019).

The information is combined with field-recorded data obtained from field assessments undertaken for the Project and used to evaluate potential critical habitat triggers that may be associated with the EAA for onshore, nearshore, and offshore components. Critical habitat is assessed by screening desktop, historic and survey data to identify these triggers. Data is screened to determine whether a species or habitat is likely to meet a critical habitat threshold. The EAA for this project is discussed in Section 7.10.1.12.

Figure 7.21 Biodiversity Assessment Areas within Study Area

7.10.1.1 Ecoregion Description

Southern Vietnam is represented by three ecoregions (WWF, 2019a), namely Indochina Mangroves (WWF, 2019b), Tonle Sap Freshwater Swamp Forests (WWF, 2019c) and Tonle Sap-Mekong Peat Swamp Forests (WWF, 2019d). The three ecoregions are described in the following sections to describe the habitat values of the greater landscape.

7.10.1.1.1 Indochina Mangroves

As one of the most diverse and extensive mangrove ecosystems in the world, this ecoregion provides extremely important habitat for some of the world's rarest waterbirds. Included in this assemblage are the lesser adjutant (*Leptoptilos javanicus*), Storm's stork (*Ciconia stormi*), white-winged wood duck (*Cairina scutulata*), and spot-billed pelican (*Pelicanus philippensis*). There are no endemic mammals in the ecoregion, but many species are known to use mangroves, including the tiger (*Panthera tigris*), tapir (*Tapirus indicus*), and siamang (*Hylobates syndactylus*) (however these species were not detected).

There are several reptile species of conservation significance in this ecoregion, including the monitor lizard (*Varanus salvator*), the false gavial (*Tomistoma schlegeli*), and the estuarine crocodile (*Crocodylus porosus*). The Mekong delta supports a valuable fishery, especially for shrimp.

The area of this ecoregion is approximately 2,693,588 ha. This ecoregion is highly threatened in nearly every site where it occurs by a range of human activities.

7.10.1.1.2 Tonle Sap Freshwater Swamp Forests

The swamp shrublands and forest of the Tonle Sap Freshwater Swamp Forests ecoregion include two forest associations that have been described for the extensive floodplain area of Tonle Sap – a short tree shrubland for most of the area and a stunted swamp forest around the lake itself. The flora of these short-tree shrublands is dominated by species of Euphorbiaceae, Fabaceae, and Combretaceae, together with *Barringtonia acutangula*. *Terminalia cambodiana* is an important local endemic and the giant mimosa (*Mimosa pigra*) is a problematic invasive species in this ecoregion. In addition to areas of woody vegetation, this ecoregion includes extensive areas of seasonally inundated grasslands growing in a mosaic of scattered individuals of *Barringtonia acutangula*.

Mammals of conservation significance include the endangered pileated gibbon (*Hylobates pileatus*), tiger (*Panthera tigris*), and several threatened species, including wild dog (*Cuon alpinus*), sun bear (*Ursus malayanus*), clouded leopard (*Pardofelis nebulosa*), common leopard (*Panthera pardus*), and banteng (*Bos javanicus*). There is one near-endemic bat species – Thailand leaf-nosed bat (*Hippisideros halophyllus*).

Although unsuitable for agriculture, areas that have been degraded to reed beds nonetheless are still important sites for waterfowl, providing feeding grounds for the eastern sarus crane (*Grus antigone*), white-shouldered ibis (*Pseudibis davisoni*), and near-endemic giant ibis (*Pseudibis gigantea*).

The area of this ecoregion is approximately 2,589,989 ha. Excessive forest exploitation has reduced many areas of this ecoregion to scrub or secondary forest invaded by exotic species, and the natural regeneration speed of large species is slow.

7.10.1.1.3 Tonle Sap-Mekong Peat Swamp Forests

Brackish and freshwater wetlands behind mangrove areas in Cambodia and the Mekong delta area of Vietnam typically are dominated by dense stands of *Meleuca leucadendron* called the paperbark swamps or rear mangrove communities. Once extensive, today the area of Melaleuca forests has been greatly diminished, although reforestation efforts have been successful. The largest remaining stands of Melaleuca forest occur on peat soils of the U Minh area of Minh Hai Province and on the acidic soils of the Plain of Reeds and Ha Tien plain in Vietnam.

Mammal species of conservation significance include the possibly extinct wild water buffalo (*Bubalus arnee*), Eld's deer (*Cervus eldii siamensis*), Indochinese hog deer (*Axis procinus annamiticus*), and banteng (*Bos javanicus*). The reed beds are important sites for waterfowl, and the habitats provide feeding grounds for the eastern sarus crane (*Grus antigone*), the near-endemic giant ibis (*Pseudibis* *gigantea*), white-shouldered ibis (*Pseudibis davisoni*), glossy ibis (*Plegadis falcinellus*), black-headed ibis (*Threskiornis melanocephalus*), Asian openbill (*Anastomus oscitans*), and possibly the lesser adjutant (*Leptoptilos javanicus*).

The area of this ecoregion is approximately 2,952,586 ha. Excessive forest exploitation has reduced many areas of this ecoregion to scrub or secondary forest made up of exotic species. Less than 1 % of the ecoregion is protected, although the Tonle Sap Great Lake reserve, which extends into the ecoregion, is extensive (272,500 ha).

7.10.1.2 World Heritage Areas

World Heritage Areas are areas of outstanding universal value designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO), as detailed in the following Sections 7.8.1.2.1 and 7.8.1.2.2.

7.10.1.2.1 World Heritage Sites

World Heritage Sites are sites selected by UNESCO as having cultural, historic, scientific or other form of significance. These areas are legally protected by international treaties and demarcated by UNESCO as protected zones. This allows for practical conservation of areas which would otherwise be subjected to threats such as uncontrolled and unrestricted access, and associated activities such as poaching and illegal logging.

Vietnam has eight registered World Heritage Sites (UNESCO, 2019a). As none of the World Heritage Sites overlap with the Study Area and the AoI, World Heritage Sites are not considered relevant for this assessment.

7.10.1.2.2 Biosphere Reserves

Biosphere Reserves are areas made up of terrestrial, coastal and marine ecosystems, internationally recognized under UNESCO's Man and Biosphere Programme. They are intended to be learning sites for sustainable development where each reserve encourages sustainable management of interactions between social and ecological systems (UNESCO, 2019b).

Vietnam has nine Biosphere Reserves. None of the Biosphere Reserves are within the Study Area, and the closest Biosphere Reserve is the Can Gio Mangrove Biosphere Reserve located approximately 55 km to the Northeast, outside the Study Area. As such, Biosphere Reserves are not considered relevant for this assessment.

7.10.1.3 Ramsar Sites

The Convention of Wetlands, also known as the Ramsar Convention, is an intergovernmental treaty that provides the framework for the conservation and use of wetlands and their resources (Ramsar Convention on Wetlands, 2019). The Ramsar Convention for Vietnam has been effective from 20 January 1989, and currently has nine sites designated as Wetlands of International Importance, which cover an approximate surface area of 120,549 ha (Ramsar Convention on Wetlands, 2011). None of these sites are within the Study Area, and hence Ramsar sites are not considered relevant for this assessment.

7.10.1.4 Biodiversity Hotspots

Vietnam, along with Cambodia, China, Lao PDR, Myanmar and Thailand, is identified as part of the Indo-Burma Biodiversity Hotspot (Conservation International, 2019). The Hotspot covers a land area of 2,308,815 km2, and is one of the most biologically important regions on the planet. The Indo-Burma Hotspot has a diversity of landforms and climatic zones encompassing a number of complete mountain ranges and sections of others. It features isolated massifs and plateaus, extensive areas of limestone karst and several of Asia's largest rivers. As a result there is a high variety of habitats and thus biodiversity (Critical Ecosystem Partnership Fund, 2007).

7.10.1.5 Key Biodiversity Areas

Key Biodiversity Areas (KBAs) are defined by the Key Biodiversity Areas Partnership[11] as sites that contribute significantly to the global persistence of biodiversity, applicable to terrestrial, freshwater, and marine ecosystems. Sites qualify as global KBAs if they meet one or more of 11 criteria as defined by the Partnership, grouped into the following five categories: threatened biodiversity, geographically restricted biodiversity, ecological integrity, biological processes and irreplaceability (BirdLife International, 2018a). KBAs include Important Bird and Biodiversity Areas (IBA), Alliance for Zero Extinction (AZE), Important Plant Areas (IPA) and Important Sites for Freshwater Biodiversity. KBAs that have been identified within the Study Area are listed in Table 7.15. The location of KBAs relative to the Project components is shown in Figure 7.22.

Table 7.15 KBAs Identified within the Study Area

S/N	Area Name	IBA	Distance and Direction
1.	Ba Tri (6000 ha)	Yes	5 km North of Project
2.	Binh Dai (30000 ha)	Yes	15 km Northeast of Project
3.	Chua Hang (2 ha)	Yes	35 km Southwest of Project
4.	Tra Cu (2 ha)	Yes	45 km Southwest of Project

Source: IBAT, 2019

[11] Key Biodiversity Partnership comprises a consortium of 12 conservation NGOs including BirdLife International, IUCN, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Rainforest Trust, Royal Society of the Protection of Birds, WWF and Wildlife Conservation Society.

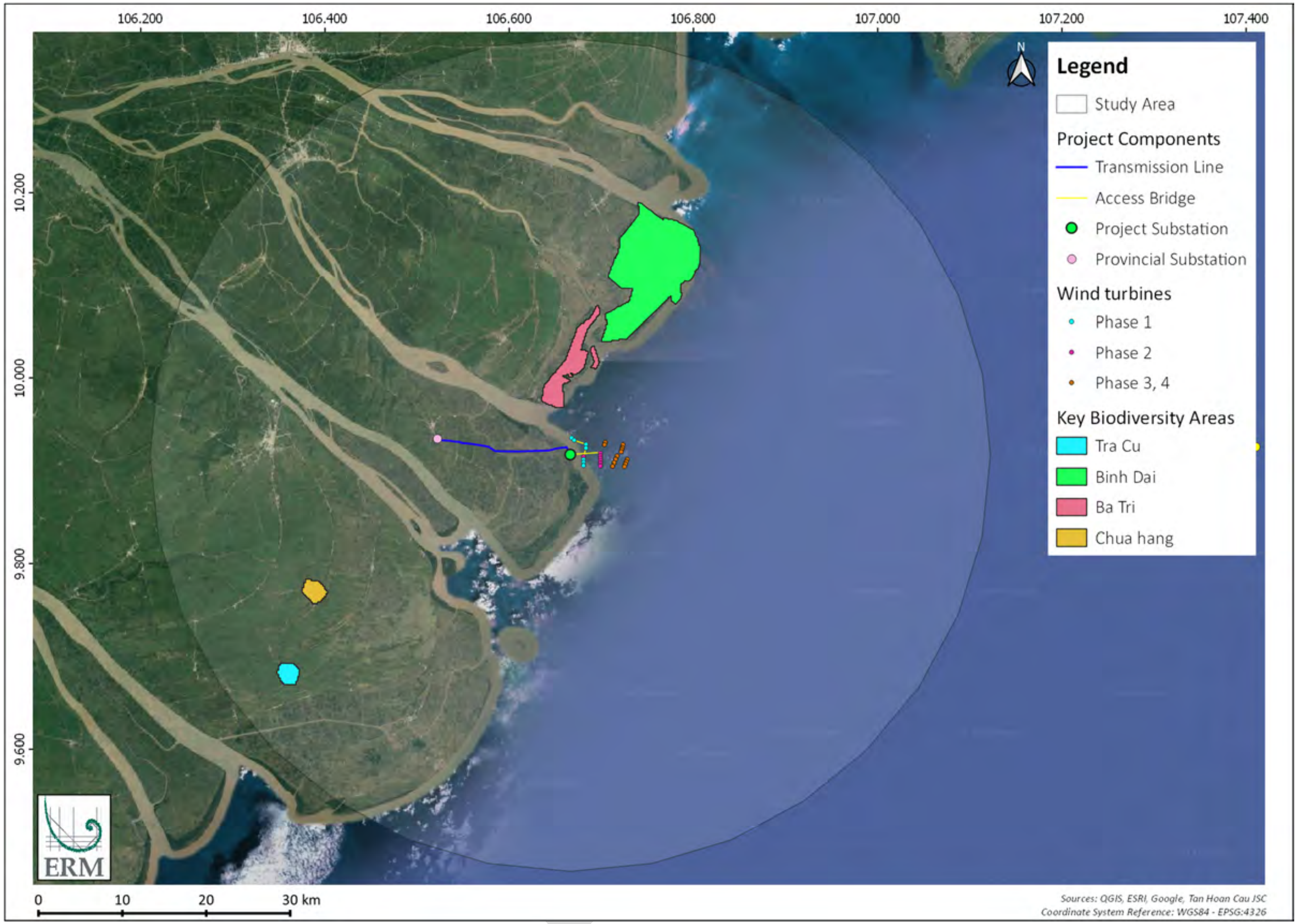


Figure 7.22 KBAs in proximity to the Project Area

7.10.1.5.1 Important Bird and Biodiversity Areas

An Important Bird and Biodiversity Area (IBA) is an area that is globally important for the conservation of birds and other biodiversity. The summary of IBAs identified within the Study Area is shown in Table 7.16.

Table 7.16 IBAs Identified within the Study Area

S/N	Area Name	Summary
1.	Ba Tri	Ba Tri is classified as an IBA approximately 6,000 ha in size, located approximately 5 km from the Project Area. This coastal IBA is situated by the mouth and riverside areas of the Bai Lai river, which opens out onto sandy and shallow flats during low tide. The sandy flats and shallow waters are an important biodiversity area as the tidal areas surrounding the Bai Lai river contain organically rich silts deposited on top of sand banks and sand flats and high tide roost has been found at the mouth of the small Con Nhan River. One of the threats associated with this IBA is a general decline in water quality and productivity. The trigger species known to use this area on a frequent basis are the Chinese Egret (migratory), the Greater Sandplover (migratory) and the Spoon-billed Sandpiper (CR and migratory) (BirdLife International, 2019a).
2.	Binh Dai	Binh Dai is classified as an IBA approximately 30,000 ha in size, located approximately 15 km from the Project Area. This coastal IBA is situated within an area of flood-prone delta marshlands and mangrove intertidal area. High tide roosts are present within the vicinity of this IBA, and it is estimated that a total of 35 shorebird species and 27 other waterbird species use this area and surrounds. The trigger species found in this IBA include the Great White Egret (migratory), Kentish Plover (migratory), Greater Sandplover (migratory), Chinese Egret (migratory), Lesser Adjutant (migratory), Black-tailed Godwit (migratory), Nordmann's Greenshank (EN and migratory) (BirdLife International, 2019b).
3.	Chua Hang	Chua Hang is classified as an IBA approximately 2 ha in size, located approximately 35 km from the Project Area. This bird sanctuary is located several kilometres outside Tra Vinh within the grounds of a pagoda. This area is known for vast numbers of birds congregating in this pagoda to roost and breed. The trigger species known to use this area on a frequent basis are the Black-crowned Night Heron (migratory) and the Oriental Darter (congregatory) (BirdLife International, 2019c).
4.	Tra Cu	Tra Cu is classified as an IBA approximately 2 ha in size, located approximately 45 km from the Project Area. This bird sanctuary is within the grounds of a pagoda, and is known as one of the most important breeding colonies in the Mekong Delta. The trigger species known to use this area on a frequent basis are the Black-crowned Night Heron (migratory) and the Black-headed Ibis (migratory) (BirdLife International, 2019d).

Source: BirdLife International, 2019.

7.10.1.5.2 Alliance for Zero Extinction Sites

The Alliance for Zero Extinction (AZE) sites work to safeguard and increase populations of critically endangered and endangered species (AZE, 2019). This involves eliminating human threats such as commercial exploitation, disease, and introduction of invasive species. None of these sites are within the Study Area, and hence AZE sites are not considered relevant for this assessment.

7.10.1.6 Endemic Bird Areas

An Endemic Bird Area (EBA) is an area to which at least two restricted range bird species (species with extent of occurrence (EOO) of ≤ 50,000 km^2) are entirely confined (BirdLife International, 2019e). Vietnam has a total of seven EBAs but none of these EBAs are located within the Study Area of the Project. The closest EBA to the Project Area is the South Vietnamese lowlands, approximately 130 km to the Northeast with a total area of 30,000 km^2 (BirdLife International, 2019f). As such, EBAs are not considered relevant for this assessment.

7.10.1.7 Protected Areas

According to the IUCN (2008), a Protected Area is "A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve long-term conservation of nature with associated ecosystem services and cultural values.". Under the provisions of IFC PS6, a Protected Area and Internationally Recognized area require specific management actions if development proceeds within the boundary (see requirements under KBAs outlined above). Consultation with protected area managers and the community will be required.

Where a proposed project is located within a legally protected area, IFC PS6 requires that:

- The natural habitats are not significantly degraded;
- Mitigations are designed to achieve no net loss of biodiversity where feasible project activities are not implemented within critical habitat;
- Demonstrate that the project's significant residual impacts on biodiversity are adequately mitigated;
- Demonstrate the proposed development is legally permitted;
- The client will act in a manner consistent with any government recognised management plans;
- Protected area sponsors and management, Affected Communities, Indigenous Peoples and other stakeholders are consulted as appropriate; and
- Additional programs to promote and enhance the conservation aims and effective management of the area are implemented as appropriate.

7.10.1.7.1 ASEAN Heritage Parks

ASEAN Heritage Parks (AHPs) are selected protected areas in the ASEAN region recognized for their unique flora and fauna and ecosystems, wilderness and excellent values (ASEAN Centre for Biodiversity, 2019). There are no AHPs located within the Study Area. The closest AHP to the Project Area is the U Minh Thuong National Park, approximately 180 km to the west. As such, ASEAN Heritage Parks are not considered relevant for this assessment.

7.10.1.7.2 Nationally Protected Areas

One Nationally Protected Area exists within the Study Area.

The Thanh Phu Protected Area is a nature reserve spanning 4800 ha, with IUCN Management Category IV. Thanh Phu is situated within the vicinity of the Project Area and is considered an important area for mangrove species diversity (Cuc & de Ruyter van Steveninck, 2015). Thanh Phu's location relative to the Project components is shown in Figure 7.23. Approximately 11.8 km^2 of the Protected Area is within the Project Area.

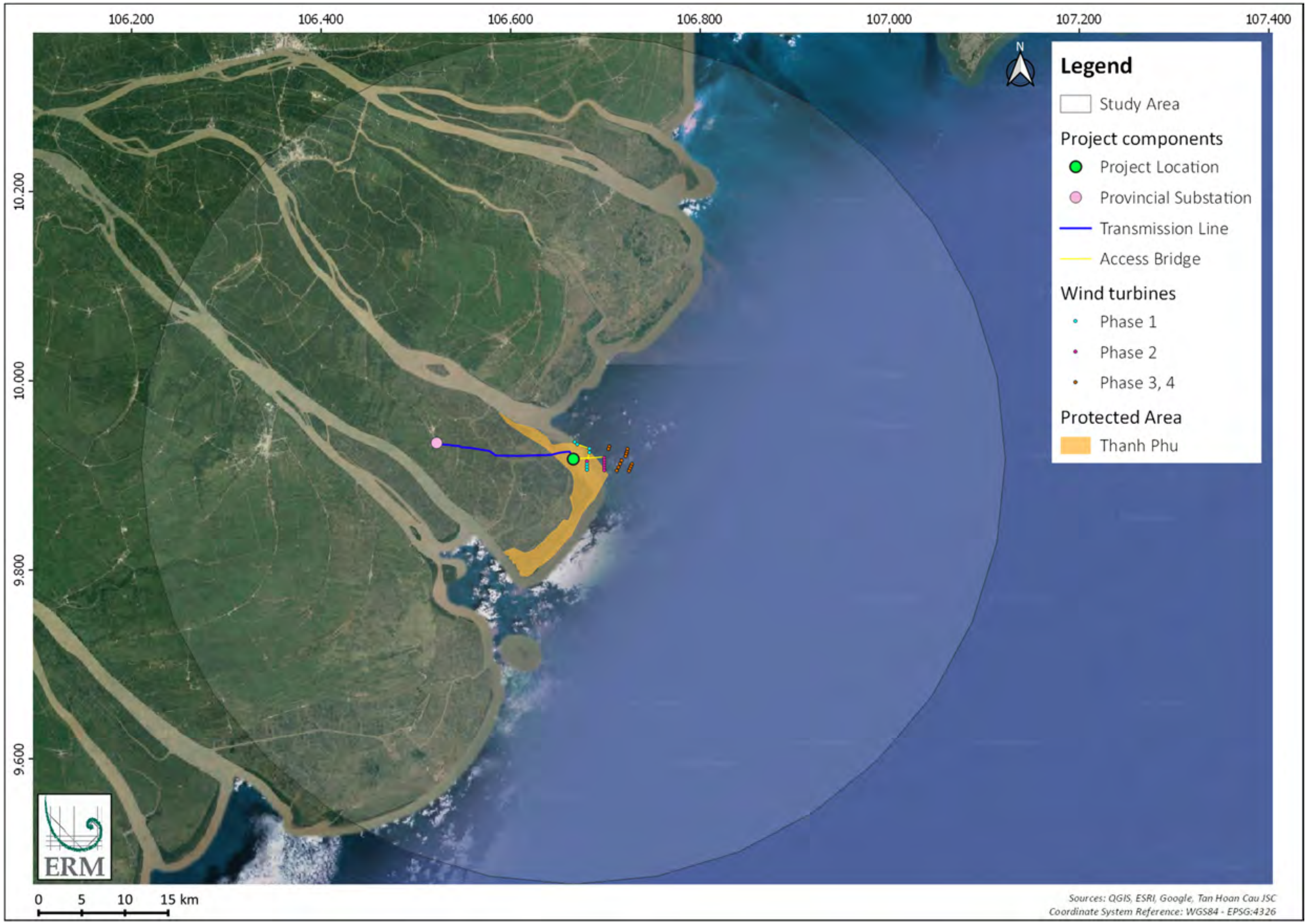


Figure 7.23 Protected Area within the Study Area

7.10.1.8 Vietnam Forest Classifications

Vietnam's forests can be categorized into three categories (Forest Science Institute of Vietnam, 2009), namely special use, production and protection under the Law on Protection and Development of Forest of the National Assembly (Forest Law) (The REDD Desk, 2004):

- Special-use forest: Special-use forests, which are used mainly for conservation of nature, specimens of the national forest ecosystems and forest biological gene sources; for scientific research; protection of historical and cultural relics as well as landscapes; in service of recreation and tourism in combination with protection, contributing to environmental protection. Special-use forest may include (1) national parks; (2) nature conservation zones; (3) landscape protection areas; and (4) scientific research and experiment forests.
- Production forest: Production forests are used mainly for production and trading of timber and non-timber forest products in combination with protection, contributing to environmental protection, including (1) natural production forests; (2) planted production forests; (3) seeding forests, including the selected and recognized planted forests and natural forests.
- Protection forest: Protection forests are used mainly to protect water sources and land, prevent erosion and desertification, restrict natural calamities and regulate climate, thus contributing to environmental protection. Protection forest may include (1) headwater protection forests; (2) wind- and sand-shielding protection forests; (3) protection forests for tide shielding and sea encroachment prevention; and (4) protection forests for environmental protection.

7.10.1.9 Conservation Significant Species

The IBAT database was used to identify potential critical habitat species (Critically Endangered, Endangered species, and Restricted Range species) within the Study Area in order to assess against the thresholds for Critical Habitat Criterion 1 (Critically endangered and endangered species) and Criterion 2 (Endemic and/or restricted-range species). The complete IBAT risk screen report (dated 13 November 2019) is shown in Table 7.17.

7.10.1.9.1 Threatened Species

Threatened species are identified as those classified on the IUCN Red List of Threatened Species. The Red List provides the conservation status of these listed species as being Critically Endangered (CR) and Endangered (EN). CR and EN species are considered to be at a heightened risk of extinction and are awarded an elevated level of consideration under IFC PS6. These species are candidates for screening against Critical Habitat Criterion 1.

Threatened species that have been identified within the Study Area are listed in Table 7.17.

Table 7.17 Threatened Species Identified within the Study Area

S/N	Scientific Name	Common Name	IUCN Category	Class
1.	*Batagur affinis*	Southern River Terrapin	CR	Reptile
2.	*Carcharhinus hemiodon*	Pondicherry Shark	CR	Cartilaginous fish
3.	*Catlocarpio siamensis*	Giant Carp	CR	Ray-finned fish
4.	*Crocodylus siamensis*	Siamese Crocodile	CR	Reptile
5.	*Datnioides pulcher*	Siamese Tiger Perch	CR	Ray-finned fish
6.	*Emberiza aureola*	Yellow-breasted Bunting	CR	Bird
7.	*Glaucostegus thouin*	Clubnose Guitarfish	CR	Cartilaginous fish
8.	*Glaucostegus typus*	Giant Guitarfish	CR	Cartilaginous fish
9.	*Gyps bengalensis*	White-rumped Vulture	CR	Bird
10.	*Indotestudo elongata*	Elongated Tortoise	CR	Reptile
11.	*Pangasianodon gigas*	Mekong Giant Catfish	CR	Ray-finned fish
12.	*Pangasius sanitwongsei*	Giant Pangasius	CR	Ray-finned fish
13.	*Pristis pristis*	Largetooth Sawfish	CR	Cartilaginous fish
14.	*Pristis zijsron*	Green Sawfish	CR	Cartilaginous fish
15.	*Probarbus jullieni*	Jullien's Golden Carp	CR	Ray-finned fish
16.	*Pseudibis davisoni*	White-shouldered Ibis	CR	Bird
17.	*Rhina ancylostoma*	Bowmouth Guitarfish	CR	Cartilaginous fish
18.	*Rhynchobatus australiae*	Bottlenose Wedgefish	CR	Cartilaginous fish
19.	*Sarcogyps calvus*	Red-headed Vulture	CR	Bird
20.	*Aetomylaeus maculatus*	Mottled Eagle Ray	EN	Cartilaginous fish
21.	*Aetomylaeus vespertilio*	Ornate Eagle Ray	EN	Cartilaginous fish
22.	*Alveopora excelsa*	-	EN	Sea anemone and coral

S/N	Scientific Name	Common Name	IUCN Category	Class
23.	*Anacropora spinosa*	-	EN	Sea anemone and coral
24.	*Anoxypristis cuspidata*	Narrow Sawfish	EN	Cartilaginous fish
25.	*Balaenoptera musculus*	Blue Whale	EN	Mammal
26.	*Fluvitrygon oxyrhyncha*	Longnose Marbled Whipray	EN	Cartilaginous fish
27.	*Holothuria lessoni*	Golden Sandfish	EN	Sea cucumber
28.	*Holothuria scabra*	Golden Sandfish	EN	Sea cucumber
29.	*Hydnophora bonsai*	-	EN	Sea anemone and coral
30.	*Isurus oxyrinchus*	Shortfin Mako	EN	Cartilaginous fish
31.	*Isurus paucus*	Longfin Mako	EN	Cartilaginous fish
32.	*Lamiopsis temminckii*	Broadfin Shark	EN	Cartilaginous fish
33.	*Lutra sumatrana*	Hairy-nosed Otter	EN	Mammal
34.	*Orcaella brevirostris*	Irrawaddy Dolphin	EN	Mammal
35.	*Pangasianodon hypophthalmus*	Striped Catfish	EN	Ray-finned fish
36.	*Platalea minor*	Black-faced Spoonbill	EN	Bird
37.	*Porites eridani*	-	EN	Sea anemone and coral
38.	*Rhincodon typus*	Whale Shark	EN	Cartilaginous fish
39.	*Scleropages formosus*	Golden Dragon Fish	EN	Ray-finned fish
40.	*Sphyrna lewini*	Scalloped Hammerhead	EN	Cartilaginous fish
41.	*Sphyrna mokarran*	Great Hammerhead	EN	Cartilaginous fish
42.	*Sterna acuticauda*	Black-bellied Tern	EN	Bird
43.	*Urogymnus polylepis*	-	EN	Cartilaginous fish

Source: IBAT, 2019.
Note: CR – Critically Endangered
EN – Endangered

7.10.1.9.2 Restricted Range Species

According to IFC PS6, restricted range species is defined as species with an estimated extent of occurrence (EOO) of ≤ 50,000 km^2 for terrestrial vertebrates and ≤ 100,000 km^2 for marine species. These species are candidates for screening against Critical Habitat Criterion 2. Two (2) restricted range species has been identified within the Study Area in the IBAT report, as shown in Table 7.18.

Table 7.18 Restricted Range Species Identified within the Study Area

S/N	Scientific Name	Common Name	IUCN Category	EOO (km^2)	Class
1.	*Pseudibis davisoni*	White-shouldered Ibis	CR	1,010,000	Bird
2.	*Platalea minor*	Black-faced Spoonbill	EN	169,000	Bird

Source: IBAT, 2019.
Note: CR – Critically Endangered
EN – Endangered

Although the White-shouldered Ibis and Black-faced Spoonbill are identified as restricted range species in the IBAT report, they have an EOO of 1,010,000 km2 (BirdLife International, 2018b) and 169,000 km2 (BirdLife International, 2017) respectively (IUCN, 2019), and this does not meet the threshold definition for Criterion 2 under IFC PS6.

7.10.1.9.3 Migratory and/or Congregatory Species

Species identified as migratory and/or congregatory within the Study Area using the relevant BirdLife International database and IUCN species profiles are also listed in order to assess against the thresholds for critical habitat Criterion 3 (Migratory and/or congregatory species). 156 migratory birds and 18 migratory and/or congregatory fish were identified as candidates, as shown in Appendix C and Appendix D.

7.10.1.10 Invasive Species

Invasive species are non-native species to a particular ecosystem and whose introduction and spread causes, or are likely to cause, socio-cultural, economic or environmental harm or harm to human health. These species become naturalized in their introduced range, and often reproduce in large numbers spread over a large area. This can result in competition and damage to native species.

Invasive species have the capacity to exacerbate their role in ecosystem degradation through combination threats by habitat change, climate change, over-exploitation of ecosystem resources and pollution. These further enhance their threat to biodiversity and the human condition.

According to the Global Invasive Species Database (GISD, 2019), Vietnam is home to 131 invasive species, of which 102 are terrestrial species and 29 are aquatic species (freshwater and marine). The list of invasive species in Vietnam are shown in Appendix D.

7.10.1.11 Natural Habitat and Modified Habitat

7.10.1.11.1 Vegetation Class

Landcover analysis (Landsat 8) was used to calculate the normalised differential vegetation index (NDVI) of the Study Area, which was subsequently used to determine the vegetation classes. Vegetation classes derived from the Study Area are described below with satellite imagery and photographs, and are shown in the map in Figure 7.24. All satellite imagery were obtained from Google Earth and all site photographs were taken by ERM.

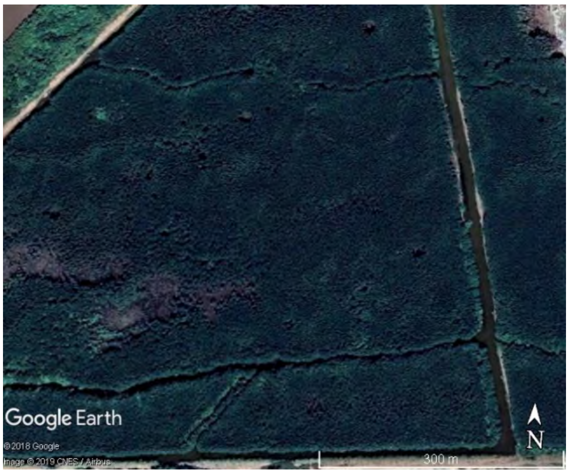
- Agriculture: Agriculture refers to agricultural land and annual crop land. Species of conservation significance may include (migratory) bird species such as Yellow-breasted Bunting, Black-browed Reed Warbler and Grey Heron. This area is considered to be modified habitat.

Satellite imagery of agricultural land **Photograph of agricultural land**

- Aquaculture: Aquaculture refers to aquacultural land, which includes fish and shrimp farms. Species of conservation significance may include (migratory) bird species as open-water areas and large concentrations of aquatic stocks are natural attractants to many birds such as the Osprey (Gorenzel et al., 1994). This area is considered to be modified habitat.

Satellite imagery of aquacultural land **Photograph of shrimp pond**

- Mangrove: Mangrove refers to area occupied by mangrove communities. Species of conservation significance may include migratory fishes and birds such as the Bloch's Gizzard Shad, Great White Egret and Striated Heron. This area is considered to be natural habitat.



Satellite imagery of mangrove **Photograph of mangrove**

- Surface water: Surface water generally refers to rivers and water bodies. Species of conservation significance may include (migratory) bird as open-water areas and large concentrations of aquatic stocks are natural attractants to many birds such as the Osprey (Gorenzel et al., 1994). It may also include endangered fish species such as the Giant Freshwater Whipray. This area is considered to be natural habitat.

Satellite imagery of surface water **Photograph of surface water**

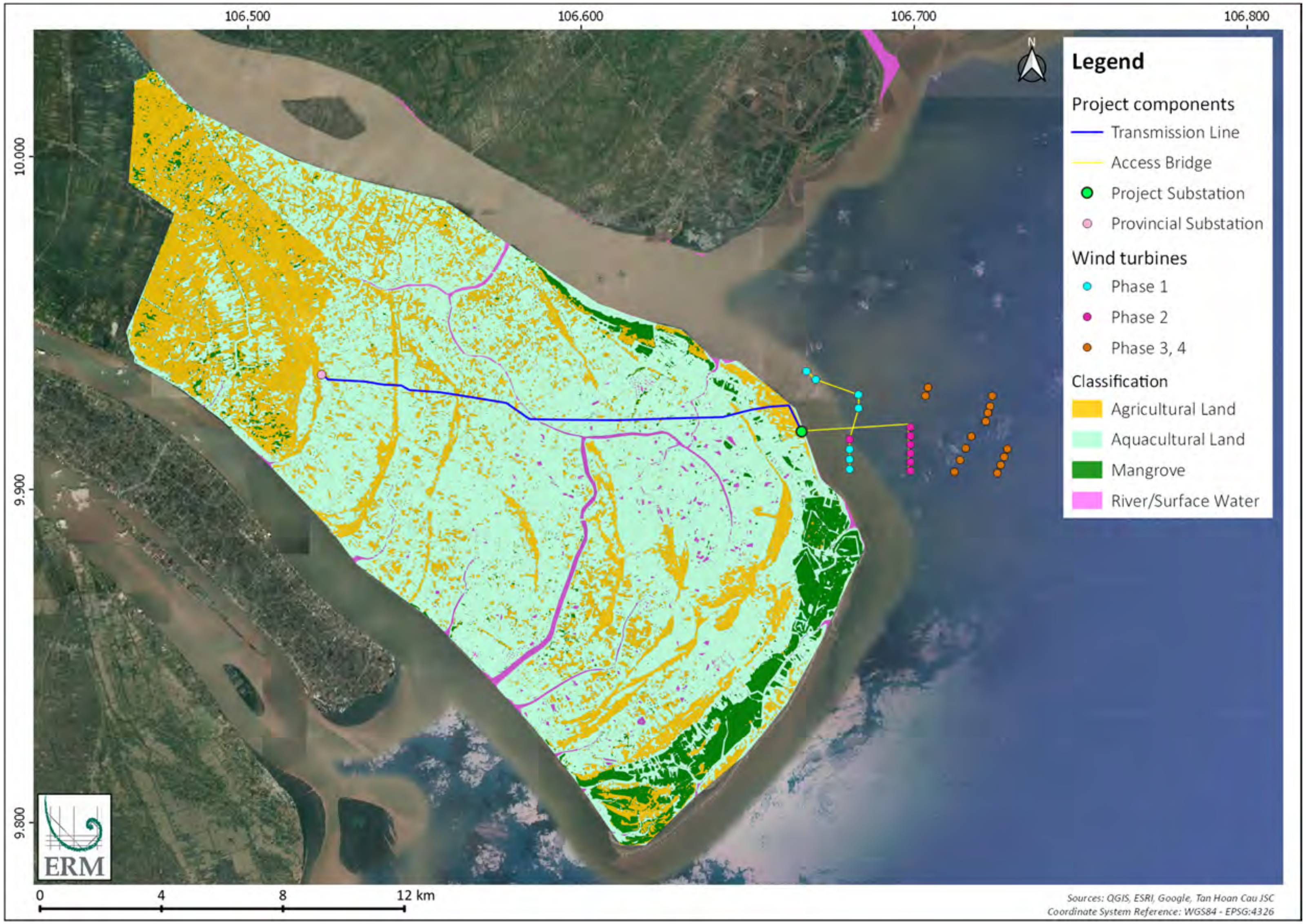


Figure 7.24 Vegetation Class in proximity to Project Area

7.10.1.11.2 Natural/Modified Habitat Assessment

IFC PS6 requires the assessment of the distribution of natural habitat and modified habitat in order to identify risks and mitigations to biodiversity values during the impact assessment phase.

The definition of natural habitat according to IFC PS6 is:

"*Areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition*".

The definition of modified habitat according to IFC PS6 is:

"*that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition*".

As required by the PS6, Clients are required to demonstrate compliance with Paragraph 14, which states:

"The client will not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified habitat;
- Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation;8 and
- Any conversion or degradation is mitigated according to the mitigation hierarchy".

If Natural Habitat is impacted, the Client is to comply with paragraph 15 which states:

"In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity where feasible. Appropriate actions include:

- Avoiding impacts on biodiversity through the identification and protection of set-asides;
- Implementing measures to minimize habitat fragmentation, such as biological corridors;
- Restoring habitats during operations and/or after operations; and
- Implementing biodiversity offsets."

There is currently no methodology within IFC PS6 and the associated Guidance Note (GN) on the approach to assess the distribution of these habitat types. ERM has utilised methods used previously in consultation with the IFC to complete this assessment using remote sensing techniques for the Study Area. The vegetation class assessment above and remote sensing have been used to define these areas.

Figure 7.25 shows the natural and modified habitat areas. Natural habitats consist of mangroves and river/surface water while modified habitats consist of agricultural land and aquacultural land.

The approximate area of each land class is summarised in Table 7.19.

Table 7.19 Natural and Modified Habitat areas within the Study Area

Habitat Type	Natural Habitat (km^2)	Modified Habitat (km^2)	Total (km^2)
Terrestrial EAA	47.25	586.23	633.48
Freshwater/Estuarine EAA	169.84	169.37	339.21
Marine EAA	884.21	0	884.21

Habitat Type	Natural Habitat (km^2))	Modified Habitat (km^2))	Total (km^2)
EAA	1101.3	755.6	1856.9
Project Area	32.17	0.65	32.82

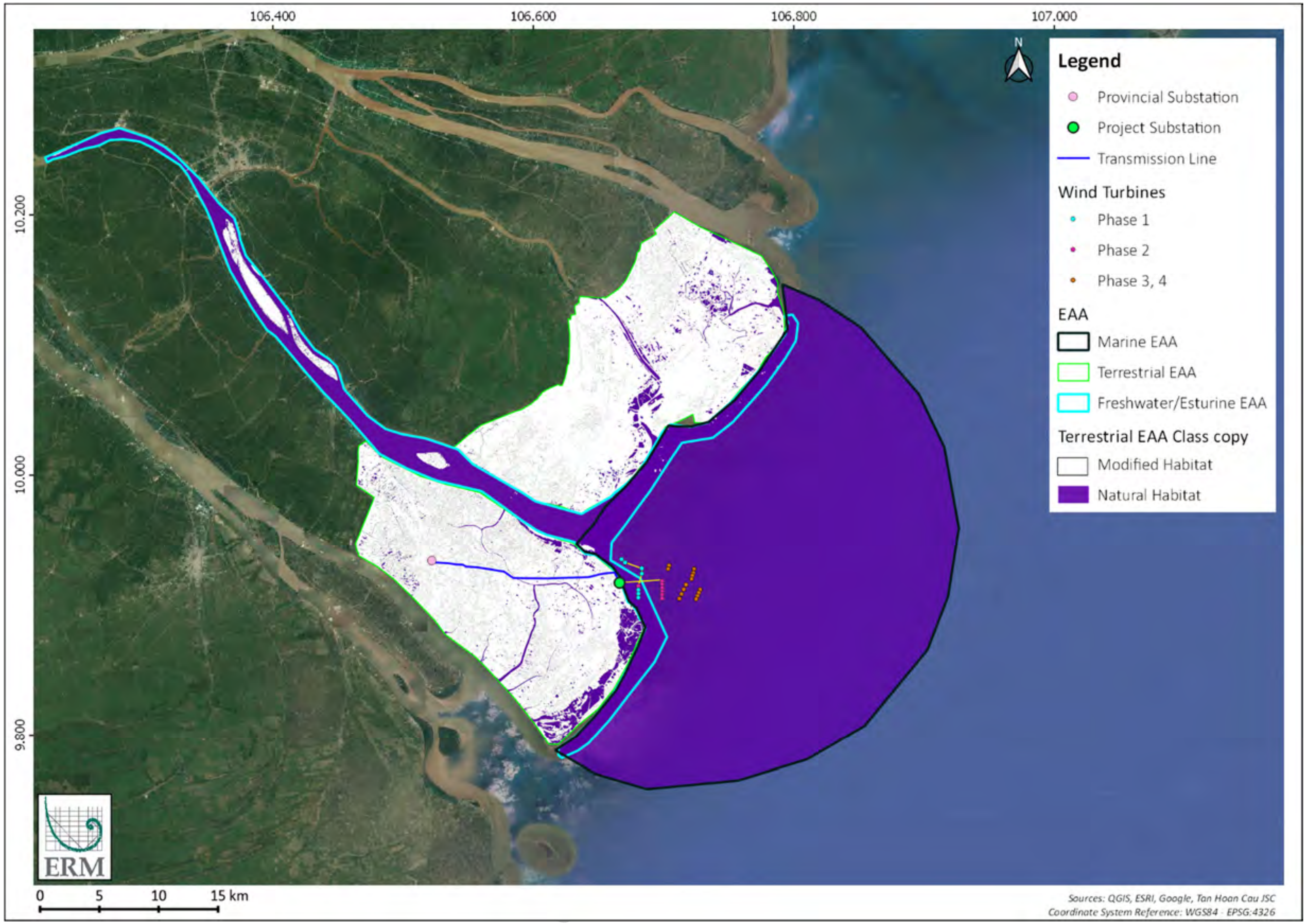


Figure 7.25 Natural and Modified Habitat areas within EAA

7.10.1.12 Ecologically Appropriate Area of Analysis

In accordance with PS6 an EAA for analysis should be identified to determine the presence of critical habitat for each species. This is the area of analysis to assess the applicability of the critical habitat criteria and thresholds. PS6 notes when defining the boundaries the following aspects should be a consideration: distribution of the species or ecosystems, ecological patterns, processes, features, and functions that are necessary for maintaining them.

The Study Area contains three key ecosystems: the terrestrial environment, the freshwater/estuarine interface, and the marine environment. The majority of candidate species align with one or two of these ecosystems and as such three EAAs have been defined for this assessment (Table 7.20).

The Terrestrial EAA was defined based on the existing Project Area, the surrounding environmental condition, surrounding land uses, likely conservation significant species present (particularly migratory birds, mammals and terrestrial reptiles), main habitat types for critical habitat candidate species, natural barriers and existing anthropogenic impacts. The Terrestrial EAA includes a range of land class types including bare land, residential areas, rivers and canals which are scattered throughout the area.

The Freshwater/Estuarine EAA encompasses the mudflat environment, mangroves, the river mouth(s) and upstream to where the river channels narrow. It is relevant for species that occupy intertidal, estuarine and river environments.

The Marine EAA is defined by the sandy sea shore and ocean. It is relevant for species that occupy intertidal environments as well as deeper marine habitats. ERM considered the wide distribution of candidate critical habitat species associated with the Project Area. It is normal practice to consider wide ranging species when determining the EAA on the basis of any aggregation, recruitment, or other specific habitat features of importance for these species within the vicinity of the Project Area.

The identified candidate species groups, main habitat types associated with these species, and type of EAA that these habitat types have been included in are outlined below in Table 7.20.

Table 7.20 Candidate Species Habitat Requirements and EAA

S/N	Identified candidate species groups	Habitat types associated with Critical Habitat candidate species	Habitat types identified within or near Project Area	EAA	Comment on inclusion/exclusion of habitat type
	Cartilaginous fishes, Reptiles, Sea cucumbers, Sea anemones and Corals	Inner continental shelf over soft sandy substrate, shallow coastal estuarine and fresh waters	Sandy sea shore, ocean	Marine	The Project Area transitions from the terrestrial environment into the marine environment and includes this area, which could be used by candidate species assessed.
	Birds	Cultivated and grassland habitats	Residential and cleared land	Terrestrial	The area within and surrounding the Project boundary contains cleared and cultivated areas, which may be used by candidate species assessed.
	(Migratory) Birds, Cartilaginous fishes,	Inland wetlands, inland rivers	River, canal, mudflat,	Terrestrial	The area within and surrounding the Project boundary contains scattered rivers and canals, mudflats and

S/N	Identified candidate species groups	Habitat types associated with Critical Habitat candidate species	Habitat types identified within or near Project Area	EAA	Comment on inclusion/exclusion of habitat type
	(Migratory) Ray finned fishes, Mammals, Reptiles		mangrove swamp		mangrove swamps which could be used by candidate species assessed.
	(Migratory) Birds, Cartilaginous fishes, (Migratory) Ray finned fishes, Mammals, Reptiles	Lowland river systems, coastal wetlands	River, mudflat and mangrove swamp	Freshwater/Estuarine	The area within and surrounding the Project boundary contains rivers, mudflats and mangrove swamps which could be used by candidate species assessed.

The Terrestrial EAA consists of approximately 47.25 km^2 of Natural Habitat and 586.23 km^2 of Modified Habitat. The Freshwater/Estuarine EAA consists of approximately 169.84 km2 of Natural Habitat and 169.37 km^2 of Modified Habitat. The Marine EAA consists of approximately 884.21 km^2 of Natural Habitat, shown below in Figure 7.26.

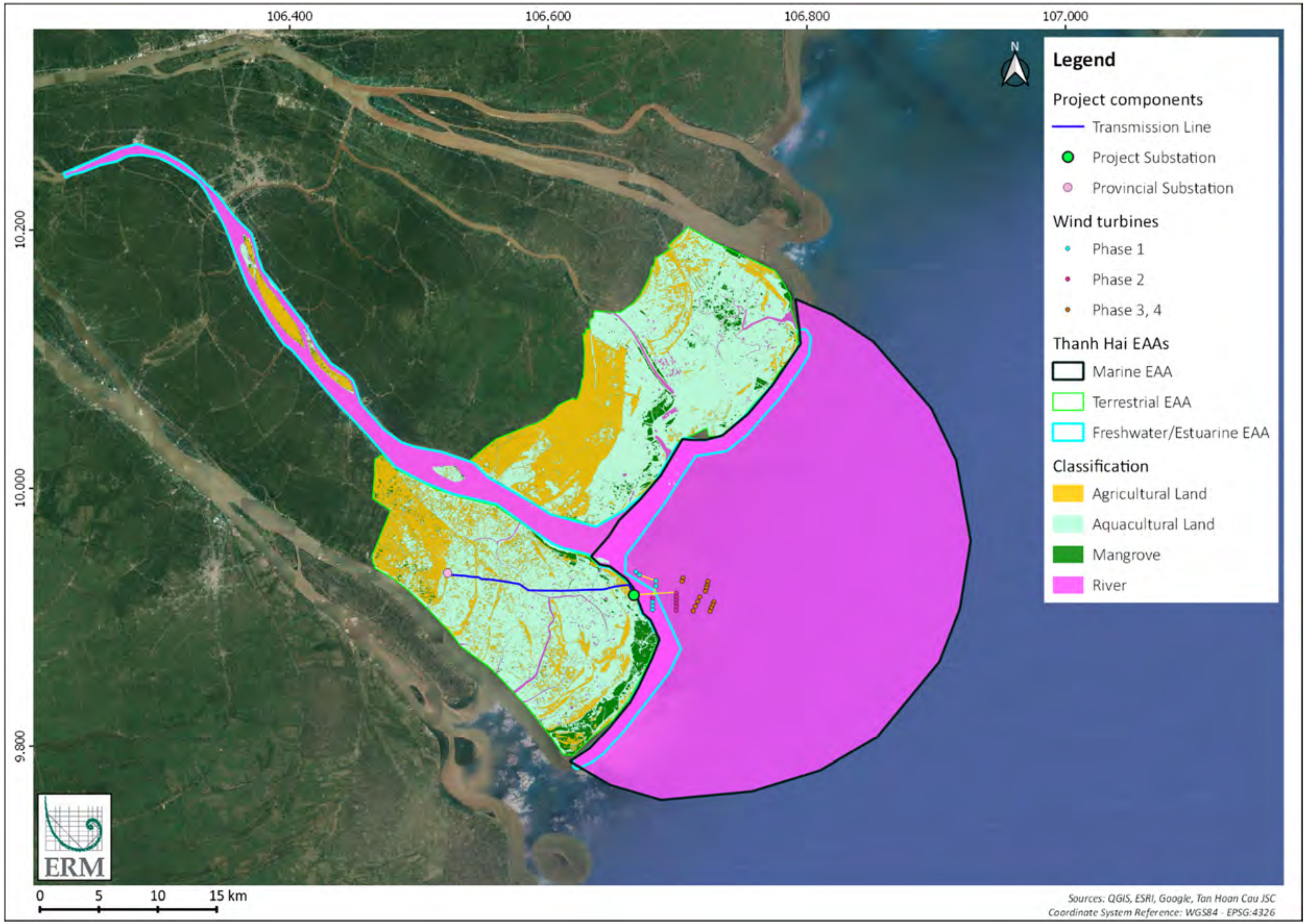


Figure 7.26 EAAs and associated land classes

7.10.2 Biodiversity Field Survey Methods

ERM contracted specialists to undertake biodiversity surveys of the Project Area and surrounds. The reports provided to ERM are found in Appendix E and Appendix F.

7.10.2.1 Field Survey Program

Multidisciplinary field surveys were undertaken in the Project Area in September/October 2019 (wet season) and in Dec 2019 (dry season).

A summary of the survey activities undertaken is provided in Table 7.21.

Table 7.21 Field Surveys undertaken within the Study Area

S/N	Dates	Target/Location	Survey Technique	Survey Methods	Survey Effort
1.	-	Flora / Terrestrial Zone (Transmission Line)	Remote Sensing	Vegetation cover under the proposed transmission line was assessed using remote sensing, specifically Landsat 8 satellite imagery and Normalized Differential Vegetation Index (NDVI).	-
2.	24 September – 26 September 2019	Avifauna / Marine Zone	Vantage Point Survey	See Section 7.10.2.2.1.	1 surveyor at each of 2 vantage points, 12 hours per day for 3 days
3.		Avifauna and marine megafauna / Marine Zone	Boat-based Line Transect Survey	See Sections 7.10.2.2.1 and 7.10.2.3.2.	13 line transects surveyed by at least 3 surveyors
4.	September / October 2019	Macrobenthos / Marine Zone	Ponar Grab Sampling	See Section 7.10.2.3.1.	3 Ponar grabs from 10 sampling stations
5.		Fauna / Terrestrial Zone	Semi Structured Interview	Semi structured interviews were systematically conducted to gain an understanding of the local biodiversity, especially species of conservation concerns such as birds, bats (mainly flying foxes), otters, marine mammals and sea turtles. Locals were shown a series of photographs of marine megafauna, flying foxes, water	2 interviewers conducted 30 interviews with local communities living near the Project Area

S/N	Dates	Target/Location	Survey Technique	Survey Methods	Survey Effort
				birds, otters and freshwater turtles and asked if they encountered any. Information on time, location, situation of each encounter was recorded. Questions regarding potentially important habitats for taxa of conservation concern such as roosting sites for bats and nesting sites for sea turtles were also asked.	
6.	24 October – 27 October 2019	Bat / Terrestrial Zone	Acoustic Line Transect Survey	See Section 7.10.2.2.2.	4 different transects on 4 days (2.5 hours per day for 3 days, 1 hour for 1 day)
			Acoustic Monitoring Station	See Section 7.10.2.2.2.	6 stations deployed over 3 days, 12.5 hours per day (17:30 – 6:00)
			Mist-net Sampling	See Section 7.10.2.2.2.	6 mist-nets deployed over 3 days, 5 hours per day (17:30 – 22:30)
			Roosting Site Investigation	See Section 7.10.2.2.2.	-
7.	19 December – 22 December 2019	Avifauna / Marine Zone	Vantage Point Survey	See Section 7.10.2.2.1.	1 surveyor at each of 2 vantage points, 12 hours per day for 3 days
8.		Avifauna and marine megafauna / Marine Zone	Boat-based Line Transect Survey	See Sections 7.10.2.2.1 and 7.10.2.3.2.	13 line transects surveyed by at least 3 surveyors

7.10.2.2 Terrestrial Biodiversity

7.10.2.2.1 Birds

Vantage Point Survey

Vantage point survey was used to investigate overlap between avifauna's movements and the Project Area (Scottish Natural Heritage, 2014). Two vantage points were located in the north and the south

(Figure 7.27) of the Project Area (Figure 7.28). At each point, one experienced bird observer equipped with 7x50 reticle binoculars was stationed and actively scanned the whole area for avifauna activity within a 2 km radius of the vantage point. Once a bird or group of birds were sighted, the observer would draw the flight path, relative to the ground as if looking down on the site from above, into a pre-printed record sheet.

For each sighting, information on species; number of birds in the flight; start time and end time of flight; height of the flight in 15 second intervals; type of flight (flapping, soaring, gliding) and notes on activity/behaviour were all recorded. Height of the flight was recorded in three height bands, namely: below rotor height (<35m), at rotor height in the Rotor Swept Zone (RSZ) (35-150m) and above rotor height (>150m). Total flying time was calculated for all bands in each vantage point.

All flying paths were digitalized into shape files (.shp) for further analysis in QGIS. A head map of avian traffic was generated in QGIS to visualise bird traffic in the Project Area.

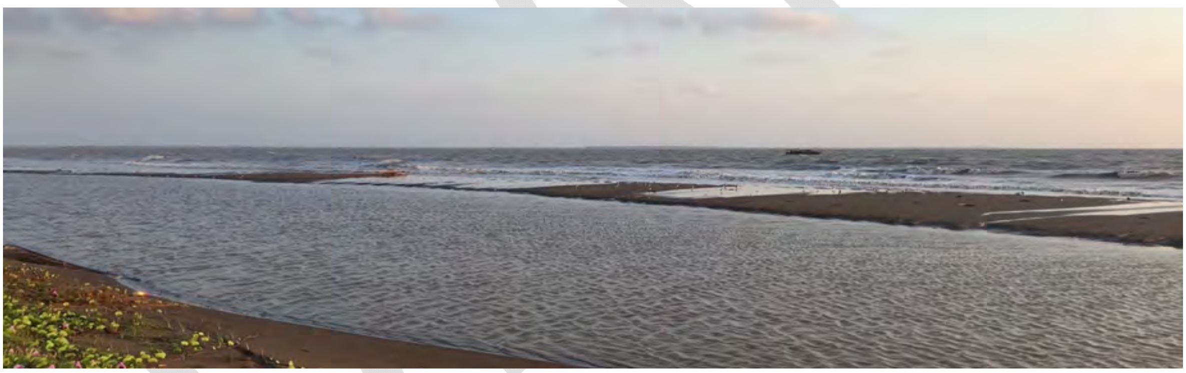


Figure 7.27 Vantage Points 1 (upper) and 2 (lower)

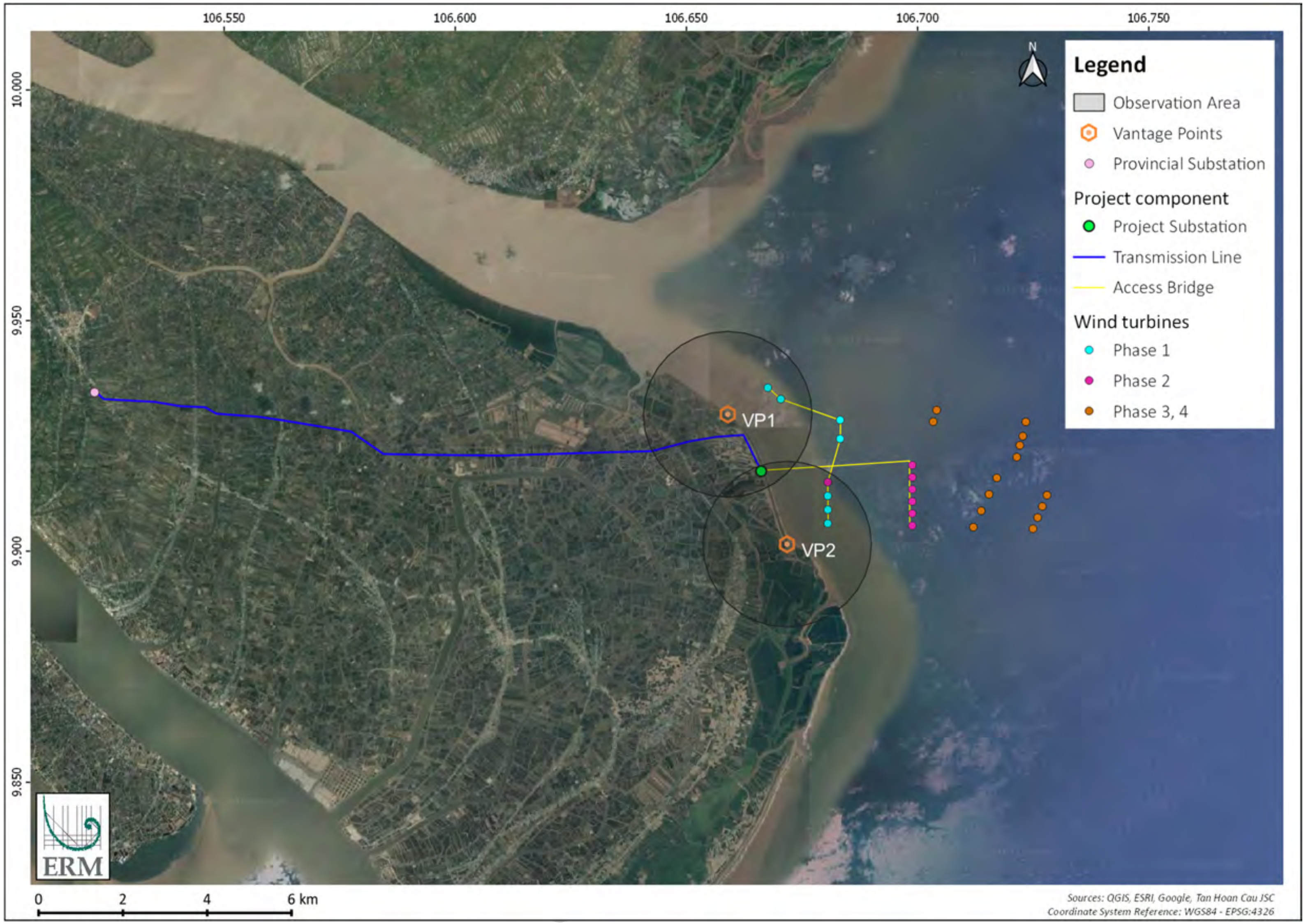


Figure 7.28 Locations of two vantage points used for avifauna survey

Boat-based Line Transect Survey

Besides vantage point surveys, boat-based line transect survey was also conducted to assess distribution and abundance of sea birds (using DISTANCE sampling) (Buckland et al., 1993). Data were collected using visual boat-based surveys following predefined line transects, a form of distance sampling (Buckland et al. 1993, 2001, 2015; Dawson et al. 2008). During the survey, a minimum of three observers were stationed at the bow, port and starboard sides of the boat to scan the surroundings for birds. Search speed was maintained below 15 km/h at a consistent speed. For each flock of birds encountered during the line transect survey (referred to as "on-effort sighting"), observers recorded location, radial distance between the boat and the group, as well as the angle to the group, and group composition (e.g. the number of animals, height of their flight etc.). Based on the combination of the number of detected animals, the average detection probabilities in surveyed area and survey design, the abundances of seabirds in the Study Area for the study period can then be reliably estimated (Buckland et al. 2001, 2015).

7.10.2.2.2 Bats

For bat field surveys, acoustic line transects, acoustic monitoring stations, mist-netting and roosting site investigation were conducted.

Acoustic Line Transect Survey

Four transect lines were used to survey bat activities in the Project Area and its vicinity. Surveyors conducted acoustic surveys equipped with EchoMeter Pro (Wildlife Acoustics, USA) synchronized with smartphone GPS along the transects. This full spectrum recorder system records time-stamped and georeferenced echolocation signals of bats, which indicates level of bat activity in the area. Bats were identified to the lowest possible taxonomic level using their echolocation signals with BatExplorer software (Elekon AG, Switzerland).

Acoustic Monitoring Stations

To understand the spatiotemporal patterns of bat activities within the Project Area, seven stationary acoustic monitoring stations were deployed in strategic points. At each station, a highly sensitive recording system BATLOGGER A: CHF 900 (Elekon AG, Switzerland) was deployed to record bat acoustic signals from sunset to sunrise each day. Similar to the acoustic transect approach, raw data records of bat collected were processed using BatExplorer 2.0 (Elekon AG, Switzerland). Species identification was done based on Borisenko & Kruskop (2003); Furey (2009); Hughes et al. (2011); Thong et al. (2012); Kruskop (2013); Francis (2019).

Mist-net Sampling

A series of mist-net (special net designed to capture bats and birds) were set up at strategic points within the Project Area to collect bat samples. After the deployment of nets, the mist-netting team checked for entangled bats every ten minutes for five hours.

Roosting Site Investigation

Semi-structured interviews were conducted to obtain information regarding charismatic bat species (e.g. flying foxes – Pteropus sp.). Bat specialists subsequently visited roosting sites identified from the interviews during daytime and counted the number of bats in the colony. The Helion XP38 thermal image scope (Pulsar Inc.), which allows the survey team to detect heat signatures of each bat roosting in dark areas, was used to aid the counting.

7.10.2.3 Marine Biodiversity

7.10.2.3.1 Macrobenthos

Baseline data of the microbenthic community was established using data collected of microbenthic community diversity and abundance in the Project Area. Sampling stations were designed to represent different depth intervals, different distances to the shore and different distances to the river mouth.

Macrobenthos was sampled using Ponar grab. Grab samples were sieved on the boat. A sieve with mesh 10 µm was used to retain macrobenthic organisms. Sediment particles that passed through the sieve were discarded. The remaining materials were soaked in 7% formalin solution and dyed with Lugol. Samples were transferred back to Ho Chi Minh City for analysis. All macrobenthic organisms recorded from samples were identified to the lowest taxonomic group possible. Number of species, number of individuals of each species, and wet biomass measurements will be recorded for each grab. Total number of species, abundance (number of individual of each species per 225 cm^2), and biomass (g per 225cm^2) were calculated for each station. In addition to species or taxon richness and density, biodiversity indices such as diversity, evenness and variability of macrobenthos in the Project Area were also calculated across sampling stations. A benthic prediction map was also generated from the spatial modelling process.

7.10.2.3.2 Marine megafauna

Boat-based line transect survey was also conducted to assess distribution and abundance of sea birds (using DISTANCE sampling) (Buckland et al., 1993). Data were collected using visual boat-based surveys following predefined line transects, a form of distance sampling (Buckland et al. 1993, 2001, 2015; Dawson et al. 2008). During the survey, a minimum of three observers will be stationed at the bow, port and starboard sides of the boat to scan the surroundings for marine megafauna. Search speed will be maintained below 15 km/h at a consistent speed. For each school of dolphins or each sea turtle encountered during the line transect survey (referred to as “on-effort sighting”), observers will record location, radial distance between the boat and the group, as well as the angle to the group, and group composition (e.g. the number of animals etc.). Based on the combination of the number of detected animals, the average detection probabilities in surveyed area and survey design, the abundances of marine megafauna in the Study Area for the study period can then be reliably estimated (Buckland et al. 2001, 2015).

7.10.2.4 Invasive Species

A list of invasive species was also generated for the Project Area, in accordance with Circular No. 22/2011/TT-BTNMT (Table 7.22). Results were based on the Vietnam Ministry of Natural Resources and Environment database (VN) and the Environment and Global Invasive Species Database (GISD).

Table 7.22 List of invasive species in the Project Area

S/N	Species	Class	Source
1	*Ageratum conyzoides*	Plant	VN/GISD
2	*Alternanthera sessilis* (L.) R.Br. ex DC.	Plant	GISD
3	*Annona glabra* L.	Plant	GISD
4	*Casuarina equisetifolia* L.	Plant	GISD
5	*Commelina benghalensis* L.	Plant	GISD
6	*Cynodon dactylon* (L.) Pers.	Plant	GISD
7	*Ipomoea aquatica* Forssk.	Plant	GISD
8	*Imperata cylindrica* (L.) Raeusch.	Plant	GISD
9	*Leucaena leucocephala* (Lam.) de Wit	Plant	VN/GISD
10	*Nypa fruticans* Wurmb	Plant	GISD
11	*Passiflora foetida* L.	Plant	GISD

S/N	Species	Class	Source
12	*Pluchea indica* (L.) Less.	Plant	GISD

7.10.3 Biodiversity Field Survey Results

7.10.3.1 Terrestrial Biodiversity

7.10.3.1.1 Flora

Vegetation cover analysis (NDVI) indicated low vegetation quality in the Project Area. The proposed transmission line will mostly pass through areas with relatively thin vegetation cover, such as grassland and aquacultural land. This confirmed the available data that the transmission line will pass through a heavily modified landscape.

Habitat along the transmission line and its surrounding areas was classified into six main categories, namely water surface, agricultural land and building, aquacultural land, mangrove, grassland, and other vegetation. The total area of each habitat/vegetation type is summarised in Table 7.23.

Table 7.23 Area of each habitat/vegetation type within 100m buffer of transmission line

S/N	Habitat/Vegetation Type	Total Area (km^2)
1.	Water bodies	0.02
2.	Agricultural land and building	0.28
3.	Aquacultural land	1.74
4.	Mangrove	0.07
5.	Grassland	1.04
6.	Other vegetation	0.21
	Total	3.36

Source: Conservation in Motion, 2019

7.10.3.1.2 Birds

Vantage Point Survey

Wet Season

During the wet season, thirty-five (35) bird species were identified. The majority of species recorded are common species in Vietnam and have not been listed as species of conservation significance nationally or internationally. Only two species (Oriental Darter and Eurasian Curlew) are listed as Near Threatened (NT) in the IUCN Red List. Of these two species, only Oriental Darter is listed as Vulnerable (VU) in the 2007 Vietnam Red Data Book. However, these species are widespread in the Mekong Delta region of Vietnam. No bird species of conservation significance was identified during the survey.

A total of 19,005 seconds of bird flying was observed from the two vantage points. All observed flights took place in band 1 (<35m), below the RSZ. No observed flight occurred in band 2 (35-150m) or band 3 (>150m). Busier avian traffic was also observed at VP1, as a direct result of larger flocks in that area. Most observed flying activities took place in the early morning (from 6:00 to 8:00) and before sunset (17:00).

Dry Season

During the dry season, twenty-six (26) bird species were identified. Similar to the wet season, majority of species recorded are common species in Vietnam and have not been listed as species of conservation significance nationally or internationally. Other than the two species identified during the wet season, one additional species (Black-tailed Godwit) identified is listed as NT in IUCN Red List.

A total of 13,440 seconds of bird flying was observed from the two vantage points. Most observed flights observed were in band 1 (<35m), below the RSZ, with few flights in band 2 (35-150m). Similarly, busier avian traffic was observed at VP1, although more species were observed at VP2. Flying activity could be observed all day from 6:00 to 17:50 although there were slight reductions in number of flights at 10:00 and 11:00 at V1 and V2, respectively.

The only species that flew in band 2 include the Common Tern (IUCN LC), Caspian Tern (IUCN LC) and Little Egret (IUCN LC). The Common Tern was observed at VP1, with flying time (s) of approximately 45 seconds at 7:00. The Caspian Tern and Little Egret were observed at VP2, with flying time (s) of approximately 30 seconds at 8:00 and 6:00 respectively. Flock sizes were generally larger at VP1, ranging from 1 to 4 individuals as compared to those at VP2, which ranges from 1 to 2 individuals.

Boat-based Line Transect Survey

Wet Season

During the wet season, ten (10) bird species were identified from 34 "on-effort sightings"[12] and 16 "off-effort sightings". Eight (8) of these species were also identified in the vantage point survey. All seabirds observed in the boat-based survey flew lower than 35 m (i.e. RSZ). The most common species in the survey area was the Common Tern (IUCN LC). All birds were observed within 150 m perpendicular distance to the transect. Seabirds in the Project Area usually travel alone or in small groups. Total number of seabirds within the Project Area in the marine zone was estimated at 87 individuals (considered to be low), with higher abundance of up to 154 individuals per km^2 at the nearshore and easternmost parts as predicted by the Density Surface Model (DSM) (Miller et al., 2013). Flocking behaviour was not common. The Spot-billed Pelican is the only species of conservation significance as it is listed as IUCN NT and EN in the 2007 Vietnam Red Data Book.

Dry Season

During the dry season, six (6) bird species were identified from 27 "on-effort sightings" and 24 "off-effort sightings". All of these species were also recorded in the vantage point survey. As in the wet season, all seabirds observed in the boat-based survey flew lower than 35 m (i.e. RSZ) and the most common species in the survey area was the Common Tern (IUCN LC). All birds were observed within 400 m perpendicular distance to the surveyed transect. Total number of seabirds within the Project Area in the marine zone was estimated at 38 individuals, which is lower than that for the wet season. Flying activity was more concentrated in the dry season, with higher concentration of seabirds of up to 237 individuals per km^2 predicted by DSM at one hotspot to the west of the Project Area. However, the current wind turbine layout does not overlap with this hotspot (closest distance of approximately 1 km). Flocking behaviour was also not common, with one flock of 25 Sanderlings (IUCN LC) and one flock of 33 Little Egrets (IUCN LC) recorded. No bird species of conservation significance was identified during the survey.

As discussed, some spatio-temporal variation in bird abundance, distribution and activity was observed between the wet and dry seasons. The list of species recorded in both surveys in both seasons is shown in Table 7.24.

[12] An "on-effort sighting" is referred to a sighting made during the line transect survey.

Table 7.24 Bird species identified during field surveys in wet and dry seasons

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book	Survey	Season
1.	*Acridotheres tristis*	Common Myna	LC	-	Vantage Point	Wet
2.	*Actitis hypoleucos*	Common Sandpiper	LC	-	Vantage Point	Wet, Dry
3.	*Aerodramus germani*	Germain's Swiftlet	LC	-	Vantage Point, Boat-based Line Transect	Wet
4.	*Anhinga melanogaster*	Oriental Darter	NT	VU	Vantage Point, Boat-based Line Transect	Wet, Dry
5.	*Apus* sp.	Fork-tailed Swift	LC	-	Vantage Point	Wet
6.	*Ardea alba*	Great Egret	LC	-	Vantage Point	Wet, Dry
7.	*Ardea cinerea*	Grey Heron	LC	-	Vantage Point	Wet
8.	*Ardeola bacchus*	Chinese Pond Heron	LC	-	Vantage Point	Wet, Dry
9.	*Butorides striata*	Striated Heron	LC	-	Vantage Point	Wet
10.	*Calidris alba*	Sanderling	LC	-	Vantage Point, Boat-based Line Transect	Wet, Dry
11.	*Charadrius alexandrinus*	Kentish Plover	LC	-	Vantage Point	Wet, Dry
12.	*Charadrius dubius*	Little Ringed Plover	LC	-	Vantage Point	Dry
13.	*Charadrius leschenaultii*	Greater Sand Plover	LC	-	Vantage Point	Wet, Dry
14.	*Charadrius mongolus*	Lesser Sandplover	LC	-	Vantage Point	Wet, Dry
15.	*Dicrurus macrocercus*	Black Drongo	LC	-	Vantage Point	Wet
16.	*Egretta garzetta*	Little Egret	LC	-	Vantage Point	Wet, Dry

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book	Survey	Season
17.	*Gelochelidon nilotica*	Gull-billed Tern	LC	-	Vantage Point	Wet, Dry
18.	*Geopelia striata*	Zebra Dove	LC	-	Vantage Point	Wet
19.	*Hirundo rustica*	Barn Swallow	LC	-	Vantage Point, Boat-based Line Transect	Wet, Dry
20.	*Hydroprogne caspia*	Caspian Tern	LC	-	Vantage Point, Boat-based Line Transect	Wet, Dry
21.	*Larus crassirostris*	Black-tailed Gull	LC	-	Vantage Point	Dry
22.	*Limosa lapponica*	Bar-tailed Godwit	LC	-	Vantage Point	Dry
23.	*Limosa limosa*	Black-tailed Godwit	NT	-	Vantage Point	Dry
24.	*Merops orientalis*	Green Bee-eater	LC	-	Vantage Point	Wet
25.	*Merops philippinus*	Blue-tailed Bee-eater	LC	-	Vantage Point	Wet
26.	*Microcarbo niger*	Little Cormorant	LC	-	Vantage Point	Dry
27.	*Numenius arquata*	Eurasian Curlew	NT	NT	Vantage Point	Wet, Dry
28.	*Numenius phaeopus*	Whimbrel	LC	-	Vantage Point	Wet, Dry
29.	*Pandion haliaetus*	Osprey	LC	-	Vantage Point, Boat-based Line Transect	Dry
30.	***Pelecanus philippensis***	**Spot-billed Pelican**	**NT**	**EN**	**Boat-based Line Transect**	**Wet**
31.	*Phalacrocorax niger*	Little Cormorant	LC	-	Vantage Point, Boat-based Line Transect	Wet, Dry
32.	*Pluvialis fulva*	Pacific Golden Plover	LC	-	Vantage Point	Wet, Dry

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book	Survey	Season
33.	*Sterna hirundo*	Common Tern	LC	-	Vantage Point	Wet, Dry
34.	*Sternula albifrons*	Little Tern	LC	-	Boat-based Line Transect	Wet
35.	*Streptopelia chinensis*	Spotted Dove	LC	-	Vantage Point	Wet, Dry
36.	*Sturnia sinensis*	White-shouldered Starling	LC	-	Vantage Point	Wet
37.	*Todiramphus chloris*	Collared Kingfisher	LC	-	Vantage Point, Boat-based Line Transect	Wet, Dry
38.	*Tringa nebularia*	Common Greenshank	LC	-	Vantage Point	Wet, Dry
39.	*Tringa ochropus*	Green Sandpiper	LC	-	Vantage Point	Wet
40.	*Tringa stagnatilis*	Marsh Sandpiper	LC	-	Vantage Point	Wet
41.	*Xenus cinereus*	Terek Sandpiper	LC	-	Vantage Point	Wet, Dry
42.	-	Unidentified Tern	LC	-	Vantage Point	Wet
43.	-	Unidentified Raptor	-	-	Vantage Point	Wet

Source: Conservation in Motion, 2019

Note: *VU – Vulnerable*
NT – Near Threatened
LC – Least Concern

7.10.3.1.3 Bats

Acoustic Line Transect Survey

A total of 5,412 acoustic signals were recorded from transects (8,825 m long). Among those, 673 signals were further identified as bat calls. A spatial variation in bat activity was detected from the transect survey in the coastal Thanh Hai area. Overall more bat calls were recorded from transects located further inland. However, there were 218 bat calls recorded right on the beach, which suggests that several bat species may fly out to the open sea and toward the wind turbine area (1 km from the beach). Four (4) bat species, none of which are of conservation significance, were identified from the bat calls (summarized in Table 7.25):

- Black-bearded Tomb Bat – with low peak frequency (below 25 kHz, generally at 19 kHz) and long call length (average call length at 15 ms) (Wei et al. 2008);
- Lesser Asiatic Yellow House Bat – with start frequency within 64kHz to 89kHz range, peak frequency within 39 kHz to 45kHz range (Zhu et al. 2012);
- Javan Pipistrelle – with signature quasi-constant-frequency (QCF) call pattern and high start frequency (>75 kHz) (Hughes et al. 2011);
- A Myotis species – with FM calls, peak frequency above 55 kHz, start frequency higher than 60 kHz (but lower than 90 kHz), then decrease to peak frequency around 55 kHz, average call duration 3 ms). This species is unlikely the Rickett's Big-footed Myotis (Myotis pilosus), which is the only Myotis listed as IUCN Near Threatened (NT) found in the area.

Acoustic Monitoring Stations

A total of 4,510 bat calls were recorded from 6 monitoring stations during the survey. A spatiotemporal variation in bat activities was also observed between stations. Since the survey conditions were unchanged during three night of deployment, the observed spatiotemporal variation in bat activities were unlikely to be due to short-term changes in environmental conditions. The same four (4) bat species were identified for the acoustic monitoring stations as for the acoustic line transects (Table 7.25).

Mist-net Sampling

During the survey period, no bat was captured in the deployed nets. This suggested bat species in the Project Area flew higher than 4 m.

Roosting Site Investigation

Interview results identified no roosting sites for flying foxes in the Project Area. However, 20 over 30 responders claimed they have observed flying foxes foraging in the fruit farms (mainly Longan fruit). Little information on other bat species can be collected from local communities, as little attention was paid to small-bodied species.

Table 7.25 Bat species identified during field surveys

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book	Survey
1.	*Taphozous melanopogon*	Black-bearded Tomb Bat	LC	-	Acoustic Line Transect, Acoustic Monitoring Station
2.	*Scotophilus kuhlii*	Lesser Asiatic Yellow House Bat	LC	-	Acoustic Line Transect, Acoustic

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book	Survey
					Monitoring Station
3.	*Pipistrellus javanicus*	Javan Pipistrelle	LC	-	Acoustic Line Transect, Acoustic Monitoring Station
4.	*Myotis* sp.	-	-	-	Acoustic Line Transect, Acoustic Monitoring Station

Source: Conservation in Motion, 2019
Note: LC – Least Concern

7.10.3.1.4 Other Terrestrial Fauna

Herpetofauna

During the vantage point survey, the survey team opportunistically identified the Ngo Van Tri's Lady Butterfly Lizard (*Leiolepis ngovantrii*) at the Vantage Point 2. This species is listed as Vulnerable (VU) in IUCN Red List. The presence of this species in the Project Area warrants attention in future planning, and it is a critical habitat candidate species. Independent surveys conducted by the Southern Institute of Ecology also recorded this species in Hiep Thanh area (Tra Vinh province), which is approximately 20 km from Thanh Hai Project Area. According to the SIE survey team (SIE, pers. comm., Sep 30, 2019), several sightings of the Ngo Van Tri's Lady Butterfly Lizard were recorded in Hiep Thanh area.

Non-volant Mammals

From the semi-structured interviews, 28 out of 30 interviewees (93%) claimed they have encountered otter(s) in the vicinity of the transmission line. All of them were also unable to distinguish the four otter species which may potentially be present in the area (i.e. Hairy-nosed Otter (IUCN: EN, VRDB: EN), Smooth-coated Otter (IUCN: VU, VRDB: EN), Eurasian Otter (IUCN: NT, VRDB: VU) and Small-clawed Otter (IUCN: VU, VRDB: VU). However, they could easily distinguish between an otter and similar carnivorous species such as mongoose or weasel. Among those responders who encountered otters, most of them saw and observed wild otters in their nature habitats in Thanh Hai area. While most otter encounters occurred more than 5 years ago, there were several recent encounters which imply presence of at least one otter species in the Project Area. In particular, one interviewee showed the interview team photographs of a pair of otters (which resemble the Small-clawed Otter) that his family captured and sold in the local market in August 2019 (Figure 7.29). The Hairy-nosed Otter and Smooth-coated Otter are candidates for Critical Habitat if present within the EAA, while mitigation measures would be needed for all otter species within the EAA to manage threats.

Source: Conservation in Motion, 2019

Figure 7.29 Photograph of a pair of otters captured by locals and sold in local market

7.10.3.2 Marine Biodiversity

7.10.3.2.1 Marine Megafauna

No dolphins, whales or sea turtles were recorded during the boat-based line transect survey in both wet and dry seasons. However, during the semi-structured interviews, more than half of the interviewees (17 out of 30) claimed to have encountered[13] marine megafauna in the offshore area of Thanh Hai.

Marine Mammals

An overview of whale species in Vietnam showed that a total of 25 whale species were identified in Vietnam (Thuoc, 2007). Of these, 17 whale species were identified in the Central and Southern Vietnam during the first survey by IUCN and some Vietnamese experts between March and April 1995. Another survey also conducted by IUCN found 10 species in the Gulf of Tonkin between October 1999 and April 2000. In later surveys, 6 more whale species were recorded in Vietnam's sea.

A survey conducted in Kien Giang Biosphere Reserve by Vietnam Marine Mammal Network in 2015 recorded 8 cetacean species, including Bryde's whale (*Balaenoptera edeni*) (IUCN LC), Omura's whale (*Balaenoptera omurai*) (IUCN DD), Pygmy sperm whale (*Kogia breviceps*) (IUCN DD), Finless porpoise (*Neophocaena phocaenoides*) (IUCN VU), Irrawaddy dolphin (*Orcaella brevirostris*) (IUCN EN), Indo-Pacific Humpback dolphin (*Sousa chinensis*) (IUCN VU, VRDB EN), Pantropical spotted dolphin (*Stenella attenuata*) (IUCN LC), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) (IUCN DD) (Long et al., 2017). Two (2) of these species are of conservation significance – Irrawaddy Dolphin and Indo-Pacific Humpback Dolphin, and are also critical habitat candidate species.

During the semi-structured interviews, interviewees who claimed to have encountered marine mammals in the Project Area could distinguish marine mammals from other marine megafauna (e.g. sharks) very well. They were aware of the existence of marine mammals in the area and were able to describe behaviour of several dolphin species (e.g. the Irrawaddy Dolphin and the Finless Porpoise) correctly when the interview team showed pictures of marine mammals. From information provided by the interviewees, the survey team recorded an occurrence of stranded whale along Con Bung beach in 2004. Examination of the teeth and bone remnants of the stranded animal (kept in the local whale

[13] In the semi-structured interviews, an "encounter" refers to direct catch, bycatch, personal observation or stranding observation.

temple) revealed the identity of this animal to be the Sperm Whale (Physeter macrocephalus) (IUCN: VU).

Sea Turtles

A study on distribution and abundance of marine turtles in 17 out of 19 provinces in Vietnam identified five marine turtle species in Vietnam (Hamann et al., 2006). These species included Loggerhead (*Caretta caretta*) (IUCN VU, VRDB CR), Olive Ridley (*Lepidochelys olivacea*) (IUCN VU, VRDB EN), Leatherback (*Dermochelys coriacea*) (IUCN VU, VRDB CR), Green (*Chelonia mydas*) (IUCN VU, VRDB: EN) and Hawksbill turtles (*Eretmochelys imbricata*) (IUCN CR, VRDB EN). All of these five species are of conservation significance, and are critical habitat candidate species. The study also reported that the nesting and foraging of turtles along the coastline of Vietnam had significantly declined due to habitat destruction, fishing gear and turtle egg hunting by local people.

The closest marine turtle breeding and foraging habitat to the Project Area is Con Dao National Park (an island approximately 135 km south of the Project Area). The island supports a moderately sized Green Turtle rookery with an average of 230 females per year (1995 to 2001) (Nguyen, 1999) and the total Viet Nam nesting population(s) is likely to be around 250 females per year (Hamann et al., 2002).

Given that turtles are a migratory species that can travel long distances across oceans, it is possible that turtles may swim along the southern coast of mainland Vietnam. However, the nearshore area of the Project does not support typical turtle habitats. Furthermore, during the semi-structured interviews, most interviewees said they did not encounter sea turtles in the Thanh Hai Sea. Interviewees who claimed to have encountered sea turtle(s) before were able to distinguish between the Leatherback turtle from the Green and Hawksbill turtles. However, there was a tendency for them to have difficulty distinguishing the Hawksbill Sea Turtle from the Green Sea Turtle which can potentially be present in the Project Area. Sea turtle encounters appeared to be uncommon in the area and no encounters have occurred in 2019 up to the point of the interview conducted for this survey. Most encounters with sea turtles were not dated as interviewees were not able to recall when they occurred, while the rest occurred in 2018.

7.10.3.2.2 Macrobenthos

A total of thirty-five (35) macrobenthic taxa, belonging to six (6) groups were recorded during this survey. Among those, most number of species recorded in the macrobenthic community were molluscs (18 identified taxa), while the highest abundance was recorded for crustaceans. The most common macrobenthos found in the Project Area were benthic crabs of superfamily Ocypodidae. A total of 126 individuals of this taxa have been recorded in the survey area. No species of conservation significance were identified. The list of the macrobenthic species recorded in the survey is presented in Table 7.26.

Within the Project Area, the diversity of the macrobenthic assemblage varied greatly across sampling stations. Depth, distance to river mouth and distance to shore were also found to have weak influences on the distribution of macrobenthic community in the Project Area. The proposed layout of the turbines did not appear to overlap with the macrobenthos hotspots.

Table 7.26 Macrobenthic species identified during field survey

S/N	Higher Taxonomic Classification	Taxa	Abundance
1.	Clitellata	Oligochaeta	1
2.	Polychaeta	Sternaspis scutata	6
3.		Chaetopteridae	1
4.		Unidentified Polychactea	1
5.		Nereididae	4
6.		Paraonidae	1
7.		Oweniidae	23

S/N	Higher Taxonomic Classification	Taxa	Abundance
8.		Oenonidae	2
9.		Orbiniidae	1
10.		Nephtyidae	1
11.	Phascolosomatidea	Phascolosomatidea	1
12.	Echinodermata	Ophiodermatidae	1
13.	Mollusca	Abra alba	1
14.		Tellinidae	4
15.		Marginellidae	3
16.		Turritellidae	30
17.		Buccinidae	1
18.		Veneridae	15
19.		Semelidae	1
20.		Arcidae	4
21.		Glyceridea	1
22.		Nassariidae	1
23.		Ostreidae	1
24.		Olividae	3
25.		Mactridae	16
26.		Cardiidae	2
27.		Mangeliidae	1
28.		Pyramidellidae	5
29.		Naticidae	1
30.		Mytilidae	1
31.	Crustacea	Cirolanidae	1
32.		Ocypodidae	126
33.		Balanidae	4
34.		Leptocheliidae	1

7.10.4 Critical Habitat Assessment

7.10.4.1 Critical Habitat Screening

A Critical Habitat assessment was undertaken in accordance with the provisions of the IFC Performance Standards. Critical habitats are areas with: "high biodiversity value, including

i. Habitat of significant importance to Critically Endangered and/or Endangered species;
ii. Habitat of significant importance to endemic and/or restricted-range species;
iii. Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
iv. Highly threatened and/or unique ecosystems; and/or

v. Areas associated with key evolutionary processes".

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

Assessment for Critical Habitat is undertaken as a screening process against the criteria defined within IFC PS 6 Guidance Note. This involved analysis of desk based data collection, habitat mapping and incorporation of field survey results. Critical Habitat criteria are defined in PS6 Guidance Note 6 (GN6), Paragraphs GN69 to 97. Table 7.27 provides detail of the qualifying requirements for Criteria 1 to 3 (i.e. thresholds), while details of the likely qualifying interests for Criterion 4 and 5 will be defined based on research and expert opinion. The criteria listed have been used to complete this assessment.

The five criteria are 'triggers' in that if an area of habitat meets any one of the criteria, it will be considered Critical Habitat irrespective of failing to meet any other criterion. This approach is generally more cautious but is used more widely in conservation. Critical Habitat criteria therefore have two distinctive characteristics. First, components of biodiversity are essentially assigned to only two levels of conservation significance, those that trigger Critical Habitat and those that do not (Tier considerations being secondary to this primary Critical Habitat determination). Second, each criterion is applied separately and not in combination, meaning that the scores are not cumulative.

Table 7.27 Critical Habitat Criteria

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

Source: IFC, 2019

Notes: Restricted-range/ Endemic Species = Species with global distributions of less than 50,000km2; Migratory species = Any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another (including within the same ecosystem); Congregatory Species = Species whose individuals gather in large groups on a cyclical or otherwise regular and/or predictable basis.

The complete critical habitat screening table is provided in Appendix E. Those considered suitable for assessment for critical habitat are discussed further in this section.

7.10.4.2 Results of Critical Habitat Screening

This section aims to identify Critical Habitat candidate species within the EAA based on the Critical Habitat criteria defined in Section 7.10.4.1. The Critical Habitat criteria aim to identify habitat important for threatened species (e.g. endangered, critically endangered species), endemic or range-restricted species, migratory species, threatened or unique ecosystems and areas associated with key evolutionary processes. Critical Habitat determination follows these steps:

- Identification of EAA;
- Collection and verification of available data on EAA biodiversity; and
- Assessment of data against IFC Critical Habitat criteria.

As a result of the initial screening assessment, 234 species are considered conservation significant species, and are candidate species for the Critical Habitat Screening Assessment. Conservation significant species include 53 critically endangered species and endangered species (in accordance with the IUCN Red List and/or Vietnam Red Data Book), 1 restricted-range species and 185 migratory and/or congregatory species. The following sections determine if the candidate species assessed trigger critical habitat within the EAA.

7.10.4.2.1 Criterion 1: Critically Endangered and/or Endangered Species

Critically Endangered (CR) and Endangered (EN) are identified as those classified on the IUCN Red List of Threatened Species. CR and EN species are considered to be at a heightened risk of extinction and are awarded an elevated level of consideration under Criterion 1 within IFC PS6. Candidates for Criterion 1 include 9 bird, 25 fish, 5 mammal, 8 reptile, 6 marine invertebrate and sea cucumber species. **Based on the screening assessment, 2 species have been identified as likely triggering critical habitat within the EAA.** These species include bird species Nordmann's Greenshank (*Tringa guttifer*; IUCN EN) (Figure 7.30) and Spoon-billed Sandpiper (*Calidris pygmaea*; IUCN CR) (Figure 7.31).

Source: IUCN, 2019

Figure 7.30 Nordmann's Greenshank

The Nordmann's Greenshank occurs in inland wetlands, marine intertidal, grassland and forest habitats types. The global population is estimated at 600-1300 and is considered to be decreasing.

Although the Project EAA does not overlap with its distribution (BirdLife International, 2016), it is associated with the Important Bird Area (Binh Dai) approximately 20 km away from the Project Area (BirdLife International, 2019b). No Nordmann's Greenshank individuals were identified during the field surveys, although the species could still utilise the Project EAA. The Project EAA contains suitable habitat for this species. There are multiple recent records of this species in Mekong Delta on eBIrd and GBIF, approximately 40 km away along the coast of Tan Thanh, Go Cong (Tien Giang Province) (eBird, 2019; GBIF, 2019). One record also was recorded for the adjacent Tra Vinh Project site in 2018. It usually frequent estuaries, coastal mudflats and lowland swamps, and sometimes damp meadows, saltpans and rice-fields – roosting or foraging habitats may exist in the Project EAA. As such, the Project EAA should be considered to support globally-important concentrations of an IUCN Red-listed endangered species (0.5 % of the global population AND 5 reproductive units of a CR or EN species), as well as an area that could contain nationally/regionally-important concentrations of an IUCN Red-listed CR or EN species, which would trigger critical habitat under Criterion 1.

Source: IUCN, 2019

Figure 7.31 Spoon-billed Sandpiper

The Spoon-billed Sandpiper occurs in marine intertidal and grassland habitats types. The global population is estimated at 240-456 and is considered to be decreasing.

No Spoon-billed Sandpiper individuals were identified during the field surveys, although the species would likely utilise the Project EAA in flight and possibly for roosting and foraging. It is associated with the Important Bird Area (Ba Tri) approximately 5 km away from the Project Area (BirdLife International, 2019a). There is a recent record of this species in Mekong Delta in February 2019 on eBird, approximately 50 km away at Tan Thanh, Go Cong (Tien Giang Province). Other recent records in October 2019 from dedicated surveys and sightings include a sighting approximately 20 km away in Binh Dai, Ben Tre Province (Vietnam Wildlife Tours & Research, 2019) and another by local bird researchers approximately 7 km away in Ba Tri beach, Ben Tri Province (Hao, pers. comm.). Although the important wintering sites are in Bangladesh, Thailand, Myanmar and China, it prefers mixed sandy tidal mudflats with an uneven surface and very shallow water, mainly in the outermost parts of river deltas and outer islands (BirdLife International, 2018c). As such, roosting or foraging habitats may exist in the Project EAA. It is thus likely that the Project EAA is large enough and contains enough habitat to support 0.5 % of the global population (1.2 Spoon-billed Sandpiper individuals). As such, the Project EAA should be considered to support globally-important concentrations of an IUCN Red-listed endangered species (0.5 % of the global population AND 5 reproductive units of a CR or EN species), as well as an area that could contain nationally/regionally-important concentrations of an IUCN Red-listed CR or EN species, which would trigger critical habitat under Criterion 1.

7.10.4.2.2 Criterion 2: Endemic or Restricted Range Species

Endemic or Restricted Range Species are species that occur within a limited distribution and/or with specific habitat requirements. These species are considered to be at a heightened risk of extinction due to their habitat and range requirements, and are awarded an elevated level of consideration under Criterion 2 within IFC PS6. The only candidate for Criterion 2 is one reptile species.

The Ngo Van Tri's Lady Butterfly Lizard is a diurnal species which inhabits disturbed forested areas and coastal dunes. This species is only found in Vietnam and only known from the type locality in Binh Chau–Phuoc Buu Nature Reserve, Xuyen Moc District, Ba Ria–Vung Tau Province, to which it is believed to be endemic (Grismer & Grismer, 2010). Based on species distribution maps obtained via online sources and literature, the estimated range of this species is 100-150 km^2. However, although the species distribution does not include the Project Area, this species was identified during the field surveys, and also in other project sites nearby. This means the estimated range may not be reliable and may have been extended. There is insufficient information on this species and its range, and hence the Project EAA may not be considered to be an area that regularly hold ≥ 10 % of the global population size AND ≥ 10 reproductive units of a species. **Based on the screening assessment, no species have been identified as likely triggering critical habitat within the EAA under Criterion 2.**

7.10.4.2.3 Criterion 3: Migratory and/or Congregatory Species

Migratory species are classified as animals that spend a proportion of their time in different locations throughout the world, depending on wintering and breeding habitat requirements. Whereas congregatory species are defined as species that meet in globally significant numbers at a particular place at a certain time of year for feeding, breeding or resting. These species are considered to be at a heightened risk of extinction due to habitat and population requirements. Candidates for Criterion 3 include 167 bird and 18 fish species. **Based on the screening assessment, 2 species have been identified as likely triggering critical habitat within the EAA.**

These species are detailed in Section 7.10.4.2.1. Apart from being an IUCN Red-listed EN and CR species, the Nordmann's Greenshank and Spoon-billed Sandpiper are also considered migratory and congregatory species.

The Nordmann's Greenshank breeds in eastern Russia and is found on passage in China, Hong Kong, Taiwan, and South Korea. It winters in Vietnam. Its estimated extent of occurrence (EOO) is 749,000 km^2. With the presence of potential roosting or foraging habitat for this species, the Project EAA should be considered to sustain, on a cyclical or otherwise regular basis, ≥ 1 % of the global population of a migratory or congregatory species at any point of the species' lifecycle, which would trigger critical habitat under Criterion 3.

The Spoon-billed Sandpiper breeds in eastern Russia and is found on passage in Japan, North Korea, South Korea, China, Hong Kong, Taiwan, and Vietnam. It also winters in Vietnam. Its EOO is 355,000 km^2. With the presence of potential roosting or foraging habitat for this species, the Project EAA should be considered to sustain, on a cyclical or otherwise regular basis, ≥ 1 % of the global population of a migratory or congregatory species at any point of the species' lifecycle, which would trigger critical habitat under Criterion 3.

7.10.4.2.4 Criterion 4: Highly Threatened and/or Unique Ecosystems

For Criterion 4, the EAAs have not been assessed by the IUCN against relevant IUCN threatened status. Given that the areas have not yet been assessed by IUCN, an assessment is required to determine whether the habitat would be of high priority for conservation by regional or national systematic conservation planning. Similarly, Vietnam has not undertaken an assessment of high priority conservation areas.

In the past century, extensive loss and degradation of mangrove habitats have occurred as a result of various human activities like coastal development, pollution, aquaculture, and logging for timber and fuel wood. As a result, 20% of the total extent of mangroves was lost between 1980 and 2005 (Spalding et al., 2010) and it continues to shrink at an estimated rate of 1-2% per year (FAO, 2003). At the present rate of loss, there is a real risk of losing the services provided by mangroves totally in the next century

(Duke et al., 2007). In Vietnam, large areas have also been cleared for aquaculture, salt ponds, and agriculture (Spalding, 1997).

Field surveys confirmed the presence of mangroves within the Project Area. However, the terrestrial zone has been intensively modified by human activities. The remaining natural vegetation is patchy, which mostly consists of secondary (regrown) mangrove species. Land class mapping (Figure 7.26) shows that mangrove communities are mainly located in the South of the Project Area.

The extent of mangrove community within the EAA would not represent ≥ 5 % of the global extent of mangrove which is almost 137,600 km^2 (Bunting et al., 2018) (Criterion 4 threshold a). Large extent of existing disturbance/ modification of the ecosystem (based on field survey and remote sensing data) suggests that the mangrove community is unlikely be of high priority for conservation or systematic conservation planning (Criterion 4 threshold b).

Furthermore, the habitats within the EAA are widespread throughout coastal Vietnam and are not considered to be unique or contain species assemblages that would be conservation significant. **The EAA therefore would not be critical habitat under Criterion 4**.

7.10.4.2.5 Criterion 5: Key Evolutionary Processes

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

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

There are no physical features within the EAA that are known to be associated with evolutionary processes. When considering the habitat within the EAA, the natural habitat areas would not be considered to substantially contribute to the biological values of the EAA that may sustain endemic populations, although one endemic reptile was identified within the EAA.

Evolutionarily distinct species have few or no phylogenetically close relatives, and are usually extremely distinct morphologically and behaviourally (Zoological Society of London, n.d.). The Ngo Van Tri's Lady Butterfly Lizard (*Leiolepis ngovantrii*), a VU and endemic species, was identified during the field surveys. It is one of the few asexual species created during the evolutionary history of the *Leiolepis* genus. There is evidence that the formation of all four distinct asexual species was a result of repeated hybridization events between *L. reevesii* and *L. guttata.* This species shares similar parental origins as another species endemic to Thailand – Böhme's Butterfly Lizard (*L. boehmei*) (Grismer et al., 2014). It coexists with its phylogenetically maternal species in its only recorded type locality in Vietnam (Malaisse et al., 2014). It originated relatively recently in 2010 and have many close relatives.

L. ngovantrii differs from all sexual species of *Leiolepis* by lacking males. It differs from all asexual species except *L. triploida* in having a narrower head (HW/HL 0.71–0.83 vs. 0.66–0.69 and 0.65–0.68 in *L. boehmei* and *L. guntherpetersi*) , 50–53 dorsal scales between the dorsolateral stripes vs. 42–48 and 38–42 in *L. boehmei* and L. *guentherpetersi*, respectively; and lacking a light lateral, caudal stripe. It differs further from all asexuals except *L. boehmei* in lacking a black, Y-shaped, pectoral marking, a vertebral stripe, and eyespots bearing white centers. *L. ngovantrii* differs further from all asexuals except *L. guentherpetersi* in having more gular scales (24–25 vs. 18–19 in *L. boehmei* and 17–19 in *L. triploida*) between the enlarged, mandibular scales; the ventrolateral stripe not reaching the axillary region; the presence of transverse bars on the flanks and thin, transverse, dorsal caudal bars; and lacking, dorsal caudal blotches. *L. ngovantrii* differs further from *L. boehmei* in having fewer supralabials (9–10 vs. 11–12) and from *L. guentherpetersi* in having more supraorbital scales across dorsal surface of supraorbital region (6–7 vs. 4) and fewer scale across the ventral side of the tibia (10–11 vs. 14) (Grismer & Grismer, 2010). However, they are all relatively close relatives of *L. ngovantrii.* As such, this species is not of special conservation concern under Criterion 5 given its recent evolutionary development. In addition, there is also a lack of other species in the EAA that have evolved due to physical features of the landscape.

As a result **it is considered unlikely that the Project Area and EAA would be considered important in the conservation of Key Evolutionary Processes, and thus, critical habitat under Criterion 5**.

However, it should be noted that the Ngo Van Tri's Lady Butterfly Lizard is still a species of conservation concern due to the lack of data, and will be a target species in the impact assessment and mitigation.

8. SOCIO-ECONOMIC BASELINE

8.1 Introduction

This report chapter describes the baseline social and economic conditions in the area that will potentially be affected by the Wind Power Project (the Project). The identified communities include Thanh Hai, An Dien, An Nhon, An Quy, An Thuan, and Binh Thanh communes of Thanh Phu district, Ben Tre province (see Figure 8.1). The baseline report includes different levels of analysis including the national, provincial, district and communal contexts with socio-economic indicators and household characteristics for the communities which are potentially affected by the Project. Efforts have been made to highlight the differences between communes and between genders on a number of socio-economic parameters. The objectives of the baseline survey are to:

- Gain an understanding of the socio-economic conditions of the Project areas in 2019;
- Identify social and economic conditions that can be used as indicators to assess the Project's impacts; and
- Identify and understand the perception/concerns of current stakeholders including local authorities and representatives of local communities, who might be affected by and influence the construction and operational activities of the Project to eliminate or reduce any negative impacts.

The reported findings are based on two periods of engagement in July 2019 and September 2019 which included:

- A review of socio-economic conditions collected during site visits;
- Key informant interviews (KIIs) with local authorities at commune level and aquaculture cooperatives;
- Focus group discussions (FGDs); and
- Household survey.

The engagement efforts resulted in 6 KIIs of local authorities, 2 KIIs of cooperatives, 21 FGDs and 70 surveyed households. While the survey in July 2019 focused on KIIs with local authorities and FDGs with participation of randomly invited local people based on profession-oriented groups, the second round of engagement in September 2019 emphasised on household interviews with Project affected population and KIIs with aquaculture cooperatives.

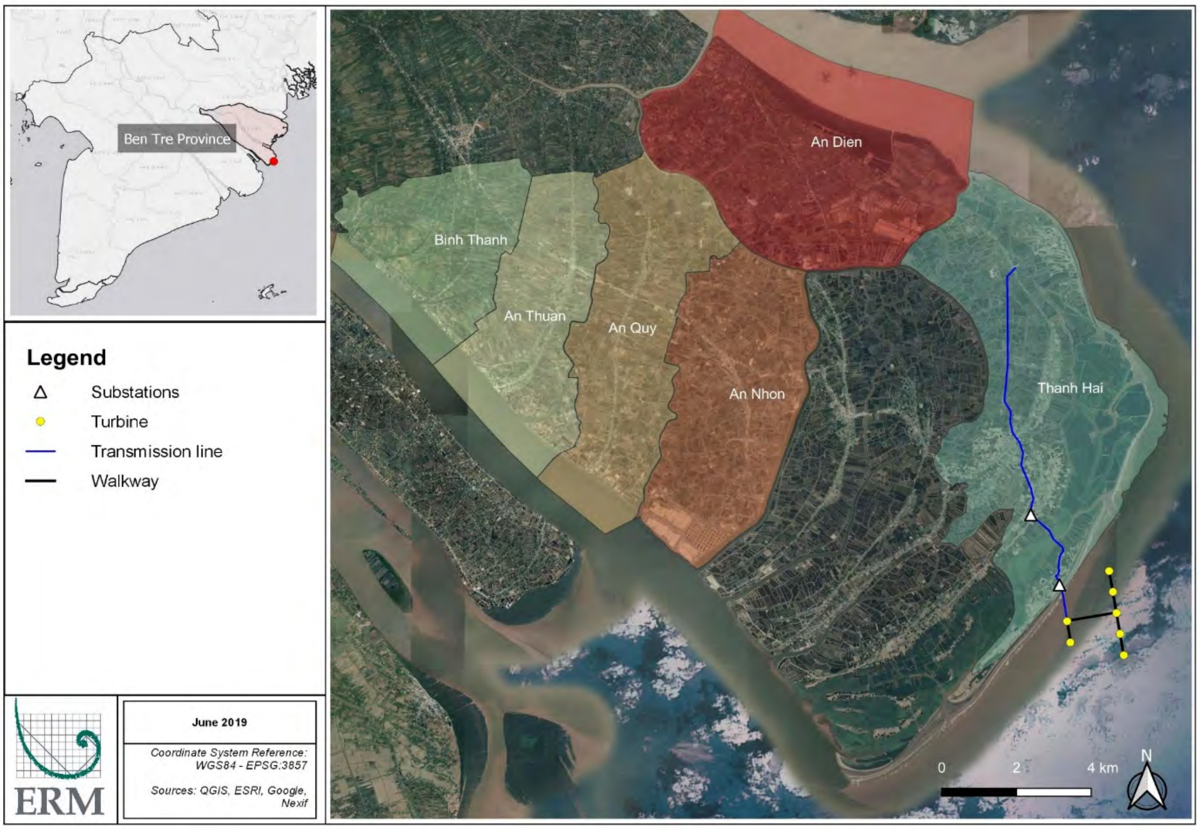


Figure 8.1 Map of the surveyed communes

8.2 Methodology

8.2.1 Target population, sample size and sample population

Table 8.1 shows the target population, sample size and sample populations that participated in the study via different research methods.

Table 8.1 Target population, sample size and sample population

Commune	KIIs		FGDs		Household survey			Surveyed population		
	Local authorities	Aquaculture cooperatives	Number of FDGs	Number of FDG participating households	Households affected by power pole construction	Households affected by power line safety corridor	Total of affected households	FGDs	Household survey	Total
Thanh Hai	1	2	6	58	8	10	18	233	89	322
An Dien	1		3	33	7	7	14	146	68	214
An Nhon	1		3	28	5	6	11	132	78	210
An Quy	1		3	26	1	6	7	138	58	196
An Thuan	1		3	23	6	10	16	117	30	147
Binh Thanh	1		3	35	2	2	4	138	13	151
Total	**6**	**2**	**21**	**203**	**29**	**41**	**70**	**904**	**336**	**1240**

Source: Socio-economic survey conducted by ERM, July and September 2019

8.2.2 Data collection

The socio-economic data collection was designed so that information was gathered at the national, regional and local levels, in enough detail to detect significant changes in perceptions of stakeholders towards the Project. Data for the national level was from secondary data sources and desk-based research while data for the regional and local levels were based on both secondary and primary data sources.

The structure of this task includes (i) secondary socio-economic baseline data collection through meetings with commune authorities; and (ii) primary socio-economic data collection via questionnaires via focus group discussions as well as in household survey and field observations.

8.2.2.1 Secondary socio-economic baseline data collection

The study collected published secondary data sources such as socio-economic statistical data, and socio-economic reports published from reliable sources at the national, provincial and district levels. In addition, socio-economic reports were collected from the local authorities at the district and commune levels. Secondary sources were used to build a socio-economic baseline on a regional level that covers, but is not limited to the following aspects:

- Regional demographic profiles: population, ethnicity, and religion;
- Administration and institutions;
- Economic, livelihoods and employment;
- Land use and tenure management; and
- Infrastructure and public services: water, electricity supply, waste management, education and health services.

They were also collected to provide a basis for comparison between the reported regional context, and the primary socio-economic baseline data collected.

8.2.2.2 Primary socio-economic baseline data collection

The study undertook the primary data collection through face to face interviews with local authorities, FGDs with participation of household representatives; surveyed representatives of 70 households and field observation to validate the data and information collected via these interviews. Primary data from the FGDs and surveyed households were used to establish the socio-economic baseline at the local level. The primary data of this report includes two sources:

The qualitative data with the results of KIIs and FGDs as mentioned above; and

The quantitative data based on collecting economic and social characteristics of 203 households participating in FGDs plus household survey data of 70 affected families from six communes.

8.2.2.3 Key informant interviews

The key informant interviews (KIIs) were conducted with People's Committees of the six communes. The KIIs were semi-structured with major questions prepared in advance in the form of open-ended questions and a statistic data table. The questions concentrated on general information about the community, infrastructure, ethnicity, vulnerable groups, education, livelihoods and employment, health, cultural heritage and perceptions about the Project. KIIs with two aquaculture cooperatives were also conducted to understand particular production activities of the cooperatives, livelihoods of its members and potential impacts on their production. Table 8.2 and Table 8.3 provide a list of authorities and aquaculture cooperatives involved in the KIIs and the number of KIIs that took place.

Table 8.2 List of KII participants and number of KIIs with local authorities

Province	District	Commune	Participants	Number of KIIs
Ben Tre	Thanh Phu	Thanh Hai	Representatives of the commune PC	1
		An Dien	Representatives of the commune PC	1
		An Nhon	Representatives of the commune PC	1
		An Quy	Representatives of the commune PC	1
		An Thuan	Representatives of the commune PC	1
		Binh Thanh	Representatives of the commune PC	1
Total				**6**

Source: Socio-economic survey conducted by ERM, July 2019

Table 8.3 List of KII participants and number of KIIs with aquaculture cooperatives

Province	District	Commune	Participants	Number of KIIs
Ben Tre	Thanh Phu	Thanh Hai	Representatives of the Thanh Loi Aquaculture Cooperative – Clam Farming	1
			Representatives of the Binh Minh Aquaculture Cooperative – Clam Farming	1
Total				**2**

Source: Socio-economic survey conducted by ERM, September 2019

8.2.2.4 Focus group discussions

ERM completed 21 focus group discussions (FGDs) with affected communities in six surveyed communes. In an effort to ensure adequate representation of the diverse local population, the FGDs attempted to encompass participants of different livelihoods, vulnerability status, impact significance levels and living within various proximities to the Project area. These included cultivation farmers, aquaculture farmers, commercial fishing people, wage-based workers, small business owners, women and vulnerable people.

In each group, a diversity of participants in terms of gender and age cohorts were invited to participate. Depending on the key livelihoods identified within of the commune, location of the commune to the Project site and potential impacts to the community, discussion groups were selected for each commune as presented in Table 8.4.

Table 8.4 FGDs by typology and commune

Commune	Number of FGDs									Total number of households participating FGDs	Total population of households participating FGDs
	Agriculture farmers	Aquaculture farmers	Commercial fishing professionals	Wage-based workers	Small business owners	Women	Vulnerable people	Fence-line community	Total		
Thanh Hai		1	1	1	1	1		1	6	58	233
An Dien	1	1					1		3	33	146
An Nhon	1			1			1		3	28	132
An Quy	1	1	1						3	26	138
An Thuan		1	1		1				3	23	117
Binh Thanh	1			1		1			3	35	138
Total	**4**	**4**	**3**	**3**	**2**	**2**	**2**	**1**	**21**	**203**	**904**

Source: Socio-economic survey conducted by ERM, July 2019

Each FGD included two sessions. Throughout the first session, individual households' information was collected. This included households' demographic data; level of education; livelihoods and economic development; land, housing and house assets; and health profile, health care behaviour and health insurance. The result of the session is the quantitative database of 203 households.

During the second session, ERM obtained the group's collective understanding of the community development, livelihood activities, production areas, products and productivity, resource use and access, evaluation on public infrastructure and services, and their awareness and perceptions about the Project.

Additionally, within the FGD for vulnerable groups, interviewee's personal satisfaction in respect to their standard of living, health, security, environment, achievements in life, personal relationships, available time for leisure activities, social inclusion and current job situation was discussed to understand how much vulnerable people ranked their well-being.

8.2.2.5 Household survey

The survey were carried out with 70 households in six communes based on the questionnaire of household socio-economic characteristics, as showed in Table 8.5.

Table 8.5 Sample size of the household survey

District	Commune	Number of affected households participated in the survey	Number of affected population participated in the survey
Thanh Phu	Thanh Hai	18	89
	An Dien	15	68
	An Nhon	6	78
	An Quy	16	58
	An Thuan	11	30
	Binh Thanh	4	13
	Total	**70**	**336**

Source: Socio-economic survey conducted by ERM, September 2019

Interviewees were adults (>18 years old) and knowledgeable about family activities (most of them were head of household or head of household's spouse). The questionnaire was designed to collect the following key information, including but not limited to:

- Age and gender;
- Educational level;
- Current health status of interviewed household members;
- Several factors regarding the household economic conditions (including the current house's condition, appliances in the house), income and expenditure of households;
- Occupation and its current status;
- Assess the current situations and expectations of households on public services and infrastructure including local roads, electricity, water, waste management, education and healthcare benefits;
- Land information; and
- Awareness on the project, how to affect, satisfaction level with acquisition and compensation of affected households.

8.2.2.6 Field observation

Field observations were carried out during the ERM survey, at the village and commune level, during interviews, group discussions and village transect walk/drive. Field observations covered the following aspects:

- Health facilities;
- Education facilities;
- Religion facilities;
- Community security system;
- Commune and Village government facilities;
- Public transportation services and infrastructures;
- Community daily activities; and
- Community use of natural resources and livelihood.

8.2.3 Limitation

Even though every effort was made to achieve the best database and sample-size, the research team recognises that the key limitations to this study are the quality and extent of available information. This study relies on the most recent reports and statistical information available at the time of writing. For some indicators, the analysis has relied on information from the 2003 Statistical Data, 2017 Statistical Yearbook and the 2009 Population and Housing Census, which may not accurately reflect current social and economic conditions. However, this information remains the best available source at the time of writing. Interviews with key informants supplemented the available statistical data, and helped to confirm understandings of existing conditions, and provided insight into local issues and trends. Reasonable efforts were made to cross-check and triangulate information from different sources to confirm their accuracy.

The FDGs were prominently used to obtain data from purposely-selected groups of individuals. At the same time, stratified random sampling was designed in recruiting households for the FDGs, on which the surveyed population was based. This approach aimed to ensure the equal representation of different start and increased analytic generalisation. However, the data from household survey in September 2019 supplement a good source of knowledge integration and comparative analysis.

The number of household survey had some changes comparing to the list of surveyed households in each commune. The main reasons was that they have migrated to big cities, such as Ho Chi Minh City for their living.

8.2.4 Data analysis

The data collected via the paper-based questionnaires was entered using Microsoft Excel. Before the analysis however, multiple checking processes were conducted to further identify potential errors. Some of the answers were cross-checked to make sure about the consistency of the data. The final databases for both surveys then were analysed by Excel to provide different frequency and percentage tables. Baseline information for the surveyed communities is presented in terms of eight socio-economic components:

- Demographic information;
- Education;
- Employment;
- Income and expenditure;
- Health;
- Access to public services;
- Land, housing and household assets; and
- Gender and vulnerability description.

Where appropriate, data for each of the communities in the Project have been checked with comparable information to provide context.

8.3 National context

8.3.1 Demographic information

The Socialist Republic of Vietnam is located on the Indochina peninsula in Southeast Asia. It is bordered by China to the North, Laos and Cambodia to the West, the Gulf of Thailand to the Southwest, and the East Sea to the East and South, and is composed of a mainland area of 331,230km^2 and more than 4000 islands. It has a population of 93.7 million (2017), equivalent to an increase of 1.06% in comparison with 2016, of which the urban population was 32.8 million people (35%) and the rural population was 60.9 million people (65%). The male and female population was 46.3 million and 47.4 million people respectively, with the corresponding composition of 49.4% and 50.6% (Vietnam General Statistics Office, 2017; also see Table 8.6*)*.

Vietnam has a total of 54 ethnic groups. The Kinh ethnic group makes up the largest proportion with approximately 86% of the population, and mainly lives in the deltas and major cities while the other 53 ethnic minority groups, especially those with small populations, are scattered across mountain areas with very limited access to infrastructure, health care and education (World Bank, 2009). Vietnamese is the official language and is spoken by around 90% of the population. Minority groups are distinguished by distinct languages including Tay, Hmong, Thai, and Khmer in the more remote rural areas. Some ethnic minority groups such as Tay, Thai, Nung, Hmong, Muong, Cham, Khmer, Kohor, Ede, Bahnar, and Jarai have their own writing systems (DFAT, 2017). Despite rapid economic growth in recent decades, ethnic minority communities living in mountainous and highland areas have been trapped in poverty. According to the World Bank (2013), ethnic minorities account for 14% of the total population but they also account for up to 50% of the total poor population.

Table 8.6 Vietnam at glance

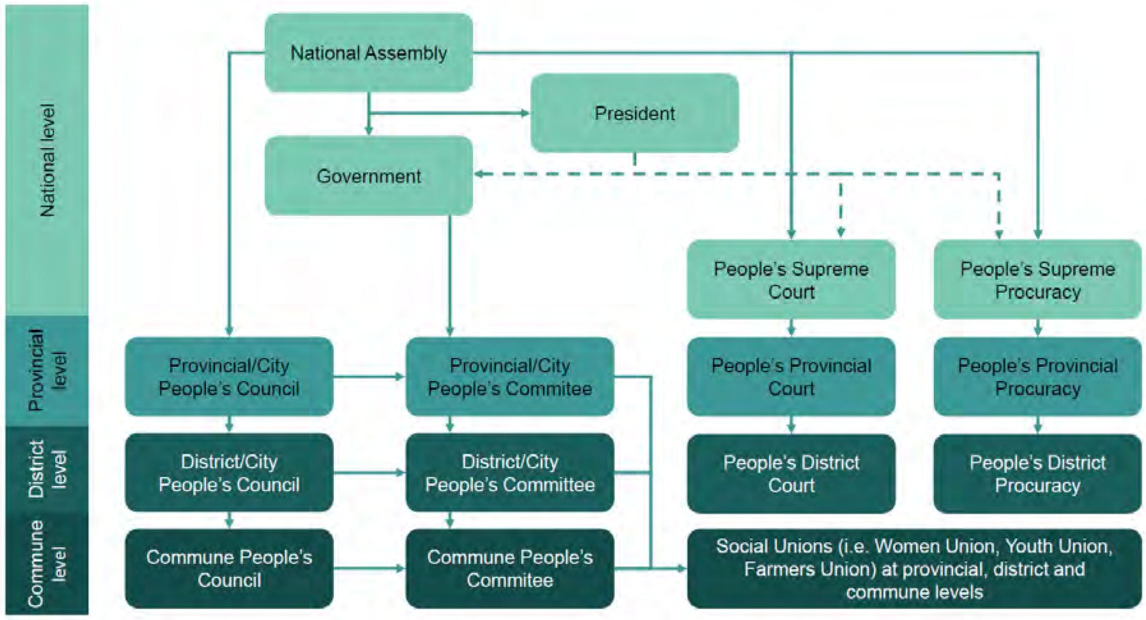
VIETNAM

Full name	Socialist Republic of Vietnam
Capital	Ha Noi
Largest city	Ho Chi Minh
Area	331,320 km^2
Official language	Vietnamese
Ethnic groups	86% Kinh 14% Ethnic minorities
Religion	73.1% Folk 12.2% Buddhism 6.9% Catholicism 1.5% Protestantism 4.8% Caodaism 1.4% Hoahaoism 0.1% Others (2014)
Population	93,671,569 persons (2017)
GRDP (total)	5,006 trillion VND (2017)
GDP per capita	53.4 million VND (2017)

Source: Vietnam General Statistics Office, 2017

8.3.2 Institution context

The state system of governance of Vietnam has four levels: national, provincial, district and commune, as illustrated in Figure 8.2



Source: ERM, 2019

Figure 8.2 The State system of Vietnam

At the national level, the State of Vietnam consists of the National Assembly, the President, the Government, the People's Supreme Court and the People's Supreme Procuracy.

- The National Assembly is the supreme organ of state and the only body with constitutional and legislative power to draw up, adopt, and amend the constitution and to make and amend laws, to legislate and implement state plans and budgets, and to initiate or conclude wars, as well as assume other duties and powers it deems necessary.
- The President represents Vietnam both domestically and internationally, and maintains the regular and coordinated operation and stability of the national government, and safeguards the independence and territorial integrity of the country.
- The Government is the executive organ of the National Assembly, the highest body of state administration of the Socialist Republic of Vietnam. It carries out overall management of work for the fulfilment of the political, economic, cultural, social, national defence, security and external duties of the State.
- The Supreme People's Court supervises the judicial work of the local People's Courts, which are responsible to their corresponding People's Councils, and the Military Tribunals. The People's Courts function at all levels of government except the commune, where the commune administrative committee functions as a primary court.

The Supreme People's Procuracy, with its local and military subdivisions, acts as a watchdog for the state. It monitors the performance of government agencies, maintains vast powers of surveillance, and acts as a prosecutor before the People's Courts.

The organisation of institutional governance from provincial/city level to commune level consists of:

- The People's Council at provincial, district and commune levels: a body of state power at the local level, representing the rights of the people and is elected by local people; and
- The People's Committee at provincial, district and commune levels: the executive body of the People's Councils and State administrative agencies at the local level. The People's Committee at the provincial/city and district level includes departments for different fields such as agriculture and rural development, natural resources and environment, transport etc. The number of staff may vary from commune to commune depending on the size and area of the commune. Vietnam has

currently 11,162 commune-level administration units, including 1,567 wards, 597 town and 9,064 communes[14]. The capacity of Vietnamese rural commune's human resources is required to be strengthened to meet the higher demand of the national development cause. Among 145,112 permanent staff of the commune level, 31% are reported to have no formal education (see Figure 8.3).

While it is not recognised within the State's local administration system, village level institutions as the basic unit of Vietnamese society and their interactions with the State are significantly crucial to understand Vietnamese socio-political characteristics and citizen's behaviours[15]. During the current New Rural Development Program, village leadership and participation is becoming more important to participatory village development planning and implementation of grassroots democracy, and thus community development.

Based on ERM's understanding, the village structure basically includes the Village Party Branch, led by the Village Party Branch secretary (*Bí thư Chi bộ thôn*), Village People's Board (*Ban Nhân dân thôn*), led by the village head *(Trưởng thôn*) and the village Committee of Actions of the Fatherland Front (*Ban Công tác Mặt trận thôn)*. Each village has its own organisations including the Women's Union, Farmer's Association, Veteran's Association, Youth Union and Elderly Association, and other social organisations such as the Red Cross Union and the Study Promotion Association.

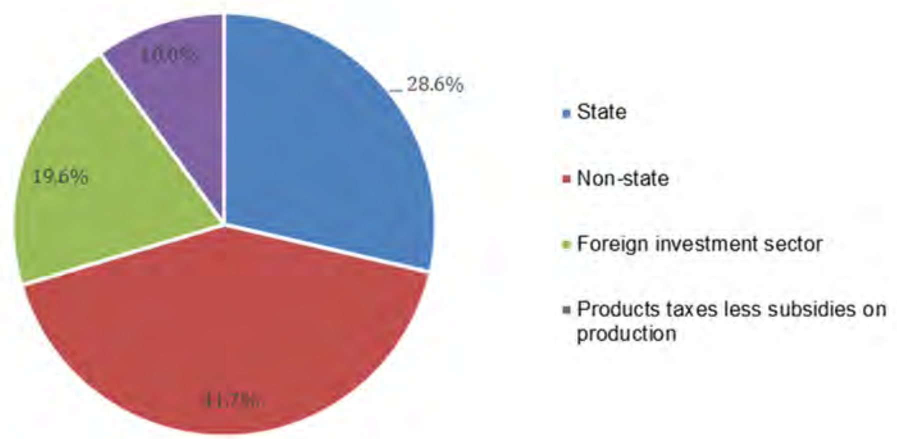
8.3.3 Economy and industry

Vietnam is described as 'a development success story' having undergone dramatic transformation from one of the poorest countries in the world at the time of economic reforms in the 80s (known as Doi Moi or Renovation reforms), to 'low middle income status' over a period of 25 years (DFAT, 2017).

Gross domestic product (GDP) in 2017 was estimated to have increased 6.8% since 2016, of which the agriculture, forestry and fishery sector increased 2.9%, contributing 0.44% to the country's economic growth rate; the industry and construction sector grew by 8.0%, contributing 2.77 percentage points; and the service sector grew by 7.4%, contributing 2.87 percentage points. In 2017, GDP at current prices reached VND 5,006 trillion. By types of ownership, GDP of non-state economy accounted for the highest proportion at 41.7% while GDP of the foreign investment sector made up 19.6% (see Figure 8.3). According to the General Statistics Office of Vietnam (2017), GDP per capita was estimated to be VND53.4 million, equivalent to US$2,389 higher than in 2016. Vietnam's two largest export partners are the US and EU while its key FDI investors are the Republic of Korea, Japan and Singapore (VCCI & PWC, 2017).

[14] Mai, Duc Ngoc. 2015. Can bo lanh dao chu chot cap xa o nong thon Viet Nam hien nay (Key Communal Human Resources in Contemporary Rural Vietnam). Khoa hoc Xa hoi Viet Nam 12(2015): 19-27.

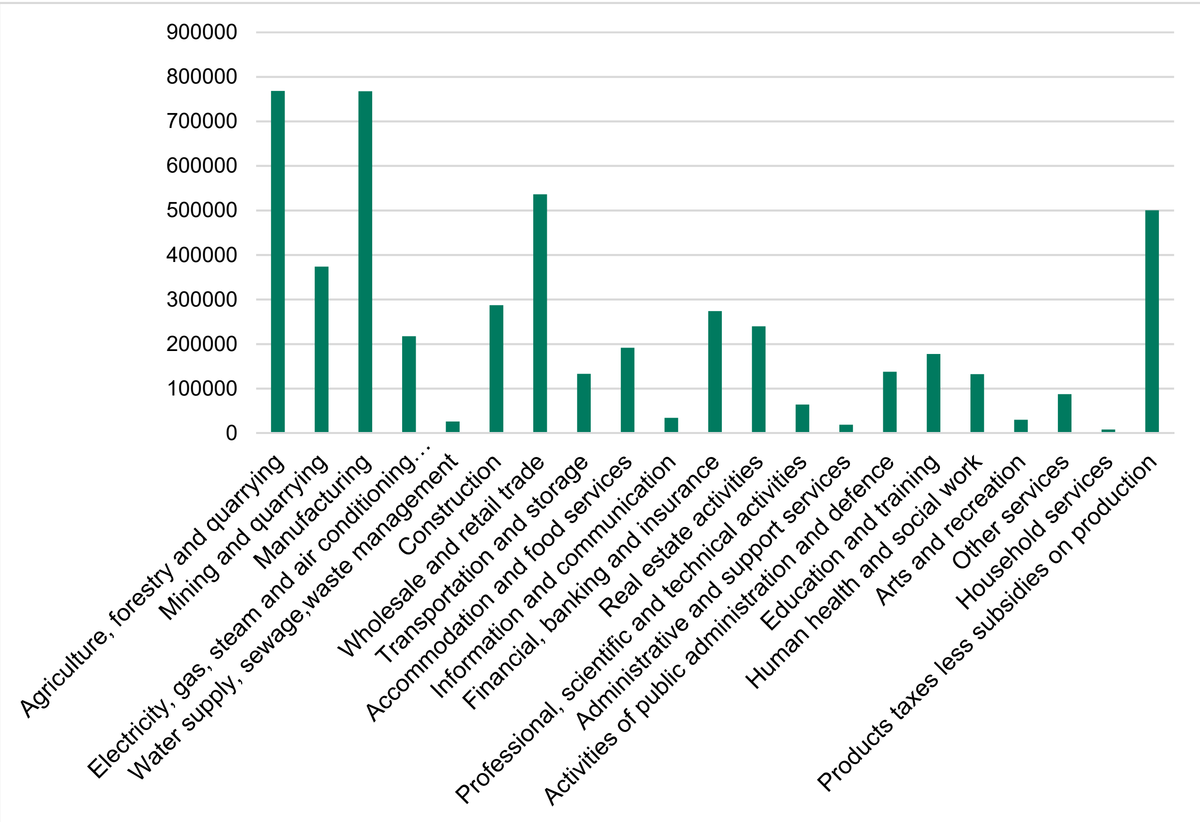
[15] Nguyen, The Anh. 2003. Village versus State: The Evolution of State-Local Relations in Vietnam until 1945. Southeast Asian Studies 41(1): 101-123.



Source: Vietnam General Statistics Office, 2017

Figure 8.3 Vietnam's GDP composition in 2017 by type

The structure of the economy has experienced a positive shift whereby the agricultural portion has been gradually reduced, and the share of industry and services has increased. In 2017, the share of the agriculture, forestry and fishery sector accounted for 15.3%, while the share of the industry and service sectors was 33.4% and 41.3% respectively (Vietnam General Statistics Office, 2017). Figure 8.4 details the contribution of different kinds of economic activity to the GDP in 2017.



Source: Vietnam General Statistics Office, 2017

Figure 8.4 Contribution to Vietnam's GDP in 2017 at current prices by type of economic activity

In 2017, Vietnam's labour force aged 15 years and over was 54.8 million people, an increase of 378,500 people from 2016, of which the male and female proportion accounted for 51.8% and 48.2% respectively. The employed population aged 15 years old and above working in economic activities reached 53.7 million people in 2017, an increase of 0.8% from 2016 and a sharp increase in urban areas.

The living standards of the Vietnamese population have also improved. The human development index (HDI) rose from 0.695 in 2016 to 0.700 in 2017, and Vietnam was ranked 116th out of 189 countries in the latest United Nations Human Development Report 2018 (UNDP, 2018).

The overall multi-dimensional household poverty rate was 7.9% in 2017, a decrease of 1.3% from 2016. In urban areas the rate was 2.7% - a drop of 0.8%, and in rural areas it was 10.8% - a decline of 1% (Vietnam General Statistics Office, 2017). By region, the North midlands and mountain areas, the central highlands and the North central and central coastal areas were the regions with highest multi-dimensional poverty household rates, at 21%, 17% and 10% respectively, while the South East region was the lowest (0.9%).

8.3.4 Renewable energy planning and development

Electricity demand in Vietnam is projected to increase by eight percent annually until 2025. Therefore, the government is promoting the development of renewable energy in addition to existing energy sources to ensure energy security and to address the growing power demand. In 2015, the Vietnam government approved 2068/QD-TTg on the Development Strategy of Renewable Energy of Vietnam (DSRE) by 2030 with a vision to 2050. The Decision clearly states the development strategy and orientation for renewable energy as follows:

"*To encourage the mobilisation of all resources from the society and people for renewable energy development to strengthen the access to the modern, sustainable and reliable energy source with rational price for all people; promote the development and use of renewable energy, increase in domestic energy supply source, gradually increase the proportion of renewable energy in production and consumption of national energy to decrease the dependence on the fossil fuel, contribute to ensure the energy security, mitigation of climate change, environmental protection and sustainable socio-economic development.*"

In 2016, the government approved the revised National Power Development Master Plan ("PDP VII") for the 2011- 2020 Period, with a vision for 2030 under the 428/QD-TTg. This Master Plan provides the development orientation for renewable energy sources in 2020, 2025 and 2030 as summarised in Table 8.7.

Table 8.7 Targets set in PDP VII for renewable energy by 2020, 2025, and 2030

Type	Capacity	2020	2025	2030
Wind	Total Capacity (MW)	800	2,000	6,000
	Electricity prod. (%)	0.8	1	2.1
Hydropower	Total Capacity (MW)	21,600	24,600	27,800
	Electricity prod. (%)	29.5	20.5	15.5
Biomass	Electricity prod. (%)	1	1.2	2.1
Solar	Total Capacity (MW)	850	4,000	12,000
	Electricity prod. (%)	0.5	1.6	3.3

Source: Vietnam Briefing, 2019

As one of the government's incentive policies for renewable energy investment in Vietnam, feed-in-tariffs in Vietnam are currently among the lowest in the world[16].

8.4 Provincial Context

8.4.1 Overview of Ben Tre Province

Approximately 85km from Ho Chi Minh City sits Ben Tre, a coastal province in the Mekong Delta covering a total natural area of 2,394.8km^2 and formed by An Hoa isle, Bao isle, Minh isle and alluvial soil from four Mekong tributaries. Ben Tre is adjacent to the East Sea with a coastline of 65 kilometres and bordered on the north by Tien Giang Province, on the west and southwest by Vinh Long Province, and on the south by Tra Vinh Province.

Table 8.8 Ben Tre Province at glance

BEN TRE PROVINCE	
No. of cities	01 (Ben Tre)
No. of districts	08
Area	2,394.8 km^2
Population	1,268,204
Proportion in poverty	6.10%
Ethnic groups	Kinh, Khmer
Key religion	Buddhism
GDP (total)	40,365 billion VND (2017)
GDP per capita	31.87 million VND (2017)

Source: Ben Tre Statistical Yearbook, 2017

8.4.2 Population

The population of Ben Tre reached 1,268,204 in 2018, with a population density of 530 people/km². A majority of the Province's population (1,131,016 people or 89.2% of the population) lives in rural areas whereas 137,188 live in urban areas, accounting for 10.8% of the provincial population. The male and female population was estimated at 624,330 and 643,874, respectively in 2018. Figure 8.5 presents the population of each district of the province by gender. The rate of annual increase in province's population is 0.26% (Ben Tre Statistical Yearbook, 2017).

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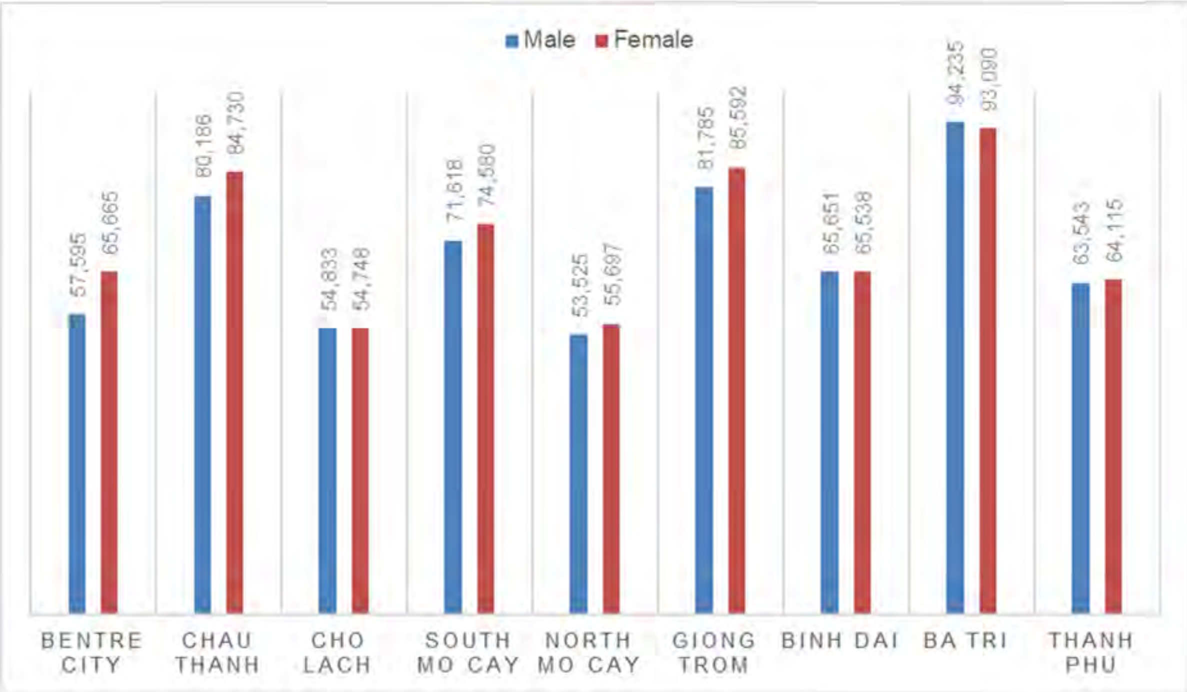
[16] Vietnam Briefing. 2019. Renewables in Vietnam: Current Opportunities and Future Outlook. Available at https://www.vietnam-briefing.com/news/vietnams-push-for-renewable-energy.html/. (Accessed 22 July 2019).

In the Ben Tre Province 63.99% of the total population is in the labour force, aged 15-60 years old. Of which, the working population in urban areas accounts for 9.42% while rural areas account for 90.58% of the total.



Source: Ben Tre Statistical Yearbook, 2017

Figure 8.5 Population of Ben Tre Province by gender and district

8.4.3 Ethnicity

The main ethnic group living in Ben Tre is the Kinh people, accounting for 99.08% of the province's total population. Other ethnic minority groups residing in the province included Khmer (0.35%), Hoa (0.47%) and Cham and other ethnic minorities (0.1%) (Table 8.9). According to the Preparatory Survey for Ben Tre Water Management Project of JICA conducted in 2016[17], minority groups including Hoa, Muong, Tay, Khmer, and Cham ethnic people are reported to reside in Giong Trom District (Thach Phu Dong Commune), Chau Thanh District (Phu Duc Commune, Tien Long Commune), and Binh Dai District (Long Dinh Commune).

[17] JICA. 2016. The Preparatory Survey for Ben Tre Water Management Project. Available at https://www.jica.go.jp/english/our_work/social_environmental/id/asia/southeast/vietnam/c8h0vm00009b2g33-att/c8h0vm0000agn6p0.pdf (Accessed 25 August 2019)

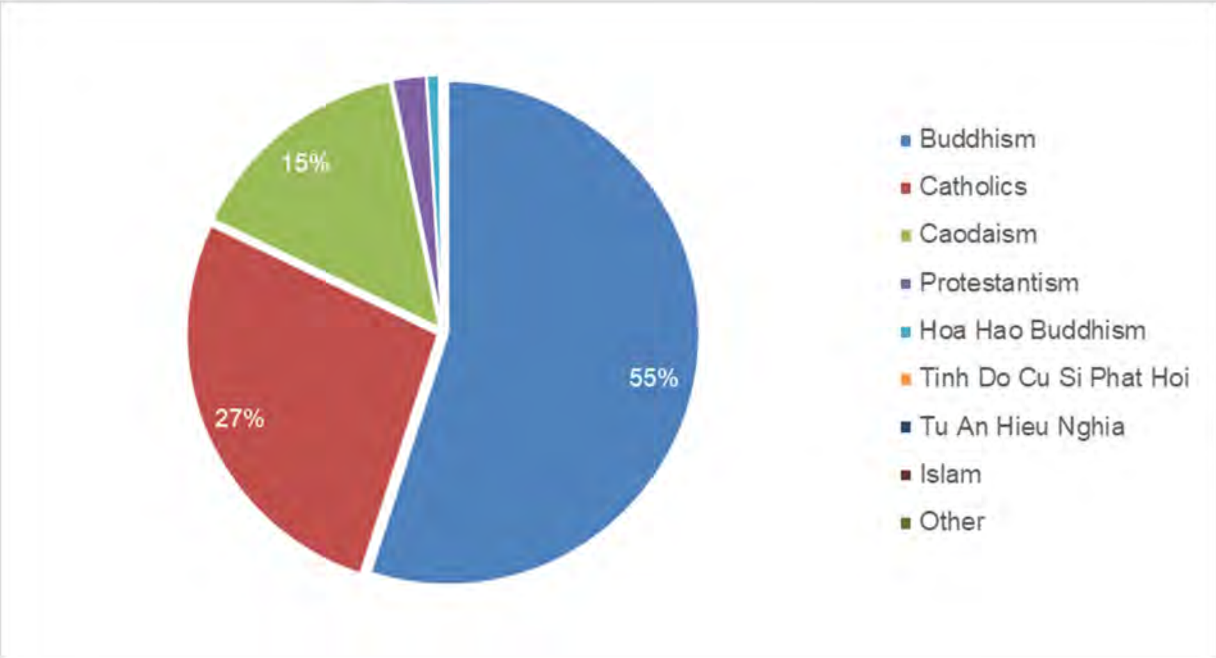
Table 8.9 Population and ethnic groups

	Population	Kinh	Hoa	Khmer	Cham and other ethnicities	Total number of ethnic minority people
No. of people	1,262,000	1,250,425	5,936	4,376	1,263	11,575
% of population	-	99.08	0.47	0.35	0.10	0.92

Source: Ben Tre Statistical Yearbook, 2003

8.4.4 Religion

The most popular religions in the Mekong Delta, which are practised in Ben Tre, include Confucianism, Buddhism, Christianity (largely Catholics), Protestantism, Caodaism, Hoa Hao and Dao Dua. Buddhism, Christianity and Caodaism[18] are the three most influential and notable religions, and have the largest number of followers in the region. In 2015, 223,920 people declared their affiliation with one of the aforementioned religions, accounting for 17.8% of the total population of the province. The relative proportion of followers of each religion is illustrated on Figure 8.6.



Source: Viet Nam Population and Housing Census, 2009

Figure 8.6 Major religious groups identified within Ben Tre Province

[18] Ben Tre Province Portal. 2019. Religion (Ton Giao). Available at http://www.bentre.gov.vn/Pages/GioiThieu.aspx?ID=2046&CategoryId=V%u0103n+h%u00f3a+x%u00e3+h%u1ed9i&InitialTabId=Ribbon.Read. (Accessed 22 July 2019)

8.4.5 Infrastructure and facilities

8.4.5.1 Road and transportation

The transportation system of Ben Tre Province includes several types of transportation to serve its development activities and local communities. Its sub-system of bridges and roads consists of key routes, as below:

- National Road 60 from Tra Vinh through Mo Cay Nam District, Mo Cay Bac District, Ben Tre City, Chau Thanh District, My Tho City, connecting with National Highway 1A. This is considered the most important road of the province. It also connects three islands in the region and forms the trading route with other nearby provinces.
- Highway 57 from Mo Cay Bac District, Cho Lach District to Vinh Long Province.

Previously, travelling on Highway 60 was difficult due to needing to transfer to many ferries, such as the Co Chien ferry from Tra Vinh to Mo Cay Nam, Ham Luong ferry from Mo Cay Bac to Ben Tre town, Rach Mieu ferry from Ben Tre to Tien Giang. The Rach Mieu bridge, Ham Luong Bridge and Co Chien Bridge were opened in early 2009, April 2010 and 2015 respectively, facilitating uninterrupted traffic flow between Ben Tre and Tra Vinh and other provinces in the south.

8.4.5.2 Waterways

Ben Tre has four large rivers, the Tien, Ham Luong, Co Chien and Ba Lai rivers with the total length of 295 kilometres. In 2017, Ben Tre had 204 inland waterway ports, including 40 passenger wharves, 161 inland wharves and three inland ports. There were 111 inland waterway ports and terminals located on the national inland waterway route but these were under the management of Ben Tre Department of Transport.

Under the Scheme on Management and Development of Cross-river Passenger Wharves in Ben Tre Province by 2020, the province planned to construct five new wharves in Binh Dai District, two in Cho Lach District and one each in the Mo Cay Bac, Ba Tri and Thanh Phu Districts[19] by 2020.

8.4.5.3 Electricity

Due to the divided terrain in the province, with numerous rivers and streams and several islands located far from the mainland, Ben Tre People's Committee has focused heavily on investing in upgrades to the grid and in bringing electricity to remote areas and to every household. After 10 years of implementing Resolution No. 26-NQ/TW on Agriculture, Farmers and Rural areas (2008-2018), the rate of households using electricity in Ben Tre Province has increased from 93% in 2008 to 99.89% at the end of 2017.

In the period of 2008 - 2017, Ben Tre invested over VND1,000 billion to upgrading and building new medium and low voltage transmission lines with a combined length of over 7,000km. Its two major projects included: (1) developing a rural distribution grid in the Ben Tre Province. The project was implemented from 2010 to 2011 with VND76.5 billion in capital. It constructed and upgraded nearly 300km of medium and low voltage transmission lines and constructed a new 3,550 kVA distribution transformer station; and (2) improving energy efficiency in rural areas in the Ben Tre Province. The project used financial support from Germany Reconstruction Bank with a VND375.4 billion loan to

[19] Giao Thong Van Tai Newspaper. 2017. Ben Tre government promotes the development of inland waterway (Ben Tre uu tien phat trien duong thuy noi dia). Available at http://www.tapchigiaothong.vn/ben-tre-uu-tien-phat-trien-duong-thuy-noi-dia-d48286.html. (Accessed 25 August 2019).

upgrade and build more than 1,200km of medium and low voltage lines and construct a 5,770kVA distribution transformer station[20].

8.4.5.4 Water supply

In 2017, the total capacity of all 77 water supply plants in the Ben Tre Province was 109,000m^3/day and night while the demand was 97,000m^3/day and night for the province. Ben Tre Water Supply and Sewerage Joint Stock Company provides a capacity of over 62,000m^3/day and night with five plants, while 41 plants operated by the Centre for Rural Water Supply and Environmental Sanitation have a combined capacity of 23,800m^3/day and night. The private suppliers have a total exploitation capacity of 23,000m^3/day and night with their 31 plants.

However, the raw water source supply only meets water demand in the rainy season. During the dry season, the raw water supply capacity is only about 60% of that required (57,000m^3/day and night including 47,000 m^3/day and night at Cai Co pumping station). The main raw water pumping station in the Province is also affected by saline intrusion and is being treated with a temporary solution.

Raw water pipelines are limited, serving only two main water plants in the province, An Hiep and Son Dong. In the southern area of Ham Luong River (Cho Lach, Mo Cay Nam, Mo Cay Bac and Thanh Phu), there seem to be no water sources for the dry months, which may lead to a limited water supply for the area with the capacity of just 23,000m^3/day & night.

Currently, Thanh Phu is considered the most challenging area in terms of water supply. Water is supplied from four factories managed by the Centre for Rural Water Supply and Environmental Sanitation, with a total capacity of 3,600m^3/day and night, and one private factory with a capacity of 700m^3/day and night. Notably, communes adjacent to the sea are currently not supplied with water from any local water plants.

In 2017, 96.5% of households used hygienic water, of which 56% was used clean water[21]. The provincial authorities planned to build new water treatment plants to increase the capacity of the existing system in accordance with the Province's Rural Water Supply and Sanitation Planning by 2020. In addition, plans to build new water plants at Luong Phu, Thanh Thoi A, Ngai Dang, Tan Thanh Tay, Thanh Phu, Hoa Loi, Phu Khanh, Thoi Thanh[22] were identified in the relevant provincial plans.

8.4.5.5 Irrigation systems

Ben Tre Province has 92 culverts of 1.5m or more and thousands of in-field sluice gates for saltwater prevention in cultivation areas and saltwater regulation in aquaculture areas[23]. Completed in 2002, the construction of the Ba Lai sluice gate is to be the considered the biggest irrigation project to have been implemented in the Mekong Delta region, costing over VND66 billion at the time. The project's objective

[20] Nhan Dan Newspaper. 2018. Ben Tre government provide electricity supply to remote areas within the province (Ben Tre dua dien luoi ve vung sau vung xa). Available at https://nhandan.com.vn/xahoi/item/38640502-ben-tre-dua-dien-luoi-ve-vung-sau-vung-xa.html. (Accessed 22 July 2019).

[21] Vietnam Government set targets and monitoring indicators in terms of 'hygienic', 'clean' and 'safe' water which are subject to change. 'Clean' water is currently defined as water that meets the Ministry of Health Quality Standard QCVN 02-BYT. With lesser standards, 'hygienic' water, means water that would be safe for drinking after filtering or boiling (World Bank. 2014. Water Supply and Sanitation in Vietnam: Turning Finance into Services for the Future).

[22] Ben Tre Province portal. 2017. Development of Water Supply System for Domestic and Production (Phat trien ha tang cung cap nuoc phuc vu san xuat va sinh hoat). Available at http://nongthonmoi.bentre.gov.vn/noi-dung/-/cms-icbt/10180/bai-viet/312912. (Accessed 22 July 2019).

[23] Tai Nguyen va Moi Truong Newspaper. 2018. Ben Tre-Irrigation system will be improved (Ben Tre-He thong thuy loi se dan hoan thien). Available at https://baotainguyenmoitruong.vn/moi-truong/ben-tre-he-thong-thuy-loi-se-dan-hoan-thien-1263422.html. (Accessed 22 July 2019).

was to prevent saltwater intrusion and reduce salinisation in the water used by more than 115,000ha of land, of which more than 88,000ha is productive land.

After 16 years of the Ba Lai dam being in operation, some places in the region are still affected by saline water intrusion although salinisation has been reduced. The problem is caused by an incomplete irrigation system on the "open" side of the upper steam in Chet Say Canal (flowing from Ham Luong river) and where the Giao Hoa Canal (on Tien river) flows back into Ba Lai River. During the dry season, this place accidentally becomes a saltwater pool.

Source: Ben Tre Province Portal, 2015

Figure 8.7 Ba Lai sluice gate in Binh Dai District, Ben Tre Province

8.4.5.6 Domestic waste management and drainage

The average urban waste collection rate in the Ben Tre Province is 78%. Ben Tre City currently has the highest waste collection rate, at 91%. Other waste collection rates in towns and residential areas of districts are between 68% and 73%. Waste collection mainly involves the collection of saleable materials (nylon, aluminium, iron, steel and plastic, etc) for sale to scrap buying facilities.

This work is conducted at three levels: the household, the transition point and at local landfill areas. For areas in Ben Tre City, Chau Thanh Town, residential areas of the Giao Long and An Hiep industrial zones and some communes of the Giong Trom District, urban waste is collected and transferred by Ben Tre Urban Construction Joint Stock Company to Phu Hung landfill (Ben Tre City) for disposal by burial.

However, Ben Tre has yet to build a proper sanitary landfill and there is no system for recovery, recycling and reuse of domestic waste. Collected waste materials are mostly disposed of at small-scale, open landfills near residential areas. Currently, Ben Tre Province has ten active solid waste disposal sites with a total area of 13.14ha. These are mainly used for solid waste treatment by urban areas. Only two landfills are equipped with a leachate collection system: the solid waste treatment area in Mo Cay Nam district and Giong Trom district solid waste treatment area[24].

8.4.5.7 Telecommunication

The Ben Tre Province currently has eight telecommunication service providers. They are VNPT, Viettel, Mobiphone, Vinaphone, EVN, G-Tel, S-Phone and Saigon Tourist Cable TV. Recently, 68 base transceiver stations have been developed, bringing the total number of mobile information stations across the province up to 1,196.

The number of current mobile subscribers is 1,665,063, an increase of 33.99% compared to the same time last year. There are also currently 193 internet agents with 131,630 users, with internet usage density in the province being 65.8 out of 100 people (Socio-economic report of Ben Tre Province, 2018).

8.4.6 Education

The education system of the Ben Tre Province includes all levels of education: pre-school, primary, secondary and high school. According to the General Statistics Office, in 2018 the Ben Tre Province had 535 schools from the kindergarten to high school. The total number of students was 246,829, including 97,137 at the primary level, 70,792 at the secondary level and 32,908 at the high school level. Details regarding the number of schools, classes, teachers and students are provided in Table 8.10.

Table 8.10 Number of classes, schools, teachers and students in Ben Tre Province in the 2018 school year

	Number
Schools of general education system	535
Classes of general education system	7,536
Students of general education system	246,829
Teachers of general education system	12,989

Source: Ben Tre Statistics Office, 2017

8.4.7 Health

In 2017, there had been 2,062,733 medical visits to Ben Tre Province's medical facilities, and the mortality rate was observed to be 0.05% (0.017% lower than the same period in 2016). The rate of under 5-year-old malnourished children decreased to 10.7% while health insurance coverage in the province increased to 89.8% (exceeding the provincial target of 9.8%).

The network of health care facilities in the province is widely developed, allowing the local community to access basic health services. The entire province has 198 medical facilities, including six provincial facilities, 18 district-level facilities, 164 communal health stations, nine inter-commune general clinics and one private health facility. The rate of beds per citizen was 26.91/10,000 in 2017.

Ben Tre Province has 7.93 doctors per 10,000 people, 100% of commune health stations have doctors and 100% of communes, wards and towns have doctors, paediatric professionals or midwifes on hand.

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[24] RadioCAND. 2018. Ben Tre and the concern on domestic waste treatment (Ben Tre va noi lo xu ly rac thai sinh hoat). Available at http://radiocand.antv.gov.vn/tin-tuc/phap-luat-cong-luan/ben-tre-va-noi-lo-xu-ly-rac-thai-sinh-hoat-31812.html. (Accessed 22 July 2019).

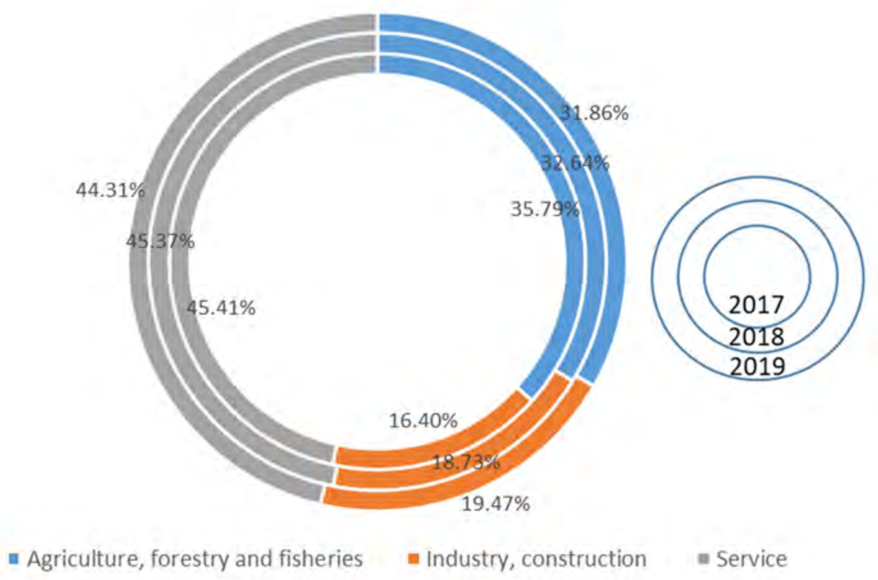
In 2017, the health sector organised professional training for 262 officials and political and administrative training for 61 officers.

Table 8.11 Statistics on health care facilities in Ben Tre Province in 2018[25]

Health care facilities	Number
Hospital	9
Regional polyclinic	15
Health centers at commune level	164
Other health care facilities	1
Total	**198**

8.4.8 Economy and industry

In 2018, the Gross Regional Domestic Product (GRDP) of the Ben Tre Province was 7.22% (Socio-economic Report of Ben Tre Province 2018). The province's economic development as documented in the socio-economic reports of Ben Tre People's Committee across 2017, 2018 and the first half of 2019, recognises that service is the strongest sector in the province, followed by agriculture, forestry and fisheries, with the industry and construction sectors accounting for the smallest proportion. The trend shifted slightly over these three years, with a small increase in industry and construction and a decrease in agriculture, forestry and fisheries (see Figure 8.4). The annual income per capita in the province is VND35.2 million ($1,600)[26].



[25] Department of Planning and Investment of Ben Tre Province. 2018. Some remarkable results on health protection, care and improvement for local people in 207, mission and solutions in 2018 (Mot so ket qua noi bat tren linh vuc bao ve, cham soc va nang cao suc khoe nhan dan nam 2017, nhiem vu va giai phap nam 2018). Available at http://skhdt.bentre.gov.vn/Pages/TinTucSuKien.aspx?ID=750&InitialTabId=Ribbon.Read. (Accessed 22 July 2019).

[26] Vietnam News. 2018. Ben Tre enjoys rapid development process. Available at https://vietnamnews.vn/society/464596/ben-tre-enjoys-rapid-development-process.html#L58ltvBJpP2uVsbu.97. (Accessed 22 July 2019).

Source: Developed based on data from the Socio-economic Reports 2017, 2018 and first half of 2019 of Ben Tre Province

Figure 8.8 Changes in economic structure of Ben Tre Province over

Until early 2019, the province had 3,975 registered fishing boats, of which offshore fishing ships accounted for 52.2% with an annual capture volume of over 200,000 tons. The province's fisheries logistics base meets the developing demand of the fishing industry with three fishing ports, two storm shelters for fishing vessels, 32 wooden shell and mechanical engineering shipbuilding facilities, with shipbuilding capacity of 160 ships per year.

The total aquaculture farming area within the province measures about 46,000ha. In particular, shrimp farming takes up 35,000ha, intensive catfish farming 770ha and mollusc farming 5,200ha. In addition, the province has more than 600ha of two-phase shrimp farms with an average productivity of 60 to 70 tons per hectare of water surface, per crop (with three crops per year). Thirteen exporting seafood processing factories are reportedly in operation in the province, with a design capacity of 150,000 tons. The province has no shrimp processing factory; currently provincial factories are processing catfish and clam products only. The main export markets include Japan, USA, EU, Central and South America and Asia[27].

Agricultural production value for the period between 2017 and first half of 2019 reached VND66.7 trillion (US$3 billion), while the industry and construction sectors recorded an annual growth of 10.22 percent during this same period. The coconut processing industry and support industries have continued to grow dramatically. Between 2016 and 2018, these industries saw an annual turnover of nearly VND60 trillion ($2.6 billion).

Administrative reform has occurred in the province and as a result Ben Tre's provincial competitiveness index has improved by seven positions in comparison with 2015; it is now ranked fifth overall among 63 cities and provinces nationwide. The province's investment encouragement policy has gained significant results, e.g. resulting in 84% of the target for newly-established enterprises and 48% of the target for household businesses being achieved.

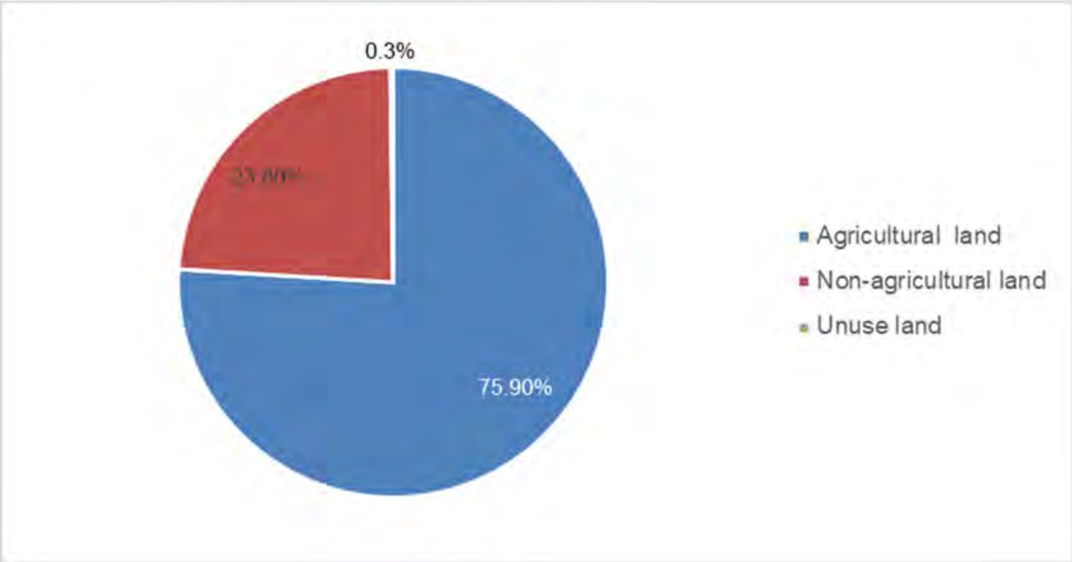
Finance and banking activities have improved from previous years too, with a total budget pool of VND8 trillion (US$351 million), over 50 percent of the Province's investment target. The Province attracted 44 investment projects with a total capital investment of VND625 billion (US$27.5 million) in the period between 2017 and the first half of 2019. VND1.7 trillion (US$74.5 million) capital investment on nine new residential areas covering some 526 ha was approved.

There are 97 co-operatives operating in the province across six fields including industry, light industry, agriculture-seafood, trade and services, transport, and natural resources and environment and 160 cooperative fishing groups, with 1,850 ships.

8.4.9 Land use

The land areas of Ben Tre Province is approximately 239,481ha (Ben Tre Statistics Office, 2017), of which agricultural land accounts for 75.9% or 181,821ha, with non-agricultural land accounting for 23.8% (57,180ha), and 0.2% is unused land (480ha) as shown in Figure 8.9.

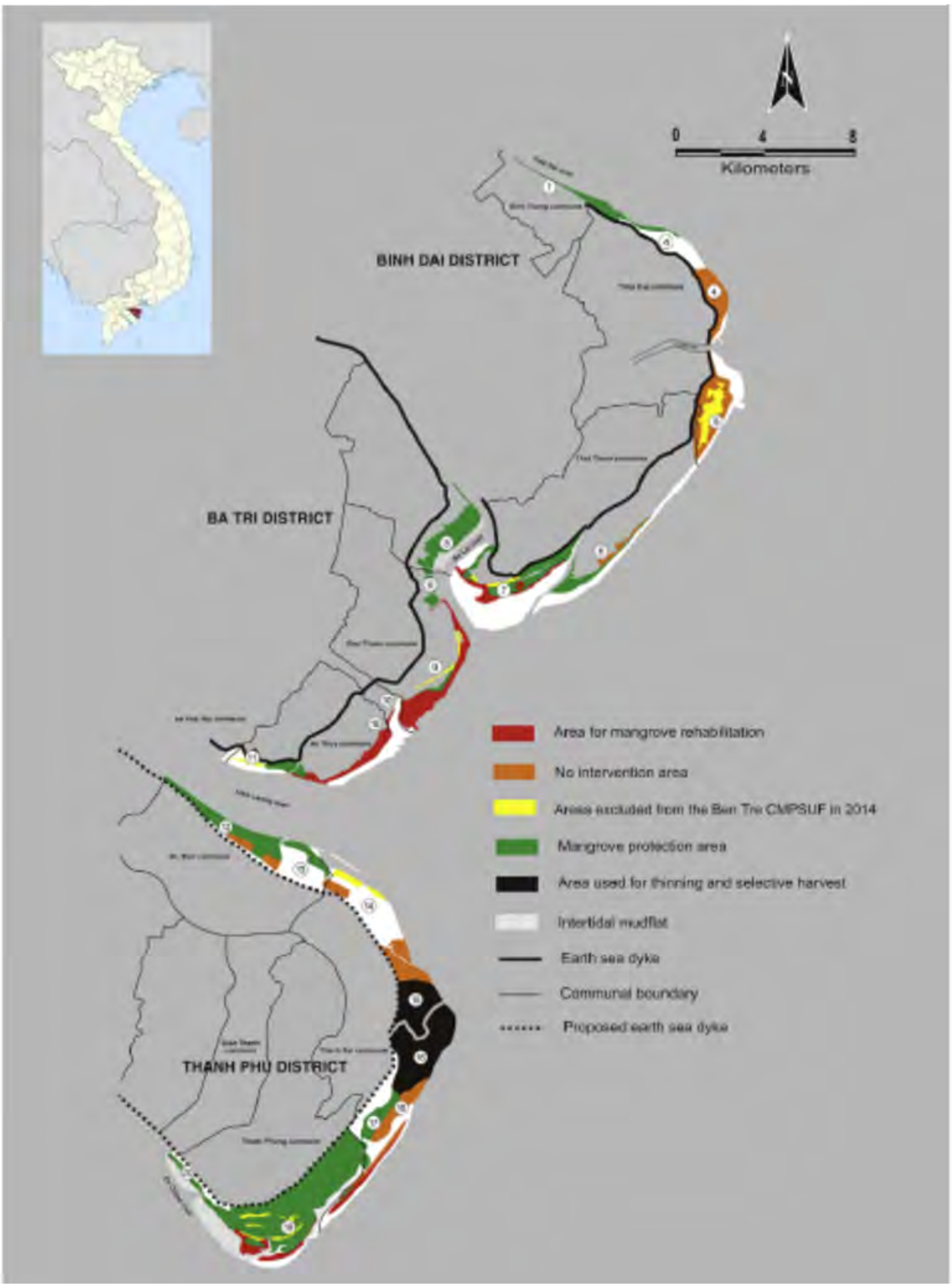
[27] Directorate of Fishery. 2019. Ben Tre promotes the aquaculture and management of fishing boats. Available at https://tongcucthuysan.gov.vn/en-us/vietnam-fisheries/doc-tin/012834/2019-05-02/ben-tre-promotes-the-aquaculture-and-management-of-fishing-boats. (Accessed 25 August 2019).



Source: Ben Tre Statistics Office, 2017

Figure 8.9 Proportion of land use types in Ben Tre Province

The Province includes the Ben Tre Coastal Mangrove Protection Area and Special Use Forest (the Ben Tre CMPSUF) of which the total mangrove area is 4,147ha extending along 65km of shoreline in the Binh Dai, Ba Tri and Thanh Phu Districts. The Ben Tre CMPSUF includes coastal mangrove protection forests (1,962ha) and the Thanh Phu Mangrove Wetland Nature Reserve (2,185ha). The Ben Tre CMPSUF is currently managed by a Management Board established in 1999 below shows the types of coastal land in the coastal districts of Ben Tre Province.



Source: Nguyen and Parnel, 2019

Figure 8.10 Types of coastal land in coastal districts of Ben Tre Province[28]

According to an analysis by Nguyen and Parnell (2019), the shoreline of Ben Tre CMPSUF changed between 2000 and 2015 due to erosion and accretion. This changes experienced by coastal districts including Binh Dai, Ba Tri and Thanh Phu are shown on Figure 8.11

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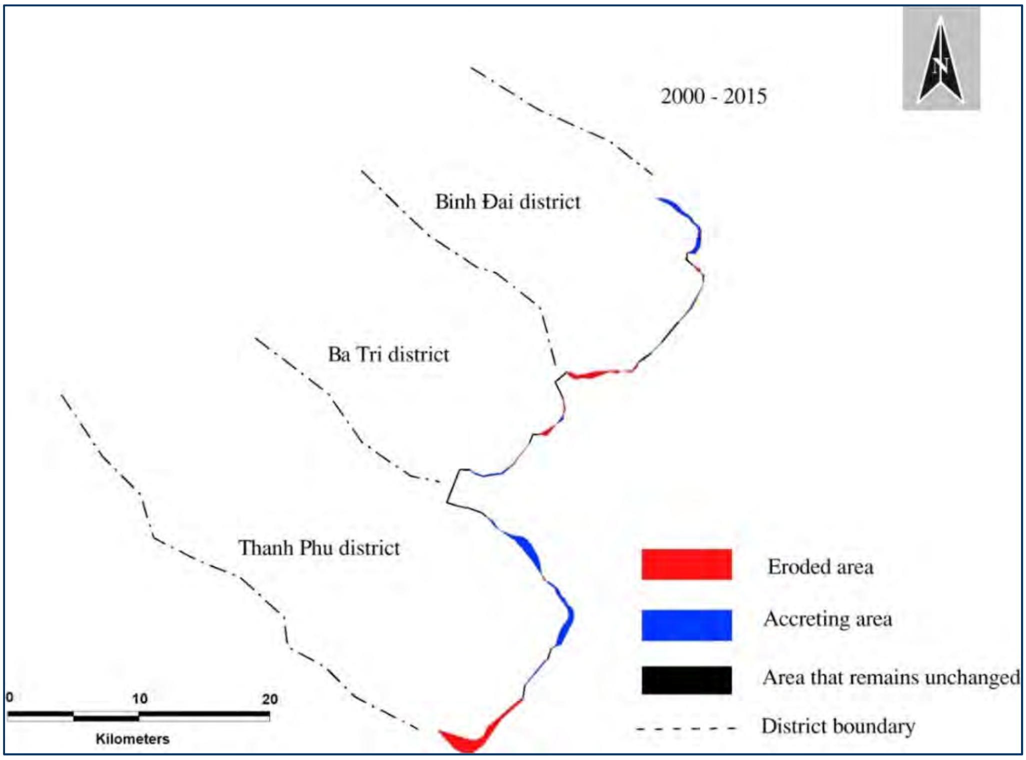
[28] Coastal land use planning in Ben Tre, Vietnam: constraints and recommendations. *Heliyon*, *5*(4), e01487. doi:10.1016/j.heliyon.2019.e01487.



Source: Nguyen and Parnell, 2019

Figure 8.11 Changes to the shoreline of the Ben Tre CMPSUF between 2000 and 2015

8.4.10 Vulnerable groups

In 2017, according to the results of the census of poor households and near-poor households under multi-dimensional poverty criteria, Ben Tre Province had 30,154 poor households, accounting for 7.89% of the total population. The proportion of near-poor households was 4.65%, or 17,777 households. The majority of both poor households (95.15% or 42,414 households) and near-poor households (95.11% or 15,501 households) were concentrated in rural areas.

The province has implemented a number of policies to help poor and near-poor households access capital sources to increase income and escape poverty. Ben Tre Bank for Social Policies has provided preferential loans totalling VND441.656 billion to 14,081 poor and near-poor households for economic development. On average, each household borrowed approximately VND31 million from the Ben Tre Bank for Social Policies[29].

8.4.11 Gender

Over recent years, the roles of women in Vietnam have improved in response to growing concerns relating to gender equality. As well as women's roles having expanded socially, women are now also playing an increasingly important role in economic development in the Ben Tre Province, as shown in Table 8.12.

[29] Department of Planning and Investment of Ben Tre. 2017. Ben Tre-Achievements in poverty reduction in 2017 (Ben tre:Nhung ket qua dat duoc trong con tac giam ngheo 2017) Available at

http://skhdt.bentre.gov.vn/Pages/TinTucSuKien.aspx?ID=741&InitialTabId=Ribbon.Read. (Accessed 22 July 2019)

According to the Deputy Director of Department of Labour, Invalids and Social Affairs of Ben Tre, gender equality and gender-based violence prevention measures have been implemented in the province with many positive results. Female participation in social activities has increased year by year, while domestic violence cases have been promptly intervened and handled. Additionally, information disclosure, education and communication activities relating to gender equality and domestic violence have been extensively undertaken by members of the provincial community. As a result, domestic violence has reportedly decreased and no cases of serious domestic violence have been reported in recent years[30].

Table 8.12 Female participation in employment and economic development

Women's level of involvement	Percentage of provincial population
Female workers who are newly engaged in jobs	53.6
Female entrepreneurs	25.8
Rural female workers under 45 years old who have received vocational training	40
Poor women who want to get preferential loans from employment programs	85

Source: Ministry of Home Affairs Portal, 2017

8.4.12 Archaeological, cultural heritage and religious sites

According to statistical data provided in the Ben Tre Province Portal[31], the province has:

- Two special national relics: Nguyen Dinh Chieu memorial shrine in Ba Tri District and Dong Khoi Ben Tre relic site in Mo Cay Nam District;
- Four national intangible aspects of cultural heritage: Nghinh Ong Binh Thanh Festival in Binh Dai District; Hat Sac Bua Phu Le in Ba Tri District; My Long rice paper and Son Doc banh phong making in Giong Trom District;
- 16 national level heritages:
  - Art heritage: Art of Phu Le temple in Ba Tri District and Binh Hoa temple in Giong Trom district;
  - Historical heritage: Tuyen Linh temple in Mo Cay Nam District, Base of Sai Gon - Gia Dinh Regional Military Commission (1960-1970) (also known as monument Y4) in Mo Cay Bac District; the bridge for transferral of weapons between the North and South during Vietnam War in Thanh Phu District; the home of Mr. Nguyen Van Cung and Nga Ba Cay Da Doi where the first Communist Party Branch was established in Ba Tri District; tombs and temple of Nguyen Ngoc Thang in Giong Trom District; the house of Mr. Nguyen Van Trac which used to be the living and working space of comrade Le Duan in Giong Trom District; tomb of Mr. Vo Truong Toan in Ba Tri District; living place of Colonel Pham Ngoc Thao in Ben Tre City; and

[30] Ministry of Home Affairs Portal. 2017. Ben Tre: Role and position of women is improving everyday (Ben Tre: Vai tro va vi the cua phu nu ngay cang cai thien). Available at https://moha.gov.vn/congtaccanbonu/binhdanggioi/ben-tre-vai-tro-vi-the-cua-nguoi-phu-nu-ngay-cang-cai-thien-36375.html . (Accessed 7 August 2019).

[31] Ben Tre Province Portal. 2019. Ben Tre has three more provincial cultural heritage sites (Ben Tre co them 3 di tich lich van hoa cap tinh). Available at http://www.bentre.gov.vn/Pages/TinTucSuKien.aspx?ID=23712&CategoryId=V%u0103n+h%u00f3a+Th%u1ec3+thao&InitialTabId=Ribbon.Read . (Accessed 25 July 2019).

evidence of the massacre of 286 innocent people by French colonialists in 1947 in Giong Trom District;

- Architectural heritage: Tan Trach temple in Chau Thanh District; Huynh Phu ancient house and burial area- Dai Dien Commune in Thanh Phu District; Long Phung temple in Binh Dai District; and Tien Thuy temple in Chau Thanh District.

■ 48 provincial-level relics[32].


Figure 8.12 Dong Khoi Ben Tre relic site (left) and Nguyen Dinh Chieu memorial shrine (right) of Ben Tre Province

8.5 District context

8.5.1 Overview of Thanh Phu District

Thanh Phu is a coastal district located 40km south of Ben Tre City, at the end of Minh isle. Lying between the Co Chien and Ham Luong rivers, Thanh Phu borders Mo Cay Nam District to the south, Giong Trom and Ba Tri Districts to the north and north east, Tra Vinh Province to the west and the East Sea to the east. Thanh Phu has 18 administrative units, including Thanh Phu Town and 17 communes.

[32] Details of these 48 provincial level relics are not publicly available to specify in this section.

Table 8.13 Thanh Phu District at glance

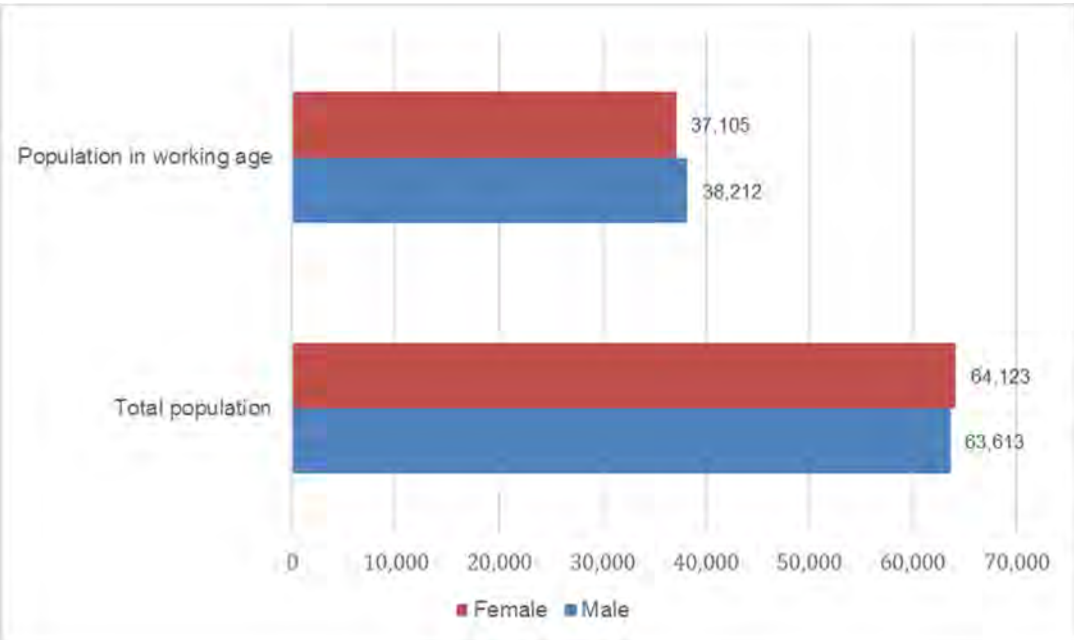
THANH PHU DISTRICT

No. of towns	01
No. of communes	17
Area	401.0 km^2
Population	127,736
No. of households	36,974
Poverty proportion	9.44%
Ethnic groups	Kinh (100%)
Key religion	Protestantism

Source: Thanh Phu Statistics Office, 2017 & Thanh Phu District People's Committee, 2018

8.5.2 Population

The population of Thanh Phu District was 127,736 persons in 2018. The male and female population was estimated at 63,613 and 64,123, or 49.8% and 50.2% respectively (Figure 8.13). The percentage of working-age population (15 to 60 years old) in the total population was 58.9%, or 75,317 people. The male and female population of a working age was at 38,212 and 37,105, respectively.



Source: Thanh Phu Statistics Office, 2017

Figure 8.13 Total population and working age population of Thanh Phu District

8.5.3 Ethnicity

The Kinh group is the only ethnic group in the Thanh Phu District; 100% are Kinh people.

8.5.4 Religion

Buddhism, Catholicism, Caodaism, and Protestantism are the four main religions in the Thanh Phu District. Buddhism is the most widely practiced religion, followed by Catholicism and then Caodaism and Protestantism.

8.5.5 Infrastructure and public facilities

8.5.5.1 Roads and transportation

As an administrative area district, Thanh Phu is accessible via several main roads of the district, including district road No. 30 at Giao Thanh, the town road in Thanh Phu Town (section from Highway 57 to Giong Mieu market) and the motorway project to the centre of An Dien, Thanh Hai, and My An communes.

A number of transportation projects have recently begun in Thanh Phu District. The Cau Van bridge is currently undergoing reconstruction/being constructed (whichever is correct) and many roads are being developed in the An Thuan, Hoa Loi, Dai Dien and My An communes.

8.5.5.2 Electricity

Approximately 99.85% of the Thanh Phu District's residents are supplied with electrical power via the national grid. Local power failures have occasionally been recorded because of extensive use of electricity for aquaculture, leading to electrical overloads in the district.

8.5.5.3 Water supply

Thanh Phu District depends on two main natural water sources: rainwater and river water. As an island district, its primary water supply comes from two major rivers, Ham Luong and Co Chien, which are influenced by a semi-diurnal regime. Many smaller rivers and canals also provide water for the region.

A hydrogeological survey of groundwater shows that the district's underground water supply is limited and distributed only in the Thanh Phu Town area along the East Sea. Groundwater in the district area is mostly always salty. Thus, local people always use rainwater or purchased water for daily use.

There are currently five water plants in the area, one in Thanh Phu Town and four in the other communes. Water supply pipeline systems connect all communes within the district. However, their total capacity does not satisfy the water needs of the whole district. About 50% of households use tap water, 20% use underground water and 30% use rainwater. Approximately 92.5% of households have access to clean water.

8.5.5.4 Irrigation system

Thanh Phu District has, over the past few years, invested in various upgrades to the local irrigation system. Over 229km of canal, six culverts and more than 10km of dykes have been constructed or upgraded to prevent saltwater intrusion. Irrigation infrastructure investment has contributed to ensuring productivity for over 22,000ha of cultivated land[33].

[33] Ben Tre Province Portal. 2015. (Thanh Phu: khoi sac qua 04 nam xay dung Nong Thon moi) Available at http://biengioibienbentre.vn/noi-dung/thanh-phu-khoi-sac-qua-04-nam-xay-dung-nong-thon-moi.html . Accessed 22 July 2019.

8.5.5.5 Domestic waste management and drainage

There is one 12.2ha landfill site in Thanh Tri Thuong Village of Thanh Phu Town. The landfill site currently receives domestic solid waste from nine of 18 local communes and the towns of Thanh Phu District. On average, the site receive 25 to 30 tons of waste per day[34]. Based on recent budget announcements by the provincial and central government, this landfill site is reportedly soon to be expanded and improved. Households who do not register for solid waste collection or who do not have access to the solid waste collection system treat their domestic waste themselves by burning or burying within their local areas.

8.5.6 Education

According to the Thanh Phu Statistics Office (2018), the district has 58 schools, including 18 kindergartens, 19 primary schools, 18 secondary schools, and three high schools. The government built two national standard schools in 2018, bringing the area's number of nationally standardised schools up to 16 out of 55, accounting for 29.09% of the country's total.

Most students complete their education with the Province has a low dropout rate in secondary schools and high schools of 0.38% and 0.86%, respectively.

8.5.7 Health

The district has one hospital, one district health centre and 17 commune health centers. In 2018, the total number of health staff at the communal level was 106, including 69 medical staff and 37 pharmaceutical staff. Among the 106 medical staff were 25 doctors, 37 nurses, 17 midwives, and other categorised staff.

Statistically, there are 5.31 doctors for every 10,000 people, with 1,876 hospital beds for every 10,000 people in Thanh Phu District. As reported by Thanh Phu District PC in a meeting with ERM held July 2019, the most common diseases and health complaints in the district are dengue fever, flu and cold, and diarrhoea.

8.5.8 Local economy and industry

Agriculture is the most dominant sector of the district's economy. From Thanh Phu Town up to Dai Dien, Phu Khanh are vast rice fields. From the town towards the sea, the area consists of rice fields gradually narrowing and giving way to shrimp farms – a type of agriculture considered far more lucrative than growing rice.

People in this area are also engaged in forestry, fishing and seafood processing. In terms of agriculture development planning, the district can be divided into three main sub-regions according to Decision No. 437/QD-UB of Ben Tre People's Committee[35]:

Sub-region 1: consists of nine northern communes of the district adjacent to Mo Cay District, including Phu Khanh, Dai Dien, Quoi Dien, Thoi Thanh, Hoa Loi, My Hung, Binh Thanh, Tan Phong and part of Thanh Phu Town. This sub-region is favourable for the production of two rice crops per year.

Sub-region 2: is located in the middle part of the district including An Thanh, An Quy, An Thuan and An Dien communes and part of Thanh Phu Town. This sub-region is characterised by intercropping of shrimp in the dry season and rice production in the rainy season.

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[34] Ben Tre Province Portal. 2018. Thanh Phu voters expect to soon deploy the investment plan of modern waste treatment technology (Cu tri Thanh Phu ky vong som trien khai Phuong an dau tu cong nghe hien dai xu ly rac thai). Available at http://hdnd.bentre.gov.vn/noi-dung/-/cms-icbt/10180/bai-viet/226355 . Accessed 26 August 2019.

[35] Decision No. 437/QD-UB on Approval on the master plan for socio-economic development of Thanh Phu District issued by Ben Tre People's Committee on 11 May 1985.

Sub-region 3: is mostly coastal areas, including the communes of An Nhon, Giao Thanh, Thanh Phong and Thanh Hai. This sub-region specialises in shrimp farming.

Source: Lam Van Tan et al, 2014

Figure 8.14 Three sub-regions of Thanh Phu District

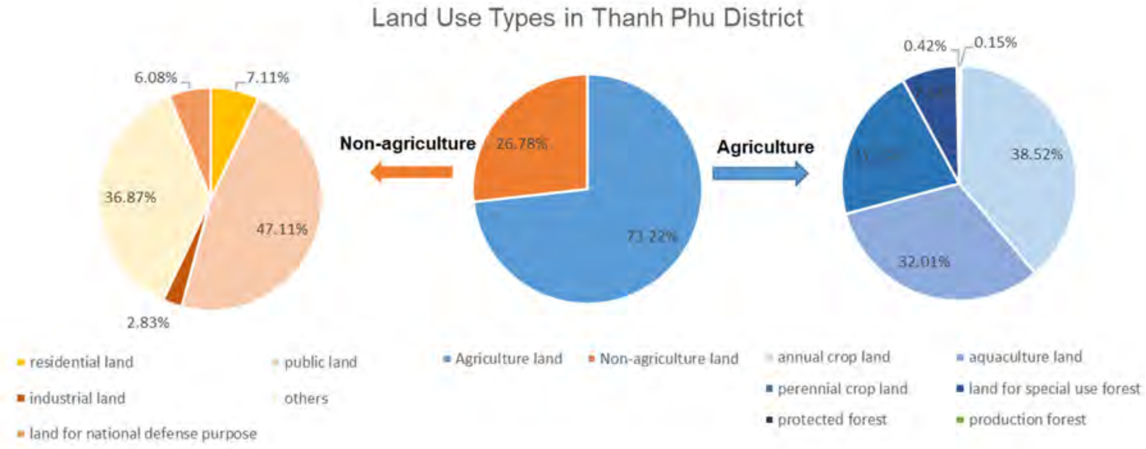
Over the past 15 years, the cooperative economic models of the district have been consistently developing and operating quite effectively. By the end of 2018, the district had 164 cooperative groups. Eleven cooperatives are currently in operation, of which three cooperatives have maintained successful business including the Thanh Phu waterway and road transportation cooperative, Thanh Loi aquaculture cooperative and Binh Minh seafood cooperative.

In recent years, the district has developed marine eco-tourism services along its 25km long coast line in the Thanh Phong and Thanh Hai communes. By utilising and effectively promoting the locality's nature and tourism potential to the media in recent years, Thanh Phu has actively implemented the promotion and introduction of tourism.

The district has attracted more and more tourists inside and outside the province, especially in the Con Bung area. In 2013 there were 150,000 visitors to Thanh Phu, and this number increased to 299,400 by 2017, consisting of tourists mostly seeking to swim in the sea and enjoy seafood. The architectural art relic area of Huynh Phu old house and the Dai Dien old grave area have attracted more than 1,000 visitors while other tourist destinations in the district have welcomed 1,500 visitors.

8.5.9 Land use

According to statistical data provided by Thanh Phu District People's Committee (2019), out of the total 42,276ha of land in Thanh Phu District, agricultural land (30,955.72ha) and non-agriculture land (11,320.44ha) accounts for 73.22% and 26.78%, respectively. The agricultural land area includes mostly annual crop land (38.52%), followed by aquaculture land (32.01%), perennial crop land (21.25%), land for special use forest (7.64%), protected forest (0.42%) and production forest (0.15%). Non-agricultural land includes mostly public land (47.11%), followed by other types of land (36.87%), residential land (7.11%), land for national defence purposes (6.08%) and land for industrial development (2.83%). Figure 8.15 presents the proportion of these land types within Thanh Phu District.



Source: Developed based on data from Thanh Phu Statistics Office, 2017

Figure 8.15 Land use types in Thanh Phu District

8.5.10 Vulnerable groups

In 2018, the Thanh Phu District had 3,488 poor households, accounting for 9.44% of the district, and 1,767 near-poor households, accounting for 4.78%. Returning to poverty rate was below 0.1%. Poverty reduction efforts in the district have reportedly seen significant impacts; however, no data was provided by the authorities to prove this.

8.5.11 Archaeological, cultural heritage and religious sites

As a coastal district, Thanh Phu is well-known for its mangrove forests, historical and cultural relics, and trade villages. A number of well-known historical and cultural sites in the district include Cau Dau bridge, which received weapons from North to South (Thanh Phong and Thanh Hai Communes) during the Vietnam war, relics of the outpost of Battalion 307 (Dai Dien Commune), An Linh pagoda (An Nhon Commune), Huynh Phu old house and grave area (Dai Dien and Phu Khanh Communes), and Ho Co martyr's cemetery (Thanh Hai Commune). The historical military events staged annually on October 30 are also key activities of the district.

In addition, fishing communities of the area hold an annual fish-catching and praying ceremony (Le hoi cau ngu - Nghinh Ong Festival) in Thanh Hai commune. They follow the custom of worshipping Ong Nam Hai (the God of the Sea) to be granted a peaceful and prosperous year for fishing, and the ceremony is usually held in January (before the fishing season) and in July and October. All fisherfolk who live along Vietnam’s coastline have the practice of burying, re-burying and worshipping whales when deceased whales are found.

Figure 8.16 Worshipping a whale skeleton in Ong Nam Hai (left) and Nghinh Ong Festival in Thanh Phu in 2017 (right)

8.6 Communal context

8.6.1 Thanh Hai Commune

8.6.1.1 Demographic information

Thanh Hai is a sea bordered commune located to the East of Thanh Phu District. It has eight villages including Thanh Thoi A, Thanh Thoi B, Thanh Thoi Dong, Thanh Hung A, Thanh Hung B, Thanh Loi, Thanh Hai, and Thanh An. Thanh Hai has a total area of 45.57km^2. According to data collected at the meeting with the People's Committee of Thanh Hai Commune (July 2019), there are eight villages with a total of 7,990 people and 2,390 households. Kinh people account for 99.81% of the total population.

Table 8.14 Thanh Hai Commune at a glance

THANH HAI COMMUNE

No. of villages	08
Area	45.57 km^2
Population	7,990
No. of households	2,390
Poverty proportion	12.36%
Ethnic groups	Kinh
Key religion	Buddhism, Caodaism and Protestantism

Source: Meeting with Thanh Hai People's Committee, July 2019

8.6.1.2 Infrastructure and public facilities

The commune has a concrete road system connecting its villages and an asphalt road system connecting with the other communes. Although Thanh Hai is a coastal commune, it does not have a commercial fishing port. Fishing boats are anchored in the Con Bung and Hang Duong rivulet mouths.

99.5% of households are connected to the national electricity grid. Eleven households in Thanh Thoi B Village and one household in Thanh An Village do not use electricity because a power line has not built.

Piped water is available in seven villages, except for Thanh Thoi B Village; however, the number of households using piped water remains low at 32%. The majority of local households use boreholes or rainwater for domestic use. A number of people that attended the FGD reported that a water supply system has not yet become available in their area.

The commune currently has no waste collection service in the area. Waste materials are buried or burned at home (Meeting with the People's Committee of Thanh Hai commune, July 2019).

8.6.1.3 Education

Thanh Hai has one kindergarten, one primary school, and one secondary school. At present, students have to attend a high school at Giao Thanh commune, about 8 kilometres from Thanh Hai Village. The illiteracy rate in the area is very low - just two people are illiterate in Thanh Hai Village, as reported by Thanh Hai People's Committee in the meeting with ERM (July 2019).

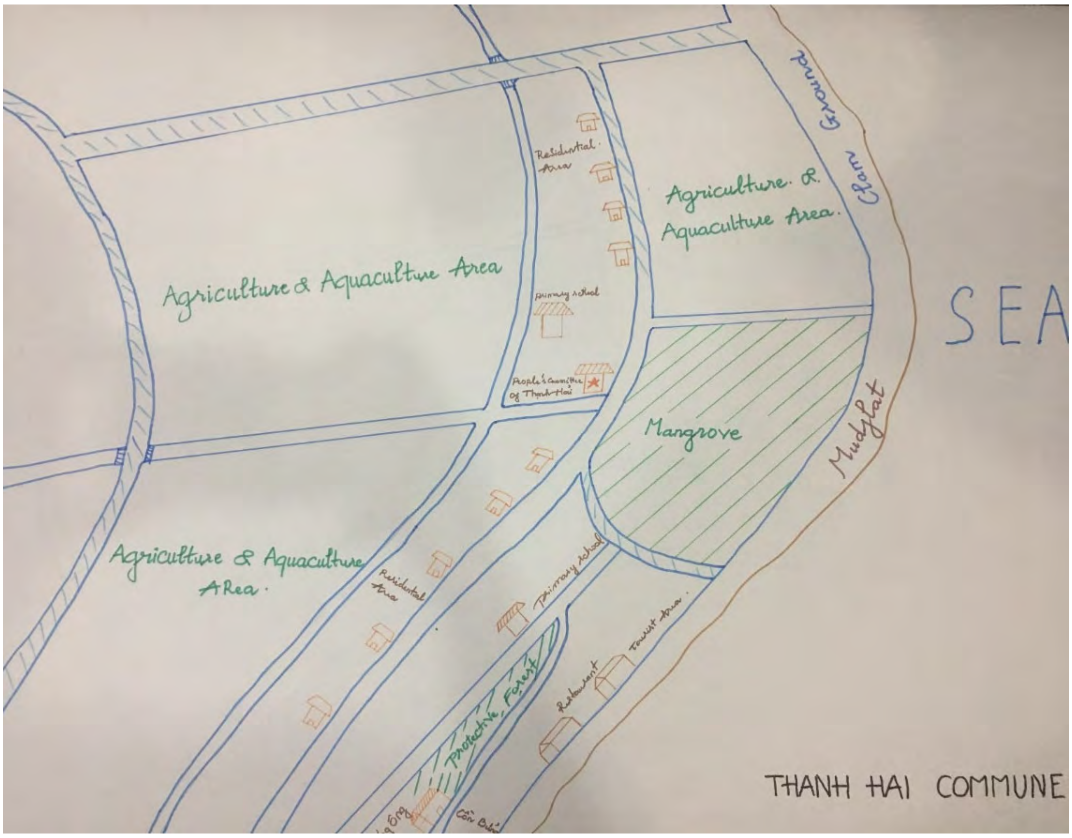
8.6.1.4 Health

According to the data collected at the meeting with the People's Committee of Thanh Hai commune (July 2019), Thanh Hai health station has four medical staff including one doctor, two nurses and one midwife. The health station is equipped with five sickbeds, an ultrasound machine, and an electrocardiogram machine, and can provide medical care services including immunisation and emergency first aid. Common diseases and health problems in the commune include high blood pressure; diabetes; respiratory disease; and hand, foot and mouth disease.

8.6.1.5 Economy

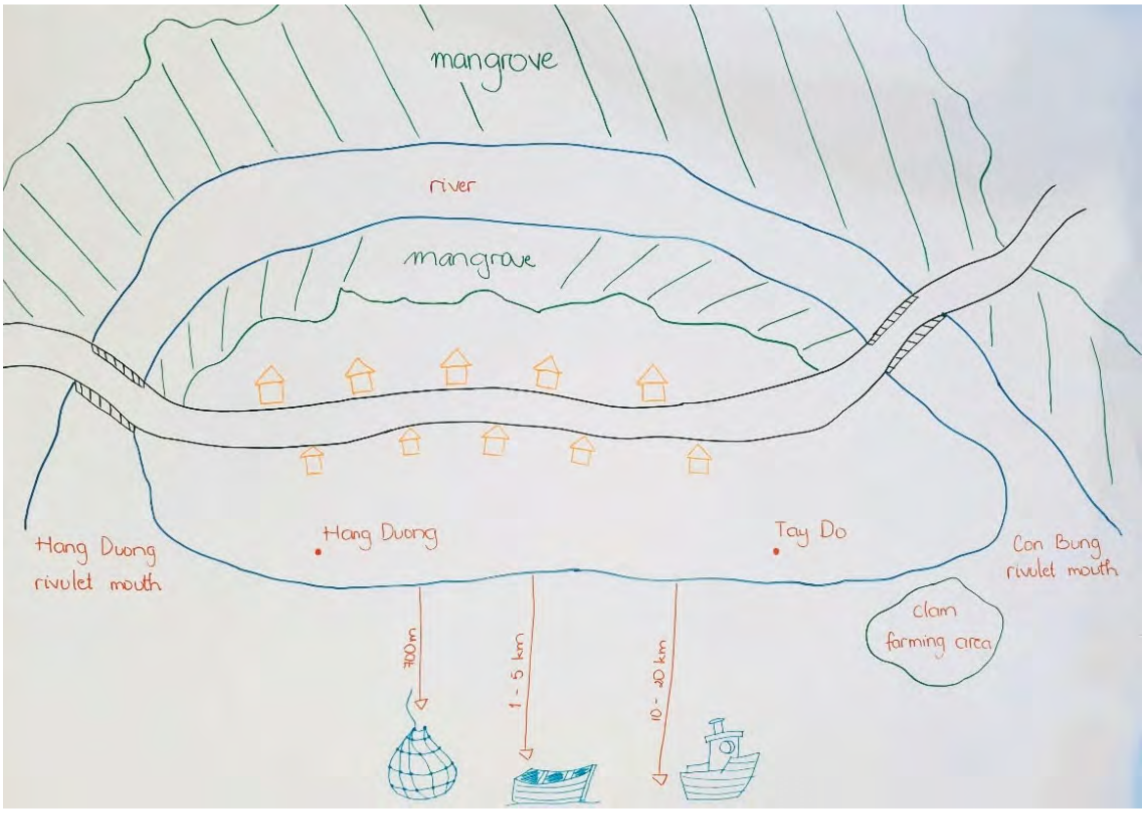
Aquaculture is the most common form of livelihood in this area, including extensive, hyper-intensive, commercial forms of shrimp, fish, crab and clam farming (see Figure 8.17). Other prominent forms of livelihood include fishing and agriculture. On average, one fishing household owns one 15 – 40CV boat, meaning there are around 37 fishing boats in the entire commune. These households normally catch fishes by a raft, net, trap or fishing rod (see Figure 8.18). The marine products are often sold at small fishing ports within the commune such as Can Bung, Vam Cay Dua, Can Tra and Voi Duoc.

Commonly grown crops in the commune include watermelon (one or two crops a year) and cassava, (one crop a year). Such crops rely on the pumping of underground water.



Source: ERM's FGD in July 2019

Figure 8.17 Illustrated map of Thanh Hai Commune showing types of land use

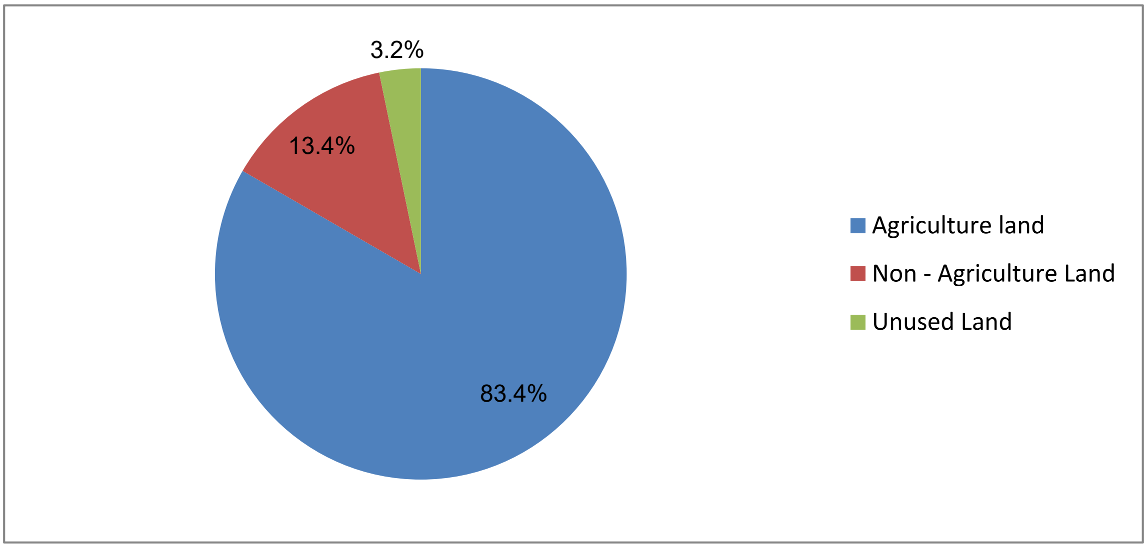


Source: ERM's FGD in July 2019

Figure 8.18 Illustration showing common fishing zones used by Thanh Hai Commune's fisherfolk

8.6.1.6 Land use

Agricultural land makes up the highest percentage of land in Thanh Hai Commune (83.4%). Some 13.4% of the total land is used for non-agricultural production. A very small proportion of land is unused (3.2%).



Source: Data provided by the People's Committee of Thanh Hai commune, 2019

Figure 8.19 Thanh Hai's land use structure

8.6.1.7 Archaeological, cultural heritage and religious sites

Thanh Hai Commune has four Buddhist pagodas, namely Mieu Ba Con Bung, Con Chim, Rung, and Lang Ong Nam Hai, and one Cao Dai Temple (Thanh Tinh temple). The commune is well-known for one relic of the Ho Chi Minh Sea Trail, one historic cemetery and a tomb with a monument honouring 21 martyrs.

Figure 8.20 Ong Nam Hai – the God of the South Sea Shrine (left) and conservation relics of the Ho Chi Minh Sea Trail (right), Thanh Hai Commune

8.6.2 An Dien Commune

8.6.2.1 Demographic information

Located in Thanh Phu District, Ben Tre Province, An Dien has an area of 43.18km^2 with four villages including An Khuong A, An Khuong B, An Dien, and Giang Ha. The commune has 1,624 households with a total population of 5,626. The commune's population density is 130 persons/km^2. The male and female populations are 50.6% (2,847 persons) and 49.4% (2,779 persons) respectively. The labour force includes 3,488 people.

Table 8.15 An Dien Commune at a glance

AN DIEN COMMUNE

No. of villages	04
Area	43.18 km^2
Population	5,626
No. of households	1,624
Poverty proportion	14.37%
Ethnic groups	Kinh
Key religion	N/A

Source: Meeting with An Dien People's Committee, July 2019

8.6.2.2 Infrastructure and public facilities

In An Dien Commune, 96.79% of households use hygienic water and 18.4% of households (290 households) gained access to clean water in 2018. No separate drainage system for sewage is available at the commune. 99.87% of households are connected to the electricity grid (Meeting with the People's Committee of An Dien Commune, July 2019). In 2018, 12 rural transportation upgrades were made with a state budget of VND6.89 billion.

8.6.2.3 Education

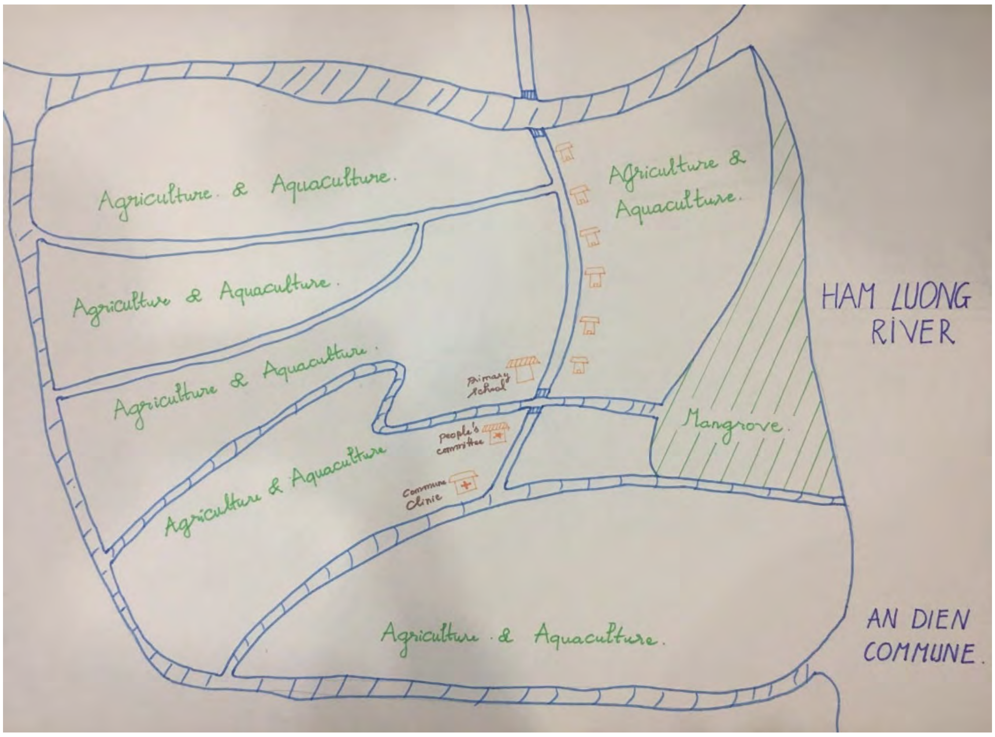
According to a 2018 socio-economic report (meeting with the People's Committee of An Dien Commune, July 2019), in the 2017-18 school year 498 students completed the primary education program (99.4%) and 100% of students (90 students) in the commune graduated from secondary schools.

8.6.2.4 Health

According to health data collected at the meeting with the People's Committee of An Dien Commune (July, 2019), An Dien health station has six medical staffs including one doctor, one nurse, one pharmacist and three physicians. The station also has four supplementary staff to support public health promotion and four physicians based at the village level. As the main provider of primary health care for the local community, the commune's health centre performed 6,500 medical examinations and treatments in 2018. Commonly reported diseases in the commune included flu, dengue fever (5 cases), and hand, foot and mouth disease (55 cases).

8.6.2.5 Economy

The main forms of economic activity in An Dien are agriculture and aquaculture, with a commonly integrated model of rice and shrimp farming (see Figure 8.21). The commune's rice cultivation area in 2018 measured 712.7ha with the main varieties being 4900, 5451 and TV39, and rice productivity was 4 tons/ha. Some models of bio-rice cultivation have also been developed in the commune.



Source: ERM's FGD in July 2019

Figure 8.21 Illustration of An Dien Commune's map of resources

According to a recent socio-economic report (Statistic Data of the People's Committee of An Dien Commune, 2018), the commune's total area for aquaculture is 2,265.3ha, including 1,858.5ha for extensive aquaculture and 406.8ha for commercial aquaculture. People used 712.7ha of farm land for aquaculture. The productivity of intensive and commercial shrimp farming in 2018 was 0.08 – 0.1 ton/ha and 8 tons/ha respectively.

The number of livestock from local husbandry were 3,015 cows, 123 pigs, 1,245 goats, and 8,025 poultries. There are 245 enterprises in operation within this commune; of these more than 15 enterprises have been established since 2017.

8.6.2.6 Vulnerable groups

The People's Committee of An Dien Commune reported that the commune has 235 poor households and 76 near-poor households in 2019. Funded by International Fund for Agricultural Development, common interest groups (CIG) have been formed and led by local women to promote household's economic development models. Nearly VND2 billion has been distributed to 182 CIG members, including 176 women-led initiatives and 66 poor households.

8.6.2.7 Archaeological, cultural heritage and religious sites

No specific archaeological, cultural heritage and religious sites have been reported by the local authority of An Dien commune or published in the public domain to be presented in this section.

8.6.3 An Nhon Commune

8.6.3.1 Demographic information

An Nhon Commune is located in Thanh Phu District, Ben Tre Province, and has an area of 28.1km^2 with three villages including An Binh, An Hoa and An Dinh. The commune had 1,513 households with a total population of 5,837 and a population density of 208 persons/km^2. The labour force is around

3,343 people, of which 1,437 people are female (43%). The proportion of Kinh people accounts for 100% of the population.

Table 8.16 An Nhon Commune at a glance

AN NHON COMMUNE

No. of villages	03
Area	28.1 km^2
Population	5,837
No. of households	1,513
Poverty proportion	3.1%
Ethnic groups	Kinh
Key religion	Buddhism and Caodaism

Source: Meeting with An Nhon People's Committee, July 2019

8.6.3.2 Infrastructure and public facilities

According to a 2019 socio-economic report (meeting with the People's Committee of An Nhon Commune, July 2019), in 2018 the An Nhon Commune concretised 0.661m of Chua Phat Cay Man street, and 0.21m of Cay Queo street that connects An Hoa village to An Binh village. In 2018, the commune mobilised different sources of finance to complete the construction of four bridges; the Giong Dong, Cai Lon, Truong Le and Xeo Ranh bridges.

In 2018, 77.4% of households used hygienic water and 51.5% of households (779 households) accessed clean water, but no separate drainage system for sewage was available at the commune. 99.55% of households were connected to the national electricity grid (Meeting with the People's Committee of An Nhon Commune, July 2019).

8.6.3.3 Education

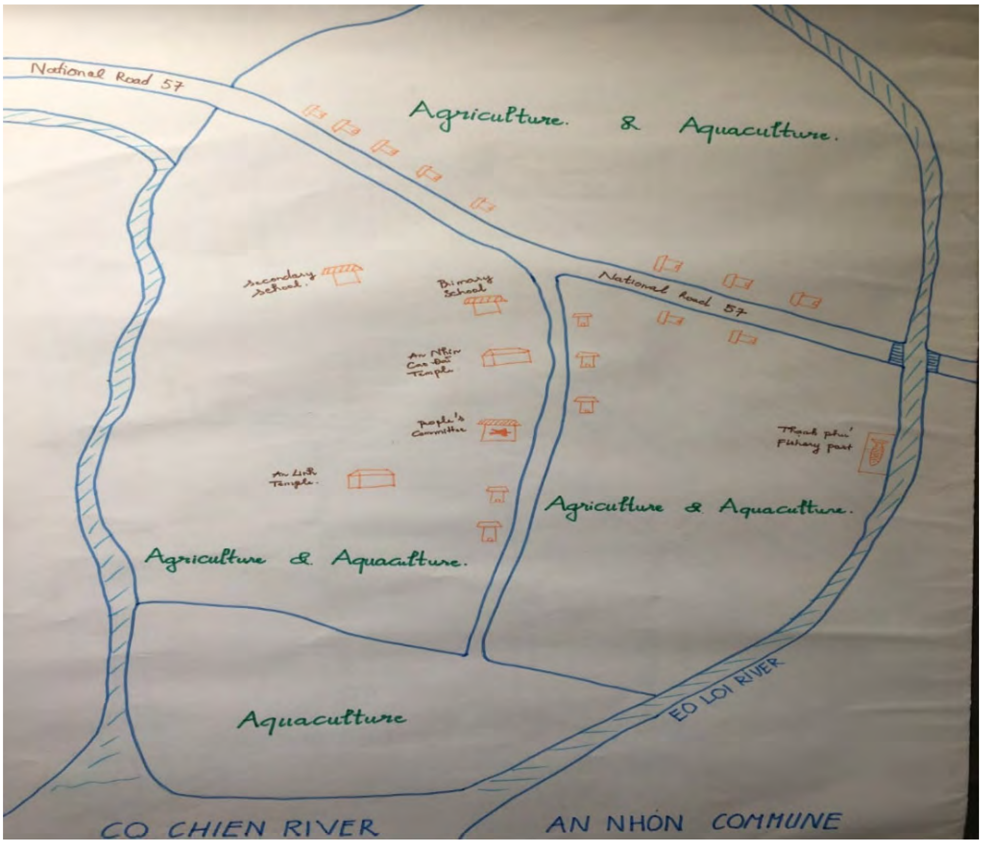
According to a 2019 socio-economic report (meeting with the People's Committee of An Nhon Commune, 2019), the commune has one kindergarten, one primary school and one secondary school. The education quality in the commune has, in general, improved and the rates of good performance among students has increased.

8.6.3.4 Health

According to data collected at the meeting with the People's Committee of An Nhon Commune (July 2019), An Nhon commune health station has five medical staff including one doctor, two nurses and one midwife. It acts as the primary health care facility for local people and performed 1,824 medical examinations and treatments in 2018. Common diseases in the commune are heart-related diseases and high blood pressure.

8.6.3.5 Economy

The An Nhon commune is located in sub-region 3 of Thanh Phu District, where aquaculture has been developed with several effective shrimp farming business models. According to a 2019 socio-economic report (meeting with the People's Committee of An Quy Commune, July 2019), the total area used for aquaculture in the commune is 2,241ha, including 1,716ha used for extensive aquaculture (1,029.6 tons of shrimp and 647.2 tons of crab) and 300ha for commercial aquaculture (456.3 tons of shrimp/35ha).



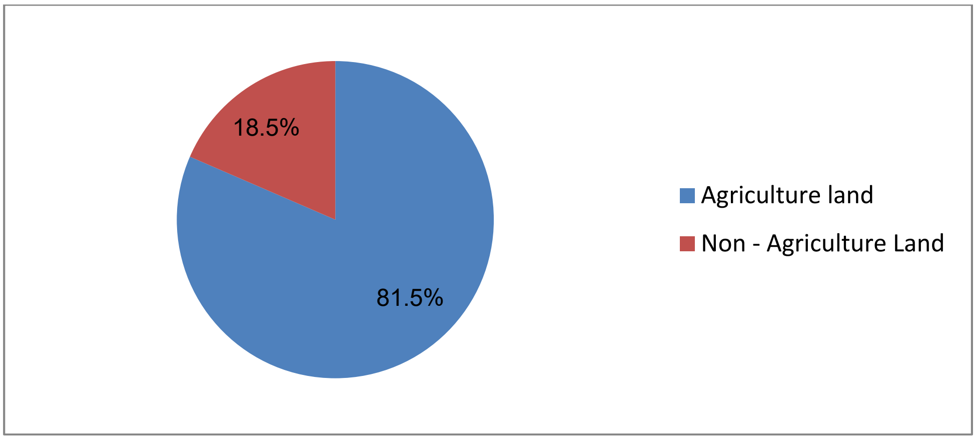
Source: ERM's FGD in July 2019

Figure 8.22 An Nhon Commune's map of resources

Local households are also engaged in husbandry, with 1,548 cows and 620 goats in the commune. A total of 349 enterprises were reportedly in operation in the commune in 2018.

8.6.3.6 Land use

In An Nhon Commune, agricultural land comprises the highest percentage in terms of land use (81.5%). The remaining proportion, 18.5%, is used for non-agricultural production (see Figure 8.23)



Source: Data provided by the People's Committee of An Nhon commune, 2019

Figure 8.23 An Nhon's land use structure

8.6.3.7 Vulnerable groups

In 2018, the commune had 47 poor households, accounting for 3.1% of the commune's total households. The rate of near-poor households was higher - 4.2% or 63 households (Statistic Data of the People's Committee of An Nhon Commune, 2018).

8.6.3.8 Archaeological, cultural heritage and religious sites

An Nhon Commune has two Buddhist pagodas: Cay Man Pagoda and An Linh Pagoda.

Figure 8.24 An Linh Pagoda

8.6.4 An Quy Commune

8.6.4.1 Demographic information

An Quy Commune has a total land area of 25.73 km^2 with six villages including An Binh, An Hue, An Ninh, An Phu, An Thoi and An Thuy. According to the commune's most recent socio-economic report (the first six months of 2019), the commune has 1,974 households with a total population of 9,185. Kinh people account for 100% of the commune's population, the population density is 357 persons/km^2 and the labour force consists of 4,937 people.

Table 8.17 An Quy Commune at a glance

AN QUY COMMUNE	
No. of villages	06
Area	25.73 km^2
Population	9,185
No. of households	1,974
Poverty proportion	11.14%
Ethnic groups	Kinh
Key religion	Buddhism, Catholicism and Caodaism

Source: Meeting with An Quy People's Committee, July 2019

8.6.4.2 Infrastructure and public facilities

According to a 2018 socio-economic report (Statistic Data of the People's Committee of An Quy Commune, 2018), An Quy commune has concretised 5.2 kilometres of communal road, 9.4 kilometres of inter-village road, and 9.808 kilometres of village lanes. Three major irrigation canal systems were dredged in 2019.

All households used hygienic water and 40% of households had access to clean water in 2018, but no separate drainage system for sewage was available at the commune. 99.95% of households are currently connected to the electricity grid (Meeting with the People's Committee of An Quy Commune, July 2019).

8.6.4.3 Education

In the 2017-18 school year, 95% of preschool pupils completed the preschool education program, 100% of pupils completed the primary education program and 98.5% of pupils graduated from secondary schools (Statistic Data of the People's Committee of An Quy Commune, 2018).

8.6.4.4 Health

In supporting the primary health care of local communities, the An Quy Commune's health station performed 2,992 medical examinations and treatments in 2018, of whom 2,540 were health insurance beneficiaries. It also expanded its immunisation program and conducted child malnutrition prevention training for women who are pregnant or raising small children (Statistic Data of the People's Committee of An Quy Commune, 2018).

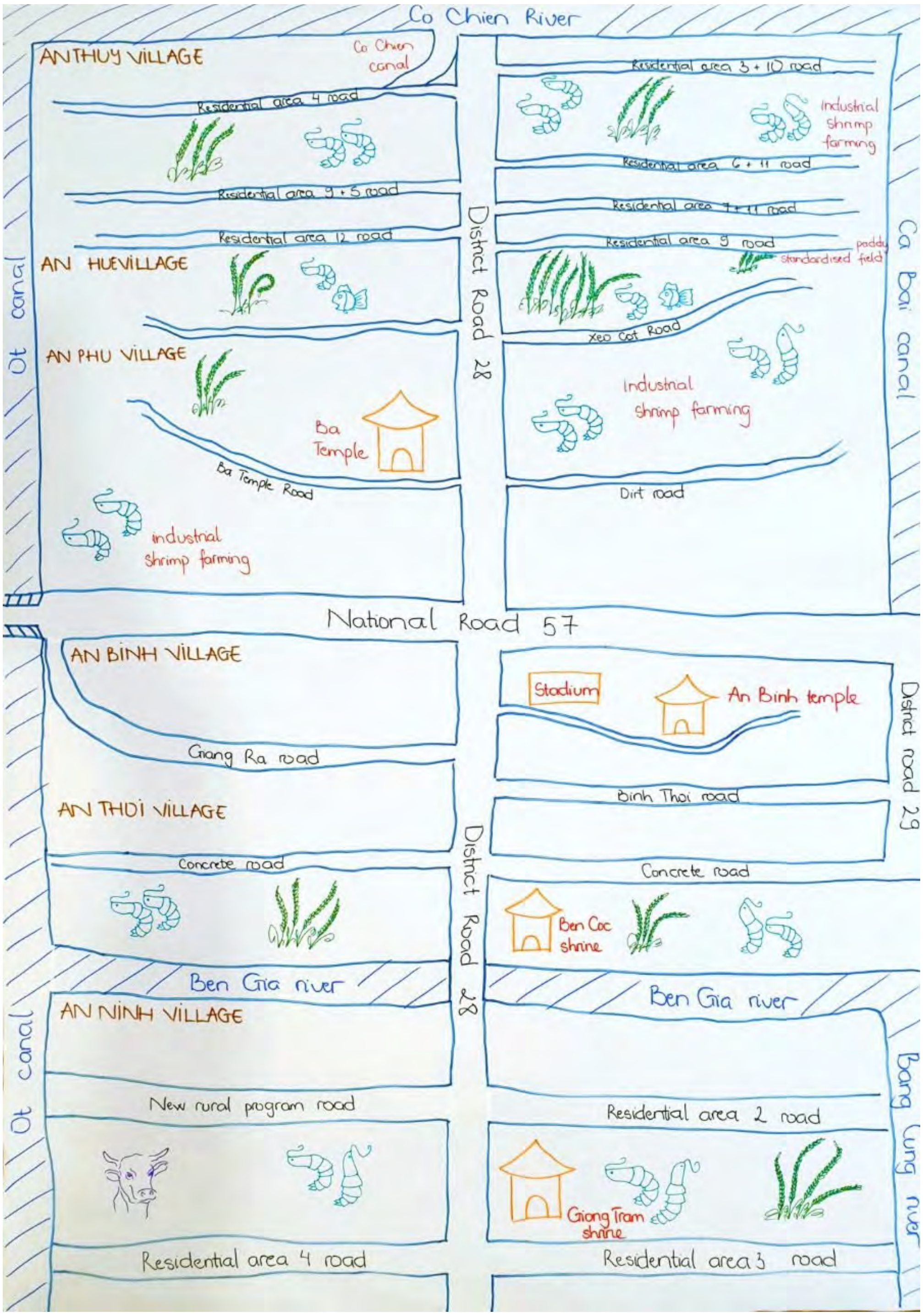
The health station, in coordination with village health workers, strengthened dengue monitoring and treatment, resulting in no major outbreak. Common diseases in the commune include flu, dengue fever, and hand, foot and mouth disease.

8.6.4.5 Economy

Similar to An Dien and An Thuan, An Quy Commune is located within sub-region 2 of Thanh Phu district. Its dominant economic activities are agriculture and aquaculture. According to a 2019 socio-economic report (meeting with the People's Committee of An Quy Commune, July 2019), the area used for aquaculture in the commune is 1,696.04ha, of which shrimp farming takes up 170 ha (Figure 8.25).

Compared with aquaculture, cultivation is less developed in this commune. Coconut planting in the area accounts for 15ha and vegetable planting for 34.03ha. Compared to other communes in the district, the commune's animal husbandry is more developed with 2,646 cows, 1,237 pigs, 1,458 goats and 24,000 poultries.

In addition to the above, fishing is main form of livelihood for local people who live along the rivers, which also contributes to the commune's economic development. In 2018, there were 18 fishing boats with a total capacity 1,572 CV in An Quy Commune, and in that same year fishing production reached 928 tons.



Source: ERM's FGD in July 2019

Figure 8.25 Illustrated map of An Nhon Commune's

8.6.4.6 Land use

An Quy Commune has 16.1 ha of public land, 1,696 ha of aquaculture land, 736 ha of paddy field land and around 18.9 ha of mudflat land is mangrove forest with prominent *Sonneratia caseolaris*.

8.6.4.7 Vulnerable groups

In 2018, 11.14% (221 households) of the commune's total households were categorised as poor households and 2.82% (59 households) as near-poor. The number of poor households has decreased by 2.24% compared to 2017 (Statistic Data of the People's Committee of An Quy Commune, 2018).

8.6.4.8 Archaeological, cultural heritage and religious sites

An Quy commune has seven religious sites where local people often visit for worship according to the local authorities.

8.6.4.9 Village level case study: An Thuy

An Thuy Village has a population of 1,438, who are registered across 355 households. The village is currently cultivating "clean" paddy rice (Bio Thai) over an area of 24ha with the participation of 25 households. It has 35 households involving in industrial shrimp farming of over 30ha ponds. Differing from the extensive farming of shrimp sold to individual dealers, industrial farming shrimp involves selling to companies who come to collect test samples. The results of the test are available after 24 hours, and the results determine the selling price. Lower quality shrimp can be sold at around VND5000-10,000 less per kilogram than higher quality shrimp.

Local farmers report that a number of training programs have been organised by the district and commune agricultural extension services. However, more up-to-date knowledge and skills are shared more frequently by feed, seedling and medicine suppliers and manufacturers.

Diseases that often occur on shrimp farmers in the village include: White Spot Syndrome, White Faeces Syndrome (WFS); and Acute Hepatopancreatic Necrosis Syndrome (AHPNS). Many farmers have heard of the new model of "advanced" extensive shrimp farming being practised in the Ca Mau Province, which uses probiotic feed, and want to learn and adopt this model in their village.

According to local villagers' knowledge, the village has 11 boats, including four offshore fishing (over 110 CV) boats. An offshore fishing trip lasts from 15 to 30 days.

8.6.5 An Thuan Commune

8.6.5.1 Demographic information

An Thuan Commune has an area of 19.59km^2 with seven villages including An Ninh A, An Ninh B, An Khuong, An Dien, An Hoa, An Hoi A and An Hoi B. The commune has 2,549 households with a total population of 10,572 and the population density is 540 persons/km^2. The male and female populations are 49% (5,181 persons) and 51% (5,391 persons) respectively. The labour force consists of 6,332 people, of which 2,950 people are females (46.6%).

Table 8.18 An Thuan Commune at a glance

AN THUAN COMMUNE

No. of villages	07
Area	19.59 km^2
Population	10,572
No. of households	2,549
Poverty proportion	9.82%
Ethnic groups	Kinh and Khmer
Key religion	Buddhism, Caodaism, Catholicism, Protestantism and Filial piety

Source: Meeting with An Thuan People's Committee, July 2019

8.6.5.2 Infrastructure and public facilities

According to a 2019 socio-economic report (meeting with the People's Committee of An Thuan Commune, July 2019), An Thuan Commune has seven kilometres of asphalt roads and 10 kilometres of concretised roads. In 2019, a number of transportation works were completed and put into operation, including Xeo No bridge (VND100 million), road section in Ninh A Village (VND25 million), and road section in An Khuong Village (VND50 million),

In 2018, 99.5% of households used hygienic water and 23.9% of households (635 households) had access to clean water, but no separate drainage system for sewage was available at the commune. Currently, 99.5% of households are connected to the electricity grid (meeting with the People's Committee of An Thuan Commune, July 2019).

8.6.5.3 Education

According to a 2019 socio-economic report (meeting with the People's Committee of An Thuan Commune, July 2019), in the 2017-2018 school year, 286 children attended kindergarten classes, 668 pupils completed the primary education program and 493 pupils graduated from secondary school in the commune. The commune's education management board has set targets to lower the dropout rate of students to less than 1%, to have 100% of students complete their primary education and to have 100% of students graduate from secondary school level.

8.6.5.4 Health

According to data collected at the meeting with the People's Committee of An Thuan Commune (July 2019), An Thuan health station has five medical staff including one doctor, two nurses, one pharmacist and one midwife. As the primary health care provider for the local community, the health station performed 1,242 medical examinations and treatments, of which 1,170 were health insurance beneficiaries in the first half year of 2019.

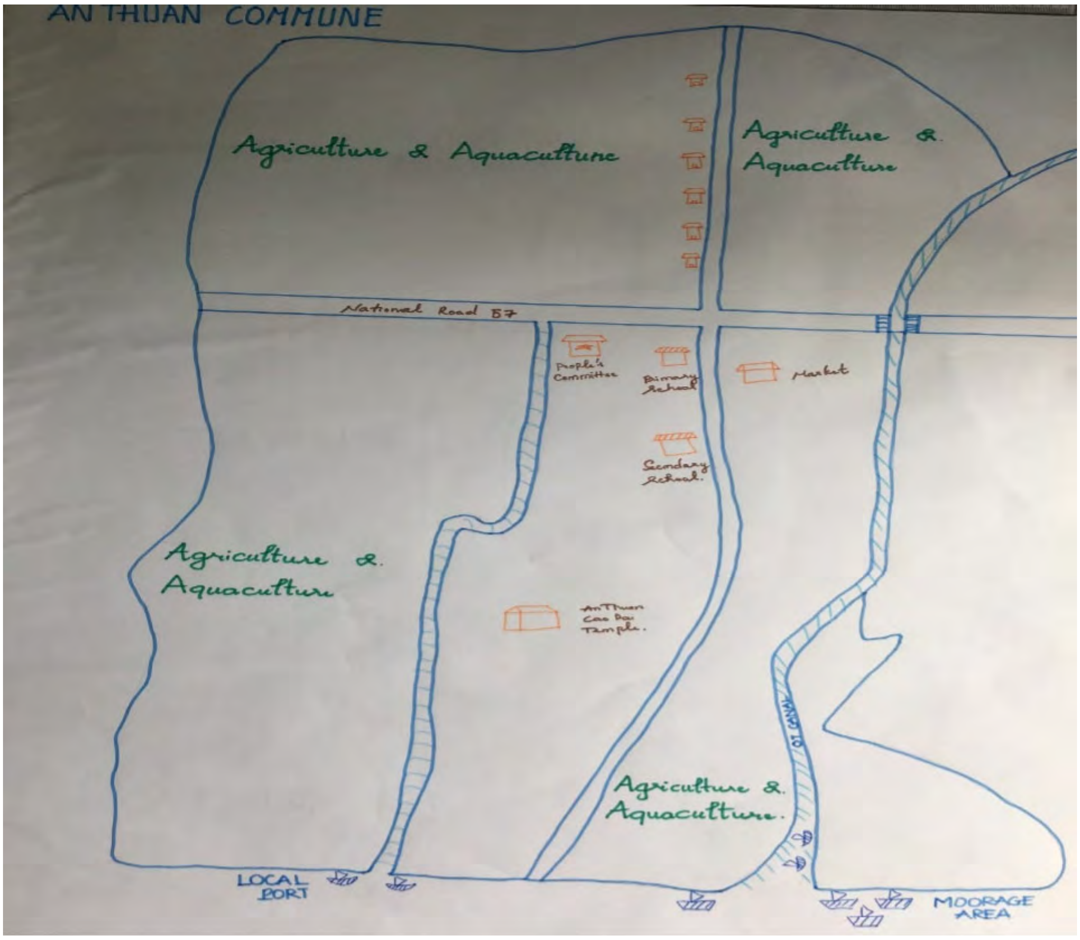
The health station is equipped with five beds and an ultrasound machine, and is equipped to provide medical care services including immunisation and emergency care. Common diseases and health complaints that occur in the commune are heart-related diseases and high blood pressure.

8.6.5.5 Economy

According to a 2019 socio-economic report (meeting with the People's Committee of An Thuan Commune, July 2019), agriculture farming is the major form of livelihood in this commune, with 200ha of area dedicated to rice cultivation. In addition, 15ha is used for vegetable planting and 13.2ha is used for fruit gardening.

The area dedicated to extensive aquaculture in the commune is 150ha, with the first season (of 40ha) usually producing 21 tons (6 tons/ha). The area dedicated to extensive shrimp aquaculture is 740ha. There are 124 fishing boats (36 offshore fishing boats) in An Thuan Commune, which processed up to 471 tons of nearshore and offshore fishing catch in the early half year of 2019.

Up to June 2019, there were 2,500 cows, 2,600 pigs, 1,230 goats and 14,600 poultries raised by local people as their main income source.

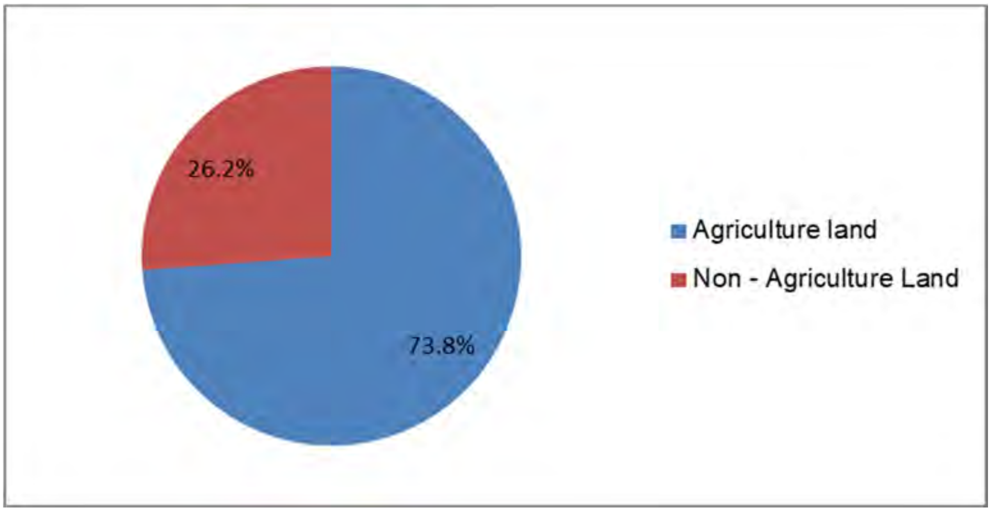


Source: ERM's FGD in July 2019

Figure 8.26 Illustrated map of An Thuan Commune's resources

8.6.5.6 Land use

Agricultural land makes up the highest proportion of land in An Thuan Commune, at 73.8%. Just 26.2% is used for non-agricultural activities (see Figure 8.27).



Source: Data provided by the People's Committee of An Thuan commune, 2019

Figure 8.27 An Thuan's land use structure

8.6.5.7 Vulnerable groups

The commune has 250 poor households, accounting for 9.82% of the commune's total households, according to Statistic Data of the People's Committee of An Thuan Commune in 2018.

8.6.5.8 Archaeological, cultural heritage and religious sites

As reported by the People's Committee of An Thuan Commune, within the commune there is one Buddhist pagoda called Mieu Chap Cha (located in An Hoa village).

8.6.6 Binh Thanh Commune

8.6.6.1 Demographic information

Binh Thanh Commune has an area of 18.63km^2 with six villages including Thanh An, Thanh Binh, Thanh Qui A, Thanh Qui B, Thanh Loi, and Thanh Tan. According to a 2018 socio-economic report, the commune has 2,350 households with a total population of 11,021 and the population density is 591 persons/km^2. The male and female populations are 49.97% (5,507 people) and 50.03% (5,514 people) respectively. The labour force is 6,626 people, of which 3,238 people are female (48.9%), with the proportion of Kinh people in the commune accounting for 100%.

Table 8.19 Binh Thanh Commune at glance

BINH THANH COMMUNE

No. of villages	07
Area	18.63 km^2
Population	11,021
No. of households	2,350
Poverty proportion	12.27%
Ethnic groups	Kinh
Key religion	Buddhism, Caodaism, Catholicism, Protestantism

Source: Meeting with Binh Thanh People's Committee, July 2019

8.6.6.2 Infrastructure and public facilities

According to the socio-economic reports of 2018 and the first half of 2019 (Statistic Data of the People's Committee of Binh Thanh Commune, 2018 and 2019), in 2018 Binh Thanh Commune concretised Highway 25 to a length of 3km, Thanh Tan street to a length of 0.7km, Lang Chay street in Thanh Qui B to a length of 1km, the street from Thanh Qui A Village to Thanh Qui B Village to a length of 600m, and Bay Nghia street to a length of 900m. In 2019, 99.6% of households are using hygienic water and 37% of households have access to clean water, but no separate drainage system for sewage is available at the commune. All households are connected to the electricity grid (Meeting with the People's Committee of Binh Thanh Commune, July 2019).

8.6.6.3 Education

In the 2017-2018 school year, there were 254 kindergarten pupils. In the 2017-2018 school year, 98.6% of pupils completed the primary education program and 100% of pupils graduated from secondary schools (Meeting with the People's Committee of Binh Thanh Commune, July 2019).

8.6.6.4 Health

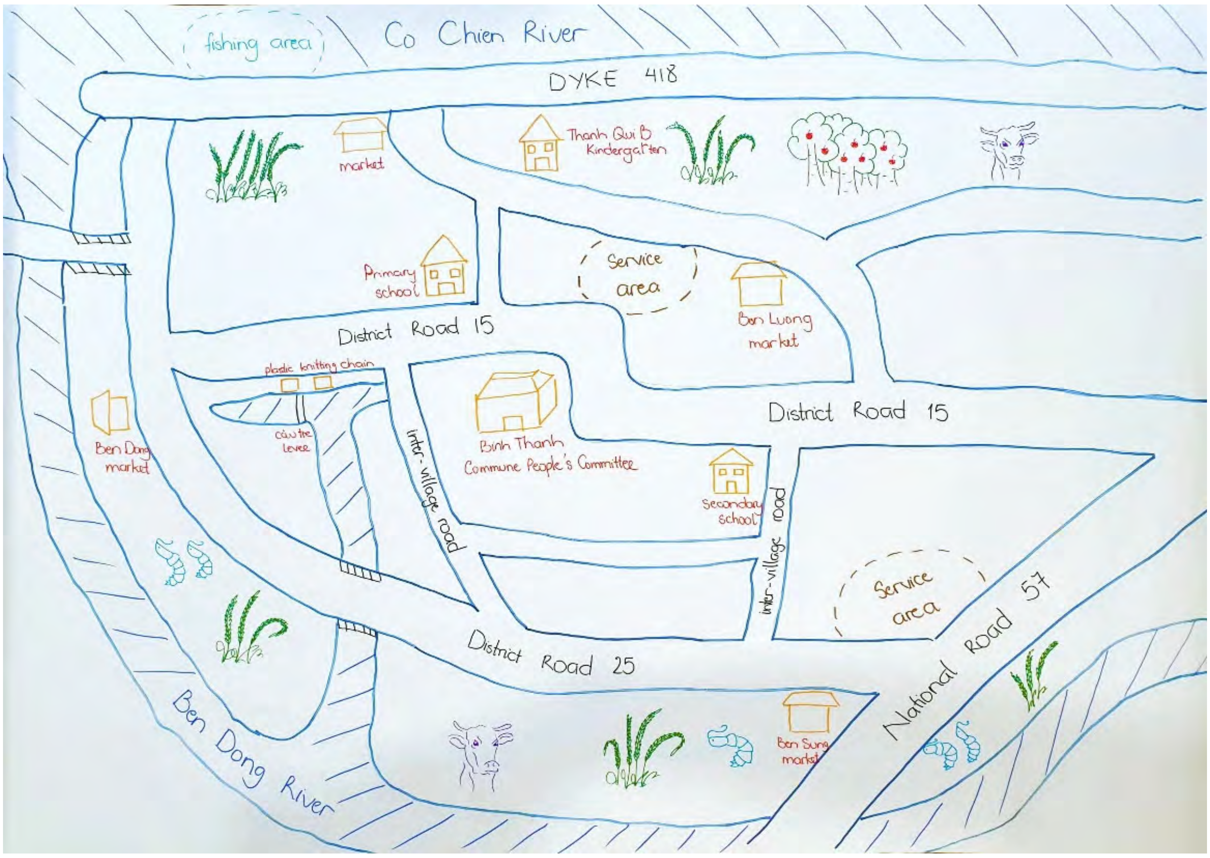
Binh Thanh health station has six medical staff including two doctors, three nurses and one pharmacist. In 2018, the commune's health station served as the primary health care facility for the local community and performed 2,623 medical examinations and treatments, of which 1,779 were health insurance beneficiaries. The health station, in collaboration with village health workers, has strengthened monitoring and treatment for dengue fever and there has been no major outbreak. It has expanded its immunisation program and has conducted child malnutrition prevention training for women who are pregnant or raising children. Some commonly found diseases and health complaints in the commune are high blood pressure, bone and joint diseases, and flu.

8.6.6.5 Economy

Rice farming is the major form of livelihood for local people in this commune, with a total production of 1,942 tons, according to a 2019 socio-economic report (meeting with the People's Committee of Binh Thanh Commune, July 2019). In addition, the total area dedicated to sugarcane in the commune is 152ha, with a productivity of 70 tons/ha.

Coconut and vegetable farming, including corn and peanut, account for 110ha and 17ha, respectively (see Figure 8.28). In 2018, the commune's animal husbandry sector included 2,580 cows, 850 pigs, 1,300 goats, and 8,000 poultries.

The area dedicated to extensive aquaculture and commercial aquaculture is 420ha and 115 ha, respectively – an increase of 14ha for commercial aquaculture compared to 2018. The first season of 93ha produced 465 tons of aquaculture products, or 5 tons per hectare.

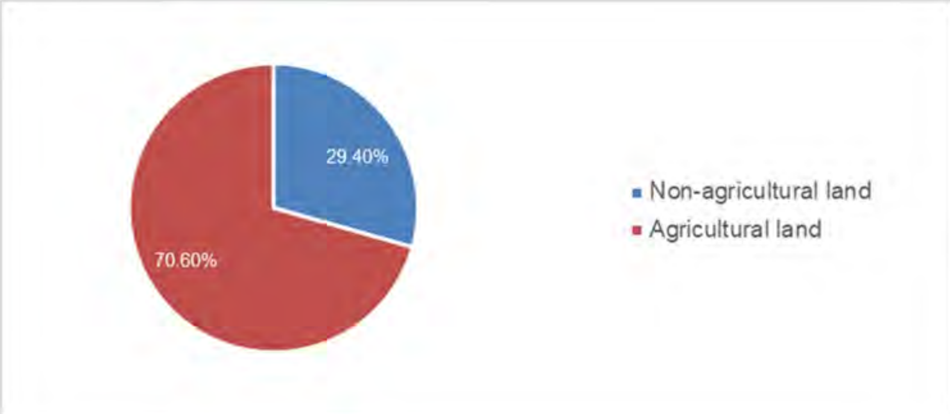


Source: ERM's FGD in July 2019

Figure 8.28 Illustrated map of Binh Thanh Commune's resources

8.6.6.6 Land use

Agricultural land makes up the highest percentage of land in Binh Thanh Commune, at 70.6%, while 29.4% is used for non-agricultural activities (Figure 8.29).



Source: Data provided by the People's Committee of Binh Thanh commune, 2019

Figure 8.29 Binh Thanh's land use structure

8.6.6.7 Vulnerable groups

In 2018, the commune had 288 poor households, accounting for 12.27% of total households. However, the proportion decreased by 2.59% compared to 2017. The number of near-poor households in 2018 was 107, accounting for 4.59% of the total population (Statistic Data of the People's Committee of Binh Thanh Commune, 2018).

8.6.6.8 Archaeological, cultural heritage and religious sites

Binh Thanh Commune has two Buddhist pagodas, five temples, and one church.

8.6.6.9 Village level case study: Thanh Qui A

The village is comprised of approximately 510 households with 2,200 people, and is mostly agriculture-based. Its agriculture production structure can be broken down into three main production categories:

- intensive rice paddy (40%);
- rice and shrimp (30%); and vegetables and
- cereals (30%).

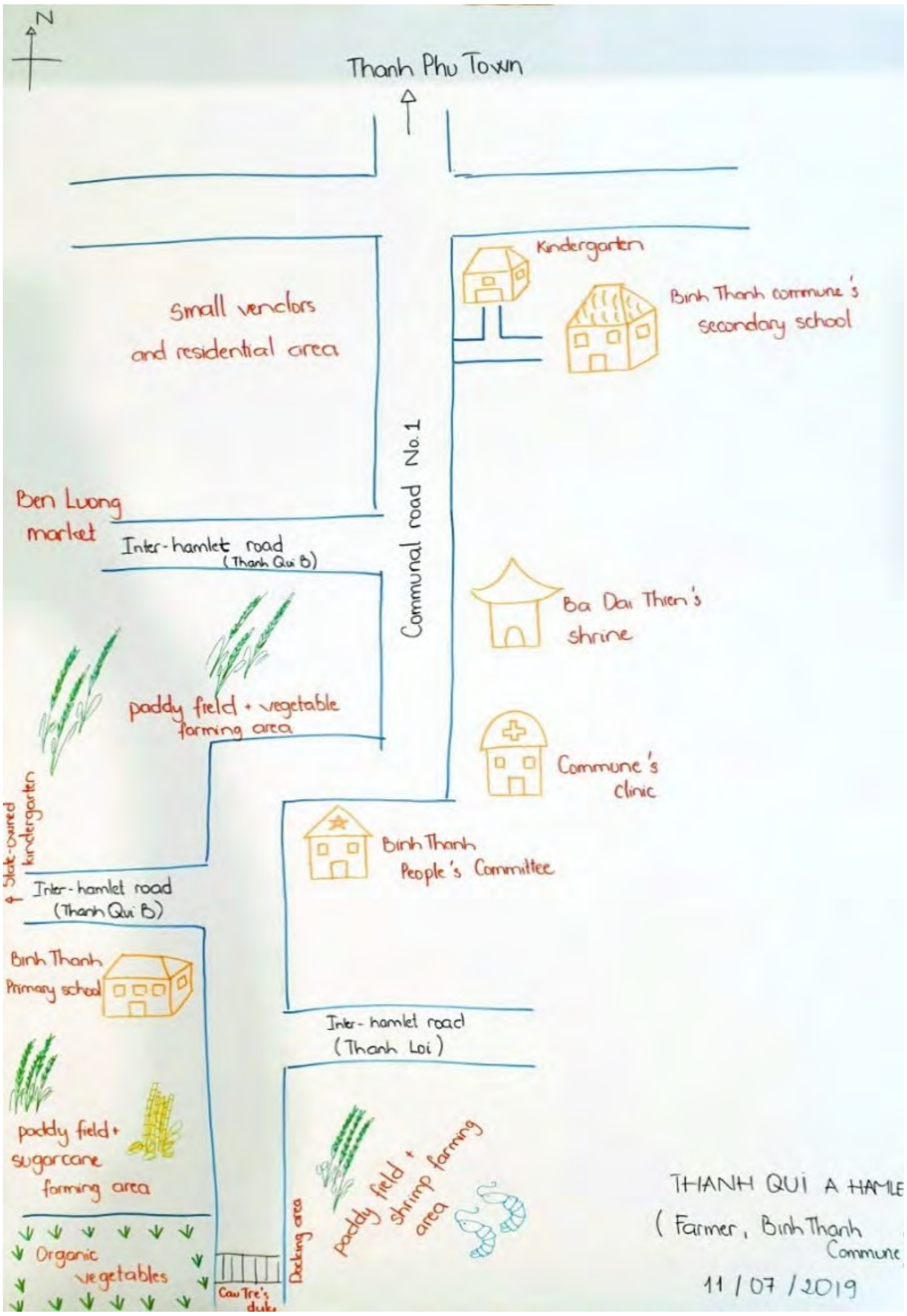
The economic situation of the village has changed significantly thanks to a dyke construction that fresh-water to the village, supporting rice paddy production and as a result supporting rice demand in the village. Sugar cane crops have produced a number of "better off" households in the village, however fruit trees are beginning to replace sugar cane crops. More sustainable models of shrimp farming have been adopted. Cattle raising is booming in the village.

The village's rice production is part of the larger commune's intensive rice zone, which includes part of Thanh Qui A Village, Thanh Qui B, Thanh Binh and part of Thanh An Village. Even though the soil and natural conditions allows two rice crops per year, there is a tendency for local farmers to prefer one rice crop (winter-spring) and the other to be dedicated to growing vegetables and cereals based on their economic profit preferences. The mechanisation of rice cultivation and harvest is very slow, with the limited application of soil making machines and rice threshers.

The village's rice paddy and sugar cane area has been dramatically transformed to orchards as sugar cane production has become less efficiently. This 30ha wide area engages the production efforts of 150 households. Newly planted trees include coconuts, jackfruit and other fruit-producing types.

A 20ha area of the village is used for shrimp-rice farming, using the "shrimps hug rice" model (con tôm ôm cây lúa). This model is seen as more sustainable because it requires farmers to use less chemicals to grow rice, and the shrimp eat natural food in the fields allowing better income from having one paddy rice crop and two shrimp harvests per year.

The village's vegetable growing area stretches over 10ha with the involvement of 60 households. It produces a variety of fruits and vegetables, including bulb, leaf, flower, fruits root and tuber which are produced mainly for domestic markets.



Source: ERM's FGD in July 2019

Figure 8.30 Illustrated map of Thanh Qui A's resources

Animal husbandry has seen a significant increase in terms of cows and goats – the village now has 350 cows. Pig raising has in comparison shrunk due to disease outbreak.

The village business is micro-sized, with main business activities including fish and vegetable selling, motorcycle repairing, and aquaculture services. The village's wharf is the place where five to seven boats are frequently docked to load and unload coconut fuelwood, water tanks, dry straw rolls and other agricultural products. As the road system improves, the use of waterway transportation of goods is becoming less and less popular.

The village's shrine of Lady of Great Heaven (Bà Đại Thiên) is the cultural centre of the village. The temple was built to worship Bà Chúa Xứ, a prosperity goddess of southern Vietnam's Thanism who is a tutelary of business, health, and a protector of the Vietnamese border and the village's guardian deity. The village's Ritual Board of 29 members are responsible for organising three main rituals and festivals annually, including "Hạ điền" (going to the field ceremony) on 16 June according to the Lunar Calendar, "Thượng điền" (harvesting ceremony) on 16 September according to the Lunar Calendar, and Kỳ Yên Festival. Each ceremony consists of rites and festive components where cultural performances and activities are integrated.

8.7 Household level analysis

8.7.1 Demographic information

8.7.1.1 Population

This section analyses socio-economic data collected from 273 households or 1,240 people in the six study communes including Thanh Hai, An Dien, An Nhon, An Quy and Binh Thanh in Thanh Phu District (see Table 8.20). The data were collected via two survey periods carried out from 8 to 11 July 2019 and 23 to 29 September 2019. The July 2019 survey data were based on 203 households with a population of 904 people participating in 21 FGDs. The household survey in September 2019 consisted of 70 affected households with 336 people, including 31 households affected by the power pole construction and 39 households affected by the power line safety corridor. The same questionnaire was used for both surveys.

Table 8.20 Surveyed households and population by commune by survey periods

Commune	Surveyed households			Surveyed population		
	FGDs in Jul. 2019	Household interviews in Sep. 2019	Total	FGDs in Jul. 2019	Household interviews in Sep. 2019	Total
Thanh Hai	58	18	76	233	89	322
An Dien	33	14	47	146	68	214
An Nhon	23	7	30	117	78	210
An Quy	28	16	44	132	58	196
An Thuan	26	11	37	138	30	147
Binh Thanh	35	4	39	138	13	151
Total	**203**	**70**	**273**	**904**	**336**	**1240**

Source: Socio-economic survey conducted by ERM, July and September 2019

As the main Project site where the Project's substations and turbines will be located, Thanh Hai had the highest surveyed population of 322 people from 76 households. The smallest surveyed population is from An Thuan Commune (147 persons) and Binh Thanh Commune (151 persons).

8.7.1.2 Gender

The participants of surveyed households were quite balanced in gender. Within the surveyed population, females account for 49.44%. An Thuan and An Nhon communes obtained a wider gender difference in population, with the rate of female proportions of 45.14% and 46.53% respectively. **Table 8.21** shows the surveyed population by gender in each commune.

Table 8.21 Surveyed population by gender

Commune	Number of households	Population	Male		Female	
			N	%	N	%
Thanh Hai	76	322	159	49.38	163	50.62
An Dien	47	214	104	48.60	110	51.40
An Nhon	30	162	85	52.47	77	47.53
An Quy	44	216	107	49.54	109	50.46
An Thuan	37	175	96	54.86	79	45.14
Binh Thanh	39	151	76	50.33	75	49.67
Total	**273**	**1240**	**627**	**50.56**	**613**	**49.44**

Source: Socio-economic survey conducted by ERM, July and September 2019

8.7.1.3 Household size

Of the 273 surveyed households, the largest household size was 12 people, in the An Thuan Commune. The largest homes in other communes housed seven to nine members. The smallest household size was a single person family. On average there were 4.5 people per household, as shown in **Table 8.22**.

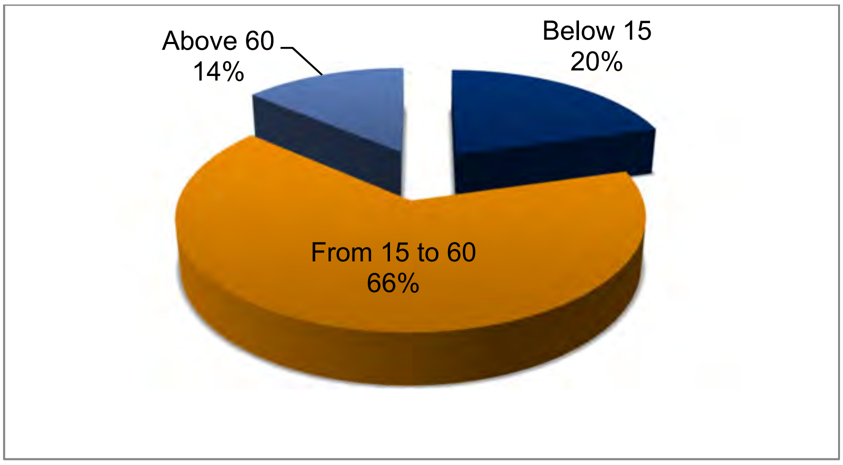
Table 8.22 Size of surveyed households

Commune	Minimum size of surveyed households (person)	Average size of surveyed households (person)	Maximum size of surveyed households (person)
Thanh Hai	1	4.5	10
An Dien	1	4.5	8
An Nhon	3	4.5	8
An Quy	3	5.0	9
An Thuan	1	5.0	12
Binh Thanh	1	3.5	7
Total	**1**	**4.5**	**12**

Source: Socio-economic survey conducted by ERM, July and September 2019

8.7.1.4 Age cohorts

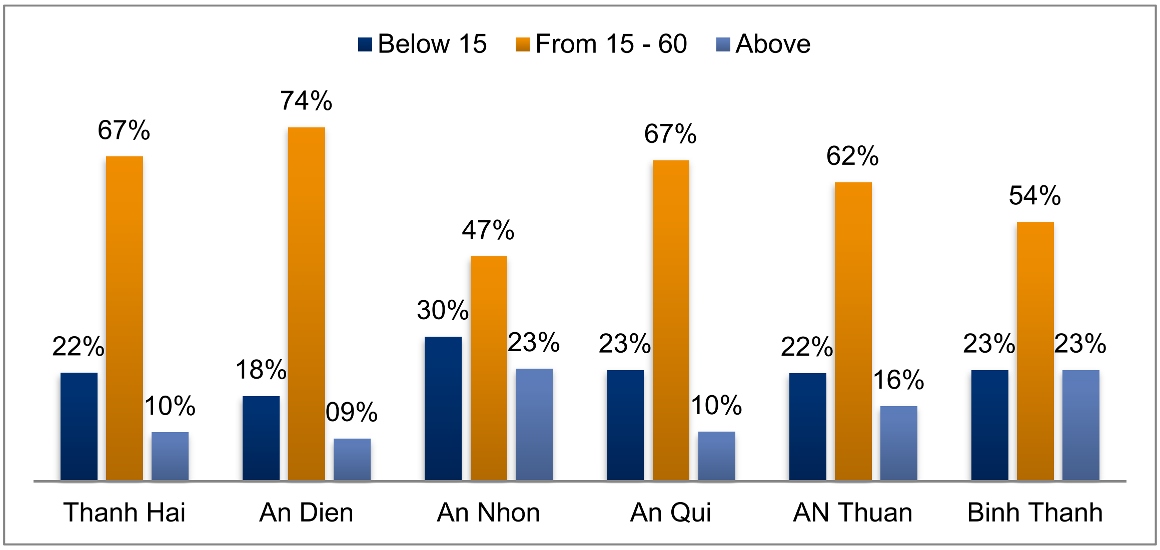
The majority of the people in the surveyed households belonged to the working age group (from 15 to 60 years old), accounting for 66% of the total sample. Of those surveyed, 20% were under 15 years old and the other 14% were elderly people aged over 60 years (see Figure 8.31).



Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.31 Composition of surveyed population by age cohorts

Compared within six communes, it is showed in Figure 8.32, An Dien had the highest rate of labor force (74.0% total population of An Dien), followed by Thanh Hai and An Quy with the same rate of 67.0%. There is not a sharp difference between the three age groups in An Nhon, that is 30.0% aged below 15 years old, 47.0% from 15 – 60 years old and 23.0% above 60.



Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.32 Surveyed population by working age cohorts by commune

The surveyed population maintained a quite equal proportion of male and female labor force, 65.5% and 64.9% respectively (see Figure 8.33). Male population groups under 15 years old and above 60 years old are approximately 4% higher and approximately 4% lower than their symmetrical female groups respectively.

Source: Socio-economic survey conducted by ERM, July and September 2019

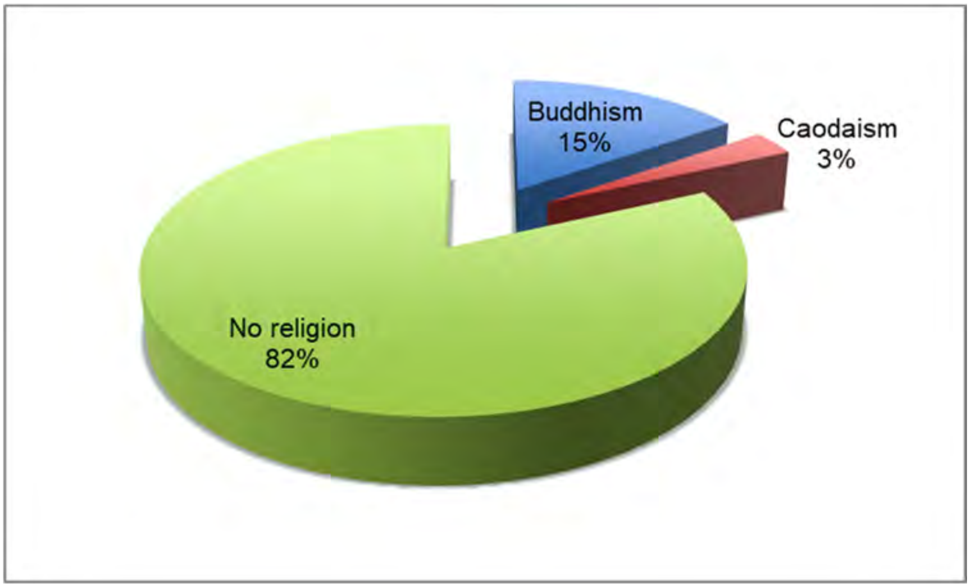
Figure 8.33 Age cohorts of surveyed population by gender

8.7.1.5 Ethnicity

There were no ethnic minority people among the surveyed households, and all 273 households that participated in the survey are of the Kinh ethnic group. All the surveyed people in the communes identified themselves as Kinh. This information is compatible with the statistical data at commune and district level, which claims that most of the population are Kinh people.

8.7.1.6 Religion

In this survey, 135 people representing approximately 15% of survey participants identified as Buddhists. The remaining population, identified as non-religion, formed the majority of the surveyed population (82%). Three percent of the surveyed population were Caodaism followers (see Figure 8.34). It is noted that some people within the same household identified with different religions. For example, a parent might have identified as Buddhist or Caodaist but their children did not follow any religion.



Source: Socio-economic survey conducted by ERM, July and September 2019

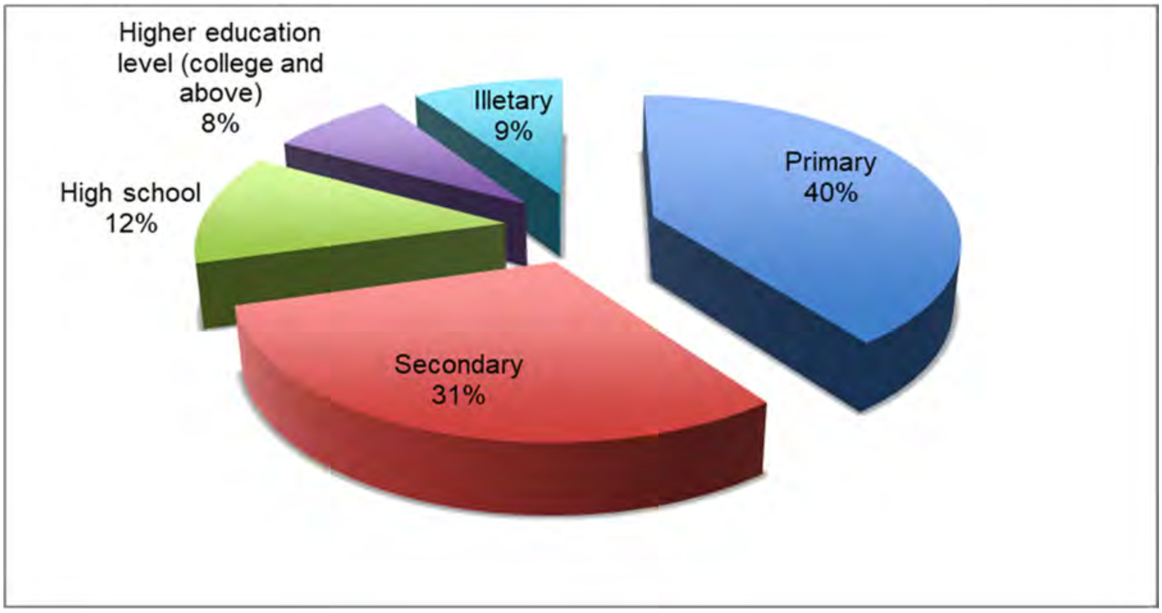
Figure 8.34 Religion structure of surveyed population

8.7.2 Education

Education levels can be calculated for people aged six years[36] and older. Given that the ages of survey participants were not identified during the FGDs, and therefore data has not been collated into age groups (such as younger than 15, between 15-60 and older than 60), the below discussion is based on the data collected from all 1240 people regardless their age. The present data regarding the highest levels of education completed by surveyed individuals at the time of surveying, broken down into proportion of survey population, commune and different groups.

The data collected shows that only a small proportion of surveyed populations is illiterate, at 9% of the 1,240 surveyed people across all six communes. However, it is noted that illiteracy data was recorded across all the three age groups. The highest illiteracy rates were identified in the An Nhon and An Quy communes at 14.39% and 12.32%, respectively. The majority had completed primary and secondary school level, accounting for 70% of the total surveyed population, and this trend was observed to be the same in each commune surveyed. Less people had completed their high school education level compared to those who had completed primary or secondary level education, at the time of the survey. An Thuan (17%) was the commune with the highest number of people who had attained a high school level education. Meanwhile, the higher education level (i.e. college and university) was recorded highest in An Dien commune (8%) and lowest in An Nhon (5%) commune.

[36] At the time of the survey (July 2019), six year old children had started 1st grade.



Source: Socio-economic survey conducted by ERM, July and September 2019

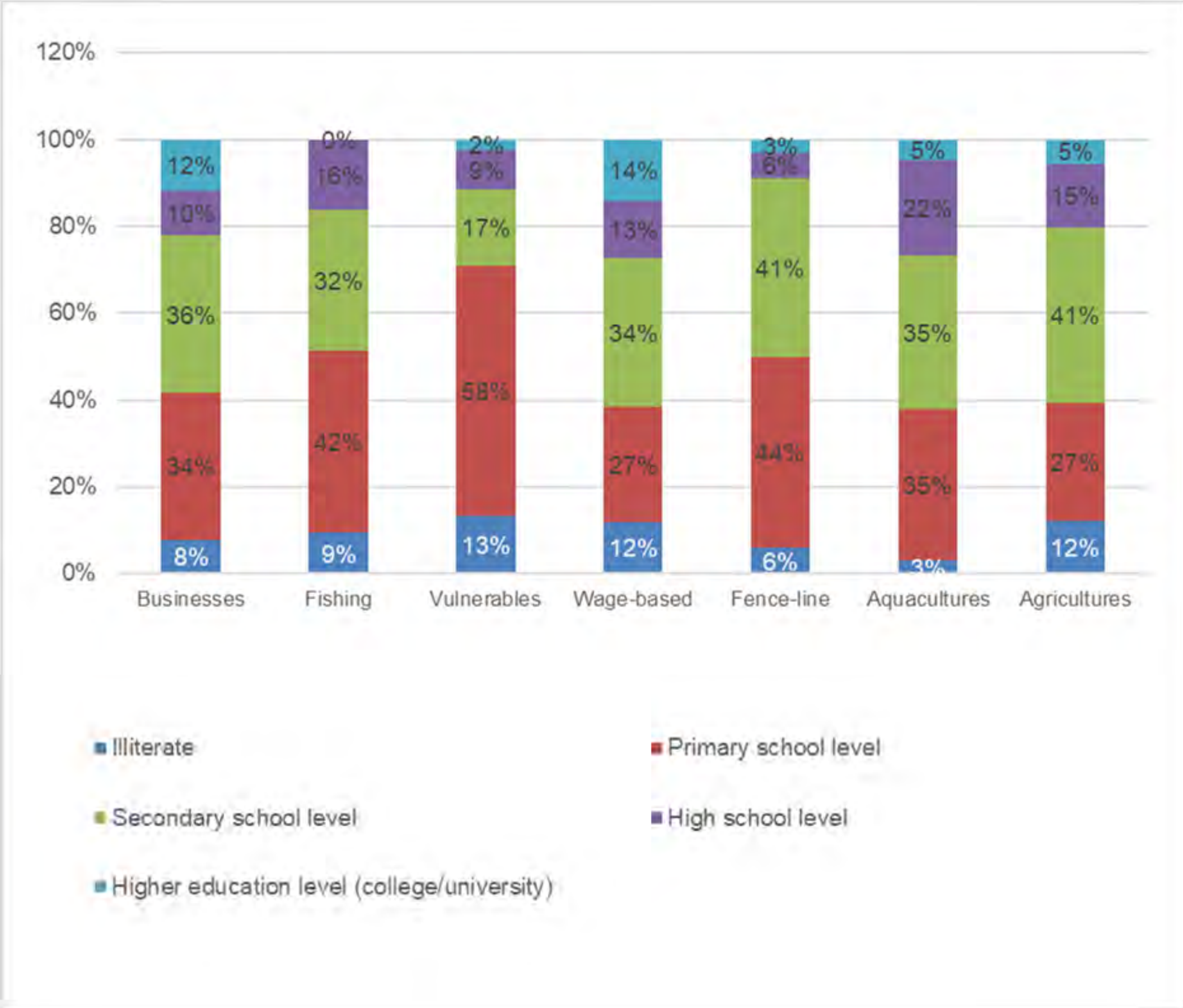
Figure 8.35 Educational attainment of surveyed population

Table 8.23 Educational attainment of surveyed population by commune

Commune	Illiteracy	Primary	Secondary	High school	Higher education level (college and above)
Thanh Hai	5%	48%	32%	8%	7%
An Dien	6%	43%	29%	14%	8%
An Nhon	7%	52%	28%	8%	5%
An Quy	8%	38%	33%	15%	7%
An Thuan	3%	49%	24%	17%	7%
Binh Thanh	5%	44%	29%	15%	7%
Total	**9%**	**39%**	**31%**	**13%**	**8%**

Source: Socio-economic survey conducted by ERM, July and September 2019

More particularly, data from our FGDs revealed that people living in households with members involved in business and wage-based livelihoods had the highest education level (12-14% achieved college or university level); in four groups including aquaculture, fishing, agriculture and wage-based, high school education levels were recorded at a high percentage. Achieving both secondary and primary education levels was recognised as the basic level for the majority surveyed groups and thus the proportions at this level were relatively equal among the groups (see Figure 8.36). The people in the vulnerable, wage-based and agriculture groups reported the highest illiteracy rates in their families (12-13%).



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.36 Education attainment by categorised groups

8.7.3 Labour force and employment

8.7.3.1 Labour force

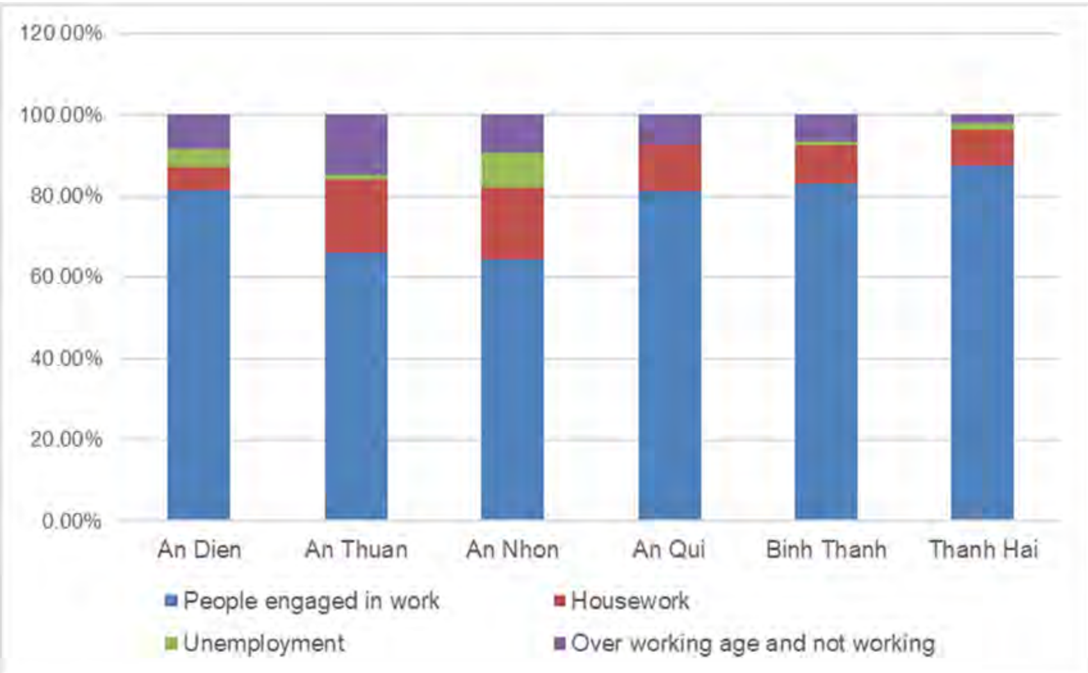
To compare livelihoods, only people of working age were included (i.e. between 15 and 60 years old and referred to as “adult people” or “working age people”). The survey data indicate that 837 people (67.5%) were of working age, as shown in , but the number engaged in work was 711 people (84,9% of total surveyed working age people). The remaining people (15.1% of total surveyed working age population) were unemployed or mentally or physically disabled or engaged in unpaid activities (e.g. housework and study).

Table 8.24 Ratio of labour resources of surveyed households

Total surveyed population	Labour force (15-60 years old)		15-60 years old and working	
	Number	Percentage out of total surveyed population	Number	Percentage out of labour force
1,240	837	67.5	711	84.9

Source: Socio-economic survey conducted by ERM, July and September 2019

More particularly, based on FGD-based data for each commune (see Figure 8.37), it is recognised that the unemployment rates in An Nhon (8.4%) and An Dien (4.59%) were the highest of the six surveyed communes, which all generally fell within the range of 0%-1.62%. In addition to the unemployed, some people engaged in housework only, and these groups together with people older than the working age and not working are the groups that did not contribute to their household income. These groups were most prominent in the An Thuan and An Nhon communes, followed by An Quy and Binh Thanh communes, while they were relatively minor in the Thanh Hai and An Dien communes. In descending order according to size, the active labour force, or people engaged in work, was largest in Thanh Hai, Binh Thanh, An Dien, An Quy, An Thuan and smallest in An Nhon.

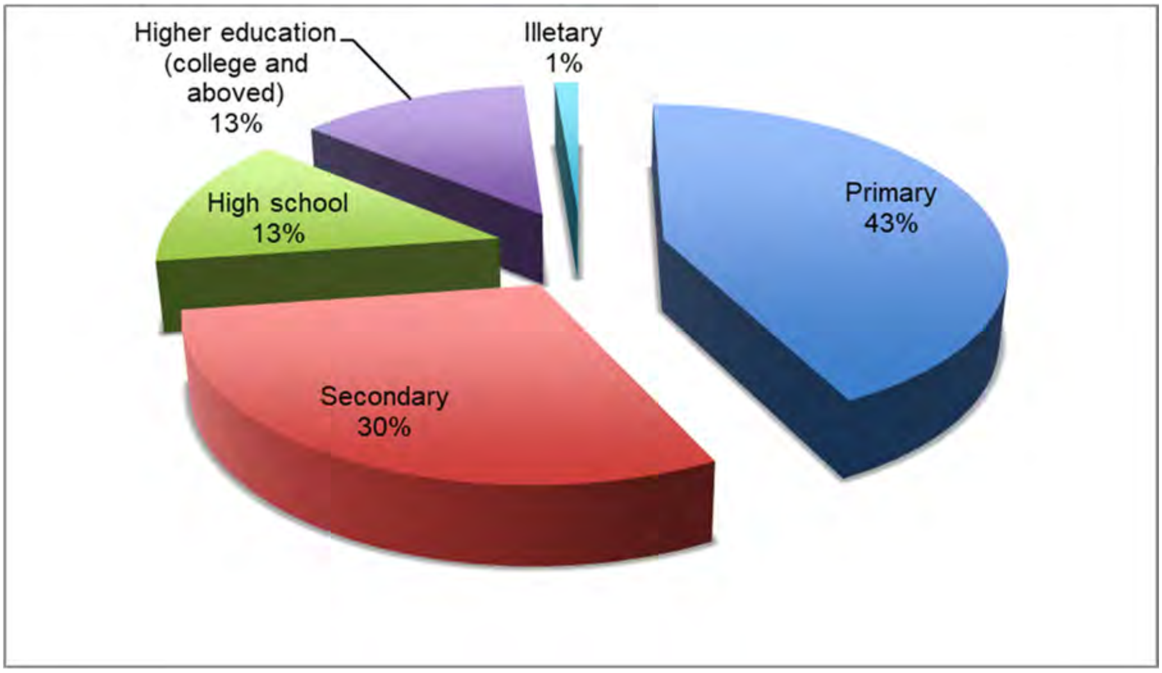


Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.37 Proportion of people engaged in work and groups not working by commune

8.7.3.2 Education of labour force

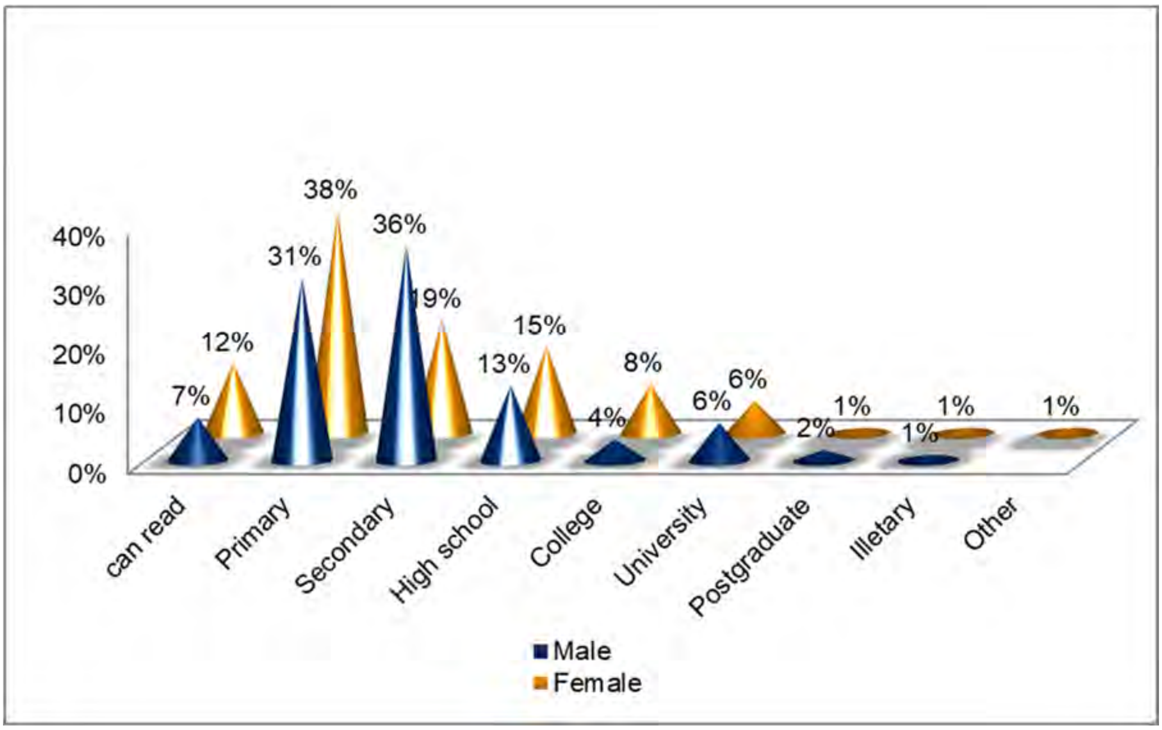
The education attainment of the labour force is quite low, 43% at the primary level and 30% secondary level. People within the labour force who obtained a high school education level accounts for 13%. This proporation remained unchanged with the higher education attainment (see Figure 8.38).



Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.38 Education of labour force

More particularly, within the Project affected population, the female working age group has the lower education than the male group. Figure 8.39 indicates that at the primary education level, the completion rate of males is 31.0% while that of female labour force is 38.0%. On the other hand, the secondary eduation rate of the male cohort was much higher (36.0% compared to 19.0% of the female group).



Source: Socio-economic survey conducted by ERM, September 2019

Figure 8.39 Education levels of labor force (Project affected population) by gender

8.7.4 Livelihoods

Of the employed population (711 people), 60% lived dependently on land while engaging in cultivation, husbandry and aquaculture, as indicated in Table 8.25. Approximately 19.85% of people worked for companies, shops or public organisations such as commune People's Committees. Some 10% had as their main job established small businesses such as grocery shops, restaurants, seafood trading businesses, fishery logistics and boat repair services. The small proportion of 5.51% earned a marine-based livelihood as fisherfolk. Some others worked as seasonal workers (construction workers, drivers) or as tailors at their houses.

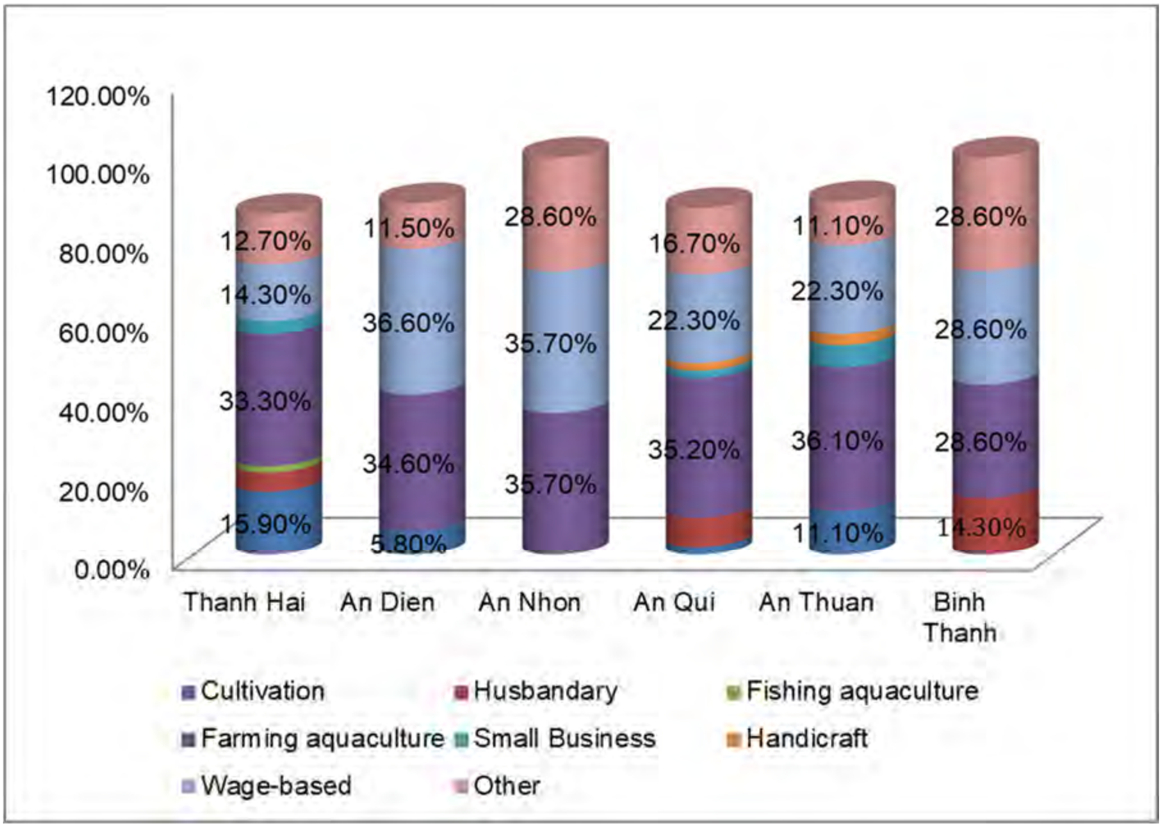
Table 8.25 Livelihoods of surveyed households

Livelihood categories	Livelihood types	Livelihood types		Livelihood categories	
		Number	%	Number	%
Land-based	Cultivation	134	19	429	60,00
	Husbandry	82	12		
	Aquaculture	213	30		
Marine-based	Fishing	31	4	30	5,51
Wage-based	Worker	137	19	108	19,85
Enterprise-based	Small business	77	11	51	9,38
Other	Others	37	5	30	5,51
Total		**711**	**100**	**711**	**100,00**

Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.40 shows the main occupations of each commune, and indicates the following:

- An Dien: the majority of people are engaged in aquaculture, cultivation and wage- based;
- An Thuan: aquaculture is the most common occupation, while the proportions of people working in other occupations are relatively similar;
- An Nhon: in a similar trend, An Nhon is a hub for aquaculture and wage based.
- An Quy: Similar to An Nhon, most of surveyed people reported they work as farmers in aquaculture and cultivation;
- Binh Thanh: beside aquaculture and wage- based, husbandry accounts for the highest rate compared to the other communes.
- Thanh Hai: As Binh Thanh, beside aquaculture and wage- based, cultivation is the highest rate in six communes.

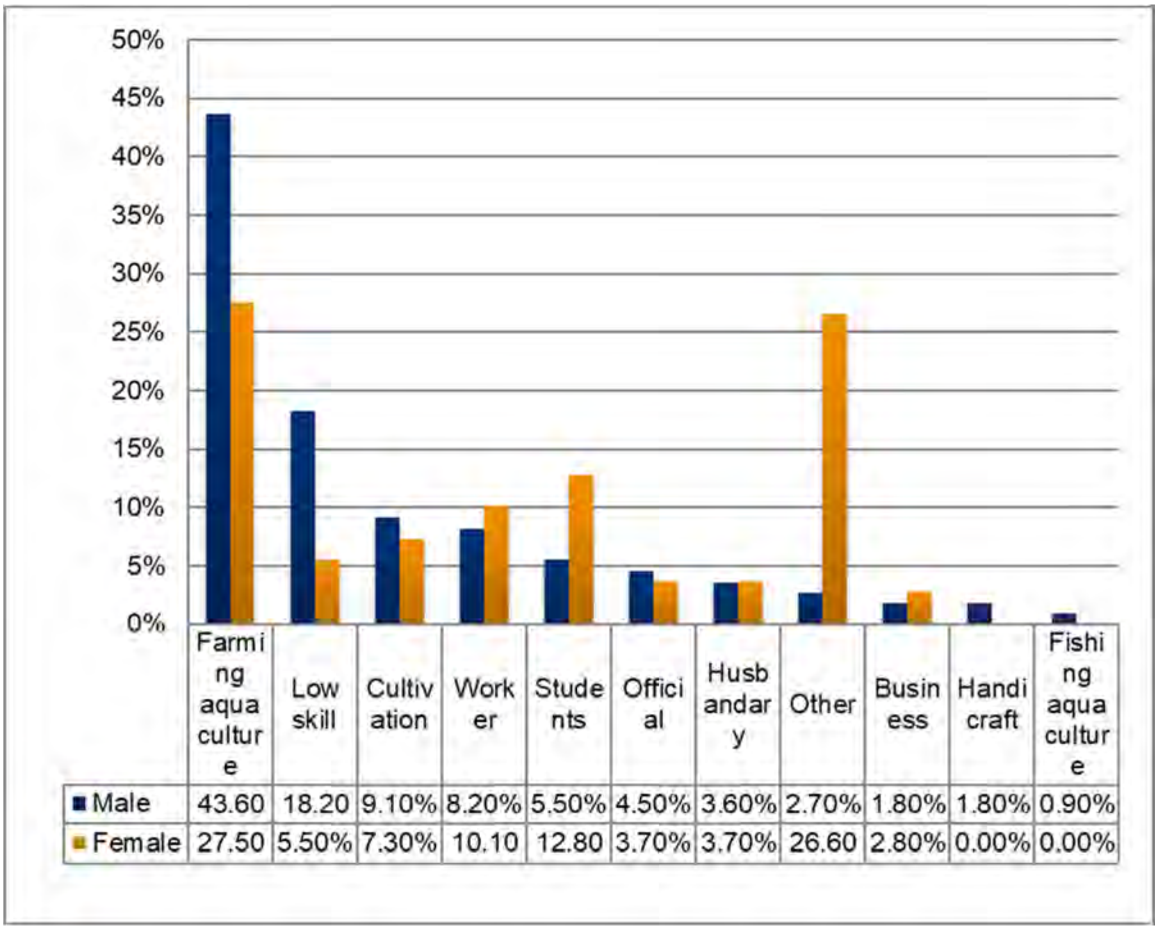


Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.40 Livelihoods across six surveyed communes

Regarding the Project affected households, economic activities of the population of working age included farming aquaculture, workers, and agriculture for cultivation, husbandry and fishing aquaculture. Among that, farming aquaculture accounts for the highest (36.0%); because it becomes the economic characteristic in coastal area, not except for the young labour force (see Figure 8.41). It is noted that, farming aquaculture is the main livelihood in the affected site of the project. The second is low skill labour force, they are workers and seasonal workers with unstable jobs. Agriculture for cultivation, husbandry and fishing aquaculture is the lower.

On the gender dimension, the role of women mainly is within the family. In the working age, 26.6% of female labour force was intensively involved in household chores, compared to 2.7% male. Females involved in farming aquaculture of households accounted for 27.5% (compared to 43.6% male). In generally, the men played a main role in livelihoods of household.

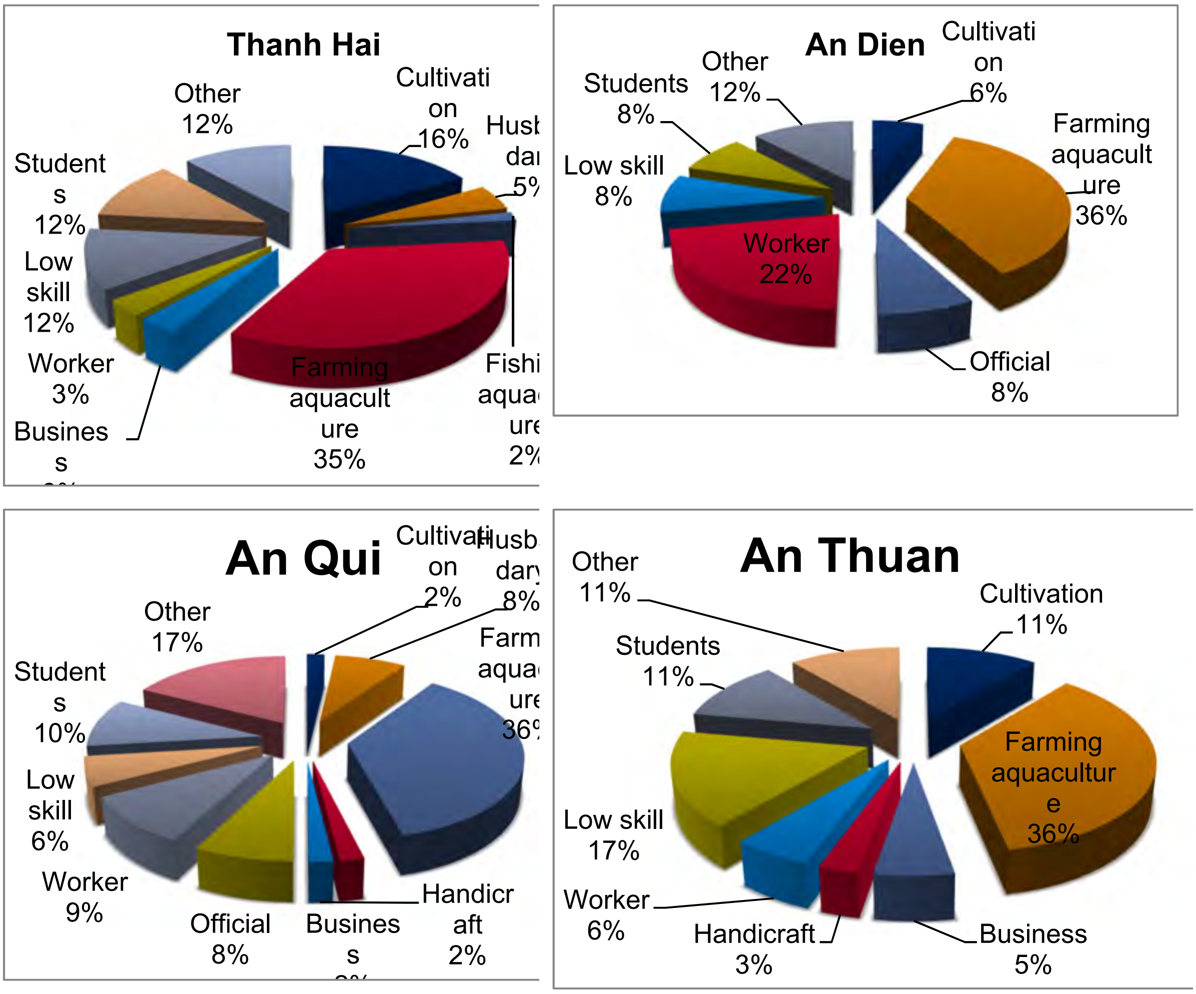


Source: Socio-economic survey conducted by ERM, September 2019

Figure 8.41 Occupation of labour force (Project affected population) by gender

However, depending on demographic information, location and economic – social information, each commune has mainly different economic activities. There are 4 communes with the survey population above 30 people which is significant enough on statistical analysis including Thanh Hai, An Dien, An Thuan and An Quy (see Figure 8.42). The economic structure of surveyed communes is as follows:

- Thanh Hai: aquaculture (35.0%), cultivation and husbandry (16.0%) and hired labor (12.0%);
- An Dien commune: aquaculture (36.0%), workers and employees (22.0%); hired workers (8.0%);
- An Thuan: aquaculture (36.0%), working as hired labor (17.0%), farming (11.0%)
- An Quy: Aquaculture (36.0%), enterprise workers (9.0%), husbandry (8.0%).



Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.42 Structure of labor force occupation (Project affected population) by commune

8.7.4.1 Land-based livelihood

A 'land-based livelihood' for the purposes of this survey includes cultivation, husbandry and aquaculture. Agriculture production in the area generally includes intensive rice paddies, vegetables and fruits (mango and watermelon), cows and goats, shrimp (white leg, tiger and cray shrimp) and crab (see Table 8.26). Some households also farm fish (tilapia and pangasius catfish), oysters, clams and shells near the coastal area.

The study area in particular is a popular place for raising intercropped white shrimp in rice fields. This particular model has been applied because agricultural land in the area is affected by salinity for several months of each year (from March to May of the lunar calendar - see Table 8.26). Intercropping has been identified as a solution for adapting to high salinity levels caused by climate change by combining shrimp farming and rice cultivation within value chains. This is because rice grown on shrimp and crab farming areas is a way of removing salt from rice fields during the rainy season, thus reducing the harmful effects of saline intrusion and prolonging land use, according to the Farmers Union of Vietnam[37].

Table 8.26 Rice and shrimp production calendar

MONTH	1	2	3	4	5	6	7	8	9	10	11	12
Paddy rice												
Intercropping (Giant tiger prawn or *Penaeus monodon*)	*2*	*2*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*
Extensive shrimp farming												
Industrial shrimp farming (*Litopenaeus vannamei*)	*2*	*2*	*Hot weather and salinisation*			*1*	*1*	*1*	*1*	*1*	*Inter-seasonal changing weather*	*2*

Source: ERM's FGD in July, 2019

The government has supported and promoted the model since its implementation, through expanding the areas and production of intercropped white shrimp in rice fields. Many trainings have been organised by the district and commune agricultural extension services. However, far more up-to-date knowledge and skills are more frequently shared by feed, seedling and medicine suppliers and manufacturers, as reported by FGD respondents.

They also reported that common shrimp diseases include White Spot Syndrome; White Faeces Syndrome (WFS); and Acute Hepatopancreatic Necrosis Syndrome (AHPNS).

The shrimp products are often sold to individual dealers, while industrial shrimp farming products are usually sold to a seafood processing company following testing. The price of shrimp varies depending on the test results, which come 24 hours after samples have been collected for testing. The price of shrimp also varies based on the size of the shrimp, as detailed below:

- Shrimp products containing 100 shrimp/kg costs from 100,000 VND/kg,
- Shrimp products containing 70 shrimp/kg costs from 105,000 – 110,000 VND/kg,
- Shrimp products containing 50 shrimp/kg costs from 120,000 - 130,000 VND/kg .
- Less quality shrimp can be valued at a price of 5,000-10,000 VND/kg.

8.7.4.2 Marine-based livelihood

A marine-based livelihood is defined as fishing in this report. Within the six surveyed communes, only An Nhon did not have any fisherfolk respond to the survey, and it is noted that only three groups of fisherfolk were invited to attend the FGD including fisherfolk from An Thuan, An Quy and Thanh Hai. However, people engaged in fishing also attended other FGDs as family members of surveyed households.

It was reported in the FGDs that local fishing practices included three main activities: coastal, nearshore and inshore fishing. Coastal fishing is fishing within an area of less than 10km from the beach to coastal

[37] Viet Nam Farmers Union 2017. Thanh Phu Cooperative: Double benefit from shrimp-rice model (Hop tac xa Thanh Phu: Loi ich kep tu mo hinh Tom – Lua) Available at

http://www.hoinongdan.org.vn/sitepages/news/1150/67630/htx-thanh-phu-ben-tre-loi-ich-kep-tu-mo-hinh-tom-lua. Accessed 22 July 2019).

line. If fisherfolk need to go farther it is considered inshore fishing (10-20km) or offshore fishing (20-30km), according to local fisherfolk who participated in the FGDs in the An Quy, An Thuan and Thanh Hai communes (see Table 8.27).

Table 8.27 Types of fishing in surveyed area

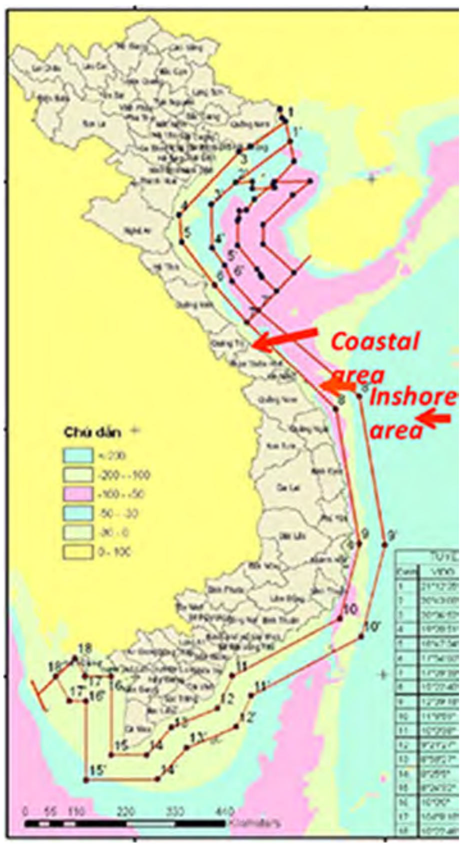
Type of fishing (named based on fishing zone)	Distance from shore	Duration of fishing trip	Capacity of fishing boat	Products captured
Coastal fishing	<1km	Within a day	<20 CV	clams, crab and fish
	1-5km	Within a day	<20 CV	
Inshore fishing	10-20km	15 days	>90CV	croaker (*Sciaenidae*), mullet (*Mugilidae*) (January and February), whiteleg shrimp (*Litopenaeus vannamei* in April), ray fish (*Batoidea*), and squid (June and July)
Offshore fishing	20-30km	6 months	220-230CV	

Source: Socio-economic survey conducted by ERM, July 2019

Fishing ground in the area is vast and constant communication between boats helps identify potential fishing areas. Fishing ground was identified within the sea from Bac Lieu to Vung Tau. Fishing products depend on the fishing zone, with common products reportedly including clams, crab, shrimp, squid and fish as detailed in Figure 8.43.

The fish products are then sold to/at:

- Directly to tourists or local restaurants, especially in Thanh Hai commune;
- Traders who visit the fisherfolk;
- Cau Van wharf, An Nhon, Thanh Phu, Ben Tre
- Binh Dai, Ben Tre
- Duyen Hai, Tra Vinh
- Lang Chim, Tra Vinh



Source: ERM's FGD in July, 2019 and Nguyen Tuan Uyen, 2017

Figure 8.43 Fishing area of surveyed area (left) and fishing zones of Vietnam (right)

The local fisherfolk shared that their common moorage areas were Co Chien River (as shown on the FGD map in Figure 8.43 above). In the FGDs, some fisherfolk who worked on an inshore fishing boat said:

> *"Each 15-day fishing trip, our team often include 5 fisherfolk, who are paid with VND 4-5 million/trip. The boat owner can save VND15-10 million per successful trip, in case of storms we have enough money to pay diesel fuel[38]."*

> *"We did not receive sufficient support from the Government. We cannot afford an upgrading to a larger ship, which costs more than VND1 billion."*

Local fisherfolk have their own calendar for fishing activities. Table 8.28 reflects the calendar, showing the times considered best for fishing, as well as for other activities such as selling the fish.

Table 8.28 Fishing calendar

MONTH	1	2	3	4	5	6	7	8	9	10	11	12
Fishing		South wind season, good for fishing								Turbulent weather, no or limited fishing		
24 HOURS	**1-2**	**3-4**	**5-6**	**7-8**	**9-10**	**11-12**	**13-14**	**15-16**	**17-18**	**19-20**	**21-22**	**23-24**

[38] The price of diesel fuel has increased substantially, from VND17,000 per litre to VND25,000 – 30,000 per litre.

Fishing	Fishing and landing to sell fish catch of the previous night						Fishing

Source: Socio-economic survey conducted by ERM, July 2019

8.7.4.3 Wage-based livelihood

Findings from interviews conducted during FGDs for wage-based livelihood people confirm that people who worked as workers were concurrently engaged in aquaculture farming with their families to supplement their income. In surveyed communes, most people worked for the public sector (commune cadres) as well as private businesses such as local restaurants, hotel and shops. Some were doctors and hotel managers. Most of people categorised as earning a wage-based livelihood were from the Binh Thanh and Thanh Hai communes.

A large of labor force work as workers of the enterprises as well as seasonal workers with low skills such as hired labor for cultivation, for farming aquaculture. Two cooperatives of aquaculture in Thanh Hai attracted many labor force in the commune and other nearby communes.

8.7.4.4 Enterprise-based livelihood

As mentioned above, key small businesses owned by local people included hotels, motels, restaurants, grocery shops. Within the surveyed samples, most of the business owners were from Thanh Hai, Binh Thanh and An Thuan. Thanh Hai is a coastal commune with many tourist sites and thus is a popular place for the development of tourism services including hotels and restaurants, whereas Binh Thanh and An Thuan as the two satellite communes of Thanh Phu town might inherit the socio-economic development advantages from the town.

8.7.5 Income and expenditure

8.7.5.1 Income

Of the 273 surveyed households, the average household's monthly income was approximately VND 8,777,000 and monthly income as per capita was approximately VND 2,715,000 (see Table 8.29). Of these, 13 and 26 households have been classified as near-poor and poor households by the Government, respectively because their monthly per capita income is lower than VND700,000 and they do not have access to at least three basic social services under the multi-dimensional poverty line[39]. Within the surveyed households, there were an additional 11 households where the income per capita was lower than VND700,000 but they had not recorded this and therefore had not been recognised by the State as poor or near poor households. These households were located in the An Dien, An Nhon, Binh Thanh and Thanh Hai communes.

[39] The poverty certificate will be given yearly to households with low income and accessibility to basic social services under national standards as described in Decision No. 59/2015/QĐ-TTg which was valid from January 1, 2016.

Income norms:

(a) Having a monthly per capita income of VND 700,000 or lower for rural areas and VND 900,000 or lower for urban areas; or
(b) Having a monthly per capita income of between VND 700,000 and VND 1,000,000 for rural areas and between VND 900,000 and VND 1,300,000 for urban areas, and deprived of at least 3 indicators measuring deprivation of access to basic social services.

Norms on deprivation of accessing to basic social services:

(a) Basic social services (5 services): health; education; housing; clean water and sanitation; and information;
(b) Indicators measuring the level of deprivation of access to basic social services (10 indicators): accessibility to health care services; health insurance; adult education; child school attendance; housing quality; housing area per capita; drinking water supply; hygienic toilet/latrine; use of telecommunication services; and assets for information accessibility.

Table 8.29 Monthly income per household and per capita of surveyed communes

Commune	Monthly minimum income per household ('000VND/ household)	Monthly average income per household ('000VND/ household)	Monthly maximum income per household ('000VND/ household)	Monthly average income per capita ('000VND/ capita)
Thanh Hai	1,000	16,089	54,833	3,543
An Dien	2,917	4,127	28,333	1,883.5
An Nhon	1,308	6,556	13,500	1,410.5
An Quy	1,667	11,231	31,500	2,218
An Thuan	1,000	9,729	27,373	1,981
Binh Thanh	2,308	4,930	107,500	8,143.5
273 households	**1,000**	**8,777**	**107,500**	**2,715**

Source: Socio-economic survey conducted by ERM, July and September 2019

Of the six surveyed communes, households in the Thanh Hai Commune were recognised as having the highest average household income per month (VND 16 million); while those in An Dien and Binh Thanh had a monthly average income of approximately VND 4 million and VND 5 million respectively, which are considered to be among the lowest. One household in Thanh Hai Commune whose key livelihood was a small business reported their monthly income was VND 350 million. This number is significantly higher than the income of other households within the surveyed sample. Surveyed households in the remaining communes including An Thuan, An Nhon and An Quy earned a similar income of VND 6.5 million to 11 million per month.

Table 8.30 Monthly income per household and per capita of surveyed groups

FGD	Monthly Minimum Income per household ('000VND/ household)	Monthly Average Income per household ('000VND/ household)	Monthly Maximum Income per household ('000VND/ household)	Monthly Average Income per capita ('000 VND/ capita)
Businesses	3,000	33,500	350,000	2,080
Fishing	3,000	12,750	40,000	2,335
Vulnerable	500	3,543	9,000	1,904
Wage-based	500	9,075	20,000	2,271
Fence-line	1,000	7,400	20,000	1,524
Aquaculture	1,000	6,611	15,000	1,958
Agriculture	1,500	5,667	20,000	1,286

Source: Socio-economic survey conducted by ERM, July 2019

Based on our FGD data (N=194 households), depending on the livelihood type, the monthly average income of surveyed households fluctuated from approximately VND5.7 million to VND 33.5 million (). The income of wage-based, aquaculture, agriculture and fence-line households were relatively similar and in the range of VND5.6-9 million per month. The highest monthly average incomes were identified in the discussion with business and fishing groups, which were VND33.5 and VND 12.75 million, respectively; while the vulnerable group had the lowest average monthly income (VND3.5 million) of the seven surveyed groups. In terms of monthly average income per capita, however, the lowest income was in the agriculture group and the highest income was in the fishing group.

In the data of Project affected population (N=70 surveyed households), based on occupation groups of head households in the survey in six communes, annual average income per household of the hired labor group is the lowest, approximately VND 8,344,000; the income of the husbandry group is VND 8,600,000; comparing with that of the aquaculture group at the highest VND 72,227,000. The structure of annual average income per household as follows: 42% aquaculture – 32% wage based livelihood (including worker and seasonal labor) – 13% agriculture (including cultivation, husbandry – 7% small business – 6% others.

Table 8.31 Average household annual income by income typology (Project affected households, N=70)

Income typology	Annual average income per household ('000VND/ household)	Percentage (%)
Cultivation	13,684	8
Aquaculture	72,227	42
Husbandry	8,636	5
Small business	11,897	7
Paid workers	46,729	27
Hired labor	8,344	5
Others	9,933	6
Total	**169,915**	**100**

Source: Socio-economic survey conducted by ERM, September 2019

8.7.5.2 Expenditure

From the expenditure analysis of surveyed households, it can be seen that the maximum monthly household expenditure is VND 30,000,000 per month and the minimum expenditure is VND 200,000 per month. On average, one household within the surveyed sample spent VND 6,055,000 per month or approximately VND 1,392,000 per capita per month (see Table 8.32).

Table 8.32 Monthly expenditure of surveyed households

Commune	Monthly Minimum expenses per household ('000VND/ household)	Monthly Average expenses per household ('000VND/ household)	Monthly Maximum expenses per household ('000VND/ household)	Monthly Average expenses per capita ('000VND/ capita)
Thanh Hai	1,000	9,282	300,000	2,130
An Dien	500	4,710	15,550	1,097
An Nhon	400	3,855	9,000	754
An Quy	1,950	5,782	13,700	1,170
An Thuan	1,400	4,921	10,000	981
Binh Thanh	200	4,908	16,250	840

Commune	Monthly Minimum expenses per household ('000VND/ household)	Monthly Average expenses per household ('000VND/ household)	Monthly Maximum expenses per household ('000VND/ household)	Monthly Average expenses per capita ('000VND/ capita)
273 households	200	6,055	300,000	1,392

Source: Socio-economic survey conducted by ERM, July and September 2019

Customarily, expenditure of local people included (1) 'daily expenses' for things such as electricity, water, energy, transportation and communications; (2) 'monthly expenses' for clothes, social activities and entertainment and finally (3) 'unplanned/irregular expenditure' such as health care, house construction and family events. In terms of expenditure by occupational groups, based on our FGD results (see Table 8.33), Corresponding to their income, the average expenditure of the businesses group was also the highest per month (approximately VND25 million), following by the average expenditure of the fence-line group (VND10 million). Expenditure of the remaining groups was identified as not significantly different and varied within the range of VND3.6-5.7 million per month, with the agriculture group spending the least within these groups.

Table 8.33 Monthly expenditure of surveyed households per household and per capita

FGD	Monthly Minimum expenses per household ('000VND/ household)	Monthly Average expenses per household ('000VND/ household)	Monthly Maximum expenses per household ('000VND/ household)	Monthly Average expenses per capita ('000VND/ capita)
Businesses	2,000	25,356	300,000	1,423
Fishing	2,000	5,588	10,000	1,519
Vulnerable	500	3,817	9,000	1,282
Wage-based	200	5,714	20,000	1,524
Fence-line	4,787	10,000	1,500	986
Aquaculture	500	4,433	12,000	1,323
Agriculture	1,500	3,570	7,800	826

Source: Socio-economic survey conducted by ERM, July 2019

8.7.5.3 Income-expenditure balance

Of the 264 surveyed households, the majority of households (117 or 60.31%) had a monthly income which was higher than their monthly expenditure (see Table 8.34). 81 out of 264 households (or 31%) had a monthly income approximately equal to their monthly expenditure (with the deviation of ±500, 000 VND). For the remaining households (47 or roughly 18%), their monthly expenditure was larger than their monthly income. Our FGDs found that the expenditure of vulnerable and fence-line groups was higher than their income.

Table 8.34 Annual income and expense balance of surveyed households

Income-expenditure balance	Surveyed households	
	Number	%
Monthly income is less than monthly expenditure	47	18%
Monthly income approximately equal to monthly expenditure	81	31%
Monthly income is higher than monthly expenditure	136	52%
Total (N=264, no data provided in 9 households)	**264**	**100**

Source: Socio-economic survey conducted by ERM, July and September 2019

8.7.5.4 Debts

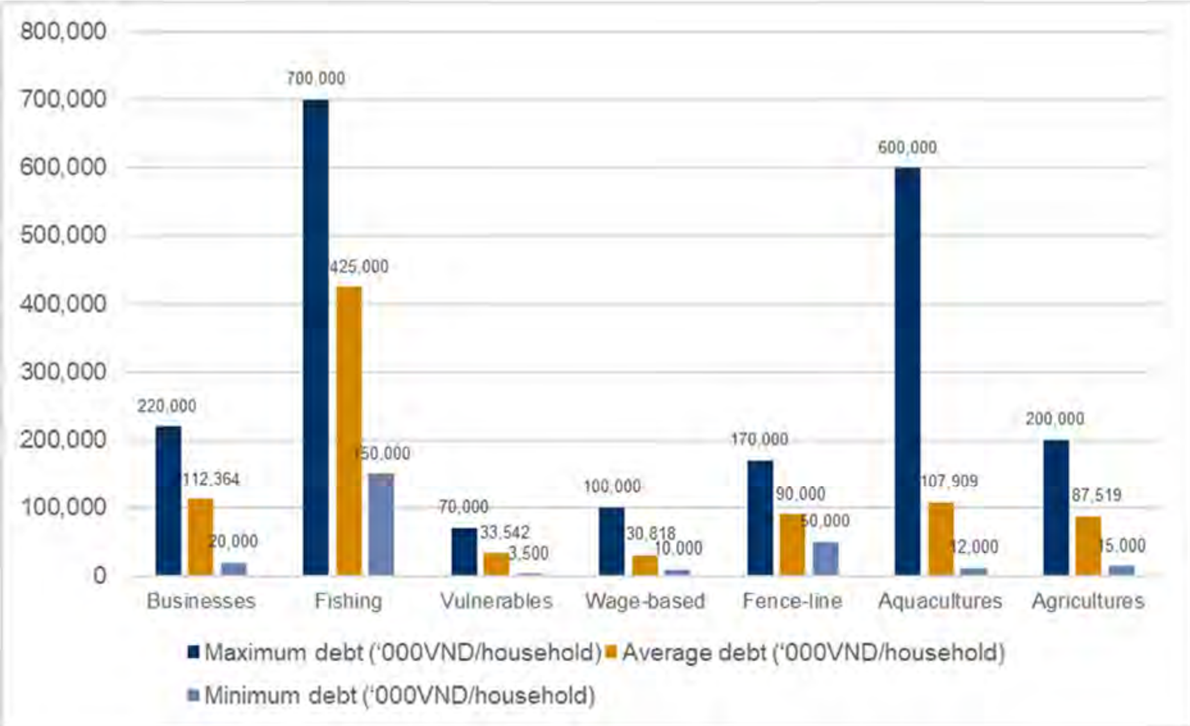
Financial support/debt of surveyed households stems from different sources, including banks, social unions, assistance programs of the government, relatives and neighbours. Of households seeking financial support/in debt, the majority (82%) got loans from banks and a small proportion of others borrowed money from other sources. The common banks named by those surveyed with respect to their loans were Agribank and Vietnam Bank for Social Policies-VBSP.

Table 8.35 Sources of financial support

Sources of financial support and debt	Of 142 surveyed households in financial support and debt	
	Number	%
Loans from banks	116	82,1
Poor People Support Union	53	3,8
Farmers Union	1	0,9
Women Union	4	2,8
Assistance Program of the District	3	1,9
Borrowing from friends, relatives	3	1,9
Borrowing from neighbours	3	1,9
Others (from loan club, children, buying on credits)	7	4,7

Source: Socio-economic survey conducted by ERM, July and September 2019

Based on ERM's FGDs, the highest debt belonging to survey participants was recorded to be in the range of VND600-700 million and this debt was reported by two households in An Dien and Thanh Hai who were engaged in aquaculture farming and fishing, respectively (see Figure 8.44). Financial resources was used for their business development including buying: fish fingerlings or shrimp post larvae and aquafeeds; or to buy fishing boat or fishing equipment. After aquaculture farming and fishing, the business and agriculture groups had debt in the range of VND15-20 million (minimum) to VND200-220 million (maximum). In general, the groups whose livelihoods require investment and maintenance costs had the highest debt, while the wage-based group[40] had the lowest debt of livelihood groups.Vulnerable households had the least debt of all seven groups of discussion, the potential reason being they did not have their own business or stable jobs and had no valuable properties for a mortgage loan.



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.44 Debt of surveyed households by group

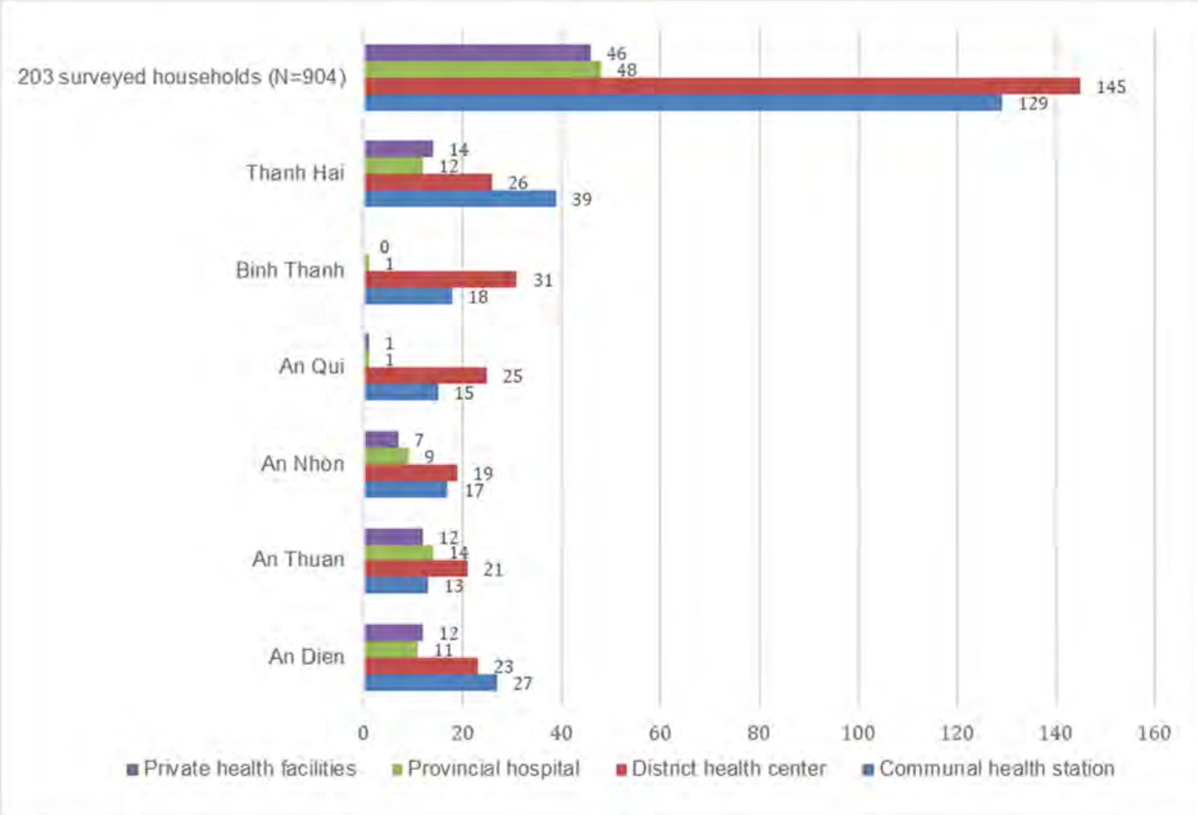
8.7.6 Health and healthcare

8.7.6.1 Healthcare facilities

Based on FGD's finding, remaining 197 households, most of them typically chose to visit the district health centre followed by the commune level health station for frequent health care services. The same trend was recognised for households in each surveyed commune (see Figure 8.45). These health centres were visited by the surveyed households for basic health care and treatment of minor illness, while the provincial hospital was chosen in cases of serious illness. Private healthcare facilities were not commonly chosen by surveyed households for their health care. All surveyed households had government health insurance, which could explain why they preferred public health care facilities to private ones.

It is noted that one household might visit more than one of the healthcare facilities listed above over a 12 month period. A total of 31 respondents mentioned that they sometimes travel to Ho Chi Minh City for healthcare reasons, and one said they went to Tien Giang Province for the same.

[40] Vulnerable and fence-line groups are not livelihood groups and thus are not discussed in this comparison.



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.45 Healthcare facilities frequented by surveyed population over last 12 months

When being asked about the place of birth of their youngest members, surveyed households responded that that person was born at a district health centre (52%), communal health station (24%), provincial hospital (18%), and at home (3%) (see Table 8.36).

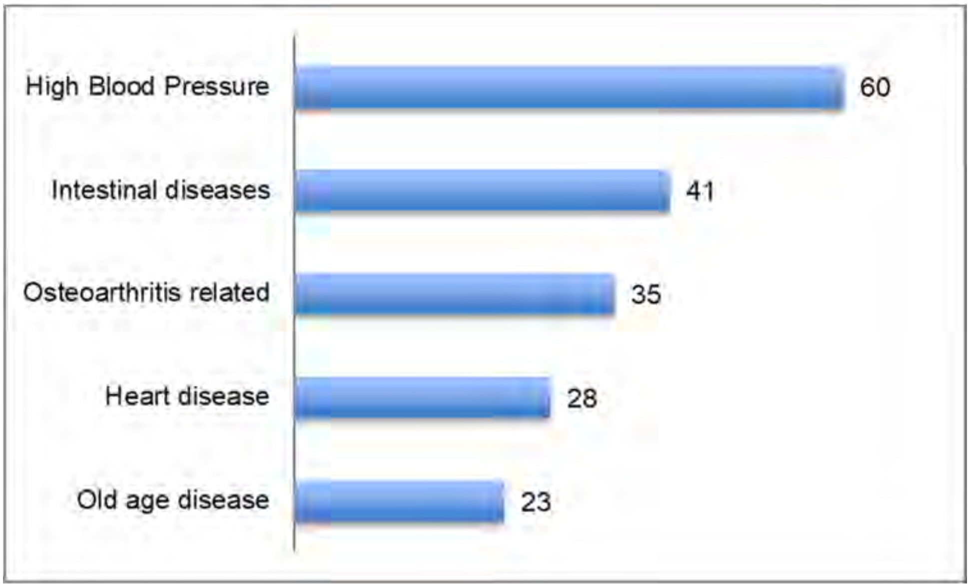
Table 8.36 Place of birth for youngest member of surveyed households

	Surveyed households	
	Number	%
Communal health station	42	24
District health centre	90	52
Provincial hospital	31	18
Central hospital	3	2
At home	6	3
Total	**102**	**100**

Source: Socio-economic survey conducted by ERM, July and September 2019

8.7.6.2 Common Diseases

Over the last 12 months, it is reported on health status of 1,240 surveyed people, common diseases included osteoarthritis related diseases (35 cases), high blood pressure (32 cases), heart disease (15 cases) and flu (15 cases) (see Figure 8.46). Other diseases or health problems also reported by those surveyed include stomach-ache, diabetes, liver failure, tumour, eye related diseases and kidney disease.



Source: Socio-economic survey conducted by ERM, July and September 2019

Figure 8.46 Common diseases in surveyed households over the past 12 months

Among the surveyed population, 91 people abused alcohol[41], accounting for 7% and 149 people were addicted to tobacco (12%) (Table 8.37). No cases of drug addiction were reported by surveyed households.

Table 8.37 Alcohol and tobacco habits in surveyed households

	Surveyed population (N=1,240)	
	Number	%
Alcohol abuse	91	7
Tobacco addiction	149	12
Drug addiction	0	0

Source: Socio-economic survey conducted by ERM, July and September 2019

8.7.7 Satisfaction to public facilities and services

The section evaluated the accessibility of surveyed households to public facilities and services including local health stations, schools, water and electricity supply, waste collection, local markets and roads. It also recorded the satisfaction levels of households with respect to public service access. In general, all surveyed households can access electricity, markets, health facilities and education facilities, with more detailed discussion below.

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[41] Alcohol abuse: For men: more than two units of alcohol (*) per day or more than 14 alcohol units per week. For women: more than one alcohol unit per day or more than seven alcohol units per week

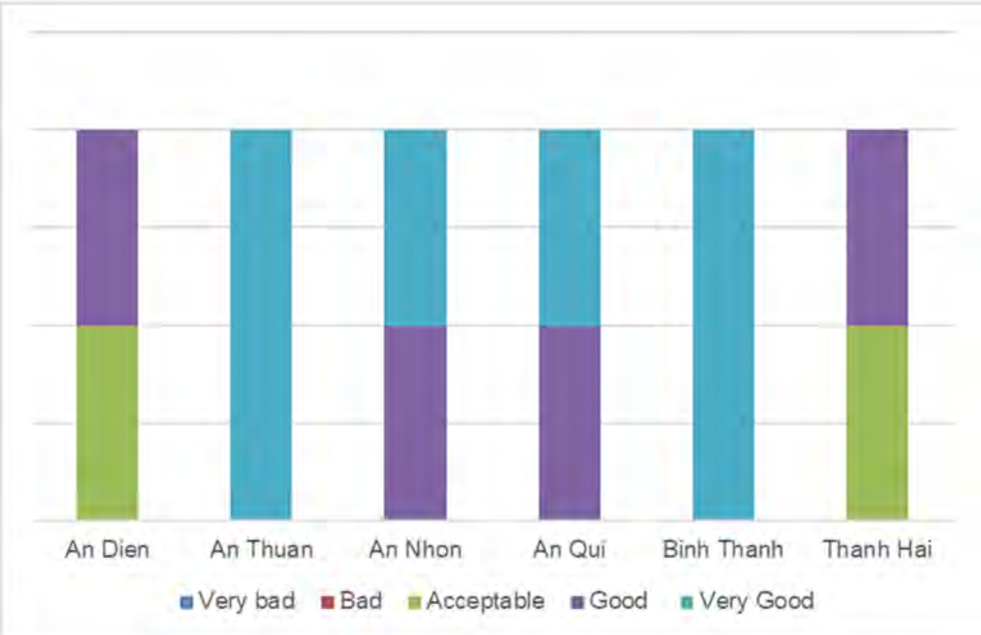
Tobacco abuse: those who use tobacco at least once a day, as defined by WHO

(*) As defined by the World Health Organisation, alcohol unit contains more than 10 grams of alcohol (12.5ml of pure alcohol). Percent of pure alcohol, calculated by the ratio of alcohol on volume (alc/vol) varies with each type of wine. In Vietnam, a unit of alcohol corresponds to 1 bottle of 330ml beer, 120ml of 12% ABC alcohol, or 30ml of 40% ABV alcohol. The Ministry of Health of Vietnam recommends that men should use no more than two units of alcohol per day and women should use no more than one unit of alcohol per day.

8.7.7.1 Communal health stations

As discussed earlier, local households tended to visit the district health centre rather than the communal health station. This may be because the communal health station only provides primary health care while local people typically seek treatment for illnesses such as heart disease and high blood pressure. For more serious diseases, local people went to the district or provincial hospitals as services provided there were faster and more convenient.

Overall, surveyed respondents in our FGDs satisfied with the quality of their communal health station. Their satisfaction was recorded from "acceptable" level to "very good" for the health station in each surveyed commune (Figure 8.47). However, there were some surveyed households that reported an inadequacy in terms of the medicine, equipment and doctor.



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.47 Local satisfaction on communal health stations by commune

Our household survey in September 2019 revelled that staff behaviour and working hours were highly evaluated (as Good by 57% and 51% respectively) (Table 8.38). 26% and 16% of respondents ranked the availability of medicine and equipment respectively to be "Not good".

Table 8.38 Local evaluation on communal health station qualities (percentage)

Evaluation criteria	Not good	Neutrel	Good	Don't know
General quality	11.4	25.7	41.4	21.4
Equipments	16	26	36	23
Working hours	4	23	51	21
Staff behavior	1	21	57	20
Medicine availability	26	9	44	21

Source: Socio-economic survey conducted by ERM, September 2019

8.7.7.2 District-level health facilities

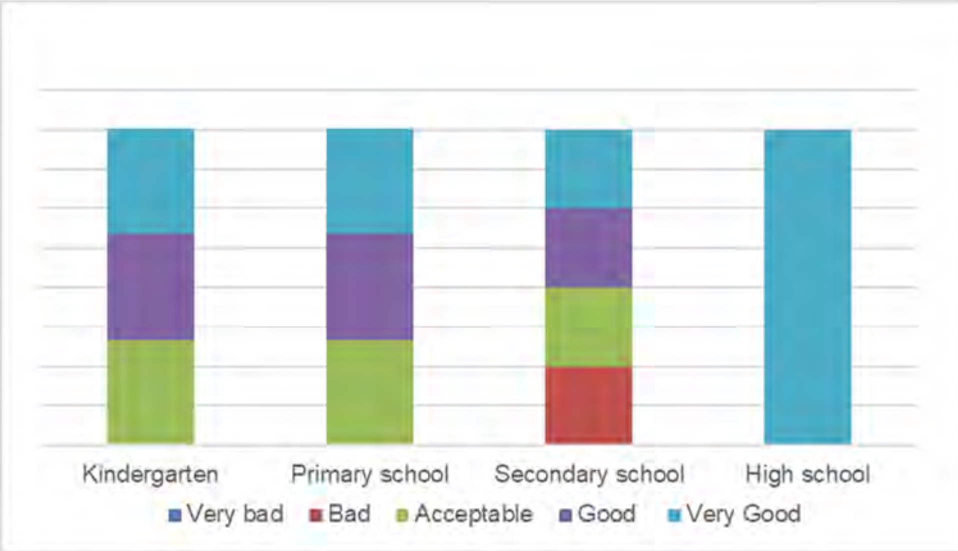
FGDs participants rated their satisfaction toward the health facilities at district level, including the district health centre and district hospital. These two facilities were viewed by the respondents as "acceptable" to "very good" with feedback on high quality equipment, available medicine and doctors (Figure 8.48). Some people provided constructive feedback, including that the attitude of health staff in the district health centre needed to be improved.

Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.48 Satisfaction of surveyed households on district level health facilities

8.7.7.3 Schools

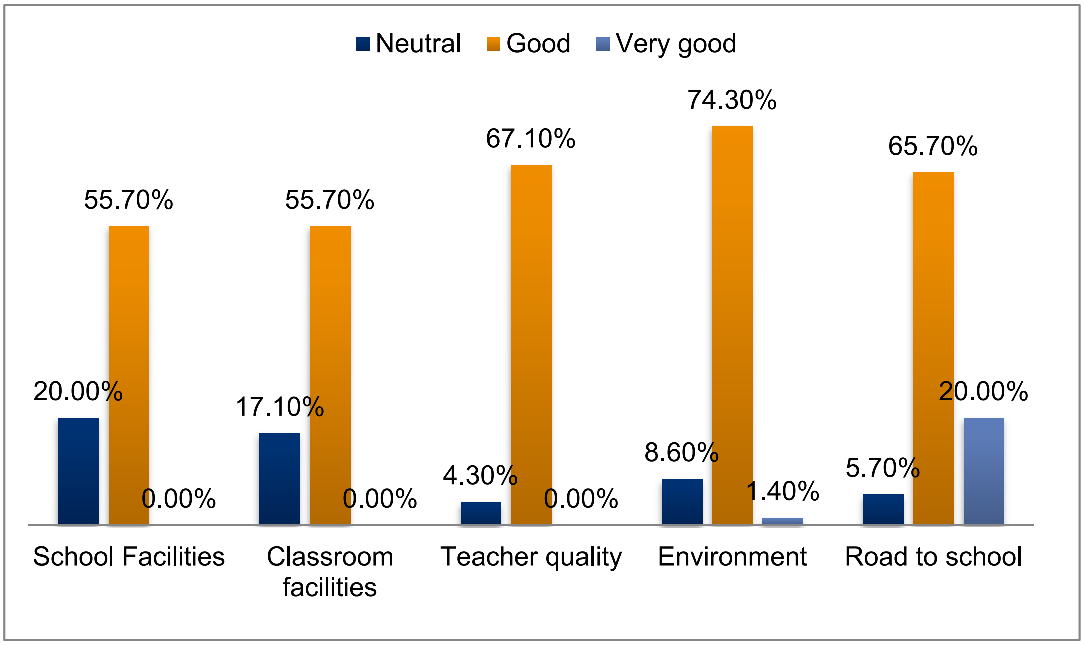
There was no significant problem with regard to education facilities in the surveyed areas, and education quality at the communes was upgraded over the past few years. Overall, FGD respondents were satisfied with the facilities and teacher quality of local schools (see Figure 8.49). However, there was some dissatisfaction with teaching facilities and the inadequacy of tables and chairs in the classrooms of primary and secondary schools; this feedback was mostly from the people of An Dien, and some in An Nhon, An Thuan, An Quy and Binh Thanh. The people surveyed were very satisfied with the quality of the local high school and rated the local high school as well as they possibly could with "very good". The same level of satisfaction was also reported by most of the respondents with respect to kindergartens in each commune, with good feedback including that they meet the national standard, there are good teachers and adequate facilities. Other views about the long distance from their houses to the schools were recorded.



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.49 Satisfaction of FGD surveyed households on local schools

Affected households reported that, most people were satisfied with schools located in the communes in terms of environment surrounding the school, teacher quality, roads to school, which were ranked "Good" by 74.3%, 67.1% and 65.7% of respondents respectively. As the same results of FGDs in six communes, the local satisfaction percentages on facilities of the school and classroom are not high, accounting for 55.7%.

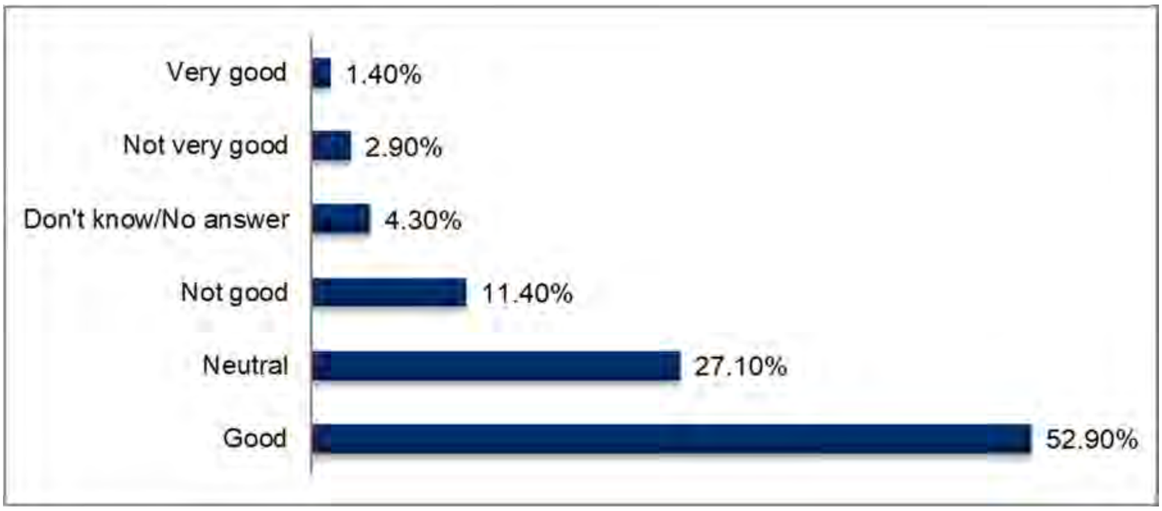


Source: Socio-economic survey conducted by ERM, September 2019

Figure 8.50 Local satisfaction on local school's qualities

8.7.7.4 Local markets

In responding to "How satisfied are you with the local market?", 52.9% of respondents ranked it good, 27.1% neutral, and 11.4% not good (see Figure 8.51). Although most of the surveyed households were satisfied with the local markets a few comments were made claiming that the local markets were spontaneous markets or in other words as free markets established by the individual vendors in an area which is not planned by the government as an official place for the market. The respondents ranked the local market as "acceptable" to "very good" in terms of quality and the variety of foods.

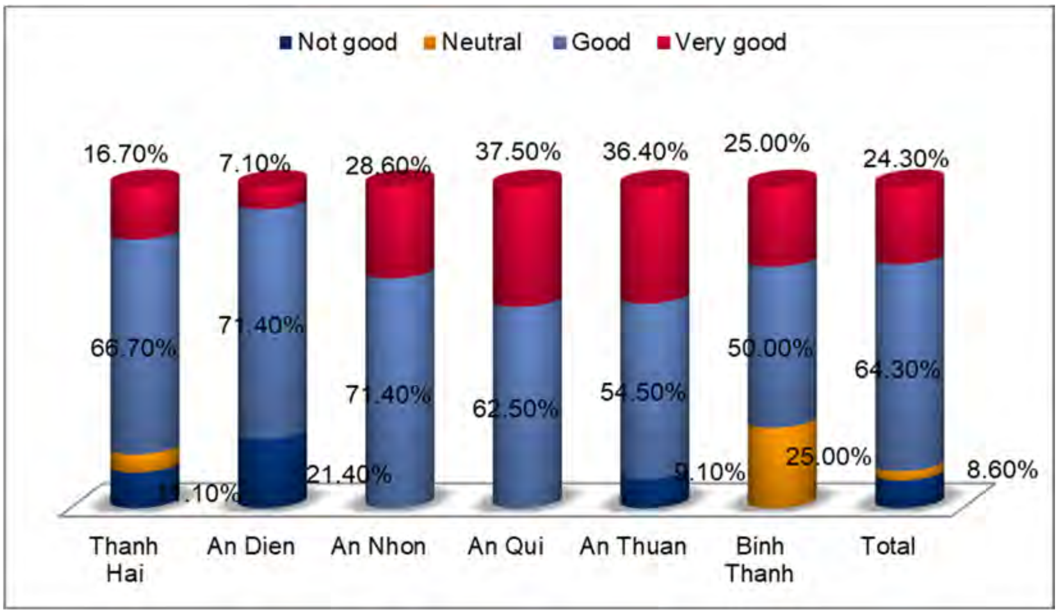


Source: Socio-economic survey conducted by ERM, September 2019

Figure 8.51 Local satisfaction on markets

8.7.7.5 Local roads

The roads connecting villages in these communes were observed to be paved in concrete or alpha coated. The majority of respondents in surveyed communes were satisfied with local roads, mostly they are good and very good. In An Dien, 71.4% of respondents categorised local roads to be in good and very good conditions while the others (21.4%) were not satisfied and evaluated not good (Figure 8.52). They explained that some roads in the commune were degraded with many potholes, and some were still unpaved. In Binh Thanh, 50.0% respondents evaluated their road system to be good. An Nhon residents were highly satisfied with their roads with a good evaluation by 71.4% and very good by 28.6%.



Source: Socio-economic survey conducted by ERM, September 2019

Figure 8.52 Local satisfaction on their road system

8.7.7.6 Waste management

When asked to evaluate the service on local solid waste collection, most people gave the answer "Don't know", accounts for 72.9%. This is because that there is no this service in this area. As a result, some households treat waste themselves in their places by burying or burning.

According to the survey results, solid waste collection was a concern in most communes including An Dien, An Nhon, An Quy and Thanh Hai. It was reported that a waste management system is available in the surveyed communes; however, due to distance waste collection can not be provided to every single household and some households are required to bring their waste to the collection point which can be far from their houses. As a result, some households treat waste themselves in their places by burying or burning. People participating in the survey from the Binh Thanh and An Thuan communes expressed their satisfaction with the waste management system in their area.

8.7.7.7 Electricity

Most households have been connecting to the national electronic grid network. More 80% reported that the service is very good. All the surveyed households were connected to the National Electricity Grid. The participants in the FGD expressed their un-satisfaction in terms of the quality of electricity supply due to unexplained power losses, intermittent problems and high prices.

8.7.7.8 Water supply

Access to clean water was a major issue for the surveyed households. Only 16% of surveyed households had access to piped water while the majority used groundwater from wells or boreholes for domestic and drinking purposes. Rainwater was also reportedly stored during the rainy season for reuse, and 84% of surveyed households used rainwater in addition to ground water and water from the pipeline system. 32 households used bottled water for drinking and cooking purposes and used other water sources for other domestic activities such as cleaning and washing. The households who had access to a water supply pipeline system were satisfied with the quality of the water and service.

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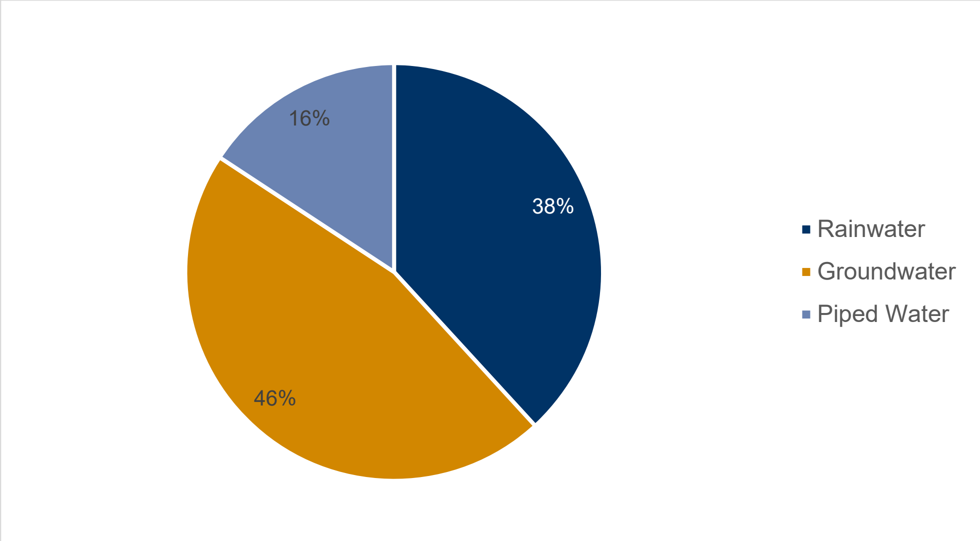
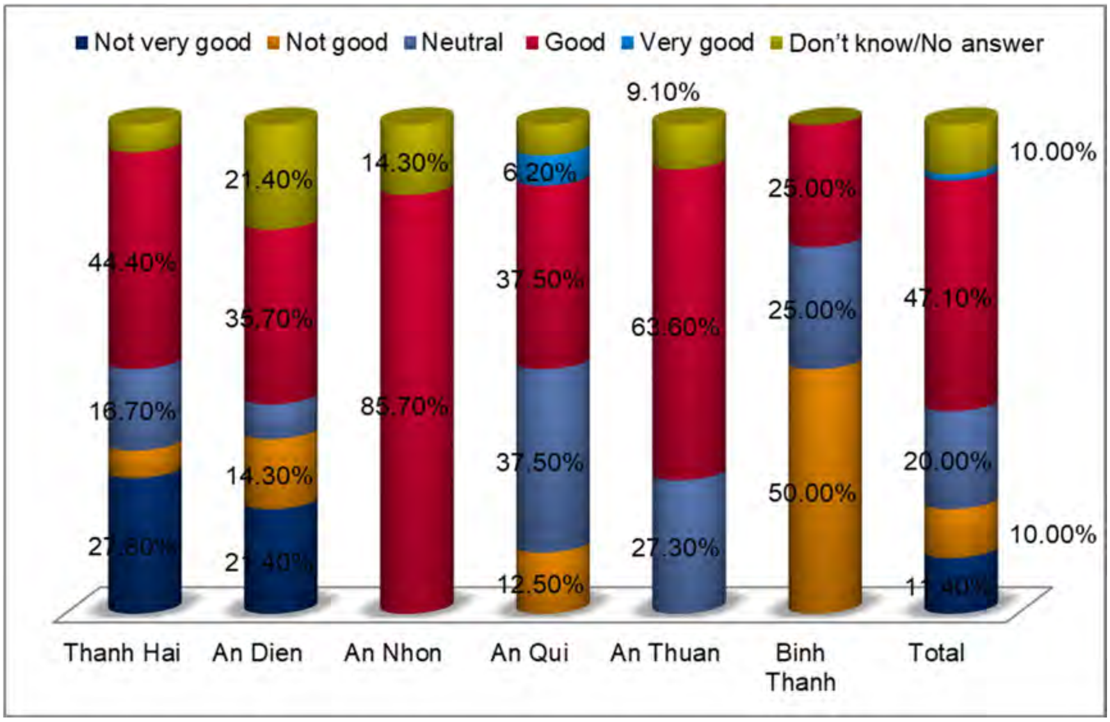


Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.53 Water source use by surveyed households

In general, the service of water supply is good and very good, as ranked by 47.1% and 20.0% of surveyed households in September 2019 (see Figure 8.54). However, the rate of not good and not very good is 21.0%. Thanh Hai and An Dien had the highest percentages of dissatisfied users of water supply, who ranked the service not very good (27.8% and 21.4% respectively). Half of Binh Thanh respondents found their water supply a not good service.



Source: Socio-economic survey conducted by ERM, September 2019

Figure 8.54 Local satisfaction on water supply

8.7.7.12 Internet services

During our FGDs, only 13 households responding to the survey provided their response about the internet service quality. They evaluated the internet service as “acceptable” to “very good quality”, although they commented that the internet connection was slow. The respondents also noted that the internet was not popular in their area since they used 3G, or the line was not available in some areas or there was a slow internet connection.

8.7.8 Land, housing and household assets

8.7.8.1 Land

Our FGDs indicated that 177 out of 203 surveyed households are using residential land and had their houses built on that land (see Table 8.39). On average, one household has one house. The remaining 26 surveyed households in An Quy (3), Binh Thanh (8) and Thanh Hai (13) did not have a residential land plot and their houses were built on agricultural land, they were living with their relatives, or their houses were constructed on the land of their relatives. The residential land of the surveyed households varied between 18m^2 and 300m^2 each, depending on each household.

156 households had other types of land plots, mostly agricultural land for cultivation and aquaculture. These households mostly planted rice (two crops per year) and various types of vegetables and fruits, as well as grass for feeding their animals (cows and goats). The minimum area used by one household in the survey was 150m^2; while other households had 30,000m^2 in area, the maximum land reported. One household can use up to 8,457m^2 of agriculture land for their production/business activities.

The number of households that had both types of land was 139, while there were nine households of Binh Thanh (4), An Quy (1) and Thanh Hai (4), mostly from the vulnerable group,that had no land of either type. However, these nine households reported they had either built a house on relative’s land or public land or rented.

Table 8.39 Land use by surveyed households

	Number of households using different types of land		Minimum area	Average area	Maximum area
	Number	m^2	%	m^2	m^2
Residential land	177	18	53.15	30,000	674
Others	156	150	46.85	40,000	8,457

Source: Socio-economic survey conducted by ERM, July 2019

For Project affected households, almost every surveyed household had their own residence land, except for one case without residence land (Table 8.40). 52 households had their land use right cetificate (LURC) or eligible to have LURC. 18 households did not have legal right of land use and one household was using the land as a temporarily borrowed lot. The average residential land area per household was is 532.81 m^2 for households with a LURC or eligible to have LURC /household and 124m^2 for households with no legal land use right.

Table 8.40 Residence land of surveyed households

	N =70	Minimum area (m^2)	Average area (m^2)	Maximum area (m^2)
LURC or eligible to have LURC	52	50	532.81	5,000
No land use right	18	24	124.00	2,000

	N =70	Minimum area (m^2)	Average area (m^2)	Maximum area (m^2)
Borrowed or temporary land without fee	1	300	4.35	300
Public land	0	0	0	0
No residence land	1	0	0	0

Source: Socio-economic survey conducted by ERM, September 2019

43 out of 70 surveyed households did not have agriculture land for cultivation. 27 households had agriculture land with LURC, with the average area of 11.260 m^2 per household. One household had a parcel of agricultural land of around 6.000m^2 with no legal land use right.

Table 8.41 Agriculture land of surveyed households

	N =70	Minimum area (m^2)	Average area (m^2)	Maximum area (m^2)
LURC or eligible to have LURC	27	563	11,260.19	50,000
No legal right	1		222.22	6,000
No	43	0	0	0

Source: Socio-economic survey conducted by ERM, September 2019

As mentioned above on the livelihood analysis, the main economic activity in this area is aquaculture farming. Among 70 surveyed households, 48 households had land for aquaculture with LURC, with the average area of 15,834 m^2 per household (see Table 8.42). 6 households had land for aquaculture farming without legal land use right, with the average area of 1,927 m^2 per household.

Table 8.42 Aquaculture land of surveyed households

	N =70	Minimum area (m^2)	Average area (m^2)	Maximum area (m^2)
LURC or eligible to have LURC	48	1,000	15,834.13	77,000
No legal right	6	2,500	1,927.08	29,000
No	22			

Source: Socio-economic survey conducted by ERM, September 2019

8.7.8.2 Housing

All 273 household representatives reported that they were living in their ownership houses, 206 owned their current house privately; 15 households were using houses owned by their parents or parents in law; 04 households were renting their houses; 03 households built their houses on land owned by their relatives and were unclear about their legal ownership of the houses; and 02 cases built temporary houses on public land (coastal land).

It should be noted that some households in Thanh Hai, An Dien and An Quy had more than one house. These houses were located in the same commune or different communes. Also, some houses were used for temporary settle serving for farming aquaculture.

The typical house design in the surveyed area was a permanent house42 (Figure 8.55). Other housing styles include semi-permanent houses and not permanent houses, with details on these listed in Table 8.43.

Table 8.43 Different types of houses owned or occupied by survey respondents

	Number	%
No permanent house	15	7.28
Semi-permanent house	93	45.15
Permanent house with one story	94	45.63
Permanent house with multiple stories	4	1.94
Total	**206**	**100.0**

Source: Socio-economic survey conducted by ERM, July 2019

Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.55 Typical permanent house (left) and typical semi-permanent house (right) in surveyed communes

8.7.8.3 Household assets and utilities

Based on FGD findings, the majority of the surveyed households (more than 70%, see Table 8.44) owned basic assets such as mobile phone, motorbike, colour TV and fridge. In addition, 15-30%

[42] According to the definition of the Ministry of Construction on permanent and semi-permanent houses, there are three criteria to categorise permanent house and semi-permanent house. In particular, permanent house is a house meets all three criteria, and semi-permanent house is a house meets two criteria. The criteria include: (1) Pillar made of materials: concrete, brick/stone, iron/steel/ durable wood; (2) Roof made of materials: concrete, tile (cement, terracotta); (3) Wall made of materials: concrete, brick / stone, wood/metal.

households had other assets which are considered more expensive or assets which are typically bought when a household has more money or higher consumption demands, including an air conditioning, washing machine and computer. There were 14 households that owned bicycles, and four households that owned a car (one, a household in Thanh Hai engaged in small business, had two cars). A total of 19 households owned fishing vessels since all of them were fisherfolk, aquaculture farmers or their family members were engaged in one of these livelihoods.

Among the households with the aforementioned assets, some households had more than one of them. In contrast, one household in the survey had no assets and this was identified as a vulnerable household in An Nhon, and so was involved in the FGD for the vulnerable group.

Table 8.44 Household assets owned by surveyed households

	Number of assets	Number of households owning the asset	%
Mobile phone	533	188	92.61
Motorbike	374	185	91.13
Colour TV	252	189	93.10
Fridge	176	155	76.35
Air conditioner	94	36	17.73
Washing machine	66	62	30.54
Computer	43	32	15.76
Fishing vessel	20	19	9.36
Bicycle	14	13	6.40
Car	5	4	1.97
Others	2	2	0.99

Source: Socio-economic survey conducted by ERM, July 2019

8.7.8.4 Source of domestic electricity

A total of 273 households surveyed via FGDs reported that they had access to the national grid for domestic electricity consumption. Only one household also used the national electricity supply system, but indirectly by connecting via the supplying line of their relative's house. Concurrently, there were seven households using additional electricity sources as back-up for potential blackouts (generators in four households) or for additional demand (rooftop solar panel in three households).

8.7.8.5 Source of domestic water

The FGD-based survey data shows that only 26.60% of households had access to a pipeline water system to use piped water and the majority of households used groundwater and rainwater for domestic activities (see Table 8.45). 31 cases bought bottled water for their drinking water source in addition to using other water sources for other domestic purposes. Some households had a mixture of water sources to meet their family's water needs and to protect their health.

Table 8.45 Sources of domestic water in surveyed households

	Surveyed households	
	Number	%
Groundwater well	158	77.83

Piped water supply	54	26.60
Rainwater	125	61.58

Source: Socio-economic survey conducted by ERM, July 2019

The survey result of 70 affected households showed that the majority 8(4.3%) used bottled water for their drinking purpose (see Table 8.46). 27 households (38.6%) used groundwater wells while 9 households (12.9%) used tap water. It is noted that there households were not accessible to the water supply system in this area, except for 7 households in Thanh Hai, 1 household in An Quy and 1 household in An Thuan.

Table 8.46 Sources of drinking water of Project affected households

	Affected households					
	Power pole		Safety corridor		Total	
	N	%	N	%	N	%
Tap water	6	19.4	3	7.7	9	12.9
Groundwater wells	10	32.3	17	43.6	27	38.6
Bottle water	26	83.9	33	84.6	59	84.3
Total	**31**	**100.0**	**39**	**100.0**	**70**	**100.0**

Source: Socio-economic survey conducted by ERM, September 2019

8.7.8.6 Cooking energy

Households participating our FGDs claimed that gas (86.21%) and electricity (65.52%) were the most popular cooking fuels among surveyed households (see Table 8.47), but 108 households (53.20%) also used firewood for cooking. Only two households used biogas as their energy source for cooking. It is recognised that only 42 households used single sources of energy for cooking while the remaining 162 used multiple sources of energy for their cooking.

Table 8.47 Energy sources used for cooking by FGD surveyed households

	Surveyed households (N=260)	
	Number	%
Biogas	2	0.99
Firewood	108	53.20
Electricity	133	65.52
Gas	175	86.21

Source: Socio-economic survey conducted by ERM, July 2019

For Project affected households, natural gas (61 households, 87.1%) was the most popular cooking energy. 42 households (60%) also used firewood or cooking and 27 households (38.6%) used electricity as a cooking energy. There is no difference between two types of affected households.

Table 8.48 Energy sources used for cooking by Project affected households

	Affected households					
	Power pole		Safety corridor		Total	
	N	%	N	%	N	%
Electricity	12	38.7	15	38.5	27	38.6
Firewood	18	58.1	24	61.5	42	60.0
Natural Gas	28	90.3	33	84.6	61	87.1
Total	**31**	**100.0**	**39**	**100.0**	**70**	**100.0**

Source: Socio-economic survey conducted by ERM, September 2019

8.7.8.7 Toilets

The survey data indicated that all surveyed households, except for 4 households, had a toilet. Within FGD dataset, out of 203 surveyd households, 182 households (89.66%) used a flush toilet with a septic tank, 18 households had “fish pond toilets”[43] (see Figure 8.56) and three households (1.48%) used a latrine. There were five households that had both flush and fish pond toilets.

Figure 8.56 A typical fish pond toilet in Ben Tre

8.7.9 Vulnerability description

Vulnerable households include ones that comply with least one of the following criteria:

[43] This type of toilet is known as using a fish pond as toilet and is called “Cầu cá” in Vietnamese. This type of toilet is very popular in Mekong Delta area.

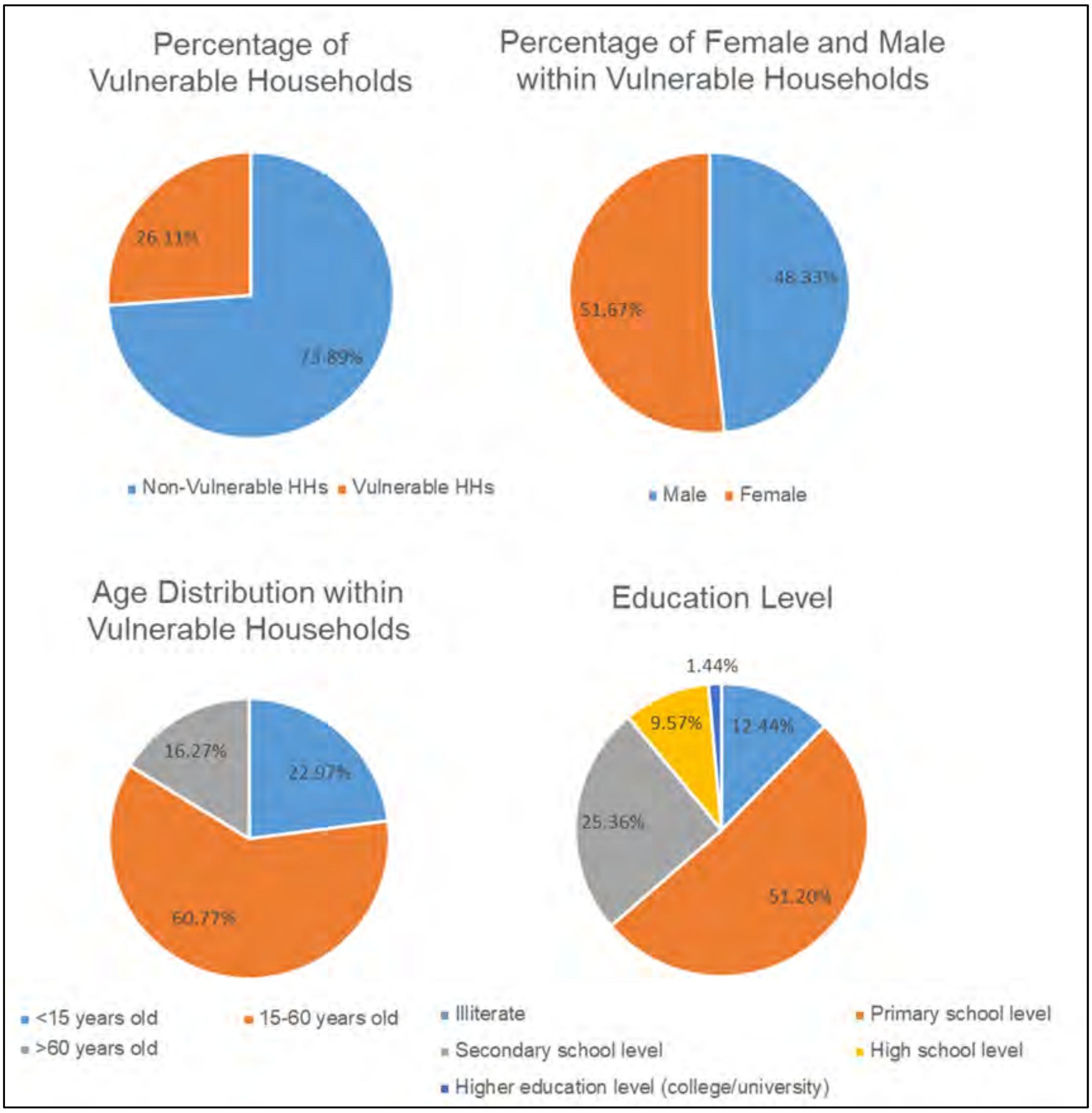
- Orphans/abandoned children aged 16-18 and attending school;
- Abandoned children under 16 years old;
- Elderly people above the age of 60 living alone;
- Elderly people over 80 years old without social welfare or insurance;
- Households with members with mental or physical disabilities or injured war veterans;
- People infected with HIV/AIDs and unable to work;
- Households with adopted orphans/abandoned children;
- Households with more than two mentally or physically disabled people;
- Single parents in the poor household category raising children under 16 years or children aged 16-18 and attending school;
- Women led/headed households; and
- Poor/near poor households (as certified by the Government).

In our FGD survey, 53 out of 203 households were classified as vulnerable (see Table 8.49). These households were identified as vulnerable since they were either recognised by the government as poor (26) or near poor (13) households or met at least one of the above criteria and were invited to attend the vulnerable FGDs of the Project. The number of vulnerable households is relatively equal in An Dien, An Nhon, Binh Thanh and Thanh Hai Communes – there is a small number in An Quy and none in An Thuan. These 53 households comprised of 209 people; of which 51.67% were female. A summary of the vulnerable household profile is illustrated in Figure 8.57.

Table 8.49 Number of vulnerable households

	Per surveyed household		Percentage per commune	
	Number	%	Commune	%
Yes	53	26.11	An Dien	22.64
			An Nhon	18.87
			An Quy	5.66
			Binh Thanh	22.64
			Thanh Hai	30.19
No	150	73.89	-	-
Total	**203**	**100.0**	**-**	**-**

Source: Socio-economic survey conducted by ERM, July 2019



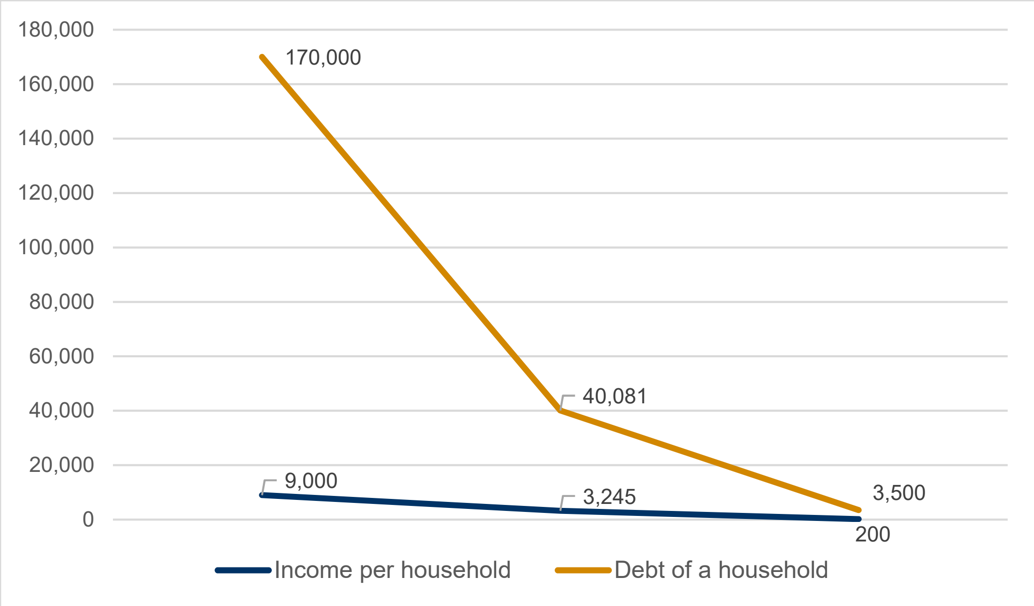
Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.57 Profiles of surveyed vulnerable households

As indicated in the profiles above, there was a relative equal number of female and male members within the vulnerable households. Additionally, the majority of the people living within vulnerable households were of working age; however, not all of them had jobs at the time of the survey. Due to a lack of information on their working capability it was not possible to discuss further the reasons why approximately 15% of working age people within these families were not involved in any employment.

Looking at the education data, it is recognized that most people within these vulnerable households had low education levels; they were illiterate, or only completed the primary or secondary level. This data shows a direct correlation between education and employment, as the most popular work for these vulnerable and lesser educated people is to be a farmer and seasonal worker.

On average, one household within this group earned approximately VND3 million per month. Compared to the regional minimum wage of Thanh Phu District (region IV-VND2,920,000) for reference, this monthly income just meets the regional standard. However, within the survey data for this group it was reported that there were 20 households whose monthly income was lower than this standard, with the lowest income per month being VND 200,000 (see Figure 8.58).



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.58 Monthly income and debt of surveyed vulnerable households

Due to receiving low income, these households reported they had previously sought finance from other sources such as banks or their relatives. Their debt varied between VND3.5 million and up to VND170 million; on average, they had borrowed VND40 million per household. Although their loans were from social banks where a low interest rate is typically applied, or given as interest free loans from their family, with consistently low monthly incomes these households may require a long time to pay off such debt.

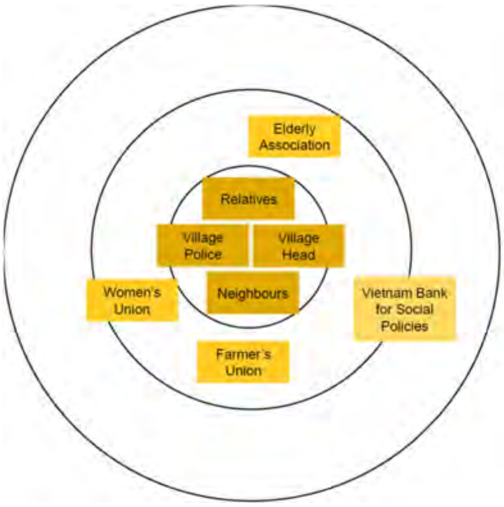
In the sample of 70 affected surveyed households, 17 households belonged to vulnerable groups, including 10 poor/near poor households as certificated by the Government), 04 households having physical disability or mental disability, 1 households with elder aged 60 above and living alone, and 2 women headed households (see Table 8.50).

Table 8.50 Vulnerable households in the Project affected population

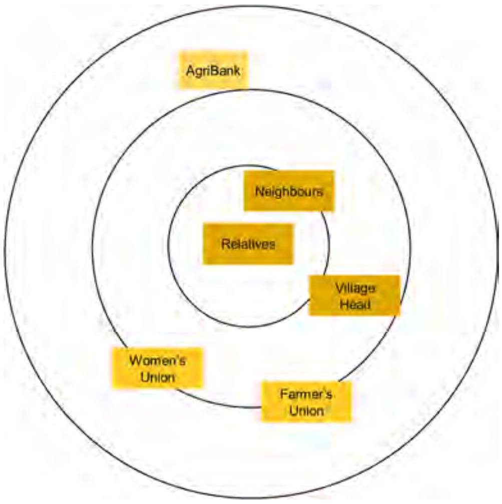
	Affected households					
	Power pole		Safety corridor		Total	
	N	%	N	%	N	%
Poor/near poor (as certificated by the Government)	5	16.1	5	12.8	10	14.3
households having physical disability or mental disability	1	3.2	3	7.7	4	5.7
Elder people who is above age 60 living alone	1	3.2	0	0.0	1	1.4
Single mom, women led/headed households	1	3.2	1	2.6	2	2.9
No	25	80.6	32	82.1	57	81.4
Total	**31**	**100.0**	**39**	**100.0**	**70**	**100.0**

Source: Socio-economic survey conducted by ERM, 2019

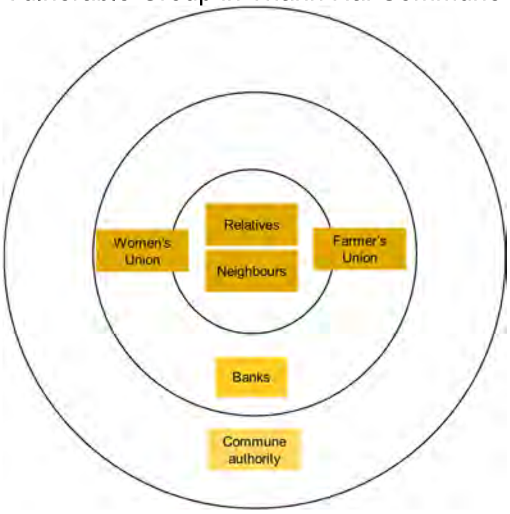
During the FGDs held with the vulnerable groups, respondents were asked to rank their financial support sources in terms of who/which organisations they would consider approaching if they needed financial support, and their answers are presented in Figure 8.59.



Vulnerable Group in Thanh Hai Commune



Vulnerable Group in An Dien Commune



Vulnerable Group in An Nhon Commune

Vulnerable Group in Binh Thanh Commune (Women)

Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.59 Circles of support defined by vulnerable groups

The most important groups to surveyed vulnerable people were their relatives, including their children, spouse and siblings, and their neighbours (Figure 8.53). Village leaders and mass organisations/village institutions, including the Women Union, Farmers Union and Elderly Association, were ranked as less important. Banks including Vietnam Bank for Social Policies and Agribank were ranked in the third level of support.

Within the discussion about support rankings with a vulnerable women' group of Binh Thanh Commune, women defined themselves as a key agent for their development beside the support from their husband, children and the government. For their second choice they thought about support from mass organisations such as the Farmers Union and Women Union, and leaders of villages such as village head and village police.

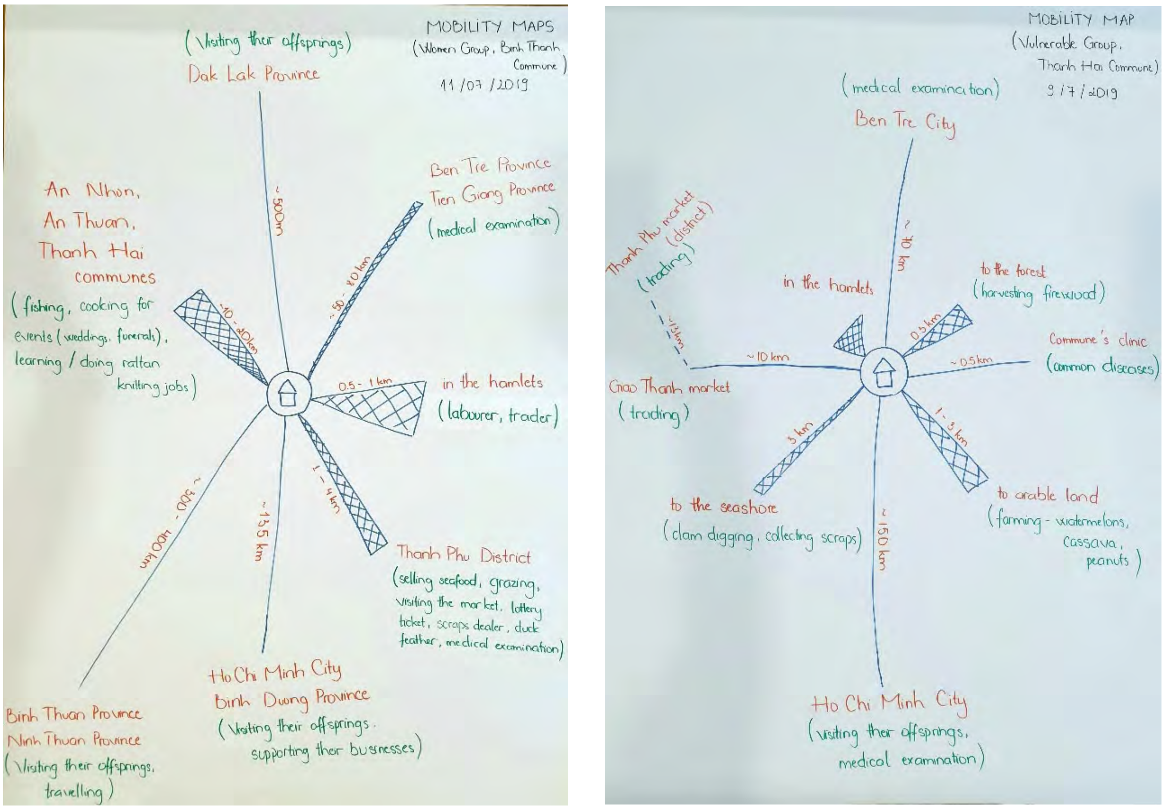
As reported during the FGD, these households have previously received support from:

- The government, via their policies for poor households (low interest loans from Women Union and Farmers Union, support for electricity bills), gifts on special occasions such as Tet; and
- Charity programs operated by corporates.

Within the discussion with vulnerable groups in the Binh Thanh and Thanh Hai communes, the participants were asked to draw a map of all the places within and outside the community that they visit.

These places included farming fields, fishing area, medical centres, their relative's houses, and so forth, which reflected their social activities and their interaction with the community (see Figure 8.60). The maps collected from the two FGDs showed that the furthest places that these groups had travelled to was Dak Lak (500km), Binh Thuan, Ninh Thuan (300-400km) for the group in Binh Thanh, and Ho Chi Minh city (135-150 km) for the group in Thanh Hai - to visit their relatives, do their health check, do health care activities or visit for their business - but infrequently. Also it was shared that for the purposes of getting a health check these people reportedly went to Ben Tre city or Tien Giang province, which is 70-80km from their area.

These vulnerable people reported that they also frequently went around among the neighbouring communes (An Nhon, An Thuan, Thanh Hai-approximately 10-20km) within the Thanh Phu District to conduct livelihood activities such as fishing, selling seafood, conduct other trading, cook for weddings or other events, and also for health care purposes. The popular places frequently visited by these people were less than 3km from their villages and communes. These included commune clinics for health care, fishing and farming areas for their livelihood activities or forests for collecting firewood. It was identified that surveyed vulnerable people in the Binh Thanh Commune visited more locations and travelled to further places than those in the Thanh Hai Commune.



Source: Socio-economic survey conducted by ERM, July 2019

Figure 8.60 Mobility maps of surveyed vulnerable groups in Binh Thanh (left) and Thanh Hai (right) communes

Table 8.51 presents how satisfied the vulnerable group participants feel about specific aspects of their life, on a scale from 0 to 10 (zero means "not at all satisfied" and 10 means "completely satisfied"). While the respondents were highly satisfied with their personal relationships, security, community integrity and local environment (only for the An Nhon vulnerable group), the aspects of well-being they were most concerned about related to their personal achievements, health issues, employment and standards of living.

As such, these aspects for vulnerable groups should be the focus areas of the Project in any community investment programs in future, including programs for local recruitment and healthcare promotion.

Furthermore, given this group is more sensitive and disadvantaged compared to other people within the community, they should be the priority group for receiving the Project's assistance in terms of community investment programs, if any.

Table 8.51 Sense of personal well-being, as ranked by vulnerable groups

No.	Aspect of well-being	An Dien	An Nhon	Thanh Hai
1	How satisfied are you with your standard of living?	6	3	NA
2	How satisfied are your with your health?	6	3	3.5
3	How satisfied are you with what you are achieving in life?	3	1	5.5
4	How satisfied are you with your personal relationships?	8	8	8.8
5	How satisfied are you with how safe you feel?	9	8	8
6	How satisfied are you with your available time to do your favourite activities?	2	NA	10
7	How satisfied are you with the quality of your local environment?	3	8	10
8	How satisfied are you with feeling part of your community?	7	9	8
9	How satisfied are you with your current job, if still working	NA	NA	5

Source: Socio-economic survey conducted by ERM, July 2019

Note: NA: Not applicable or no answer

8.7.10 Local perceptions about the Project

The section presents the awareness of representatives of 70 affected surveyed households on information of the Project, type of information which they want to know further and how they are satisfied on the compensation policy. Almost every respondent (97.0%) has already known about the Project for the last 1 year (86.0%) or for the last 1-3 years (11.0%). Only 5.1% of respondents said that this was the first time they heard about the Project. The power pole affected households got to know about the project earlier than the corridor affected households (see Table 8.52).

Table 8.52 Local knowledge about the Project

	Affected households				Total	
	Power pole		Safety corridor			
	N	%	N	%	N	%
The first time	0	0.0	2	5.1	2	5.1
Under 1 year	25	80.6	35	89.7	60	86.0
For 1 – 3 years	6	19.4	2	5.1	8	11.4
Total	**31**	**100.0**	**39**	**100.0**	**70**	**100.0**

Source: Socio-economic survey conducted by ERM, September 2019

Respondents have indicated that local authorities and mass organisations (78.3%) and neighbourhood (44.9%) are two major channels to get information of the project. Moreover, investors of the project directly provided some households (23.2%) with Project infomation. There is a significant difference related to access to Project information by two types of affected households. Most power pole affected households got information from the local authorities/unions (93.5%), compared with 52.6% of the corridor affected households. More than 50.0% corridor affected households received Project information from the neighbourhood, compared with 35.5% of the power pole affected households.

In 70 affected surveyed households, 32 households (45.7%) did not belong to the group of land acquisition. In 38 land acquisition households, 30 households did not yet receive the notice of land acquisition (see Table 8.53). Most households received the notice of land acquisition from the beginning of 2019 until now.

When asked about local engagement with the Project, 33 households mentioned that they attended land acquisition related meetings. 25 out of 33 households found satisfied with the information provision. The other 8 households wishes to get more information on Project impacts and mitigation/management measures.

Table 8.53 Local knowledge about the land acquisition process

Commune	Not yet recevicing notice of land acquisition	Already recevicing notice of land acquisition	No relating to land acquisition	Total
Thanh Hai	2	8	8	18
An Dien	1	6	7	14
An Nhon	3	1	3	7
An Quy	1	9	6	16
An Thuan	1	4	6	11
Binh Thanh	0	2	2	4
Total	**8**	**30**	**32**	**70**

Source: Socio-economic survey conducted by ERM, September 2019

9. ENVIRONMENTAL IMPACT ASSESSMENT

This chapter presents an assessment of impacts for key environmental aspects identified in the scoping process (see Chapter 5). The impact assessment method is described in Chapter 4. The outcomes of the assessment will inform the development of the ESMP, which will be used to provide high-level guidance for the mitigation and management of potential impacts.

9.1 Air Quality Impact Assessment

9.1.1 Scope of Assessment

Activities causing the potential impacts to air quality and stakeholders who are identified as receptors of the impacts are listed in Table 9.1.

The key activities that are likely to negatively impact air quality during the construction phase include:

- Nearshore activities:
  - Equipment and material transport and supply;
  - WTGs' foundations construction; and
  - Construction of access bridge.
- Onshore activities:
  - Land preparation and civil works such as land clearance, demolition, earthworks;
  - Substation, transmission line, laydown area and office construction;
  - Operation of associated facilities such as the batching plant; and
  - Transportation of equipment, workers and materials.

Activities during the operation phase is likely to have an insignificant impact on air quality. Therefore, the scope for impact assessment on air quality is limited to only activities in the construction phase for this ESIA.

9.1.2 Baseline Conditions of Air Quality

The concentrations of Carbon monoxide (CO), Sulfur dioxide (SO_2) and Nitrogen dioxide (NO_2) and total suspended particles (TSP) in all ambient air samples collected met the National Technical Regulations.

9.1.3 Relevant Guidelines and Criteria

9.1.3.1 Vietnamese Regulations

- Circular No.16/2009/TT-BTNMT dated 7th October 2009 of Ministry of Natural Resources and Environment on guiding the implementation of National technical regulations on environmental protection;
- QCVN 05:2013/BTNMT - National Technical Regulation on Ambient Air Quality; and
- QCVN 06:2009/BTNMT - National Technical Regulation on Hazardous Substances in Ambient Air.

9.1.3.2 International Guidelines

- IFC Performance Standard 3: Resource Efficiency and Pollution Prevention requires the Project to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimize adverse impacts on human health and the environment; and

- IFC General EHS Guidelines (Section 1.1, 2007): Air Emissions and Ambient Air Quality contains common techniques for emission management that can be applied to a range of industry sectors. The guideline provides suggested approaches for the management of potentially significant emission sources and includes specific guidance for monitoring and assessment of impacts.

Table 9.1 Scope of Air Quality Impact Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Construction (nearshore activities)	Equipment and material transport and supply	■ Increased dust (e.g. PM10) from ground preparation, work sites and material / equipment transportation; ■ Exhaust emissions (e.g. CO, NOX) from movement and operation of construction vehicles, machinery and other heavy equipment such as bulldozers, excavators, compactors and back-up diesel generator.	■ Annoyance and nuisance to the general public as a result of dust deposition on properties, dwellings and places of business; ■ Increased effects of morbidity/ reduced health due to exposure to dust and exhaust emissions.	■ Nearby residents ■ Construction workers
	WTGs' foundations construction			
Construction (onshore activities)	Land preparation and civil works such as land clearance, demolition, earthworks			
	Substation, transmission line and laydown area and office construction			
	Operation of associated facilities such as the batching plant			
	Transportation of equipment, workers and materials			

9.1.4 Impacts Assessment

9.1.4.1 Construction Phase – Emissions

9.1.4.1.1 Potential impacts

- Increased dust (e.g. PM_{10}) from ground preparation, work sites and material / equipment transportation;
- Exhaust emissions (e.g. CO, NO_X) from movement and operation of construction vehicles, machinery and other heavy equipment such as bulldozers, excavators, compactors and back-up diesel generator.

9.1.4.1.2 Existing controls

No existing control is in place.

9.1.4.1.3 Significance of impacts

The assessment has indicated that the impacts to air quality from construction activities are expected to be localised, periodic, and temporary, occurring over 12 months of the construction phase. Therefore, the impact magnitude is considered **Small**. Key receptors potentially affected by dust and emissions from Project activities (construction, transportation) are construction workers, local people residing at the residential area along the provincial road or at farm houses along the access road, as well as those residing along the 110 kV transmission line (particularly at the pylon locations). Therefore, the receptor sensitivity is **Medium**. In consideration of the above, the significance of the negative impact is said to be **Minor**, as shown in Table 9.2.

Table 9.2 Impacts on Air Quality during Construction Phase

Impact Description	Impact on air quality due to emissions (dust and gaseous pollutants) during construction phase				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Intermittent over 12 months of the construction period.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor**.				

9.1.4.1.4 Additional mitigation measures

The following additional mitigation measures are based on ESIA requirements to minimise impacts associated with air emissions:

- Develop and implement a Traffic Management Plan to reduce the impacts of dust and emissions from transport vehicles;

- Cover construction material trucks during the transportation;
- Clean transport vehicles when leaving the construction sites;
- Control the speed limit of trucks and other vehicles, so as not to exceed more than 10 km/hour within the Project's boundaries;
- Areas of construction, stockpile areas and other exposed soils should be designated as such in order to minimise vehicle movements over these areas; and
- Maintain all vehicles and equipment in good working order.

9.1.4.1.5 Residual impacts

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Negligible**.

9.1.4.1.6 Monitoring and audit

No monitoring or audit are recommended.

9.1.4.2 Operation Phase - Emissions

The potential impacts on air quality from operation activities (e.g. WTG operations, inspection and maintenance) are considered **Negligible** so no further assessment is needed.

9.2 Marine Water Impact Assessment

9.2.1 Scope of Assessment

Activities causing the potential impacts to marine water quality and stakeholders who are identified as receptors of the impacts are all listed in Table 9.3.

- Construction Phase
  - Nearshore civil works;
  - Piling and WTG foundation installation;
  - Generation, handling and transport of waste; and
  - Presence of vessels and discharges of substances from vessels.
  - Presence of vessels and discharges of substances from vessels.
- Operation Phase
  - Waste handling and disposal, emissions and discharge generation.

Table 9.3 Scope of Marine Water Quality

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Construction (nearshore activities)	Nearshore civil works	■ Increased turbidity due to suspended sediment from seabed disturbance during dredging, piling and turbine installation; ■ Increased contaminants such as heavy metals, oil and grease etc. washed into seawater from construction activities; and ■ Waste discharged from construction activities	■ Marine life is affected due to increased turbidity and pollution; ■ Decreased productivity of aquaculture farms and; and ■ Loss of subtidal habitats within and around the dredging area and the piling area.	■ Marine flora and fauna; ■ Two clam farms nearby the Project's WTGs area.
	Piling and WTG foundation installation			
	Generation, handling and transport of waste			
	Presence of vessels and discharges of substances from vessels			
Operation (nearshore activities)	Waste handling and disposal, emissions and discharge generation	■ Increased turbidity due to suspended sediment from seabed disturbance during pilling.		

9.2.2 Baseline Conditions of Marine Water Quality

Based on the laboratory results, the total content of suspended solids, microbiological criterias and iron concentration were relatively high in all samples, exceeding the permitted regulations. At the sampling locations NBVB-01 and NBVB-02, ammonium concentration was above its thresholds limit. The exceedance is mostly caused from alluvial deposits during the rainy season. The exceedances relating to Coliforms at NBVB-02 is a result of contaminated surface and ground water entering the ocean.

9.2.3 Relevant Guidelines and Criteria

9.2.3.1 Vietnamese Regulations

- Circular No.16/2009/TT-BTNMT dated 7th October 2009 of Ministry of Natural Resources and Environment on guiding the implementation of National technical regulations on environmental protection;
- QCVN 10:2015/BTNMT - National Technical Regulation on Marine Water Quality;
- QCVN 14:2008/BTNMT - National Technical Regulation on Domestic Wastewater Discharge; and
- Decree No. 201/2013/ND-CP Government Decree on detailing the implementation a number of articles of the Law on Water Resources.

9.2.3.2 International Guidelines

- IFC Performance Standard 3: Resource Efficiency and Pollution Prevention requires the Project to consider ambient conditions and apply technically and financially feasible resource efficiency and pollution prevention principles and techniques that are best suited to avoid, or where avoidance is not possible, minimize adverse impacts on human health and the environment;
- IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources recognizes that protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources are fundamental to sustainable development;
- IFC General EHS Guidelines (Section 1.3, 2007): Wastewater and Ambient Water Quality contains guidelines for projects that have discharge of process water, wastewater from utility operations or storm water to the environment. The guideline provides suggested approaches for the management of wastewater, including water conservation, wastewater treatment, storm water management and wastewater and water quality monitoring;
- IFC General EHS Guidelines (Section 1.4, 2007): Water Conservation contains general recommendations for water conservation programmes, water monitoring and management programmes and process water reuse and recycling;
- IFC General EHS Guidelines (Section 4.0, 2007): Construction and Decommissioning provides specific guidance on prevention and control of community health and safety impacts that may occur during new project development. It covers various aspects of the environment, including noise and vibration, soil erosion, air quality, solid waste, hazardous materials, wastewater discharges etc. It also covers occupational and community health and safety;
- IFC Environmental Health and Safety Guidelines for Wind Energy (2015) provides EHS guidelines for onshore and offshore wind energy facilities. It covers environmental impacts and provides associated recommendations for mitigation measures in the areas of noise and visual impact, biodiversity, water quality, shadow flicker etc.

9.2.4 Impacts Assessment

9.2.4.1 Construction Phase – Pollution of Marine water (turbidity and discharges)

9.2.4.1.1 Potential impacts

The WTG and access bridges will take up an area of 85,000 m^2 (~8.5 ha). The potential impacts from piling and WTG installation activities include:

- Increased turbidity due to suspended sediment from seabed disturbance during pilling and WTGs installation;
- Increased contaminants such as heavy metals, oil and grease into seawater from construction activities; and
- Waste discharged from construction activities and workers.

9.2.4.1.2 Existing controls

The mitigation measures for nearshore construction and waste management identified in the locally approved regulatory EIA include:

- Domestic water waste will be collected and processed by the septic tank (BASTAF). The design and construction of the septic tank should be in accordance with Ministry Decision No. 3733/2002/QT-BYT;
- Hazardous waste will be collected and stored by project owners and handled by the official hazardous disposal organisation, in accordance with Circular No. 12/2011/TT-BTNMT dated 21/04/2011;

9.2.4.1.3 Significance of impacts

The assessment has indicated that impacts to marine water quality from nearshore construction activities are expected to be localised, periodic, and temporary, occurring over 12 months of the construction phase. Therefore, the impact magnitude is considered **Small**. Key receptors potentially affected by the decrease in marine water quality from Project activities (construction, transportation) are marine flora and fauna and two clam farms at the Project's WTG area. Therefore, the receptor sensitivity is **High**. In consideration of the above, the negative impact is assessed to be of **Moderate** significance, as shown in Table 9.4.

Table 9.4 Impacts on Marine Water Quality during Construction Phase

Impact Description	Decreased seawater quality due to turbidity, discharge and pollution from nearshore construction activities				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Intermittent over xx months of the construction period.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.2.4.1.4 *Additional mitigation measures*

The following mitigation measures are proposed to minimise impacts on marine water quality:

- Train workers on relevant regulations and provide them with information regarding biological diversity and disciplinary actions if regulations are violated;
- Select appropriate methods and equipment to reduce disturbance (e.g., turbidity, oil leakages or spills) to seawater;
- Prohibit the discharging of waste and wastewater into the sea;
- Supervise the implementation of the proposed mitigation measures by the Contractors;

9.2.4.1.5 *Residual impacts*

With the implementation of the above mitigation measures, the residual impacts would be anticipated to be **Negligible**.

9.2.4.1.6 *Monitoring and audit*

No monitoring or audits are recommended.

9.2.4.2 Operation Phase – Pollution of Marine Water

Impacts from all activities occurring during the operation phase on marine water quality are considered **Negligible** so no further assessment is needed.

9.3 Noise Impact Assessment

Nuisance, or an unacceptable level of noise amenity, may arise from operational (and construction) activities associated with new or existing 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. Operational noise from turbines is the focus of this assessment. Other operational noise emission generating items such as substation equipment (e.g. transformers), or plant/equipment used at permanent facilities, are often situated within or near to a wind farm but do not commonly represent significant noise generating source/s with the potential cause noise issues at nearby receptors. Although insignificant, the noise impacts from typical 110kV substation emissions have been included in the noise model.

This report has been prepared to document the findings of the Project wind farm noise assessment, provide an evaluation of potential impacts, identify potential mitigation measures that may be required to achieve compliance and then highlight any potential residual noise issues.

9.3.1 Scope of Assessment

The scope of this assessment is limited to the supplied Project design, environmental air-borne noise modelling, assessment and associated reporting conducted to document the methodology, findings and any agreed recommendations for the wind farm site/design. The assessment scope of works include:

- Reviewing existing project information and operational activities to identify noise generating equipment that are being used as part of the wind farm's general operation.
- Identifying the closest and/or potentially most affected receptors situated within the potential area of influence of the wind farm and quantifying existing conditions near these receptors.
- Establishing project-specific operational noise limits for integer wind speeds.
- Establishing a noise model to predict operational noise levels associated with the Project wind farm, and also predict cumulative operational noise levels of known wind farm operations in the area.
- Providing a comparison of predicted operational noise levels to the project-specific operational noise limits and identifying any levels that exceed criteria.
- Conducting a qualitative assessment of potential construction noise impacts.
- Evaluating the magnitude and extent of potential impacts associated with the wind farm's construction and operation.
- Providing recommendations for potentially effective mitigation, where the impacts warrant. These recommendations are designed for potential implementation into the wind farms design, where considered feasible and reasonable.

Note that the IFC wind farm noise assessment requirements specify that cumulative emissions (from the project and any nearby wind farms) must be assessed as a standard methodology. This has been addressed in this noise assessment that has incorporated emissions of the nearby Nexif Ben Tre 1 wind farm into the assessment.

9.3.1.1 Potentially sensitive receptors

The closest and/or potentially most affected noise sensitive receptors are described in Table 9.5 below. This list of receptors includes five dwelling locations and a shrine, and then the three Noise Monitoring Locations (NML) where baseline conditions were measured.

Table 9.5 Noise Sensitive Receptors

Location ID	UTM[1] WGS84 North Zone 48 (metres)		Comment
	Easting	Northing	
R01	682124.3	1097612	Residential area situated near NML03
R02	682410.8	1096802	House near substation situated near NML02

Location ID	UTM[1] WGS84 North Zone 48 (metres)		Comment
	Easting	Northing	
R03	682580.8	1096636	House near substation situated near NML02
R04	683056.9	1095288	Resident situated near NML01
R05	682010.2	1097428	Shrine situated near NML03
R06	682260.7	1097203	Residential area situated near NML06
N1 or NML01	683073	1095307	Noise Monitoring Location #1
N2 or NML02	682419	1096834	Noise Monitoring Location #2
N3 or NML03	682139	1097656	Noise Monitoring Location #3

1. *Universal Trans Mercator = UTM.*

9.3.1.2 Noise modelling

Noise modelling used in this study to predict wind farm noise levels at sensitive receptors occurred based on International Organisation for Standardisation (ISO) 9613-2:1996 (ISO9613:2) - *Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation* as implemented in Brüel and Kjær's Predictor 7810 (Version 12) noise modelling computer software. The model predicts noise level through spherical spreading and includes the effect of air absorption (as per ISO 9613), ground attenuation and shielding.

Predicted L_{eq} noise levels were calculated based upon sound power levels determined in accordance with the recognised standard IEC-61400-11:2002 "*Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques*", where available, for the wind range of 3 m/s to 27 m/s.

9.3.1.3 Key features, inputs and assumptions

Key features, inputs and assumptions that have informed the noise modelling and assessment are reproduced or outlined in Table 9.6 below.

Table 9.6 Noise Modelling Features, Inputs and Assumptions

ID	Feature	Description
1	Noise modelling software	Brüel and Kjær's Predictor 7810 (Version 12) noise modelling software package was utilised to calculate noise levels using ISO 9613:2, 1996 noise propagation algorithms (international method for general purpose, 1/1 octaves). For sound calculated using ISO9613:2, 1996 the indicated (and industry accepted) accuracy is ± 3 dBA at the source to receiver distances of up to 1000 metres and unknown at distances above 1000 metres. The Predictor software package allowed 3D elevation data to be combined with ground regions, water, foliage, significant building structures etc. and receptor locations, to create a detailed and accurate representation of the site and surrounding area. The noise model allowed for the quantification of noise levels from multiple sources, based on sound power or pressure levels emitted from each source. The model computed the noise propagation in the assessment area of influence to precisely quantify A-weighted decibels (Leq, 15 minute in dBA) at identified receptors. Brüel and Kjær's Predictor 7810 (Version 12) software achieves the requirements of ISO/TR 17534-3:2015: Acoustics - Software for the Calculation of Sound Outdoors as applicable to the ISO9613:2, 1996 calculative algorithm.
2	Operational Noise Level Predictions	All sound pressure levels presented in this report (e.g. noise levels predicted at a receptor) are in decibels referenced to 2 x 10^{-5} Pa, with A-weighting applied. All sound power levels presented in this report e.g. noise levels assigned to specific sources) are decibels referenced to 10^{-12}W, with A-weighting applied. Sound Power Level (LW, dBA) data incorporated into the project-specific noise models obtained from manufacturers data available at the time of the assessment. LW is a measure of the total power radiated by a source; it is a fundamental property of the source and is independent of the surrounding environment. LW differs from a Sound Pressure Level (LP) which is the level of sound pressure as measured at a distance by a standard sound level meter with a microphone. LP is the received sound (e.g. Leq, 15 minute in dBA) as opposed to LW which is the sound 'intensity' at the source. Project-specific information is provided for the wind farm under assessment and for the nearby Nexif wind farm, refer Section 9.3.3.2. A ground absorption factor of 0.0 was adopted for the modelling area. 0.0 is for hard ground and 1.0 is for soft ground. Noise levels were predicted at a height of 1.5 metres above ground level. This is the same approximate height of noise monitoring and is representative of an average human in a seated or standing position.
3	Meteorological Conditions	General meteorological conditions for the project-specific noise models included a temperature of 30°C and humidity of 80% representative of worst-case noise propogation conditions. An assumed atmospheric pressure of 101.33 kPA was adopted.

9.3.2 Baseline Condition

Please refer to Section 9.1 of this report that identifies the baseline noise conditions and applicable wind farm noise limits that have been utilised to assess potential impacts associated with the Project.

9.3.3 Impacts Assessment

This section presents the outcomes of the construction and operational noise assessment completed for the Project.

9.3.3.1 Impacts during Construction Phase

The IFC - *Environmental, Health and Safety (EHS) Guidelines - General EHS Guidelines: Environmental Noise Management*, Section 1.7 Noise (IFC 1.7 Noise), dated 30 April 2007 was adopted to define thresholds above which construction emissions could be an issue.as required by the IFC: Wind Energy Guideline, 2015.

Section 1.1.2-17 of the IFC: Wind Energy Guideline, 2015 states that “onshore construction noise should be limited to protect people living nearby. Noise-producing activities include blasting, piling, construction of roads and turbine foundations, and the erection of the turbines themselves. Guidance on acceptable levels can be found in the General EHS Guidelines”. These acceptable levels (55 dBA daytime and 45 dBA night-time) form the basis of the qualitative assessment provided herein and are reproduced in Table 9.7 below.

Table 9.7 IFC 1.7, Table 1.7.1 – Noise Level Guideline

Receptor	One Hour Leq (dBA)	
	Daytime 07:00 – 22:00	Nighttime 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Section 1.1.2-21 to Section 1.1.2-23 of the IFC: Wind Energy Guideline, 2015 provides information regarding noise mitigation measures. Mitigation measures for construction noise have been addressed in Section 9.3.3.1.4 of this report.

9.3.3.1.1 Potential impacts

To construct the Project a range of works and activities may 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;
- Piling works to construct the offshore foundation of each turbine;
- Construction and installation of the internal electrical network (between turbines) and any associated transmission lines; and
- Use of specialised (e.g. concrete batching plants) or unforeseen wind farm construction equipment, or activities that are to be undertaken.

9.3.3.1.2 Existing controls

There are no existing controls.

9.3.3.1.3 Significance of impacts

The assessment indicates that noise impacts on terrestrial receptors during the Construction Phase are expected to be negative, indirect, temporary (during construction period only) and localised. Therefore the impact magnitude of noise impacts is considered **Small**. At the potentially sensitive receptors detailed in Section 9.3.1.1, the significance of impacts is considered **High**. The negative impact is therefore ranked as being of **Moderate** significance, as shown in Table 9.8.

Table 9.8 Noise impacts during the Construction Phase

Impact Description	Noise impacts during Construction Phase				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	Direct	**Indirect**	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Intermittent over 12 months of the construction period.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.3.3.1.4 Additional mitigation measures

Based on the findings of the qualitative construction noise and vibration assessment presented in the section above it is recommended that:

- 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.
- 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 (7AM to 10PM), and work should be avoided on Sundays or public holidays if possible.

- Any works that are required during the night time period (10PM to 7AM) 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.
- 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 "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 if possible. 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.

9.3.3.1.5 Residual impacts

Based on the recommended mitigation measures presented above, residual impacts have been rated following the same process as the impacts were rated pre-mitigation. The residual impacts from noise during the construction phase are therefore considered to be **Minor**.

9.3.3.1.6 Monitoring and audit

Construction noise monitoring should be conducted if any repeated/ valid noise complaints are received. Where noise monitoring occurs the work should be scoped and then conducted by a suitably experienced person. The purpose of the monitoring is to understand in-situ levels such that any additional controls be identified and then implemented if feasible, reasonable and practical to do so. If this is required:

- All project / site noise levels (Leq, 1 hour in dBA) should be measured in the absence of any influential source not associated with the project;
- They should be measured at the closest and/or potentially most affected noise sensitive receptors in the vicinity of the works being undertaken and at the complainants location;
- If the measured site noise levels are below 55 dBA and 45 dBA (Leq, 1 hour in dBA) for the daytime and then night-time, no further noise control is required; and
- If the measured site noise levels are above 55 dBA and 45 dBA (Leq, 1 hour in dBA) for the daytime and then night-time, further noise control should be considered.

9.3.3.2 Impacts during Operation Phase

9.3.3.2.1 Assessment Overview

The key document considered for the terms of reference from which operational wind farm noise criteria were established is the *World Bank Group: International Finance Corporation (IFC) - Environmental, Health and Safety Guidelines for Wind Energy*, dated August 2015 (IFC: Wind Energy Guideline, 2015).

In particular the requirements of Section 1.1.2 of the IFC: Wind Energy Guideline, 2015 were referenced for the purpose of this assessment.

Section 1.1.2-19 of the IFC: Wind Energy Guideline, 2015 states that “wind turbines produce noise through a number of different mechanisms, which can be roughly grouped into mechanical and aerodynamic sources. The major mechanical components include the gearbox, generator, and yaw motors, each of which produce their own characteristic sounds. Other mechanical systems, such as fans and hydraulic motors, can also contribute to the overall acoustic emissions. Mechanical noise is radiated by the surface of the turbine and by openings in the nacelle housing. The interaction of air and the turbine blades produces aerodynamic noise through a variety of processes as air passes over and past the blades. This feature is considered and addressed in the noise modelling conducted and documented herein.

Section 1.2.2-20 identifies the principles that wind farm noise impacts should be assessed. These are reproduced below and form the basis of this noise assessment:

- Receptors should be chosen according to their environmental sensitivity (human, livestock, or wildlife).
- Preliminary modelling should be carried out to determine whether more detailed investigation is warranted. The preliminary modelling can be as simple as assuming hemispherical propagation (i.e., the radiation of sound, in all directions, from a source point). Preliminary modelling should focus on sensitive receptors within 2,000 m of any of the turbines in a wind energy facility.
- If the preliminary model suggests that turbine noise at all sensitive receptors is likely to be below an LA90 of 35 dBA at a wind speed of 10 m/s at 10 m height during day and night times, then this preliminary modelling is likely to be sufficient to assess noise impact; otherwise it is recommended that more detailed modelling be carried out, which may include background ambient noise measurements.
- All modelling should take account of the cumulative noise from all wind energy facilities in the vicinity having the potential to increase noise levels.
- If noise criteria based on ambient noise are to be used, it is necessary to measure the background noise in the absence of any wind turbines. This should be done at one or more noise-sensitive receptors. Often the critical receptors will be those closest to the wind energy facility, but if the nearest receptor is also close to other significant noise sources, an alternative receptor may need to be chosen.
- The background noise should be measured at 10 m height over a series of 10-minute intervals, using appropriate wind screens. At least five of these 10-minute measurements should be taken for each integer wind speed from cut-in speed to 12 m/s.

As noted in Chapter 7, wind farm noise compliance limits for receptors have been derived based on the background noise plot and the limits defined in the ETSU-R-97 “*The Assessment & Rating of Noise from Wind Farms*” document referenced in the IFC which is 45 dBA or the background noise plus 5 dBA, whichever is the greater i.e. the screening criteria does not apply as baseline monitoring has been conducted.

All modelling has taken into account the cumulative noise from the Project and nearby Nexif Ben Tre 1 wind farm both of which have the potential to increase noise levels at some receptors. The Nexif Ben Tre 1 wind farm is located approximately 7 kilometres (km) south-west of the Project site.

IFC Section 2.1.2-79 states that “Noise generated from wind energy facilities tends to increase with the speed of the wind, as does overall background noise due to the friction of air over existing landscape features. Increased wind speeds may also mask the noise emitted by the wind energy facility itself, and wind speed and direction may affect the direction and extent of noise propagation. The application of noise guideline values and the assessment of background levels should therefore take these factors into consideration. It is considered good practice to undertake noise compliance testing when the project becomes operational to verify the modelled noise levels at nearby properties and confirm the appropriateness of any mitigation applied”. This feature is considered and addressed in the noise modelling conducted and documented herein.

In addition IFC Section 2.1.2-80 states that “additional consideration may be required to address the nuisance factor associated with impulsive or tonal (sound of a specific frequency) characteristics of noise emitted from some wind energy facilities’ configurations”. Impulsive or tonal characteristics are not considered to be a feature of the turbines proposed for the Project, and those at the nearby Nexif Ben Tre 1 wind farm.

IFC Section 2.1.2-79 and Section 2.1.2-80 apply to noise monitoring and are reproduced here as they provide insight and further relevant information regarding the Section 1.2.2-19 principles reproduced above in relation to background noise measurements.

The features discussed in Section 2.1.2-79 and Section 2.1.2-80 relating to an increase in background levels with wind speed identifies the conservative nature of the project-specific noise criteria defined by IFC and adopted in this report.

9.3.3.2.2 Noise emissions sources

The Project will consist of four phases with seven turbines in each. The information for Phase 1 and 2 is available however Phase 3 and 4 is yet to be designed and suitable information (other than estimated turbine locations) for noise modelling is not yet available.

In accordance with the IFC guideline, cumulative operational noise of the Project (all components) and any nearby wind farm project is required to be assessed. Hence, it has been assumed that Phase 3 and 4 will consist of 14 turbines with the same specification of those at Phases 1 and 2.

The Nexif Ben Tre 1 wind farm has been identified to be close to the project, approximately seven kilometres from the Project site, and would potentially impact on the receptors in the vicinity of the Project. The WTG specifications and model for the Nexif Ben Tre 1 wind farm has also been provided by the client. See Figure 9.1 showing Nexif Ben Tre 1 wind farm project and Thanh Hai project.

Table 9.9 to Table 9.17 consolidate the modelling data inputs for the Project and nearby Nexif Ben Tre wind farm.

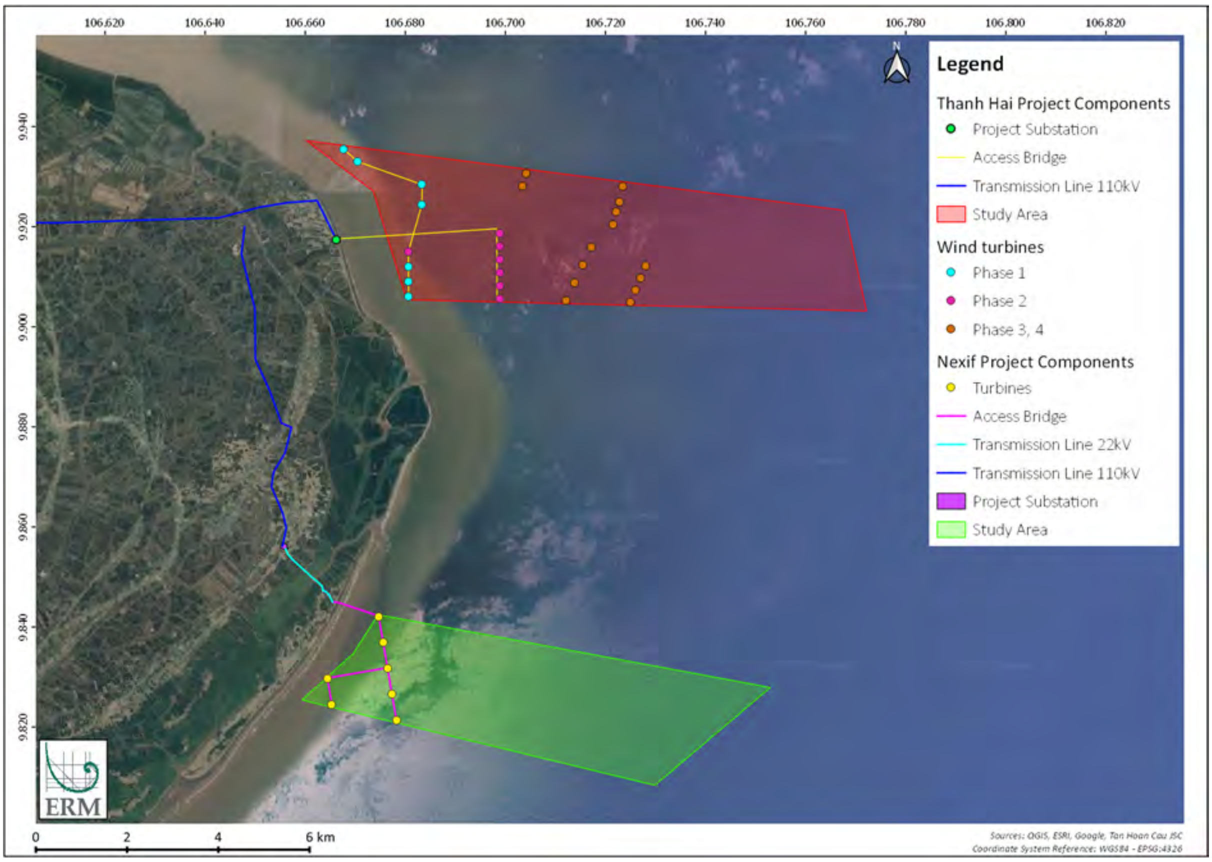


Figure 9.1 Location of Thanh Hai and Nexif projects

Table 9.9 Project WTGs Overview

Phase	ID	UTM1 WGS84 North Zone 48 (metres)		Hub Height (metres)
		Easting	Northing	
01	TB1	682822	1098737	106.5
	TB2	683131	1098466	106.5
	TB3	684540	1097972	106.5
	TB4	684542	1097522	106.5
	TB6	684258	1096149	106.5
	TB7	684259	1095819	106.5
	TB8	684261	1095489	106.5
02	TB5	684256	1096479	106.5
	TB9	686257	1096897	106.5
	TB10	686259	1096607	106.5

Phase	ID	UTM1 WGS84 North Zone 48 (metres)		Hub Height (metres)
		Easting	Northing	
	TB11	686260	1096317	106.5
	TB12	686262	1096027	106.5
	TB13	686263	1095737	106.5
	TB14	686264	1095447	106.5
03 & 04	W1	686830	1098220	106.5
	W2	686748	1097942	106.5
	W3	688944	1097948	106.5
	W4	688875	1097606	106.5
	W5	688806	1097385	106.5
	W6	688736	1097103	106.5
	W7	688264	1096601	106.5
	W8	688081	1096206	106.5
	W9	687898	1095811	106.5
	W10	687714	1095417	106.5
	W11	689456	1096193	106.5
	W12	689347	1095924	106.5
	W13	689237	1095655	106.5
	W14	689128	1095387	106.5
-	Substation	682673	1096735	n/a

1. *Universal Transverse Mercator coordinate system*

Table 9.10 Project WTG Manufacturer's Data

Make, Model, Power	Siemens SG 4.2-145, 4.2 MW
Rotor Diameter	145 metres
Hub Height	106.5 metres
Cut-In Wind Speed	3 m/s
Cut-Out Wind Speed	26 m/s
Max. Sound Power Level	106.9 dBA

Table 9.11 Siemens SG 4.2-145 Sound Power Levels @ 4.2 MW

Wind Speed at Hub Height (m/s)	Sound Power Level at Hub Height (dBA)
3	95.1
4	95.1
5	95.5
6	99.7
7	103.2
8	106.2
9	106.9
10	106.9
11	106.9
12	106.9
13	106.9
14	106.9
15+	106.9

Table 9.12 Siemens SG 4.5-145 Reference Spectrum for the Project

Make, Model, Mode, Wind Speed	Spectral Data – dBA in 1/1 Octave Bands: 31.5 to 8kHz									Overall Lw (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
SG 4.5-145 @ 4.2 MW rated power, 9 m/s	78.9	86.7	91.3	92.3	96.9	102.0	103.0	96.8	78.3	106.9

Table 9.13 Substation Reference Spectrum

Make / Model	Spectral Data – dBA in 1/1 Octave Bands: 31.5 to 8kHz									Overall Lw (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Assumed value based on wind farm capacity, all wind speeds	81.3	77.7	86.9	84	77.7	68.2	63.5	63	65.6	90

Table 9.14 Nexif Ben Tre 1 WTGs Overview

ID	UTM[1] WGS84 North Zone 48 (metres)		Hub Height (metres)
	Easting	Northing	
1	683645	1088406	105.5
2	683750	1087841	105.5
3	683848	1087266	105.5
4	683945	1086698	105.5
5	684050	1086118	105.5
6	682531	1087034	105.5
7	682620	1086458	105.5

Note 1: Universal Transverse Mercator coordinate system

Table 9.15 Nexif Ben Tre 1 WTGs Manufacturer's Data

Make, Model, Power	Vestas V150-4.0/4.2 MW
Rotor Diameter	150 metres
Hub Height	105.5 metres
Cut-In Wind Speed	3 m/s
Cut-Out Wind Speed	24.5 m/s
Standard Mode Max. Sound Power Level	104.8 dBA
Optional 0-0S Mode Max. Sound Power Level	108 dBA

Table 9.16 Vestas V150 Sound Power Levels

Wind Speed at Hub Height (m/s)	Sound Power Level at Hub Height (dBA) Mode 0-0S (Blades without Serrated Trailing Edge)
3	93.4
4	94.0
5	97.1
6	100.5
7	103.8
8	106.6
9	108.0

Wind Speed at Hub Height (m/s)	Sound Power Level at Hub Height (dBA) Mode 0-0S (Blades without Serrated Trailing Edge)
10	108.0
11	108.0
12	108.0
13	108.0
14	108.0
15+	108.0

Table 9.17 Vestas V150 Reference Spectrum for the nearby Nexif Ben Tre 1 wind farm

Make, Model, Mode, Wind Speed	Spectral Data – dBA in 1/1 Octave Bands: 31.5 to 8kHz									Overall Lw (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
Vestas V150, Mode 0-0S, 9 m/s	80.1	87.9	92.5	93.5	98.1	103.3	103.8	98.0	79.5	108.0

9.3.3.2.3 Predicted wind farm operational noise

Based on the methodology and input data summarised above noise levels have been predicted at all identified receptors. The resultant noise levels for the most affected location / receptors at or near the three NML positions are then presented below in Figure 9.2 to Figure 9.4.

A noise contour map of the worst-case operational scenario showing all noise emission sources and identified receptors is then provided in Figure 9.5 and Figure 9.6.

As discussed below, wind farm noise levels (including the substation) are fully compliance with the specified noise limits and emissions at all other receptors are lower than those documented below and insignificant.

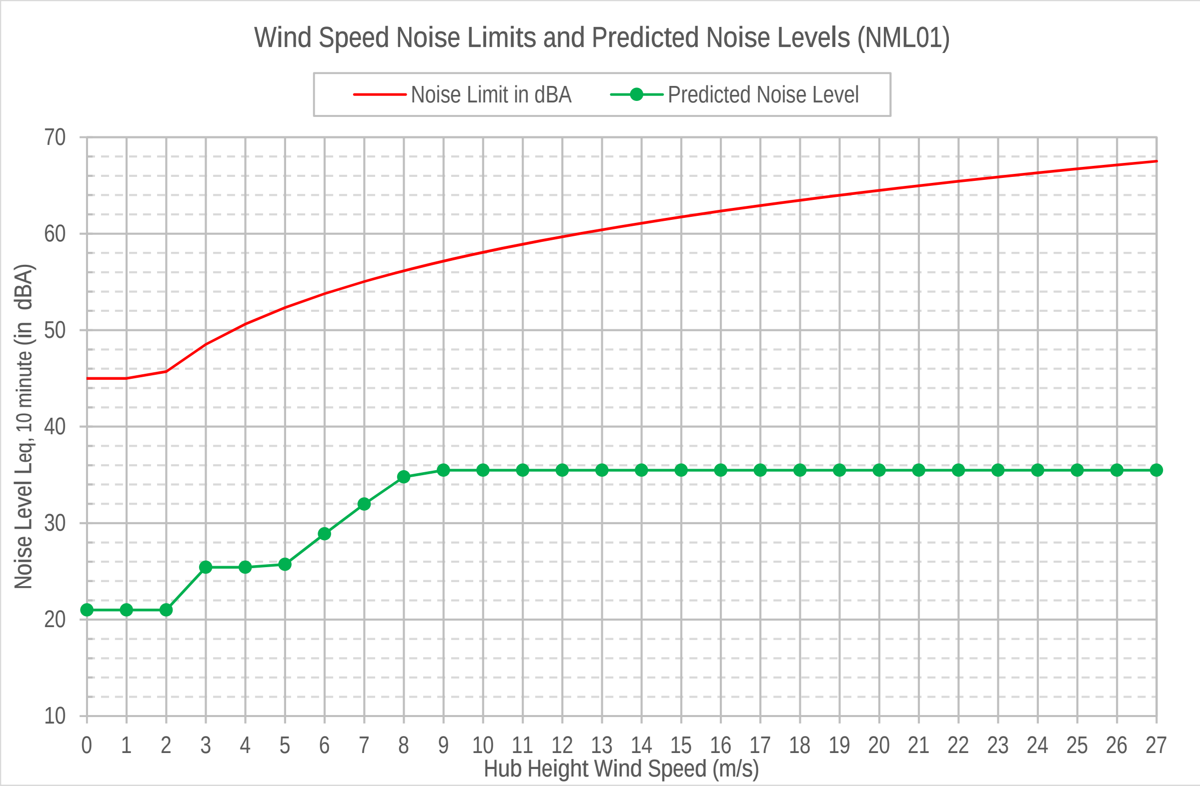


Figure 9.2 Predicted Noise Levels and Compliance Assessment (NML01)

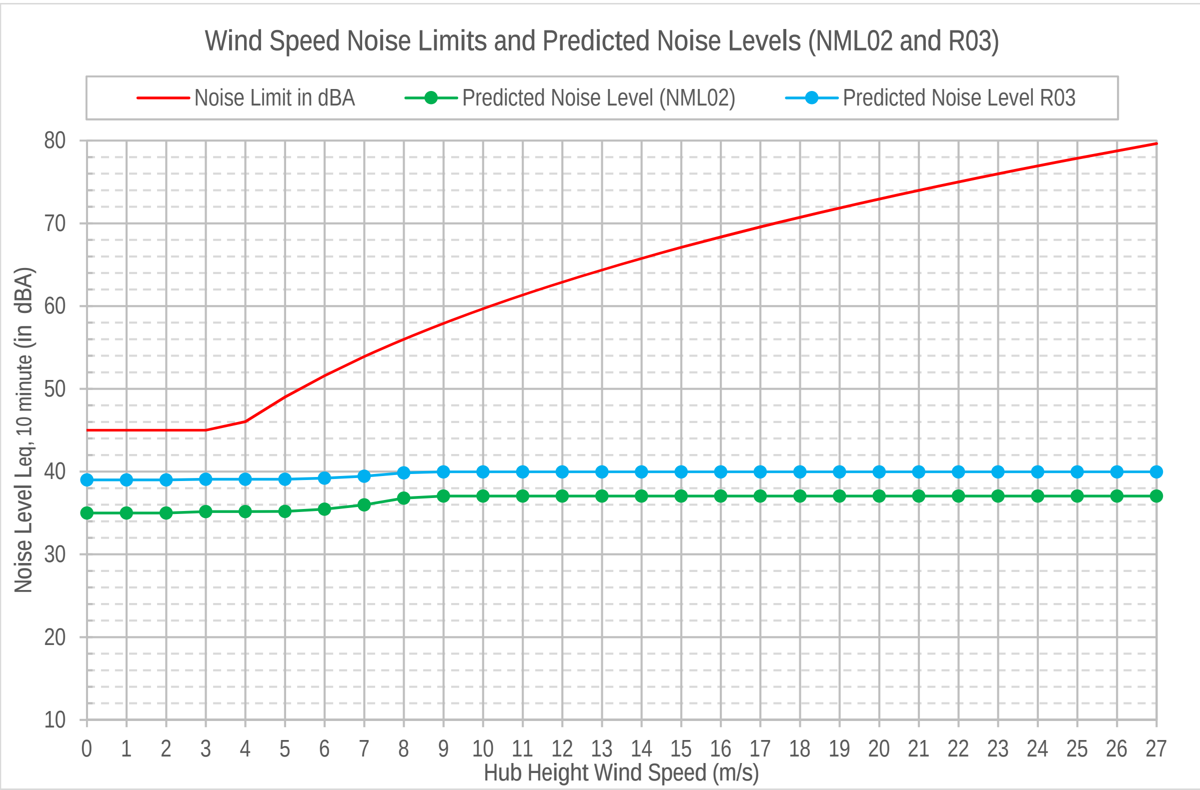


Figure 9.3 Predicted Noise Levels and Compliance Assessment (NML02)

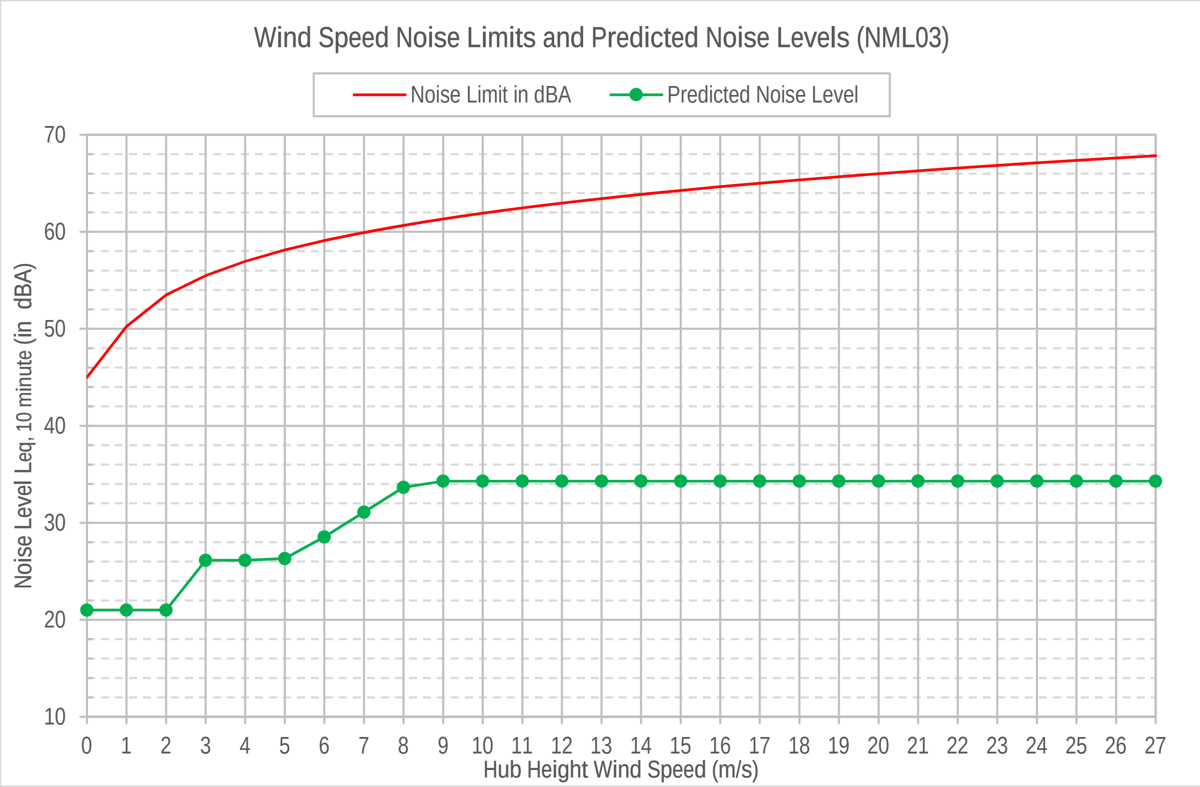


Figure 9.4 Predicted Noise Levels and Compliance Assessment (NML03)

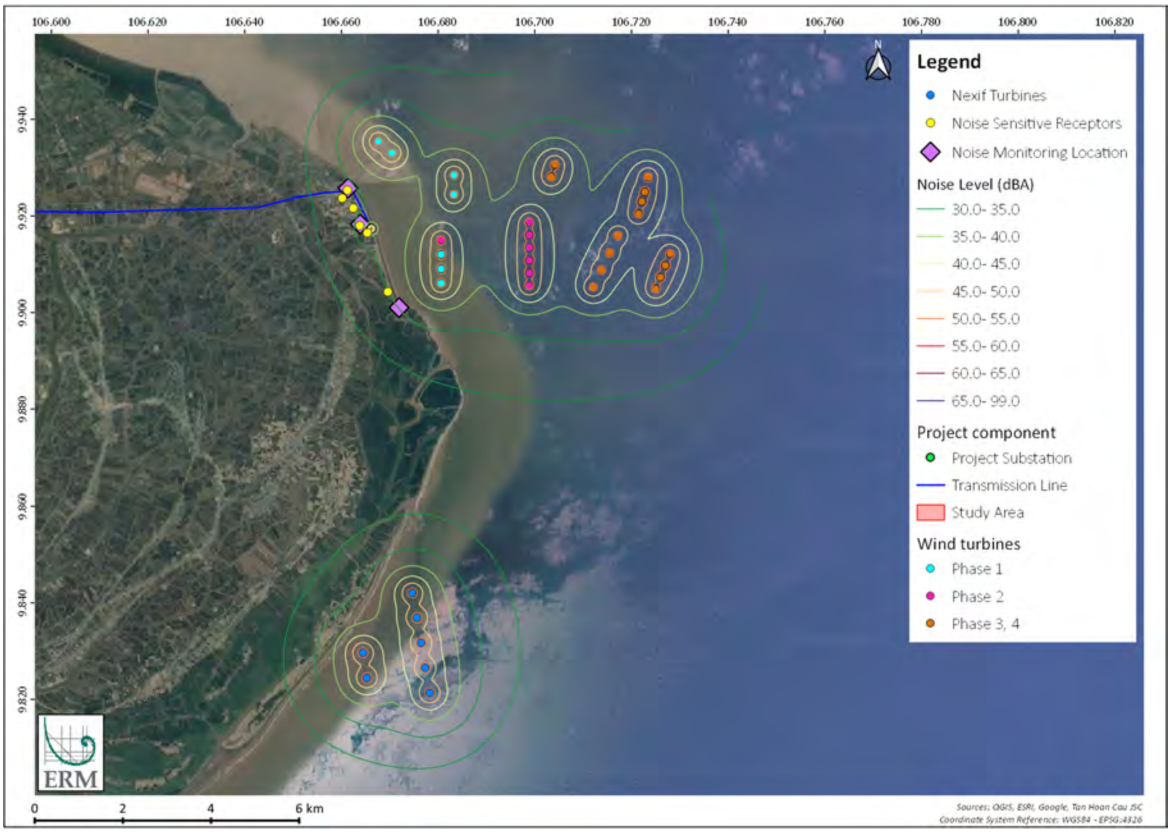


Figure 9.5 Noise Contour Map (Worst-Case Operational Scenario, Far View)

Figure 9.6 Noise Contour Map (Worst-Case Operational Scenario, Close View)

9.3.3.2.4 *Discussion of predicted wind farm noise*

The predicted overall wind farm noise levels are at or below 40 dBA at all assessed receptors and substantially below the wind speed based noise limits derived in accordance with the IFC: Wind Energy Guideline, 2015. This comparison includes wind farm noise predictions for the worst-case operational scenario with all turbines operating in an unconstrained mode for both the Project (all four phases including the substation) and nearby Nexif Ben Tre 1 wind farm project.

9.3.3.2.5 *Significance of impacts*

The assessment has indicated that noise impacts from the Project's WTGs operations are expected to be neutral because predicted noise levels are below criteria when operating at the acoustically worst-case scenario. The impact magnitude is therefore considered **Negligible**. The sensitivity of receptors in the area is considered **High**. Therefore, the negative impact is ranked as being of **Minor** significance, as shown in Table 9.18.

Table 9.18 Impact rating during Operation Phase

Impact Description	Operational Noise				
Impact Nature	Negative	Positive	**Neutral**		
Impact Type	Direct	**Indirect**	Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Throughout the operation phase.				
Impact Magnitude	Positive	**Negligible**	Small	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered to be **Minor.**				

9.3.3.2.6 *Additional mitigation measures*

As the predicted worst-case wind farm noise levels are substantially below the wind speed based noise limits additional mitigation measures are not warranted or recommended in this report.

However, if the turbine selection and/or layout are to be changed, and noise levels are expected to increase at receptors then compliance with the noise limits would need to be reassessed.

9.3.3.2.7 *Residual impacts*

As the predicted worst-case wind farm noise levels are substantially below the wind speed based noise limits the pre-mitigation impact was rated as negligible. Hence residual impacts are also rated as negligible.

9.3.3.2.8 *Monitoring and audit*

Wind farm noise monitoring should be conducted if any repeated / valid noise complaints are received. Where noise monitoring occurs the work should be scoped and then conducted by a suitably experienced person.

The purpose of the monitoring is to understand in-situ levels and compare them to the predicted values and limits identified in this report, such that any remedial measures (however unlikely) be identified and then implemented if feasible, reasonable and practical to do so. If this monitoring is required:

- All project / site noise levels (Leq, 10 minute in dBA) should be measured in the absence of any influential source not associated with the project.
- Project / site noise levels should be measured at the closest and/or potentially most affected noise sensitive receptors in the vicinity of the wind farm and at the complainants location.
- If the measured site noise levels are below the predicted values presented in this report and the applicable noise limits, no further noise control or remedial measures are required.
- If the measured site noise levels are above the predicted values presented in this report but below the applicable noise limits, no further noise control or remedial measures are required.
- If the measured site noise levels are above both the predicted values presented in this report and the applicable noise limits, further noise control / remedial measures are required. The type, scale

and extent of the remedial measures should be evaluated at the time and designed to reduce noise levels to be below the applicable noise limits presented in this report, if feasible, reasonable and practical to do so.

9.4 Biodiversity Impact Assessment

In accordance with IFC PS1 and PS6, the assessment process aims to predict and assess the Project's potential adverse impacts and risks to biodiversity values, in quantitative terms where possible. The objectives of the biodiversity impact assessment are to identify and quantify the potential Project impacts; design measures to avoid, minimise or mitigate potential adverse impacts; and identify likely residual impacts. The background assessment and baseline studies to identify relevant values have been reported in Section xx. The remaining steps reported in this section include:

- Impact analysis to assess the extent and complexity of potential adverse impacts considering the two parameters of habitat area (spatially) and threatened species individually;
- Development of mitigation measures to avoid and minimise potential adverse impacts to biodiversity with a priority given to impacts on features with significant biodiversity values; and
- Determine residual impacts in the event significant residual impacts occur biodiversity offsets need to be considered.

9.4.1 Scope of Assessment

Table 9.19 broadly defines the threats to biodiversity values that have potential to occur as a result of a Project. These threats to biodiversity are derived from IFC PS6 and relate to the activities that are likely to occur during construction and operation phases.

Table 9.19 Potential Threats to Biodiversity Values

Term	Description
Loss of terrestrial and marine habitat at footprint of the transmission line infrastructure and turbines	■ Temporary and permanent loss of habitat or species due to permanent or temporary site activities. Temporary and permanent impacts to marine habitat from turbine anchoring to the seabed.
Disturbance or displacement of individuals from light; noise and/or vibration impacts	■ Disturbance to, or displacement/exclusion of a species from foraging habitat due to construction activities, and operation and maintenance activities. ■ Impacts from light, noise and vibration sources on surrounding habitats causing disturbance and displacement and changes in behaviour.
Barrier creation, fragmentation and edge effects	■ Creation of barriers to the movements of animals, especially fish, but also mammals, reptiles and amphibians and invertebrates and plants with limited powers of dispersal due to the transmission line and/or subsea cable. ■ Fragmentation of habitat, or permanent/temporary severance of wildlife corridors between isolated habitats of importance for biodiversity due to the transmission line and/or subsea cable. ■ Impacts that occur when a habitat is exposed to a different adjacent habitat type or structure. These impacts can include increased risk of parasitism or disease, increased risk of predation, adverse microclimate conditions (including drying out and subsequent fire risk), and competition from invasive species.
Degradation of habitat from dust; water pollution; or invasive species	■ Disturbance or damage to adjacent habitat and species caused by changes in microclimate, vulnerability to predation and invasion and overall changes in conditions that can lead to a change in the community and its values for flora and fauna. This can include increased exposure to noise, light and dust. ■ Introduction or spreading of alien species during the construction works.

Term	Description
Mortality – vehicle/vessel strike, hunting and poaching, transmission line, turbine strike	■ Mortality of individual fauna species as a result of vehicle/vessel or machinery strike or falling debris during clearing activities. ■ Mortality to individual fauna species as a result of worker influx and hunting/poaching of extant fauna. ■ Mortality due to collision and electrocution with transmission line. ■ Mortality due to potential flight of avifauna and bats through the Rotor Swept Zone (RSZ) of the wind turbines.

Table 9.20 scopes the likely impacts during the construction and operation phases of the Project. The impact assessment for these impact types are further assessed in the subsequent sections.

Table 9.20 Scoping of Potential Impacts during Project Phases

Impact	Construction Phase	Operation Phase
Loss of terrestrial habitat; Loss of marine habitat from anchoring of turbines	Yes	Continuing from construction phase
Disturbance or displacement of fauna	Yes	Reassessed for operation phase
Barrier creation, fragmentation and edge effects	Yes	Continuing from construction phase
Degradation of habitat	Yes	Continuing from construction phase
Mortality – vehicle/vessel strike, hunting and poaching, transmission line, turbine strike	Yes	Reassessed for operation phase (birds and bats), Continuing from construction phase (marine mammals)

Note:
Yes*: considered to be likely impacts during the phase.*
No*: considered to be no impacts or negligible impacts during the phase.*
Continuing from construction phase*: impact is likely to continue from the construction phase and the mitigations outlined are appropriate to manage impacts during construction, operation.*
Reassessed for operation phase*: impact is likely to be different during the phase and hence is reassessed based on the likely impacts. Additional mitigations may be outlined to apply to this phase.*

9.4.2 Impact Assessment Criteria

In order to assess the significance of impacts due to the project before and after mitigation, the following impact assessment matrices have been used to classify the severity of impacts. The matrix for habitat classification is presented in Table 9.21, while Table 9.22 defines the criteria that will be used to define the significance of the impacts on species. The matrices outline the sensitivity of the receptor based on IFC PS6 thresholds and the magnitude of effect, which is based on changes to ecological conditions due to the project.

Table 9.21 Habitat Impact Assessment – Significance Criteria

Habitat Sensitivity/Value		Magnitude of Effect			
		Negligible	Small	Medium	Large
Low	Habitats with no or local designation/ recognition; habitats of significance for	Negligible	Negligible	Minor	Moderate

Habitat Sensitivity/Value		Magnitude of Effect: Negligible	Small	Medium	Large
	species of Least Concern; habitats which are common and widespread within the region.				
Medium	Habitats within nationally designated or recognised areas; habitats of significant importance to globally Vulnerable, Near Threatened or Data Deficient species; habitats of significant importance for nationally restricted range species; habitats supporting nationally significant concentrations of migratory species and/or congregatory species; nationally threatened or unique ecosystems.	Negligible	Minor	Moderate	Major
High	Habitats within internationally designated or recognised areas; habitats of importance to globally Critically Endangered or Endangered species; habitats of importance to endemic and/or globally restricted-range species; habitats supporting globally significant concentrations of migratory species and/ or congregatory species; highly threatened and/or unique ecosystems, areas associated with key evolutionary species.	Negligible	Moderate	Major	Critical

Magnitude of Effect Definition

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

Table 9.22 Species Impact Assessment – Significance Criteria

Species Sensitivity/Value		Magnitude of Effect: Negligible	Small	Medium	Large
Low	Species which are included on the IUCN Red List of Threatened Species as Least Concern (LC).	Not significant	Not significant	Minor	Moderate
Medium	Species included on the IUCN Red List of Threatened Species as Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD). Species protected under national legislation. Nationally restricted range species. Nationally important number of migratory or congregatory species.	Not significant	Minor	Moderate	Major

High	Species included on the IUCN Red List of Threatened Species as Critically Endangered (CR) or Endangered (EN). Species having a globally Restricted Range (i.e. plants endemic to a site or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km^2. Internationally important numbers of migratory or congregatory species. Key evolutionary species.	Not significant	Moderate	Major	Critical

Magnitude of Effect Definition

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

9.4.3 Impacts Assessment

9.4.3.1 Loss of Terrestrial Habitat

9.4.3.1.1 Potential impacts

The geospatial assessment undertaken to define natural habitat and modified habitat has classified the majority of the terrestrial portion of the Project Area as modified habitat. There are 0.0068 km^2 of natural habitat and 0.65 km^2 of modified habitat within the transmission line Right of Way (ROW – 20 m buffer of the line) of the Project. Approximately 1 % of the corridor is natural habitat.

Natural habitat areas in particular provide habitat values for a variety of native flora and fauna species, including species such as the Spot-billed Pelican (IUCN NT; VRDB EN) and Oriental Darter (IUCN NT; VRDB VU) detected within the Project Area. The natural habitat areas within the Project Area are patchy and consists mainly of secondary (regrown) mangrove species and river bodies. Albeit modified, the modified habitat areas also provide value to native species, in particular those adapted to disturbed environments (e.g. Ngo Van Tri's Lady Butterfly Lizard (IUCN VU) and Black-bearded Tomb Bat (IUCN LC)).

The Project EAA contains two (2) Critical Habitat species. Nordmann's Greenshank (IUCN EN) winters along the Vietnamese coast from December to March annually as the species migrates south during the Northern winter. The species may fly through the Project Area between roosting and foraging habitat during this period until it travels into the Southern Hemisphere (April/May). Spoon-billed Sandpiper (IUCN CR) winters along the Southern Vietnamese coast although Vietnam is not one of its important wintering grounds. This species may fly through the Project Area between roosting and foraging habitat during the winter period. Both species roost and forage in adjacent terrestrial wetland habitats associated with the nearby Important Bird Areas (Ba Tri and Binh Dai IBAs) that are between 5 to 15 km away from the Project Area. No loss of habitat is likely for these species during construction. Some disturbance to flight behaviour is expected during construction and operation (see impact assessment for disturbance below), and minor direct impact to the species populations and habitat is expected due to the Project (see impact assessment for bird mortality below).

Construction of the transmission line, substation and operation house may lead to the permanent, direct loss of habitat within the footprint of the transmission line towers, substation and operation house. There will also be temporary laydown areas for the purposes of housing fill material along the transmission line. Table 9.23 details the terrestrial habitat area that will be permanently and temporarily lost during construction and/or throughout the operation of the Project due to the transmission lines. The exact location of each tower is not defined, however, based on the proportion of natural habitat within the corridor, an impact estimate would be in the order of 0.0001 km^2 of natural habitat permanently lost. For the substation and operation house, no natural habitat will be lost. For the temporary laydown areas, as locations for these areas are not set at the time of the reporting, the worst-case scenario (i.e. entirely natural habitat) will be assumed.

Table 9.23 Land area occupied by transmission line

Project components	Duration	Estimated land area (km^2)
110 kV transmission line (16.61 km) tower footings	Permanent	0.0086
Substation and operation house	Permanent	0.014
Laydown areas	Temporary	0.010
	Total	**0.033**

The transmission line towers will be approximately 38 m in height. Not all habitat/vegetation within the ROW of the transmission line will be cleared for the Project. Trees and vegetation will not be required to be cleared beneath the strung wires where the canopy of the vegetation is below the minimum clearance height. Only the locations of the transmission line tower footings and any laydown areas will be cleared of vegetation (if any) during the construction phase.

The Project Area will intercept the Thanh Phu Protected Area (approximately 1.94 km2). This area is mapped as a combination of mangrove (natural habitat), aquaculture land (modified habitat) and agriculture/residential land (modified habitat).

9.4.3.1.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.1.3 Significance of impacts

The area of natural habitat potentially lost is considered to be minimal (approximately 0.0001 km^2), representing a loss of 0.0002 % of natural habitat in the terrestrial EAA. Part of the mangrove area, and a small area (1.94 km^2) of protected area will be affected but the long-term viability/function of the habitat is unlikely to be lost. The area of modified habitat lost will consist mainly of existing aquacultural and agricultural land underneath the transmission line route, substation and operation house area and are not considered to be sensitive. No roosting or foraging habitat for migratory birds is present within the Project Area, although IBAs are nearby (5 – 45km away). Given that these IBAs are not contiguous habitats with the Project Area, impacts on habitats associated with these IBAs are considered unlikely to occur and the Project Area is not expected to play an important role in maintaining the value of the IBAs for biodiversity. The footprint of the transmission line towers and substation will result in a permanent loss of habitat (transmission line, substation and operation house), as well as temporary loss of habitat (temporary laydown areas).

The nature of the impact will be direct to resident fauna within the Project Area, however the Study Area is substantially modified and is not considered of importance to resident flora and fauna as they are generally widespread and of low conservation significance. The magnitude of impact is expected to be **Small** as the impact affects a small area of habitat, but without the loss of viability/function of the habitat.

The sensitivity of the receptor is considered to be **Medium** as the habitat plays host to IUCN listed Vulnerable (VU) species (Ngo Van Tri's Lady Butterfly Lizard) and cuts through a nationally designated Protected Area.

The Project EAA plays host to transit habitat for globally EN and CR species and potentially supports globally significant concentrations of migratory and congregatory species – Nordmann's Greenshank and Spoon-billed Sandpiper. Nonetheless, minor impacts are expected on Critical Habitat species within the Project Area[44], and this is assessed at Section 9.4.3.8 below. Given that the habitat for these species is transit habitat and this habitat will not be physically lost, the impact assessment has used the rating for impacts to terrestrial resident fauna as discussed above. The overall significance is therefore considered to be **Minor**.

Table 9.24 Loss of Terrestrial Habitat Impact Assessment

Impact Description	Loss of terrestrial habitat				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	**Permanent**	
Impact Extent	**Local**	Regional	International		
Frequency	The impact is considered a one-off event.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered to be **Minor.**				

9.4.3.1.4 Additional mitigation measures

The following mitigation measures are proposed to be applied during construction and continued during operation if necessary:

- A Biodiversity Action Plan (BAP) will be prepared for the management and monitoring of natural and critical habitats within the Project EAA as required by IFC PS6.
- The laydown areas will not be located within natural habitat area.
- Where possible, transmission line tower footings will be located outside natural habitat.
- Legal permission will be sought and appropriate consultation will be undertaken specific to operating in the Protected Area.
- Clearing vegetation outside of designated areas will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation.

[44] It should be noted that as required by IFC PS6, if critical habitat is determined for a species, a net-gain outcome is required to be achieved through the application of a Biodiversity Action Plan for the project, even if there are no substantive impacts to that critical habitat due to the project.

- The planned vegetation clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing.
- The Project owner shall provide training to staff and workers on all rules, regulations and information concerning restrictions related to unauthorised clearing of vegetation, as well as the punishment that can expected if any staff or worker or other person associated with the Project violates rules and regulations.
- Once construction is complete the laydown area will be re-instated to pre-construction land type.
- All land rehabilitation will be undertaken using native indigenous species.

9.4.3.1.5 Residual impacts

The application of the mitigation measures is likely to reduce the impact due to loss of habitat within the project area to **Negligible** during construction and operation. It is not considered necessary for the Project to require compensation measures or biodiversity offsets to achieve no-net-loss. However, given that the Project has triggered critical habitat, a Biodiversity Action Plan (BAP) will be required to outline measures to manage critical habitat values. The Plan will also contain a Biodiversity Monitoring and Evaluation Plan that outlines measures to assess Critical Habitat values.

9.4.3.1.6 Monitoring and audit

The following measures are recommended:

- Regular (weekly) checks during construction are to occur along all project boundaries to ensure compliance with clearing within marked boundaries.
- Records are to be kept and regularly reviewed (quarterly) for implementation of the workforce training program for fauna/flora awareness.
- Monitoring if rehabilitation success/failure is to occur on all replanting sites. Monitoring is to consist of regular inspections (quarterly) to determine plant establishment. Where plant establishment is determined to have failed, reestablishment is to occur.

9.4.3.2 Loss of Marine Habitat

9.4.3.2.1 Potential impacts

The intertidal and marine environment associated with the Project is considered to be natural habitat. The intertidal mudflats hold a variety of native aquatic species, including species listed on the IUCN Red List of Threatened Species. Use of the area by fauna species in particular varies and includes use for foraging (for example for wader birds and fish species), pathway for passage to river mouths, and for smaller fauna such as crustaceans and invertebrates, location for residence.

The Irrawaddy Dolphin (IUCN EN) commonly occur in areas affected by freshwater inputs such as river mouths and estuaries, which are habitats present within the Project EAA. The species is cryptic and difficult to identify through survey. A carcass of this species was recently found near the river mouth that leads to the Project Area (70 km away). There has been no records of this species in the past 30 years in the area however this recent record suggest that the species may be present. Based on this information, this species has not triggered critical habitat. Some disturbance to the species is expected during construction and operation, if present (see impact assessment for disturbance below).

Loss of marine habitat from anchoring of turbines is considered to be minimal – 0.010 km^2, which is 0.001% of the marine EAA. There may also be temporary loss of marine habitat as a result of the construction phase (including piling) and laying of the subsea cables.

9.4.3.2.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.2.3 Significance of impacts

Impacts to marine habitat will be negative and direct. The footprint of the Project will be temporarily and permanently converted from the current land type to facilitate the construction and operation of the Project respectively. Impact on marine habitat is localised, to the location of the 28 wind turbines. The magnitude of impact is expected to be **Small** as there will be impact on a small area of habitat (0.001% of natural habitat in the marine EAA). The Project EAA contains habitat that sustains an IUCN Red-listed CR or EN species – Irrawaddy Dolphin. Hence it is classified as **High** sensitivity. The overall significance is therefore considered to be **Moderate**. The impact of habitat loss will continue into operation.

Table 9.25 Loss of Marine Habitat Impact Assessment

Impact Description	Loss of marine habitat				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	**Permanent**	
Impact Extent	**Local**	Regional	International		
Frequency	The loss will be permanent.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.4.3.2.4 Additional mitigation measures

The following mitigation measures are proposed to be applied during construction and continued during operation if necessary:

- Subsea cables will be installed to connect to landfall using shortest length that is feasible. The cable installation will be done on a section-by-section basis, allowing time for the environment to be restored to its previous state once a section is completed.

9.4.3.2.5 Residual impacts

The residual impact significance is **Minor/Negligible**. It is not considered necessary to require compensation measures or biodiversity offsets to achieve no-net-loss for natural habitats. The total habitat losses due to the Project are calculated at 0.010 km^2 marine habitat.

9.4.3.2.6 Monitoring and audit

No specific monitoring is proposed.

9.4.3.3 Disturbance and/or Displacement of Fauna – Terrestrial

9.4.3.3.1 Potential impacts

The disturbance and displacement of resident fauna species within the footprint will primarily be caused by light, noise, vibration and heat impacts for terrestrial habitats. The immediate displacement of fauna will occur during construction works, however the impact to these communities will continue throughout the life of the Project but will be considerably less in extent.

Noise, light, vibration and heat disturbances have the potential to influence breeding, roosting or foraging behaviour of fauna. During the construction phase temporary impacts from the Project are expected. Noise will be the primary disturbance of this nature due to vegetation clearing, excavation, movement of materials, drilling and general construction activities. These activities will introduce noise sources to areas not currently exposed to these disturbances. Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species. In addition there may be vibration associated with drilling activities and the movement of any heavy vehicles/machinery.

The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations. For example if breeding and communication is inhibited influencing lifecycle, or, if individuals are displaced from noisy areas and home ranges are reduced.

There are two (2) Critical Habitat species that exists within the Project EAAA. During the winter migratory period, two bird species may be present in the EAAA – Nordmann's Greenshank and Spoon-billed Sandpiper. These species may be temporarily displaced from their transit habitat between foraging areas and roosts during the wintering period. Impacts therefore may mean temporary changes to flight patterns during construction.

The duration of construction activities is expected to be short-term and will not span multiple breeding seasons. Similarly, it should be noted that the noise, light and vibration disturbances will not be continuous for the construction period. They will occur throughout the Project Area during construction for the Project components identified. However, they are unlikely to occur at all locations simultaneously and will be localized.

9.4.3.3.2 Existing controls

The mitigation measures identified in the locally approved regulatory EIA include:

Construction Phase

- Where possible, all noise-generating construction activities will be restricted to only daytime.

Operation Phase

No existing controls were identified to mitigate this impact.

9.4.3.3.3 Significance of impacts

The nature of the impact will be negative to resident fauna within the Project Area. The impact type is likely to be direct. Disturbance and/or displacement impacts for terrestrial habitats will occur largely during the construction phase (with some impact in the operation phase).The magnitude of impact is expected to be **Small** as the impact will likely affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. The sensitivity of the receptor is considered to be **High**, as the Project EAA contains a nationally designated Protected Area – Thanh Phu, and also habitat potentially of importance to globally EN and CR species, supporting globally significant concentrations of migratory and congregatory species and potentially containing nationally/regionally-important concentrations of an IUCN Red-listed CR or EN species – Nordmann's Greenshank and Spoon-billed Sandpiper. The overall impact significance is therefore considered to be **Moderate**.

Table 9.26 Disturbance and/or Displacement (Terrestrial) Impact Assessment

Impact Description	Disturbance and/or Displacement (Terrestrial)		
Impact Nature	**Negative**	Positive	Neutral
Impact Type	**Direct**	Indirect	Induced

Impact Duration	**Temporary**	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The impact frequency is expected to be intermittent as the likelihood of Critical Habitat species being in the Project Area (e.g. turbines) is anticipated to be possible for the Nordmann's Greenshank and Spoon-billed Sandpiper given that the Project Area contains potential transit habitat during winter migratory period.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.4.3.3.4 Additional mitigation measures

The following mitigation measures are proposed to be applied during the construction phase

- All machinery and hand held equipment used must comply with required air and noise emission standards.
- All light sources are to be directed away from areas of natural habitat.
- A Fauna Shepherding Protocol is to be used within the terrestrial Project Area to ensure that any resident species have vacated the area prior to any clearance work.
- A Fauna Shepherding Protocol is to be used within the terrestrial Project Area to ensure that any resident species have vacated the area prior to any clearance work.

9.4.3.3.5 Residual impacts

With the implementation of the above mitigation measures, the residual impacts are expected to be reduced from **Moderate to Minor/Negligible**.

9.4.3.3.6 Monitoring and audit

No additional monitoring or auditing is proposed.

9.4.3.4 Disturbance and/or Displacement of Fauna – Marine

9.4.3.4.1 Potential impacts

The disturbance and displacement of resident fauna species within the footprint will primarily be caused by light, noise, vibration and heat impacts for the marine habitats as well. The immediate displacement of fauna will occur during construction works, however the impact to these communities will continue throughout the life of the Project but will be considerably less in extent.

Noise, light, vibration and heat disturbances have the potential to influence breeding or foraging behaviour of fauna. During the construction phase temporary impacts from the Project are expected. Noise will be the primary disturbance of this nature due to excavation, movement of materials, drilling and general construction activities, including pile driving in estuarine habitats. These activities will introduce noise sources to areas not currently exposed to these disturbances. Excessive noise can impede fauna communication and deter the use of habitats nearby. Similarly, introducing light sources has the potential to deter foraging and dispersal activities of nocturnal species. In addition there may be vibration associated with drilling activities and the movement of any heavy machinery. Also, as a result of the piling activities, minor impacts to neighbouring benthic habitat is likely within the vicinity of the construction activities, however this is considered to persist only during the construction phase (within 7 months). Minor smothering of benthic organisms is likely to occur during this period in the immediate vicinity where a plume may spread. Some minor increases in turbidity are likely around the piling activities. This is likely to reduce significantly once the construction has finalised and will not persist into operation.

The consequences of these influences are dependent on the extent of disturbance but in extreme cases these factors can influence local populations. For example if breeding and communication is inhibited influencing lifecycle, or, if individuals are displaced from noisy areas and home ranges are reduced.

The nearshore area may play host to marine mammals and turtles. These fauna groups are susceptible to noise impacts as a result of pile driving. Pile driving activities may impact on habitat for these species during construction leading to individual avoidance of the area and changes to behaviour locally. Impacts are likely however to be minor given the intertidal and therefore shallow nature of Project footprint in the mudflat area. Elevated noise and vibration is likely to displace marine species (e.g. epibenthic community, fish, shellfish and mammals) from the turbine location. For cetaceans, there may be disturbance and displacement due to increased number of vessels within the Project Area during construction in addition to pile driving. In particular, underwater piling noise induces considerable hydro sound that is radiated from the piles into the surrounding water. As such, they may be disturbed if underwater noise is uncontrolled, resulting in behavioral changes. Furthermore, as a result of their acute hearing abilities, direct auditory injury may also be inflicted on cetaceans. This would be in the form of temporary threshold shift (TTS; temporary hearing impairment) and/or permanent threshold shift (PTS; permanent hearing impairment) if the cetacean is present in the zone of injury during pile driving. Based on literature review, the minimum distance at which at least TTS would occur for cetaceans is in the range of 1,800 – 2,300 m (Brandt et al., 2011; Madsen et al., 2006; Thomsen et al., 2006). However, these species are likely to re-inhabit the area shortly after the installation of the turbines. Ongoing impacts are considered negligible during operation.

During operation, there may also be disturbance to the marine mammals and benthic organisms in the form of electromagnetic fields (EMF) and heat emission from power cables in the marine habitat, however this is expected to be minimal and be restricted to areas surrounding the cables.

There are no Critical Habitat species that exists within the marine Project EAA. It should also be noted that the noise, light and vibration disturbances will not be continuous for the construction period. They will occur throughout the Project Area during construction for the Project components identified. However, they are unlikely to occur at all locations simultaneously and will be localized.

9.4.3.4.2 Existing controls

The mitigation measures identified in the locally approved regulatory EIA include:

Construction Phase

- Where possible, all noise-generating construction activities will be restricted to only daytime.

Operation Phase

No existing controls were identified to mitigate this impact.

9.4.3.4.3 Significance of impacts

Disturbance and/or displacement impacts for marine habitats will occur largely during the construction phase (with some impact in the operation phase). The nature of the impact will be negative to resident fauna within the Project Area. The impact type is likely to be direct. These impacts are associated with both the construction (temporary) and operation (long-term) phases. The magnitude of impact is expected to be **Small** as the impact will likely affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. The sensitivity of the receptor is considered to be **High**, as the Project EAA contains habitat that potentially plays host to an IUCN Red-listed CR or EN species – Irrawaddy Dolphin. The overall impact significance is therefore considered to be **Moderate**.

Table 9.27 Disturbance or Displacement (Marine) Impact Assessment

Impact Description	Disturbance and/or Displacement (Marine)				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	**Temporary**	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional		International	
Frequency	The impact frequency is expected to be intermittent as the noise, light and vibration disturbances will not be continuous for the construction period, and the frequency of vessel movements is also unlikely to be continuous. EMF and heat disturbance during operation is expected to be continuous throughout operation.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium		**High**	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.4.3.4.4 Additional mitigation measures

The following mitigation measures are proposed to be applied:

Construction Phase

- *All machinery, pile driving equipment and hand held equipment used must comply with required air and noise emission standards.*
- *To reduce the impact to the habitat in the immediate vicinity of the turbine foundations, it is recommended that construction mainly occur during low (or slow) tide conditions when turbidity plumes will not spread.*
- *Acoustic decoupling of noisy equipment on work barges should be undertaken.*
- *Vessel and dredger maintenance to be performed as adequate maintenance, including lubrication and repair of winches, generators, propulsion components and other potential sources is an effective measure for noise reduction.*
- *Pile driving management measures consistent with JNCC (2010) standard pile driving protocol:*
  - Trained Marine Fauna Observers (MFOs) and Passive Acoustic Monitoring (PAM) operatives during pile driving;
  - Mitigation zone of 2000 m (Figure 9.7) will be implemented around piling activities;
  - 30-minute pre-start observations;
  - Delay-start procedure (if marine fauna sighted within the mitigation zone);
  - Soft-start procedure (minimum 20 minutes); and
  - Shut-down procedures if marine fauna sighted within the mitigation zone during pile driving.

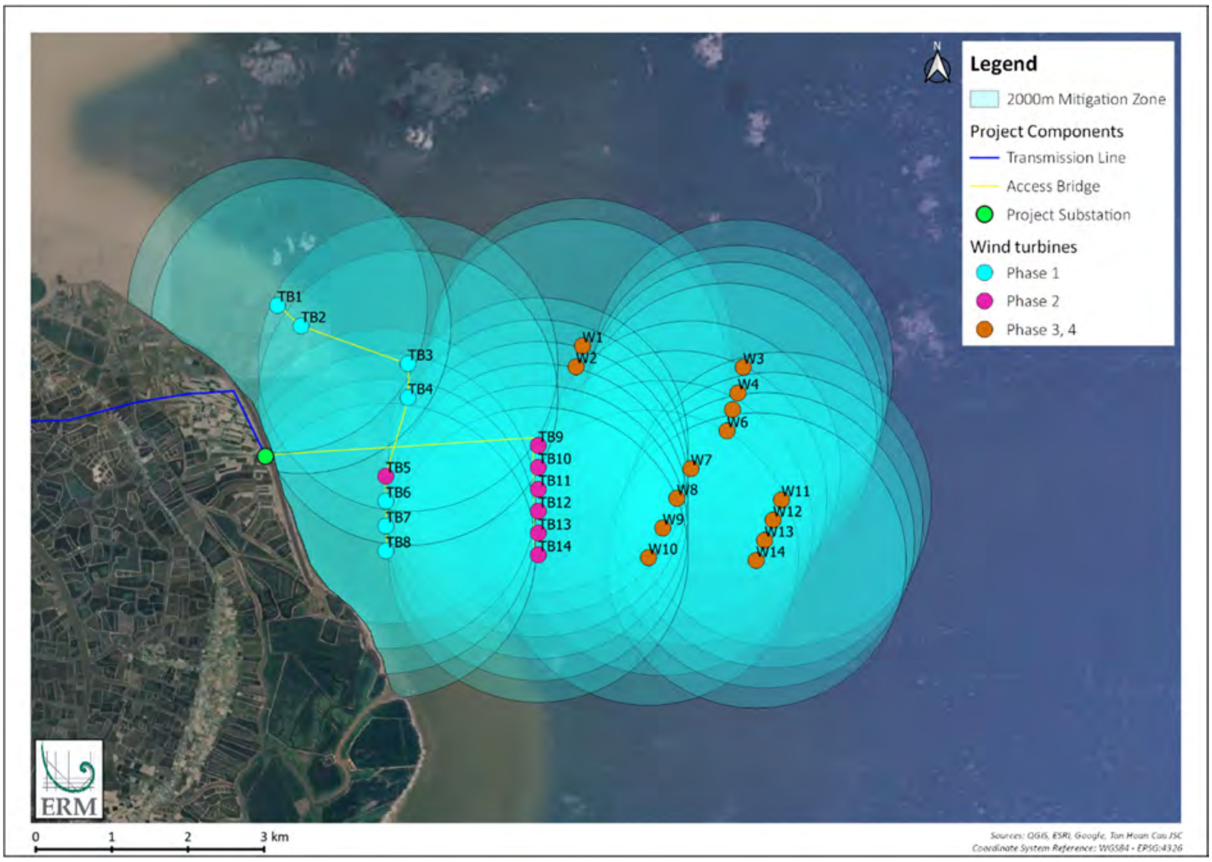


Figure 9.7 Mitigation Zones for Pile Driving

Operation Phase

- Vessel maintenance to be performed as adequate maintenance, including lubrication and repair of winches, generators, propulsion components and other potential sources is an effective measure for noise reduction.
- EMF and heat emission from the export cables will be controlled to an acceptable level, through engineering factors, including current flow, cable configuration, conductivity and permeability of sheathing and armouring materials, as well as consideration on burial depth. The EMF level at the water-sediment interface with a 2m burial depth would be approximately 25% of its initial value versus 60% for a 1m burial depth (Taormina et al., 2018).

9.4.3.4.5 Residual impacts

With the implementation of the above mitigation measures, the residual impacts are expected to be reduced from **Moderate to Minor/Negligible**.

9.4.3.4.6 Monitoring and audit

Records shall be maintained of all marine species sightings in the area, including date and time, weather conditions, species identification, approximate distance from the pile, direction and heading in relation to the pile driving, and behavioural observations. When marine species (marine mammals and turtles) are observed in the mitigation zone, additional information and corrective actions taken such as a shutdown of the pile driver, duration of the shutdown, behaviour of the animal, and time spent in the mitigation zone will be recorded.

9.4.3.5 Barrier Creation, Fragmentation and Edge Effects – Terrestrial

9.4.3.5.1 Potential impacts

Construction activities relating to infrastructure have potential to create a barrier to fauna movement (for some fauna groups). This includes construction of the access roads, the transmission line and other infrastructure. Most other Project components are discrete areas that may be navigated around by fauna that may be moving through the area. The construction of the project will primarily be within modified habitat.

Fragmentation of habitats can occur where currently linked habitats are disconnected through the construction of Project components. Fragmentation reduces the continuity of habitat and hence the ability for fauna to move within and between habitat patches. The resulting impact can cause reductions in access to foraging and breeding habitats. Species with limited home ranges may have a reduction in available area, leading to conflict over resources or negative interactions over territories. Fragmentation of existing habitats is not considered to be a significant impact as the infrastructure design does not lead to isolation of habitat patches and is primarily within modified habitat. This includes impacts as a result of strung wires of the transmission line, which also include bird/bat collision risks (see impact assessment for mortality below).

Edge effects may be generated when vegetation clearing or land disturbance occurs in a current unmodified environment. Creation of new edges in a landscape has potential to cause areas of natural habitat to become vulnerable to impacts such as weed invasion, opportunistic predation and changes in neighbouring vegetation communities. These aspects have potential to reduce the value of natural habitat for native flora and fauna. However, as majority of the Project Area is modified habitat, edge effects are not considered to be a significant impact.

9.4.3.5.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.5.3 Significance of impacts

All these impacts are expected to be minimal on the Critical Habitat species present within the EAA, as these species have relatively large ranges and high mobility. The nature of the impact will be negative to resident fauna within the Project Area. The impact type is likely to be indirect, as a consequence of vegetation clearing and habitat disturbance during construction and ongoing during operation. The magnitude of impact is expected to be **Negligible** as the impacts are likely within the normal range of variation. The sensitivity of the receptor is considered to be **High**, as the Project EAA contains habitat potentially of importance to globally EN and CR species, supporting globally significant concentrations of migratory and congregatory species and potentially containing nationally/regionally-important concentrations of an IUCN Red-listed CR or EN species – Nordmann's Greenshank and Spoon-billed Sandpiper. The overall impact significance is therefore considered to be **Negligible**.

Table 9.28 Barrier Creation, Fragmentation and Edge Effects (Terrestrial) Impact Assessment

Impact Description	Barrier Creation, Fragmentation and Edge Effects (Terrestrial)			
Impact Nature	**Negative**	Positive	Neutral	
Impact Type	Direct	**Indirect**	Induced	
Impact Duration	Temporary	Short-term	Long-term	**Permanent**
Impact Extent	**Local**	Regional	International	
Frequency	Construction will occur only once.			

Impact Magnitude	Positive	**Negligible**	Small	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	**Negligible**	Minor	Moderate	Major	
	Significance of impact is considered to be **Negligible.**				

9.4.3.5.4 Additional mitigation measures

The following mitigation measures are proposed to be applied:

Operation Phase

- Disturbed land not required for the operation of the project will be rehabilitated using native species and minimising the exposed width of the transmission line ROW.

9.4.3.5.5 Residual impacts

With the implementation of the mitigation measures, the residual impact significance is expected to be **Negligible**.

9.4.3.5.6 Monitoring and audit

No specific monitoring is proposed.

9.4.3.6 Barrier Creation, Fragmentation and Edge Effects – Marine

9.4.3.6.1 Potential impacts

Construction activities relating to infrastructure have potential to create a barrier to fauna movement (for some fauna groups). This includes construction of the access bridge, the turbine foundations and other infrastructure. The construction of the project will primarily be within modified habitat, however marine habitat is considered to be natural habitat.

Fragmentation of habitats can occur where currently linked habitats are disconnected through the construction of Project components. Fragmentation reduces the continuity of habitat and hence the ability for fauna to move within and between habitat patches. The resulting impact can cause reductions in access to foraging and breeding habitats. Species with limited home ranges may have a reduction in available area, leading to conflict over resources or negative interactions over territories. It is not considered that marine habitats will be physically fragmented due to erection of stays for the turbines. However, noise generated during construction activities (i.e. piling) may result in habitat fragmentation as marine mammals (such as the Irrawaddy Dolphin) that may avoid the entire channel if present and use alternative routes.

Edge effects may be generated when land clearing or disturbance occurs in a current unmodified environment. Creation of new edges in a landscape has potential to cause areas of natural habitat to become vulnerable to impacts such as weed invasion, opportunistic predation and changes in neighbouring vegetation communities. These aspects have potential to reduce the value of natural habitat for native flora and fauna. Minor and localised edge effects may occur along the edge of the subsea cables that may be subject to increases in heat during operation. Localised impacts to epifauna may be possible.

9.4.3.6.2 Existing controls

The mitigation measures identified in the locally approved regulatory EIA include:

Construction Phase

- Where possible, all noise-generating construction activities will be restricted to only daytime.

Operation Phase

No existing controls were identified to mitigate this impact.

9.4.3.6.3 Significance of impacts

The nature of the impact will be negative to resident fauna within the Project Area. The impact type is likely to be indirect, as a consequence of clearing and habitat disturbance during construction and operation. The magnitude of impact is expected to be **Small** as the impacts affect a small area of habitat, without the loss of viability/function of the habitat. The sensitivity of the receptor is considered to be **High**, as the Project EAA contains habitat that potentially plays host to an IUCN Red-listed CR or EN species – Irrawaddy Dolphin. The overall impact significance is therefore considered to be **Moderate**.

Table 9.29 Barrier Creation, Fragmentation and Edge Effects (Marine) Impact Assessment

Impact Description	Barrier Creation, Fragmentation and Edge Effects (Marine)				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	Direct	**Indirect**	Induced		
Impact Duration	Temporary	Short-term	Long-term	**Permanent**	
Impact Extent	**Local**	Regional	International		
Frequency	Construction will occur only once, while impact frequency will be continuous throughout operation.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.4.3.6.4 Additional mitigation measures

The following mitigation measures are proposed to be applied during the construction phase

- All machinery, pile driving equipment and hand held equipment used must comply with required air and noise emission standards.
- Pile driving management measures consistent with JNCC (2010) standard pile driving protocol:
  - Trained Marine Fauna Observers (MFOs) and Passive Acoustic Monitoring (PAM) operatives during pile driving;
  - Mitigation zone of 2000 m (refer to Figure 9.7) will be implemented around piling activities;
  - 30-minute pre-start observations;
  - Delay-start procedure (if marine fauna sighted within the mitigation zone);
  - Soft-start procedure (minimum 20 minutes); and
  - Shut-down procedures if marine fauna sighted within the mitigation zone during pile driving.

9.4.3.6.5 Residual impacts

With the implementation of the mitigation measures, the residual impact significance is expected to be **Minor/Negligible**.

9.4.3.6.6 Monitoring and audit

Records shall be maintained of all marine species sightings in the area, including date and time, weather conditions, species identification, approximate distance from the pile, direction and heading in relation to the pile driving, and behavioural observations. When marine species (marine mammals and turtles) are observed in the mitigation zone, additional information and corrective actions taken such as a shutdown of the pile driver, duration of the shutdown, behaviour of the animal, and time spent in the mitigation zone will be recorded.

9.4.3.7 Degradation of Habitat

9.4.3.7.1 Potential impacts

A range of Project activities have the potential to lead to degradation of flora and fauna habitats including excavation, construction, land clearing, movement of vehicles, barging, drilling, refuelling, hazardous materials storage and maintenance. In general the impacts may result in: dust; runoff; release of potential contaminants; and introduction or spread of invasive species. Construction activities have been assessed for these impact types, including: construction of the access roads, erection of transmission towers, erection of wind turbines and installation of cables/wires and installation of associated infrastructure (such as the substation and laydown area). The type and scale of impacts are variable between activities undertaken in the marine environment and those undertaken on land.

Dust

During construction on land, movement of vehicles, clearing and excavation activities have the potential to generate dust which may settle on vegetation adjacent to the construction area (including access roads). Excessive dust deposition on flora may act to suppress growth through limiting photosynthesis and the dusted foliage may also become unpalatable to foraging fauna. The construction activities will be temporary and dust generation is likely to be localised to active work areas. Rainfall will generally remove dust from foliage.

In addition to land disturbance, activities in the substrate of the marine environment or in tidal areas (that may include mangrove communities), will mobilise sediments into the water body. Mobilised sediments have the potential to settle in adjacent areas, however, the existing environment is dominated by mudflats, mangroves and tidal areas where fine sediments are typical and flora and fauna are generally adapted to settlement of fine sediment.

Erosion

Land preparation will expose earth areas to erosion (wind and/or runoff) until construction or replanting is completed to stabilise the surface. Erosive processes transport sediment depositing mobilized sediment downslope of terrestrial habitats and potentially into adjacent waterways. This indirect impact has potential to degrade downstream habitat areas or change habitat characteristics, and as such influencing suitability for native flora and fauna communities. Downstream, natural habitats include the mangrove community, the mudflats and the marine environment. These habitats (mangroves and mudflats) are often associated with fine sediments that are easily redistributed with flora and fauna adapted to fine sediments. As a result the potential for negative influence for native flora and fauna is expected to be minor.

During construction within the marine environment (the mudflats as well as any tidal areas), movement of vessels, excavation activities and drilling or piling will cause local impacts to water quality by increasing the turbidity of water. Many mangrove areas are also tidal and as such this community is vulnerable to these impacts as well. Mudflats and mangroves are often associated with fine sediments and are often associated with elevated turbidity.

Release of contaminants

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

During construction within the marine environment, accidental release or spill of fuels, chemicals and hazardous substances from piling vessels, concrete barges and other supporting vessels may also impact on fauna. The key impact from spills will be the contamination of seawater and sediments in the nearshore Project Area.

Invasive species

Invasive species (flora and fauna) have the potential to be introduced or spread throughout the Project Area through increased movement of people, vehicles, machinery, vegetation and soil. Natural habitat areas are most sensitive to the introduction of invasive species. An increase in the prevalence of weeds or other pests has the potential to reduce the quality of habitat for some native flora and fauna, including conservation significant species. Invasive flora species can rapidly germinate in disturbed areas whereby affecting the ability of native vegetation communities to re-establish. Invasive animals also have the potential to be introduced or increased in abundance. These animals may adversely impact native fauna as a result of increased competition for resources, predation or habitat degradation. While this impact can be significant, the existing environment is already highly modified.

Marine pests are also a consideration given construction activities will require vessels and a barge to be mobilised to the Project Area. Vessels that pass through different locations pose a risk of spreading marine pests that can compete with native species and damage coastal areas.

For the two (2) Critical Habitat species (Nordmann's Greenshank and Spoon-billed Sandpiper), as no wintering habitat exists within the Project Area, impacts are therefore expected to be minimal.

9.4.3.7.2 Existing controls

- Loose vegetation as a result of construction activities will be collected and deposited at areas near operation house and/or laydown areas and fenced up for natural decomposition.
- Disturbed land not required for the operation of the project will be rehabilitated.

The mitigation measures identified (if any) related to dust, erosion, and release of contaminants are outlined in previous sections of the environmental impact assessment.

9.4.3.7.3 Significance of impacts

The nature of the impact will be negative to resident fauna within the Project Area. Impacts to terrestrial and marine environments are localised and limited to where clearing or land disturbance is required. The impact type is likely to be indirect, as a consequence of vegetation clearing and habitat disturbance. The magnitude of impact is expected to be **Small** as the impacts affect a small area of the habitats, but does not result in loss of viability/function of the habitats. The sensitivity of the receptor is considered to be **High**, as the Project EAA contains a nationally designated Protected Area – Thanh Phu, and also contains habitat potentially of importance to globally EN and CR species, supporting globally significant concentrations of migratory and congregatory species and potentially containing nationally/regionally-important concentrations of an IUCN Red-listed CR or EN species – Nordmann's Greenshank and Spoon-billed Sandpiper. The overall impact significance is therefore considered to be **Moderate**.

Table 9.30 Degradation of Habitat Impact Assessment

Impact Description	Degradation of Habitat			
Impact Nature	**Negative**	Positive	Neutral	
Impact Type	Direct	**Indirect**	Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent

Impact Extent	**Local**	Regional		International	
Frequency	Construction will occur only once.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium		**High**	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.4.3.7.4 Additional mitigation measures

The following mitigation measures are proposed to be applied during construction and continued during operation if necessary:

- Sediment and erosion control measures are to be used in all terrestrial areas of construction to minimise soil contaminated runoff entering waterways. These measures are to be outlined in a Sediment and Erosion Control Plan.
- Similar sediment control measures are also to be used in intertidal and marine areas of construction to limit sediment mobilisation to adjacent areas, including silt curtains to be installed around work areas and ensuring area of dredging is minimised as much as possible. These measures are also to be outlined in the Sediment and Erosion Control Plan.
- Develop and implement appropriate emergency spills response procedures to avoid and manage accidental spills of any fuels, oils or other chemicals during construction activities.
- Avoid construction in intertidal areas (mangroves and mudflats) when water is present where possible. Where it is not practical for construction during lowest tide conditions, avoid peak ebb and flow periods when water movement is at its maximum.
- Disturbed land not required for the operation of the project will be rehabilitated using native species.
- Existing populations and the introduction of new invasive species into natural habitats are to be managed. These measures are to be outlined in an Invasive Species Management Plan incorporated into the BAP and include measures such as:
  - The provenance of any fill material brought onto the site is to be checked regarding invasive species contamination.
  - Vehicle inspection and/or wash down procedures are to be used to reduce the transmission of invasive species into and from the Project Area(s).
  - Invasive species control measures are to be utilised in areas of natural habitat.
  - Vessels used to transport turbine components and to erect turbines in the marine environment will be checked to be free of marine pests prior to use.

9.4.3.7.5 Residual impacts

The implementation of the mitigation measures are likely to limit the extent of these impacts, reducing the impact magnitude to negligible. The residual impact significance is **Minor**.

9.4.3.7.6 Monitoring and audit

Monitoring will be required as part of the Invasive Species Management Plan and rehabilitation works.

9.4.3.8 Mortality – Birds

9.4.3.8.1 Potential impacts

Mortality risks of birds as a result of the Project differs for the construction and operation phases. During the construction phase, mortality of birds may occur due to vehicle or machinery strike, falling debris, or hunting or poaching as a result of worker influx. Heightened risk of mortality for avifauna during operation of the windfarm may be a risk to birds within the Project Area. This mortality risk arises from possible collision and electrocution with the transmission line and potential collision with the wind turbines.

Results from the vantage point survey indicated that most bird species inhabiting the Project Area fly lower than the Rotor Swept Zone (RSZ) (35 – 150 m). Only three species including Common Tern (IUCN LC), Caspian Tern (IUCN LC) and Little Egret (IUCN LC) were recorded to fly in the RSZ in the dry season. These species are not Critical Habitat trigger species. The pattern observed of most birds in the Project Area flying below the rotor height suggests the collision risk between birds and wind turbines is relatively low.

Critical Habitat trigger species Nordmann's Greenshank have been observed flying at low heights up to 20 m while foraging (Zöckler et al., 2018). It was also observed at another project site nearby to fly below 35 m in height to forage at sea at dawn and return at dusk to wetland roosting sites onshore and therefore, would be unlikely to be impacted by the turbines during operation. However, the elevation range of the other Critical Habitat trigger species (Spoon-billed Sandpiper) is recorded as 0 – 70 m (BirdLife International, 2018c), which overlaps with the RSZ.

As a result of the low level of flight activity recorded within the Project Area by the surveys, the overall risk of bird collision with turbines is considered low, and as such collision risk modelling was not warranted and has not been undertaken as part of this impact assessment. Impacts to bird species may occur from time to time, however given their low densities and observations at the Project site indicating that most species fly below the RSZ, the risk of impact is considered to be low.

9.4.3.8.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.8.3 Significance of impacts

The impacts on birds relate to the collision risk with the transmission line and the turbines during wind farm operation. Impacts are restricted to the location of the transmission line and 28 wind turbines. The impact magnitude is considered **Small** as the impact will likely affect a small proportion of a population, but does not substantially affect other species dependent on it, or the populations of the species itself. The receptor sensitivity is considered **High** as the Project EAA contains habitat potentially of importance to globally EN and CR species and potentially supporting globally significant concentrations of migratory and congregatory species – Nordmann's Greenshank and Spoon-billed Sandpiper. Significance of impact is therefore considered to be **Moderate.**

Table 9.31 Bird Mortality Impact Assessment

Impact Description	Bird Mortality			
Impact Nature	**Negative**	Positive	Neutral	
Impact Type	**Direct**	Indirect	Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent
Impact Extent	**Local**	Regional	International	
Frequency	The transmission line and turbines will be operational 24hrs of the day. Impact frequency is expected to be intermittent over the operation phase. However, the			

	likelihood of occurrence, and thus collision, of substantial numbers of the Critical Habitat species is low because of the relatively small footprint of the Project as compared to the extent of occurrences (EOOs).				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

9.4.3.8.4 Additional mitigation measures

The following mitigation measures are proposed be applied during the construction and operation phases:

Construction Phase

- Hunting and poaching will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation.

Operation Phase

- The transmission line will include the following measures:
  - Use of bird deflectors on the length of the power line. The deflectors will increase line visibility by thickening the appearance of the line for easier detection by avifauna;
  - Moveable markers of contrasting colours (e.g. black and white) that protrude above and below the line, and be placed 5-10 m apart;
  - Removing the thin neutral or earth (shield) wire above the high voltage transmission lines where feasible, and where this is not possible, marking the line to make it more visible;
  - Minimising the vertical spread of power lines. Having lines in a horizontal plane reduces collision risk;
  - Habitat manipulation to influence flight activity and bird behaviour, e.g. tree lines under the high voltage lines to increase visibility;
  - Insulating cables close to poles, at least 70 cm on both sides and around perching areas, and up to at least 140 cm; and
  - Hanging insulators under cross arms and poles, provided the distance between a likely perch (mainly the transmission tower cross arm) and the energised parts (conductors) is at least 70 cm.
- Installation of colourful or reflective components at strategic points on the propellers (depend on the final design of the wind turbines) to deter birds.
- Given that the Project has triggered critical habitat, development of a Bird Management Plan in the BAP is required to outline measures specific to bird species. The plan may include:
  - Seasonal studies during the initial phase of operation in support of adaptive impact management to bird populations.

9.4.3.8.5 Residual impacts

The implementation of the mitigation measures are likely to limit the extent of these impacts, reducing the impact magnitude to negligible. The residual impact significance is **Minor/Negligible**.

9.4.3.8.6 Monitoring and audit

Monitoring will be required as part of the Bird Adaptive Management Monitoring in the BAP. Fatalities will be recorded along with information relating to the season, species and location of the fatalities to assist in determining whether management measures are required to be adjusted. The requirements for monitoring are to be outlined within the BAP prepared for the Project.

9.4.3.9 Mortality – Bats

9.4.3.9.1 Potential impacts

Mortality risks of bats as a result of the Project differs for the construction and operation phases. During the construction phase, mortality of bats may occur due to vehicle or machinery strike, falling debris, or hunting or poaching as a result of worker influx. Heightened risk of mortality for volant fauna during operation of the windfarm may be a risk to bats within the Project Area. This mortality risk arises from possible collision and electrocution with the transmission line and potential collision with the wind turbines.

The risk of turbine collision impact on bats has been assessed using species-based risk assessment informed by species ecology and biology. Species' distribution data from IUCN Red List suggests 36 bat species (of 7 families) might inhabit or frequent the Project Area and its vicinity. This information was collated from previous records and ecological assumptions of each species' distribution ranges, biogeographical conditions and expert opinions. Data from the GBIF database shows only one bat specimen found within a 25 km radius of the Project Area – a Greater Bamboo Bat (*Tylonycteris robustula*) – back in 1929. There are no bats recorded between 25 km and 50 km of the Project Area, however 92 bat individuals have been identified between 50 km and 100 km from the Project Area. Based on available information on the 36 bat species that may occur within the Project Area, the risk of turbine impact on each species was evaluated and presented in Table 9.32 below. Bat species that may occur in the Project Area and its vicinity are small-bodied species that unlikely to fly far in the open sea against strong wind. Since all turbines of the project will be located offshore, the impact is generally minimized.

For the 8 high-risk bat species identified, of which 3 were identified during field surveys within the Project EAA, current data suggests that these species do not forage at sea and hence would not fly through the RSZ. These species are insectivorous bats that forage in unobstructed airspaces found in large clearings or high above the forest canopy (open-space foragers) and hence are likely to forage in nearby terrestrial agricultural areas only. The species are likely to be of low density in the landscape if they are present and would be restricted to terrestrial environments. Individuals may, from time to time, travel along the shoreline between habitat patches for foraging. From the field surveys, bat activity was found to be higher inland than the beach/open sea area. However, there was still activity recorded at the beach, suggesting that several bat species may still fly toward the open sea. Nonetheless, bat fauna are less likely to be encountered 1 km offshore and near to the proposed turbines. Impact magnitude on bats due to the Project is therefore considered to be small.

Table 9.32 Results of species-based risk assessment matrix

	Risk of turbine impact		
Factor	**Low risk**	**Medium Risk**	**High Risk**
Habitat reference	Bats preferring cluttered habitat	Bats able to exploit background cluttered space	Bats preferring to use open habitat
Echolocation characteristics	Short range High frequency Low intensity	Intermediate – more plastic in their echolocation	Long range Low frequency High intensity

	Risk of turbine impact		
Factor	**Low risk**	**Medium Risk**	**High Risk**
	Detection distance ~15m		Detection distance ~80m
Wing shape	Long wing loading Low aspect ratio Broadest wing	Intermediate	High wing loading High aspect ratio Narrow wings
Flight speed	Slow	Intermediate	Fast
Flight behaviour and use of landscape	Manoeuvre well Will travel in cluttered habitat Keeps close to vegetation Gaps may be avoided	Some flexibility	Less able to manoeuvre May avoid clustered habitat Aerial hawker Feed in open habitat
Migration	Local or regional movements	Regional migrant in some parts of range	Long-range migrant in some parts of range
Species or taxa that match at least one criterion	*Hipposideros pomona* *Cynopterus brachyotis* *Cynopterus sphinx* *Eonycteris spelaea* *Macroglossus sobrinus* *Megaerops niphanae* *Pteropus vampyrus* *Rousettus amplexicaudatus* *Rousettus leschenaultii* *Rhinolophus malayanus* *Rhinolphus microglobosus* *Rhinolophus stheno* *Kerivoula hardwickii* *Kerivoula picta* *Murina cyclotis* *Tylonycteris pachypus* *Glischropus tylopus*	*Hipposideros armiger* *Hipposideros diadema* *Hipposideros galeritus* *Hipposideros larvatus* *Megaderma lyra* *Megaderma spasma* *Rhinolophus acuminatus* *Rhinolophus affinis* *Myotis horsfieldii* *Myotis muricola* *Myotis rosseti*	*Taphozous melanopogon* *Taphozous theobaldi* *Miniopterus magnate* *Miniopterus schreibersii* *Pipistrellus coromandra* *Pipistrellus javanicus* *Pipistrellus tenuis* *Scotophilus kuhlii*
	Total: 17 species	**Total: 11 species**	**Total: 8 species**

9.4.3.9.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.9.3 Significance of impacts

The impacts to bats relate mostly to the collision risk with turbines during turbine operations. Impacts are therefore restricted to the location of the wind turbines area and the transmission line. The transmission line and turbines will be operational 24hrs of the day. Impact frequency is expected to be intermittent over the operation phase. The impact magnitude is considered **Small** because there are few or no potential roost features. Similarly, there is low quality foraging habitat that could be used by small numbers of foraging bats (IUCN LC). In addition the turbines are located offshore whereas foraging would occur over the terrestrial area. Thus it may affect a small proportion of the populations, but does not substantially affect other species dependent on it, or the populations of the species themselves. Therefore, the receptor sensitivity is considered **Low.** Significance of impact is therefore considered to be **Negligible.**

Table 9.33 Bat Mortality Impact Assessment

Impact Description	Bird Mortality				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The transmission line and turbines will be operational 24hrs of the day. Impact frequency is expected to be intermittent over the operation phase.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	**Low**	Medium	High		
Impact Significance	**Negligible**	Minor	Moderate	Major	
	Significance of impact is considered to be **Negligible.**				

9.4.3.9.4 Additional mitigation measures

The following mitigation measures are proposed to be implemented during the construction and operation phases:

Construction Phase

- Any trees to be cleared will be checked for roosting bats prior to felling. These trees will be avoided where possible.

Operation Phase

- Elimination of blade movement by feathering blades (blades pitched 90° and parallel to the wind) at or below normal cut-in speeds when turbines are not producing electricity into the power grid.
- Habitat modification measures are to be used within the shoreline adjacent to the Project Area to introduce deterrents and reduce bat foraging opportunities. These measures are to include:
  - ensuring all night lighting of the turbines consists of LED lights (LED lights may deter some bat genera) (Spoelstra et al., 2017); and

  - using lights that have low ultraviolet wavelengths onshore and offshore (reduce insect congregations around lights that bats forage on).

- Development of a Bat Management Plan in the BAP is recommended in order to better understand bat utilisation within the Project Area. The plan may include:
  - Seasonal studies during the initial phase of operation in support of adaptive impact management to bat populations.

9.4.3.9.5 Residual impacts

The residual impact significance is likely to be **Negligible**.

9.4.3.9.6 Monitoring and audit

Monitoring will be required as part of the Bat Adaptive Management Monitoring in the BAP. The requirements for monitoring are to be outlined within the BAP prepared for the Project.

9.4.3.10 Mortality – Marine mammals

9.4.3.10.1 Potential impacts

Mortality risks of marine mammals (e.g. cetaceans) as a result of the Project, unlike those of birds and bats, are similar for the construction and operation phases. During the construction and operation phases, mortality of marine mammals may occur due to vessel or machinery strike as a result of increased number of vessels during construction or maintenance.

9.4.3.10.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.10.3 Significance of impacts

These impacts are related to the collision risk of the vessels. Impacts are restricted to the location of the offshore Project Area. Impact magnitude is considered **Small** because the impact may affect a small proportion of the population, but does not substantially affect other species dependent on it, or the populations of the species itself. Receptor sensitivity is **High** as Project EAA contains habitat that potentially plays host to an IUCN Red-listed CR or EN species – Irrawaddy Dolphin. Impact significance is therefore determined **Moderate.**

Table 9.34 Marine Mammal Mortality Impact Assessment

Impact Description	Marine mammal mortality				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The impact frequency (i.e. the frequency of vessel movement) cannot be determined, however it is expected to be low due to low likelihood of vessel collision.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	Medium	**High**		

Impact Significance	Negligible	Minor	**Moderate**	Major
	Significance of impact is considered to be **Moderate.**			

9.4.3.10.4 Additional mitigation measures

The following mitigation measures are proposed to be applied during construction and continue during operation if necessary:

- Work vessel speed will have a speed limit of 6 knots within the Project EAA and within the 1500m precautionary zone. Slow moving vessel would not pose a significant risk to marine mammals including young animals. The risk of vessel strike would also be managed through precautionary measures such as using marine mammal spotters during transit.

9.4.3.10.5 Residual impacts

The residual impact significance is likely to be **Minor/Negligible**.

9.4.3.10.6 Monitoring and audit

Records shall be maintained of all marine mammal species sightings in the area, including date and time, weather conditions, species identification, approximate distance from the vessel, direction and heading in relation to the vessel, and behavioural observations.

9.4.3.11 Mortality – Other fauna

9.4.3.11.1 Potential impacts

Mortality risks of other fauna as a result of the Project are mainly present in the construction phase. During the construction phase, mortality of other fauna may occur due to vehicle strike and hunting or poaching as a result of worker influx during construction.

Although not a Critical Habitat species due to lack of data, the Ngo Van Tri's Lady Butterfly Lizard (IUCN VU) is a species of conservation concern owing to its little known (and potentially highly restricted) range and its presence near the Project Area. It was identified during field surveys. This species is recently discovered and only found in Vietnam, and it is only known from the type locality in Binh Chau–Phuoc Buu Nature Reserve, Xuyen Moc District, Ba Ria–Vung Tau Province, to which it is believed to be endemic (Grismer & Grismer, 2010). It thrives in disturbed habitats, and is common where it is found. It is trapped by locals and sold to restaurants to be marketed as food (Grismer, pers. comm.). In additional, the Small-clawed Otter is also identified in the semi-structured interview, as fauna likely to be caught and sold locally. Hence, the mortality risk of these fauna may be increased as a result of the construction activities and the accompanying worker influx.

9.4.3.11.2 Existing controls

No existing controls were identified to mitigate this impact.

9.4.3.11.3 Significance of impacts

Mortality risks of these species are directly related to the transportation activities of construction and indirectly related to the Project in the form of worker influx and possible poaching. These impacts are related to the construction activities of the Project. Impacts are restricted to the location of the terrestrial portion of Project Area. The impact may affect a small proportion of the population, but does not substantially affect other species dependent on it, or the populations of the species itself, hence the impact magnitude is **Small**. Receptor sensitivity is considered **Medium** because species included on the IUCN Red List of Threatened Species as Vulnerable (VU), Near Threatened (NT) or Data Deficient (DD). Impact significance is therefore **Minor.**

Table 9.35 Other Fauna Mortality Impact Assessment

Impact Description	Marine mammal mortality				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The impact frequency (i.e. the frequency of vessel movement) cannot be determined, however it is expected to be low due to low likelihood of vessel collision.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered to be **Minor.**				

9.4.3.11.4 Additional mitigation measures

The following mitigation measures will be applied:

- A Fauna Shepherding Protocol is to be used within the Project Area to ensure that any resident species have vacated the area prior to any clearance work.
- Hunting and poaching will be prohibited for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws for clearing vegetation.

9.4.3.11.5 Residual impacts

The residual impact significance is likely to be **Negligible**.

9.4.3.11.6 Monitoring and audit

No specific monitoring measures are identified.

9.5 Shadow Flicker Impact Assessment

Shadow flicker is a term used to describe the pattern of alternating light intensity observed when the rotating blades of a wind turbine cast a shadow on a receptor under certain wind and light conditions. Shadow flicker occurs under a limited range of conditions when the sun passes behind the hub of a wind turbine and casts an intermittent shadow over neighbouring properties.

9.5.1 Scope of Assessment

9.5.1.1 Scope of work

Shadow flicker is a term used to describe the pattern of alternating light intensity observed when the rotating blades of a wind turbine cast a shadow on a receptor under certain wind and light conditions. Shadow flicker occurs under a limited range of conditions when the sun passes behind the hub of a wind turbine and casts an intermittent shadow over neighbouring properties.

Certain weather conditions at the site, such as bright sunshine, will greatly enhance the occurrence and intensity of shadow flicker, whereas cloud density, haze or fog will cause a reduction in shadow flicker. Receptors further away from the turbines which may have experienced a shadow flicker effect under bright sunshine conditions will, as a result of the abovementioned poor weather conditions, experience either no effect or effects greatly reduced in intensity. The distance between receptors and turbines has a large effect on the intensity of shadow flicker. Shadow flicker intensity can be defined as the difference in brightness between the presence and absence of a shadow at any given location. This study does not examine variations in intensity but rather the number of hours shadow flicker might occur, whether it is clearly distinct or barely noticeable. The assessment takes a conservative worst-case approach where it is assumed the sun is always shining (from sunrise to sunset), the turbine is always running and the rotor is oriented perpendicular to neighbours.

It is to be noted that shadow flicker assessment was done, considering SIEMENS SG 4.5-145 wind turbine specifications, proposed to be used in this Project. Considering all the above points, the likelihood of shadow flicker occurring is greatest when the circumstances listed below exist simultaneously.

- The receptor is at a position which is between 130° clockwise (1) and anticlockwise from north and located within 10 turbine rotor diameters of the wind turbine (~1,500 m).
- The sun is shining and visible in the sky, in line with the monthly mean sun-shine hours at nearby location.
- The wind speeds are between 3 m/s and 22 m/s and the turbine is therefore in operation.
- The turbine blades are perpendicular to the line between the sun and the observer or receptor most of time.

The turbines (proposed to be used in this Project) being considered operate at a frequency outside the range where negative health effects may result. Potential effects on people are likely to be limited to nuisance.

9.5.1.2 Applicable Reference Framework

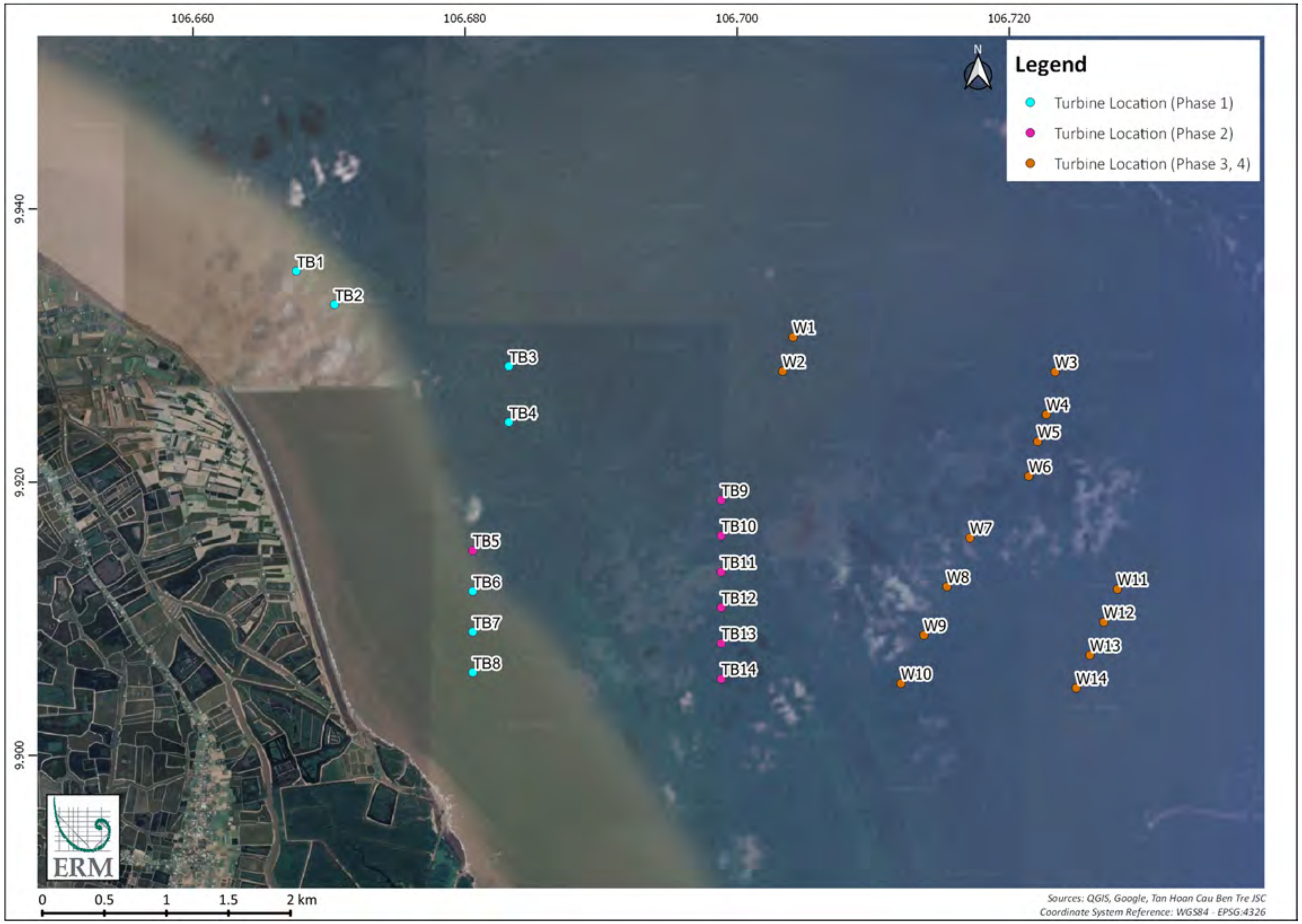
ERM has conducted the assessment with respect to the following requirements of the specified framework as follows:

- Applicable local, national and international laws and regulations;
- International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012);
- The applicable IFC/World Bank Guidelines:
  - General Environment, Health and Safety (EHS) Guidelines (2007),
  - Environmental, Health and Safety Guidelines for Wind Energy, dated August 2015.

In the Vietnam context, at present, there is neither regulation nor decided level of shadow flicker identified as causing a significant effect[45]. However, the Danish Wind Industry Association note on their website that in Germany, the rule of thumb is that 30 hours shadow flicker a year received at a property is acceptable[46]. The 'Wind Energy Development Guidelines, 2006' published by the Irish Government Department of the Environment, Heritage and Local Government recommend that shadow flicker at neighbouring offices and dwellings within 800 m should not exceed 30 hours per year. A threshold of 30 hours per year has therefore been considered and applied for this assessment.

[45] Assumption based upon review of the Vietnam Environment Administration website.

[46] www.windpower.org



Source: Google Earth Pro as accessed on December 01, 2019 (Satellite Imagery dated 09.10.2018)

Figure 9.8 Map showing the Location of Wind Turbines and Surrounding Features

9.5.1.3 Receptors

The maximum horizontal distance between a receptor affected by shadow flicker and turbine location for example has been identified as being equal to the diameter of the turbine multiplied by ten. In this instance, turbine rotor diameter is considered maximum of 145 m; and therefore an area envelope of 1,500 m from the nearest turbine is used in shadow flicker analyses. However, the shadow receptors have been taken into consideration falling within 2,000 m from centre of the project area to cover larger area. As reported, project will be developed in four (4) phases. Each phase will have seven (7) WTGs. A total of 45 receptors have been identified within the study area considering 28 WTG (for all four phases). All the shadow receptors considered in this study are located within 2,000 m from the nearest WTG locations. Where there is cluster of residential dwelling are present, representative sensitive receptors are selected (sample basis).

9.5.2 Assessment Methodology and Modelling

Shadow flicker calculations have been made using *WindPRO 3.3* software. The model used in this analysis is very conservative and assumes the following conditions:

- the average monthly sunshine hours for Ho Chi Minh City ;
- the wind turbines have been considered operational with wind speed more than 3 m/s and for the same, based on annual wind rose and wind frequency data (wind mast data shared by client) it has been assumed that about 90% time of the year, the wind turbines will be operational;
- the blades of the wind turbines are perpendicular with west-southwest orientation have been considered based on the predominant wind direction available from the wind mast data, which could result in maximum possible size circular/ elliptical;
- there are no trees, or vegetation on the surface which may obscure the line of sight between shadow receptor and turbine;
- the sun can be represented as a single point;
- Flicker is ignored if sun is less than 3° above horizon (due to atmospheric diffusion/ low radiation/ sheltering);
- Sample basis structures/group of residential dwellings identified within 2,000 m around the wind turbine locations are considered as shadow receptors.

The following data inputs were used in this study:

- a digital elevation model of the site (National Aeronautics and Space Administration (NASA) Shuttle Radar Topography Mission (SRTM) Data at 30 m resolution);
- Latitude and longitude at center of the site used to calculate the position of the sun (calculated in GIS using UTM co-ordinates);
- Average monthly sun-shine hours recorded;
- turbine locations – coordinates (provided by the Client);
- turbine rotor diameter for SIEMENS SG 4.5-145 is considered to be 145 m;
- height to bottom of Turbine hub is considered to be 127.5 m;
- tilt angle of the 'window' (always assumed vertical);
- shadow receptors contain on openings measuring 1 m by 1 m facing towards the closest wind turbines; and
- Height above ground level of the 'window' 1 m.

9.5.3 Shadow Flicker Analysis

The map showing the extent of shadow flicker caused by the proposed project to corresponding receptors within 2,000 m from nearest WTG locations is shown in Figure 9.9. Calculated shadow flicker at each identified shadow receptor due to proposed project *(considering SIEMENS SG 4.5-145)* is presented in Table 9.36.

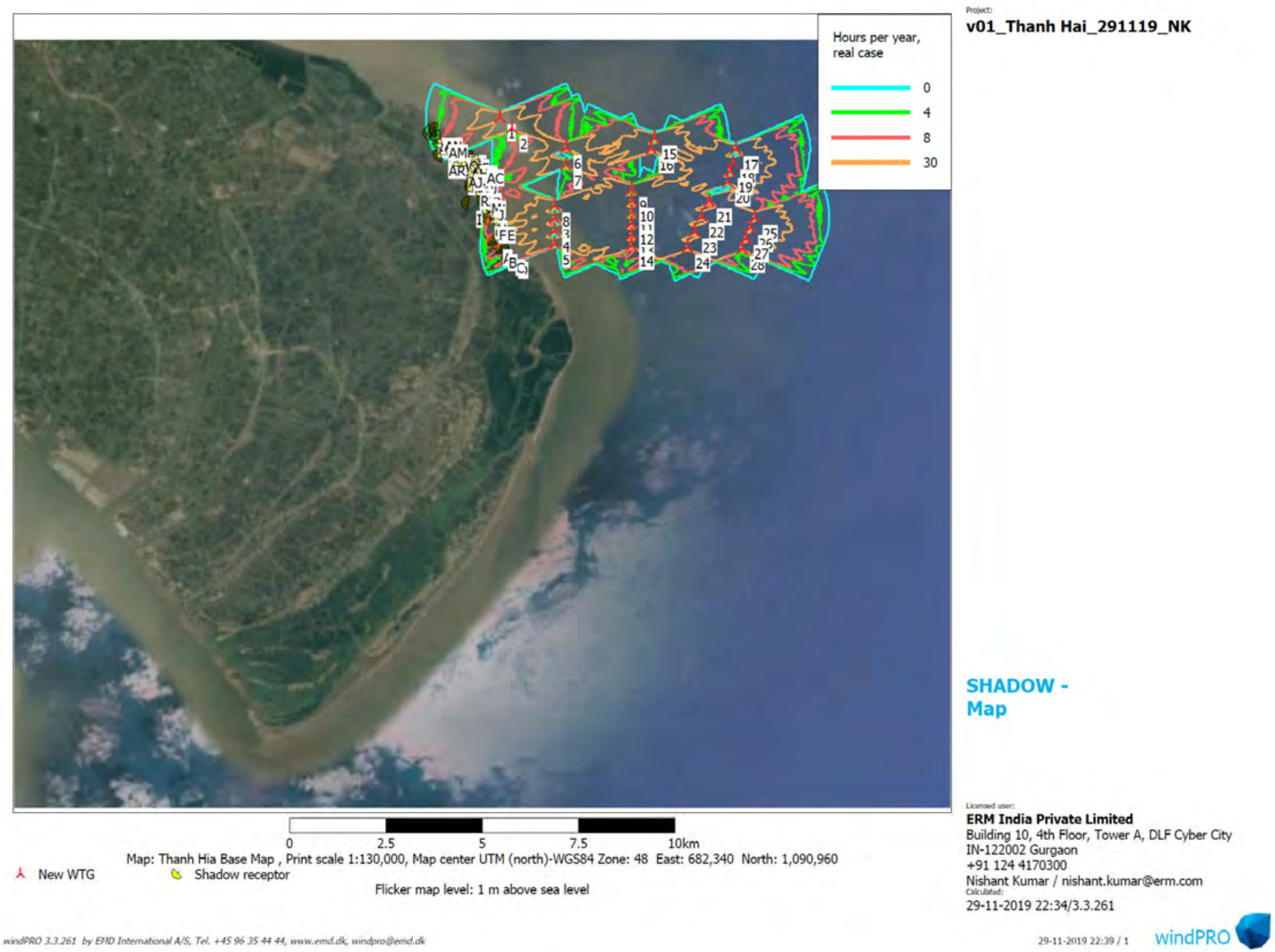


Figure 9.9 Flicker Map showing the Turbines and the Interactions with the Receptors that are Located within 2,000 m

Table 9.36 Shadow Flicker Analysis at Each Receptor (SIEMENS SG 4.5-145)

Shadow Receptor Code	Type of Receptor based on satellite information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow hours per year [hr/year] *	Real Case Scenario Shadow hours per year [hr/year] *¤
Phase 1									
A (SF 1)	Residential Dwelling	48 P	682,822	1,098,737	T08	1,170.9	-101.8	31:18	14:09
B (SF 2)	Residential Dwelling	48 P	683,131	1,098,466	T08	1,220.7	-78.7	20:43	9:24
C (SF 3)	Residential Dwelling	48 P	684,258	1,096,149	T08	1,396.5	-84.9	28:30	13:05
D (SF 4)	Residential Dwelling	48 P	684,259	1,095,819	T08	1,522.9	-106.6	17:46	8:15
F (SF 6)	Residential Dwelling	48 P	684,540	1,097,972	T06	1,448.6	-72.7	26:44	9:59
G (SF 7)	Residential Dwelling	48 P	684,542	1,097,522	T06	1,630.3	-70.8	23:41	8:32
H (SF 8)	Residential Dwelling	48 P	684,256	1,096,479	T06	1,655.7	-54.2	24:22	8:13
Phase 2									
E (SF 5)	Residential Dwelling	48 P	684,261	1,095,489	T06	1,412.3	-81.6	43:30	15:15
I (SF 9)	Residential Dwelling	48 P	686,257	1,096,897	T05	2,230.1	-80.3	0:00	0:00
J (SF 10)	Residential Dwelling	48 P	686,259	1,096,607	T05	1,673.3	-61.2	16:48	5:12
K (SF 11)	Residential Dwelling	48 P	686,260	1,096,317	T05	1,817.9	-61.9	8:44	3:07
L (SF 12)	Residential Dwelling	48 P	686,262	1,096,027	T05	1,767.8	-59.5	10:47	3:32
M (SF 13)	Residential Dwelling	48 P	686,263	1,095,737	T05	1,880.1	-116.2	4:03	1:29

Shadow Receptor Code	Type of Receptor based on satellite information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow hours per year [hr/year] *	Real Case Scenario Shadow hours per year [hr/year] *¤
N (SF14)	Residential Dwelling	48 P	686,264	1,095,447	T05	1,716.3	-62.3	12:47	3:58
Phase 3 & 4									
O (SF 15)	Residential Dwelling	48 P	686,830	1,098,220	T05	1,885.7	-104.2	0:00	0:00
P (SF 16)	Residential Dwelling	48 P	686,748	1,097,942	T05	1,907.9	-98.7	0:00	0:00
Q (SF 17)	Residential Dwelling	48 P	688,944	1,097,948	T05	2,178.7	-109.6	0:00	0:00
R (SF 18)	Residential Dwelling	48 P	688,875	1,097,606	T05	2,203.6	-97.0	0:00	0:00
S (SF 19)	Residential Dwelling	48 P	688,806	1,097,385	T02	1,619.6	-99.5	0:00	0:00
T (SF 20)	Residential Dwelling	48 P	688,736	1,097,103	T02	1,475.6	-49.0	0:00	0:00
U (SF 21)	Residential Dwelling	48 P	688,264	1,096,601	T02	1,338.8	-78.0	0:00	0:00
V (SF 22)	Residential Dwelling	48 P	688,081	1,096,206	T02	1,457.4	-63.4	0:00	0:00
W (SF 23)	Residential Dwelling	48 P	687,898	1,095,811	T02	1,473.7	-85.6	0:00	0:00
X (SF 24)	Residential Dwelling	48 P	687,714	1,095,417	T02	1,305.3	-67.7	0:00	0:00
Y (SF 25)	Residential Dwelling	48 P	689,456	1,096,193	T02	1,569.7	-67.7	0:00	0:00
Z (SF 26)	Residential Dwelling	48 P	689,347	1,095,924	T02	1,428.8	-63.7	0:00	0:00
AA (SF 27)	Residential Dwelling	48 P	689,237	1,095,655	T02	1,322.3	-80.8	0:00	0:00
AB (SF 28)	Residential Dwelling	48 P	689,128	1,095,387	T02	1,302.3	-78.3	0:00	0:00

Shadow Receptor Code	Type of Receptor based on satellite information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow hours per year [hr/year] *	Real Case Scenario Shadow hours per year [hr/year] *¤
AC (SF 29)	Residential Dwelling	48 P	682,822	1,098,737	T02	1,214.1	-92.9	0:00	0:00
AD (SF 30)	Residential Dwelling	48 P	683,131	1,098,466	T02	1,273.4	-81.6	0:00	0:00
AE (SF 31)	Residential Dwelling	48 P	684,258	1,096,149	T02	1,710.3	-78.3	0:00	0:00
AF (SF 32)	Residential Dwelling	48 P	684,259	1,095,819	T02	1,320.8	-127.9	0:00	0:00
AG (SF 33)	Residential Dwelling	48 P	684,261	1,095,489	T02	1,473.8	-75.6	0:00	0:00
AH (SF 34)	Residential Dwelling	48 P	684,540	1,097,972	T02	1,458.9	-80.7	0:00	0:00
AI (SF 35)	Residential Dwelling	48 P	684,542	1,097,522	T01	1,319.5	-122.4	0:00	0:00
AJ (SF 36)	Residential Dwelling	48 P	684,256	1,096,479	T01	1,607.2	0.0	0:00	0:00
AK (SF 37)	Residential Dwelling	48 P	686,257	1,096,897	T01	1,233.7	-123.1	25:56	11:51
AL (SF 38)	Residential Dwelling	48 P	686,259	1,096,607	T01	1,659.6	-101.1	17:51	8:10
AM (SF39)	Residential Dwelling	48 P	686,260	1,096,317	T01	1,614.6	-103.8	14:15	6:36
AN (SF40)	Residential Dwelling	48 P	686,262	1,096,027	T01	1,671.8	-80.9	6:31	3:05
AO (SF 41)	Residential Dwelling	48 P	686,263	1,095,737	T01	1,829.1	-91.5	4:59	2:21
AP (SF 42)	Residential Dwelling	48 P	686,264	1,095,447	T01	1,754.8	-76.3	5:23	2:33
AQ (SF 43)	Residential Dwelling	48 P	686,830	1,098,220	T01	1,480.1	-110.6	14:18	6:40
AR (SF 44)	Residential Dwelling	48 P	686,748	1,097,942	T01	1,788.7	-102.0	0:00	0:00

Shadow Receptor Code	Type of Receptor based on satellite information (1)	Zone	UTM Co-ordinates (mE)	UTM Co-ordinates (mN)	Nearest WTG	Approximate Distance from Nearest WTG [m]	Direction from WTG (Degree from south CW)	Worst Case Scenario Shadow hours per year [hr/year] *	Real Case Scenario Shadow hours per year [hr/year] *¤
AS (SF 45)	Residential Dwelling	48 P	688,944	1,097,948	T01	1,726.6	-96.8	6:45	3:07

(Figures highlighted and bold represent greater than 30 hours per year of shadow flicker)
**Worst-case scenario represents the maximum potential risk of shadow impact.*

Note: Colour coding used to represent exceedance from applicable standards is as follows:

	Shadow hours per year	Max. shadow hours per day
	> 200 hr/year	02:00 hr/day
	200 hr/year < x < 100 hr/year	02:00 hr/day < x < 01:00 hr/day
	100 hr/year < x < 30 hr/year	01:00 hr/day < x < 0:50 hr/day
	< 30 hr/year	< 0.50 hr/day

9.5.1 Impact Assessment

9.5.1.1 Potential shadow flicker impact due to the proposed Project

Given the guidelines of 30 hours or less per year is considered to be acceptable, the operation of the wind farm theoretically results in shadow flicker impacts that could be considered as significant for the purposes of this study. As per the above table, magnitude of the impact is considered to be high in case of shadow hours per year is > 200 hr/year, medium in case of shadow hours per year is 200 hr/year < x < 100 hr/year, low in case of shadow hours per year is 100 hr/year < x < 30 hr/year and acceptable in case shadow hours per year is < 30 hr/year.

The results show that shadow flickers in **real case scenario does not exceed** the standard acceptable limit of 30 hr/year at any of the shadow receptors. In case of worst case scenario, low SF impacts are estimated only at two locations, negligible SF impacts at 19 locations and no impacts at 24 locations.

The maximum shadow flicker occurs at receptor 'E (SF 5)', located close to the wind turbines WTG T06 with a maximum of 43:30 hr./year followed by receptor 'A (SF 1)', located close to wind turbine WTG T08 with a maximum of 31:18 hr./ year in worst case scenario.

9.5.1.2 Existing/ In-place controls

There are no existing controls.

9.5.1.3 Significance of impacts

It is relevant to emphasise that predicted hours of shadow flicker effects are real case scenarios with certain assumptions. Assumptions made during the analysis include optimal meteorological, natural light and geometrical conditions for the generation of shadow flicker. The assessment does not account for trees or other obstructions that intervene between receptor and turbine during times when effects may occur. The assessment calculation is therefore an over estimation in the probability of effects. It should also be noted that for shadow effects to occur, properties need to be occupied, with blinds or curtains open and views to the wind turbine unobstructed.

Impact magnitude varies based on distance of receptors from the WTGs and their orientation. Out of the 2 shadow receptors identified in the study, impact magnitude:

- Small/low impact (100 hr./year < x < 30 hr./year): 02
- Negligible impact (<30 hr./year): 19
- No impact: 24

Considering the small impact magnitude for all the shadow receptor in real case scenario, the impact significance is **Negligible**.

Table 9.37 Impact Significance of Shadow Flickering pertaining to the Project WTGs

Impact	Shadow Flickering during Operation Phase – worst-case scenario				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The turbines will be operational 24hrs of the day.				
Impact Magnitude	Positive	**Negligible**	Small	Medium	Large

Receptor Sensitivity	Negligible	Low	**Medium**	High
Impact Significance	**Negligible**	Minor	Moderate	Major
	Significance of impact is considered to be **Negligible.**			

9.5.1.4 Additional mitigation measures

Although there are no real case of shadow flicker impacts as assessed from the modelling study. However, the following additional mitigations are suggested as below:

- In case the locations have been finalized by the project proponent and earmarked for construction, there needs to be close monitoring through engagement with residents during the operational phase where there are predicted impacts from shadow flicker.
- The likelihood of direct line of sight to the location of proposed turbine locations can be assessed visually and the potential for using screening like higher fencing and planting trees can be explored at problem locations. The use of curtains can also be explored.
- If these prove effective and the impacts mitigated, the shutting down of turbines during certain environmental conditions, which meet the physical requirements for theoretical shadow flicker to occur, will not be required.

Should the impact of shadow flicker be identified, and the mitigation measures proposed above prove ineffective, further analysis can be carried out to identify the exact timings and conditions under which shadow flicker occurs, and a technical solution sought. This is likely to involve pre-programming the turbine with dates and times when shadow flicker would cause a nuisance for nearby receptors. A photosensitive cell can be used to monitor sunlight, and the turbine could potentially then be shut down, when the strength of the sun, wind speed and the angle and position of the sun combines to cause a flicker nuisance.

9.5.1.5 Residual impacts

Residual impacts following the application of required mitigation measures, as discussed above, is likely to result in **negligible** impacts.

9.6 Visual Impact Assessment

Visual impact assessment means assessing the impacts on specific views and on the general visual amenity experienced by people. Landscapes are not static but are dynamic, not least due to the range of natural and human factors that define their characteristics, but also due to the many different pressures that have altered landscapes in the past and will continue to do so in the future. Therefore, determining the significance of visual effects identified can be particularly challenging.

9.6.1 Scope of Assessment

Visual impacts relate to changes that arise in the composition of available views as a result of changes made to the landscape for the Project, to people’s response to any changes, and the overall impacts with respect to visual amenity.

Based on the Shuttle Radar Topography Mission data at 30 m resolution, it is observed that the wind turbines have a site elevation of between 0 and 4 m above mean sea level. It is also noted that there is no major elevation difference between the receptors within 2,000 m of the wind turbines. The Project’s WTG layout is spread across an aerial distance of approximately 2 km.

As stated in the report, the proposed wind farm will be developed in four (4) phases. Each phase comprises of seven (7) wind turbines which makes it 28 wind turbines (considering all four phases) Hub height of the proposed wind turbine (SIEMENS SG 4.5-145) is considered to be 127.5 m. The wind farm is spread across an aerial distance of ~8.5 km (NW to SE).

From the technical specifications of the SIEMENS SG 4.5-145, tower type is tubular steel tower and turbines have rotating blades of ~72.5 m length. The typical turbine colour is light grey and turbines have aviation markings on the blades.

9.6.2 Site Settings

Based on a review of the Project site and surroundings from satellite images and field survey work, the proposed Project area is surrounded by the East Vietnam Sea to the north, south and east directions. To the west, the Project is surrounded by open coastal area (~ 800 m), and beyond this are restaurants, a sparsely populated rural area and dense mangrove forest. The residential area is observed to comprise of residential dwellings (one to two storey houses) as well as community infrastructure such as schools, kindergartens and health centres, which are located within the Project's footprint. The Project area is also a tourist attraction.

Figure 9.10 Examples of landscape that have been observed during the site visit

Figure 9.11 Examples of residential structures and village related infrastructure that have been observed during the site visit.

9.6.3 Receptors

The receptors in the Project area are mostly people occupying individual houses, restaurants and schools and these have been elaborated on in Table 9.36 in order to establish the extent of shadow flicker impacts. However, the nature of impact varies based on the outdoor activities of the residents in the community and the view shed[1]. Following a desktop review and judging by information available, it is understood that there are no historically or culturally relevant structures associated with the landscape of the Project area.

9.6.4 Impact Assessment

9.6.4.1 Potential impacts

It is understood from the google imagery that none of the turbines are within 500 m from the residential area. Out of 28 turbines, only three turbines are within 1,300m from the turbines T01, T02 and T08 but even then it is unlikely to have any direct impact (only transient impacts) on the visual aesthetics of the

[1] The view shed is the area in which the Project could create a recognisable visual impact for a viewer.

area or the people. Some of the scattered residential dwellings close to the coast may have direct impact on the visual aesthetics. People engaged in aquaculture activities near to the project site may have temporary visual impact. Overall it is assessed that as the WTGs are away from the shore it may not have turbines visually noticeable from a distant range.

9.6.4.2 Existing/ in place controls

- The siting has been carried out appropriately so that the Site can comfortably accommodate the proposed number of turbines without being visually overwhelming.
- The turbines are light grey in colour which will help them blend into the background and make the Project less visually obtrusive.

9.6.4.3 Significance of impacts

Considering the number of proposed turbines (seven), the site setting and the existing wind farms in the area, the visual impact magnitude is assessed as **Medium**. This is because the Project will not result in significant changes to the view at an intermediate distance, and offers a less concentrated change across an expansive area. The impact will be medium to long term though not irreversible.

The visual receptors in this case are residents living within the Project area of influence, tourists and people traversing the roads in the Project area. As mentioned above, the Project area is recognised as a tourist destination because of its scenic views. The anticipated changes to visual amenity are not expected to be new or unprecedented, as people in the Project area are already familiar with the view of wind turbines due to the existing projects in the area (another wind turbine project is operational about 7 km from the Project site). Therefore, the sensitivity of visual receptors is assigned as **Low**. Accordingly, the impact significance is considered **Minor.**

Table 9.38 Significance impacts on visual aesthetics

Impact	Visual Aesthetics during Operation Phase				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The turbines will be operational 24hrs of the day.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Receptor Sensitivity	Negligible	**Low**	Medium	High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered to be **Minor.**				

9.6.4.4 Additional mitigation measures

- Use of materials that will minimise light reflection should be used for all Project components.
- Bright patterns and obvious logos should be avoided on WTGs.
- The replacement of wind turbines with visually different wind turbines can result in visual clutter, so replacing wind turbines with the same or a visually similar model over the lifetime of the project may be an important requirement.

- Existing vegetation should be retained to the greatest extent possible. Vegetation should be retained along roads, substations, and other Project infrastructure.

9.6.4.5 Residual impacts

The residual impacts are considered to be **Negligible**.

9.6.4.6 Monitoring and audit

No specific monitoring measures are identified.

9.7 Electric and Magnetic Fields (EMF)

All transformers and transmission lines, especially high voltage lines, emit a type of low frequency non-ionizing radiation caused by the generation of electric fields, due to electric charges (voltage), and magnetic fields, due to the flow of electrical current through transmission lines, which collectively is referred to as Electric and Magnetic Fields (EMF). Exposure to high levels of EMF can pose a health risk for people.

9.7.1 Scope of Assessment

Activities causing the potential impacts to electromagnetic interference (EMI) and stakeholders who are identified as receptors of the impacts are all listed in Table 9.39.

The key activities that are likely to negatively impact receptors during the operation phase include electromagnetic interference generated by the wind turbines transformers, transmission line and substation transformers when the wind turbines are in operation (i.e. once electrical current flows through the conductors).

Table 9.39 Scope of Electromagnetic Interference Assessment

Phases	Potential Activities	Potential Impacts	Potential Consequences	Receptor
Operation (onshore activities)	Waste, emissions (including electromagnetic interference) and discharge generation, handling and disposal	Electromagnetic fields from transmission line and transformers in substations	Health risks	Receptors along the transmission line and near the substation

9.7.2 Impact Assessment

9.7.2.1 Transmission line

9.7.2.1.1 Potential impacts

EMF can affect human health directly and indirectly. Direct effects result from direct interactions of fields with the body; indirect effects involve interactions with a conduction object where the electric potential of the object is different from that of the body. Exposure to low-frequency electric fields may cause well-defined biological responses, ranging from perception to annoyance, through surface electric-charge effects due to stimulation of central and peripheral nervous tissues and the induction in the retina of phosphenes, a perception of faint flickering light in the periphery of the visual field.

9.7.2.1.2 Existing Controls

The mitigation measures identified in the design EIA include:

- Establishing an adequate ROW width to ensure EMF levels meet international safety standards at the ROW edge. The proposed design indicates a free space and minimum free distance of 21 m around the transmission line (i.e. 10.5 m ROW on either side of the transmission line);
- Compliance with Decree No.14/2014/ND-CP, conducting wires at least 15m above ground level (as such it is expected that conducting wires and L3 phase conductor will be at least 8.5 m above ground level and the tops of buildings within the ROW);
- Using phase cancellation; and
- Shielding.

9.7.2.1.3 Significance of Impacts

Operation of the Electricity Transmission Projects (ETP) will result in the formation of EMF along the transmission line and at the substations. Although high-voltage transmission lines like the ETP do generate higher EMFs, this effect is offset by the fact that the towers are higher, the ROW is wider, and phase cancellation shielding is applied, all of which lower EMF levels, as typically measured at the edge of the ROW. Figure 9.12 and Figure 9.13 illustrate the variation of EEP model calculated electric and magnetic fields with distance from the transmission line at 12 m above the ground. The maximum electric and magnetic fields are 1189 kV/m and 9709 A/m, respectively, at 12 m above the ground. At 12 m, two symmetric peaks of maximum values exist on either side of the tower but reduces drastically to zero within 1 m distance. Figure 9.14 and Figure 9.15 illustrate the variation of EEP model calculated electric and magnetic fields with distance from the transmission line at 1 m above the ground. The maximum electric and magnetic fields are 2.45 kV/m and 10.55 A/m, respectively, for the proposed 123kV tower configuration directly below the line (at 1 meter above the ground surface) and reduce rapidly with distance from the lines.

The maximum calculated electric field occurs directly under the conductors and decreases out to the edge of the ROW at 1 m above the ground calculations. The phasing of double circuit that will be used in the proposed transmission line configuration results in cancellation effects for the electric fields resulting in rapid decrease with distance. The maximum calculated electric field inside the ROW does not exceed the recommended ICNIRP occupational exposure limits.

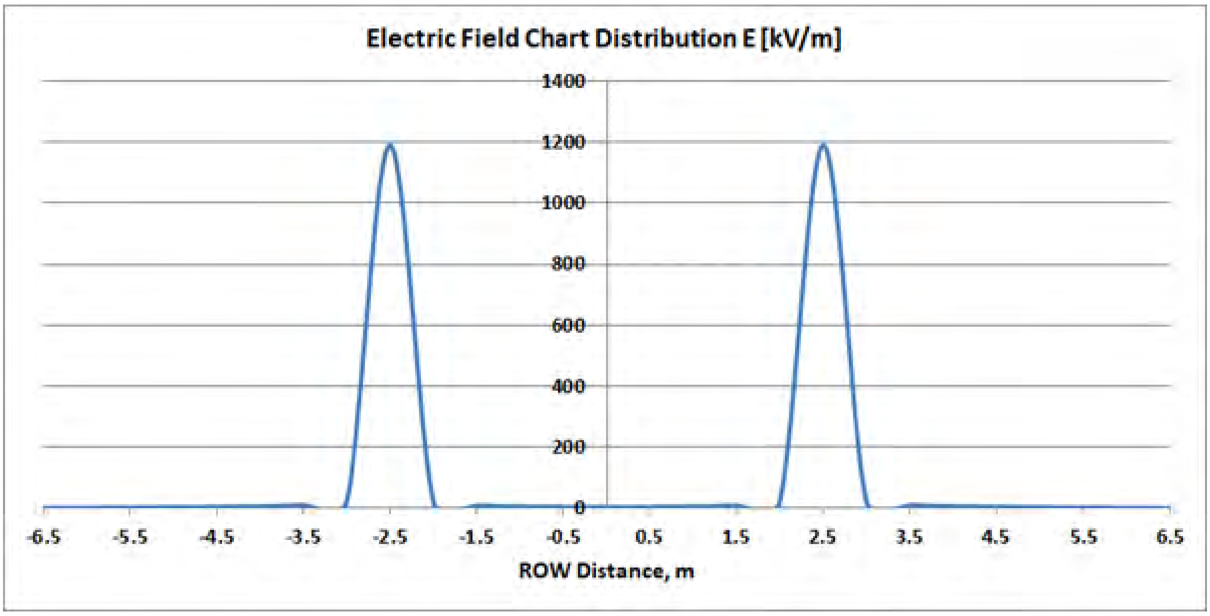


Figure 9.12 Electric Field Distribution for the Proposed Transmission Tower at 12 m above the Ground

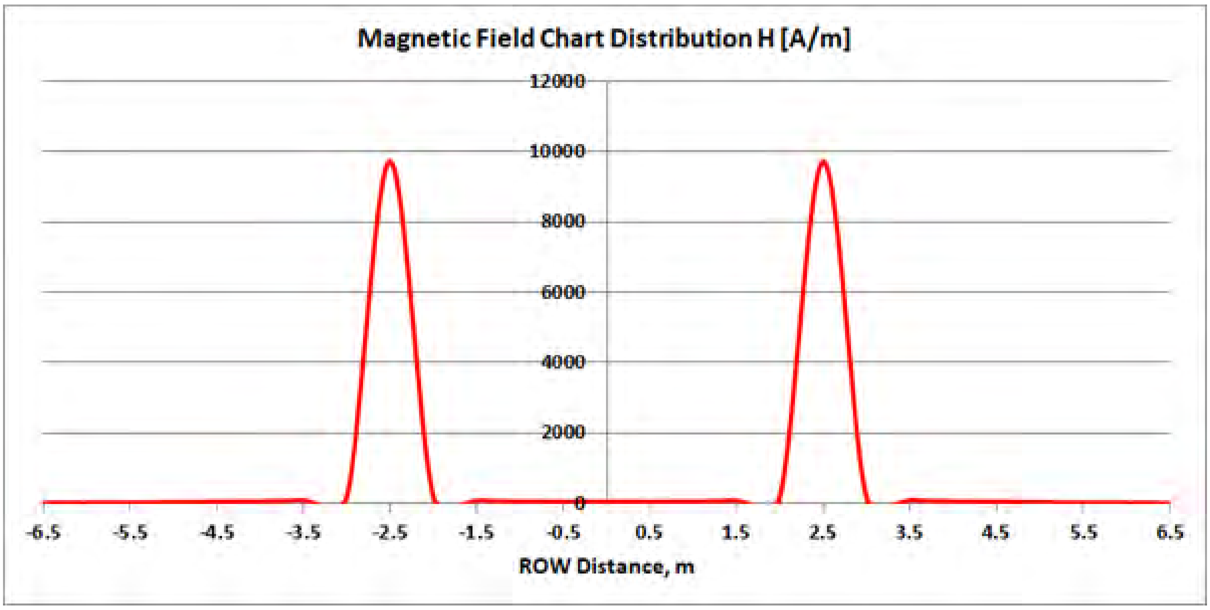


Figure 9.13 Magnetic Field Distribution for the Proposed Transmission Tower at 12 m above the Ground

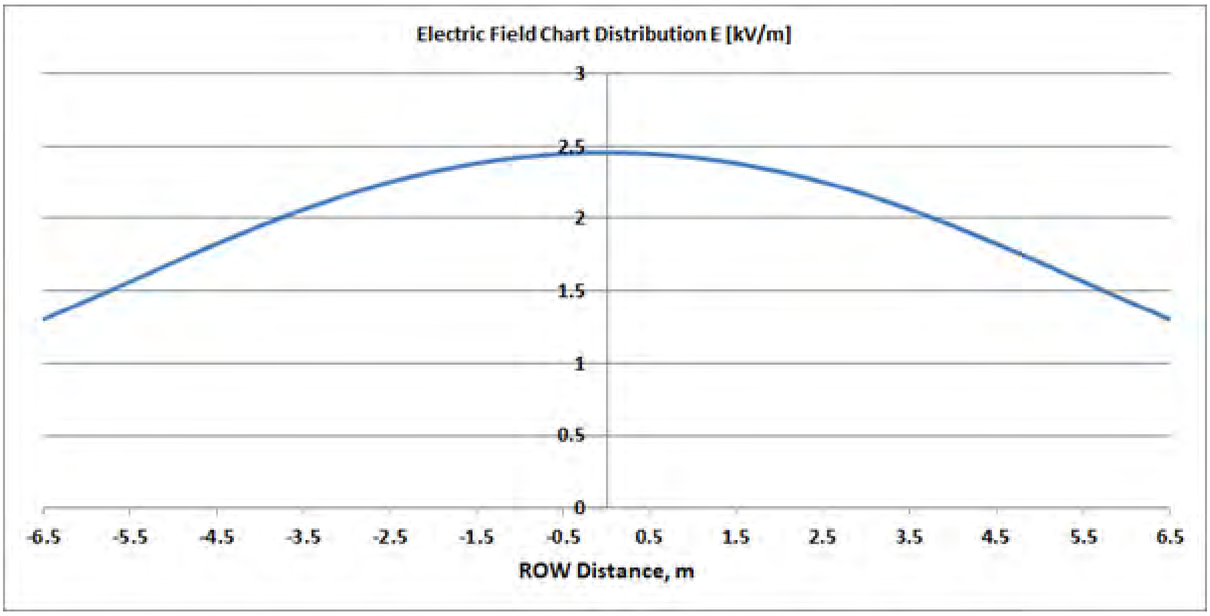


Figure 9.14 Electric Field Distribution for the Proposed Transmission Tower at 1 m above the Ground within the ROW

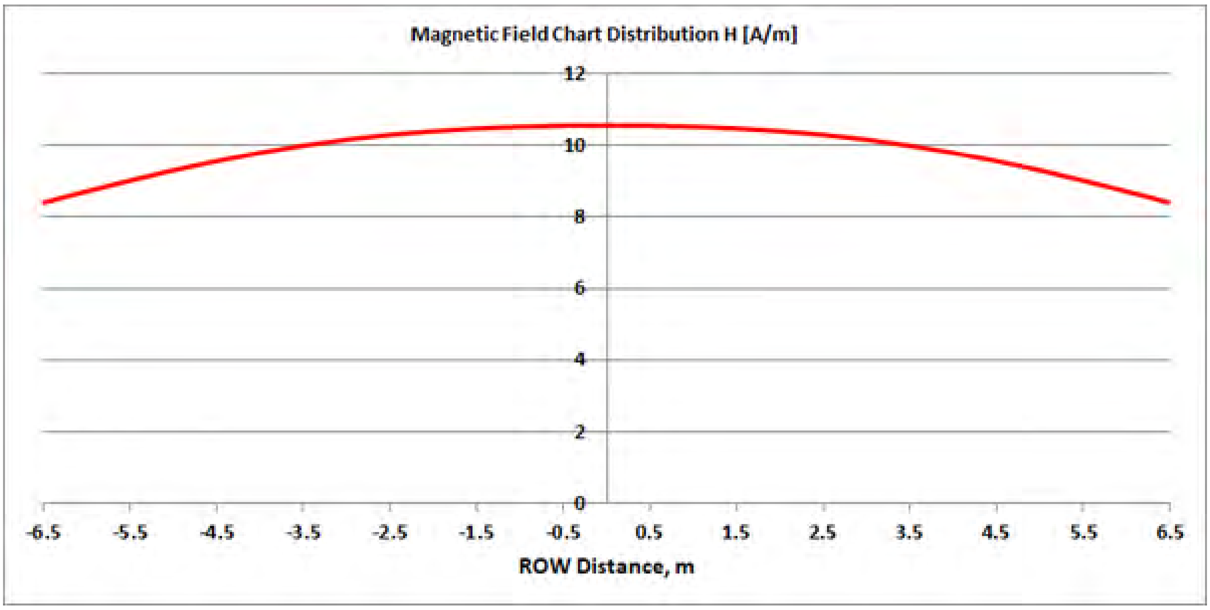


Figure 9.15 Magnetic Field Distribution for the Proposed Transmission Tower at 1 m above the Ground within the ROW

Based on the analysis the assessment of impacts of EMF on both occupational and public thresholds is shown in Table 9.40.

Table 9.40 Impacts of EMF during Operation Phase from the Transmission Line

Impact	Health Impact due to EMF from Transmission Line				
Impact Nature	**Negative**	Positive	Neutral		
	Impacts on health is considered **Negative**				
Impact Type	**Direct**	Indirect	Induced		
	Health of livelihoods or residences within the ROW				
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
	The impact duration is **Temporary** within the ROW.				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the ROW.				
Impact Scale	The impact scale is **Small** and limited to ROW.				
Impact Frequency	The impact frequency is closely related to the operation of the wind farm and substation, and assumed to be **continuous** during operation as a worst case.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	**Low**	Medium	High		
	The vulnerability of receptor is **Low** as explained above.				

Significance	**Negligible**	Minor	Moderate	Major
	The significance is **Negligible.**			

9.7.2.1.4 *Additional Mitigation and Management Measures*

Other additional mitigations measures are based on ESIA requirements to minimise impacts associated with EMF include:

- Avoid residential buildings, or acquire houses within the ROW, if possible;
- Avoid schools, hospitals, health clinics, and other similar buildings – the ETP alignment avoids these sensitive buildings and maintains at least a 20 m buffer to all schools and health clinics;
- Tower safety features – place warning signs prohibiting climbing on towers and incorporate design elements that prevent climbing of the towers; and
- Emergency contact information – provide signage at each tower with emergency phone numbers.

Electric fields can be easily shielded by trees, fences, buildings and most other structures. However, magnetic fields are much more difficult to shield than electric fields.

9.7.2.1.5 *Residual Impacts*

The residual impact to occupational and public from the transmission of power through the proposed 110 kV voltage transmission line is considered to be negligible.

9.7.2.1.6 *Monitoring and Audit*

As there is the potential for buildings within the ROW, it is proposed that EMF monitoring is carried out by measuring at discrete distances from the transmission lines within the first year of the operation on a quarterly basis. Should thresholds be exceeded further mitigation options should be review and considered.

9.7.2.2 Substation

9.7.2.2.1 *Potential impacts*

Similar to potential impacts from the transmission line.

9.7.2.2.2 *Existing Controls*

No existing controls were identified to mitigate this impact.

9.7.2.2.3 *Significance of Impacts*

Predicting magnetic field profiles for substations is a complex exercise given the multitude of time varying sources orientated in multiple directions. As a result, the magnetic field profile is highly dependent on the particular circumstances. In order to understand the magnetic field pattern in the proposed step up substation, similar substation modelling performed elsewhere Tarmizi et al. (2016) was identified for discussion. Tarmizi et al. modelled magnetic field variability in a substation that had the 400kV side connected to three loads, a shunt reactance and an autotransformer to step down the voltage to 220kV. The substation considered by Tarmizi et al. was 280 m long, 140 m wide and the conductors are located at the height of 12m above the ground (on the 400kV side). The normal operating currents at frequency of 50Hz for each load. The magnetic field distribution was calculated at the height of 1.7m where measurements were available for comparison. The computed results for the normal operating currents are presented in Figure 9.16.

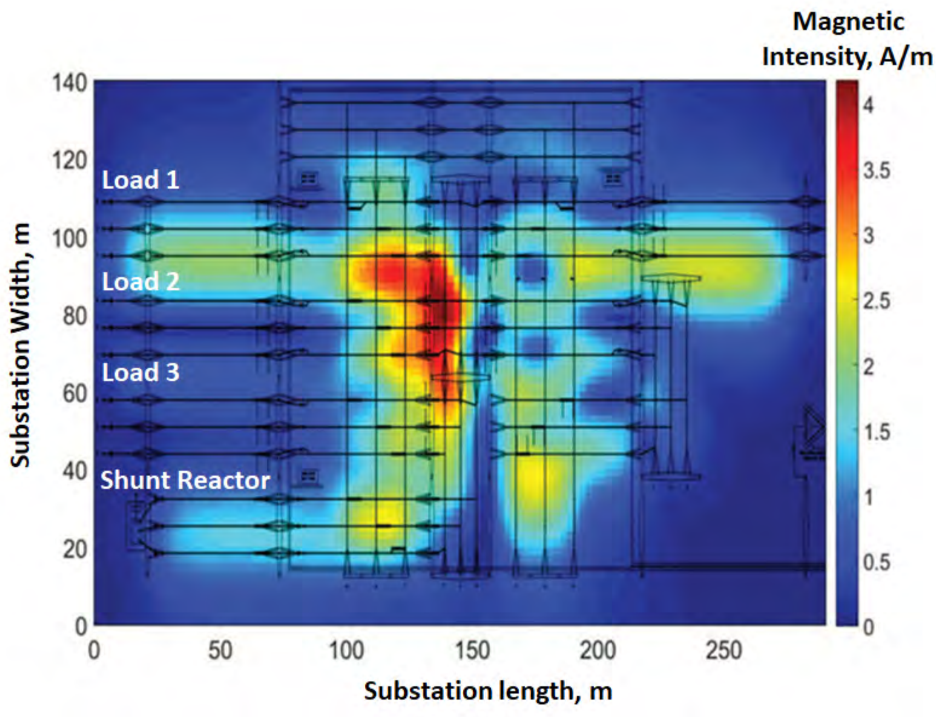


Figure 9.16 Magnetic Field Distribution in the Substation Studied by Tamrizi et al. (2016) for a 400kV substation (280m by 140m).

Figure 9.16 shows that the predicted highest value of the magnetic field was 4.164A/m located along busbar 1. For the normal operation conditions of the substation, the maximum values of the magnetic field were found to be below public exposure limits proposed by ICNIRP. In addition, it clearly shows that the magnetic field decreases rapidly within the perimeter of the substation. However, for a lightning strike scenario, the magnetic field in the substation exceeded the public and the occupational exposure limit set by ICNIRP. The voltages and size of the substation used in the study by Tarmizi et al. were much higher than the proposed substation (voltage of 110 kV; and size up to 80m long by 70m wide) and hence the EMF impact is anticipated to be contained within the substation.

Additionally, another study by Grbic et al., (2017) concluded that within two 110/x kV substations the measured and maximum values of electric fields are lower than the low AL (Action Levels) of 10kV/m (i.e. ICNIRP ELF exposure limits for occupational exposure); and the measured and maximum values of magnetic flux density are lower than the low AL of 1mT (796 A/m, ICNIRP ELF exposure limits for occupational exposure). ALs are action levels prescribed by Directive 2013/35/EU , which states the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (EMF).

Based on the analysis the assessment of impacts of EMF during operation phase is shown in Table 9.41.

Table 9.41 Impacts of EMF during Operation Phase from the Substation

Impact	Health Impact due to EMF from Substation		
Impact Nature	**Negative**	Positive	Neutral
	Impacts on health is considered **Negative**		
Impact Type	**Direct**	Indirect	Induced
	Health of livelihoods or residences within the substation		

Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
	The impact duration is **Temporary** within the substation				
Impact Extent	**Local**	Regional	Global		
	Impacts are within the substation.				
Impact Scale	The impact scale is **Small** and limited to substation.				
Impact Frequency	The impact frequency is closely related to the operation of the wind farm, and assumed to be continuous during operation as a worst case.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
	The impact magnitude is **Small**.				
Vulnerability of Receptors	**Low**	Medium	High		
	The vulnerability of receptor is **Low** as explained above.				
Significance	**Negligible**	Minor	Moderate	Major	
	The significance is **Negligible**				

9.7.2.2.4 Additional Mitigation and Management Measures

Electric fields can be easily shielded by trees, fences, buildings and most other structures. However, magnetic fields are much more difficult to shield than electric fields. Therefore, it is important that all sources of magnetic field inside and near the substation should be identified and proper mitigation measures have to be implemented so that it will be reduced well below the ICNIRP standards for occupational and public. Some general mitigation measures which could be further explored as part of a site specific assessment are 1) distance of various sources within the substation, 2) conductor spacing and busbar arrangement, 3) phase configuration and 4) shielding.

9.7.2.2.5 Residual Impacts

With appropriate mitigation measures, the occupational and human exposure can be minimized to fall under ICNIRP standards, therefore the residual impact to occupational and public from the substation is considered to be Negligible.

9.7.2.2.6 Monitoring and Audit

As there is the potential for buildings within the vicinity of the substation, it is proposed that EMF monitoring is carried out by measuring at discrete distances in the vicinity surrounding the substation within the first year of the operation on a quarterly basis. Should thresholds be exceeded further mitigation options should be review and considered.

9.7.2.3 Wind turbines

9.7.2.3.1 Potential impacts

Similar to potential impacts from the transmission line.

9.7.2.3.2 Existing Controls

No existing controls were identified to mitigate this impact.

9.7.2.3.3 Significance of Impacts

Some types of wind turbines includes a step up transformer either in the nacelle of the turbine rotor unit or at some height below it. The step up transformer increases the voltage to 22 kV with 275 Amps. This may result in electric and magnetic field generation during the operation of the wind turbine. The model used for transmission line EMF analysis was applied to calculate EMF at 1 m above the ground as per IFC and ICNIRP regulations. Figure 9.17 and Figure 9.18 illustrate the variation of EEP model calculated electric and magnetic fields with distance from the wind turbine. The maximum electric and magnetic fields are 0.0028 kV/m and 0.0073 A/m, respectively, at 1 m above the ground. The maximum calculated electric field occurs directly under the base of the turbine and decreases out to the edge of the ROW. The maximum calculated electric and magnetic fields inside the ROW does not exceed the recommended ICNIRP occupational exposure limits.

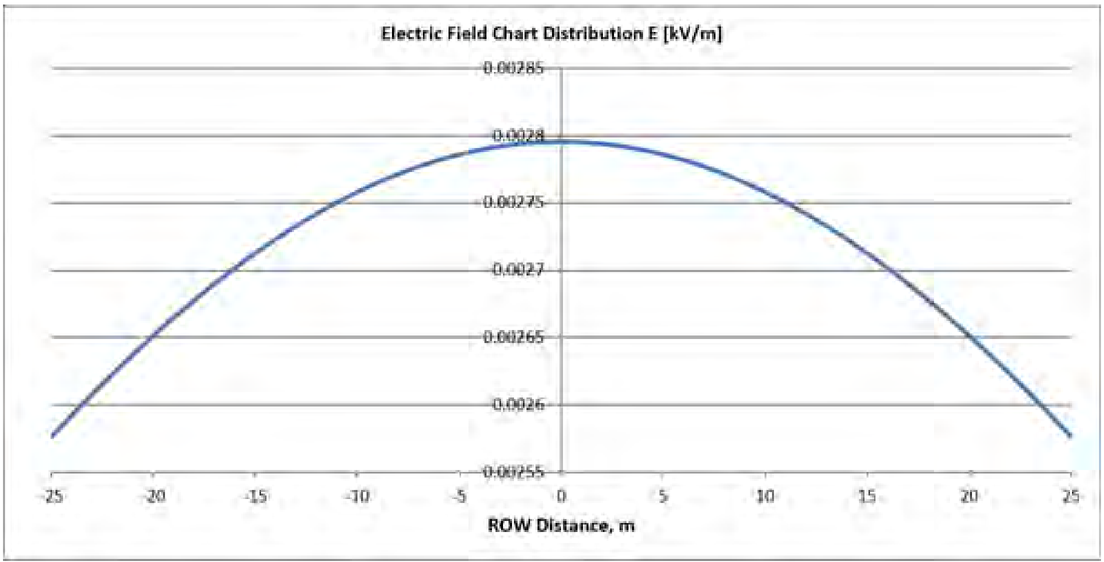


Figure 9.17 Electric Field Distribution for the Proposed Wind Turbine at 1 m above the Ground

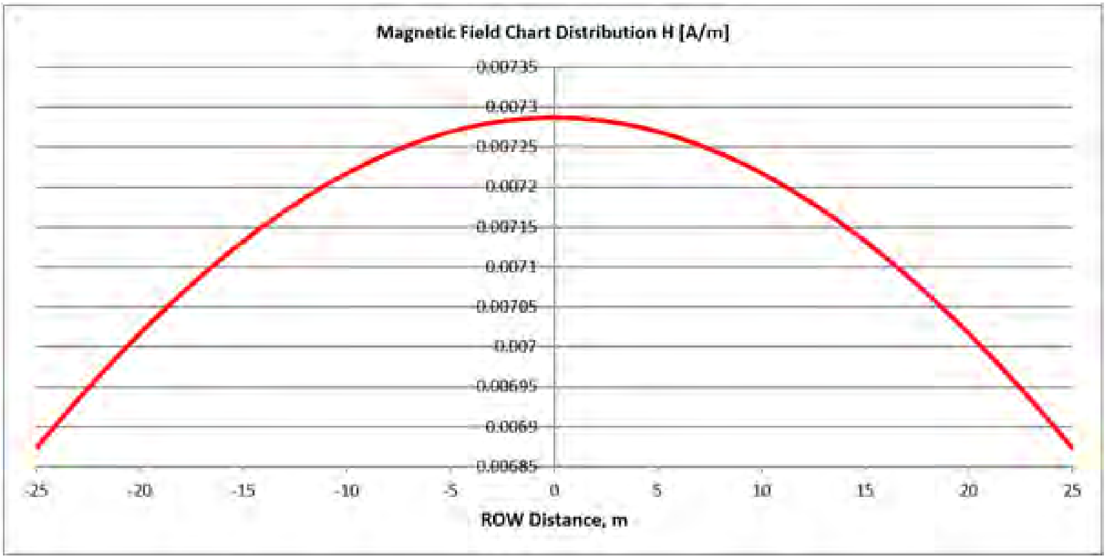


Figure 9.18 Magnetic Field Distribution for the Proposed Wind Turbine at 1 m above the Ground

Similar EMF results have been identified elsewhere through various field measurements in other parts of the world. McCallum et al. (2014) conducted EMF field measurements in some of the Canadian wind farms. Based on this study, the mean EMF level (characterized here by magnetic flux density) measured were 0.9 mG at the base of the wind turbines and dropped off to background levels (0.2-0.3 mG) within 2 m with levels consistently remaining at background out to 200 m and as far afield as 500 m. Additionally, magnetic fields measured at 1 m above buried collector lines were at background (0.2-0.3 mG), and readings taken below overhead 27.5 kV and 500 kV lines were consistent with other power distribution systems in North America. These results suggest that there is nothing unique to wind farms with respect to EMF exposure.

In fact, magnetic field levels near wind turbines are lower than levels that people are exposed to on a daily basis in homes, offices and schools, and much lower than exposure we receive from many common household electrical devices (See Figure 9.19). The results from this study are consistent with those EMF measurements collected by Israel et al. (2011). Furthermore, when compared to ICNIRP guidelines, the levels of EMF measured around wind turbines were all well below levels known to cause harm to human health. Collectively, these results suggest that the EMF surrounding wind turbines and their distribution systems (i.e., 27.5 and 500 kV power lines) are similar or lower than those commonly found throughout Ontario and across Canada. There was nothing unique about the EMF readings surrounding the wind turbines. Furthermore, the magnetic fields associated with power distribution systems, including those found in the vicinity of wind farms, are below levels that are expected to cause harm to human health based on international regulatory guidelines. Overall, our results do not support a potential causal link between power frequency EMF and human health impacts at the low levels measured in the vicinity of the wind turbines.

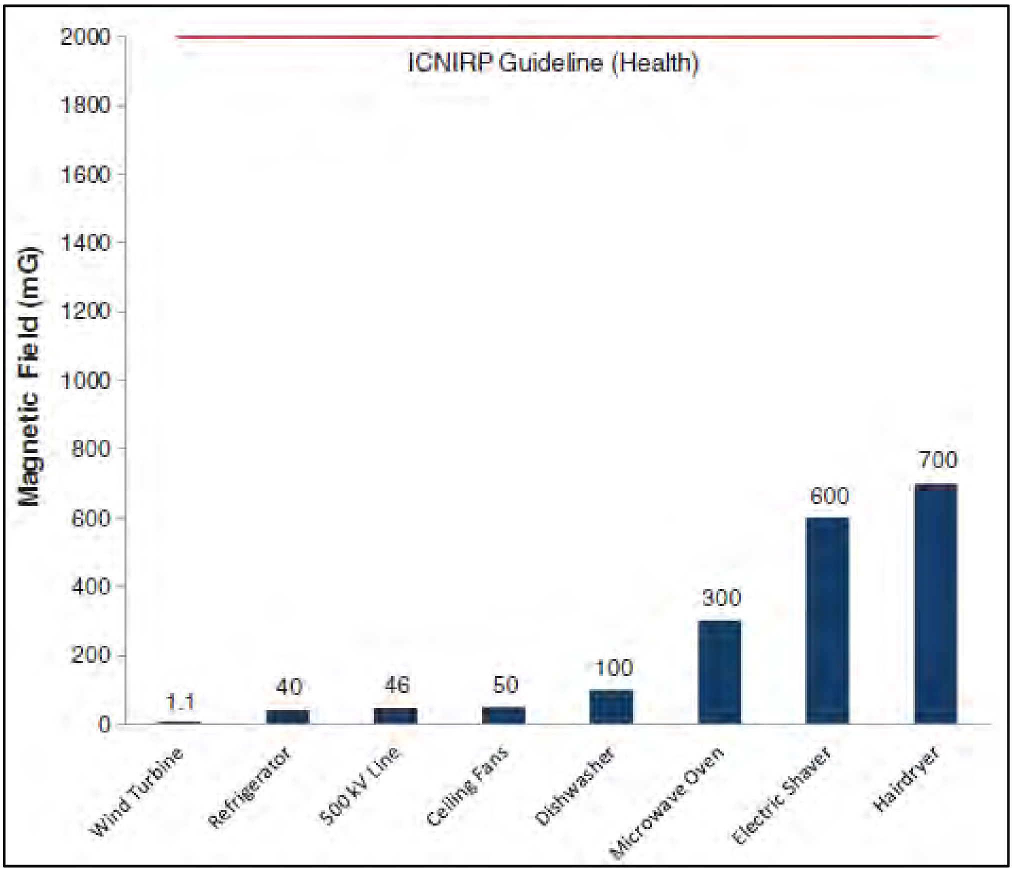


Figure 9.19 Magnetic Fields Comparison from Wind Turbines and 500 kV Power Lines with Common Household Electrical Devices (Source: McCallum et al. 2011)

Based on the analysis the assessment of impacts of EMF on both occupational and public is considered **Negligible**.

9.7.2.3.4 Additional Mitigation and Management Measures

An additional measure recommended to put in place is:

- Wind turbine safety features – place warning signs ensuring public stay away, and prohibiting climbing on towers and incorporate design elements that prevent climbing of the towers; and
- Emergency contact information – provide signage at each tower with emergency phone numbers.

9.7.2.3.5 Residual Impacts

The residual impact to occupational and public from the wind turbines is considered to be Negligible

9.7.2.3.6 Monitoring and Audit

No specific monitoring and auditing is recommended.

10. SOCIAL IMPACT ASSESSMENT

This chapter presents the assessment of socio-economic impacts resulting from the construction and operation of the Project and is based on the baseline data presented in Chapter 8 and the impact assessment methodology detailed in Chapter 4

This chapter aims to:

- Define the scope of the social impact assessment, including area of influence (as shown in Table 10.1) and receptors considered;
- Present the potential social impacts associated with the land acquisition, construction (including displacement) and operation of the Project; and
- Identify appropriate management and mitigation measures and corresponding monitoring that can be implemented by the Project owner.

This chapter also identifies existing management plans and mitigation measures which the Project owner has already developed and implemented in the pre-construction phase.

10.1 Scope of assessment

Based on the Project Description (Chapter -) and the socio-economic baseline (described in Chapter-), the land acquisition, construction and operation of Thanh Hai 1 Wind Power project may result in potential impacts to local communities as summarized in Table 10.1.

Table 10.1 Summary of Potential Impacts, Receptors and Area of Influence

Potential Impacts	Receptor	Area of influence
Land Acquisition Phase		
Economic Displacement		
■ Loss of land ■ Loss or relocation of land attachments ■ Change of land use ■ Loss of/Impact on livelihood associated with loss of land resulting in full or partial loss of income ■ Restriction of access to marine areas	■ Local land users who have their production land acquired by the Project. ■ Local aquaculture farmers and local fishers who do aqua-farming and fishing in and near the mudflat area where the Project located	■ Thanh Hai (main site), An Dien, An Nhon, An Qui, An Thuan (transmission lines)
Construction Phase		
Potential project benefits		
■ Increased local employment and revenue ■ Temporary direct employment for the Project and induced employment opportunities by local suppliers ■ Improved local infrastructure ■ Support to community development via community develop program of the Project	■ Local authorities at commune/district level ■ Local economy, local businesses ■ Local communities also using infrastructure ■ Local contractors/suppliers	■ Thanh Hai, An Dien, An Nhon, An Qui and An Thuan communes and other communes within Thanh Phu District.

Potential Impacts	Receptor	Area of influence
Impact on Community Health and Safety Due to Construction Activities (Non-influx issue)		
■ Health impacts associated with dust, waste management, noise generated from construction activities ■ Increased incidence of traffic accidents from construction vehicle traffic and commuting ■ Security related impacts or concerns ■ Community safety due to the transportation of equipment and machine	■ Local communities living near the Project ■ People who have livelihood activities near the construction area of the Project	■ Thanh Hai (main site), An Dien, An Nhon, An Qui, An Thuan (transmission lines)
Impacts on Community due to Presence of Influx		
■ Potential increase in the transmission of communicable diseases including vector borne, water borne and sexually transmitted diseases ■ Tension with local community linked to issues of cultural conflict ■ Tension among different stakeholder groups due to unequal distribution of benefits and impacts ■ Public services and infrastructure (health care, food and commodities, road, electricity supply, water supply and waste collection).	■ Local authorities at commune/district level ■ Local communities ■ Contractors' employees including construction workers	■ Thanh Hai (main site), An Dien, An Nhon, An Qui, An Thuan (transmission lines)
Impacts to Cultivation, Aquaculture and Fishing Activities during Construction		
■ General disturbances by construction activities producing dust, waste and wastewater ■ Temporary occupation of farming land during construction of transmission line and substation	■ Local communities who are farmers and fishers having their cultivation, aquaculture and fishing activities nearby the Project's components	Thanh Hai (main site), An Dien, An Nhon, An Qui, An Thuan (transmission lines)
Impact to Traffic Safety due to Increased Transportation Volume during Construction		
■ Potential traffic congestion and risk to traffic safety in the area along the transportation route of the Project both on road and marine	■ People who are fishers having their fishing activities along the transportation route ■ People living along the road of transportation of the Project	■ Within Ben Tre Province
Operational Phase		
General Disturbances from operation activities on local community		
■ Change of income sources, occupational profiles and land use ■ Impacts from operation noise of turbines and transformers	■ Affected households ■ Local communities	■ Thanh Hai (main site), An Dien, An Nhon, An Qui, An Thuan (transmission lines)

Potential Impacts	Receptor	Area of influence
■ Visual impact ■ Impacts from shadow flicker		
Project Benefits		
■ Increase local revenue and employment; ■ Improved local supply and skills; improved local infrastructure (access road, school and clinics); ■ Support to local community development plans	■ Local communities and suppliers ■ Local authorities ■ Vietnam Electricity Corporate (EVN)	■ Thanh Hai Commune, Thanh Phu District and Ben Tre province
■ Increase local revenue and employment; ■ Improved local supply and skills; improved local infrastructure (access road, school and clinics); ■ Support to local community development plans	■ Local communities and suppliers ■ Local authorities ■ Vietnam Electricity Corporate (EVN)	■ Thanh Hai Commune, Thanh Phu District and Ben Tre province

10.2 Impact Assessment

10.2.1 Construction – Economic Displacement Impact from Land Acquisition Process

10.2.1.1 Potential Impacts

Thanh Hai 1 Wind Farm Project is located in Thanh Phu District, Ben Tre Province. The land acquisition and CSR process for the Project is government-led in accordance with the national regulations.

Phase 1 of the Project includes both nearshore and onshore areas. Details of the proposed land area are summarized in Table 10.2.

Table 10.2 Required Land for Project

No	Project Component	Area (m^2)	Current status	Land acquisition required	Remark
1	The location of seven wind turbines	4,500 m^2	Alluvial ground (Location: It is 875m-2,250m away from the shore line of Thanh Hai Commune)	No	No household on the nearshore area but there are aquaculture farms in the Project area.
2	27,34 km undersea 22kV cable	8,200 m^2			
3	Operation house and 22/110kV substation	14,000 m^2	Completed surface clearance (Location:)	Yes	The Project Owner has directly purchased the land from affected households.
4	2,5km Internal roads	15,000 m^2			
5	Electric poles for 110kV line	8,600 m^2			
6	Ground for construction equipment	10,000 m^2			
7	Closed warehouse for construction equipment	500 m^2			
8	Open warehouse for construction equipment	2,000 m^2			
9	Parking lot and construction equipment	2,000 m^2			
10	110 kV overhead transmission lines with the length of 18 km	135,504m^2	Agricultural and aquatic production land, residential land and other land types	Yes	The line will run through Thanh Hai, An Dien, An Nhon, An Quy, An Thuan and

No	Project Component	Area (m^2)	Current status	Land acquisition required	Remark
			being used by households/local authorities		Binh Thanh communes. 51 households will be affected by the transmission line.
	TOTAL	**200,304m^2**			

According to the local EIA 2019, the location of the 110kV substation and the base of the 110kV line pole do not coincide with the location of the households (at least 100m away), so the Project does not affect people's houses and architectural construction, neither did it affect public architectures. Therefore, it is not necessary to arrange resettlement and alternative farming land.

There were 79 households whose land was acquired for the Project. A total area of 1,468.2 m2 was permanently acquired for the total seven turbine's footprint and corridor of underwater transmission line and 65,582.3 m2 was temporarily cleared for the construction of the T-line.

Seven turbines are being built on a coastal alluvial area; the sea floor is relatively flat, close to the mudflats. The permanent land will be acquired for total 07 turbine's footprint and corridor of underwater transmission line is approximately 10.3 hectare and the shortest distance from each of them is roughly 450m.

Construction and operation of the Project facilities, including wind turbines and undersea cables, did not require land clearance.

The substation 110kV and electricity poles for 110kV transmission line do not collide with residential household (the closest is 100m). Therefore, there will be no significant impact in term of changes in architecture of public buildings and facilities as well as residents' properties. However, during the construction phase, some land will be temporarily occupied for transmission line construction and laydown area and/or will only be affected by crop height restriction due to safety reasons.

At the time of this report was written, there were two aquaculture farming areas under the ownership of Binh Minh Clam Cooperative and Thanh Loi Fishier Cooperative and cultivated land (water melon, peanut and cassava, etc.) along the coast. Two cooperatives are in the coastal area belonging to Thanh Hai commune which is between the project substation and turbines. Figure 10.1 -- presents the location of two cooperatives. The Project activities will certainly impact the farming activities of these two cooperatives and potentially loss of cultivated land.

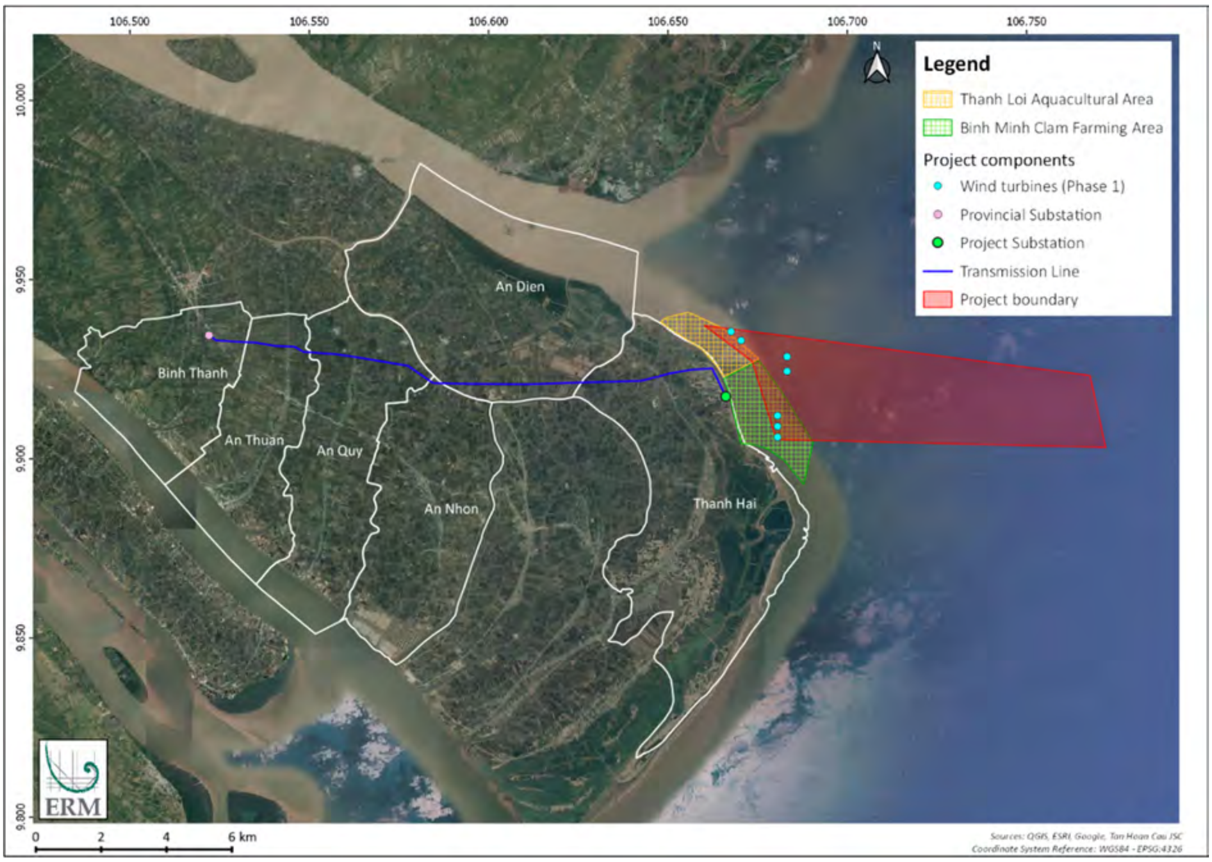


Figure 10.1 Locations of Thanh Loi and Binh Minh Cooperatives

As per the above description, Project activities of the Project will have impacts the on community, in particular on their access to agriculture and aquaculture-based livelihoods. In addition, the Project may also impact their physical assets if they are located on land to-be-acquired land. As the result of these impacts, the local people will need to find a way to adapt to the changes brought about by the Project in order to continue living as they have been; while the Project Company needs to propose and implement actions to mitigate such impacts at the same time.

During construction of the transmission line, there will be a temporary impact on the local community's land. It is considered to be temporary since land parcels belonging to the community will be used only for laydown and transmission line construction activity.

10.2.1.2 .Existing Controls

It is understood that the land acquisition process for the Project is government-led, in accordance with national requirements. According to the Land Law 2013 and its under-law regulations, compensation and assistance shall be provided by the Government to the households who are economically displaced by the land acquisition for the Project. At the time of developing this assessment, it was reported that compensation and assistance were being provided by Ben Tre province authority to the households who are economically displaced by the land acquisition of the transmission line.

10.2.1.3 Significance of Impact

As previously noted, the impact on land acquisition is considered Minor for the Project since no physical displacement and only a relatively small area of land is planned to be acquired from individual landholders both temporarily and permanently during construction and this is unlikely to significantly affect economic activities taking place on the land. In the case of the operation station, it was reported in the local EIA that the Project Owner had purchased the land from the affected households.

Table 10.3 Economic displacement impact from land acquisition of the Project

Impact	Economic impacts to land users as a result of land acquisition				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	**Permanent**	
Impact Extent	**Local**	Regional	International		
Frequency	One-off				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Negligible	Low	**Medium**	High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered to be **Minor.**				

10.2.1.4 Additional Mitigation and Management Measures

- The land acquisition process should be monitored by the Project Owner to ensure the compliance with Vietnamese regulations. All records obtained from the Government should be documented and retained for internal and external audits.
- A Stakeholder Engagement Plan detailing a Grievance Mechanism should be developed and implemented to support the local authorities in receiving and transferring land acquisition-related grievances from the affected people to the relevant authorities and explain the concerns in

grievance procedure to affected people. The grievance mechanism should be disclosed to all affected communities so that they may be aware of the procedure, submission channels, and responsible person from the Project owner.

- Livelihood Restoration Plan (LRP) should be developed and implemented for those identified as significantly affected land users. The LRP will be designed to ensure sustainable outcomes for impacted people.
- The Project Company shall prepare and implement a Community Development Plan (CDP) during the Project's lifetime that focuses on the affected community, with the intention that the affected community will benefit from the existence of the Project.

10.2.1.5 Residual Impact

The impact significance will remain Minor.

10.2.1.6 Monitoring and Audit

The following monitoring and audit measures are recommended:

- Monitor the land acquisition process to ensure it complies with the Vietnamese regulations for land acquisition.
- Monitor the implementation of the SEP, Grievance Mechanism and CDP.

10.2.2 Construction - Impact to Local Economy from Employment and Business

10.2.2.1 Potential Impacts

The impacts to the local economy from Employment and Business opportunities arising during Project Construction include local employment and local procurement.

According to the local EIA 2019, the Project will require approximately 200 workers during the Construction Phase which will last 12 months. At this stage, there is no information on the proportion of unskilled jobs that could be filled by local community members. Based on the socio-economic baseline results, the local population of working age mostly have primary and secondary education and skill levels suitable for manual work or unskilled employment. The local EIA states that the majority of workers will come from out of town because the local recruitment will not fulfil the Project's requirements.

In addition to employment opportunities, the Project will also require goods and services for its construction activities such as construction materials, equipment, cleaning, catering and other hospitality services. Therefore, the above-mentioned opportunities are likely to provide additional markets for existing small businesses located around the Project Area. These may include sand and rock suppliers, excavator and bulldozer equipment suppliers, restaurants, and lodging providers. In addition, grocery supplies and to some extent, restaurant services offer potential for the local community close to the Project location.

10.2.2.2 Significance of Impact

Based on the above analysis, the Project is expected to have a positive impact in terms of employment, procurement and induced job opportunities, and modest increase the economic condition of the local people. However, the construction phase is relatively short, the numbers of workers required limited and the adaptability of local people for employment and business opportunities is low. As such, the significance of this positive impact will be minor.

Table 10.4 Impact to local economy from employment and business during construction

Impact	Economic impacts to local communities derived from employment and business		
Impact Nature	Negative	**Positive**	Neutral

<table>
<tr><td>Impact Type</td><td colspan="4">Direct</td><td colspan="3">Indirect</td><td colspan="3">Induced</td></tr>
<tr><td>Impact Duration</td><td colspan="2">Temporary</td><td colspan="3">Short-term</td><td colspan="3">Long-term</td><td colspan="2">Permanent</td></tr>
<tr><td>Impact Extent</td><td colspan="4">Local</td><td colspan="3">Regional</td><td colspan="3">International</td></tr>
<tr><td>Frequency</td><td colspan="10">Permanent</td></tr>
<tr><td>Impact Magnitude</td><td colspan="2">Positive</td><td colspan="2">Negligible</td><td colspan="2">Small</td><td colspan="2">Medium</td><td colspan="2">Large</td></tr>
<tr><td>Receptor Sensitivity</td><td colspan="2">Negligible</td><td colspan="3">Low</td><td colspan="3">Medium</td><td colspan="2">High</td></tr>
<tr><td rowspan="2">Impact Significance</td><td colspan="2">Negligible</td><td colspan="3">Minor</td><td colspan="3">Moderate</td><td colspan="2">Major</td></tr>
<tr><td colspan="10">Significance of impact is considered to be Minor.</td></tr>
</table>

10.2.2.3 Measures for Positive Impact Promotion

To optimise Project benefits to the local community through employment and business opportunities, the Project Owner should implement the following additional measures:

- Instruct the EPC contractors to prioritize hiring qualified local people, especially affected people, as construction workers in accordance with the needs of the Project;
- Communicate clear information about Project-related employment and business opportunities and prioritize local people when feasible. Such communication should be conducted at least four months before recruitment so that local people have enough time to prepare for the recruitment process (for example, by attending short training courses to improve their skills);
- The Project owner should develop and implement a Livelihood Restoration Plan for those identified as significantly affected land users and Community Development Plan (CDP) to invest in the community. Training to improve skills of local people can be provided under the CDP;
- If possible, the Project Owner and the EPC contractors should work closely with local government agencies, particularly in Thanh Hai, An Dien, An Nhon, An Quy, An Thuan and Binh Thanh communes to synchronize the Project's needs in terms of local labor, as well as locals' capacity; and
- Establish a clear grievance mechanism as mentioned in the previous section.
- At the end of the construction phase, the Project Owner should, for those who will have worked for the Project during the construction phase, consider to provide skill improvement training for them to be able to access to similar jobs in other projects in the country.

10.2.3 Construction - Disturbance to Cultivation, Aquaculture and Fishing Activities

10.2.3.1 Potential Impacts

The 2019 ERM Social Baseline Survey identified that agriculture is the most dominant sector of Thanh Phu district's economy. From Thanh Phu Town up to Dai Dien, Phu Khanh are vast rice fields. From the town towards the sea, the area consists of rice fields gradually narrowing and giving way to shrimp farms – a type of agriculture considered far more lucrative than growing rice.

People in this area are also engaged in forestry, fishing and seafood processing. In terms of agriculture development planning, the district can be divided into three main sub-regions according to Decision No. 437/QD-UB of Ben Tre People's Committee:

- Sub-region 1: consists of nine northern communes of the district adjacent to Mo Cay District, including Phu Khanh, Dai Dien, Quoi Dien, Thoi Thanh, Hoa Loi, My Hung, Binh Thanh, Tan Phong and part of Thanh Phu Town. This sub-region is favourable for the production of two rice crops per year.

- Sub-region 2: is located in the middle part of the district including An Thanh, An Qui, An Thuan and An Dien communes and part of Thanh Phu Town. This sub-region is characterised by intercropping of shrimp in the dry season and rice production in the rainy season.
- Sub-region 3: is mostly coastal areas, including the communes of An Nhon, Giao Thanh, Thanh Phong and Thanh Hai. This sub-region specialises in shrimp farming.

During construction, the main risks to aquaculture activities are physical disturbance and water quality degradation (i.e. increased sedimentation from dredging activities in the mudflat area for turbine foundation and access bridge construction) of the coastal water in Thanh Hai commune. As such, the impact will be limited to the aquaculture areas of this commune where the coastal water is used as the water source for aquaculture farming. Other in-land aquaculture farms where the water source is from nearby rivers will not be impacted. The clam farming area located in the mudflat area approximately 1.1-2.2 km from the turbine area will be affected by the construction of the foundation for the turbines.

At the time of writing this report, the 22/110kV lift transformer station is being built in Thanh Hai Commune. This location is about 10km from Con Bung beach (also known as Thanh Phu beach or Thanh Hai beach). Geographic location is as follows:

- The North border clam farming;
- The South border bare land;
- The East border shoreline, about 10km from the road to Con Bung beach; and
- The West border on cultivated land of people.

Since the construction borders both clam farming area and cultivated land, both aquaculture and agriculture farming will be disturbed. During the construction of the transmission line and the Project substation, land will be temporarily used for 15 laydown areas and transmission pole platforms (approximately 20,100 m2). These areas will be returned to current land users following construction. Land for the 53 transmission pole foundations will be permanently acquired; however, the area occupied for each will be small.

During construction, earthworks, concreting and transportation may generate dust, wastewater and solid waste (including rock, soil and sludge from excavation) may impact cultivation and aquaculture along the transmission line and surrounding the substation.

10.2.3.2 Existing Control

The local EIA recommended that the Project Owner ensure the following measures be implemented to minimise the above impacts.

- When transporting construction materials, trucks will be covered with tarpaulin to protect loads. When loading and unloading materials, workers will be provided with adequate personal protective equipment.
- At the construction site, there will be cleaning areas for vehicles carrying materials and construction machines before leaving the site, limiting the amount of soil and sand stuck in the wheels.
- The contractor will coordinate with the material suppliers to clean the road surface immediately if the materials fall onto the roads so as not to affect traffic participants and residents.
- Moisten the soil surface by spraying water to reduce the amount of dust entrained by the wind.
- The measures to reduce emissions are mainly technical measures to minimize the sources of impact from emissions such as:
  - Using machines and equipment with gas, dust and noise emissions lower than the permitted level.

- Using construction equipment that meet the registered standards.
- Maintain and repair machines periodically and safely in construction.

- Construction works will be planned and coordinated in order to be as efficient as possible, thus reducing emissions of dust and other pollutants such as SO2, NO2, and VOCs.
- Workers' camps will be located at the construction site together with facilities such as toilets, bathrooms, 3-composting septic tank, etc. to prevent sanitation issues caused by domestic wastewater. Daily domestic wastewater is estimated at 10m3/day, high concentration of easily decomposing organic substances should be collected and treated by a 3-compartment septic tank before being discharged into the environment.
- Daily solid waste will be collected at the waste collection area (near the construction site). Project owners will sign contracts with local units to collect and process them in accordance with regulations. Every week, the local waste collector will transport the waste to the sanitary facilities. Impacts associated with waste generation, storage, handling and disposal are considered to be minor.
- Construction waste (such as cement, brick, stone, etc.) will be collected, sorted into groups and can be reused, recycled or disposed of at the scrap facility.
- Waste grease from maintenance and repairs to construction vehicles and equipment will be collected, stored and processed by a specialized contractor.
- Sea navigation routes will be fixed and unnecessary disturbance to the sea floor will be avoided.
- Any unplanned oil leakage shall be prevented from being washed offsite. Sand and rocks shall be shielded to avoid suspended solids being washed offsite during heavy rain events.
- Hazardous wastes shall be collected and stored by the project owner prior to disposal by the official hazardous waste disposal organization.
- Indiscriminate garbage disposal by workers shall be prohibited.
- Petrol and oil used shall meet appropriate standards for construction equipment and transportation vehicles.

10.2.3.3 Significance of Impact

The duration of impacts from construction will range from temporary to short-term, and as such impacts to air quality, sea water, and land and sea use (cultivation, aquaculture and fishing) are considered minor.

Table 10.5 Impacts to cultivation, aquaculture and fishing activities during construction

Impact	Disturbance to cultivation, aquaculture and fishing activities during Project construction				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	**Temporary**	**Short-term**	Long-term	Permanent	
Impact Extent	**Local**	Regional		International	
Frequency	Intermittent over the laydown development and construction phase				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large

Receptor Sensitivity	Negligible	Low	**Medium**	High
Impact Significance	Negligible	**Minor**	Moderate	Major
	Significance of impact is considered to be **Minor.**			

10.2.3.4 Additional Mitigation and Management Measures

- The Project Owner and EPC Contractor should implement the measures proposed in Chapter -- for controlling the impact to air quality and seawater quality;
- The Project Owner should disclose the construction timeframe and safety plan to the local fishers prior to the construction phase;
- The Project Owner should conduct regular consultation with the local fishers during the construction phase to identify access constraints. Issues should be resolved in consultation with the local authority;
- The Project Owner should consult with the local authorities, affected households and other relevant third parties to develop and implement a CDP as recommended above in order to share the mutual benefits from the Project development with the local community. The households identified through this impact assessment should be prioritised;
- A robust implementation of the SEP would enable the Project Owner to reach harmonization and alignment with the community members (besides the local authorities), thus, reducing the risk of interruptions to the Project. It will be important to provide and communicate detailed information about the Project's plan and schedule, particularly that which relates to land clearing and construction, with special attention given to farmers near Project locations;
- The Project Owner should establish and implement a grievance mechanism as discussed in the above section.

10.2.3.5 Residual Impacts

As a result of the implementation of proposed additional measures, the residual impact will remain minor.

10.2.3.6 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical audit are required to check if the above mitigation measures are in implementation;
- Monitoring and audit are also required to be conducted in accordance to those proposed in Chapter -- for Air Quality Impact Assessment, Seawater Quality Impact Assessment, the ESMP and CDP.

10.2.4 Construction – Impact to Community due to the Presence of Migrant Influx

10.2.4.1 Potential Impacts

Community health and safety impacts resulting from the influx of the construction workforce, Project-induced immigrants to the Project area and noise from Project activities have been the main social concerns in many industrial projects. This section provides an assessment of such impacts.

Based on information from the local EIA report in 2018, the Project is likely to employ approximately 200 workers during the Construction Phase. The proportion of local workforce is unknown at the time of this assessment; as such the following assessment will be for the worst case when all 200 workers will be people from other areas.

According to the local EIA, approximately 60 workers and 10 experts are expected to stay in temporary workers' camps on site built by the Project.

However, the potential interaction between the workforce and local communities still poses the risk of conflicts including fighting due to heavy drinking, and gambling.

Another risk which is likely to occur due to the influx is the transmission of communicable diseases such as Tuberculosis, Hepatitis A, Hepatitis B, HIV/AIDS and other sexually transmitted diseases between migrant workers and local people which could threat the health of the local communities.

With the limited condition of the local infrastructure and public services including lack of waste collection services within local communities and the frequent lack of water in the dry season and underdeveloped of services the presence of the influx in local area could be a pressure to these infrastructure and services. Over use of water supply and electricity, increase in disposal of domestic waste, increase demand in using health care service and buying foods and commodities will be the predictable consequence of this impact.

10.2.4.2 Existing Control

Some mitigation measures were provided in the local EIA including strict management of workers/ staff and collaboration with local authorities for security status updates.

- Coordinating with local authorities and relevant agencies to organize programs such as education and awareness raising for workers.
- Providing training to local people for them to satisfy the recruitment requirements of the Project to increase local employment opportunities.
- Coordinating with local authorities to manage temporary resident registration for migrant workers and to monitor social security in the area where migrant workers will be accommodated.

10.2.4.3 Significance of Impact

Given the proportion of migrant workers (200) compared to the total population of the Project's footprint area is medium, and given their relatively short presence in the area (12 months), the aforementioned impacts are assessed to be **Moderate**.

Table 10.6 Impacts to community due to presence of migrant influx

Impact	Community health and safety impacts associated with migrant influx				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	**Indirect**	Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Continuous over 12 months of construction period.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Receptor Sensitivity	Negligible	Low	**Medium**	High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate.**				

10.2.4.4 Additional Mitigation and Management Measures

The Project Owner should implement the following additional measures to manage the potential negative impacts associated with the presence of migrants.

- EPC Contractor should conduct compulsory medical examinations (i.e. annual health check-ups) for Project workers, including contractors, as required by national regulations, to ensure they are fit for work and to monitor the prevalence of communicable diseases;
- EPC Contractor should establish an onsite health clinic for Project workers involved in construction;
- Project Owner and EPC Contractor should maximise local employment;
- EPC Contractor should implement a “zero tolerance” policy towards inappropriate behaviour from and amongst the workforce;
- EPC Contractor should register temporary residence for non-local workers to local authorities to ensure the management of Project’s related workforce;
- EPC Contractor should develop a Project Code of Conduct;
- EPC Contractor should share the Project Code of Conduct with workers of contractors and requesting their compliance;
- EPC Contractor should develop and implement regulations/policies for non-local workers staying in construction camps regarding behaviour towards local communities and restricting hours for going out;
- Project Owner should implement the SEP. Community Liaison Officers of the Project should assign and deliver induction training to provide guidance on requirements for culturally appropriate behaviours, and an overview of the risks to migrant staff and workers. The training will include key cultural sensitivity awareness topics/programs to ensure workers including security staff do not un-intentionally offend the local community, especially ethnic minority;
- Project Owner should establish and disclose a grievance mechanism as mentioned in above section;
- Project Owner and EPC Contractor should regularly engage with local authorities relevant to crime (i.e. local police) or other social problems (e.g. village leaders) for prevention of issues and for mitigation purposes when issues arise;
- EPC Contractor should conduct appropriate workers-community engagement programs such as sporting or cultural events to improve understanding and cohesion between non-local workers and the surrounding communities;
- Project Owner should support local health centres to conduct campaigns on community health education as part of the CDP, to enhance the community’s resilience to potential negative impacts arising from industrial projects;
- Project Owner should support local authority to improve and maintain the local roads if any damages caused by the Project activities both directly (due to Project vehicle) and indirectly (due to workers’ transportation).

10.2.4.5 Residual Impacts

As a result of the implementation of the proposed management measures, the impact on community health and safety associated with a non-local presence remains as Minor.

10.2.4.6 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical audit are required to check if the above mitigation measures are in implementation;
- Monitoring and audit are also required to be conducted in accordance to the schedule proposed in the CDP.

10.2.5 Construction – Direct Impact on Community Health and Safety during Construction (non-influx issue)

10.2.5.1 Potential Impacts

General construction activities of an nearshore wind project includes dredging activities, jetty construction, building and concrete works, transportation of materials and workers and construction of associated facilities including the access road, and transmission line. These activities are likely to generate noise, dust, and risk to community safety.

Without proper management of dust and noise from such construction activities, local residents may experience nuisance. This includes residents living along coast line of Thanh Hai and the transmission line in An Dien, An Nhon, An Quy, An Thuan and Binh Thanh communes.

The main sources of noise and vibration in this phase are transportation and operation of machines during the construction process (main site and transmission line). However, these construction emissions do not represent a constant source of noise that will occur on a day-to-day basis or for the duration of the construction schedule. These emissions will occur for only portions of the works, and during those works will not occur for the entire daytime periods. This is typical of construction works and for projects of this scale and nature.

Dust will be mostly produced during the earth work and transport of construction materials to and from the Project site frequently. The construction activities (such as soil disturbing activities, storage of materials such as concrete, and transportation of materials), without proper controls, are likely to result in dust generation during transportation, especially in the dry season. This is also discussed in detail in the air quality impact assessment presented in Chapter 9.

In terms of traffic safety due to the transportation of heavy equipment and construction materials during the construction phase will be discussed in details in the next section.

10.2.5.2 Existing/In Place Control

Refer to Chapter - for existing controls proposed for dust, noise and vibration impacts.

10.2.5.3 Significance of Impact

From the assessment of dust, noise and vibration in Chapter 9, these impacts on local residents are predicted minor.

Table 10.7 Direct impact to community health and safety during Construction Phase

Impact	Impact to community health and safety during construction activities				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Intermittent over 12 months of the construction period.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large

Receptor Sensitivity	Negligible	Low	**Medium**	High
Impact Significance	Negligible	**Minor**	Moderate	Major
	Significance of impact is considered to be **Minor.**			

10.2.5.4 Additional Mitigation and Management Measures

For safety reasons, although this impact is predicted to be Minor, the Project is required to comply with the measures proposed Air Quality Impact Assessment and Noise and Vibration Impact Assessment in Chapter - and in the next section of "Traffic Safety due to Increased Transportation Volume during Construction" to minimise traffic accidents and disturbances to local people and to maintain the significance of the impact as Minor.

10.2.5.5 Residual Impact

The impact significance will remain Minor.

10.2.5.6 Monitoring and Audit

Monitoring and audit will follow the recommendation in Air Quality Impact Assessment and Noise Impact Assessment, Traffic Safety due to Increased Transportation Volume during Construction.

10.2.6 Construction - Traffic Safety due to Increased Transportation Volume during Construction

According to the local EIA report in 2019, the entire land area of the project including the operation station, the 110kV line, the transmission lines is mainly agricultural land, mainly coconut and some short-term agricultural crops. The area is sparsely populated, with arterial roads passing through and connected to Provincial and National highways. As such, the transportation route of the Project for materials, equipment and construction equipment very has little interference. The exact number of vehicle and truck movements however remains unknown.

It is noted there is no information regarding the number of trucks and vessels to be used for material transportation in the local EIA to assess the actual impact scale on local transportation (for both road and waterway). Based on the experiences of similar projects, local transportation may be interrupted during the peak transportation periods of the construction phase, mainly from the middle to the end of the 12 month period.

The information on transportation routes indicates that Project vehicles will be moving on the main national, provincial and district roads, which are considered busy roads. As such, it is expected to potentially lead to traffic congestion and is likely affect traffic safety in the area along the route.

It is noted that transportation of machinery, equipment or materials on the waterway (Ham Luong river) might also affect the waterway traffic.

10.2.6.1 Existing/In Place Control

- Install the sign "Regular access vehicles" at the construction site to limit the occurrence of traffic accidents.
- Dividing waterway and road traffic to limit congestion and traffic accidents in the area.
- When transporting construction materials, it is required to exercise caution when entering and leaving the Project area to limit traffic accidents.
- During the process of transporting machinery, equipment, materials with large loads that could potentially damage the roads, the Project Owner is responsible for upgrading the transportation routes so as not to affect the infrastructure. transportation, transportation and daily life of people in the area

10.2.6.2 Significance of Impact

In the absence of the estimated number of vehicles and barges required, Project impacts to local transportation as a result of increased vehicle movement during construction were assessed as being of Moderate significance during peak time (Table 10.8).

Table 10.8 Impact to traffic safety due to increased transportation volume during Construction

Impact	Disturbance to local transportation due to increased vehicle and barge movement during construction				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	Local	**Regional**	International		
Frequency	Intermittent over 12 months of construction period.				
Impact Magnitude	Positive	Negligible	Small	**Medium**	Large
Receptor Sensitivity	Negligible	Low	**Medium**	High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered to be **Moderate**.				

10.2.6.3 Additional Mitigation and Management Measures

The Project Owner should implement the following measures during the Construction Phase:

- EPC Contractor should ensure:
  - All new drivers (including contractors for construction material transportation) should be required to undergo safety training;
  - Flagmen should operate at the junction between the main roads and the access road to coordinate the trucks entering and exiting;
  - Speed limits should be enforced for all Project vehicles and barges;
- Local communities (including those living along the access route, fishermen, and clam-farmers near the Project turbine area) should be familiarised with traffic management approaches such as warning signs, speed limits and notifications of the risks of traffic accidents. These measures should be incorporated into the SEP;
- Project Owner and EPC Contractor should consult with the Port Authorities to understand legal requirements for port operation and marine transportation to comply with;
- Project Owner and EPC Contractor should develop and implement a Safety Transportation Management Plan and a Traffic Management Plan during Construction Phase for both marine and road transportation;
- Project Owner should, where road conditions are poor occur as a result of Project activities, improve the road to ensure conditions meet the standard required for construction vehicle use;
- The Project Owner should carry out prompt investigation when the community submits related complaints.

10.2.6.4 Residual Impacts

Following the implementation of proposed additional measures, the residual impact is considered Minor.

10.2.6.5 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical audit are required to check if the above mitigation measures are in implementation;
- Monitoring and audit are also required to be conducted in accordance to the schedule proposed in the Safety Transportation Management Plan and Traffic Management Plan.

10.2.7 Operation - Impact to Local Economy from Employment and Business

10.2.7.1 Potential Impacts

During the operational phase of the Project, the local economy will be positively influenced by an increase in taxation revenue of the Province, demand for materials and services and tourism development. The Project expects to employ -- employees in total for operation, of which percentage of local employees is not determined at the time of this assessment. Operations Phase will last up to -- years[48].

Given the fact that the area has been a tourist attraction, Thanh Hai Wind Farm may contribute to tourism development of the area. Besides, people in the area will have the opportunity to operate businesses associated with tourism as well as obtain employment from new businesses.

Based on above analysis, the Project is expected to have a Positive impact in terms of employment, procurement and induced job opportunities, and increase the economic condition of the local people.

10.2.7.2 Significance of Impact

Table 10.9 Impact to local economy from employment and business during Operation Phase

Impact	Economic impacts to local communities from employment and business				
Impact Nature	Negative	**Positive**	Neutral		
Impact Type	**Direct**	**Indirect**	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	**Permanent**	
Impact Extent	**Local**	Regional	International		
Frequency	Permanent				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Negligible	Low	**Medium**	High	
Impact Significance	Negligible	**Minor**	Moderate	Major	

(48) Phase 1 of the Project is aiming to commence construction in Q1-2019 and be operational by Q2-2020. Project life cycle is approximately 20 years (Source: Project description).

	Significance of impact is considered to be **Minor**.

10.2.7.3 Measures for Positive Impact Promotion

These positive impacts can be enhanced by the following measures:

- Project Owner should hire local people for at least un-skilled positions during operation. The Project can also encourage the contractors to hire local labour when necessary.
- Project Owner should apply local procurement during operation of the Project. In particular, the Project Owner should use local foods/products and local supply to enhance benefiting to the local communities.
- Project Owner should continue implementing CDP during the Project's operation phase. Conduct the monitoring of the implementation of this plan.

10.2.8 Operation - General Disturbance on Local Community in Operations

10.2.8.1 Potential Impacts

It is assumed that a targeted CDP, including support on improving living standards of local community in terms of health care and accessibility to public services for example, will be developed and implemented from construction phase. During operation, only -- workers will be required for the operation workforce. It is assumed that, therefore, only a very small proportion of employment, mostly unskilled jobs, could be sourced from local community. Therefore, the opportunities for local employment will be significantly reduced and this will be an impact on income and livelihoods of local people, especially those will have worked for the Project in construction phase.

Noise from the operation of turbines, substation and transformers of the Project is defined as another potential factor caused nuisance and disturbance to surrounding community. The noise screening for Thanh Hai Wind Power project shows that at all monitoring sites, the noise levels at night-time did not meet

10.2.8.2 Existing Controls

There is no existing/in place control.

10.2.8.3 Significance of Impact

The magnitude of the aforementioned impacts is predicted minor during operation as discussed above. Although the local community will experience with the disturbance from construction the impacts from operation are expected to be different in nature and impact sources such as noise from the operation of turbines and transformers, shadow flicker and the physical presence of turbine.

Table 10.10 Impact significance of disturbance to local community

Impact	General disturbance to community during operations				
Impact Nature	**Negative**		Positive		Neutral
Impact Type	**Direct**		Indirect		Induced
Impact Duration	**Temporary**	Short-term		Long-term	**Permanent**
Impact Extent	**Local**		Regional		International
Frequency	Permanent				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large

Receptor Sensitivity	Negligible	Low	**Medium**	High
Impact Significance	Negligible	**Minor**	Moderate	Major
	Significance of impact is considered to be **Minor**.			

10.2.8.4 Additional Mitigation and Management Measures

To remain the significance of the impact as minor or reduce to negligible, the Project is required to implement the additional measures as proposed in Chapter -- for Noise Impact Assessment, Visual Impact Assessment and Shadow Flicker Impact Assessment and other measures as below:

- Project Owner should keep implementing the CDP to support the local people in improvement of their socio-economic conditions. The CDP should be in implementation throughout the Project's operation period and considered as Corporate Social Responsibility program of the Project Company.
- Project Owner should keep implementing the SEP including grievance procedure during the Project's operation.
- There needs to be close monitoring through engagement with residents during the operational phase where there are predicted impacts from shadow flicker. Planting trees to create green space to increase the aesthetics of the Project;
- The reflected rays from the turbine blades generated by the reflection, can be minimized by optimizing the smoothness of the rotor surface as well as coating with less reflective material
- In order to harmonize with the general landscape of the area, wind turbine pillars are often painted light grey to create a comfortable, pleasant and gentle environment for people living around or near the wind turbine columns. The distance of each turbine is 300 - 320m to avoid causing visual disturbances.
- Project Owner should, for those who will have worked for the Project in construction phase, consider to provide skill improvement training for them to be able to access to similar jobs in other projects in the country.

10.2.8.5 Residual Impacts

Following the implementation of proposed additional measures, the residual impact is considered Minor.

10.2.8.6 Monitoring and Audit

The following monitoring activities are recommended:

- Ongoing monitoring and periodical audit as proposed in the ESMP to ensure the above mitigation measures are in implementation;
- Monitoring and audit are also required to be conducted in accordance to the schedule proposed in Chapter -- for Noise Impact Assessment, Visual Impact Assessment and Shadow Flicker Impact Assessment.

11. UNPLANNED EVENTS

This chapter presents the potential impacts of unplanned events associated with the Construction and Operation Phases of the project. Unplanned events are considered separate from the routine and non-routine activities, as they arise as a result of a technical failure, human error, or natural disaster.

Based on the scoping study (Chapter 5), this assessment addresses the following unplanned and non-routine events:

- Leakage and spill incidents;
- Fire and explosion;
- Vessel collision; and
- Blade throw.

11.1 Leakage and Spill Incidents

11.1.1 Scope of Assessment

- Oil leakage from vehicle maintenance or fixing, machine breakdown or vehicle collision;
- Dumping garbage or parts of equipment that contain hazardous materials in water bodies or on land. This is likely to happen in both water and soil environments, but in a small area;
- Leak or rupture of container with hazardous materials; and
- Spills from loading and unloading materials during construction or operation of the Project facilities.

11.1.2 Impact Assessment

11.1.2.1 Potential impacts and consequences

Potential impacts on the environment and human health from leakage of hazardous materials, including oils to water bodies include the following:

- Fur-bearing animals are vulnerable to oil since it can damage their insulating fur layer and therefore spills could induce a drop in their body temperature.
- Aquatic organisms exposed to oil slick are in danger of smothering and poisoning.
- Plants, grasses, and algae in aquatic environments can be blocked from oxygen exchange by oil slick.
- Drinking water sources can be contaminated and then pose a threat to human health.
- Oil contamination can increase soil pH level and reduce phosphorus concentration, adversely affecting soil fertility and physio-chemical properties.
- Aquatic food resources and fauna habitats can be poisoned with hazardous materials.

11.1.2.2 Existing/ in-place controls

No existing control are in place.

11.1.2.3 Significance of impacts

11.1.2.3.1 *Onshore leakage and spill incidents*

The local environment may be impacted by leakage and spills of hazardous materials as the result of incidents such as vehicle collision, machine breakdown, and leakage of containers. The Project's onshore facilities and activities are on land and do not consume or produce large amounts of hazardous materials so if any incident occurs it will be within the Project Area and controllable, so the impact magnitude is considered **Small**. In addition, the impact duration is considered short-term and soil can act as a filter and buffer for contaminants so sensitivity of receptors is considered **Medium**. Based on all the above information, the impact significance is considered to be **Minor**.

Table 11.1 Impact significance of onshore leakage and spill incidents

Impact Description	Impacts from unplanned onshore leakage and spills				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Leakage and spills events rarely occur.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor**.				

11.1.2.3.2 Offshore Leakage and Spill Incident

The Project's offshore components occupy around a total area of 2,861 ha. The nearshore area is of greater concern as a result of a spill or leak of oil due to the fast spreading of chemicals and difficulties in containing spreading and removal of contaminants. Given a small scale of offshore construction, the Project does not consume or produce large amounts of oil and hazardous chemicals so the magnitude of impact is considered to be **Small**. As presented above, the receptors that could be affected by spill and leakage include marine fauna and species, so their sensitivity to this type of incident is anticipated to be **High**. Therefore, the overall significance of impact is considered to be **Moderate.**

Table 11.2 Impacts significance of offshore leakage and spill incidents

Impact Description	Impacts from unplanned offshore leakage and spills				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Leakage and spills events rarely occur.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**	**High**		
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **Moderate**.				

11.1.2.4 Additional mitigation measures

The following mitigation measures are designed to minimise the impacts associated with leakage and spill incidents:

- Develop an Oil and Chemical Spill Response Plan (OCSRP) for the area of the WTGs;
- Provide training on the OCSRP;
- Maintain a register of onsite hazardous substances during Construction and Operation Phases;
- Use appropriate bunding when there is a risk of leaks, spills or loss of containment.
- Any deficiencies found must be recorded and immediately reported to the work area manager in order for the deficiency to be rectified as soon as practicable.
- Maintain clean-up spill kits in relevant locations within the Project area.
- Securely store hazardous materials in impermeable containers in buildings. Set up protective barriers where applicable.
- Develop procedures for loading/ unloading to minimize the risk of incidents during Operation Phase.
- Conduct routine inspections and preventive maintenance for all vehicles and equipment on a regular basis to detect spills, leaks and the potential for such occurrences.

11.1.2.5 Residual impacts

With the implementation of the above mitigation measures, the residual impacts would be expected to be **Negligible** for onshore and **Minor** for offshore incidents.

11.1.2.6 Monitoring and audit

No specific monitoring is recommended.

11.2 Fire and Explosion

11.2.1 Scope of Assessment

- Damage of the WTG, transmission lines, insulators or other supporting parts (e.g. cable) due to unpredictable causes;
- Electrical arcs or flashovers;
- Lightning strike;
- Storage of combustible materials; and
- Transformer, substation and equipment failure.

11.2.2 Impact Assessment

11.2.2.1 Potential impacts and consequences

- Large scale fire can release smoke and fumes into a large area, resulting in uncontrollable fire, loss of crops and habitats;
- People and animals that inhale smoke or toxic chemicals could be injured or suffer health impacts;
- Fire could cost local people and workers jobs and incomes; and
- Fire could threaten local communities' health and safety.

11.2.2.2 Existing/ in-place controls

No existing controls are in place.

11.2.2.3 Significance of impacts

The land areas used for the Project’s onshore components are relatively small and so any fire occurring in these areas would be localised and controllable. As such, the impact magnitude is considered **Small**. The Project’s components are to be designed in accordance with national regulations, with strict safety specifications and as such equipment failure and related fire is considered very unlikely. The immediate area surrounding the Project’s onshore facilities is rural area which is sparsely populated and so receptor sensitivity is considered **Low**. Therefore, the impact significance of fire and explosion is classified as **Negligible**.

Table 11.3 Impact significance of fire and explosion

Impact Description	Impacts from fire and explosion				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The likelihood of fire and explosion is unlikely.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	**Low**	Medium	High		
Impact Significance	**Negligible**	Minor	Moderate	Major	
	Significance of impact is considered **Negligible**.				

11.2.2.4 Additional mitigation measures

The following mitigation measures are designed to minimise the impacts associated with fire and explosion:

- Conduct regular inspection programs to maintain equipment and operability of mechanical systems;
- Store flammable materials away from ignition sources and oxidising materials;
- Equip the site with proper equipment and regularly inspect and maintain them;
- Conduct regular inspections and maintenance to eliminate potential risks; and
- Establish an emergency response and evacuation plan.

11.2.2.5 Residual impacts

The residual impacts are considered **Negligible.**

11.2.2.6 Monitoring and audit

No specific monitoring is recommended.

11.3 Vessel Collision

11.3.1 Scope of Assessment

- Increased vessel transportation for construction material, equipment and WTGs; and
- Increased risks of vessel collision due to improper management of marine transportation.

11.3.2 Impact Assessment

11.3.2.1 Potential impacts and consequences

Project activities including the importation of WTGs and transportation of construction material and equipment during the Project's Construction Phase require marine and road transportation. There will therefore be an increase in the number of vessels navigating in and out the Project offshore area as a result of the Project that will increase the risk of collision or maritime incident. At the time of ESIA development, the estimated number of vessels required or equipment and material transportation during construction was not available.

11.3.2.2 Existing/ in-place controls

No existing controls are in place.

11.3.2.3 Significance of impacts

The level of impact due to collisions may vary from property damage, injuries to personnel to fatality, depending on various factors including the type of vessel, the size of vessel and velocity at which the vessel is traveling at the time of the collision.

According to the International Association of Oil and Gas Producers (OGP), the global probability of vessel collision is 3.6×10^{-4} for total hull loss and 2.1×10^{-3} for serious casualty.

The Project will utilise the Phu My – Cai Cui Channel, and it is noted that traffic volume in the Phu My Channel is currently classed as 'heavy'.

In southern Vietnam, there were 3 ship collisions between 1992 and 2003. Therefore, it is possible that a vessel collision will occur if vessel navigation is improperly managed.

Using an impact significance matrix, the significance of the potential impact is considered **Minor** as shown in Table 11.4.

Table 11.4 Impact significance of vessel collision

Impact Description	Impact from vessel collision				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	**Temporary**	Short-term	Long-term	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	The likelihood of vessel collision is unlikely.				
Impact Magnitude	Positive	Negligible	**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**	High		
Impact Significance	Negligible	**Minor**	Moderate	Major	

	Significance of impact is considered **Minor**.

11.3.2.4 Additional mitigation measures

The following mitigation measures are designed to minimise the impacts associated with vessel collision:

- Establish a dedicated safety distance between construction area of marine components and navigation route, and provide details of this to relevant authorities and local fisherfolk.
- The construction contractor shall coordinate with relevant authorities such as the Southern Vietnam Maritime Safety Corporation and fisherfolk to disseminate information regarding the construction schedule, construction area, and related activities; and
- The construction contractor shall install buoys, navigation lights, or warning signs as appropriate to demarcate the construction area.

11.3.2.5 Residual impacts

The residual impacts are considered Negligible.

11.3.2.6 Monitoring and audit

No specific monitoring is recommended.

11.4 Blade Throw / Blade Ejection Impact Assessment

11.4.1 Scope of Assessment

Blade throw events have reportedly occurred in the past on wind farms as a result of the failure of the rotor blade, which results in the ejection or throwing of the rotor blade. Blade throw can endanger people living or working close to the wind farm. Assessment of reports and case studies available to the public have revealed an increasing trend to locate wind farms in proximity to build-up areas, which can endanger people living or working close by. Therefore, it has become strictly necessary to define setback distances and/or buffer zones to minimise the risk of damage or injury from rotor blade failure.

Blade throw/ ejection incidents have been classified as the following modelling studies conducted by various research groups and blade test practices based on the IEC 61400-23 technical specifications. They have been classified as (a) root connection failure; (b) catastrophic structural buckling or separation; (c) leading edge, trailing edge, or other bond separation; (d) lightening damage; (e) erosion; (f) failure at outboard aerodynamic device; (g) reduction in stiffness of blades (up to 10%); (h) superficial structural or delamination/ laminate wrinkling that eventually becomes permanent, leading to damage; and (h) over speeding due to failure of supervisory control and data acquisition (SCADA) to rectify the failure or high wind/ cyclonic/ meteorological conditions [(49)] .

Considering all the above, it is difficult to attribute blade throw failure to a single attribute or a combination of attributes that result in these incidents occurring. Therefore, national regulations or recommendations are in place in some countries to define setback distances and/or buffer zones surrounding WTGs to minimise the risk of damage or injury from component failure.

In the current Vietnamese context, there exist no regulations regarding setback distances required to ensure safety of nearby settlements. However, the IFC EHS Guidelines on Wind Energy, 2015 has recommended a setback distance, based on a review of existing literature in this domain, (encompassing the rationale that WTG models have varying dimensions) which is 1.5 x turbine height

(49) Robinson et al. study and development of a methodology for the estimation of the risk and harm to persons from wind turbines. 2013. Prepared by MMI Engineering Ltd for the Health and Safety Executive 2013

(tower + rotor radius), although modelling suggests that the theoretical blade throw distance can vary with the size, shape, weight, and speed of the blades, and the height of the turbine. It is therefore recommended that the minimum setback distances required to meet noise and shadow flicker limits be maintained with respect to sensitive residential receptors to provide further protection.

The Project comprises four phases each with seven (7) wind turbines and a total of 28 turbines. The blade throw/blade ejection (BT/BE) assessment was carried out considering Siemens wind turbine specifications (proposed to be used in this Project). Wind turbine considered in BT/BE assessment are Siemens SG 4.5-145: 127.5 m (hub height) and 145.0 m (rotor diameter)

The theoretical setback distances of the WTGs as per IFC wind guidelines have been presented in Table 11.5. This information was utilised to independently assess the setback distances of the receptors that were identified using the latest satellite imagery of the Project Area.

Table 11.5 Setback distances adopted for the Thanh Hai Wind Turbines as per IFC Wind EHS Guidelines

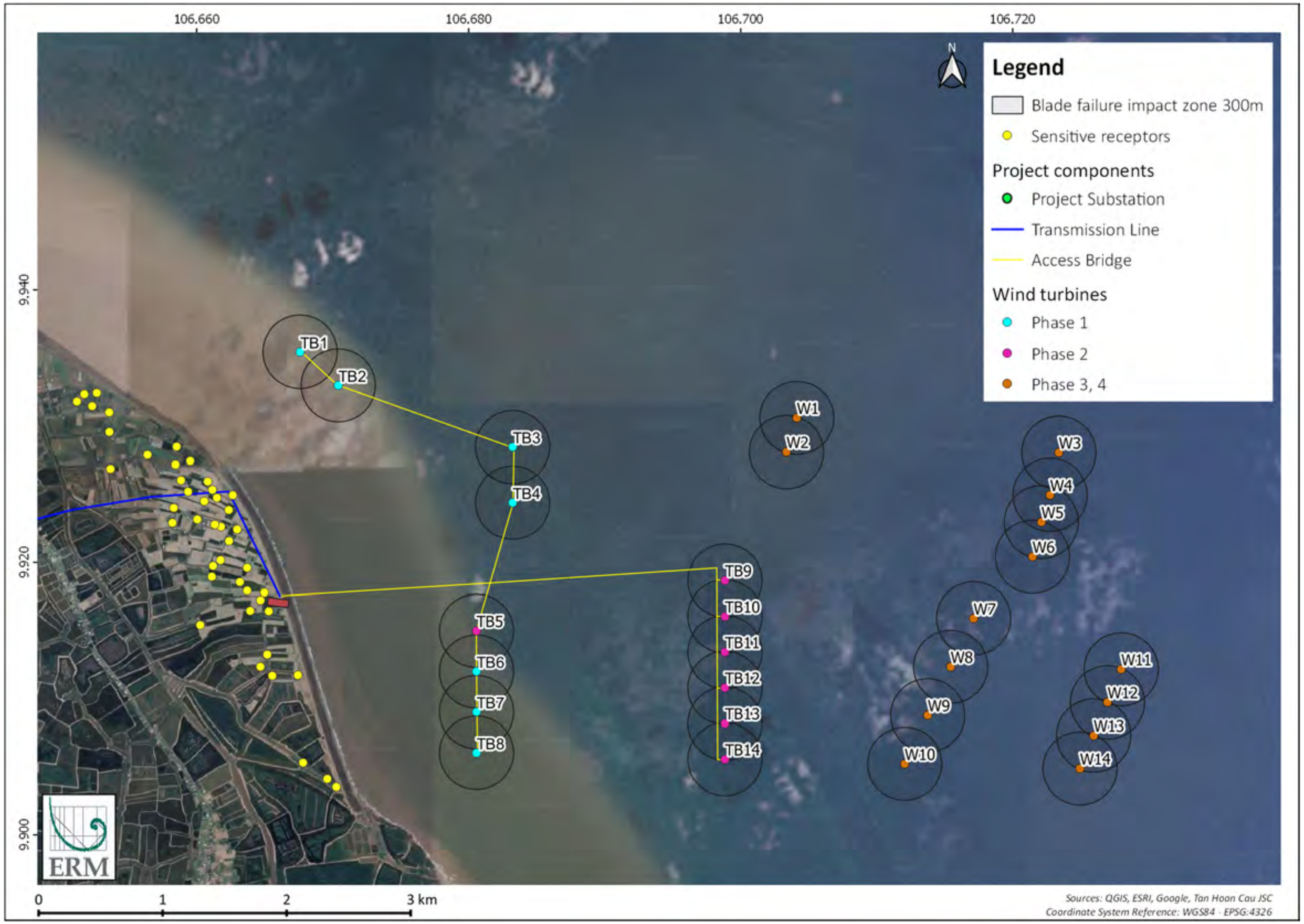
WTG Model	Project	Tower height	Rotor Radius	Calculated setback distances in metres as per IF Wind EHS guidelines (50)
Siemens Gamesa SG 4.5-145	Thanh Hai	127.5 m	72.5 m	300.0

Source: EHS guidelines for wind energy, IFC, August 7, 2015

11.4.2 Receptors

The number of receptors and the setback distance with regard to the Thanh Hai wind farm has been presented in Figure 11.1, where the circle around each WTGs is of 300 m. It is evident from the figure that none of the receptor is located within the impact zone of theoretical blade throw.

(50) EHS guidelines for wind energy, IFC, August 7, 2015



Source: Google Earth Pro; Satellite Imagery dated 09/10/2018 as accessed on 01/12/2019

Figure 11.1 Receptors within Potential Impact Zone of Blade Throw of Thanh Hai Project

11.4.3 Impact Assessment

11.4.3.1 Potential blade throw/ blade ejection impacts

The impacts from blade throw may result in various scenarios, including property damage, injuries and/or fatality, depending on where the fragment or blade lands. It might not affect any property or person if it lands on vacant land. The probability of fatality within occupied properties would also be subject to Impact Impulse, type of structure, number of occupants at the time of the impact etc. (coverage beyond the scope of this qualitative study).

11.4.3.2 Significance of impacts

Although incident data for blade throw is not extensive, there are now reliable data available for over 200,000 turbine years of operating experience in Europe. This includes around 100 incidents of blade failure in Europe over the period from 1995 to 2009. The failure frequency per 1 MW turbine per year = 5 x 10-4 blade failures/turbine /year[51]. Note however, that this approach cannot be used to identify blade failure frequency as a function of wind turbine power rating. Impact magnitude is considered **Negligible.**

Based on qualitative analysis of blade throw, considering the setback distance proposed by the IFC in Table 11.6, blade throw impacts are identified in none of the structural receptors located within the impact zone of theoretical blade throw of the wind turbines. Therefore, receptor sensitivity is considered **Negligible**, and the significance of the impact is assessed to be **Negligible**.

Meanwhile, based on the qualitative analysis of blade throw considering the setback distance as proposed by the IFC in Table 11.6**,** blade throw impacts are identified for individual wind turbines for nineteen (19) WTGs (T05, T06, T07, T08, T09, T10, T11, T12, T13, T14, W1, W2, W4, W5, W6, W11, W12, W13 and W14).

Table 11.6 Significance of impacts of blade throw/ blade ejection

Impact	Blade Throw / Blade Ejection during Operation Phase				
Impact Nature	**Negative**	Positive	Neutral		
Impact Type	**Direct**	Indirect	Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional	International		
Frequency	Blade throw events rarely occur				
Impact Magnitude	Positive	Negligible	Small	Medium	**Large**
Receptor Sensitivity	**Negligible**	Low	**Medium**	High	
Impact Significance	**Negligible**	Minor	**Moderate**	Major	
	Negligible for all receptors but **Moderate** for individual wind turbines.				

[51] Study and development of a methodology for the estimation of the risk and harm to persons from wind turbines. HSE Report No. RR968, 2013

11.4.3.3 Additional Mitigation and Management Measures

The blade throw impact can be avoided if there is option of altering the micrositing of the WTGs. There is also a finite probability of new receptors - residential and commercial structures coming up within the impact zone of turbines. Therefore, in order to avoid any incident in future, it is important to adopt following mitigation measures:

- explore the possibility of changing the siting of WTGs to create a minimum space of minimum 300 m between them;
- strengthen the foundation of all WTGs;
- provide anchors to all WTGs to delay the immediate impacts;
- carryout periodic blade inspections and repair any defects that could affect the blade integrity;
- ensure that lightning protection systems are properly installed and maintained;
- equip wind turbines with vibration sensors that can react to any imbalance in the rotor blades and shut down the turbine, if necessary;
- monitor any development close to the turbines within the impact zone;

11.4.3.4 Residual Impacts

The results of the Blade throw assessment show a real case estimate with certain assumptions and the mitigation measures above will be implemented to avoid / minimise adverse potential impacts, if any. Residual impacts following the application of required mitigation measures, as discussed above, is likely to result in **Minor** impacts.

11.4.3.5 Monitoring and audit

No specific monitoring measures are identified.

12. CUMMULATIVE IMPACT ASSESSMENT

12.1 Introduction

Cumulative impacts are generally considered as those, which are additive or interactive in nature that arise as a result of an impact from the Project interacting with an impact from another activity to create an intensified impact.

The IFC World Bank Group defines a cumulative impact as the:

"…result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted. Cumulative impacts are limited to those impacts generally recognised as important on the basis of scientific concerns and/or concerns from Affected Communities" (IFC World Bank Group Performance Standard 1 (IFC PS 1)).

IFC PS 1 requires that an environmental assessment should also address cumulative impacts. The objective of the Cumulative Impact Assessment (CIA) is to identify those environmental, social or health aspects that may not on their own constitute a significant impact but when combined with impacts from past, present or reasonably foreseeable future Project activities or other projects/activities may result in a larger and more significance impact.

In order to gain an understanding of the Project's overall contribution to impacts within Thanh Hai commune and other communes in Thanh Phu district, a cumulative impact assessment (CIA) is required to be undertaken. Whilst total cumulative impacts due to multiple projects within a given area should be identified within government led spatial planning efforts (generally as part of a Strategic Environmental Assessment), the Client needs to determine the degree to which it is contributing to these overall cumulative impacts on Valued Environmental and Social Components (VEC). In this regards, the objectives of the CIA are:

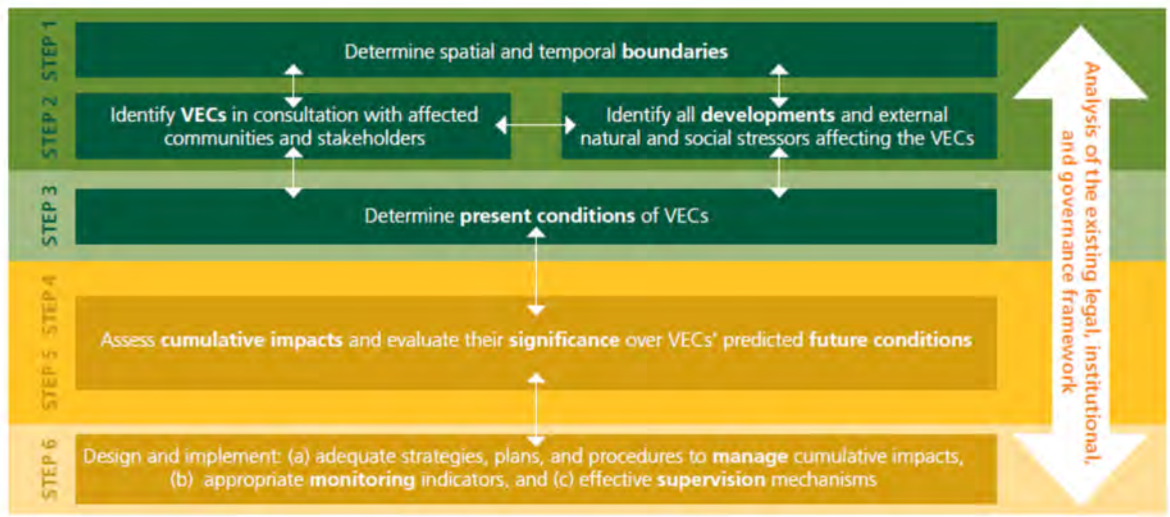
- Use the outcomes of the preceding chapters of this ESIA to determine spatial and temporal boundaries, identify VEC's and all development and external natural and social stressors affecting them;
- Recognise and identify how the project, along with other existing and future projects may contribute to cumulative impacts on the predicted future condition of the identified VEC's; and
- Develop measures to ensure these are avoided and/or minimised to the greatest extent possible.

To achieve these objectives and gain an understanding of the complexities of cumulative impacts, this Chapter presents a Rapid Cumulative Impact Assessment (RCIA), which has been undertaken largely in accordance with the IFC's Good Practice Handbook: Cumulative Impact Assessment and Management Guidance for Private Sector in Emerging Markets (the "IFC Handbook").

12.2 Methodology

This chapter presents an RCIA in accordance with the IFC Handbook and therefore with regard to the six-step process outlined in Figure 12.1. As this RCIA forms part of the overall ESIA, the general conditions and trends of the VECs are already known (they were established during environmental and social baseline condition assessments), as are the impacts from the Project (as part of the impact assessment) and the proposed mitigation, management and monitoring measures. Given this, VECs and impacts have been quickly established, with an emphasis placed on the steps pertaining to CIA and management.

In developing the methodology for this CIA, emphasis has been placed upon following a largely qualitative approach, allowing for identification of general trends and then developing appropriate management, mitigation and monitoring measures. This is primarily due to lack of clear data or information on surrounding projects. Given this approach, the majority of the methodology relies upon the use of professional judgements, complimented by ERM's understanding of the Project and impacts and experience with similar projects in similar settings.



Source: General RCIA Methodology (Source: IFC Handbook, 2013)

Figure 12.1 Six step process

12.2.1 Determining Spatial and Temporal Boundaries and VEC's

The methodology used in the setting of spatial and temporal boundaries is largely qualitative and is based upon the general "rules of thumb" suggested in Box 7 of the IFC Handbook. The following factors have been established within the methodology:

- Temporal boundaries have been set based on a desktop review of available information pertaining to other proposed projects within the area (see Section 12.2.3);
- ERM's understanding of projects currently within and proposed to be developed within the local area; and
- Geographic boundaries are a composite of the location of the identified VECs (see section 12.3 below), assessed impacts of the Project and the degree to which they may overlap with other external projects and stressors to impact upon an identified VEC.

12.2.2 Identifying VEC's and their Present Conditions

As this RCIA is part of an ESIA, the identification of VEC's is able to be largely drawn upon work already undertaken, supplemented by stakeholder engagement. VEC's are defined as follows:

- Those defined as sensitive receptors within the ESIA. An example of this is any village or house or identified as a sensitive receptor for the purposes of the noise assessment or biodiversity values identified at Chapter 7.3.1;
- Any particular resource or ecosystem service identified as being utilised by sensitive receptors. An example of this would be fishery activities at the nearshore or the mangrove area of the local community for domestic purposes.
- Those identified as part of stakeholder engagement, regardless of whether or not they meet either of the above definitions.

12.2.3 Identifying Developments and External Social Stressors Affecting VEC's

External developments, also known as reasonably foreseeable future actions, are identified utilising knowledge gained through the ESIA process (including field observations), stakeholder engagement and the interpretation of readily available external data. The outcomes of these considerations will be a simple binomial decision, i.e. yes the project is likely and therefore will be included within the CIA, or no, it is unlikely and therefore will not be included within the CIA.

The second step is to determine the extent of the various impacts of these projects. This allows for a decision to be made as to whether there is the potential for an overlap in Project impacts that could lead to a measurable cumulative impact. Key to this are the following elements:

- Identification of appropriate geographical/spatial boundaries. Where potentially interacting projects are not located close enough, or sufficiently linked through various ecological and social processes, for relevant impacts to overlap, cumulative impacts are less likely;
- Identification of temporal boundaries. Where the schedules of various components of projects do not overlap in time, particularly with regards to the construction phase of large projects, cumulative impacts are less likely. Additionally, where projects are going to be short term, cumulative impacts will generally be of limited duration;
- Consideration of impact type. Whilst there may be no direct geographical overlap in project boundaries, there is the possibility that their offsite impacts may directly overlap elsewhere and cause offsite cumulative impacts. Examples are sediment discharges into river systems, air pollutant emissions, and social impacts associated with overall migration influx;
- Determination of any “aggravating factors” that may be evident within a particular project identified for inclusion within the CIA. This includes elements such as the size of the project, environmental management performance, and the regulatory regime under which it operates; and
- Identification of potential externalities, that is a project ability to influence (either positively or negatively) the behaviours of other operations in the area.

The other element identified as part of this scope is external natural and social stressors which aren’t related to a single project or source. As these are ongoing stressors it has been assumed that they have already been captured as part of the Project baseline conditions (refer to Chapter 7 and 8) and the impact assessment. Specific additional identification and assessment of these is therefore not considered necessary as part of this RCIA.

12.2.4 Identification and Assessment of Impacts

Impact scoping and identification needs to be in alignment with those assessed throughout the main body of the ESIA, and needs to include those which are recognised as important on the basis of genuine scientific concerns and the views of affected communities and other stakeholders. This allows for impacts to be appropriately grouped and added to impacts identified as likely to occur from other projects.

A largely qualitative approach was taken for the RCIA. This is to enable a focus upon identification of trends across the various projects in the area, their temporal and spatial interactions and how these are likely to impact upon VEC’s. Whilst impacts arising from the Project have been defined and assessed in isolation, it can be difficult to accurately quantify cumulative impacts as there can be a high degree of uncertainty in interactions with other projects and activities that may be occurring in the area as well as a lack of confirmed project information. Therefore, the impacts are to be assessed qualitatively based on the identified trends and grouped according to impact type, rather than VEC, in accordance with the overall methodology adopted for the ESIA. The RCIA is also based on the assumption that all assessed residual impact levels within the ESIA are achievable.

12.2.5 Development of Management, Mitigation and Monitoring Measures

Based upon identification of broad impact trends, broad scale mitigation measures will need to be developed. Generally, these are based upon:

- Effective application of, and adherence to, the mitigation hierarchy in environmental and social management of the specific contributions by the project expected cumulative impacts. This is generally achieved through stringent implementation of the measures developed specifically for the project; and

- Development of best efforts to engage in, enhance and/or contribute to a multi-stakeholder, collaborative approach to implementing management actions which are beyond the capacity of an individual project proponent.

Any measures developed to address concerns identified within this CIA will take into account these general concepts. There also needs to be scope to develop these measures further when detailed information regarding projects becomes available.

12.3 Identification of VEC's and Their Present Condition

The ESIA identifies and describes the current condition of a range of Sensitive Receptors, defined as VEC's for the purposes of this RCIA. These are:

- Noise receptors in close proximity to the Project site;
- The inhabitants of the Thanh Hai, An Nhon, An Thuan, An Dien, An Qui and Binh Thanh communes of Thanh Phu district which occur within the projects AoI; and
- Biodiversity values and particularly bird and bats which are at risk from blade strike, and to a lesser extent habitat loss.

No specific additional VEC's were identified during stakeholder engagement.

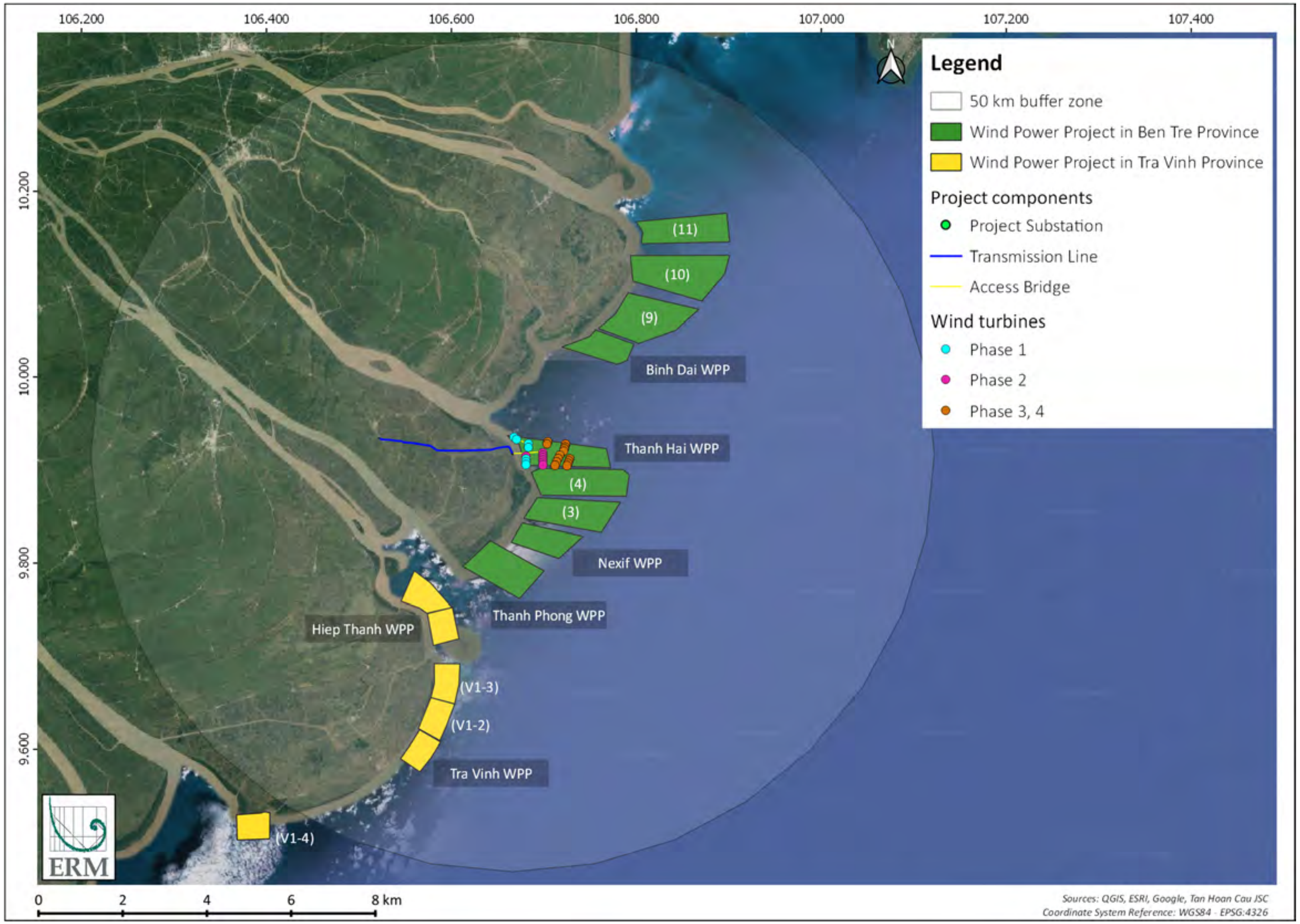


Figure 12.2 Major developments and key VECs in the Project region

12.4 Identification of Relevant Development and External Natural and Social Stressors

With reference to decisions on approval of master plan of windfarm projects in Ben Tre[52] and Tra Vinh[53] until 2020 and vision to 2030, the following windfarm projects are either under construction or plan to begin construction in the future, within the immediate Project area. Figure 12.3 illustrated the locations of these windfarm projects in Ben Tre Province.

[52] Decision No. 2497/QD-BCT issued by the Ministry of Industry and Trade dated 18 March 2015 on the approval of master plan of windfarm projects in Ben Tre until 2020 and vision to 2030.

[53] Decision No. 13309/QD-BCT issued by the Ministry of Industry and Trade dated 04 December 2015 on the approval of master plan of windfarm projects in Tra Vinh until 2020 and vision to 2030.

Table 12.1 Key developers in the immediate region

	Key developers		Capacity (MW)	Land Area (ha)	Development Status at the Time of CIA	Expected Start of Construction	Tentative Schedule for Operation	Distance to Project Components		
	Project	Description						Turbines (km)	Substation (km)	Transmission Line (km)
1	Wind Farm Project in V1-4 Area	Nearshore windfarm	48	1,200	Planning	NA	NA	43.3	45.3	45.0
2	Wind Farm Project in V1-2 Area	Nearshore windfarm	48	1,220	Planning	NA	NA	20.7	23.6	22.9
3	Wind Farm Project in V1-3 Area	Nearshore windfarm	48	1,225	Planning	NA	NA	15.9	18.9	18.0
4	Hiep Thanh Wind Farm	Nearshore windfarm	78	2,747	Technical design	Q4 2019	Q3 2020	10.6	12.0	12.1
5	Thanh Phong Wind Farm	Nearshore windfarm	125	3,200	Permitting	NA	NA	1.2	3.7	3.5
7	Nexif Ben Tre 1 Wind Farm	Nearshore	30	2,000	Construction	In construction	Q4 2020	8.3	7.2	3.5
8	Wind Farm Project in Ben Tre (3)	Nearshore windfarm	140	3,600	Planning	NA	NA	1.7	2.9	2.2
9	Wind Farm Project in Ben Tre (4)	Nearshore windfarm	120	3,100	Planning	NA	NA	5.5	5.7	4.6
10	Binh Dai Windfarm	Nearshore and offshore windfarm	160	4,900	Permitting	2020	2021	21.6	20.7	18.1

	Key developers		Capacity (MW)	Land Area (ha)	Development Status at the Time of CIA	Expected Start of Construction	Tentative Schedule for Operation	Distance to Project Components		
	Project	Description						Turbines (km)	Substation (km)	Transmission Line (km)
11	Tra Vinh Windfarm	Nearshore windfarm	48	1,208	Technical design	Q1 2020	Q1 2021	25.1	27.8	27.1
12	Wind Farm Project in Ben Tre (9)	Nearshore windfarm	140	3,700	Planning	NA	NA	25.0	24.5	18.9
13	Wind Farm Project in Ben Tre (10)	Nearshore windfarm	190	4,900	Planning	NA	NA	31.9	35.9	26.1
14	Wind Farm Project in Ben Tre (11)	Nearshore windfarm	120	3,200	Planning	NA	NA	36.0	35.9	30.3

12.5 Summary of Trends, VEC's and Scope Refinement

A cumulative screening assessment was carried out to consider the interactions of impacts from various key developers on the relevant VECs, including:

- Bird and bat strike and habitat loss;
- Economy and employment;
- Community health and safety;
- Infrastructure and public services;
- Traffic; and
- Visual amenity.

Cumulative impacts that are not contributed significantly from the Project were scoped-out. Results of the impact screening on VECs are presented in Appendix H.

Table 12.2 presents the outcomes of scoping, based upon identified VECs, assessed Project impacts, the identified external projects, and the summary of trends.

Table 12.2 Scoping of Impacts

Impact Type	VEC's Likely to be Impacted	Existing Assessment in ESIA	RCIA Scope
Noise	Local communities living along the coastal area in Thanh Hai Commune.	Section 9.3 provides an assessment of noise impacts for both the Nexif Ben Tre 1 and Thanh Hai windfarm projects. Based on the assessed compliance of the individual operation of the Thanh Hai Project and the cumulative operation of the Nexif Ben Tre 1 Project and the Thanh Hai Project, predicted cumulative noise levels from these two windfarms are below the compliance limits and therefore, achieves compliance at all onshore receptors.	No further CIA is proposed.
Bird and bat strike and habitat loss.	Species of conservation significance known to habitat the local area (Chapter 7.8)	A detailed assessment of biodiversity impacts is provided in Section 11.3 and identifies impacts associated with the Thanh Hai development only.	Cumulative assessment to be conducted using the findings of the Thanh Hai assessment as guidance on the extent and likely significance of impacts.
Visual Impacts	Local communities living along the coastal area of Thanh Phu District.	A visual assessment is provided at Section 9.6 which indicated that the impact of the Thanh Hai Project on visual aesthetics is assessed as Minor. Additionally, as Thanh Hai Project is located about 7 km away from the Nexif Ben Tre 1 Project, impacts on visual aesthetics from these two projects are not considered cumulatively.	No further cumulative impact assessment is proposed.
Waste	No VEC's are likely to be impacted by waste.	Waste has also not been considered in the CIA as the ESMP has proposed appropriate management and mitigation measures. It is expected that any future developments will comply with Vietnamese waste storage and management regulations (as a minimum).	No further assessment is required

Impact Type	VEC's Likely to be Impacted	Existing Assessment in ESIA	RCIA Scope
Socio-Economic: Community Health and Safety	The VECs likely to be impacted are those people residing in Thanh Phu District.	Section 10.2.5 and 10.2.8 present a detailed assessment of impacts relating to community health and safety during Construction and Operation Phases.	A qualitative assessment will be undertaken, focusing on identification of ways in which cumulative impacts may occur to VECs, and develop appropriate mitigation strategies.
Socio-Economic: Economy and Employment	The VECs likely to be impacted are those people residing in Thanh Phu District.	Social impacts of the Project, including impacts to employment and economy during both the Construction and Operation Phases, were assessed as part of Section 10.2.2 and 10.2.7.	A qualitative assessment will be undertaken, focusing on identification of ways in which cumulative impacts may occur to VECs, and develop appropriate mitigation strategies to ensure that positive impacts are maximised.
Socio-Economic: Traffic	The VECs likely to be impacted are those people residing in Thanh Phu District.	Section 10.2.6 presents a detailed assessment of impacts relating to traffic during Construction phase.	A qualitative assessment will be undertaken, focusing on identification of ways in which cumulative impacts may occur to VECs, and develop appropriate mitigation strategies.
Socio-Economic: Infrastructure and Public Services	The VECs likely to be impacted are those people residing in Thanh Phu District.	Section 10.2.4 presents a detailed assessment of impacts relating to infrastructure and public services during Construction phase.	A qualitative assessment will be undertaken, focusing on identification of ways in which cumulative impacts may occur to VECs, and develop appropriate mitigation strategies.

12.6 Cumulative Impacts on Bird and Bat Strike and Habitat Loss

The Project could have potential impacts on biodiversity, including habitat loss, mortality or injury as a result of blade strike. The impact assessment indicated that the impact significances on biodiversity range from **Negligible** to **Moderate**. Of these, most impacts were considered to be **Moderate**. The habitat in the Project area is trigger Critical Habitat. A Biodiversity Action Plan will be prepared for the management and monitoring of natural and critical habitats within the Project EAA as required by IFC PS6.

The location of the Nexif Ben Tre 1 windfarm is within close proximity to windfarms currently under construction or sites where windfarm construction will begin in the future (see Table 12.1). Of concern is the potential for cumulative impacts to biodiversity, as a result of increases in bird flight risk throughout the Rotor Swept Zone of these additional farms. It is anticipated that the potential risk of increased mortality of avifauna is likely.

It is difficult to predict the cumulative impacts of Ben Tre Province's numerous windfarms on bird and bat populations. Species detected in the surveys conducted for this ESIA have been of lower conservation concern (generally of Least Concern or Near Threatened on the IUCN Red List). Cumulative impacts however may result in local reductions in avifauna populations that may cause impacts on ecosystem services provided by these species, such as pollination and pest control. Birds and bats can be key pollinators for flora, including for agriculture, and bats play an important role in reducing insect populations in agricultural areas.

12.7 Cumulative Impacts on Economy and Employment

In terms of economy and employment, the cumulative impact will be **Positive** and this positive impact will be assessed at national, provincial and local level through analysing tax revenue, economic development and employment opportunities, respectively. As indicated in Table 12.3, the cumulative impacts will occur during both the Construction and Operation Phases of the Project. Benefits will be visible in the local employment and procurement activities of the Project as well as other local developments, both directly to the projects and indirectly via their subcontractors and suppliers. It is estimated that each wind power project (with the capacity of 30 MW) requires at least 200 workers during construction and 25 workers during operations. Although not all of these workers will be recruited from the local area, some will be employed from the local communities for unskilled and semi-skilled jobs. Business and service development, including shops, restaurants and hotels, will increase in the area leading to increased incomes and induced employment for local people.

Table 12.3 Cumulative impact scoping for economy and employment

	Project	Economy and Employment
Proposed developments		
1	Wind Farm Project in V1-4 Area	O
2	Wind Farm Project in V1-2 Area	O
3	Wind Farm Project in V1-3 Area	O
4	Hiep Thanh Wind Farm	CO
5	Thanh Phong Wind Farm	O
7	Nexif Ben Tre 1 Wind Farm	CO
8	Wind Farm Project in Ben Tre (3)	O

	Project	Economy and Employment
9	Wind Farm Project in Ben Tre (4)	O
10	Binh Dai Windfarm	C
11	Tra Vinh Windfarm	O
12	Wind Farm Project in Ben Tre (9)	O
13	Wind Farm Project in Ben Tre (10)	O
14	Wind Farm Project in Ben Tre (11)	O

Note:
C Construction phase
O Operation phase
D Decommissioning phase
N Negligible / Managed risk
Large scale negative
Small scale negative
Positive

When assessing the benefits that these developments would bring to Vietnam and the Tra Vinh and Ben Tre provinces, as well as these provinces' districts, communes and local people, the cumulative impact on economy and employment is considered Moderate.

12.8 Cumulative Impacts on Community Health and Safety

The cumulative impacts on community health and safety are assessed for both labour influx and non-influx related issues during construction and operation of the Project, concurrently with other developments in Tra Vinh and Ben Tre, as shown in Table 12.1. As indicated in the scoping matrix (Appendix H and Table 12.4), most of the cumulative impacts on community health and safety will be from the Project's construction activities interacting with the construction of the Thanh Phong and Thanh Hai Windfarm projects. Other developments are scoped out for this CIA due to their early stage of development and distance from the Project.

Table 12.4 Cumulative impact scoping for community health and safety

	Project	Community Health and Safety
Proposed developments		
1	Wind Farm Project in V1-4 Area	N
2	Wind Farm Project in V1-2 Area	N
3	Wind Farm Project in V1-3 Area	N
4	Hiep Thanh Wind Farm	N
5	Thanh Phong Wind Farm	C
7	Nexif Ben Tre Wind Farm	C
8	Wind Farm Project in Ben Tre (3)	N

9	Wind Farm Project in Ben Tre (4)	N
10	Binh Dai Windfarm	N
11	Tra Vinh Windfarm	N
12	Wind Farm Project in Ben Tre (9)	N
13	Wind Farm Project in Ben Tre (10)	N
14	Wind Farm Project in Ben Tre (11)	N

Note:
C Construction phase
O Operation phase
D Decommissioning phase
N Negligible / Managed risk
Large scale negative
Small scale negative
Positive

Key cumulative impacts include increased risk of infectious disease, potential for increased crime and cultural impacts such as the erosion of traditional values and changes in social networks due to the influx of migrant workers and non-local people who come to Ben Tre. Other impacts caused by the construction and operation activities (non-influx issues) of these developments comprise of noise, dust, waste and traffic safety issues. Based on the assessment of these impacts for the Project, the cumulative impacts on community health and safety will be in the range of **Moderate** to **Major.**

In addition to the mitigation measures proposed in Section 10, the Client should adopt a collaborative approach and work with other local projects' owners and the local authorities as part of the Project Stakeholder Engagement Plan. In particular, the Project should implement its ESMP to manage labour influx and environmental issues and to share good practices with other local project owners.

The Client should collect periodic reports from local clinics at commune and district levels to understand the community health and safety status in the area prior to and during Project development. There should be a monitoring mechanism for ESMP implementation to identify its effectiveness and to allocate responsibility to certain developers in the instance where any issue arises. Where necessary, propose and conduct corrective actions in a timely manner.

12.9 Cumulative Impacts on Infrastructure and Public Services

As indicated in the scoping matrix (Appendix H and Table 12.5), the cumulative impacts on infrastructure and public services include both negative and positive impacts. Negative impacts are mostly associated with the additional strain on local services (roads, health care, electricity), rising prices for commodities, and food. Positive impacts include improvements to infrastructure and public services via the CDP or CSR programs of these developments, such as road upgrades, health facilities and health care service support, and the increase and stabilisation of electricity supply, which become significant during the Operation Phase when projects begin generating revenue.

Table 12.5 Cumulative impact scoping for infrastructure and public services

	Project	Infrastructure and Public Services	
Proposed developments			
1	Wind Farm Project in V1-4 Area	N	O
2	Wind Farm Project in V1-2 Area	N	O

3	Wind Farm Project in V1-3 Area	N	O
4	Hiep Thanh Wind Farm	N	O
5	Thanh Phong Wind Farm	C	O
7	Nexif Ben Tre 1 Wind Farm	C	O
8	Wind Farm Project in Ben Tre (3)	N	O
9	Wind Farm Project in Ben Tre (4)	N	O
10	Binh Dai Windfarm	N	O
11	Tra Vinh Windfarm	N	O
12	Wind Farm Project in Ben Tre (9)	N	O
13	Wind Farm Project in Ben Tre (10)	N	O
14	Wind Farm Project in Ben Tre (11)	N	O

Note:
C Construction phase
O Operation phase
D Decommissioning phase
N Negligible / Managed risk
Large scale negative
Small scale negative
Positive

The adverse impact is expected to be **Moderate** overall, with the construction and operation simultaneously of these developments. The positive impact will be **Minor** since CDP/CSR programs may not be in place and implemented by all of these projects.

In addition to mitigation measures proposed in Section 10, the Client should take a collaborative approach to working with local authorities and owners of other developments within Ben Tre Province as part of the Project Stakeholder Engagement Plan. In particular, the Client should implement its ESMP to manage impacts on infrastructure and public services and to share good practices with other development owners. The Client can also cooperate with other developers to develop and implement an infrastructure improvement project via its CDP/CSR program.

There should be a monitoring mechanism for ESMP implementation to identify its effectiveness and to allocate responsibility to certain developers in the instance where any issue arises. Where necessary, propose and conduct corrective actions in a timely manner.

12.10 Cumulative Impacts on Traffic

Impacts on traffic comprise of potential traffic congestion and increased traffic safety risk in the areas along the transportation routes of projects, both on land and water. The interactions causing these cumulative impacts occur mostly during projects' construction phase; a phase that requires a high frequency and volume of transportation activities and, taking into account the transportation activities of the Thanh Phong and Thanh Hai projects which are the neighbouring projects and may commence activities concurrently, the cumulative impacts on traffic could be **Moderate** during operations.

Table 12.6 Cumulative impact scoping for traffic

	Project	Traffic
Proposed developments		
1	Wind Farm Project in V1-4 Area	N
2	Wind Farm Project in V1-2 Area	N
3	Wind Farm Project in V1-3 Area	N
4	Hiep Thanh Wind Farm	N
5	Thanh Phong Wind Farm	C
7	Nexif Ben Tre 1 Wind Farm	C
8	Wind Farm Project in Ben Tre (3)	N
9	Wind Farm Project in Ben Tre (4)	N
10	Binh Dai Windfarm	N
11	Tra Vinh Windfarm	N
12	Wind Farm Project in Ben Tre (9)	N
13	Wind Farm Project in Ben Tre (10)	N
14	Wind Farm Project in Ben Tre (11)	N

Note:
C Construction phase
O Operation phase
D Decommissioning phase
N Negligible / Managed risk
Large scale negative
Small scale negative
Positive

Overall, this cumulative impact is predicted to be Moderate.

In addition to the mitigation measures proposed in Section 10, the Client should take a collaborative approach to working with the local authorities and owners of other developments within Ben Tre, as part of the Project Stakeholder Engagement Plan.

12.11 Cumulative Impacts on Visual Amenity

Visual impact is assessed only for the Operation Phase, which is when the wind turbine plant will be fully constructed and present in the area. Since all of the aforementioned developments are and will be located nearby and along the coastline between the Ben Tre and Tra Vinh provinces, depending on the perception of receptors (who are local people living in the areas where these developments are or will be situated) the visual impact will be **Negligible** to **Moderate**. From interviews with local people regarding their perception of the Project, some reported their pleasure and anticipation to see the Project come to fruition. However, if all aforementioned nearshore projects finish their construction simultaneously and numerous turbines are located along the coastline, the visual effect could be negative. Accordingly, the cumulative impacts to visual amenity are considered **Negligible** to **Moderate**.

Table 12.7 Cumulative impact scoping for visual amenity

	Project	Community Health and Safety
Proposed developments		
1	Wind Farm Project in V1-4 Area	O
2	Wind Farm Project in V1-2 Area	O
3	Wind Farm Project in V1-3 Area	O
4	Hiep Thanh Wind Farm	O
5	Thanh Phong Wind Farm	O
7	Nexif Ben Tre 1 Wind Farm	O
8	Wind Farm Project in Ben Tre (3)	O
9	Wind Farm Project in Ben Tre (4)	O
10	Binh Dai Windfarm	O
11	Tra Vinh Windfarm	O
12	Wind Farm Project in Ben Tre (9)	O
13	Wind Farm Project in Ben Tre (10)	O
14	Wind Farm Project in Ben Tre (11)	O

Note:
C Construction phase
O Operation phase
D Decommissioning phase
N Negligible / Managed risk
Large scale negative
Small scale negative
Positive

In addition to the mitigation measures proposed in Section 10, the Project could enhance its positive impacts on local communities via its CDP.

12.12 Conclusions of the CIA

Based upon a review of existing projects and potential developments within a 50 km range of the Project, it is concluded that cumulative impacts associated with projects that occur in Thanh Phu District will likely be experienced during the construction and operation phases of the Project.

The major cumulative impacts include those to:

- Bird and bat strike and habitat loss;
- Economy and employment;
- Community health and safety;
- Infrastructure and public services;
- Traffic; and

- Visual amenity.

The successful implementation of the various mitigation and management measures recommended to mitigate or manage project-induced cumulative impacts will require collaboration with a number of stakeholders. Key stakeholders include local authorities, owners of projects in Thanh Phu District and local communities. In situations such as this, where there are multiple levels of stakeholders required to cooperate in order to minimise impacts, a multi-user group is vital for managing cross-project impacts. To achieve this, the Client should seek to actively collaborate with all stakeholders identified within the SEP as well as surrounding project owners, to exchange information on the management of environmental and social impacts of the projects. The management and mitigation measures have been incorporated into the ESMP.

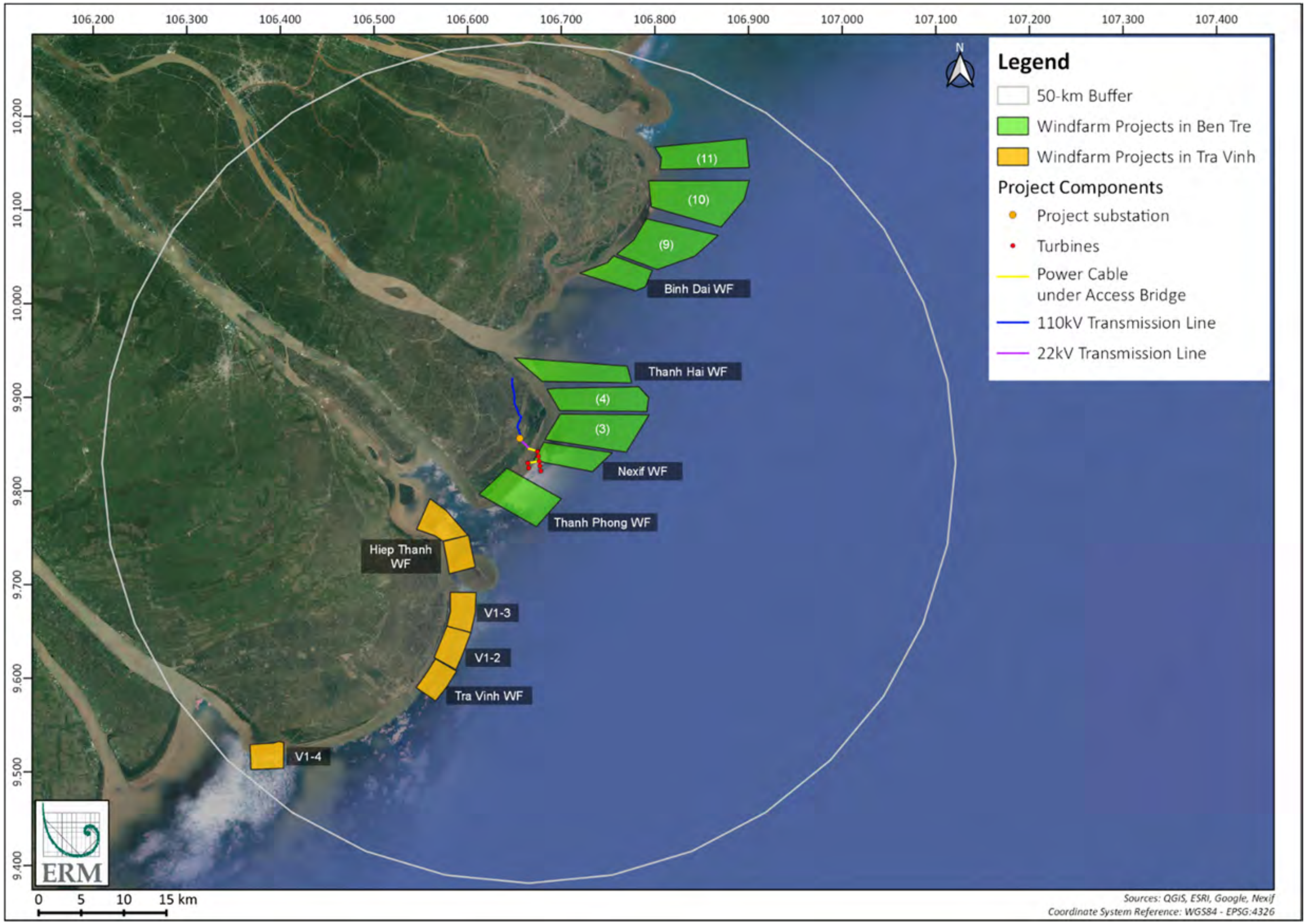


Figure 12.3 **Approximate location of the proposed windfarms in the area**

13. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

13.1 Introduction and Objectives

The ESIA process has identified the key environmental, social and health issues, impacts and risks associated with the Project requiring implementation of a wide range of mitigation measures. The necessary actions required managing these issues, impacts and risks are presented in this Environmental and Social Management Plan (ESMP). These include the identification of all Project commitments (including legislative and IFC compliance requirements), mitigation measures that have been identified from the Impact Assessment (IA), and other best practice measures designed to avoid, minimise or reduce negative impacts and enhance positive impacts. The objectives of the ESMP are to:

- Identify a set of responses to potentially adverse impacts;
- Define the responsibilities for implementation and monitoring;
- Determine requirements for ensuring that mitigation and management measures are implemented effectively and in a timely manner; and
- Describe the means for meeting those requirements.

The purpose of this Chapter is to demonstrate how the mitigation commitments made through the IA Process will be put into practice, monitored and upheld. The content of this chapter is crucial to bridging the findings of the IA with implementation of the mitigation measures, and to provide an early framework of management systems/ monitoring regimes that will help to deliver the IA commitments.

Specifically, this Chapter provides information and instructions on how environmental, social, and health commitments of the Project will be managed from pre-construction through to the Construction and Operation Phases. The ESMP is a living document which:

- Incorporates the environment and social mitigation measures identified as a result of the ESIA process into a comprehensive framework to facilitate and ensure appropriate management throughout the Project cycle;
- Provides a framework for incorporating commitments into the Project plans and procedures for activities that have risks, as identified in the IA;
- Presents responsibilities for meeting ESMP requirements including the provision of training;
- Provides a framework for the implementation of specific management plans by the EPC; and
- Defines the monitoring/verification and reporting program (including corrective actions).

13.2 Scope of this ESMP

The scope of this ESMP covers the construction, and operational aspects that have the potential to affect, positively or negatively, the environment and communities in which Thanh Hai 1 or its contractors, sub-contractors will operate. As required by this ESMP, a range of detailed management plans will be developed and implemented for each specific phase of the Project. The responsibility for the implementation of these plans will lay variously with Thanh Hai 1, contractors and sub-contractors.

13.3 Responsibility for Implementing the ESMP

The key parties and their primary roles in implementing the ESMP are as follows:

- The Client – responsible for the overall Project monitoring, ensuring compliance with environmental policy and obligations established in the ESMP;
- EPC – responsible for complying with ESMP requirements set out by the Client; and
- Other operational contractors – responsible for complying with the ESMP requirements set out by the Client.

ERM has provided guidance on the types of roles and responsibilities that would be required for implementation of the ESMP during construction.

13.3.1 Project Director

The Project Director is responsible for all construction activities and accountable for overall Environmental, Health, Safety and Social (EHSS) performance of the Project. Expectations for the role in terms of implementing a management system would include:

- Actively promoting and participating in the Project's EHSS Plan;
- Ensuring that the ESMP, procedures and work practices are implemented across the Project;
- Ensuring that the ESMP reflects the requirements of the Project in terms of resources and budget;
- Ensuring that all legislative and company requirements are complied with;
- Ensuring that all scopes of work are defined in accordance with the Project's ESMP rules and regulations, work practices and procedures, as detailed in this ESMP and other associated documentation (e.g. the EIA);
- Ensuring that all contractors are made aware of their roles and responsibilities with regard to EHSS management;
- Ensuring that EHSS is regularly discussed and reported on i.e. in the weekly contractor progress meeting;
- Ensuring that all contractors are evaluated throughout the duration of the Project, as to their capabilities and performance; and
- Ensuring implementation of EHSS audit recommendations for non-compliance issues.

13.3.2 EHS Focal Point

The Environmental, Health and Safety (EHS) Focal Point would be expected to undertake the following roles:

- Manage, review and develop the EHS program to ensure that it fulfils Project requirements, including measures observed in this ESMP, and monitor the implementation including, for example, patrolling the job site daily to ensure construction works' compliance with Project EHS Procedures and safe working practices;
- Coordinate and evaluate the effectiveness of all program elements;
- Liaise with relevant government bodies as necessary;
- Ensure that all areas of the Project are given the required level of safety support and attention;
- Ensure proper housekeeping and waste disposal in accordance with company requirements and regulations;
- Ensure that the respective control areas are given the required level of safety support and attention, for example by ensuring only safety-approved material and equipment are allowed to be brought onsite;
- Ensure that all EHS reports/ findings of any unsafe conditions/practices are brought to the attention of field management and are immediately corrected; coordinate accident/ incident investigations and report them to Project Manager; and
- Manage EHS Audits and report the results to the Project Director.

13.3.3 Social Focal Point

The Social Focal Point would be expected to undertake the following:

- Manage, review and develop the Social Program to ensure that it fulfils Project requirements, including measures observed in this ESMP, and monitor its implementation;
- Coordinate and evaluate the effectiveness of all social management plans;
- Manage the implementation of stakeholder relations and grievance management to ensure that all social-related requirements of this ESMP are implemented;
- Manage the implementation of the community health program, including coordination with the EHS Focal Point on OHS measures associated with the management of impacts to community health;
- Coordinate with EHS Focal Point on implementation of the Project's vehicle safety measures associated with management of impacts to community safety;
- Coordinate with HR (Human Resources) to ensure implementation of labour-related measures required in this ESMP;
- Consult with community and liaise with relevant stakeholders in implementing the required stakeholder and grievance management measures, including liaising with related government bodies as necessary;
- Lead collaboration efforts to establish and implement the Project's Grievance Mechanism during Construction Phase, and supervise contractor's social performance as required in this ESMP; and
- Managing social monitoring and reporting the results to the Project Director.

13.3.4 EPC's Site Representative/ EHS Department

The EPC and its contractors, depending on their scopes of work, would be expected to have an EHS Department. The contractors' site representatives or EHS Department should be assigned clear responsibilities and expectations with respect to implementing the Project's EHSS expectations and should be fully responsible for implementing any required expectations which fall under their scopes of work. More specifically, they will:

- Actively promote and implement all Project EHS Plans related to the work they are preforming. The contractor will make sure that all activities under his/her responsibility follow all safety regulation/requirements, in coordination with the Project Director; and
- Ensure that committed resources (personnel, material, and equipment) used are consistent with achieving the objectives and requirements of the Project's EHSS Plan.

13.3.5 Employees

All employees involved in the Project will be qualified through training, experience, or knowledge. Non-supervisory personnel employed by the Project shall:

- Familiarise themselves with the concept of the Project's EHSS rules and regulations;
- Work in accordance with Project's EHSS Procedure, safe work practices, and method statements, risk assessments, permits to work and any other instructions or regulations that apply to their works;
- Use only tools/ equipment and materials which have been approved for use, and employ them only for the purpose for which they were designed;
- Take an active part in the protection of themselves, fellow workers, property and the environment from accidental losses;
- Immediately report to his/ her respective supervisor or EHS officer/inspector if any potential hazards (relating to unsafe conditions and/or unsafe acts) are identified which could lead to an accident;
- Report any incidents/ near misses as well as injuries, regardless how minor, promptly to immediate supervisor and EHS officer/inspector; and

- Attend project safety training and drills programs as required.

13.4 Training, Awareness and Competency

It is expected that the Project would implement a training and awareness program covering EHSS expectations of the Project. As a minimum, this should be implemented during induction for all employees and contractors engaged in the Project's construction, with further training given depending on the level of responsibility for implementing EHS and social expectations and exposure to environmental and safety risks.

The Project should ensure that all personnel responsible for the implementation of this ESMP are competent on the basis of education, training and experience. All personnel shall be provided with environmental and social training appropriate to their scope of work and level of responsibility.

13.5 Monitoring, Review, Audit and Reporting

It would be expected that a monitoring, review and auditing program would be implemented during construction and operation phases to monitor implementation of the Project's EHS requirements and environment and social commitments. Ultimately, the Client would normally be responsible for ensuring that the EPC and its contractors are complying with the applicable EHS and social requirements.

13.6 Project Environmental and Social Management Plan

The development of an ESMP is considered to be good management practice for any project or activity with the potential to impact upon the physical, chemical, biological, social and health environment. In this instance, it provides guidance and a framework for ensuring that the commitments of the Client, made both within this ESIA and within the Project's EIA, are upheld and that the EHS impacts of the Project are managed to an acceptable level and in accordance with the requirements of the Project's ESIA.

Specifically, this ESMP pulls together the mitigation and management measures identified within the ESIA as necessary during the Construction and Operation Phases of the Project.

The mitigation and management measures occur throughout the Project's lifetime, from pre-construction through to construction, operation and decommissioning. In addition, there are common mitigation and monitoring requirements that apply to all phases of the Project, e.g., vehicle use/operation.

The mitigation and monitoring measures specific to the impact assessment conducted for this Project's ESIA are detailed in *Section 13.9,* together with information on:

- Relevant phase and activity;
- Impact summary and receptor impacted;
- Mitigation measures, responsibility and timing;
- Monitoring requirements, responsibility and timing; and
- Reporting requirements.

Where specific mitigation measures cannot be adequately defined due to lack of Project information or uncertainty regarding the environmental or social baseline, recommendations for the development of specific management plans or procedures or follow-up actions have been made.

13.7 ESMP Links to Other EHS Management Plans

Other types of plans or studies are required to facilitate the practical implementation of the ESMP's commitments, are not substitutes for the overall ESMP, but serve to describe how the commitments will be implemented in detail (and likely at a later stage in Project development) than in the ESMP.

This ESMP will form part of future construction and operational activities, and plans for these Project phases will confirm how these commitments will be incorporated into the relevant EHSS management systems. Their implementation will fall under the responsibility of the Client. This ESMP is a live document and will be updated periodically, depending on Project progress and performance.

13.8 Plans, Policies and Procedures

The following plans and follow-up actions are identified as necessary for managing identified risks or for further understanding of potential environmental and social impacts (see Table 13.1). These plans will be developed by the Client to manage specific risks or issues and to align the Project with the expectations of the applicable standards.

Table 13.1 Specific management plans and policies

Management Plan	Description
Livelihood Restoration Plan (LRP)	The LRP provides description on the socio-economic baseline of all affected people by the Project's land acquisition and provides mitigation measures to restore the livelihood/ income of affected people.
Community Development Plan (CDP)	The CDP incorporates mutually agreed upon support activities based on "good faith" negotiations with affected communities.
Occupational Health and Safety (OHS) Management Plan	An OHS Management Plan includes the mitigation measures proposed in this ESMP to manage OHS impacts to workers (e.g., compulsory medical examinations for Project workers).

13.9 Construction and Operational Environment and Social Management Plan

This section outlines the construction and operational ESMP, which will be developed for the Project. The ESMP is based on the Project's approved EIA and the outcomes of the ESIA.

13.9.1 Air Quality Management

Table 13.2 Air Quality Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Construction Phase							
■ Ground preparation, work sites and material/ equipment transportation; ■ Movement and operation of construction vehicles, machinery and other heavy equipment such as bulldozers, excavators, compactors and back-up diesel generator.	■ Increased dust (e.g. PM10); ■ Exhaust emissions (e.g. CO, NOX).	EIA	Cover construction materials during transportation; do not load construction material fully in trucks to avoid falling out	■ Thanh Hai 1	■ Ambient air	■ Biannually	■ Monitoring report
			Clean trucks/vehicles when leaving the construction site and clean roads in case construction materials scatter on the road				
			Install air filtration system at asphalt plant				
			Use low-Sulphur oil and regularly check the quality of oil to minimize contaminated air emission				
		ESIA 9.1.4.1	Develop and implement a Traffic Management Plan to reduce the impacts of dust and emissions from transport vehicles	■ Thanh Hai 1 ■ EPC Contractor	No monitoring or audit are recommended.	–	–
			Cover construction material trucks during the transportation				
			Clean transport vehicles when leaving the construction sites				
			Control the speed limit of trucks and other vehicles, so as not to exceed more than 10 km/hour within the Project's boundaries				
			Areas of construction, stockpile areas and other exposed soils should be designated as such in order to minimise vehicle movements over these areas				

			Maintain all vehicles and equipment in good working order				
Operation Phase							
■ WTG operations, inspection and maintenance.	■ The potential impacts on air quality from operation activities are considered Negligible.	EIA	Ensure the area of green trees is greater than 20% of the total construction area of the plant (according to QCVN 01:2008/BXD)	■ Thanh Hai 1	–	–	–
			Arrange working areas at the factory, with ventilation and door systems such as offices, operators, oil depots, etc.				
			Equip fully labor protection for officials and employees, especially for workers operating the transformer station				
			Construct a private, airtight container with chimney from 5-10m higher than the roof for the generator to quickly release emissions around				
		ESIA 9.1.4.2	The potential impacts on air quality from operation activities (e.g. WTG operations, inspection and maintenance) are considered Negligible so no further assessment is needed.	–	–	–	–

13.9.2 Marine Water Management

Table 13.3 Marine Water Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Construction Phase							
■ Piling and WTG installation activities.	■ Increased turbidity due to suspended sediment from seabed disturbance during pilling and WTGs installation ■ Increased contaminants such as heavy metals, oil and grease into seawater ■ Waste discharged from construction activities and workers	EIA	–	–	–	–	–
		ESIA 9.2.4.1	Train workers on relevant regulations and provide them with information regarding biological diversity and disciplinary actions if regulations are violated Select appropriate methods and equipment to reduce disturbance (e.g., turbidity, oil leakages or spills) to seawater Prohibit the discharging of waste and wastewater into the sea Supervise the implementation of the proposed mitigation measures by the Contractors	■ Thanh Hai 1 ■ EPC Contractor	No monitoring or audit are recommended.	–	–
Operation Phase							
■ All activities occurring during the operation phase.	■ Impacts from all activities occurring during the operation phase on marine water quality are considered Negligible.	EIA	–	–	–	–	–
		ESIA 9.2.4.2	Impacts from all activities occurring during the operation phase on marine water quality are considered Negligible so no further assessment is needed.	–	No monitoring or audit are recommended.	–	–

13.9.3 Noise Management

Table 13.4 Noise Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Construction Phase							
■ Site preparation, construction and installation works associated with each of the proposed wind turbines. Site preparation and building construction works associated any permanent facilities. ■ Piling works to construct the offshore foundation of each turbine. 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	■ These works and activities (or similar activities) are expected to generate noise levels that would potentially exceed 55 dBA and 45 dBA during the daytime and night-time respectively. Construction noise levels would only be experienced for limited periods of time when works are occurring at select locations.	EIA	Select machines and vehicles to meet standard for material transportation and construction	■ Thanh Hai 1	■ Noise	■ Biannually	■ Monitoring report
		ESIA 9.3.3.1	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 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 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; and select the quietest item of plant available where options that suit the	■ Thanh Hai 1 ■ EPC Contractor	■ All project / site noise levels (Leq, 1 hour in dBA) ■ They should be measured at the closest and/or potentially most affected noise sensitive receptors in the vicinity of the works being undertaken and at the complainants' location. ■ If the measured site noise levels are below 55 dBA and 45 dBA (Leq, 1 hour in dBA)	■ In the absence of any influential source not associated with the project	■ Monitoring report

activities that are to be undertaken.			design permit during the construction design.		for the daytime and then night-time, no further noise control is required ■ If the measured site noise levels are above 55 dBA and 45 dBA (Leq, 1 hour in dBA) for the daytime and then night-time, further noise control should be considered		
			Limit high noise generating construction works and activities to the daytime period (7AM to 10PM), and avoid work on Sundays or public holidays if possible				
			Justify any works that are required during the night time period (10PM to 7AM) and implement task-specific noise mitigation and management measures 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.				
			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 “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 if				

			possible. 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.				
			Identify and evaluate the problem source and any potential noise reducing measures for implementation during the works, if any validated noise complaints are received. If the noise complaint cannot be validated, no further mitigation or management measures are required.				
Operation Phase							
■ Wind turbines from both the Project and nearby Thanh Hai 1 wind farm produce noise through a number of different mechanisms.	■ Noise from wind turbines	EIA	Use sound absorbing materials to cover engine for mitigating noise from turbine operation	■ Thanh Hai 1	■ Noise, in compliance with: QCVN 26:2010/BTNMT	■ Biannually	■ Monitoring report
			Regularly check and maintaining machine and equipment to ensure all machines used on the site are in good condition. Oil check and viscosity change periodically to minimize noise and vibration				
			Put substation in isolated and closed area				

		ESIA 9.3.3.2	Not warranted or recommended additional mitigation measures in this report, as the predicted worst-case wind farm noise levels are substantially below the wind speed based noise limits	■ Thanh Hai 1	■ Wind farm noise monitoring should be conducted if any repeated / valid noise complaints are received. If noise monitoring is required: All project / site noise levels (Leq, 10 minute in dBA) should be measured. Project / site noise levels should be measured at the closest and/or potentially most affected noise sensitive receptors in the vicinity of the wind farm and at the complainants' location.	■ In the absence of any influential source not associated with the project	■ Monitoring report
			Reassess compliance with the noise limits, if the turbine selection and/or layout are to be changed, and noise levels are expected to increase at receptors				
			Require further noise control / remedial measures, if the measured site noise levels are above both the predicted values presented in this report and the applicable noise limits. The type, scale and extent of the remedial measures should be evaluated at the time and designed to reduce noise levels to be below the applicable noise limits presented in this report, if feasible, reasonable and practical to do so.				

13.9.4 Biodiversity Management

Table 13.5 Biodiversity Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Construction Phase							
■ Land preparation and civil work in the construction phase.	■ Loss of Terrestrial Habitat	EIA	–	–	–	–	–
		ESIA 9.4.3	Prepare a Biodiversity Action Plan (BAP) for the management and monitoring of natural and critical habitats within the Project EAA as required by IFC PS6				
			Not locate the laydown area within a Natural Habitat area.				
			Locate transmission line tower footings where possible, outside Natural Habitat.				
			Seek legal permission and undertake specific appropriate consultation to operating in the Protected Area.				
			Prohibit clearing vegetation outside of designated areas for Project staff, workers, all contractors and personnel engaged in or associated with the Project. Penalties, including fines and prosecution under the relevant laws for clearing vegetation may be applied.				
			The planned vegetation clearance area for the construction works shall be clearly identified and marked to avoid accidental clearing.				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			Provide training to staff and workers on all rules, regulations and information concerning restrictions related to unauthorised clearing of vegetation, as well as the punishment that can expected if any staff or worker or other person associated with the Project violates rules and regulations.				
			Re-instated the laydown area once construction is complete to pre-construction land type.				
			Undertake all land rehabilitation, using native indigenous species.				
■ The anchoring of turbines Construction activities Ground disturbance activities	■ Loss of Marine Habitat	EIA	–	–	–	–	–
		ESIA 9.4.3	No specific mitigation measures are proposed	–	No specific monitoring measures are identified.	–	–
■ Noise, light and vibration disturbances during construction phase	■ Disturbance of Displacement Impacts	EIA	–	–	–	–	–
		ESIA 9.4.3	Direct all light sources away from areas of Natural Habitat.	■ Thanh Hai 1 ■ EPC Contractor	■ Monitoring will be required as part of the role of Marine Fauna Observers.	–	–
			Ensure the compliance of all machinery, pile driving equipment and hand held equipment used with required air and noise emission standards.				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			Perform vessel maintenance, as adequate maintenance - including lubrication and repair of winches, generators, propulsion components and other potential sources - is an effective measure for noise reduction.				
			Pile driving management measures consistent with JNCC (2010) standard pile driving protocol:				
			Trained and dedicated Marine Fauna Observers (MFOs) and Passive Acoustic Monitoring (PAM) operatives during pile driving;				
			Mitigation zone of 500 m will be implemented around piling activities;				
			30-minute pre-start observations;				
			Delay-start procedure (if marine mammal sighted within the mitigation zone);				
			Soft-start procedure (minimum 20 minutes); and				
			Shut-down procedures if marine mammal sighted within the mitigation zone during pile driving.				
			Implement delay-start and shut-down procedures if a marine turtle or marine mammal is sighted within 500 m of pile driving activity.				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			Use a Fauna Shepherding Protocol within the Project area to ensure that any resident species have vacated the area prior to any clearance work.				
			Place fencing around major Project sites during construction to restrict access to fauna.				
			Prohibit hunting and poaching for Project staff, workers, all contractors and personnel engaged in or associated with the Project, with penalties levied, including fines and dismissal, and prosecution under the relevant laws.				
■ Construction of the access roads, the transmission line and other infrastructure Construction of Project components Vegetation clearing or land disturbance	■ Impacts from Barrier Creation, Fragmentation and Edge Effect	EIA	–	–	–	–	–
		ESIA 9.4.3	Use native species and minimise the exposed width of the transmission line corridor, as rehabilitate disturbed land not required for the operation of the Project.	■ Thanh Hai 1 ■ EPC Contractor	■ Monitoring will be required as part of the Invasive Species Management Plan and Rehabilitation work.	–	–
			Manage existing populations and the introduction of new invasive species into Natural Habitats. These measures includes, such as:				
			Check the provenance of any fill material brought onto the site for invasive species contamination.				
			Implement vehicle inspection and/or wash down procedures to reduce the transmission of invasive species into and from the project site(s).				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			Utilise invasive species control measures in areas of Natural Habitat.				
■ Project activities: excavation, construction, land clearing, movement of vehicles, barging, drilling, refuelling, hazardous materials storage and maintenance	■ Degradation of flora and fauna habitats Generate dust which may settle on vegetation adjacent to the construction area Erosion Release of contaminants Invasive species have the potential to be introduced or spread throughout the Project area through increased movement of people, vehicles, machinery, vegetation and soil.	EIA	–	–	–	–	–
		ESIA 9.4.3	Develop and implement appropriate emergency spill response procedures to avoid and manage accidental spills of any fuels, oils or other chemicals during construction activities.	■ Thanh Hai 1 ■ EPC Contractor	■ Monitoring will be required as part of the Invasive Species Management Plan and Rehabilitation work.		
			Avoid construction in tidal areas (mangrove and mudflat) when water is present, where possible. Where not practical to construct during lowest tide conditions, avoid peak ebb and flow periods when water movement is at its maximum.				
			Utilise construction vessels free from marine pests.				
			Use sediment and erosion control measures in all terrestrial areas of construction to minimise soil contaminated runoff from entering waterways. Outline these measures in a Sediment and Erosion Control Plan.				
			Implement sediment and control measures to limit sediment mobilisation to adjacent areas when constructing in the water and intertidal areas. Measures include installing silt curtains around work areas to limit sediment spread. Outline these measures in the Sediment and Erosion Control Plan.				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			Rehabilitate disturbed land not required for the operation of the Project, using native species.				
			Manage existing populations and the introduction of new invasive species into Natural Habitats. These measures are to be outlined in an Invasive Species Management Plan incorporated into the EMP and will include measures such as:				
			■ The provenance of any fill material brought onto the site is to be checked for invasive species contamination.				
			■ Vehicle inspection and/or wash down procedures are to be conducted to reduce the transmission of invasive species into and from the Project area(s).				
			■ Invasive species control measures are to be utilised in areas of Natural Habitat.				
			■ Vessels used to transport turbine components and to erect turbines in the marine environment will be checked to ensure they are free of marine pests prior to use.				
■ Vehicle or machinery strike, falling debris, or hunting or poaching as a result of worker influx	■ Mortality of bats		Check any trees to be cleared for roosting bats prior to felling. These trees will be avoided where possible.				

Operation Phase

■ Turbine operations	■ Mortality Impacts on Birds, bird collision with wind turbines	EIA	–	–	–	–	–
		ESIA 9.4.3	Should the collision risk assessment indicate that a risk is present, development of a Bird Management Plan is required to outline measures specific to bird species. The plan may include:	–	■ Monitoring will be required as part of the Bird Management Plan.	–	–
			■ Installation of reflective materials at strategic points on the propellers (depends on the final design of the wind turbines) to deter birds;				
			■ Use of large sound sources during the morning period when most bird activity takes place. Sources (e.g. horn, loud speaker, air gun) would be set up to routinely emit loud noises to scare birds away from moving rotors.				
■ Turbine operations	■ Mortality Impacts on Bats, collision risk with turbines	EIA	–	–	–	–	–
		ESIA 9.4.3	Eliminate of blade movement by feathering blades (blades pitched 90° and parallel to the wind) at or below normal cut-in speeds when turbines are not producing electricity into the power grid.	–	No specific monitoring measures are identified.	–	–
			Use habitat modification measures within the shoreline adjacent to the Project Area to introduce deterrents and reduce bat foraging opportunities. These measures are to include: ■ ensure all night lighting of the turbines consists of LED lights (LED lights may deter some bat genera) (Spoelstra et al., 2017); and ■ use lights that have low ultraviolet wavelengths onshore and offshore				

			(reduce insect congregations around lights that bats forage on).				
			Develop a Bat Management Plan in the BAP to better understand bat utilisation within the Project Area. The plan may include: ■ Seasonal studies during the initial phase of operation in support of adaptive impact management to bat populations.				

13.9.5 Shadow Flicker Management

Table 13.6 Shadow Flicker Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure and Responsibility for Implementation	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Operation Phase							
■ Operation of the turbines	■ Shadow flicker impacts	EIA	–	–	–	–	–
		ESIA 9.5.4	Close monitoring through engagement with residents during the operational phase where there are predicted impacts from shadow flicker in case the locations have been finalised by the project proponent and earmarked for construction.	■ Thanh Hai 1	–	–	–
			Assess visually the likelihood of direct line of sight to the location of proposed turbine locations and explore the potential for using screening like higher fencing and planting trees at problem locations. The use of curtains can also be explored.				
			Require the shutting down of turbines during certain environmental conditions, which meets the physical requirements for theoretical shadow flicker to occur, if				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure and Responsibility for Implementation	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			these prove effective and the impacts mitigated.				

13.9.6 Visual Quality Management

Table 13.7 Visual Quality Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Operation Phase							
■ Operation of the turbines	■ Visual impacts	EIA	–	–	–	–	–
		ESIA 9.6.4	Use of materials that will minimize light reflection should be used for all project components.	■ Thanh Hai 1	–	–	–
			Avoid bright patterns and obvious logos.				
			Replace wind turbines with the same or a visually similar model over the lifetime of the project, since the replacement of wind turbines with visually different wind turbines can result in visual clutter.				
			Maintain a uniform size and design of turbines (e.g., type of turbine and tower, as well as height)				
			Minimise presence of ancillary structures on the site by minimizing site infrastructure, including the number of roads, as well as by burying collector system power lines, avoiding stockpiling of excavated material or construction debris.				
			Implement erosion measures and promptly re-vegetated cleared land				

			with local seed stock of native species.				
			Retain existing vegetation to the greatest extent possible. Vegetation should be retained along roads and around turbine pads, substations, and other project infrastructure.				

13.9.7 Social Management

Table 13.8 Social Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Construction Phase							
■ Land Acquisition Process	■ Economic Displacement Impact from Land Acquisition Process: - Impacts on their access to agriculture and aquaculture-based livelihoods of the community. - Impact on their physical assets if they are located on land to-be-acquired land.	EIA	–	–	–	–	–
		ESIA 10.2	Monitor the land acquisition process by the Project Owner to ensure the compliance with Vietnamese regulations. Document and retain all records obtained from the Government for internal and external audits.	■ Thanh Hai 1	■ Monitor the land acquisition process. ■ Monitor the implementation of the SEP, Grievance Mechanism and CDP.	–	–
			Develop and implement a Stakeholder Engagement Plan detailing a Grievance Mechanism to support the local authorities in receiving and transferring land acquisition-related grievances from the affected people to the relevant authorities and explain the concerns in grievance procedure to affected people. Disclose the grievance mechanism to all affected communities so that they may be aware of the procedure, submission channels, and responsible person from the Project owner.				
			Develop and implement Livelihood Restoration Plan (LRP) for those identified as significantly affected land users. Design the LRP to ensure				

			sustainable outcomes for impacted people.				
			Prepare and implement a Community Development Plan (CDP) by the Project Company during the Project's lifetime that focuses on the affected community, with the intention that the affected community will benefit from the existence of the Project.				
■ Employment and Business opportunities arising during Project Construction include local employment and local procurement.	■ Impact to Local Economy: positive impact in terms of employment, procurement and induced job opportunities, and modest increase the economic condition of the local people.	EIA	–	–	–	–	–
		ESIA 10.2	Measures for Positive Impact Promotion:	■ Thanh Hai 1	–	–	–
			Instruct the EPC contractors to prioritize hiring qualified local people, especially affected people, as construction workers in accordance with the needs of the Project				
			Communicate clear information about Project-related employment and business opportunities and prioritize local people when feasible. Such communication should be conducted at least four months before recruitment so that local people have enough time to prepare for the recruitment process (for example, by attending short training courses to improve their skills)				
			Develop and implement a Livelihood Restoration Plan for those identified as significantly affected land users and Community Development Plan (CDP) to invest in the community. Training to improve skills of local				

			people can be provided under the CDP				
			Establish a clear grievance mechanism as mentioned in the previous section				
			Consider to provide skill improvement training for those who will have worked for the Project during the construction phase to be able to access to similar jobs in other projects in the country, at the end of the construction phase				
			If possible, work closely with local government agencies, particularly in Thanh Hai, An Dien, An Nhon, An Quy, An Thuan and Binh Thanh communes to synchronize the Project's needs in terms of local labor, as well as locals' capacity	■ Thanh Hai 1 ■ EPC Contractor	–	–	–
■ Physical disturbance and water quality degradation of the coastal water due to construction activities	■ Disturbance to cultivation, aquaculture and fishing Activities	EIA	Cover trucks with tarpaulin to protect loads, when transporting construction materials,. When loading and unloading materials, workers will be provided with adequate personal protective equipment.	■ Thanh Hai 1 ■ EPC Contractor	–	–	–
			Provide cleaning areas for vehicles carrying materials and construction machines before leaving the site, limiting the amount of soil and sand stuck in the wheels.				
			Coordinate with the material suppliers by the contractor to clean the road surface immediately if the materials				

			fall onto the roads so as not to affect traffic participants and residents.				
			Moisten the soil surface by spraying water to reduce the amount of dust entrained by the wind.				
			Reduce emissions to minimize the sources of impact from emissions, such as: ■ Use machines and equipment with gas, dust and noise emissions lower than the permitted level. ■ Use construction equipment that meet the registered standards. ■ Maintain and repair machines periodically and safely in construction.				
			Plan and coordinate construction works in order to be as efficient as possible, thus reducing emissions of dust and other pollutants such as SO_2, NO_2, and VOCs.				
			Locate workers' camps at the construction site together with facilities such as toilets, bathrooms, 3-composting septic tank, etc. to prevent sanitation issues caused by domestic wastewater. Daily domestic wastewater is estimated at $10m^3$/day, high concentration of easily decomposing organic substances should be collected and treated by a 3-compartment septic tank before being discharged into the environment.				

			Collect daily solid waste at the waste collection area (near the construction site). Project owners will sign contracts with local units to collect and process them in accordance with regulations. Every week, the local waste collector will transport the waste to the sanitary facilities. Impacts associated with waste generation, storage, handling and disposal are considered to be minor.				
			Collect, sort construction waste (such as cement, brick, stone, etc.) into groups and can be reused, recycled or disposed of at the scrap facility.				
			Collect, store and process waste grease from maintenance and repairs to construction vehicles and equipment by a specialized contractor.				
			Fix sea navigation routes and avoid unnecessary disturbance to the sea floor				
			Prevent any unplanned oil leakage from being washed offsite. Shield sand and rocks to avoid suspended solids being washed offsite during heavy rain events.				
			Collect and store hazardous wastes by the project owner prior to disposal by the official hazardous waste disposal organization.				
			Prohibit indiscriminate garbage disposal by workers				

			Ensure petrol and oil used meet appropriate standards for construction equipment and transportation vehicles.				
		ESIA 10.2	Implement the measures proposed in Chapter -- for controlling the impact to air quality and seawater quality	■ Thanh Hai 1	■ Ongoing monitoring and periodical audit are required to check if the above mitigation measures are in implementation; ■ Monitoring and audit are also required to be conducted in accordance to those proposed in ESIA for Air Quality Impact Assessment, Seawater Quality Impact Assessment, and in the ESMP and CDP.		
			Disclose the construction timeframe and safety plan to the local fishers prior to the construction phase	■ Thanh Hai 1			
			Conduct regular consultation with the local fishers during the construction phase to identify access constraints. Issues should be resolved in consultation with the local authority				
			Consult with the local authorities, affected households and other relevant third parties to develop and implement a CDP as recommended above in order to share the mutual benefits from the Project development with the local community. The households identified through this impact assessment should be prioritized.				
			Implement the Stakeholder Engagement Plan (SEP) to enable the Project Owner to reach harmonization and alignment with the community members (besides the local authorities), thus, reducing the risk of interruptions to the Project.				
			Establish and implement a grievance mechanism as discussed in the above section				

■ The influx of the construction workforce, Project-induced immigrants to the Project area and noise from Project activities have been the main social concerns in many industrial projects.	■ Community health and safety impacts	EIA	Coordinate with local authorities and relevant agencies to organize programs such as education and awareness raising for workers.	■ Thanh Hai 1	–	–	–
			Provide training to local people for them to satisfy the recruitment requirements of the Project to increase local employment opportunities.				
			Coordinate with local authorities to manage temporary resident registration for migrant workers and to monitor social security in the area where migrant workers will be accommodated.				
		ESIA 10.2	Maximise local employment;	■ Thanh Hai 1 ■ EPC Contractor	■ Ongoing monitoring and periodical audit are required to check if the above mitigation measures are in implementation: ■ Monitoring and audit are also required to be conducted in accordance to the schedule proposed in the CDP.	–	–
			Regularly engage with local authorities relevant to crime (i.e. local police) or other social problems (e.g. village leaders) for prevention of issues and for mitigation purposes when issues arise;				
			Establish an onsite health clinic for Project workers involved in construction;	■ EPC Contractor			
			Conduct compulsory medical examinations (i.e. annual health check-ups) for Project workers, including contractors, as required by national regulations, to ensure they are fit for work and to monitor the prevalence of communicable diseases;				

			Implement a "zero tolerance" policy towards inappropriate behaviour from and amongst the workforce;				
			Register temporary residence for non-local workers to local authorities to ensure the management of Project's related workforce;				
			Develop a Project Code of Conduct;				
			Share the Project Code of Conduct with workers of contractors and requesting their compliance;				
			Develop and implement regulations/policies for non-local workers staying in construction camps regarding behaviour towards local communities and restricting hours for going out;				
			Conduct appropriate workers-community engagement programs such as sporting or cultural events to improve understanding and cohesion between non-local workers and the surrounding communities;				
			Establish and disclose a grievance mechanism as mentioned in above section;	■ Thanh Hai 1			
			Implement the SEP. Community Liaison Officers of the Project should assign and deliver induction training to provide guidance on requirements for culturally appropriate behaviours, and an overview of the risks to migrant staff and workers. The training will include key cultural				

			sensitivity awareness topics/programs to ensure workers including security staff do not un-intentionally offend the local community, especially ethnic minority;				
			Support local health centres to conduct campaigns on community health education as part of the CDP, to enhance the community's resilience to potential negative impacts arising from industrial projects;				
			Support local authority to improve and maintain the local roads if any damages caused by the Project activities both directly (due to Project vehicle) and indirectly (due to workers' transportation).				
■ General construction activities of an nearshore wind project includes jetty construction, building and concrete works, transportation of materials and workers and construction of associated facilities including the access road, and	■ Noise, dust, and risk to community health and safety.	EIA	Refer to Section 13.9.1, 13.9.3 for existing controls proposed for dust, noise and vibration impacts.				
		ESIA 10.2	Comply with the measures proposed Air Quality Impact Assessment and Noise and Vibration Impact Assessment in Chapter 9 of EIA and in the next section of "Traffic Safety due to Increased Transportation Volume during Construction" to minimise traffic accidents and disturbances to local people and to maintain the significance of the impact as Minor.	■ Thanh Hai 1 ■ EPC Contractor	■ Monitoring will follow the recommendation in Air Quality Impact Assessment and Noise Impact Assessment, Traffic Safety due to Increased Transportation Volume during Construction.	–	–

transmission line.							
■ Increased Transportation Volume during Construction	■ Traffic congestion and impacts on traffic safety in the area along the transportation routes.	EIA	Install the sign "Regular access vehicles" at the construction site to limit the occurrence of traffic accidents.	■ Thanh Hai 1 ■ EPC Contractor	–	–	–
			Divide waterway and road traffic to limit congestion and traffic accidents in the area.				
			Exercise caution when entering and leaving the Project area to limit traffic accidents when transporting construction materials				
			Upgrade the transportation routes so as not to affect the infrastructure. transportation, transportation and daily life of people in the area, during the process of transporting machinery, equipment, materials with large loads that could potentially damage the roads	■ Thanh Hai 1			
		ESIA 10.2	Ensure: ■ Require all new drivers (including contractors for construction material transportation) to undergo safety training; ■ Operate flagmen at the junction between the main roads and the	■ EPC Contractor	■ Ongoing monitoring and periodical audit are required to check if the above mitigation	–	–

			access road to coordinate the trucks entering and exiting; ■ Enforce speed limits for all Project vehicles and barges		measures are in implementation; ■ Monitoring and audit are also required to be conducted in accordance to the schedule proposed in the Safety Transportation Management Plan and Traffic Management Plan.		
			Familiarise local communities (including those living along the access route, fishermen, and clam-farmers near the Project turbine area) with traffic management approaches such as warning signs, speed limits and notifications of the risks of traffic accidents. These measures should be incorporated into the SEP	■ Thanh Hai 1			
			Improve the road to ensure conditions meet the standard required for construction vehicle use where road conditions are poor occur as a result of Project activities				
			Carry out prompt investigation when the community submits related complaints.				
			Consult with the Port Authorities to understand legal requirements for port operation and marine transportation to comply with;	■ Thanh Hai 1 ■ EPC Contractor			
			Develop and implement a Safety Transportation Management Plan and a Traffic Management Plan during Construction Phase for both marine and road transportation;				
Operation Phase							

■ Increase in taxation revenue of the Province, demand for materials and services and tourism development.	■ Positive impact to local economy	EIA	–	–	–	–	–
		ESIA 10.2	Measures for Positive Impact Promotion: Hire local people for at least un-skilled positions during operation. The Project can also encourage the contractors to hire local labour when necessary. Apply local procurement during operation of the Project. In particular, the Project Owner should use local foods/products and local supply to enhance benefiting to the local communities. Continue implementing CDP during the Project's operation phase. Conduct the monitoring of the implementation of this plan.	■ Thanh Hai 1	–	–	–
■ During operation, it is assumed that, only a very small proportion of employment, mostly unskilled jobs, could be sourced from local community.	■ Impact on income and livelihoods of local people, especially those will have worked for the Project in construction phase.	EIA	–	–	–	–	–
		ESIA 10.2	Keep implementing the CDP to support the local people in improvement of their socio-economic conditions. The CDP should be in implementation throughout the Project's operation period and considered as Corporate Social Responsibility program of the Project Company.	■ Thanh Hai 1	■ Ongoing monitoring and periodical audit as proposed in this ESMP to ensure the above mitigation measures are		

			Keep implementing the SEP including grievance procedure during the Project's operation.		in implementation; ■ Monitoring and audit are also required to be conducted in accordance to the schedule proposed in Chapter 9 for Noise Impact Assessment, Visual Impact Assessment and Shadow Flicker Impact Assessment.		
			Closely monitor through engagement with residents during the operational phase where there are predicted impacts from shadow flicker. Planting trees to create green space to increase the aesthetics of the Project;				
			Minise the reflected rays from the turbine blades generated by the reflection by optimizing the smoothness of the rotor surface as well as coating with less reflective material				
			Paint wind turbine pillars light grey to create a comfortable, pleasant and gentle environment for people living around or near the wind turbine columns in order to harmonize with the general landscape of the area. The distance of each turbine is 300 - 320m to avoid causing visual disturbances.				
			Consider to provide skill improvement training for those who will have worked for the Project in construction phase, to be able to access to similar jobs in other projects in the country.				

13.9.8 Unplanned Events Management

Table 13.9 Unplanned Events Management

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Blade Throw / Blade Ejection Impact Assessment							
Operation Phase							
■ Operation of the turbines	■ Blade throw or ejection	EIA	–	–	–	–	–
		ESIA 11.4.3	Explore the possibility of changing the siting of WTGs to create a minimum space of minimum 300 m between them.	■ Thanh Hai 1	–	–	–
			Strengthen the foundation of all WTGs.				
			Provide anchors to all WTGs to delay the immediate impacts.				
			Carryout periodic blade inspections and repair any defects that could affect the blade integrity.				
			Ensure that lightning protection systems are properly installed and maintained.				
			Equip wind turbines with vibration sensors that can react to any imbalance in the rotor blades and shut down the turbine, if necessary.				
			Monitor any development close to the turbines within the impact zone.				
Leakage and spill Incident							
Construction Phase							

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
■ Leakage and spill incident		EIA	Use cloth to remove oil spillage with small amount and clean contaminated area	■ Thanh Hai 1	–	–	–
			Contain the spillage and avoid infiltration to soil/groundwater				
			Implement Emergency Response Plan (ERP), including measures, procedures of prevention and emergency response for oil spillage and fire incident				
Operation Phase							
■ Leakage and spill incident		EIA	Check oil and chemical containers before use	■ Thanh Hai 1	–	–	–
			Storage areas for fuel and chemical substances must have awning, floor must be screeded and building edge to avoid fuel overflow				
			Store fuel, chemical substances in safe place and away from electricity sources, ignition sources and domestic water source				
Construction/ Operation Phase							
■ Leakage and spill incidents	■ Fur-bearing animals are vulnerable to oil since it can damage their insulating fur layer and therefore induces a drop in body temperature.	ESIA 11.1.2	Develop an Oil and Chemical Spill Response Plan (OCSRP) for the area of WTGs;	■ Thanh Hai 1	–	–	–
			Provide training and refresh sources on the OCSRP;				
			A register of on-site hazardous substances should be maintained during construction and operation phases;				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
	■ Aquatic organisms exposed to oil slick are in danger of smothering and poisoning. ■ Plants, grasses, and algae in aquatic environments can be blocked from oxygen exchange by oil slick. ■ Drinking water sources can be contaminated and then pose a threat to human health. ■ Oil contamination can increase soil pH level and reduce phosphorus concentration, adversely affecting soil fertility and physio-chemical properties. ■ Aquatic food resources and habitats of fauna are poisoned with hazardous materials.		Use appropriate bunding when there is a risk of leaks, spills or loss of containment.				
			Record any deficiencies found and immediately report to the work area manager in order for the deficiency to be rectified as soon as practicable.				
			Maintain clean-up spill kits in relevant locations within the Project area.				
			Securely store hazardous materials in impermeable containers in buildings. Set up protective barriers as applicable.				
			Develop procedures for loading/ unloading to minimize the risk of incidents during operation phase.				
			Conduct routine inspections and preventive maintenance for all vehicles and equipment on a regular basis to detect spills, leaks and the potential for such occurrences.				
Fire and explosion							

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
Construction Phase							
■ Fire and explosion		EIA	Mine Clearance is conducted before pile-driving, geotechnical drilling…	■ Thanh Hai 1	–	–	–
Operation Phase							
■ Fire and explosion		EIA	Establish Fire Fighting and Prevention system in the Control Room to receive signal from Fire alarm system and transmit signal to each area	■ Thanh Hai 1	–	–	–
			Training program for employee about safe work practice, procedure for fire				
			Install water storage for Fire Fighting and Prevention				
			Regularly check and maintain equipment				
			Store flammables away from ignition sources and oxidizing materials				
			Install Lightning Protection System in some areas surrounding plant, install air termination in the roof of plant				
			Regularly check fuel and chemical containers to avoid leakage				
			Set "Stop Fire" board is visible				
Construction/ Operation Phase							
■ Fire and Explosion	■ Large scale fire can release smoke and fumes	ESIA 11.2.2	Maintain equipment and operability of mechanical systems through inspection programs.	■ Thanh Hai 1	–	–	–

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
	in a large area, resulting in uncontrollable fire, loss of crops and habitats; ■ People and animals inhale smoke or toxic chemicals could injure or suffer health impacts; ■ Fire could cost local people and workers jobs and incomes; and ■ Fire could threaten the local community health and safety.		Store flammable materials away from ignition sources and oxidizing materials.				
			Equip with proper equipment on the site and regularly inspect and maintain them.				
			Conduct regular inspection and maintenance to eliminate potential risks.				
			Establish an emergency response and evacuation plan.				
Vessel Collision							
Construction Phase							
■ Vessel Collision	■ There will be an increase in the number of vessels navigating in-out the Project WTG's layout as a result of the project that will increase the risk of collision or maritime incident.	EIA	–	–	–	–	–
		ESIA 11.3.2	Provide a dedicated safety distance between construction area of marine components and navigation route to relevant authorities and local fisherman.	■ Thanh Hai 1	–	–	–
			Coordinate with relevant authorities such as the Southern Vietnam Maritime Safety Corporation and fishermen by the construction contractor in order to disseminate information regarding the construction schedule, construction area, and activities.				

Activity/Aspect	Potential Impact	Source Document	Mitigation Measure	Responsibility	Monitoring Parameter	Monitoring Frequency	Reporting
			Install buoy, navigation light, or warning sign as appropriate to demarcate the construction area by the construction contractor.				

APPENDIX A NOISE MONITORING REPORT

Report

NOISE LEVELS IN THANH HAI, THANH PHU DISTRICT, BEN TRE PROVINCE

Prepared for:

ERM

ERM VIETNAM LIMITED COMPANY

Prepared by:

UNIVERSITY OF HOCHIMINH CITY
INSTITUTE FOR ENVIRONMENT AND RESOURCES

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I. INTRODUCTION:

This report summarizes noise monitoring at three locations in Thanh Hai Commune, Thanh Phu District, Ben Tre Province, where the wind power project No.5 will be and is being invested and built. The noise monitoring aims to serve the implementation of socio-economic environmental impact assessment report for the project "the wind power plant 5" (Thanh Hai 1).

The objective of the baseline noise study was to evaluate the existing noise levels at selected noise monitoring locations based on methods outlined in IFC standard noise. Survey of this type and duration provide information on daily variability in noise levels, as well as provide an expected typical or average daily condition.

Thanh Hai is a coastal commune. From April to October the sea waves are calm and sea water is clear, it is a favor condition of beach tourism and seafood harvesting. From November to March of the coming year is the time the sea not calm with strong wind, sea water is unclear with sand. Therefore, in this period all activities related to the beach and sea in both communes are closed.

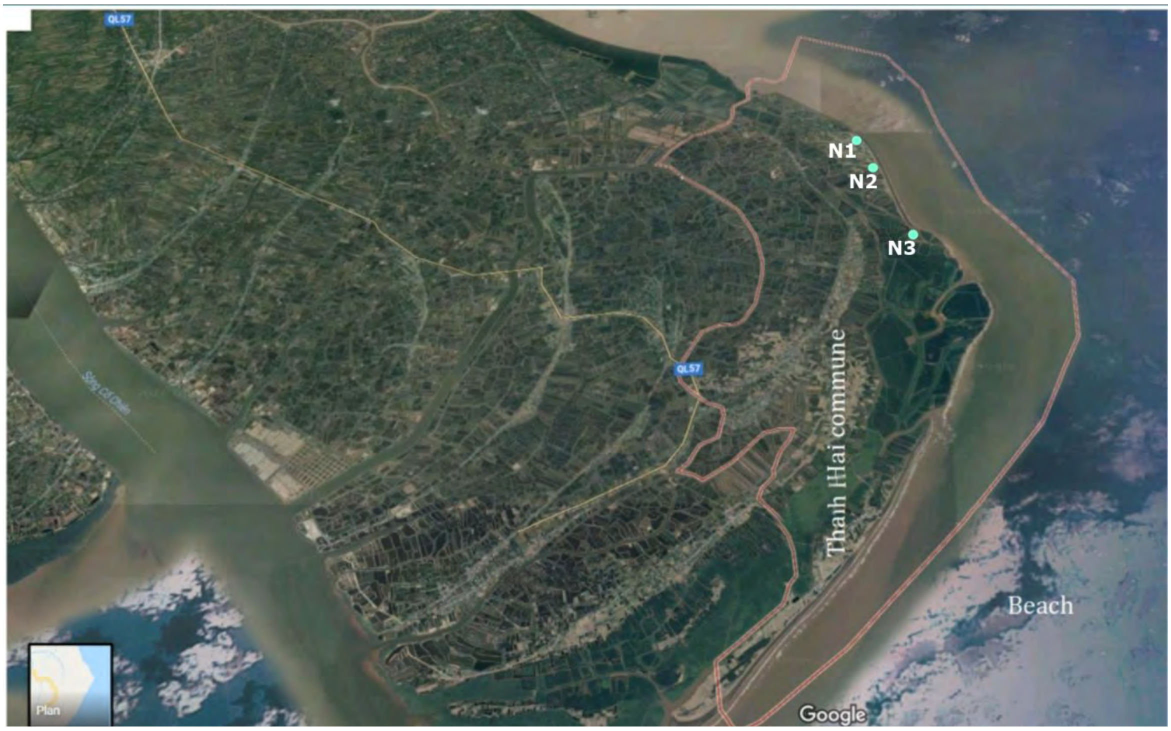


Figure 1. Geography of Thanh Hai communes Thanh Phu district, Ben Tre province

II. METHODOLOGY:

2.1. Site selection:

Three sites of noise monitoring in Thanh Hai communes, Thanh Phu district, Ben Tre province were selected by ERM (Figure 2).
The first and second site are located in a Jícama (water cassava) garden, and the last site is located in shrimp farming area (facing to the Con Loi beach). All sites are north of Thanh Hai commune.

Figure 2. Geography location of three noise monitoring from Sep 23-29, 2019

2.1.1. Noise monitoring location No.01 (N1):

The first noise monitoring is located at $9^{0}55'433.6"N$, $106^{0}33'43.2"E$ (in the Jícama garden).

Figure 3. The first noise monitoring site in Thanh Hai commune, Thanh Phu district, Ben Tre province from Sep 25 to Sep 27, 2019

- Far away about 30m in the Southern direction is village road, 90m far away in the Northeast is sea dyke.
- There are about 8 households within a radius of 150m from the noise measurement site. Residents go to bed rather early, about 8PM. Two nearest households are 25m to the southwest and 35m to the north.
- The weather was dominant with strong Southeast or Northeast wind and nearly no rain. However, this site is quite closed windy from under 1.8m due to the high embankment. The noise team set the height of the wind meter at approximately 1.5 m (the height of the sound level meter).
- The farmer visits to their Jícama once a day for spraying water and removing grass.

  In general, the main sources of noise at the first monitoring site are wind, roaster, verhicles and sea waves.

Figure 4. The first noise monitoring site (in a Jícama garden)

2.1.2. Noise monitoring location No.02:

The second noise monitoring is located at $9^0$55'4.8"N, $106^0$39'50.4"E (in the Jícama garden and besides a small pond).

Figure 5. The second noise monitoring site at Thanh Hai commune, Thanh Phu district, Ben Tre province (from Sep 23 to Sep 25, 2019)

– About 50m away from the West is a small village road, 230m to the Northeast is the Con Loi beach. Residents living in this area are not crowded, with about 5 households within a radius of 150m from the noise measurement site. The nearest household is 20m to the southwest.

Figure 6. The second noise monitoring site (in a Jícama garden)

Figure 7. The farmer is spraying his Jícama garden

Figure 8. The nearest household

- This site is quite ventilated and nearly un-shielded by anything. Therefore, wind speed was very strong and noisy, especially at night.
- One household, 120 meters away from the noise measurement site, played karaoke from 17:25 to 18:50 on September 24, 2019. Occasionally, goose of a nearby house make noise (noise level is up to 62dBA)
- The determined sources of noise in this measuring site were winds, waves, goose and vehicles.

2.1.3 Noise monitoring site No.3:

The third noise monitoring site is located at $9^0$54'3.6"N và $106^0$39’32.4”E, in Thanh Hai commune, Thanh Phu district, Ben Tre province. This site is opposite to some shrimp ponds and is covered with mangrove rows close to the beach, 135m Northeast of the measuring point.

Figure 9. The third noise monitoring location in Thanh Hai commune, Thanh Phu district, Ben Tre province (from Sep 27 to Sep 29, 2019)

- There is a village road leading to the sea, 30 meters northwest of the measuring point. When the sea level rises, it is impossible to move along the beach from the northwest, people have to go through this road. Motorbikes traveling through this road are mainly of clam catchers or members of the Binh Minh Fisheries Cooperative.It is easy to realize that at the third site the wind was not as strong as at the second site but the sound of sea waves could be heard clearly at this site.
- There is not any household around the third measuring site, except for the shrimp farmer's hut. 340m northwest from the monitoring site is the housing and office of Binh Minh Fisheries cooperative.
- The measuring area has two large dogs and four puppies. There is a herd of more than 20 goats in the barn 85 meters from the measuring point. Every morning they are released to go out to eat and nearly 5PM return to the barn.
- 150m to the East and 200m to the Southeast are boundaries of protection forest (mangrove trees)
- The sources of noise in the third site were goasts, sea waves, dogs, and vehicles.

Figure 10. The third noise monitoring site

Figure 11. View of the third noise measuring site

Figure 12. Cattles at the third noise monitoring site

2.2. Sampling method

Monitoring is to be carried out using methodology specified in the Environmental Noise Survey according to ISO 1996 – 2:2007. This includes measuring the following parameters:
- Leq: Equivalent continuous sound level (A-weighted sound level);
- Lmax, Lmin: Maximum, minimum A-weighted sound level;
- L90: 90 percentile noise level;
- L10: 10 percentile noise level; and
- L1: 1 percentile noise level.

Each sampling point was measured for 48 hours continuously, intergating every 10 minute.

Measuring equipment was mounted on a tripod with the height of approximately from 1.2-1.5 m. The tripod was placed at sampling point to its distance to surrounding walls were over 3.5 m (as in accordance with ISO 1996 – 2:2007). Windscreen was also used to reduce the effects of windy weather.

2.3. Noise measuring instrument

Instrument: the Sound Level Meter 3M Sound Pro (DL 2-1/1)

Some its characteristic:

- ✓ ANSI and IEC standards compliant
- ✓ Class/ Type 2
- ✓ A, C and Z (flat) frequency weighting
- ✓ Fast, slow, and IEC impulse time response
- ✓ Selectable thresholds 10 dB – 140 dB
- ✓ 3, 4, 5, 6 dB exchange rates
- ✓ SD memory card slot
- ✓ Time history data logging with 1 second to 60 minute intervals
- ✓ Full (1/1) octave band real-time analysis

3M Sound Pro DL 2/1-1 conforms to legal requirements for quantity measurements ANSI and IEC standards. Its unit supports real-time octave band analysis in the range from 16 Hz to 16 kHz. Logged data is automatically saved to the instrument's memory card.

Figure 13. Noise meter instrument & calibrator

2.4. QA/QC

Calibration was carried out using an external sound calibrator – Sound Calibrator 0554.0009 (Sound-calibration) at 94 dB and 104dB at 1KHz. Sound level meter equipment was calibrated before and after each sampling point. Calibration uncertainty ranged within ± 0.2 dBA. Calibration results are presented in Table 01. Pictures of calibration are attached in Appendix C.

Table 1. Calibration results

Monitoring location	Date	Time	Calibration result (dBA)	
At Lab	Sep 21, 2019		94.1 104	
No.1	Sep 25, 2019	12:05	103.9	
	Sep 26, 2019	12:22	103.9	
No.2	Sep 23, 2019	10:50	103.9	

No.3	Sep 27, 2019	13:05	104.0	
	Sep 27, 2019	12:24	104.0	

III. RESULTS AND DISCUSSION

3.1. Noise monitoring site No.1: Jícama garden.

- As described in Section 1.1, the noise monitoring site (at a height of 1.5 m) is shieltered by a sea dyke. Therefore, although the wind is strong, the wind at the measurement location is not much affected. However, the sound of the waves greatly affects. In the afternoon and evening, the stronger the ocean waves, the closer the sea level was to the dykes. Therefore, the measured noise level was increased to more than 56 dBA in the evening.
- However, the noise levels measured in 48 hours continuously at the first location fluctuated greatly. It varied around the noise limit at special areas regulated by IFC (55dBA for daytime from 7 am to 22 pm) but much higher than 45dBA at night, even higher than the limit daytime noise. The evening noise is high mainly due to the sound of the waves.
- The results presented in the figure showed that the highest noise level measured on 26 Sep at 9:10AM (56.6 dBA) and the midnight (12PM – 2AM) was 55.2-56 dBA, higher than the noise limit of 55 dBA. The lowest noise level measured 41.6 dBA at 11:05-11:25AM of Sep 26, 2019. The noise level, in duration 8AM -12:30AM of Sep 26, 2019, was lower than 45dBA.

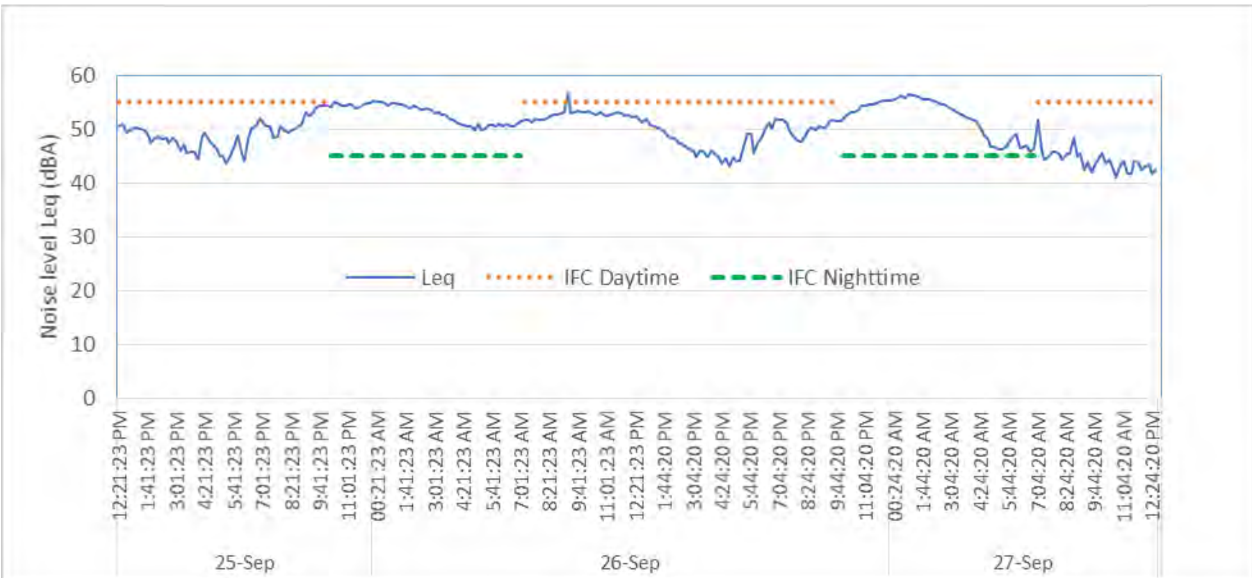


Figure 14. Leq (dBA) at monitoring site No. 1

3.2. Noise monitoring site No. 2: Jícama garden

- As described in Section 1.2, the location for noise monitoring is quite airy.
- Most measured wind speed values were higher than 5.0 m/s, even above 8 m/s, which was why the noise level reaches more than 60 dBA.
- The noise level reached a peak of 64.5 dBA at around 22:00 pm on September 24, 2019 and dropped to a minimum of 42.6 dBA at around 11:45 AM on September 23, 2019.
- The daytime wind speed of the second day is higher than the first day, so the measured noise value is also higher

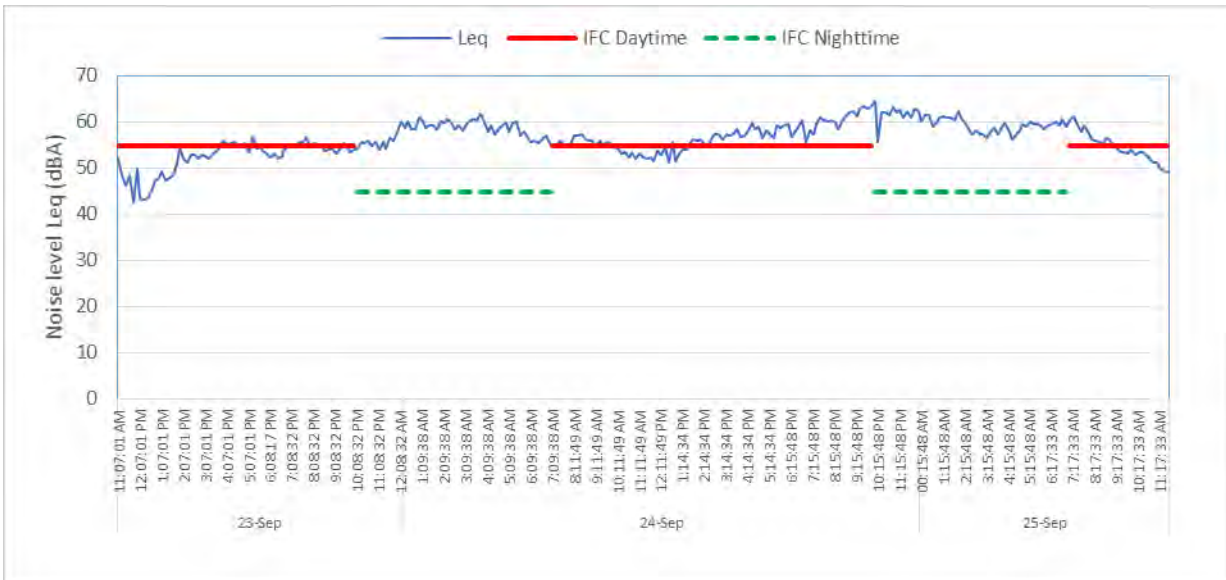


Figure 15. Diagram of Leq (dBA) in monitoring site No. 2

3.3. Noise monitoring location No.03:

- This was the nearest site from the Con Loi beach compared to the first and second noise monitoring site. This site is also shielded by that minimizing the influences of wind from the beach.
- The noise levels increased gradually in the afternoon and evening, this is the time of sea level rise (2 times a day). This phenomenon was caused by the higher of the sea level, the louder the sound of the wave. However, the noise levels measured in 48 hours continuously at the third location was much fluctuated. Most of the peak noise was due to the barking of dogs. At night, when motorbikes passed, dogs always barked.
- On Sep 28, 2019, from 13:30-15:00, some fishing boats passed near the shore. Their sound contributes to the noise but not too much.
- Noise levels of Sep 27 and Sep 29 were lower than IFC standard noise for special location (55dBA) from 7AM to 22PM. The noise levels of Sep 28 from 11:00 16:00 were higher than 55dBA (up to 64,9 dBA at 1:30AM of Sep 29). The

highest Leq noise level at 5:08AM on September 29, 2019, it reached 68.4dBA. The reason was that motorbikes passed and dogs were barking too close to the measurement location.

– The noise levels from 22PM-7AM were much higher than 45dBA - IFC standard noise level of the night-time.

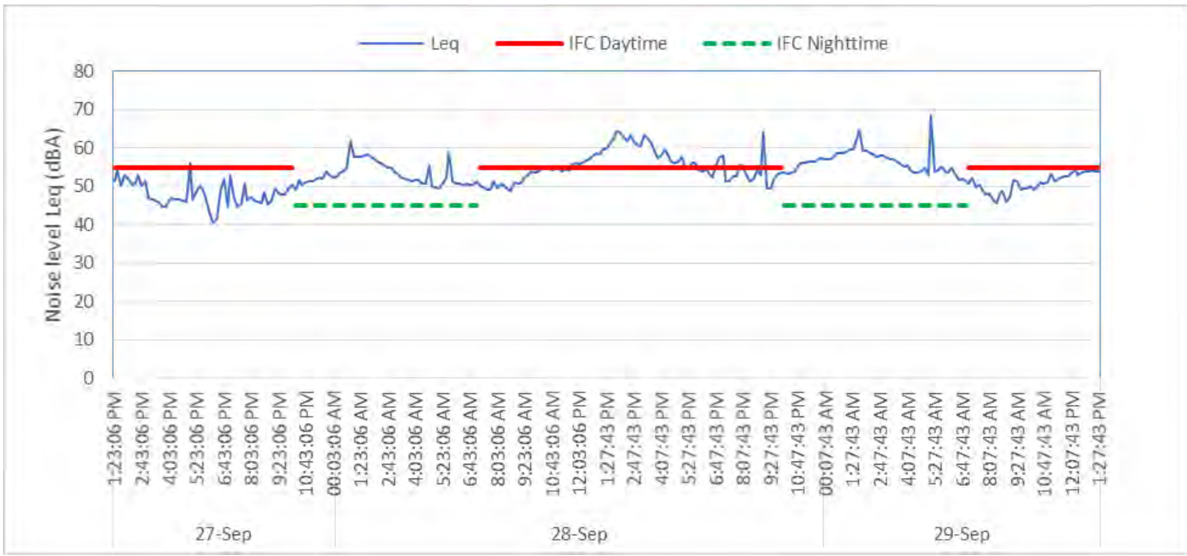
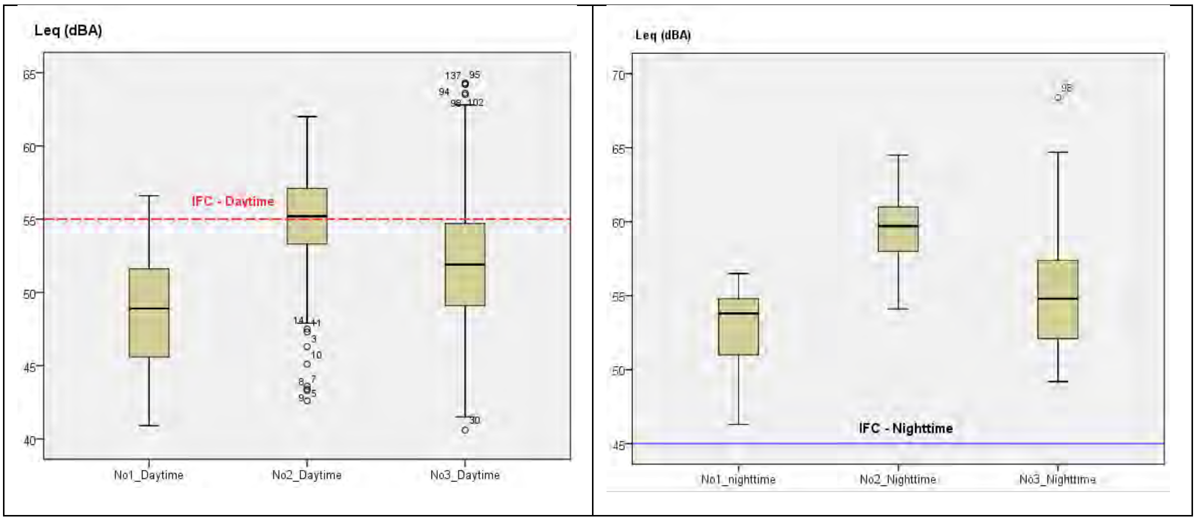


Figure 16. Diagram of Leq (dBA) in monitoring site No. 3

3.4. Noise level of 3 monitoring sites:

3.4.1. Leq day and night:



a, Day time (7AM-10PM) b, Night time (10PM-7AM)

Figure 17. Plot box charts of Leq

Noise statistics at 3 locations as plot boxs show that:

– The nighttine noise values of 3 sites are higher than the IFC noise standard.

- The daytime noise values of site No.1 vary from 41 dBA to 57dBA, most of them meet IFC standards for noise.
- The daytime Leq values of measurement site No.2 range from 42.6 to 63.5 dBA, which is about 50% higher than the IFC noise standard.
- Similarly, the daytime Leq values of site No.3 are in the range of 40,6 to 64,3 dBA, of which, about 23% is higher than the IFC noise standard (See frequency chart in Figure 18 below).

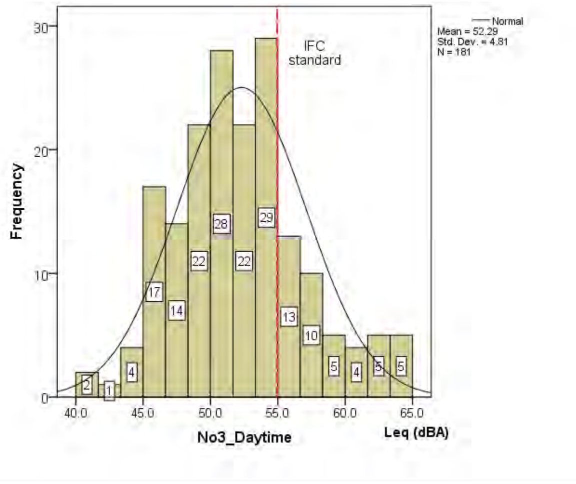


Figure 18. Day Leq statistics at position 3 in the form of histogram

Figure 19 shows the average day and night Leq values for the two measurement days.

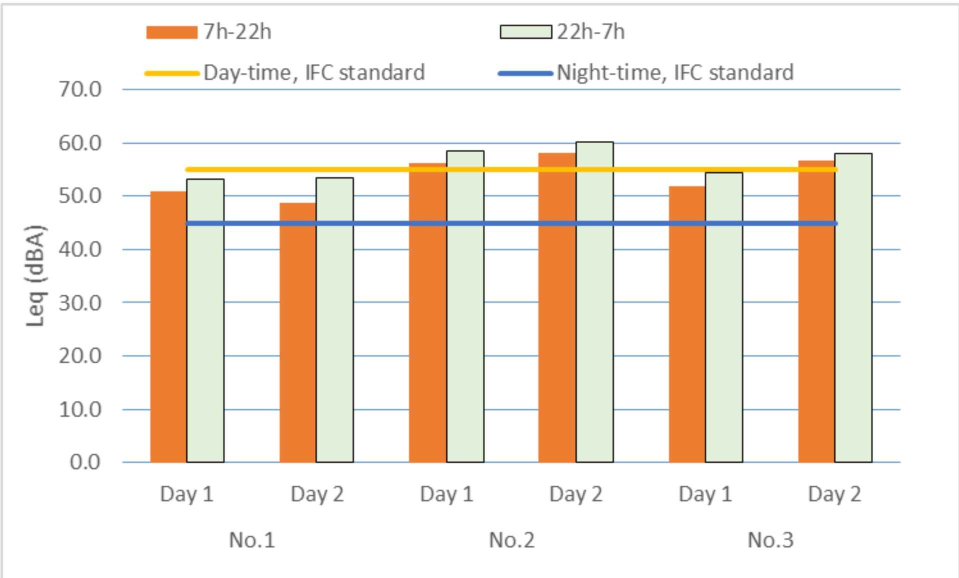


Figure 19. Average day/night Leq of all monitoring location

- At location No.1: We can see the stability of noise level in night-time with the Leq was about 53 dBA. The noise level in day-time of the first day was 51dBA, higher than the second day (49dBA).

- At location No.2: the noise level of night-time was higher 2,1dBA than of daytime. The noise level of second day was about 1.8 dBA higher than the first day. Noise levels of second day were higher than the first day.
- At location No.3: The noise level during the day of the first day was much lower than the second day. The main reason was higher wind speed and stronger waves.

3.4.2. Leq 24h:

24-hour average levels of Leq, Lmax, Lmin of each monitor site are presented in Table 02.

Table 2: Average Leq from three monitoring sites

Monitoring Site	Day	Time duration	Leq (dBA)	Lmax (dBA)	Lmin (dBA)
No.1	Day 1	7h-22h	50.9	79.7	38.7
		22h-7h	53.2	65.6	47.7
		Average 24h	52.0	79.7	38.7
	Day 2	7h-22h	48.8	65.6	37.6
		22h-7h	53.4	61.1	41.2
		Average 24h	51.1	65.6	37.6
No.2	Day 1	7h-22h	56.3	74.8	38.8
		22h-7h	58.5	71.0	50.6
		Average 24h	56.3	74.8	38.8
	Day 2	7h-22h	58.1	90.2	46.7
		22h-7h	60.2	81.8	50.9
		Average 24h	59.0	90.2	46.7
No.3	Day 1	7h-22h	52.0	79.7	38.1
		22h-7h	54.3	79.5	46.1
		Average 24h	53.0	79.7	38.1
	Day 2	7h-22h	56.8	87.6	43.8
		22h-7h	58.1	93.6	48.0
		Average 24h	57.3	93.6	43.8

The results presented in Figure 20 show Leq for 24 hours at three noise monitoring locations.

Leq of first and second site respectively was lowest and highest. Except for position No.1, the noise levels of the second day were higher the first day.

The noise levels of second sites were higher than IFC noise standards, both of day-time and night-time.

Noise level in night-time of all monitoring sites were higher than IFC noise standards (45dBA).

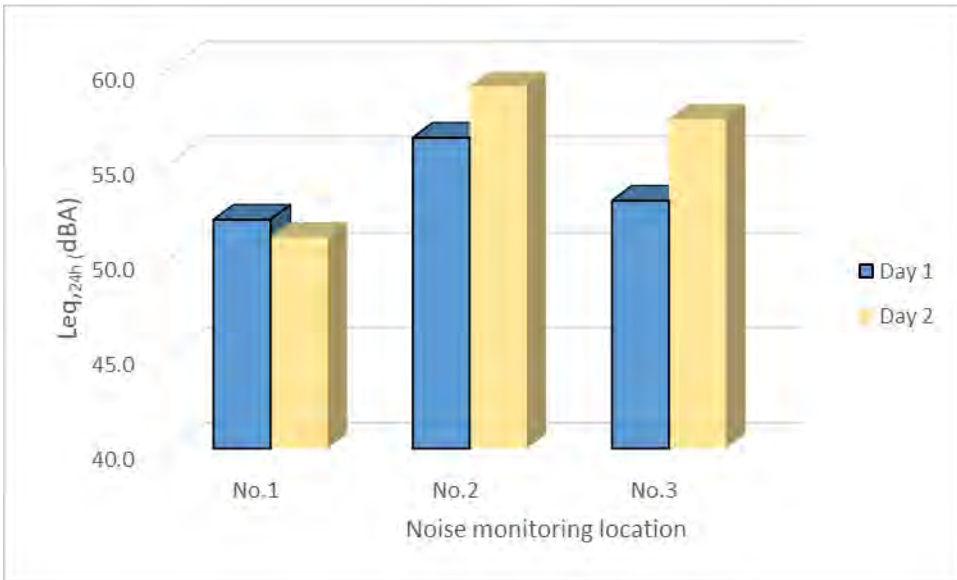


Figure 20. $L_{eq,24h}$ (dBA) in monitoring sites

IV. SUMMARY

Sampling campaign from Sep 23, 2019 to Sep 29, 2019 was conducted to measure the noise baseline at Thanh Hai commune, Thanh Phu district, Ben Tre province. Some summaries can be drawn as follow:

- At all monitoring sites, the noise levels at night-time did not meet IFC standard noise for residential area (45dBA).
- The noise level at the second and third sites were strongly influenced by the wind and waves from Con Loi beach.
- The noise levels at these sites were found to increase in the evening.
- At monitoring location No.1, average Leq of both day-times (about 50dBA) met IFC standard noise. Site No.1 had the lowest average Leq among three sampling sites.
- At monitoring location No.2, In the day-time, the noise level is commonly measured in the range of 53 – 55dBA.
- At monitoring location No.3, the highest noise level was recorded of 68,4 dBA at 5:10AM because of both motorbike and dogs barking.
- In general, the wind and wave from the sea is considered as main noise sources. Besides, dogs, roaster, goasts, goose, and verhicle are also noise sources influenced to the noise level at three monitoring sites in Thanh Hai commune, Thanh Phu district, Ben Tre province.
- The detail noise level and these sources and is showed in appendix A and appendix B.

APPENDIX A: DETAILS OF NOISE LEVEL ($L_{EQ,10MIN}$, L_{MAX},, L_{MIN}, L_{90}, L_{10}, L_1) AT MONITORING SITES

Table A1: Details of noise level monitoring location No.01 –

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
25-Sep	12:11:23 PM	12:21:23 PM	59.7	52.2	48.8	50.6	64.7	47.6	3.3-4.6	29.6	68.4	NE80
	12:21:23 PM	12:31:23 PM	57.9	52.1	49.1	50.9	66.1	48.0				
	12:31:23 PM	12:41:23 PM	52.2	50.8	48.1	49.3	53.7	46.8	3.5-5.1	29.7	69.2	NE80
	12:41:23 PM	12:51:23 PM	51.5	51.2	48.3	49.7	54.3	46.7				
	12:51:23 PM	1:01:23 PM	53.5	51.6	48.6	50.1	54.5	47.4	4.0-4.8	30.2	70.1	NE80
	1:01:23 PM	1:11:23 PM	55.7	51.9	48.4	50.2	57.3	47.1	4.2-5.4			NE80
	1:11:23 PM	1:21:23 PM	55.7	51.9	48.1	50.0	59.6	47.0	3.3-4.2	30.8	71.6	SE100
	1:21:23 PM	1:31:23 PM	53.2	51.4	48.1	49.8	61.0	46.9				
	1:31:23 PM	1:41:23 PM	53.7	50.9	47.1	48.9	55.0	45.8	3.1-4.3	30.9	69.8	SE100
	1:41:23 PM	1:51:23 PM	50.9	49.0	46.4	47.5	52.2	45.1				
	1:51:23 PM	2:01:23 PM	52.2	50.1	46.8	48.3	53.5	45.9	3.2-4.7	31.2	70.2	SE140
	2:01:23 PM	2:11:23 PM	53.1	50.5	46.9	48.7	54.4	46.0				
	2:11:23 PM	2:21:23 PM	51.9	50.0	46.2	48.0	53.2	44.6	3.3-4.8	31.2	70.5	SE140
	2:21:23 PM	2:31:23 PM	54.0	50.2	46.0	48.3	59.2	44.9				
	2:31:23 PM	2:41:23 PM	52.6	49.8	45.3	47.5	53.6	43.7				
	2:41:23 PM	2:51:23 PM	52.9	50.8	45.5	48.3	54.2	44.0	3.1-5.2	30.4	74.6	SE140
	2:51:23 PM	3:01:23 PM	52.5	50.1	44.9	47.7	53.8	43.6				
	3:01:23 PM	3:11:23 PM	50.5	48.2	43.8	45.9	51.8	42.4	3.6-5.5	30.2	74.1	SE140
	3:11:23 PM	3:21:23 PM	53.4	49.8	43.9	47.2	55.3	42.3				
	3:21:23 PM	3:31:23 PM	50.7	48.2	42.4	45.4	52.0	41.2	3.7-5.6	30.1	74	SE140
	3:31:23 PM	3:41:23 PM	51.1	49.0	42.4	45.8	53.2	40.8				
	3:41:23 PM	3:51:23 PM	51.0	48.8	42.4	45.8	52.6	40.6	3.4-5.2	30.2	73.7	SE140
	3:51:23 PM	4:01:23 PM	50.8	47.0	41.6	44.4	53.5	40.5				
	4:01:23 PM	4:11:23 PM	53.3	50.8	45.2	48.6	55.8	41.1	3.2-5.1	30.1	78.7	SE140

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
25-Sep	4:11:23 PM	4:21:23 PM	55.3	51.5	45.9	49.2	57.2	43.8				
	4:21:23 PM	4:31:23 PM	51.8	50.2	45.0	48.0	53.1	43.2	3.2-5.3	29.8	81.1	SE140
	4:31:23 PM	4:41:23 PM	51.5	50.0	43.7	47.1	52.8	42.2				
	4:41:23 PM	4:51:23 PM	52.1	49.5	42.7	46.5	53.4	41.0	3.7-5.6	29.7	81.4	SE140
	4:51:23 PM	5:01:23 PM	51.4	47.6	41.8	45.1	53.1	40.9				
	5:01:23 PM	5:11:23 PM	51.9	48.1	41.5	45.1	53.3	39.4	3.1-4.9	29.1	79.2	SE140
	5:11:23 PM	5:21:23 PM	49.9	46.0	41.3	43.7	51.5	39.9				
	5:21:23 PM	5:31:23 PM	51.4	47.6	41.8	45.0	54.2	40.2	3.6-5.1	29.2	80.0	NE80
	5:31:23 PM	5:41:23 PM	53.9	50.1	41.5	46.8	59.1	38.7				
	5:41:23 PM	5:51:23 PM	55.9	52.1	42.3	48.8	62.1	39.1	3.3-4.2	29.1	82.1	NE80
	5:51:23 PM	6:01:23 PM	51.6	48.5	42.1	45.5	53.3	40.0				
	6:01:23 PM	6:11:23 PM	49.7	46.2	40.8	44.0	59.1	39.2	3.5-4.8	29.5	82.4	NE80
	6:11:23 PM	6:21:23 PM	52.0	50.9	44.5	48.2	53.3	41.4				
	6:21:23 PM	6:31:23 PM	56.9	53.1	45.6	50.3	60.7	44.2	4.0-5.6	29.4	82.6	NE80
	6:31:23 PM	6:41:23 PM	54.6	52.3	47.6	50.4	55.9	46.0				
	6:41:23 PM	6:51:23 PM	58.0	54.2	49.6	52.0	64.5	47.4				
	6:51:23 PM	7:01:23 PM	55.9	55.2	48.3	51.4	57.2	46.8	4.0-5.6	29.0	83.2	NE80
	7:01:23 PM	7:11:23 PM	55.5	51.7	48.8	50.4	57.2	46.0				
	7:11:23 PM	7:21:23 PM	55.5	51.7	48.7	50.4	56.8	46.9				
	7:21:23 PM	7:31:23 PM	52.5	49.4	47.0	48.3	53.8	45.7	3.5-5.0	28.9	83.9	SE100
	7:31:23 PM	7:41:23 PM	53.2	50.2	46.9	48.5	55.6	45.4				
	7:41:23 PM	7:51:23 PM	55.0	51.9	49.3	50.5	57.2	48.1	3.3-4.4	28.8	83.5	SE100
	7:51:23 PM	8:01:23 PM	52.1	50.9	48.4	49.8	53.9	47.0				
	8:01:23 PM	8:11:23 PM	51.3	50.7	48.0	49.2	53.1	46.6	3.8-4.7	28.8	84.0	SE100
	8:11:23 PM	8:21:23 PM	53.4	50.8	48.6	49.7	55.2	47.0				
	8:21:23 PM	8:31:23 PM	51.7	51.3	48.9	50.1	53.5	48.1	3.4-5.2	29	84.2	SE100
	8:31:23 PM	8:41:23 PM	54.1	51.7	49.6	50.5	55.9	48.8				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
25-Sep	8:41:23 PM	8:51:23 PM	55.9	52.1	49.8	50.9	59.5	48.8	3.9-5.0	29.1	84.2	SE100
	8:51:23 PM	9:01:23 PM	56.7	54.9	51.0	53.0	62.0	49.4				
	9:01:23 PM	9:11:23 PM	56.8	53.7	51.4	52.4	58.6	50.4	3.3-5.7	29.3	84.4	SE100
	9:11:23 PM	9:21:23 PM	56.7	54.2	52.2	53.2	58.5	51.5				
	9:21:23 PM	9:31:23 PM	57.0	55.6	52.9	54.1	58.8	51.5	4.9-5.5	29.2	84.5	SE100
	9:31:23 PM	9:41:23 PM	56.6	55.4	53.3	54.2	58.8	52.5				
	9:41:23 PM	9:51:23 PM	57.9	55.5	53.3	54.3	60.1	52.2	3.4-5.2	29.2	83.8	E90
	9:51:23 PM	10:01:23 PM	57.0	55.1	53.3	54.2	59.2	52.4				
	10:01:23 PM	10:11:23 PM	56.0	55.1	53.3	54.1	56.7	52.6	3.7-4.9	29.3	83.8	E90
	10:11:23 PM	10:21:23 PM	58.7	56.1	54.0	55.0	60.9	52.8				
	10:21:23 PM	10:31:23 PM	56.0	55.7	54.2	54.8	58.2	53.2	3.6-5.6	29.4	83.7	E90
	10:31:23 PM	10:41:23 PM	56.8	55.2	53.6	54.3	59.0	52.4				
	10:41:23 PM	10:51:23 PM	58.9	55.1	53.6	54.4	65.6	52.7	3.9-5.3	29.6	83.9	E90
	10:51:23 PM	11:01:23 PM	56.2	55.4	53.6	54.5	58.4	52.8				
	11:01:23 PM	11:11:23 PM	58.5	55.7	53.6	54.6	60.7	52.3	3.5-5.5	29.8	83.5	E90
	11:11:23 PM	11:21:23 PM	55.5	54.8	53.2	53.9	56.0	51.8				
	11:21:23 PM	11:31:23 PM	55.7	54.9	53.1	54.0	56.3	51.6	3.4-5.9	29.9	83.1	E90
	11:31:23 PM	11:41:23 PM	56.3	55.8	53.5	54.6	58.5	52.2				
	11:41:23 PM	11:51:23 PM	56.1	55.7	53.9	54.7	58.3	52.6	3.5-4.9	29.7	83.2	E90
	11:51:23 PM	00:01:23 AM	57.4	55.9	54.0	54.9	59.6	52.4				
26-Sep	00:01:23 AM	00:11:23 AM	56.9	56.2	54.3	55.2	59.1	53.0	3.0-4.5	29.6	83.4	E90
	00:11:23 AM	00:21:23 AM	56.9	55.9	54.1	55.0	57.6	53.1				
	00:21:23 AM	00:31:23 AM	56.9	55.9	54.1	55.0	59.1	52.7	2.8-4.4	29.4	83.6	SE110
	00:31:23 AM	00:41:23 AM	56.1	55.8	54.0	54.9	58.3	53.0				
	00:41:23 AM	00:51:23 AM	55.8	55.3	53.5	54.4	58.0	52.1	3.8-4.6	29.1	83.6	SE110
	00:51:23 AM	1:01:23 AM	59.0	55.9	53.8	54.9	61.2	52.3				
	1:01:23 AM	1:11:23 AM	56.1	55.7	53.9	54.7	56.8	52.5	3.3-4.4	28	83.7	SE110

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
26-Sep	1:11:23 AM	1:21:23 AM	56.2	55.6	53.8	54.6	57.1	52.6				
	1:21:23 AM	1:31:23 AM	56.3	55.4	53.8	54.5	57.5	52.4	3.2-4.0	28.1	83.8	E90
	1:31:23 AM	1:41:23 AM	59.0	55.2	53.0	54.2	64.9	51.3				
	1:41:23 AM	1:51:23 AM	55.4	54.8	53.0	53.9	56.1	51.3	3.2-4.9	28.6	84.8	E90
	1:51:23 AM	2:01:23 AM	55.7	55.1	53.5	54.2	56.1	51.9				
	2:01:23 AM	2:11:23 AM	55.5	54.9	53.2	54.1	57.8	52.0	2.8-3.6	28.3	81.7	SE100
	2:11:23 AM	2:21:23 AM	55.0	54.5	53.0	53.7	55.5	51.4				
	2:21:23 AM	2:31:23 AM	55.1	54.5	52.9	53.7	55.7	51.7	2.7-3.4	28.5	80.9	SE100
	2:31:23 AM	2:41:23 AM	55.5	54.8	53.1	53.8	57.0	51.6				
	2:41:23 AM	2:51:23 AM	55.0	54.3	52.7	53.5	56.5	51.9	3.3-3.9	28.1	81.2	NE80
	2:51:23 AM	3:01:23 AM	54.4	53.7	52.0	52.9	55.1	51.0				
	3:01:23 AM	3:11:23 AM	54.7	54.0	52.3	53.0	55.9	51.2	3.0-3.6	28.4	81.8	NE80
	3:11:23 AM	3:21:23 AM	54.0	53.3	52.1	52.6	54.4	51.1				
	3:21:23 AM	3:31:23 AM	54.2	53.5	51.8	52.6	55.7	50.8	2.7-3.5	28.6	81.4	E90
	3:31:23 AM	3:41:23 AM	53.5	52.8	51.5	52.0	54.2	50.5				
	3:41:23 AM	3:51:23 AM	52.7	52.3	51.0	51.6	53.2	50.2	2.2-3.3	28.3	81.5	NE80
	3:51:23 AM	4:01:23 AM	52.3	51.8	50.3	51.1	53.0	48.7				
	4:01:23 AM	4:11:23 AM	52.4	51.7	50.4	51.0	53.8	49.6				
	4:11:23 AM	4:21:23 AM	52.4	51.6	50.1	50.8	54.6	49.2	2.8-3.6	28.3	81.2	E90
	4:21:23 AM	4:31:23 AM	51.6	51.2	50.0	50.5	52.0	48.9				
	4:31:23 AM	4:41:23 AM	51.6	51.1	49.9	50.4	53.8	48.8	2.9-3.3	28.5	80.8	E90
	4:41:23 AM	4:51:23 AM	50.7	50.6	49.2	49.8	52.9	48.2				
	4:51:23 AM	5:01:23 AM	54.0	53.2	49.3	51.0	55.2	48.1	3.0-3.8	28.4	81.3	E90
	5:01:23 AM	5:11:23 AM	55.3	51.2	48.7	49.9	57.5	47.7				
	5:11:23 AM	5:21:23 AM	55.9	51.4	48.8	50.0	58.1	47.8	2.8-3.6	28.8	80.5	NE70
	5:21:23 AM	5:31:23 AM	56.3	52.4	49.3	50.7	58.5	47.7				
	5:31:23 AM	5:41:23 AM	56.9	52.2	49.3	50.8	59.1	48.2				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
26-Sep	5:41:23 AM	5:51:23 AM	55.3	51.7	49.6	50.6	57.5	48.1	2.8-3.4	28.7	80.7	E90
	5:51:23 AM	6:01:23 AM	54.3	52.2	49.9	50.9	56.5	48.5				
	6:01:23 AM	6:11:23 AM	52.3	51.2	49.6	50.4	54.5	48.8	2.7-3.4	28.2	80.3	E90
	6:11:23 AM	6:21:23 AM	53.7	51.9	49.9	50.9	55.9	49.0				
	6:21:23 AM	6:31:23 AM	52.9	51.5	49.6	50.5	55.1	48.2	2.8-4.5	28.5	80.9	SE100
	6:31:23 AM	6:41:23 AM	56.6	51.8	49.4	50.6	58.8	48.3				
	6:41:23 AM	6:51:23 AM	53.9	52.2	49.8	50.9	56.1	48.5	3.1-4.8	28.8	81.5	SE100
	6:51:23 AM	7:01:23 AM	54.6	52.6	50.3	51.4	56.2	49.3				
	7:01:23 AM	7:11:23 AM	57.9	52.8	50.2	51.6	60.1	49.0	2.9-4.7	28.4	81.3	SE100
	7:11:23 AM	7:21:23 AM	54.8	53.0	50.3	51.6	57.0	49.4				
	7:21:23 AM	7:31:23 AM	54.6	52.1	50.3	51.1	56.8	48.8	2.7-3.4	28.2	81	SE100
	7:31:23 AM	7:41:23 AM	54.7	53.1	51.0	51.9	56.9	50.0				
	7:41:23 AM	7:51:23 AM	55.4	52.9	50.7	51.8	61.6	49.7	2.3-3.6	28.1	80.7	SE100
	7:51:23 AM	8:01:23 AM	53.6	52.6	50.8	51.6	54.8	49.8	2.8-4.3	29.3	80.4	SE100
	8:01:23 AM	8:11:23 AM	54.2	52.8	51.2	51.9	56.4	50.0				
	8:11:23 AM	8:21:23 AM	53.4	53.2	51.7	52.3	55.6	50.7	2.8-4.3	29.3	80.4	SE100
	8:21:23 AM	8:31:23 AM	54.1	53.4	52.0	52.6	55.4	50.9				
	8:31:23 AM	8:41:23 AM	54.3	53.6	52.0	52.7	55.5	50.7	2.6-3.9	30	78.3	E90
	8:41:23 AM	8:51:23 AM	54.3	53.6	52.1	52.8	55.8	51.2				
	8:51:23 AM	9:01:23 AM	56.5	54.0	52.1	53.0	58.7	51.1	2.7-4.6	30.2	77.9	SE100
	9:01:23 AM	9:11:23 AM	57.8	54.3	52.2	56.6	79.7	51.2				
	9:11:23 AM	9:21:23 AM	53.8	53.7	52.4	52.9	56.0	50.8	2.4-3.9	30.4	77.7	SE100
	9:21:23 AM	9:31:23 AM	56.0	53.8	52.3	53.0	58.2	51.0				
	9:31:23 AM	9:41:23 AM	56.2	54.5	52.5	53.4	58.4	51.2	3.1-4.3	30.6	77.9	SE100
	9:41:23 AM	9:51:23 AM	54.3	53.9	52.5	53.1	55.5	51.3				
	9:51:23 AM	10:01:23 AM	55.1	54.0	52.5	53.1	56.2	51.8	3.2-4.9	30.8	77.5	SE100
	10:01:23 AM	10:11:23 AM	55.8	54.1	52.5	53.3	58.0	51.1				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
26-Sep	10:11:23 AM	10:21:23 AM	54.2	53.6	52.2	52.8	55.2	51.2	3.4-4.6	30.9	76.8	SE100
	10:21:23 AM	10:31:23 AM	54.0	53.4	52.1	52.7	54.8	50.9				
	10:31:23 AM	10:41:23 AM	57.9	54.2	52.3	53.2	60.1	51.3				
	10:41:23 AM	10:51:23 AM	52.1	53.3	51.9	52.6	54.3	51.0	2.2-3.4	30.6	77.8	SE100
	10:51:23 AM	11:01:23 AM	56.7	53.2	51.7	52.5	62.3	50.6				
	11:01:23 AM	11:11:23 AM	54.0	53.5	52.0	52.7	54.6	50.2	2.8-3.6	30.8	78.1	SE100
	11:11:23 AM	11:21:23 AM	54.1	53.6	52.1	52.8	55.0	51.0				
	11:21:23 AM	11:31:23 AM	54.3	53.8	52.3	53.0	54.7	51.4	2.3-3.7	30.9	77.1	SE100
	11:31:23 AM	11:41:23 AM	54.1	53.6	52.2	52.8	55.6	51.4				
	11:41:23 AM	11:51:23 AM	53.8	53.3	51.9	52.5	54.5	50.7	3.1-4.8	31.2	76.2	SE100
	11:51:23 AM	00:01:23 PM	55.8	53.6	51.7	52.6	58.0	50.7				
	00:01:23 PM	00:11:23 PM	54.9	52.8	51.5	52.1	57.1	50.2	2.8-4.5	31.3	75.7	SE100
	00:11:23 PM	00:21:23 PM	56.5	53.2	51.4	52.3	61.7	50.2				
	00:24:20 PM	00:34:20 PM	56.2	52.3	50.9	51.6	59.2	50.0	3.1-4.2	31.7	74.7	E90
	00:34:20 PM	00:44:20 PM	53.2	52.0	50.6	51.2	53.7	49.6				
	00:44:20 PM	00:54:20 PM	54.8	52.4	50.3	51.9	63.0	48.8	3.0-4.1	31.7	72.4	SE100
	00:54:20 PM	1:04:20 PM	53.7	51.7	50.1	50.8	54.9	49.1				
	1:04:20 PM	1:14:20 PM	53.1	51.5	49.7	50.5	53.9	48.6	2.6-4.2	31.9	72.1	SE110
	1:14:20 PM	1:24:20 PM	53.7	51.4	49.3	50.2	55.1	48.4				
	1:24:20 PM	1:34:20 PM	53.2	51.2	49.1	50.0	54.1	47.7	3.1-4.5	32.3	72.3	SE100
	1:34:20 PM	1:44:20 PM	52.3	50.5	48.6	49.5	52.8	47.0				
	1:44:20 PM	1:54:20 PM	51.7	49.5	47.7	48.5	52.9	46.6	3.0-4.2	31.5	75.1	SE100
	1:54:20 PM	2:04:20 PM	52.2	49.4	47.6	48.4	53.7	46.5				
	2:04:20 PM	2:14:20 PM	51.1	49.4	47.3	48.2	51.9	45.4	2.8-3.8	31.2	74.7	SE120
	2:14:20 PM	2:24:20 PM	51.3	48.6	46.4	47.5	52.5	45.0				
	2:24:20 PM	2:34:20 PM	50.3	48.3	46.0	47.1	51.2	44.6	2.2-3.7	31.4	74.7	SE120
	2:34:20 PM	2:44:20 PM	51.1	48.0	45.6	46.8	52.3	44.3				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
26-Sep	2:44:20 PM	2:54:20 PM	49.3	47.3	45.1	46.2	50.1	43.7	3.2-4.1	31.5	74.2	SE100
	2:54:20 PM	3:04:20 PM	48.8	47.2	44.5	45.9	49.6	43.5				
	3:04:20 PM	3:14:20 PM	49.3	46.2	43.7	44.9	51.0	42.7	2.6-3.7	31.6	73.8	SE130
	3:14:20 PM	3:24:20 PM	51.2	48.0	44.1	46.0	54.0	42.7				
	3:24:20 PM	3:34:20 PM	53.0	47.6	43.0	45.7	56.5	41.8				
	3:34:20 PM	3:44:20 PM	51.6	46.8	42.8	44.9	52.7	41.6	2.8-4.1	31.8	72.9	SE120
	3:44:20 PM	3:54:20 PM	50.1	48.0	43.8	45.9	51.9	42.4				
	3:54:20 PM	4:04:20 PM	50.3	47.0	43.4	45.2	52.5	42.3	3.1-4.3	31.5	72.7	SE120
	4:04:20 PM	4:14:20 PM	50.2	46.8	43.0	45.0	52.6	41.6				
	4:14:20 PM	4:24:20 PM	49.7	45.5	41.6	43.6	51.1	40.3	2.2-3.5	30.8	76.4	SE130
	4:24:20 PM	4:34:20 PM	48.9	46.9	41.7	44.6	54.4	40.5				
	4:34:20 PM	4:44:20 PM	47.0	45.0	40.3	43.1	56.1	38.9	3.0-4.1	30.5	75.2	SE110
	4:44:20 PM	4:54:20 PM	49.7	47.7	41.8	44.8	53.4	40.5				
	4:54:20 PM	5:04:20 PM	48.7	46.7	40.3	44.0	54.5	39.1	2.8-3.6	30.2	75.8	SE110
	5:04:20 PM	5:14:20 PM	48.3	46.3	41.3	44.1	53.9	39.5				
	5:14:20 PM	5:24:20 PM	51.3	49.3	43.0	46.6	55.7	41.1	2.8-3.3	29.6	79.2	SE110
	5:24:20 PM	5:34:20 PM	53.5	51.5	42.0	49.1	65.6	40.1				
	5:34:20 PM	5:44:20 PM	54.7	52.7	41.9	49.0	60.9	39.3	2.6-3.5	29.6	79.2	SE110
	5:44:20 PM	5:54:20 PM	50.4	48.4	42.4	45.6	55.2	40.9				
	5:54:20 PM	6:04:20 PM	51.8	49.8	44.2	47.3	57.8	42.3	2.7-3.4	29.4	81.6	SE100
	6:04:20 PM	6:14:20 PM	52.8	50.8	45.0	48.3	56.2	42.8				
	6:14:20 PM	6:24:20 PM	53.8	51.8	47.8	50.0	56.4	45.2	2.3-3.4	29.2	82.5	SE100
	6:24:20 PM	6:34:20 PM	56.3	54.3	48.1	51.3	58.1	45.1				
	6:34:20 PM	6:44:20 PM	53.4	51.4	47.7	50.0	58.0	46.0	2.0-3.8	29.2	82	SE100
	6:44:20 PM	6:54:20 PM	55.9	53.9	48.8	52.0	60.2	46.6				
	6:54:20 PM	7:04:20 PM	56.6	54.6	48.4	51.8	61.7	46.1	2.2-3.5	29.0	82	SE100
	7:04:20 PM	7:14:20 PM	55.8	53.8	49.1	51.7	60.8	46.8				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
26-Sep	7:14:20 PM	7:24:20 PM	55.0	53.0	48.0	50.9	57.2	45.8	3.1-4.6	28.9	83.2	SE100
	7:24:20 PM	7:34:20 PM	53.6	51.6	46.5	49.5	55.6	44.4				
	7:34:20 PM	7:44:20 PM	52.9	50.9	45.6	48.6	55.5	43.5				
	7:44:20 PM	7:54:20 PM	51.4	49.4	46.0	47.8	54.0	43.6	2.8-3.6	28.9	83.5	SE100
	7:54:20 PM	8:04:20 PM	51.0	49.0	46.4	47.6	53.1	44.8				
	8:04:20 PM	8:14:20 PM	52.7	50.7	46.6	48.6	55.3	45.6	2.5-3.4	28.8	84.1	SE100
	8:14:20 PM	8:24:20 PM	53.8	51.8	47.0	49.6	57.9	45.7				
	8:24:20 PM	8:34:20 PM	54.0	52.0	48.2	50.3	58.7	47.1	2.3-3.7	28.8	83.6	E90
	8:34:20 PM	8:44:20 PM	53.5	51.5	48.4	49.9	56.4	47.4				
	8:44:20 PM	8:54:20 PM	53.6	51.6	48.9	50.4	55.5	48.0	2.8-3.6	28.8	84.7	E90
	8:54:20 PM	9:04:20 PM	53.2	51.2	49.4	50.3	53.6	47.4				
	9:04:20 PM	9:14:20 PM	52.0	51.0	49.6	50.2	52.7	48.5	2.9-3.7	28.9	84.5	NE80
	9:14:20 PM	9:24:20 PM	54.5	52.5	50.6	51.5	57.9	49.5				
	9:24:20 PM	9:34:20 PM	54.5	52.5	50.8	51.6	55.7	49.8	2.6-3.2	28.9	85.1	E90
	9:34:20 PM	9:44:20 PM	54.7	52.7	50.5	51.5	56.6	49.4				
	9:44:20 PM	9:54:20 PM	53.0	52.4	50.7	51.5	53.5	49.7	2.4-3.6	28.8	85.1	E90
	9:54:20 PM	10:04:20 PM	54.7	52.7	51.4	51.9	55.8	49.9				
	10:04:20 PM	10:14:20 PM	54.6	53.9	51.7	52.7	55.6	50.9				
	10:14:20 PM	10:24:20 PM	54.2	53.6	52.5	53.0	54.7	51.3	2.7-3.9	28.9	85.2	E90
	10:24:20 PM	10:34:20 PM	54.5	53.9	52.6	53.2	54.9	51.8				
	10:34:20 PM	10:44:20 PM	55.1	54.5	53.0	53.7	55.5	51.9	2.6-4.0	28.8	82.4	NE80
	10:44:20 PM	10:54:20 PM	55.4	55.0	53.6	54.2	55.8	52.7				
	10:54:20 PM	11:04:20 PM	55.7	55.1	53.6	54.3	56.1	52.1	2.8-3.6	28.7	82.5	E90
	11:04:20 PM	11:14:20 PM	56.1	55.5	53.9	54.6	56.7	52.2				
	11:14:20 PM	11:24:20 PM	57.7	55.7	53.7	54.6	58.3	52.4				
	11:24:20 PM	11:34:20 PM	57.9	55.9	53.9	54.9	60.7	52.0	3.1-4.3	28.7	82.8	NE80
	11:34:20 PM	11:44:20 PM	56.6	56.1	54.2	55.1	57.7	52.3				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
	11:44:20 PM	11:54:20 PM	56.5	56.1	54.4	55.3	56.9	53.2	2.7-3.8	28.5	82.2	NE80
	11:54:20 PM	00:04:20 AM	56.7	56.2	54.3	55.2	57.2	53.1				
27-Sep	00:04:20 AM	00:14:20 AM	56.7	56.2	54.4	55.2	57.7	52.9	2.1-3.2	28.6	82.1	NE80
	00:14:20 AM	00:24:20 AM	57.0	56.5	54.6	55.5	58.9	52.8				
	00:24:20 AM	00:34:20 AM	57.2	56.7	54.7	55.8	58.7	53.1				
	00:34:20 AM	00:44:20 AM	59.3	57.3	55.2	56.3	59.8	53.1	2.8-3.5	28.7	82.5	E90
	00:44:20 AM	00:54:20 AM	58.8	56.8	54.9	55.8	60.0	53.1				
	00:54:20 AM	1:04:20 AM	59.8	57.8	55.5	56.5	60.1	54.3	2.7-3.6	28.5	82.8	E90
	1:04:20 AM	1:14:20 AM	59.5	57.5	55.1	56.3	61.1	54.0				
	1:14:20 AM	1:24:20 AM	59.2	57.2	55.0	56.1	59.4	53.9	2.6-3.7	28.3	82.1	E90
	1:24:20 AM	1:34:20 AM	59.0	57.0	54.9	55.9	59.5	53.0				
	1:34:20 AM	1:44:20 AM	57.7	56.6	54.7	55.6	58.6	53.4	2.8-3.9	28.4	81.4	E90
	1:44:20 AM	1:54:20 AM	57.1	56.5	54.8	55.6	57.7	52.9				
	1:54:20 AM	2:04:20 AM	57.1	56.5	54.8	55.6	57.9	53.5	2.5-3.6	28.3	81.3	E90
	2:04:20 AM	2:14:20 AM	56.7	56.1	54.4	55.3	57.1	53.1				
	2:14:20 AM	2:24:20 AM	56.5	55.9	54.3	55.1	57.3	53.3	3.4-4.6	28.5	84.4	NE80
	2:24:20 AM	2:34:20 AM	56.1	55.5	53.9	54.6	57.0	52.7				
	2:34:20 AM	2:44:20 AM	56.0	55.4	53.8	54.5	56.5	52.8	2.8-3.8	28.2	84.3	NE60
	2:44:20 AM	2:54:20 AM	55.5	55.0	53.5	54.1	55.9	52.5				
	2:54:20 AM	3:04:20 AM	55.1	54.6	53.2	53.8	55.5	51.6	2.1-3.5	28.1	84.1	NE60
	3:04:20 AM	3:14:20 AM	54.8	54.3	52.8	53.4	55.4	51.8				
	3:14:20 AM	3:24:20 AM	54.2	53.7	52.3	52.9	54.6	51.0	2.4-3.5	28	83.9	NE60
	3:24:20 AM	3:34:20 AM	54.0	53.6	52.0	52.7	54.4	51.0				
	3:34:20 AM	3:44:20 AM	53.3	52.9	51.6	52.2	54.0	50.9	2.7-3.6	28	84.8	NE60
	3:44:20 AM	3:54:20 AM	53.4	52.9	51.3	52.0	54.9	49.9				
	3:54:20 AM	4:04:20 AM	52.8	52.6	51.1	51.7	53.2	50.1	2.5-3.3	27.9	85.5	NE60
	4:04:20 AM	4:14:20 AM	53.5	52.5	50.4	51.4	54.6	48.9				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
27-Sep	4:14:20 AM	4:24:20 AM	51.4	51.0	49.5	50.2	52.0	48.7	2.0-3.4	27.6	85.1	NE60
	4:24:20 AM	4:34:20 AM	50.6	50.1	47.8	48.9	51.1	46.5				
	4:34:20 AM	4:44:20 AM	49.6	49.0	47.1	48.0	50.4	45.4	2.9-4.2	27.8	86.2	NE60
	4:44:20 AM	4:54:20 AM	48.0	47.6	45.8	46.6	48.7	44.6				
	4:54:20 AM	5:04:20 AM	48.3	47.7	45.5	46.6	49.0	44.2	3.2-4.0	27.9	86.5	NE60
	5:04:20 AM	5:14:20 AM	48.1	47.5	45.2	46.3	48.9	43.7				
	5:14:20 AM	5:24:20 AM	49.3	47.3	44.8	46.3	60.3	43.4	2.4-3.7	27.5	86.3	NE50
	5:24:20 AM	5:34:20 AM	49.9	47.9	44.7	46.6	60.4	42.8				
	5:34:20 AM	5:44:20 AM	51.9	49.9	44.9	47.3	53.5	43.5	1.7-3.6	27.2	86	NE40
	5:44:20 AM	5:54:20 AM	52.8	50.8	44.6	48.3	60.7	42.6				
	5:54:20 AM	6:04:20 AM	54.0	52.0	45.7	49.1	55.6	43.2	1.3-3.2	27.1	86.4	NE40
	6:04:20 AM	6:14:20 AM	51.6	49.6	43.5	46.5	54.0	41.5				
	6:14:20 AM	6:24:20 AM	50.9	48.9	44.1	46.6	54.5	41.7	2.0-3.4	26.8	86.8	NE30
	6:24:20 AM	6:34:20 AM	51.9	49.9	43.5	47.0	58.6	41.7				
	6:34:20 AM	6:44:20 AM	50.1	48.1	43.5	45.8	52.3	41.2	1.8-2.8	26.9	86.9	NE30
	6:44:20 AM	6:54:20 AM	50.3	48.3	44.5	46.5	55.1	42.8				
	6:54:20 AM	7:04:20 AM	58.8	56.2	44.7	51.6	61.1	43.0	1.9-3.0	27.1	85.4	NE20
	7:04:20 AM	7:14:20 AM	52.1	47.7	43.9	45.9	54.9	42.4				
	7:14:20 AM	7:24:20 AM	49.8	46.3	42.3	44.3	52.1	40.9	2.0-3.2	28.2	85.6	NE10
	7:24:20 AM	7:34:20 AM	49.3	47.3	42.3	44.9	52.2	40.4				
	7:34:20 AM	7:44:20 AM	57.9	48.1	42.8	45.8	62.1	41.0	2.3-3.1	28.3	83.7	WN340
	7:44:20 AM	7:54:20 AM	50.1	48.1	43.4	45.7	51.3	41.8				
	7:54:20 AM	8:04:20 AM	49.8	47.0	43.7	45.3	52.3	42.0	2.9-3.8	28.5	83.5	N0
	8:04:20 AM	8:14:20 AM	48.2	46.2	42.6	44.4	51.7	40.6				
	8:14:20 AM	8:24:20 AM	59.1	45.9	42.4	45.3	64.8	41.0	2.2-3.0	28.9	77.3	N0
	8:24:20 AM	8:34:20 AM	48.9	46.9	43.7	45.4	50.1	41.6				
	8:34:20 AM	8:44:20 AM	51.9	49.9	46.8	48.3	53.3	45.7	2.3-3.2	29.2	77.8	N10

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
27-Sep	8:44:20 AM	8:54:20 AM	48.8	46.8	42.8	44.9	50.2	40.4				
	8:54:20 AM	9:04:20 AM	55.5	47.0	40.7	45.6	61.3	38.7	2.2-3.8	29.0	76.8	NE70
	9:04:20 AM	9:14:20 AM	47.6	44.1	39.9	42.5	49.3	38.0				
	9:14:20 AM	9:24:20 AM	51.4	45.1	41.4	43.8	56.6	39.7	2.0-3.3	29.5	78.3	N0
	9:24:20 AM	9:34:20 AM	45.8	43.8	39.5	41.9	46.8	37.8				
	9:34:20 AM	9:44:20 AM	50.2	44.9	41.1	43.7	56.3	39.6	1.8-2.7	29.9	75.7	WN350
	9:44:20 AM	9:54:20 AM	47.4	45.4	43.0	44.3	49.8	41.6				
	9:54:20 AM	10:04:20 AM	54.5	46.3	42.4	45.4	58.9	40.5	1.9-2.8	30.5	73.8	WN350
	10:04:20 AM	10:14:20 AM	47.1	45.1	41.4	43.5	52.9	38.5				
	10:14:20 AM	10:24:20 AM	55.7	44.5	40.6	44.2	58.8	38.4	1.7-2.5	31.1	72.8	NE70
	10:24:20 AM	10:34:20 AM	50.4	44.0	40.0	42.4	54.6	38.6				
	10:34:20 AM	10:44:20 AM	44.4	42.4	39.4	40.9	46.6	37.9	1.3-2.2	31.6	72.5	NE60
	10:44:20 AM	10:54:20 AM	53.4	44.6	40.2	43.1	59.0	37.6				
	10:54:20 AM	11:04:20 AM	46.3	44.3	40.5	44.0	62.0	38.4	1.5-2.3	32.1	68.3	NE60
	11:04:20 AM	11:14:20 AM	45.0	43.0	40.1	41.6	48.3	38.5				
	11:14:20 AM	11:24:20 AM	44.0	43.2	40.0	41.6	45.2	38.2				
	11:24:20 AM	11:34:20 AM	47.0	45.0	42.0	44.0	56.0	39.9	1.3-2.0	32.5	66.9	E90
	11:34:20 AM	11:44:20 AM	47.2	45.2	41.7	43.8	56.7	39.1				
	11:44:20 AM	11:54:20 AM	46.0	44.0	40.7	42.3	47.2	39.2	1.5-2.1	32.3	69.2	NE70
	11:54:20 AM	00:04:20 PM	46.8	44.7	41.2	43.1	48.5	39.5				
	00:04:20 PM	00:14:20 PM	47.2	45.0	41.7	43.4	49.2	39.2	1.7-2.5	32.5	69.3	E90
	00:14:20 PM	00:24:20 PM	45.1	43.5	40.0	41.7	46.4	38.2				
	00:24:20 PM	00:34:20 PM	47.0	44.2	39.9	42.3	49.7	38.2	1.4-2.6	32.6	68.7	E90

Table A2: Details of noise level at monitoring site No.02

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
23-Sep	10:57:01 AM	11:07:01 AM	62.1	54.7	44.4	52.1	67.9	40.9	2.4-3.1	31.1	72.4	NE50
	11:07:01 AM	11:17:01 AM	55.4	51.1	44.9	48.6	56.9	42.1				
	11:17:01 AM	11:27:01 AM	55.2	48.4	43.4	46.3	57.9	41.2	2.6-3.3	31.1	72.3	NE50
	11:27:01 AM	11:37:01 AM	56.1	53.0	42.2	48.4	57.9	40.1				
	11:37:01 AM	11:47:01 AM	48.4	44.3	40.5	42.6	50.2	38.9	2.2-3.7	31.5	71.4	NE60
	11:47:01 AM	11:57:01 AM	48.5	44.4	40.8	50.0	74.8	38.8				
	11:57:01 AM	12:07:01 PM	49.0	45.5	41.6	43.6	50.9	40.3	2.5-4.3	30.5	71	NE60
	12:07:01 PM	12:17:01 PM	49.1	45.5	40.5	43.3	51.9	39.0				
	12:17:01 PM	12:27:01 PM	49.5	45.2	40.7	43.4	54.9	39.3				
	12:27:01 PM	12:37:01 PM	49.5	47.0	42.8	45.1	50.7	40.7	2.9-3.7	30.4	69.5	NE60
	12:37:01 PM	12:47:01 PM	53.3	49.4	44.5	47.3	56.0	42.6				
	12:47:01 PM	12:57:01 PM	54.1	50.2	45.3	47.9	56.1	43.1	3.1-4.2	30.4	69.7	NE80
	12:57:01 PM	1:07:01 PM	55.7	51.8	45.5	49.2	57.4	43.5				
	1:07:01 PM	1:17:01 PM	53.5	49.7	44.2	47.5	56.7	41.4				
	1:17:01 PM	1:27:01 PM	54.0	49.8	45.0	48.0	56.2	42.1	3.3-4.6	30.4	69.5	E90
	1:27:01 PM	1:37:01 PM	55.5	52.2	43.1	48.4	56.3	40.5				
	1:37:01 PM	1:47:01 PM	57.5	53.7	48.0	51.1	59.5	46.2				
	1:47:01 PM	1:57:01 PM	60.1	56.8	51.5	54.5	61.1	48.3	2.4-3.5	30.5	70.2	E90
	1:57:01 PM	2:07:01 PM	58.9	55.1	47.5	52.0	60.2	44.2				
	2:07:01 PM	2:17:01 PM	57.1	53.3	48.2	51.2	60.4	45.0				
	2:17:01 PM	2:27:01 PM	58.7	56.0	49.2	52.9	59.7	46.8	3.2-4.7	30.5	71.5	E90
	2:27:01 PM	2:37:01 PM	60.0	54.9	49.7	52.9	64.1	46.2				
	2:37:01 PM	2:47:01 PM	58.3	54.5	49.0	52.2	60.6	45.6	3.8-5.9	30.6	73.5	E90
	2:47:01 PM	2:57:01 PM	58.7	55.2	49.5	52.9	60.4	47.9				
	2:57:01 PM	3:07:01 PM	58.2	55.1	49.3	52.6	60.3	46.9	3.2-4.3	30.6	76.9	E90
	3:07:01 PM	3:17:01 PM	58.5	54.7	49.3	52.1	61.3	46.7				
	3:17:01 PM	3:27:01 PM	59.4	55.6	50.0	53.3	60.6	46.3				
	3:27:01 PM	3:37:01 PM	64.3	56.5	47.1	53.8	68.3	43.4	3.6-4.8	30.3	77.8	SE100
	3:37:01 PM	3:47:01 PM	61.2	58.4	47.2	54.9	62.5	42.2				
	3:47:01 PM	3:57:01 PM	60.8	58.6	53.0	56.1	62.3	49.3				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
23-Sep	3:57:01 PM	4:07:01 PM	62.4	58.0	48.6	55.2	66.8	43.8	3.7-4.5	30.5	77.2	SE110
	4:07:01 PM	4:17:01 PM	62.0	57.9	52.2	55.4	63.0	49.6				
	4:17:01 PM	4:27:01 PM	60.7	58.3	52.0	55.7	61.9	49.4	3.2-4.9	30.6	76.5	SE100
	4:27:01 PM	4:37:01 PM	58.7	56.7	51.7	54.6	60.5	49.6				
	4:37:01 PM	4:47:01 PM	59.9	57.4	52.0	55.0	61.2	49.3	3.8-4.6	30.5	76.9	SE100
	4:47:01 PM	4:57:01 PM	61.7	57.9	51.8	55.3	64.7	49.2				
	4:57:01 PM	5:07:01 PM	59.5	56.5	48.1	53.4	60.7	46.5	4.1-5.2	30.5	77.5	E90
	5:07:01 PM	5:17:01 PM	64.0	59.7	51.2	56.7	67.6	47.2				
	5:17:01 PM	5:27:01 PM	61.2	57.4	48.9	54.4	63.2	46.6	4.4-5.6	30.3	77.8	E90
	5:28:17 PM	5:38:17 PM	59.7	58.2	49.6	54.7	61.6	46.5				
	5:38:17 PM	5:48:17 PM	60.0	56.4	49.5	53.7	64.4	46.7	4.2-5.5	29.6	76.2	E90
	5:48:17 PM	5:58:17 PM	59.8	56.2	49.6	53.3	62.3	47.6				
	5:58:17 PM	6:08:17 PM	58.4	54.8	49.6	52.4	63.8	47.8	4.9-5.7	29.1	74.8	E90
	6:08:32 PM	6:18:32 PM	57.3	55.5	50.2	53.3	58.3	47.7				
	6:18:32 PM	6:28:32 PM	58.1	54.4	49.5	52.2	59.0	47.8	4.1-5.3	29.1	74.5	SE100
	6:28:32 PM	6:38:32 PM	56.9	54.5	50.6	52.7	58.0	49.3				
	6:38:32 PM	6:48:32 PM	59.8	56.3	51.6	54.2	60.9	49.6	4.5-5.8	29.1	75.8	SE100
	6:48:32 PM	6:58:32 PM	59.6	56.8	51.9	54.7	60.6	50.1				
	6:58:32 PM	7:08:32 PM	60.3	56.8	51.6	54.5	61.2	49.9	5.3-6.6	29.2	76.9	E90
	7:08:32 PM	7:18:32 PM	59.9	57.5	52.3	55.2	61.1	50.3				
	7:18:32 PM	7:28:32 PM	60.0	57.5	53.5	55.6	61.1	52.0	5.7-7.6	29.5	77.3	SE100
	7:28:32 PM	7:38:32 PM	61.6	57.9	52.4	55.4	62.8	50.0				
	7:38:32 PM	7:48:32 PM	61.0	58.9	54.0	56.7	62.2	52.1	5.0-7.1	29.4	77.9	SE100
	7:48:32 PM	7:58:32 PM	65.5	56.5	53.0	55.0	68.9	51.8				
	7:58:32 PM	8:08:32 PM	60.5	57.6	53.2	55.5	61.6	51.1	5.6-6.5	29.4	78.1	E90
	8:08:32 PM	8:18:32 PM	60.1	56.9	53.0	55.1	61.0	51.1				
	8:18:32 PM	8:28:32 PM	58.8	56.6	53.1	54.8	59.7	51.7	5.3-6.9	29.3	78.3	SE100
	8:28:32 PM	8:38:32 PM	58.7	55.7	51.8	53.8	59.5	49.9				
	8:38:32 PM	8:48:32 PM	58.2	55.8	51.8	54.0	59.1	49.9	4.1-6.0	29.2	78.6	SE100
	8:48:32 PM	8:58:32 PM	58.7	56.1	52.8	54.4	59.7	50.9				
	8:58:32 PM	9:08:32 PM	56.7	54.6	51.8	53.2	57.8	50.8				
	9:08:32 PM	9:18:32 PM	59.1	55.7	52.3	54.1	60.0	50.8	5.0-5.9	29.1	78.9	SE100

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
23-Sep	9:18:32 PM	9:28:32 PM	61.9	57.8	53.1	55.5	63.0	51.1				
	9:28:32 PM	9:38:32 PM	59.0	56.8	53.1	55.0	59.8	51.7	4.5-6.2	29.4	79.2	SE100
	9:38:32 PM	9:48:32 PM	58.0	55.3	52.1	53.6	58.9	49.9				
	9:48:32 PM	9:58:32 PM	59.0	55.8	52.2	54.0	60.1	50.2	5.7-6.6	29.4	79.5	SE100
	9:58:32 PM	10:08:32 PM	58.6	56.2	52.5	54.3	59.7	50.9				
	10:08:32 PM	10:18:32 PM	59.0	57.4	53.6	55.6	60.0	51.6				
	10:18:32 PM	10:28:32 PM	60.1	57.1	53.5	55.3	61.1	52.4	5.5-6.8	29	79.3	SE120
	10:28:32 PM	10:38:32 PM	60.1	58.1	54.2	56.1	61.0	52.4				
	10:38:32 PM	10:48:32 PM	59.2	57.0	52.7	55.0	60.4	51.0	5.3-5.9	29.1	80	E90
	10:48:32 PM	10:58:32 PM	60.2	57.5	53.5	55.6	61.4	52.1				
	10:58:32 PM	11:08:32 PM	57.0	55.8	52.5	54.1	58.0	50.6	5.3-6.6	29.4	81	SE120
	11:08:32 PM	11:18:32 PM	59.8	57.8	53.2	55.7	60.8	51.7				
	11:18:32 PM	11:28:32 PM	58.0	56.0	52.5	54.2	58.9	50.9	3.8-5.5	28.8	81.5	SE100
	11:28:32 PM	11:38:32 PM	60.2	58.7	54.0	56.5	61.0	52.2				
	11:38:32 PM	11:48:32 PM	60.2	58.1	54.0	56.1	61.1	52.2	4.3-6.5	28.9	80.2	SE100
	11:48:32 PM	11:58:32 PM	65.0	60.5	54.3	57.8	66.2	52.1				
	11:58:32 PM	12:08:32 AM	66.3	62.9	56.7	60.1	67.4	54.4	5.2-6.4	28.9	80.6	SE100
24-Sep	12:08:32 AM	12:18:32 AM	63.4	60.8	56.1	58.7	64.2	53.0				
	12:18:32 AM	12:28:32 AM	65.2	62.6	56.8	60.2	66.3	54.7	5.9-7.3			SE100
	12:29:38 AM	12:39:38 AM	63.8	60.9	55.3	58.4	66.3	53.1	5.2-6.2			SE110
	12:39:38 AM	12:49:38 AM	64.3	60.9	55.2	58.5	66.5	52.5	5.2-9.3	28.8	81.5	E90
	12:49:38 AM	12:59:38 AM	66.9	63.4	57.9	61.1	69.5	55.6	6.6-7.7			SE110
	12:59:38 AM	1:09:38 AM	64.5	62.6	56.8	60.2	66.3	54.8	4.6-6.4			E90
	1:09:38 AM	1:19:38 AM	63.4	60.9	56.3	58.8	65.5	54.3	5.4-6.7	28.7	79.5	E90
	1:19:38 AM	1:29:38 AM	63.2	61.6	56.5	59.2	65.2	54.4				
	1:29:38 AM	1:39:38 AM	64.5	61.6	56.0	59.2	66.8	53.8	5.7-6.9	28.4	79.7	E90
	1:39:38 AM	1:49:38 AM	63.8	60.7	55.4	58.5	65.8	53.4				
	1:49:38 AM	1:59:38 AM	65.2	62.3	57.2	60.2	67.2	54.9	5.8-7.1	28.5	80.3	E90
	1:59:38 AM	2:09:38 AM	64.2	62.3	56.8	59.9	66.2	54.6				
	2:09:38 AM	2:19:38 AM	65.6	63.3	57.3	60.7	67.6	55.3	5.7-7.2	28.3	79.8	E90
	2:19:38 AM	2:29:38 AM	66.3	62.4	56.7	60.0	68.3	53.9				
	2:29:38 AM	2:39:38 AM	62.1	60.7	55.9	58.6	64.1	53.5	6.1-7.8	28.6	80.1	SE100

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
24-Sep	2:39:38 AM	2:49:38 AM	64.6	62.0	55.5	59.2	66.6	53.1				
	2:49:38 AM	2:59:38 AM	62.6	60.3	55.5	58.2	64.6	53.2	6.1-7.3	28.3	80.1	E90
	2:59:38 AM	3:09:38 AM	65.4	62.3	55.0	59.7	68.1	52.8				
	3:09:38 AM	3:19:38 AM	66.6	62.6	57.0	60.2	68.6	54.0				
	3:19:38 AM	3:29:38 AM	68.0	63.1	57.7	60.8	71.0	56.2	6.7-7.8	28.5	79.8	E100
	3:29:38 AM	3:39:38 AM	67.0	63.0	56.7	60.3	69.2	53.3				
	3:39:38 AM	3:49:38 AM	68.0	64.0	58.6	61.7	70.3	55.6				
	3:49:38 AM	3:59:38 AM	65.4	62.2	56.8	59.9	67.2	54.7	6.1-7.3	28.4	80.1	E90
	3:59:38 AM	4:09:38 AM	63.9	60.4	54.5	57.9	65.9	52.3				
	4:09:38 AM	4:19:38 AM	63.6	61.6	55.9	59.2	65.6	52.5	5.2-6.9	28.3	79.8	E90
	4:19:38 AM	4:29:38 AM	61.7	60.0	54.5	57.5	63.7	53.0				
	4:29:38 AM	4:39:38 AM	62.0	61.0	55.2	58.4	64.0	53.4	5.8-6.6	28.4	79.3	E90
	4:39:38 AM	4:49:38 AM	63.4	61.9	55.9	59.3	65.2	54.2				
	4:49:38 AM	4:59:38 AM	65.7	63.1	56.1	59.9	67.9	53.4				
	4:59:38 AM	5:09:38 AM	63.1	60.3	55.4	58.0	65.2	53.2	5.5-6.3	28.2	80.3	E90
	5:09:38 AM	5:19:38 AM	65.7	62.5	56.4	59.9	67.7	53.9				
	5:19:38 AM	5:29:38 AM	66.1	63.2	56.1	60.1	68.1	53.9	5.1-6.4	28.3	82.2	E90
	5:29:38 AM	5:39:38 AM	61.8	59.4	54.1	57.1	63.5	52.2				
	5:39:38 AM	5:49:38 AM	63.2	60.3	54.6	58.0	65.2	52.6	4.6-6.4	28.4	81.5	E90
	5:49:38 AM	5:59:38 AM	61.1	58.8	54.1	56.6	63.1	52.1				
	5:59:38 AM	6:09:38 AM	59.5	57.8	53.2	55.7	61.8	51.4				
	6:09:38 AM	6:19:38 AM	63.3	58.1	53.5	56.0	65.3	51.8	5.4-6.7	29.2	80.5	E90
	6:19:38 AM	6:29:38 AM	58.8	57.7	53.6	55.5	60.9	51.9				
	6:29:38 AM	6:39:38 AM	59.7	58.3	53.6	56.3	61.9	52.1	5.0-6.2	29.2	80.5	E90
	6:39:38 AM	6:49:38 AM	61.6	59.1	54.9	57.1	63.5	52.7				
	6:49:38 AM	6:59:38 AM	61.1	56.9	53.9	55.4	62.8	52.5	4.6-6.0	29.3	77.8	E90
	6:59:38 AM	7:09:38 AM	60.1	56.6	53.1	55.0	62.6	51.6				
	7:09:38 AM	7:19:38 AM	58.1	56.5	53.6	55.0	59.1	51.8				
	7:21:49 AM	7:31:49 AM	60.5	57.5	53.7	55.9	71.5	52.1	5.0-5.5	29.5	70.4	E90
	7:31:49 AM	7:41:49 AM	59.8	56.8	53.6	55.2	60.1	52.1				
	7:41:49 AM	7:51:49 AM	58.3	56.2	53.3	54.7	60.5	52.3				
	7:51:49 AM	8:01:49 AM	60.2	57.2	53.0	55.1	63.4	51.5	5.2-60	29.8	67.2	E90

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
24-Sep	8:01:49 AM	8:11:49 AM	60.5	58.7	55.3	57.0	61.2	53.7				
	8:11:49 AM	8:21:49 AM	61.0	59.3	55.0	57.2	62.1	53.5				
	8:21:49 AM	8:31:49 AM	62.5	59.6	54.8	57.3	63.5	52.8	5.0-5.7	31.3	64.5	SE100
	8:31:49 AM	8:41:49 AM	60.2	58.2	54.2	56.3	61.3	52.6				
	8:41:49 AM	8:51:49 AM	60.9	58.4	53.5	56.1	62.1	52.2	4.7-5.3	31.3	63.3	E90
	8:51:49 AM	9:01:49 AM	60.8	57.8	54.1	56.0	62.6	52.2				
	9:01:49 AM	9:11:49 AM	58.8	56.8	53.0	54.9	59.8	51.0				
	9:11:49 AM	9:21:49 AM	60.9	58.0	53.6	56.0	62.2	51.6	5.1-5.8	32.3	59.4	SE100
	9:21:49 AM	9:31:49 AM	60.3	57.0	52.6	54.9	64.4	51.0				
	9:31:49 AM	9:41:49 AM	60.3	57.9	52.9	55.7	61.6	50.4				
	9:41:49 AM	9:51:49 AM	60.2	57.2	52.9	55.2	61.8	51.4	5.8-6.6	30.8	64.7	E90
	9:51:49 AM	10:01:49 AM	58.3	56.2	52.9	54.5	59.7	50.8				
	10:01:49 AM	10:11:49 AM	59.2	56.2	52.1	54.2	61.2	50.9	5.5-6.1	31.7	62.4	NE80
	10:11:49 AM	10:21:49 AM	57.8	54.8	51.7	53.3	60.7	49.9				
	10:21:49 AM	10:31:49 AM	58.5	55.5	51.1	53.4	61.6	49.6				
	10:31:49 AM	10:41:49 AM	57.2	54.2	50.5	52.5	64.6	49.3	5.3-5.9	31.3	64.6	E90
	10:41:49 AM	10:51:49 AM	56.9	55.6	50.9	53.4	58.0	49.4				
	10:51:49 AM	11:01:49 AM	56.2	54.0	50.1	52.1	57.4	48.5	4.9-5.8	32.2	63.6	SE100
	11:01:49 AM	11:11:49 AM	58.2	56.3	50.2	53.3	59.3	48.7				
	11:11:49 AM	11:21:49 AM	58.2	55.2	49.2	52.4	61.1	47.1	4.6-5.2	32.5	63.7	E90
	11:21:49 AM	11:31:49 AM	57.2	54.2	50.1	52.2	58.2	48.1				
	11:31:49 AM	11:41:49 AM	57.1	54.7	50.1	52.4	58.1	47.8				
	11:41:49 AM	11:51:49 AM	56.6	53.6	49.3	51.6	59.8	47.8	5.4-5.7	32.3	64.5	E90
	11:51:49 AM	00:01:49 PM	61.0	57.1	49.0	53.7	67.7	47.0				
	00:01:49 PM	00:11:49 PM	59.5	55.3	50.2	53.0	59.7	48.6				
	00:11:49 PM	00:21:49 PM	60.4	57.4	50.2	54.5	64.1	47.5	4.6-57	32.1	64.8	E90
	00:21:49 PM	00:31:49 PM	56.8	53.8	48.3	51.2	57.8	46.7				
	00:31:49 PM	00:41:49 PM	60.0	57.0	49.2	55.8	70.0	46.8				
	00:44:34 PM	00:54:34 PM	55.2	53.8	48.5	51.5	57.0	47.1	4.3-5.6	32.5	64.9	SE100
	00:54:34 PM	1:04:34 PM	57.6	55.8	49.9	53.2	59.5	47.7				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
24-Sep	1:04:34 PM	1:14:34 PM	62.4	55.9	50.8	53.9	67.0	47.5	4.8-5.9	32.6	68.5	E90
	1:14:34 PM	1:24:34 PM	58.4	56.2	51.7	54.1	60.4	49.2				
	1:24:34 PM	1:34:34 PM	59.9	58.1	52.1	55.7	61.8	49.8	4.5-6.1	32.2	68.8	E90
	1:34:34 PM	1:44:34 PM	60.5	58.5	52.8	56.2	62.7	49.3				
	1:44:34 PM	1:54:34 PM	60.2	58.5	53.1	56.1	63.0	50.1	4.2-5.9	31.8	69.2	E90
	1:54:34 PM	2:04:34 PM	59.9	58.4	53.6	56.3	62.4	51.2				
	2:04:34 PM	2:14:34 PM	60.6	57.4	52.4	55.2	63.0	50.1	4.3-6.2	31.7	70.1	E90
	2:14:34 PM	2:24:34 PM	58.0	57.2	52.6	55.0	60.8	49.9				
	2:24:34 PM	2:34:34 PM	61.5	59.0	54.0	56.7	64.0	52.1	4.0-6.0	31.6	72.2	E90
	2:34:34 PM	2:44:34 PM	61.6	59.9	54.1	57.5	63.6	50.9				
	2:44:34 PM	2:54:34 PM	63.0	59.6	54.3	57.4	65.1	52.7	4.4-5.7	31.5	73.1	E90
	2:54:34 PM	3:04:34 PM	60.1	58.2	54.0	56.3	62.1	50.6				
	3:04:34 PM	3:14:34 PM	62.6	60.1	53.8	57.4	64.6	50.1				
	3:14:34 PM	3:24:34 PM	65.2	59.3	54.0	57.1	69.4	50.8	4.8-5.8	30.2	75.3	E90
	3:24:34 PM	3:34:34 PM	63.3	59.9	55.0	57.7	66.4	53.0				
	3:34:34 PM	3:44:34 PM	63.8	60.6	55.5	58.5	67.6	53.0				
	3:44:34 PM	3:54:34 PM	62.5	59.8	52.4	56.9	64.5	49.8	4.2-6.5	30	76	E90
	3:54:34 PM	4:04:34 PM	62.1	60.3	52.9	57.0	64.2	50.2				
	4:04:34 PM	4:14:34 PM	63.2	61.0	54.2	58.3	67.0	51.4	4.8-6.2	29.8	76.5	E90
	4:14:34 PM	4:24:34 PM	65.5	62.6	55.4	59.8	69.7	51.9				
	4:24:34 PM	4:34:34 PM	64.0	61.0	54.4	58.4	66.0	50.6	5.5-6.4	29.5	76.3	SE120
	4:34:34 PM	4:44:34 PM	64.5	62.0	54.5	59.0	66.8	51.4				
	4:44:34 PM	4:54:34 PM	62.1	59.8	52.2	56.6	64.1	47.3	5.2-6.5	29.4	76.2	SE120
	4:54:34 PM	5:04:34 PM	64.4	61.3	53.3	58.3	67.5	49.9				
	5:04:34 PM	5:14:34 PM	63.0	60.1	53.2	57.3	65.1	51.1	4.6-6.2	29.5	76.8	SE120
	5:14:34 PM	5:24:34 PM	62.5	59.2	52.2	56.4	64.7	49.2				
	5:24:34 PM	5:34:34 PM	64.2	62.1	55.8	59.3	66.8	53.1	5.3-6.8	29.5	76.9	SE100

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
24-Sep	5:34:34 PM	5:44:34 PM	62.1	61.2	55.1	58.7	64.8	50.8				
	5:44:34 PM	5:54:34 PM	66.1	61.8	55.1	59.4	68.6	51.7	5.5-6.6	28.8	75.2	SE110
	5:54:34 PM	6:04:34 PM	63.7	62.3	56.1	59.6	66.7	52.6				
	6:05:48 PM	6:15:48 PM	62.9	59.7	53.8	56.9	65.0	51.1	6.8-7.3	28.1	81.2	SE110
	6:15:48 PM	6:25:48 PM	65.5	61.0	53.9	58.3	68.9	51.1				
	6:25:48 PM	6:35:48 PM	65.1	61.9	54.6	58.9	68.3	52.0	6.4-7.2	29.2	79.9	SE110
	6:35:48 PM	6:45:48 PM	66.7	63.5	55.2	60.4	68.0	50.9				
	6:45:48 PM	6:55:48 PM	61.9	58.7	51.6	55.8	63.8	48.3	5.3-6.7	28.1	80.2	SE100
	6:55:48 PM	7:05:48 PM	64.5	61.3	53.2	58.1	66.7	50.9				
	7:05:48 PM	7:15:48 PM	63.3	60.1	53.5	57.5	64.8	50.7	5.2-6.4	28.4	79.7	SE100
	7:15:48 PM	7:25:48 PM	65.4	62.2	55.6	59.7	68.2	53.1				
	7:25:48 PM	7:35:48 PM	67.3	64.1	56.8	61.1	69.7	53.8	5.8-6.7	29	82.2	SE100
	7:35:48 PM	7:45:48 PM	66.5	63.3	56.0	60.5	72.5	53.1				
	7:45:48 PM	7:55:48 PM	66.2	63.0	55.8	60.1	70.7	53.0	5.5-6.6	28.7	81.5	SE100
	7:55:48 PM	8:05:48 PM	66.0	62.8	56.5	60.3	71.1	54.6				
	8:05:48 PM	8:15:48 PM	65.5	62.3	56.6	59.9	67.8	54.6	5.6-6.4	29.1	81.3	SE100
	8:15:48 PM	8:25:48 PM	64.6	61.4	54.7	58.6	65.9	52.2				
	8:25:48 PM	8:35:48 PM	66.4	63.2	55.7	60.2	68.9	53.2	5.8-6.3	29.3	81.7	SE100
	8:35:48 PM	8:45:48 PM	67.2	64.0	57.1	61.3	70.9	54.9				
	8:45:48 PM	8:55:48 PM	67.9	64.7	57.6	62.0	70.5	55.1	5.3-6.5	29.0	81.6	SE100
	8:55:48 PM	9:05:48 PM	68.6	65.4	58.5	62.3	69.4	56.2				
	9:05:48 PM	9:15:48 PM	67.6	64.4	56.9	61.3	68.5	54.0	5.1-6.9	28.8	81.5	SE100
	9:15:48 PM	9:25:48 PM	69.6	66.4	56.9	63.0	73.4	53.6				
	9:25:48 PM	9:35:48 PM	70.1	66.9	57.7	63.4	72.1	55.1	6.0-7.1	28.5	80.2	SE100
	9:35:48 PM	9:45:48 PM	70.0	66.8	56.7	63.0	70.8	54.3				
	9:45:48 PM	9:55:48 PM	69.5	66.3	59.2	63.5	71.1	56.5	5.6-6.8	28.1	81.6	SE100
	9:55:48 PM	10:05:48 PM	70.0	63.0	56.0	64.5	90.2	53.8				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
24-Sep	10:05:48 PM	10:15:48 PM	61.0	57.8	53.2	55.6	61.6	50.9	6.8-7.9	28.2	80.9	SE100
	10:15:48 PM	10:25:48 PM	72.1	65.5	56.2	62.2	77.5	53.6				
	10:25:48 PM	10:35:48 PM	67.7	64.5	59.0	62.1	68.6	56.2	5.2-7.5	28.2	80.5	SE100
	10:35:48 PM	10:45:48 PM	67.0	63.8	58.3	61.4	69.6	56.0				
	10:45:48 PM	10:55:48 PM	69.1	65.9	59.4	63.2	70.0	56.8	6.8-7.4	28.3	80.7	SE100
	10:55:48 PM	11:05:48 PM	67.8	65.0	58.0	62.1	68.9	55.7				
	11:05:48 PM	11:15:48 PM	68.8	65.6	58.8	62.7	69.7	57.0	6.6-7.7	28.2	81.1	SE100
	11:15:48 PM	11:25:48 PM	66.5	63.3	58.0	61.0	67.6	56.4				
	11:25:48 PM	11:35:48 PM	68.4	65.2	59.0	62.4	71.2	57.1	5.3-7.0	28.3	80.5	SE100
	11:35:48 PM	11:45:48 PM	66.9	63.7	58.0	61.0	67.5	55.2				
	11:45:48 PM	11:55:48 PM	68.4	65.2	59.8	62.9	70.3	57.4	5.9-6.8	28.4	81.5	SE100
	11:55:48 PM	00:05:48 AM	68.0	64.8	59.3	62.4	70.8	57.6				
25-Sep	00:05:48 AM	00:15:48 AM	65.7	62.5	57.4	60.2	68.1	55.8	5.2-6.2	28.3	81.2	SE100
	00:15:48 AM	00:25:48 AM	66.4	63.8	58.4	61.4	67.6	55.9				
	00:25:48 AM	00:35:48 AM	67.5	64.3	57.9	61.5	67.8	55.3	4.3-6.6	28.4	81.0	SE100
	00:35:48 AM	00:45:48 AM	64.1	61.4	55.8	58.9	64.9	54.5				
	00:45:48 AM	00:55:48 AM	65.3	62.1	57.0	59.9	66.4	55.0	5.5-6.6	28.4	80.7	SE100
	00:55:48 AM	1:05:48 AM	67.4	63.5	58.0	61.1	69.8	55.8				
	1:05:48 AM	1:15:48 AM	66.7	63.5	58.4	61.3	68.5	55.5	5.2-6.9	28.7	80.6	SE100
	1:15:48 AM	1:25:48 AM	65.8	63.3	58.3	61.0	66.9	55.8				
	1:25:48 AM	1:35:48 AM	65.8	63.3	57.9	60.9	66.9	56.1	5.5-6.7	28.9	80.8	SE100
	1:35:48 AM	1:45:48 AM	65.6	63.1	57.3	60.5	66.4	55.0				
	1:45:48 AM	1:55:48 AM	67.5	65.0	59.1	62.5	68.3	55.9	5.3-6.6	28.5	80.7	SE100
	1:55:48 AM	2:05:48 AM	66.1	63.1	58.0	60.9	67.8	55.0				
	2:05:48 AM	2:15:48 AM	65.3	62.3	56.7	60.0	67.2	53.9	4.4-6.2	28.3	80.5	SE100
	2:15:48 AM	2:25:48 AM	64.0	60.8	55.7	58.5	65.6	54.3				
	2:25:48 AM	2:35:48 AM	62.8	59.6	55.1	57.5	65.4	53.4	5.4-6.8	28.2	80.3	SE100

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
25-Sep	2:35:48 AM	2:45:48 AM	63.6	60.4	55.5	58.2	64.7	53.8				
	2:45:48 AM	2:55:48 AM	62.6	59.8	54.4	57.4	63.8	51.7	5.7-6.9	28.3	80.2	SE100
	2:55:48 AM	3:05:48 AM	62.4	59.6	54.7	57.3	64.0	53.1				
	3:05:48 AM	3:15:48 AM	60.6	58.8	54.5	56.6	61.5	52.9	5.0-6.2	28.2	80.8	SE100
	3:15:48 AM	3:25:48 AM	61.9	60.1	55.3	58.0	63.4	52.7				
	3:25:48 AM	3:35:48 AM	64.2	61.2	55.4	58.8	65.7	53.9	5.5-6.7	28.1	81.3	SE100
	3:35:48 AM	3:45:48 AM	62.0	60.0	54.5	57.5	63.5	52.8				
	3:45:48 AM	3:55:48 AM	62.6	60.6	55.5	58.4	64.1	53.5	5.4-6.6	28.1	82.3	SE100
	3:55:48 AM	4:05:48 AM	65.4	62.2	56.5	59.8	66.8	54.2				
	4:05:48 AM	4:15:48 AM	63.0	61.0	55.0	58.4	64.6	53.0	4.5-6.1	28.2	82.0	SE100
	4:15:48 AM	4:25:48 AM	60.2	58.6	53.7	56.3	61.8	52.4				
	4:25:48 AM	4:35:48 AM	61.4	59.7	54.5	57.4	63.0	52.9	5.7-6.9	28.2	81.6	SE100
	4:35:48 AM	4:45:48 AM	62.9	60.8	55.0	58.2	64.5	52.0				
	4:45:48 AM	4:55:48 AM	64.3	62.2	56.3	59.7	66.1	53.4				
	4:55:48 AM	5:05:48 AM	65.0	61.8	55.4	59.0	66.5	53.7	5.3-6.7	28.1	82.4	SE100
	5:05:48 AM	5:15:48 AM	65.6	62.4	57.2	60.1	67.3	54.3				
	5:15:48 AM	5:25:48 AM	65.5	62.3	56.0	59.7	67.1	53.4	5.0-6.5	28.2	82.0	SE100
	5:25:48 AM	5:35:48 AM	65.4	62.2	56.4	59.7	67.9	54.1				
	5:35:48 AM	5:45:48 AM	64.1	61.7	55.6	58.9	65.5	52.8	5.2-6.4	28.3	81.7	SE100
	5:45:48 AM	5:55:48 AM	63.6	61.2	55.1	58.5	64.8	52.8				
	5:57:33 AM	6:07:33 AM	66.6	62.5	53.7	59.2	68.7	51.9	6.3-7.2	28.4	83.3	SE100
	6:07:33 AM	6:17:33 AM	63.1	62.0	56.3	59.6	64.8	54.1				
	6:17:33 AM	6:27:33 AM	69.7	60.9	54.9	60.1	81.8	53.4	6.1-7.2	28.6	83.6	SE100
	6:27:33 AM	6:37:33 AM	63.4	61.3	56.3	59.2	65.0	53.6				
	6:37:33 AM	6:47:33 AM	66.5	63.1	57.1	60.6	68.6	53.9	7.3-8	28.6	83.5	SE100
	6:47:33 AM	6:57:33 AM	63.9	61.1	56.2	58.9	65.8	54.1				
	6:57:33 AM	7:07:33 AM	64.4	62.7	56.9	60.3	65.8	54.4				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
25-Sep	7:07:33 AM	7:17:33 AM	65.1	63.8	58.2	61.3	66.8	55.7	6.5-7.8	28.8	80.3	SE100
	7:17:33 AM	7:27:33 AM	63.5	61.5	57.0	59.3	65.5	55.5				
	7:27:33 AM	7:37:33 AM	61.0	59.9	55.4	57.8	62.2	53.2	5.8-7.2	29.0	76.7	SE100
	7:37:33 AM	7:47:33 AM	64.1	61.3	56.3	59.2	65.8	54.3				
	7:47:33 AM	7:57:33 AM	62.1	60.1	55.1	57.8	63.4	52.9	5.5-7.5	29.4	76.0	SE100
	7:57:33 AM	8:07:33 AM	60.3	58.0	54.5	56.3	61.8	52.8				
	8:07:33 AM	8:17:33 AM	59.7	57.6	54.4	56.1	61.8	53.2	6.3-7.8	30.2	75.2	SE100
	8:17:33 AM	8:27:33 AM	60.6	57.4	54.2	55.8	62.7	53.0				
	8:27:33 AM	8:37:33 AM	58.0	56.8	53.6	55.1	59.1	52.2	6.1-7.2	31.2	72.6	NE80
	8:37:33 AM	8:47:33 AM	64.4	58.8	54.0	56.5	66.9	52.1				
	8:47:33 AM	8:57:33 AM	61.0	58.2	54.5	56.2	62.6	52.8				
	8:57:33 AM	9:07:33 AM	59.4	56.6	53.3	54.9	61.5	52.1	4.8-5.7	31.9	65.0	E90
	9:07:33 AM	9:17:33 AM	56.6	55.5	52.9	54.2	58.7	51.4				
	9:17:33 AM	9:27:33 AM	60.4	54.9	51.9	53.5	62.9	50.7	5.1-6.9	31	66.5	E90
	9:27:33 AM	9:37:33 AM	58.4	55.0	51.8	53.4	62.9	50.1				
	9:37:33 AM	9:47:33 AM	56.3	54.5	51.6	53.1	57.3	50.6	5.3-6.5	30.5	66.9	E90
	9:47:33 AM	9:57:33 AM	59.9	55.4	52.4	53.9	62.0	51.2				
	9:57:33 AM	10:07:33 AM	56.0	54.5	51.5	53.0	58.1	50.0	4.5-6.8	30.2	68.2	E90
	10:07:33 AM	10:17:33 AM	56.4	54.9	52.3	53.5	58.5	50.9				
	10:17:33 AM	10:27:33 AM	55.6	54.7	52.2	53.4	57.7	51.0	4.1-5.6	29.8	70.5	E90
	10:27:33 AM	10:37:33 AM	56.9	54.6	51.2	52.9	58.6	49.8				
	10:37:33 AM	10:47:33 AM	55.9	53.6	50.8	52.2	58.0	49.6	3.8-5.2	29.9	77.7	E90
	10:47:33 AM	10:57:33 AM	55.8	52.5	50.0	51.2	57.8	49.1				
	10:57:33 AM	11:07:33 AM	54.3	52.6	50.1	51.2	56.4	49.0	4.2-5.7	30.1	75.2	E90
	11:07:33 AM	11:17:33 AM	52.9	51.1	48.8	50.0	53.9	47.8				
	11:17:33 AM	11:27:33 AM	53.5	50.4	48.4	49.3	55.6	47.5				
	11:27:33 AM	11:37:33 AM	54.4	50.5	48.1	49.3	56.5	47.0	4.4-5.8	30.2	73.6	E90

Table A3: Details of noise level at monitoring site No.03

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
27-Sep	1:13:06 PM	1:23:06 PM	58.2	53.9	48.2	51.5	62.7	46.6	2.4-3.8	31	65.4	SE100
	1:23:06 PM	1:33:06 PM	65.0	56.8	48.3	54.3	69.5	46.1				
	1:33:06 PM	1:43:06 PM	55.9	52.0	47.5	50.1	60.4	45.2	2.7-3.7	31.6	64.7	SE100
	1:43:06 PM	1:53:06 PM	66.4	54.2	47.2	52.9	72.6	45.2				
	1:53:06 PM	2:03:06 PM	62.6	54.0	46.8	51.9	67.1	44.1	2.2-3.3	31.8	64.2	SE100
	2:03:06 PM	2:13:06 PM	54.6	52.7	47.1	50.3	57.1	45.4				
	2:13:06 PM	2:23:06 PM	62.7	53.7	45.3	50.7	67.2	43.2	1.3-2.8	31.5	65.3	E90
	2:23:06 PM	2:33:06 PM	64.6	51.4	44.8	53.0	70.6	43.6				
	2:33:06 PM	2:43:06 PM	65.7	48.3	44.3	50.1	71.5	42.5	1.3-2.4	31.4	65.6	SE110
	2:43:06 PM	2:53:06 PM	65.1	52.4	45.1	51.3	70.0	43.3				
	2:53:06 PM	3:03:06 PM	53.4	48.6	44.9	47.1	57.9	43.0	1.5-2.8	31.4	65.8	SE110
	3:03:06 PM	3:13:06 PM	54.0	48.4	44.4	46.7	58.5	42.9				
	3:13:06 PM	3:23:06 PM	52.5	47.3	44.0	46.2	57.0	42.5	1.3-2.5	31.3	66.5	SE110
	3:23:06 PM	3:33:06 PM	51.4	47.8	43.4	46.0	55.9	41.5				
	3:33:06 PM	3:43:06 PM	46.4	46.0	43.2	44.7	50.9	41.4	1.2-2.0	31.2	66.8	SE110
	3:43:06 PM	3:53:06 PM	50.9	45.8	41.9	44.6	55.4	40.5				
	3:53:06 PM	4:03:06 PM	55.4	47.9	41.7	46.7	59.9	40.4	1.0-2.2	30.9	67.8	SE150
	4:03:06 PM	4:13:06 PM	51.3	47.3	45.5	47.0	55.8	44.7				
	4:13:06 PM	4:23:06 PM	52.4	47.5	45.2	46.7	56.9	44.5	1.8-2.4	30.7	68.4	SE150
	4:23:06 PM	4:33:06 PM	52.4	47.8	45.2	46.6	56.9	44.5				
	4:33:06 PM	4:43:06 PM	52.9	46.6	45.0	46.3	57.4	43.9				
	4:43:06 PM	4:53:06 PM	48.6	46.5	45.4	45.9	50.6	44.2	1.7-2.5	30.5	70.2	SE150
	4:53:06 PM	5:03:06 PM	66.9	48.2	45.7	56.0	79.7	44.5				
	5:03:06 PM	5:13:06 PM	55.5	47.2	45.3	46.6	60.0	44.4	1.3-2.9	30.2	70.9	SE150
	5:13:06 PM	5:23:06 PM	56.8	49.8	45.3	48.6	66.3	44.5				
	5:23:06 PM	5:33:06 PM	57.9	50.3	41.2	50.1	64.3	38.6	2.8-4.0	30.2	71.3	SE100

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
	5:33:06 PM	5:43:06 PM	58.4	53.5	40.9	48.8	62.9	38.7				
	5:43:06 PM	5:53:06 PM	54.1	48.2	40.6	45.7	58.6	38.6	2.3-3.5	29.4	71.8	SE100
	5:53:06 PM	6:03:06 PM	53.8	44.2	39.6	43.0	58.3	38.1				
	6:03:06 PM	6:13:06 PM	44.9	41.8	39.4	40.6	49.4	38.1	2.5-3.8	29.3	72.2	SE110
	6:13:06 PM	6:23:06 PM	47.1	42.7	40.0	41.5	51.6	39.0				
	6:23:06 PM	6:33:06 PM	60.5	47.5	41.6	48.9	66.4	40.3				
	6:33:06 PM	6:43:06 PM	60.8	51.5	42.5	51.9	66.7	41.6	2.7-3.7	29.4	72.8	SE100
	6:43:06 PM	6:53:06 PM	50.3	45.5	43.3	44.6	56.2	42.3				
	6:53:06 PM	7:03:06 PM	62.0	55.9	43.6	53.1	68.9	42.9	1.7-2.3	29.6	73.9	NE80
	7:03:06 PM	7:13:06 PM	52.9	45.4	43.9	47.2	61.8	42.8				
	7:13:06 PM	7:23:06 PM	52.8	44.9	43.6	44.8	62.3	42.5	2.0-2.8	29.8	74.1	NE80
	7:23:06 PM	7:33:06 PM	52.5	45.8	44.3	45.5	60.5	43.0				
	7:33:06 PM	7:43:06 PM	61.0	54.2	44.1	50.9	65.5	42.5	2.1-2.8	29.4	74.5	NE70
	7:43:06 PM	7:53:06 PM	53.2	46.7	45.7	46.2	57.7	44.4				
	7:53:06 PM	8:03:06 PM	54.0	48.6	45.5	47.3	58.5	44.1	2.2-2.9	29.7	74.8	NE60
	8:03:06 PM	8:13:06 PM	48.5	47.7	45.4	46.3	49.5	43.8				
	8:13:06 PM	8:23:06 PM	47.2	46.5	45.3	45.9	51.7	44.2	2.1-2.7	29.6	75.1	NE70
	8:23:06 PM	8:33:06 PM	48.2	46.5	44.7	45.6	50.4	43.7				
	8:33:06 PM	8:43:06 PM	53.9	52.1	44.7	48.6	57.3	43.8	2.6-3.3	29.6	75.4	NE60
	8:43:06 PM	8:53:06 PM	54.6	46.0	44.5	45.5	59.1	43.6				
	8:53:06 PM	9:03:06 PM	47.3	46.8	45.7	46.2	47.8	45.0	2.2-3.7	29.5	75.8	NE60
	9:03:06 PM	9:13:06 PM	56.0	52.0	46.5	49.5	60.5	45.8				
	9:13:06 PM	9:23:06 PM	50.2	48.7	47.4	48.2	54.7	46.3	2.5-3.1	29.4	75.3	NE60
	9:23:06 PM	9:33:06 PM	50.2	49.1	47.2	48.0	51.1	46.1				
	9:33:06 PM	9:43:06 PM	49.2	48.9	47.3	48.0	49.6	46.3	2.3-3.0	29.1	75.6	SE110
	9:43:06 PM	9:53:06 PM	55.5	50.0	48.2	49.4	60.0	46.9				
	9:53:06 PM	10:03:06 PM	61.0	51.2	48.2	50.3	65.5	46.3	2.1-2.9	29.2	75.5	SE100

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
	10:03:06 PM	10:13:06 PM	51.0	50.0	48.2	49.2	55.5	47.2				
	10:13:06 PM	10:23:06 PM	67.2	50.4	48.4	51.6	71.7	47.4	1.8-2.8	29.4	75.0	SE100
	10:23:06 PM	10:33:06 PM	55.5	51.7	49.1	50.4	60.0	48.2				
	10:33:06 PM	10:43:06 PM	53.1	52.1	50.2	51.1	53.9	48.9	1.6-2.7	29.3	75.9	SE100
	10:43:06 PM	10:53:06 PM	53.0	52.4	50.5	51.4	53.8	49.5				
	10:53:06 PM	11:03:06 PM	53.2	52.5	50.5	51.5	53.7	48.3	1.3-2.2	29.4	75.6	NE80
	11:03:06 PM	11:13:06 PM	53.4	52.9	50.9	51.9	54.2	49.5				
	11:13:06 PM	11:23:06 PM	54.0	53.3	51.0	52.2	54.5	49.5	1.9-2.5	29.5	75.8	E90
	11:23:06 PM	11:33:06 PM	54.5	53.1	51.1	52.1	55.0	49.7				
	11:33:06 PM	11:43:06 PM	63.2	53.8	51.3	53.8	72.1	50.2				
	11:43:06 PM	11:53:06 PM	55.6	54.1	51.8	52.9	56.1	50.4	1.6-2.5	29.3	75.9	NE80
	11:53:06 PM	00:03:06 AM	54.1	53.6	51.6	52.5	54.4	50.4				
28-Sep	00:03:06 AM	00:13:06 AM	54.8	53.7	51.5	52.6	55.4	50.4	1.5-2.3	29.4	76.9	WN320
	00:13:06 AM	00:23:06 AM	55.0	54.5	52.7	53.5	55.3	51.2				
	00:23:06 AM	00:33:06 AM	55.9	55.1	52.7	53.9	56.5	51.2				
	00:33:06 AM	00:43:06 AM	56.5	56.0	53.9	54.8	57.1	52.6	1.4-1.7	29.3	77.5	WN330
	00:43:06 AM	00:53:06 AM	62.5	57.1	54.6	61.9	79.5	53.2	1.6-1.8	29.2	77.6	WN330
	00:53:06 AM	1:03:06 AM	65.9	58.1	55.9	57.7	75.4	54.5				
	1:03:06 AM	1:13:06 AM	60.9	59.1	56.1	57.6	65.4	54.9	1.5-2.2	29.3	77.8	NE80
	1:13:06 AM	1:23:06 AM	61.3	58.3	56.1	57.7	71.4	54.4				
	1:23:06 AM	1:33:06 AM	60.2	59.0	56.7	57.9	61.1	55.2				
	1:33:06 AM	1:43:06 AM	60.0	59.5	57.3	58.4	64.5	56.0	1.6-2.3	29.3	78	WN330
	1:43:06 AM	1:53:06 AM	59.0	58.9	56.7	57.8	63.5	55.4				
	1:53:06 AM	2:03:06 AM	61.4	58.1	56.0	57.2	65.9	54.8	1.4-1.9	29.4	80.1	WN320
	2:03:06 AM	2:13:06 AM	58.5	57.8	55.6	56.6	59.1	54.5				
	2:13:06 AM	2:23:06 AM	57.9	57.2	55.4	56.2	58.5	53.6	1.5-2.1	29.3	80.5	WN330
	2:23:06 AM	2:33:06 AM	57.2	56.7	54.3	55.6	57.8	52.6				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
28-Sep	2:33:06 AM	2:43:06 AM	56.5	55.9	54.1	55.0	57.1	53.0	1.6-2.5	29.6	80.3	NE80
	2:43:06 AM	2:53:06 AM	56.6	55.9	53.7	54.8	57.2	51.8				
	2:53:06 AM	3:03:06 AM	55.3	54.9	53.1	53.9	55.8	52.2	1.5-2.2	29.4	80.2	WN330
	3:03:06 AM	3:13:06 AM	54.9	54.6	52.3	53.4	55.3	50.7				
	3:13:06 AM	3:23:06 AM	59.8	53.2	51.2	52.4	64.3	50.1	1.6-2.5	29.3	80.2	WN320
	3:23:06 AM	3:33:06 AM	55.1	52.9	51.4	52.1	57.4	50.4				
	3:33:06 AM	3:43:06 AM	53.4	52.5	50.7	51.6	53.7	49.6	1.8-2.9	29.1	80.3	NE80
	3:43:06 AM	3:53:06 AM	53.2	52.3	50.7	51.4	53.2	49.7				
	3:53:06 AM	4:03:06 AM	53.2	52.6	50.9	51.7	53.7	49.5				
	4:03:06 AM	4:13:06 AM	53.0	52.5	51.0	51.7	53.3	50.4	1.6-2.8	29.4	79.9	WN320
	4:13:06 AM	4:23:06 AM	52.5	51.9	49.7	50.8	53.9	48.7				
	4:23:06 AM	4:33:06 AM	52.1	51.7	49.7	50.6	52.8	48.7	1.7-2.9	29.2	79.8	NE80
	4:33:06 AM	4:43:06 AM	55.0	51.8	50.0	55.4	76.1	48.7				
	4:43:06 AM	4:53:06 AM	51.8	51.1	49.1	50.0	52.2	48.0	1.6-3.0	29.3	80.8	NE80
	4:53:06 AM	5:03:06 AM	53.8	50.6	49.1	49.9	59.9	48.1				
	5:03:06 AM	5:13:06 AM	53.4	50.2	48.2	49.4	63.4	46.1	1.8-2.9	29.4	80.6	NE80
	5:13:06 AM	5:23:06 AM	53.9	50.7	47.9	50.6	72.1	46.8	2.0-2.9	29.3	80.5	WN320
	5:23:06 AM	5:33:06 AM	58.0	54.8	49.1	52.2	61.3	47.6				
	5:33:06 AM	5:43:06 AM	60.7	57.5	49.8	59.1	76.4	46.9				
	5:43:06 AM	5:53:06 AM	55.6	52.4	50.2	51.3	57.8	49.2	2.3-3.3	29.2	80.1	NE80
	5:53:06 AM	6:03:06 AM	54.8	51.6	49.7	50.7	58.6	48.9				
	6:03:06 AM	6:13:06 AM	55.4	52.2	49.6	50.8	59.2	48.8	2.4-3.7	29.3	80.2	NE80
	6:13:06 AM	6:23:06 AM	54.0	50.8	49.3	50.4	59.6	48.3	2.2-3.5	28.8	86.6	NE80
	6:23:06 AM	6:33:06 AM	55.2	52.0	49.4	50.6	58.4	48.6				
	6:33:06 AM	6:43:06 AM	54.9	51.7	48.8	50.5	63.5	47.9				
	6:43:06 AM	6:53:06 AM	54.6	51.4	49.1	50.4	57.7	48.1	2.6-3.7	28.5	84.9	NE80
	6:53:06 AM	7:03:06 AM	55.2	52.0	48.8	51.3	64.3	47.9				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
28-Sep	7:03:06 AM	7:13:06 AM	54.7	51.5	48.3	50.1	59.6	47.5	2.9-4.0	28.4	83.6	NE80
	7:13:06 AM	7:23:06 AM	54.4	51.2	48.3	49.7	58.3	47.3				
	7:23:06 AM	7:33:06 AM	53.5	50.3	48.4	49.3	58.1	47.5	2.6-3.8	28.4	85.8	NW310
	7:33:06 AM	7:43:06 AM	51.5	50.3	48.3	49.3	52.6	47.5				
	7:43:06 AM	7:53:06 AM	55.8	52.6	48.3	51.4	63.4	47.5	2.0-3.7	28.1	84.2	NW320
	7:53:06 AM	8:03:06 AM	54.5	51.3	48.0	49.6	56.0	46.9				
	8:03:06 AM	8:13:06 AM	55.0	51.8	48.8	50.9	63.5	47.4	2.2-3.6	28.3	84.1	NW310
	8:13:06 AM	8:23:06 AM	54.3	51.1	48.8	50.2	61.2	47.8				
	8:23:06 AM	8:33:06 AM	51.5	50.3	48.7	49.4	52.4	46.6	2.1-2.8	28.9	82.1	NW320
	8:33:06 AM	8:43:06 AM	53.5	50.3	47.5	48.9	54.8	46.8				
	8:43:06 AM	8:53:06 AM	54.9	51.7	48.5	51.1	65.3	47.0	1.3-2.4	29.2	80.2	NW320
	8:53:06 AM	9:03:06 AM	54.8	51.6	49.3	50.7	58.5	48.0				
	9:03:06 AM	9:13:06 AM	53.0	52.0	50.0	51.0	53.6	49.0	1.2-2.0	30.5	78.6	NW320
	9:13:06 AM	9:23:06 AM	56.5	53.3	51.2	52.5	61.1	49.4				
	9:23:06 AM	9:33:06 AM	56.3	54.1	51.8	52.9	57.5	50.4	1.4-1.9	31.1	78.5	NW320
	9:33:06 AM	9:43:06 AM	56.4	55.1	52.6	53.9	57.4	51.4				
	9:43:06 AM	9:53:06 AM	56.0	54.9	52.2	53.5	57.1	51.0	2.0-2.8	31	78.1	NW320
	9:53:06 AM	10:03:06 AM	58.4	55.2	52.7	54.0	59.4	51.5				
	10:03:06 AM	10:13:06 AM	59.0	55.8	53.1	54.6	61.9	52.0	1.4-2.7	30.9	78	NW320
	10:13:06 AM	10:23:06 AM	59.0	55.8	53.6	54.7	61.4	52.3				
	10:23:06 AM	10:33:06 AM	59.4	56.2	53.6	55.0	60.2	52.3	1.8-2.6	30.8	77.4	NW320
	10:33:06 AM	10:43:06 AM	59.1	55.9	52.9	54.4	61.9	50.9				
	10:43:06 AM	10:53:06 AM	57.0	56.0	53.8	54.8	57.8	51.7	2.1-2.9	30.9	77.2	NE40
	10:53:06 AM	11:03:06 AM	59.0	55.8	53.6	54.9	61.9	51.9				
	11:03:06 AM	11:13:06 AM	57.0	55.2	52.8	54.0	58.3	51.4	2.6-3.3	30.7	76.9	NE50
	11:13:06 AM	11:23:06 AM	57.6	55.8	53.2	54.5	60.0	50.8				
	11:23:06 AM	11:33:06 AM	57.5	55.7	53.2	54.4	58.0	51.5	3.7-4.5	30.6	76.8	NE40

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
28-Sep	11:33:06 AM	11:43:06 AM	57.7	56.9	54.5	55.8	59.6	53.0				
	11:43:06 AM	11:53:06 AM	58.3	57.2	54.5	56.0	60.8	52.8	4.3-5.2	30.7	76.5	NE50
	11:53:06 AM	00:03:06 PM	58.9	57.1	54.4	55.8	62.2	52.7				
	00:03:06 PM	00:13:06 PM	59.0	57.6	54.7	56.0	60.2	52.7	3.8-4.7	30.9	76.4	NE50
	00:13:06 PM	00:23:06 PM	59.3	58.1	55.4	56.9	62.4	53.5	4.3-5.8	30.8	76.4	NE50
	00:27:43 PM	00:37:43 PM	59.7	58.4	55.8	57.1	61.2	54.1	3.2-4.6	30.8	76.4	NE80
	00:37:43 PM	00:47:43 PM	60.2	59.3	56.6	57.9	61.4	55.0				
	00:47:43 PM	00:57:43 PM	62.3	60.0	57.1	58.6	64.8	55.3	3.1-4.3	30.7	75.6	NE80
	00:57:43 PM	1:07:43 PM	60.3	59.5	57.3	58.3	62.1	56.4				
	1:07:43 PM	1:17:43 PM	62.5	61.3	57.4	59.5	65.0	56.3	4.3-6.5	30.6	75.8	NE80
	1:17:43 PM	1:27:43 PM	63.1	61.7	58.2	59.9	66.3	56.9	4.1-6.2	30.6	75.7	NE80
	1:27:43 PM	1:37:43 PM	65.4	63.5	58.9	61.3	69.5	56.9				
	1:37:43 PM	1:47:43 PM	66.4	64.7	59.5	62.4	68.9	57.8	4.5-6.1	30.5	75.6	NE80
	1:47:43 PM	1:57:43 PM	68.7	66.7	61.6	64.3	70.8	58.3				
	1:57:43 PM	2:07:43 PM	68.5	67.1	60.9	64.2	70.5	58.3	4.3-6.7	30.4	76.2	NE80
	2:07:43 PM	2:17:43 PM	67.0	65.1	60.1	62.8	69.5	58.4				
	2:17:43 PM	2:27:43 PM	66.3	64.7	59.1	61.9	68.8	57.6	4.8-7.3	30.2	76.7	NE80
	2:27:43 PM	2:37:43 PM	69.7	66.3	59.9	63.5	72.0	57.5				
	2:37:43 PM	2:47:43 PM	65.5	64.1	59.1	61.8	68.0	57.4	4.7-7.2	30.1	77.3	NE80
	2:47:43 PM	2:57:43 PM	66.3	62.7	57.8	60.8	75.8	55.6				
	2:57:43 PM	3:07:43 PM	66.1	63.8	57.4	60.7	71.6	55.8	4.3-7.0	30	77.4	NE80
	3:07:43 PM	3:17:43 PM	68.2	66.8	59.2	63.6	71.9	56.8				
	3:17:43 PM	3:27:43 PM	67.5	65.6	58.1	62.6	71.8	54.8	4.3-6.6	30.1	77.6	NE80
	3:27:43 PM	3:37:43 PM	67.4	64.6	56.8	61.1	69.9	55.3	4.7-7.1	30	77.7	NE80
	3:37:43 PM	3:47:43 PM	65.8	62.9	56.2	59.8	68.3	54.7				
	3:47:43 PM	3:57:43 PM	64.4	59.7	55.1	57.4	66.9	53.8	4.9-7.5	30	77.8	NE80
	3:57:43 PM	4:07:43 PM	64.3	60.0	55.5	57.9	66.8	54.0				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
28-Sep	4:07:43 PM	4:17:43 PM	66.3	63.0	55.6	59.6	69.9	53.5	4.5-7.1	29.9	79.1	NE80
	4:17:43 PM	4:27:43 PM	65.7	60.4	54.7	57.9	68.2	53.5				
	4:27:43 PM	4:37:43 PM	63.1	58.7	53.9	56.6	65.6	52.9	4.7-7.3	29.4	79.4	NE80
	4:37:43 PM	4:47:43 PM	63.3	58.3	53.8	56.1	65.8	52.8				
	4:47:43 PM	4:57:43 PM	62.9	58.9	53.8	56.4	65.4	52.9	4.5-6.6	29.5	79.3	NE80
	4:57:43 PM	5:07:43 PM	65.8	60.7	54.2	57.8	70.3	53.1				
	5:07:43 PM	5:17:43 PM	60.1	56.5	52.9	54.7	62.6	51.7	4.2-6.4	29.3	79.6	NE80
	5:17:43 PM	5:27:43 PM	63.5	58.1	51.8	55.2	66.0	50.7				
	5:27:43 PM	5:37:43 PM	64.7	59.7	51.1	56.0	67.2	49.1	4.6-6.4	29.2	79.5	NE90
	5:37:43 PM	5:47:43 PM	65.4	59.7	51.3	56.3	67.9	49.9				
	5:47:43 PM	5:57:43 PM	61.0	57.8	50.0	54.1	63.5	48.8	4.0-5.9	29.1	80.2	NE90
	5:57:43 PM	6:07:43 PM	64.1	57.4	49.4	54.0	66.6	48.2				
	6:07:43 PM	6:17:43 PM	63.7	58.1	49.1	54.5	66.2	47.5	3.8-5.3	28.4	84.2	NE90
	6:17:43 PM	6:27:43 PM	60.1	57.1	48.8	53.5	62.6	47.8				
	6:27:43 PM	6:37:43 PM	61.7	56.0	47.7	52.5	64.2	46.5	4.2-6.2	28.1	83.2	NE90
	6:37:43 PM	6:47:43 PM	66.1	58.9	48.2	55.5	68.6	46.4				
	6:47:43 PM	6:57:43 PM	66.6	59.9	46.8	57.7	79.1	44.5	3.9-4.4	28.5	82.1	SE120
	6:57:43 PM	7:07:43 PM	68.6	55.5	45.8	57.9	81.0	44.7				
	7:07:43 PM	7:17:43 PM	60.4	54.3	46.0	51.3	62.9	44.3	3.7-4.5	28.8	81.5	SE120
	7:17:43 PM	7:27:43 PM	58.8	54.8	46.7	51.4	61.3	45.1				
	7:27:43 PM	7:37:43 PM	58.4	56.1	46.6	52.6	60.9	44.5	4.2-5.0	28.8	81.6	E90
	7:37:43 PM	7:47:43 PM	64.1	55.5	46.0	52.8	66.6	44.6				
	7:47:43 PM	7:57:43 PM	68.2	55.9	46.6	55.9	81.0	44.7	4.0-5.3	29	81.1	E90
	7:57:43 PM	8:07:43 PM	67.3	57.4	46.8	54.6	72.7	44.4				
	8:07:43 PM	8:17:43 PM	63.5	56.3	47.0	53.0	66.0	44.9	3.9-5.6	29	81	E90
	8:17:43 PM	8:27:43 PM	57.9	55.1	47.1	51.4	60.4	45.0				
	8:27:43 PM	8:37:43 PM	60.3	55.2	47.6	51.9	62.8	45.5	4.5-6.2	29.2	80.7	E90

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
28-Sep	8:37:43 PM	8:47:43 PM	64.6	58.1	47.2	54.2	67.1	45.0				
	8:47:43 PM	8:57:43 PM	63.0	56.8	47.4	53.1	65.5	45.7	4.4-5.8	29.2	78.8	SE100
	8:57:43 PM	9:07:43 PM	85.1	55.0	47.3	64.2	87.6	46.4				
	9:07:43 PM	9:17:43 PM	55.4	51.4	47.3	49.4	57.9	46.4	4.3-5.5	29.3	76.4	SE100
	9:17:43 PM	9:27:43 PM	53.5	51.6	47.9	49.6	56.0	46.7				
	9:27:43 PM	9:37:43 PM	55.6	54.6	49.6	52.1	58.1	47.8	4.1-5.2	29.5	77.1	SE100
	9:37:43 PM	9:47:43 PM	58.4	55.6	50.7	53.2	60.9	49.4				
	9:47:43 PM	9:57:43 PM	62.4	55.3	51.6	53.5	64.9	50.2	3.5-4.9	29.4	76.9	SE100
	9:57:43 PM	10:07:43 PM	57.0	55.2	52.1	53.6	59.5	50.9				
	10:07:43 PM	10:17:43 PM	55.1	54.3	52.6	53.4	55.8	51.2	3.1-4.3	28.8	78.5	SE100
	10:17:43 PM	10:27:43 PM	55.0	54.5	52.7	53.5	55.8	51.5				
	10:27:43 PM	10:37:43 PM	56.0	55.1	53.2	54.0	58.0	51.8	2.5-4.0	28.6	78.3	SE100
	10:37:43 PM	10:47:43 PM	57.2	56.8	54.4	55.5	58.3	52.6				
	10:47:43 PM	10:57:43 PM	58.3	57.0	55.1	56.0	59.2	53.8	3.2-4.5	28.7	78.6	SE110
	10:57:43 PM	11:07:43 PM	58.3	57.2	55.2	56.1	59.2	53.7				
	11:07:43 PM	11:17:43 PM	58.3	57.6	55.7	56.6	60.3	54.1	4.1-5.3	28.6	78.9	E90
	11:17:43 PM	11:27:43 PM	58.2	57.5	55.5	56.5	58.8	54.0				
	11:27:43 PM	11:37:43 PM	58.3	57.7	55.0	56.4	58.8	53.9	4.3-5.1	29.1	77.8	SE110
	11:37:43 PM	11:47:43 PM	59.2	58.1	56.1	57.1	60.2	54.1				
	11:47:43 PM	11:57:43 PM	65.8	58.5	56.2	57.3	68.3	54.6	4.2-5	29	77.9	SE110
	11:57:43 PM	00:07:43 AM	63.2	58.5	56.0	57.2	65.7	54.8				
29-Sep	00:07:43 AM	00:17:43 AM	59.2	58.5	55.9	57.0	60.0	54.8	4.4-5.8	29.3	78.6	SE100
	00:17:43 AM	00:27:43 AM	59.8	58.8	56.1	57.5	60.4	54.8				
	00:27:43 AM	00:37:43 AM	60.4	59.8	57.4	58.6	61.7	55.9	4.1-5.3	29.2	79	SE110
	00:37:43 AM	00:47:43 AM	61.5	60.1	57.3	58.8	64.0	55.9				
	00:47:43 AM	00:57:43 AM	60.4	59.7	57.8	58.6	61.1	56.4	4.4-5.2	28.9	78.8	SE100
	00:57:43 AM	1:07:43 AM	65.3	60.1	57.8	59.1	67.8	55.8				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^{0}C	Humidity %	Wind Direction
29-Sep	1:07:43 AM	1:17:43 AM	61.5	60.6	58.4	59.5	62.2	57.4	4.2-5.5	28.5	78.9	SE110
	1:17:43 AM	1:27:43 AM	61.1	60.7	58.9	59.7	61.4	57.4				
	1:27:43 AM	1:37:43 AM	67.3	62.9	59.1	61.5	77.0	57.1	4-5.1	29.4	78.6	SE110
	1:37:43 AM	1:47:43 AM	69.7	67.9	59.1	64.7	80.0	56.4				
	1:47:43 AM	1:57:43 AM	61.2	60.3	58.1	59.2	61.9	56.9	3.9-5.2	28.9	77.9	SE110
	1:57:43 AM	2:07:43 AM	60.9	60.3	58.1	59.2	61.3	56.7				
	2:07:43 AM	2:17:43 AM	60.6	59.8	57.6	58.7	61.0	56.5	3.2-4.5	28.8	79.3	E90
	2:17:43 AM	2:27:43 AM	60.2	59.4	57.3	58.3	60.9	56.0				
	2:27:43 AM	2:37:43 AM	59.7	59.0	56.6	57.8	60.3	55.1	2.2-3.8	28.6	79.8	E90
	2:37:43 AM	2:47:43 AM	59.6	59.2	56.6	57.9	59.9	55.7				
	2:47:43 AM	2:57:43 AM	59.7	59.1	56.7	57.9	60.1	55.0	2.8-4.9	28.6	79.5	E90
	2:57:43 AM	3:07:43 AM	59.2	58.3	56.5	57.4	60.0	55.0				
	3:07:43 AM	3:17:43 AM	59.2	58.4	56.0	57.2	61.7	54.3	4.0-5.3	28.5	78.2	E90
	3:17:43 AM	3:27:43 AM	59.3	58.3	55.9	57.1	60.2	54.7				
	3:27:43 AM	3:37:43 AM	58.2	57.5	55.6	56.5	58.8	54.5	3.7-5.0	28.4	78.9	E90
	3:37:43 AM	3:47:43 AM	58.0	57.0	54.7	55.9	58.6	52.9				
	3:47:43 AM	3:57:43 AM	57.1	56.2	54.2	55.2	57.5	52.8	2.7-4.2	28.4	79.5	SE100
	3:57:43 AM	4:07:43 AM	57.3	56.6	54.2	55.4	58.0	53.0				
	4:07:43 AM	4:17:43 AM	56.0	55.3	53.5	54.3	56.9	51.0	3.6–5.1	28.3	80.2	SE110
	4:17:43 AM	4:27:43 AM	56.5	54.8	52.6	53.6	62.5	51.1				
	4:27:43 AM	4:37:43 AM	55.8	54.7	52.8	53.7	56.8	51.7	3.6-4.2	28.3	80.5	SE110
	4:37:43 AM	4:47:43 AM	56.9	55.1	52.5	53.8	58.3	51.0				
	4:47:43 AM	4:57:43 AM	58.8	54.8	52.2	54.8	74.2	50.4	4.2-5.5	28.4	80.6	SE110
	4:57:43 AM	5:07:43 AM	55.7	54.3	52.0	53.1	57.5	50.6				
	5:07:43 AM	5:17:43 AM	59.3	56.2	52.3	68.4	93.6	50.4				
	5:17:43 AM	5:27:43 AM	57.9	55.9	52.3	54.0	61.0	51.3	3.5-4.8	28.2	81	SE110
	5:27:43 AM	5:37:43 AM	58.6	56.3	52.3	54.2	61.5	50.8				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
29-Sep	5:37:43 AM	5:47:43 AM	59.2	56.8	53.4	55.1	62.9	52.1	2.4-4.4	28.1	81	SE110
	5:47:43 AM	5:57:43 AM	56.6	54.9	52.9	53.9	58.1	51.4				
	5:57:43 AM	6:07:43 AM	56.7	54.9	52.4	53.7	60.6	51.4	3.2-4.5	28	81.1	NE90
	6:07:43 AM	6:17:43 AM	58.9	56.8	52.8	55.0	64.3	51.7				
	6:17:43 AM	6:27:43 AM	59.1	54.6	52.0	53.3	61.6	51.1	3.7-5.1	28.1	81.2	NE90
	6:27:43 AM	6:37:43 AM	53.8	52.4	50.9	51.6	55.8	50.0				
	6:37:43 AM	6:47:43 AM	61.0	52.7	50.1	52.1	68.5	49.2	3.1-4.5	28.1	84.2	NE90
	6:47:43 AM	6:57:43 AM	59.5	52.2	49.6	51.5	63.5	48.5				
	6:57:43 AM	7:07:43 AM	61.0	51.3	49.5	50.7	63.5	48.6	1.8-2.6	28.1	86.8	NE50
	7:07:43 AM	7:17:43 AM	58.2	52.6	49.2	52.5	69.4	48.2				
	7:17:43 AM	7:27:43 AM	55.8	50.8	48.8	49.7	58.3	48.0	1.6-2.3	28.2	86.7	NE50
	7:27:43 AM	7:37:43 AM	56.3	52.1	48.3	50.5	60.8	47.2				
	7:37:43 AM	7:47:43 AM	53.9	50.2	47.7	48.9	56.4	46.9	1.5-2.4	28.2	86.8	NE50
	7:47:43 AM	7:57:43 AM	49.4	48.8	47.4	48.0	50.5	46.8				
	7:57:43 AM	8:07:43 AM	59.1	49.1	45.4	48.1	61.6	44.1	1.6-3.1	28.2	88.8	NE60
	8:07:43 AM	8:17:43 AM	56.1	46.6	44.9	46.6	58.6	44.0				
	8:17:43 AM	8:27:43 AM	54.5	46.5	44.7	45.8	57.0	43.8	1.5-2.4	28.4	88.6	NE60
	8:27:43 AM	8:37:43 AM	56.7	48.0	45.8	48.3	59.4	44.3				
	8:37:43 AM	8:47:43 AM	58.2	48.6	45.8	48.7	66.9	44.8	1.7-2.8	28.5	88.7	NE60
	8:47:43 AM	8:57:43 AM	49.0	46.9	45.3	46.1	51.9	44.5				
	8:57:43 AM	9:07:43 AM	53.8	48.5	45.1	47.4	60.3	44.1	2.1-2.9	28.6	86.4	NE60
	9:07:43 AM	9:17:43 AM	62.9	54.4	46.7	51.6	65.4	45.5				
	9:17:43 AM	9:27:43 AM	61.6	52.1	47.9	51.4	66.1	46.3				
	9:27:43 AM	9:37:43 AM	50.3	50.1	48.3	49.1	52.8	47.1	1.9-2.7	28.9	87.2	NE60
	9:37:43 AM	9:47:43 AM	59.2	50.2	48.5	49.6	61.7	47.5				
	9:47:43 AM	9:57:43 AM	54.5	50.1	48.4	49.4	57.0	47.2	1.6-2.3	29.4	81.6	NE60
	9:57:43 AM	10:07:43 AM	56.9	50.8	48.6	50.0	59.4	47.5				

Date	Time Start	Time end	L1 dBA	L10 dBA	L90 dBA	Leq dBA	Lmax dBA	Lmin dBA	Wind speed m/s	Temperature ^0C	Humidity %	Wind Direction
29-Sep	10:07:43 AM	10:17:43 AM	54.0	50.3	48.2	49.3	56.5	47.0				
	10:17:43 AM	10:27:43 AM	57.1	51.1	49.2	50.2	59.6	48.1	1.3-2.4	30.5	77.8	NE50
	10:27:43 AM	10:37:43 AM	59.4	52.0	49.5	51.1	61.9	48.1				
	10:37:43 AM	10:47:43 AM	52.9	52.2	49.5	50.8	55.4	47.9	2.1-3.4	30.6	74.3	NE60
	10:47:43 AM	10:57:43 AM	57.3	52.4	49.4	51.1	59.8	48.0				
	10:57:43 AM	11:07:43 AM	56.4	53.2	50.3	53.2	68.7	49.0	2.8-4.3	31	73.2	NE60
	11:07:43 AM	11:17:43 AM	53.4	52.8	50.1	51.5	55.9	48.9				
	11:17:43 AM	11:27:43 AM	54.2	53.2	50.9	52.0	55.0	49.8	1.8-2.7	31.3	72.7	NE60
	11:27:43 AM	11:37:43 AM	56.4	53.8	51.1	52.5	60.3	49.8				
	11:37:43 AM	11:47:43 AM	57.8	54.0	51.2	52.7	62.0	49.7	2.1-3.2	31.5	72.0	NE60
	11:47:43 AM	11:57:43 AM	55.8	54.0	51.2	52.7	58.3	50.0				
	11:57:43 AM	00:07:43 PM	56.4	54.9	51.8	53.5	58.9	50.5	2.5-3.8	31.6	71.8	NE80
	00:07:43 PM	00:17:43 PM	56.2	55.7	52.8	54.3	56.8	50.8				
	00:17:43 PM	00:27:43 PM	55.1	54.3	51.9	53.0	55.6	50.5	2.6-3.8	32	70.1	NE70
	00:27:43 PM	00:37:43 PM	59.4	54.6	52.2	53.7	63.4	50.7				
	00:37:43 PM	00:47:43 PM	56.6	55.4	52.2	53.8	57.8	51.1	2.7-3.5	32.1	69.2	NE70
	00:47:43 PM	00:57:43 PM	56.5	55.1	52.8	53.9	57.7	51.3				
	00:57:43 PM	1:07:43 PM	58.1	55.5	52.7	54.3	62.1	50.9	2.0-3.1	32.4	69.0	NE70
	1:07:43 PM	1:17:43 PM	55.9	55.2	52.7	53.9	56.8	50.8				
	1:17:43 PM	1:27:43 PM	57.7	55.3	52.4	53.9	60.6	50.4	1.3-2.6	32.5	68.6	NE70

APPENDIX B: DAILY LOG

INSTITUTE FOR ENVIRONMENT AND RESOURCES
ENVIRONMENTAL QUALITY LABOLATORY

DAILY LOG SHEET

Sampling position:		**Cassava garden, Thanh Hai commune, Thanh Phu district, Ben Tre province**			
Latitute:		9^{0}55'433.6"N, 106^{0}33'43.2"E			
Sampling period		September 25-27, 2019			
No.	*Parameters*	*Sampling method*	*Equipment*	*Sample codes*	*Note*
1	Noise level	ISO 1996-2-2007	3M SoundPro DL 1-2/1	No. 1	

Date	*Time*	*Equipment status*	*Note*
Sep 25, 2019	12:05	Calibration passed	Calibration sound level meter
	12:11	Working property	Starting noise measuring
	12:15		A motorbike passing
	12:25		A motorbike passing
	From 21:20		Sound of wave clearly
Sep 26, 2019	To 3:30		sound of waves is reduced
	4-6h		Occationally, a rooster crows in the distance of 30m
	7:10		A motorbike passing
	12:21	Stop Sound level meter	Change battery and re-calibration
	12:24	Run Sound level meter	Continue measuring noise
	12:50	Working property	Dog barking
	19:00		A motorbike passing
	19:08		A motorbike passing
	From 21:30		Sound of wave clearly
Sep 27, 2019	9:00		two motorbikes passing
	12:34	Stop Sound level meter	Team finished measuring this location

INSTITUTE FOR ENVIRONMENT AND RESOURCES
ENVIRONMENTAL QUALITY LABOLATORY

DAILY LOG SHEET

Sampling position:	**Jímaca garden, besides a small pond, Thanh Hai commune, Thanh Phu district, Ben Tre province**				
Latitute:	$9^0$55'4.8"N, $106^0$39'50.4"E				
Sampling period	September 23-25, 2019				
No.	*Parameters*	*Sampling method*	*Equipment*	*Sample codes*	*Note*
1	Noise level	ISO 1996-2-2007	3M SoundPro DL 2-1/1	No. 2	

Date	*Time*	*Equipment status*	*Note*
Sep 23, 2019	10:50	Calibration passed	Calibration sound level meter
	10:57		Starting noise measuring
	10:57	Working property	Far southeast, a sand blower working
	11:00		a motorbike into the house
	13:25		sand blower stop
	15:30		a motorbike into the house
	16:30		Wind speed higher than 5m/s
Sep 24, 2019	7:30		motorbike out of the house
	From 7:30		sand blower works during the day
	12:28	Stop	Change battery
	12:29	Running	Continue noise measuring
	17:25	Working property	Karaoke playing from a household about 120m away
	18:50		Karaoke stop
Sep 25,2019	4:30		the goose cried out
	11:38	Stop Sound level meter	Team finished noise measuring at this site

INSTITUTE FOR ENVIRONMENT AND RESOURCES
ENVIRONMENTAL QUALITY LABOLATORY

DAILY LOG SHEET

Sampling position:	**Shrimp ponds, Thanh Hai commune, Thanh Phu district, Ben Tre province**				
Latitute:	$9^{0}54'3.6"N, 106^{0}39'32.4"E$				
Sampling period	September 27-29, 2019				
No.	*Parameters*	*Sampling method*	*Equipment*	*Sample codes*	*Note*
1	Noise level	ISO 1996-2-2007	3M SoundPro DL 2-1/1	No. 3	

Date	*Time*	*Equipment status*	*Note*
Sep 27, 2019	13:05	Calibration passed	Calibration sound level meter
	13:13	Working property	Starting noise measuring
	13:50		A motorbike passing
	13:55		A motorbike passing
	13:59		A motorbike passing
	14:20		A motorbike passing
	14:26		A motorbike passing
	14:30		A motorbike passing
	14:33		A motorbike passing
	16:50		The goats returning to the barn make noise
	17:00		Lowering sea level, decreasing wave
	18:35		Dog barking
	18:55		Dog barking
	19:10		Dog barking
	21h		Many of the clam fishermen's motorbikes passing
	21:45		A motorbike passing
	22:15		A motorbike passing
	23:35		Dog barking
Sep 28,2019	0:45		Dog barking
	4:35		A motorbike passing
	11:00		Sea level up, sea waves noisy
	12:23	Stop measurement	Change battery and re-calibration
	12:27	Re-start	
	13:30 – 15:05	Working property	Sea level rise, some fishing boats passed

	16:00		Sea level down slowly
	19:05		A motorbike passing, dog barking
	19:44		A motorbike passing, dog barking
	20:05		A motorbike passing, dog barking
	21:00		A motorbike passing, dog barking
Sep 29, 2019	1:30		dogs barking
	1:45		dogs barking
	4:00		The receding waves still hear the sound of the waves
	4:50		dogs barking
	5:10		motorbike passing, dogs barked violently
	12:15		Sea level rise, the sound of the sea waves get bigger
	13:28	Stop Sound level meter	Team finish noise measuring

APPENDIX C: OCTAVE 1/1 RECORDS

SESSION REPORT

Place name: **No.1**

Information Panel	**S014**	**S015**
Description		
Name	S014_BHJ110005_30092019_070936	S015_BHJ110005_30092019_070941
Start Time	9/25/2019 12:11:23	9/26/2019 12:24:20
Stop Time	9/26/2019 12:22:51	9/27/2019 12:36:01
Device Name	BHJ110005	BHJ110005
Model Type	SoundPro DL	SoundPro DL
Device Firmware Rev	R.13H	R.13H
Comments		

Summary Data Panel	**S014**	**S015**
Description	**Value**	**Value**
Exchange Rate	3 dB	3 dB
Weighting	A	A
Response	SLOW	SLOW
Bandwidth	1/1	1/1
L1	55.9 dB	56.8 dB
L10	54.4 dB	55 dB
L50	51.5 dB	48.2 dB
L90	46.2 dB	42.2 dB
Leq	51.9 dB	50.8 dB
Lmax	79.7 dB	65.6 dB
Lmin	38.7 dB	37.6 dB
Leq 16 Hz	23.2 dB	21.6 dB
Lmax 16 Hz	39.9 dB	38.5 dB
Lmin 16 Hz	1.8 dB	1.1 dB
Leq 31.5 Hz	33.6 dB	32 dB
Lmax 31.5 Hz	50.2 dB	50.6 dB
Lmin 31.5 Hz	11.7 dB	12.5 dB
Leq 63 Hz	38 dB	36.9 dB
Lmax 63 Hz	54.8 dB	56.1 dB
Lmin 63 Hz	21.6 dB	20.3 dB
Leq 125 Hz	35.7 dB	35.4 dB
Lmax 125 Hz	54.4 dB	54.8 dB
Lmin 125 Hz	20.5 dB	18.3 dB

Leq 250 Hz	35.6 dB	34.6 dB
Lmax 250 Hz	59.1 dB	57.2 dB
Lmin 250 Hz	19.5 dB	19.5 dB
Leq 500 Hz	43.3 dB	42 dB
Lmax 500 Hz	70.4 dB	62.6 dB
Lmin 500 Hz	27.6 dB	26 dB
Leq 1 kHz	47.2 dB	46 dB
Lmax 1 kHz	72.4 dB	64.6 dB
Lmin 1 kHz	32.3 dB	29.1 dB
Leq 2 kHz	45.5 dB	44.2 dB
Lmax 2 kHz	78.3 dB	59.5 dB
Lmin 2 kHz	32 dB	29.1 dB
Leq 4 kHz	42.8 dB	41.7 dB
Lmax 4 kHz	69.9 dB	61.8 dB
Lmin 4 kHz	30 dB	25.5 dB
Leq 8 kHz	38.8 dB	37.9 dB
Lmax 8 kHz	63.8 dB	55 dB
Lmin 8 kHz	25.4 dB	25.3 dB
Leq 16 kHz	34.2 dB	33.7 dB
Lmax 16 kHz	51.1 dB	54.6 dB
Lmin 16 kHz	25.3 dB	25.3 dB

SESSION REPORT

Place name: No.2/1

BHJ110005_30092019_070903:

Information Panel	S006	S007	S008
Description			
Name			
Start Time	9/23/2019 10:57:01	9/23/2019 17:28:17	9/23/2019 18:08:32
Stop Time	9/23/2019 17:27:58	9/23/2019 18:08:24	9/24/2019 0:28:56
Device Name	BHJ110005	BHJ110005	BHJ110005
Model Type	SoundPro DL	SoundPro DL	SoundPro DL
Device Firmware Rev	R.13H	R.13H	R.13H
Comments			

Summary Data Panel	S006	S007	S008
Description	**Value**	**Value**	**Value**
Exchange Rate	3 dB	3 dB	3 dB
Weighting	A	A	A
Response	SLOW	SLOW	SLOW
Bandwidth	1/1	1/1	1/1
L1	59.6 dB	59.9 dB	61.8 dB
L10	55.9 dB	56.3 dB	57.9 dB
L50	50.3 dB	52.1 dB	54.5 dB
L90	43 dB	49.4 dB	52.1 dB
Leq	52.4 dB	53.5 dB	55.6 dB
Lmax	74.8 dB	64.4 dB	68.9 dB
Lmin	38.8 dB	46.5 dB	47.7 dB
Leq 16 Hz	20.3 dB	25.6 dB	25.7 dB
Lmax 16 Hz	36.6 dB	40.9 dB	46.2 dB
Lmin 16 Hz	3.2 dB	13 dB	8.5 dB
Leq 31.5 Hz	32 dB	36.9 dB	37.4 dB
Lmax 31.5 Hz	49.4 dB	50.6 dB	56 dB
Lmin 31.5 Hz	18.4 dB	25.6 dB	21.4 dB
Leq 63 Hz	39.4 dB	43.1 dB	42.6 dB
Lmax 63 Hz	56.8 dB	56.2 dB	59.1 dB
Lmin 63 Hz	29.5 dB	34.6 dB	27.2 dB
Leq 125 Hz	38.4 dB	40.9 dB	40.8 dB
Lmax 125 Hz	61.4 dB	54.7 dB	56.9 dB
Lmin 125 Hz	29.6 dB	29.5 dB	30.2 dB
Leq 250 Hz	38 dB	40.7 dB	40.9 dB

Lmax 250 Hz	60.2 dB	53.5 dB	52.6 dB
Lmin 250 Hz	24 dB	31.8 dB	33.1 dB
Leq 500 Hz	41.6 dB	45.7 dB	46.7 dB
Lmax 500 Hz	63.8 dB	59.2 dB	67.8 dB
Lmin 500 Hz	23.3 dB	36.6 dB	38.7 dB
Leq 1 kHz	44.4 dB	47.3 dB	49.7 dB
Lmax 1 kHz	65.8 dB	61.4 dB	60.2 dB
Lmin 1 kHz	25.7 dB	40.6 dB	41.9 dB
Leq 2 kHz	47.8 dB	45.7 dB	49.2 dB
Lmax 2 kHz	69.1 dB	57.6 dB	60.9 dB
Lmin 2 kHz	28.4 dB	39.6 dB	40.3 dB
Leq 4 kHz	45.8 dB	45.5 dB	47.7 dB
Lmax 4 kHz	70.5 dB	57.2 dB	61.5 dB
Lmin 4 kHz	26.9 dB	36.9 dB	38.5 dB
Leq 8 kHz	38.8 dB	39.7 dB	43.5 dB
Lmax 8 kHz	67.6 dB	53.1 dB	57.4 dB
Lmin 8 kHz	25.3 dB	30.6 dB	32.8 dB
Leq 16 kHz	27 dB	27.4 dB	33.4 dB
Lmax 16 kHz	60.1 dB	40.1 dB	47.3 dB
Lmin 16 kHz	25.3 dB	25.3 dB	25.3 dB

SESSION REPORT

Place name: **No.2/2**

BHJ110005_30092019_070903:

Information Panel	S009	S010	S011
Description			
Name			
Start Time	9/24/2019 0:29:38	9/24/2019 7:21:49	9/24/2019 12:44:34
Stop Time	9/24/2019 7:21:41	9/24/2019 12:41:55	9/24/2019 18:05:40
Device Name	BHJ110005	BHJ110005	BHJ110005
Model Type	SoundPro DL	SoundPro DL	SoundPro DL
Device Firmware Rev	R.13H	R.13H	R.13H
Comments			

Summary Data Panel	S009	S010	S011
Description	**Value**	**Value**	**Value**
Exchange Rate	3 dB	3 dB	57.2 dB
Weighting	A	A	3 dB
Response	SLOW	SLOW	A
Bandwidth	1/1	1/1	SLOW
L1	64.7 dB	60 dB	SLOW
L10	61.5 dB	57.1 dB	63.3 dB
L50	57.8 dB	53.8 dB	60 dB
L90	54.5 dB	50.4 dB	56 dB
Leq	58.8 dB	54.7 dB	52.4 dB
Lmax	71 dB	71.5 dB	69.7 dB
Lmin	51.4 dB	46.7 dB	47.1 dB
Leq 16 Hz	29.3 dB	25.6 dB	32.2 dB
Lmax 16 Hz	45 dB	40.6 dB	45.6 dB
Lmin 16 Hz	11.6 dB	9.5 dB	10.8 dB
Leq 31.5 Hz	41 dB	37.8 dB	44.6 dB
Lmax 31.5 Hz	54.7 dB	52.6 dB	56 dB
Lmin 31.5 Hz	21.4 dB	19.3 dB	20.4 dB
Leq 63 Hz	46.9 dB	42.3 dB	49.6 dB
Lmax 63 Hz	59.6 dB	59 dB	63.9 dB
Lmin 63 Hz	29.2 dB	29.3 dB	31.2 dB
Leq 125 Hz	45.3 dB	40.9 dB	47.6 dB
Lmax 125 Hz	60.5 dB	57.4 dB	63.9 dB
Lmin 125 Hz	32.7 dB	29.1 dB	31.4 dB

Leq 250 Hz	44.3 dB	40.7 dB	43.8 dB
Lmax 250 Hz	57 dB	61.2 dB	58.3 dB
Lmin 250 Hz	37.3 dB	32.6 dB	31.9 dB
Leq 500 Hz	49.5 dB	45.3 dB	47.1 dB
Lmax 500 Hz	65.4 dB	67.7 dB	64.7 dB
Lmin 500 Hz	42.9 dB	37.1 dB	37.4 dB
Leq 1 kHz	51.9 dB	48.2 dB	49.4 dB
Lmax 1 kHz	62.3 dB	67.3 dB	65 dB
Lmin 1 kHz	45.9 dB	40.8 dB	40.1 dB
Leq 2 kHz	52.3 dB	48.8 dB	49.7 dB
Lmax 2 kHz	65.2 dB	68.6 dB	63.1 dB
Lmin 2 kHz	44.3 dB	39.9 dB	39.4 dB
Leq 4 kHz	51.9 dB	47.4 dB	48.2 dB
Lmax 4 kHz	65.6 dB	64.1 dB	59.2 dB
Lmin 4 kHz	41.9 dB	38.4 dB	38.4 dB
Leq 8 kHz	47.6 dB	40.9 dB	42.7 dB
Lmax 8 kHz	60.7 dB	58.9 dB	56.7 dB
Lmin 8 kHz	33.8 dB	30 dB	32.7 dB
Leq 16 kHz	37.1 dB	28.7 dB	31.2 dB
Lmax 16 kHz	49.6 dB	47.2 dB	48.9 dB
Lmin 16 kHz	25.3 dB	25.3 dB	25.3 dB

SESSION REPORT

Place name: **No.2/3**

BHJ110005_30092019_070903:

Information Panel	S012	S013
Description		
Name		
Start Time	9/24/2019 18:05:48	9/25/2019 5:57:33
Stop Time	9/25/2019 5:57:02	9/25/2019 11:38:42
Device Name	BHJ110005	BHJ110005
Model Type	SoundPro DL	SoundPro DL
Device Firmware Rev	R.13H	R.13H
Comments		

Summary Data Panel	S012	S013
Description	**Value**	**Value**
Exchange Rate	3 dB	3 dB
Weighting	A	A
Response	SLOW	SLOW
Bandwidth	1/1	1/1
L1	66.9 dB	63.5 dB
L10	63.2 dB	60 dB
L50	59 dB	54.7 dB
L90	55.3 dB	50.4 dB
Leq	60.5 dB	56.7 dB
Lmax	90.2 dB	81.8 dB
Lmin	48.3 dB	47 dB
Leq 16 Hz	32 dB	27.7 dB
Lmax 16 Hz	48.6 dB	46.5 dB
Lmin 16 Hz	9.4 dB	9.2 dB
Leq 31.5 Hz	45.3 dB	40.3 dB
Lmax 31.5 Hz	62.6 dB	58.1 dB
Lmin 31.5 Hz	19.8 dB	19 dB
Leq 63 Hz	51.8 dB	46.4 dB
Lmax 63 Hz	68.3 dB	61.1 dB
Lmin 63 Hz	29.6 dB	27.2 dB
Leq 125 Hz	50 dB	44.7 dB
Lmax 125 Hz	76.3 dB	62.5 dB
Lmin 125 Hz	31.9 dB	28 dB
Leq 250 Hz	47.1 dB	43.2 dB

Lmax 250 Hz	79.4 dB	58.9 dB
Lmin 250 Hz	34.4 dB	34.1 dB
Leq 500 Hz	51 dB	47.3 dB
Lmax 500 Hz	39.7 dB	74.1 dB
Lmin 500 Hz	78 dB	37.5 dB
Leq 1 kHz	53.3 dB	50.5 dB
Lmax 1 kHz	83.1 dB	78.7 dB
Lmin 1 kHz	42.7 dB	41.8 dB
Leq 2 kHz	53.1 dB	50.5 dB
Lmax 2 kHz	86.2 dB	75.9 dB
Lmin 2 kHz	38.5 dB	41 dB
Leq 4 kHz	81.7 dB	48.1 dB
Lmax 4 kHz	37.4 dB	70.3 dB
Lmin 4 kHz	51.9 dB	36.6 dB
Leq 8 kHz	47.6 dB	42.2 dB
Lmax 8 kHz	32.2 dB	57 dB
Lmin 8 kHz	75.6 dB	28.1 dB
Leq 16 kHz	64.2 dB	30.7 dB
Lmax 16 kHz	25.3 dB	47.4 dB
Lmin 16 kHz	36.9 dB	25.3 dB

SESSION REPORT

Place name: **No.3**

Information Panel	S016	S017
Description		
Name	S016_BHJ110005_30092019_070945	S017_BHJ110005_30092019_070949
Start Time	9/27/2019 13:13:06	9/28/2019 12:27:43
Stop Time	9/28/2019 12:26:24	9/29/2019 13:30:47
Device Name	BHJ110005	BHJ110005
Model Type	SoundPro DL	SoundPro DL
Device Firmware Rev	R.13H	R.13H
Comments		

Summary Data Panel	S016	S017
Description	**Value**	**Value**
Exchange Rate	3 dB	3 dB
Weighting	A	A
Response	SLOW	SLOW
Bandwidth	1/1	1/1
L1	58.9 dB	65.6 dB
L10	55.8 dB	59.9 dB
L50	50.1 dB	54 dB
L90	44.7 dB	48.2 dB
Leq	52.7 dB	57.4 dB
Lmax	79.7 dB	93.6 dB
Lmin	38.1 dB	43.8 dB
Leq 16 Hz	9.5 dB	23.2 dB
Lmax 16 Hz	31.1 dB	46 dB
Lmin 16 Hz	0.8 dB	1 dB
Leq 31.5 Hz	23.3 dB	34.7 dB
Lmax 31.5 Hz	45.1 dB	56.9 dB
Lmin 31.5 Hz	10.1 dB	9.7 dB
Leq 63 Hz	36.1 dB	42.4 dB
Lmax 63 Hz	52.4 dB	67.5 dB
Lmin 63 Hz	23.9 dB	21 dB
Leq 125 Hz	39 dB	43.9 dB
Lmax 125 Hz	66.4 dB	71.3 dB
Lmin 125 Hz	23.3 dB	22.1 dB
Leq 250 Hz	42 dB	46.3 dB
Lmax 250 Hz	67.5 dB	71.2 dB

Lmin 250 Hz	21.2 dB	28.2 dB
Leq 500 Hz	46.5 dB	51.8 dB
Lmax 500 Hz	76.7 dB	90.5 dB
Lmin 500 Hz	26.4 dB	33.4 dB
Leq 1 kHz	47.4 dB	52.1 dB
Lmax 1 kHz	76 dB	88.8 dB
Lmin 1 kHz	29 dB	37.3 dB
Leq 2 kHz	45.4 dB	49.5 dB
Lmax 2 kHz	75.4 dB	85.2 dB
Lmin 2 kHz	28 dB	36.6 dB
Leq 4 kHz	42.3 dB	45.5 dB
Lmax 4 kHz	70.3 dB	76 dB
Lmin 4 kHz	25.3 dB	33.5 dB
Leq 8 kHz	36.8 dB	40 dB
Lmax 8 kHz	61.3 dB	76.7 dB
Lmin 8 kHz	25.3 dB	25.3 dB
Leq 16 kHz	25.4 dB	26.5 dB
Lmax 16 kHz	44.7 dB	62.3 dB
Lmin 16 kHz	24.3 dB	25.3 dB

APPENDIX D: SOME PICTURES

FIGURE C1. CALIBRATION IN THE LAB

FIGURE C2. CALIBRATION IN THE FIELD

FIGURE C3. ANEMOMETER AT THE SCENE

APPENDIX E: CERTIFICATE OF CALIBRATION

TỔNG CỤC TIÊU CHUẨN ĐO LƯỜNG CHẤT LƯỢNG
TRUNG TÂM KỸ THUẬT TIÊU CHUẨN ĐO LƯỜNG CHẤT LƯỢNG 3
QUALITY ASSURANCE & TESTING CENTER 3

QUATEST 3

KT3-1766ADE8/2

GIẤY CHỨNG NHẬN HIỆU CHUẨN
CERTIFICATE OF CALIBRATION

23/10/2018
Page: 01/04

1. Phương tiện đo/*Object*: **PHƯƠNG TIỆN ĐO ĐỘ ỒN CHỈ THỊ SỐ** ***DIGITAL SOUND LEVEL METER***
2. Nơi sản xuất/*Manufacturer*: QUEST - USA
3. Kiểu/*Type*: SOUNDPRO SE/DL SN: BHJ110005 ID: N/A
4. Đặc trưng kỹ thuật/*Specification*:
   - Phạm vi đo/*Range*: 0 - 140 dB
   - Dải tần/*Frequency Band*: 16 Hz - 16 kHz
   - Cấp chính xác/*Accuracy class*: 2 (IEC 61672)
5. Khách hàng: *Customer* **VIỆN MÔI TRƯỜNG VÀ TÀI NGUYÊN** **142 Tô Hiến Thành, Q10, TP Hồ Chí Minh**
6. Nơi hiệu chuẩn: *Place of Calibration* **TRUNG TÂM KỸ THUẬT 3/QUATEST 3** **7 Đường 1, KCN Biên Hòa 1, Đồng Nai**
7. Phương pháp hiệu chuẩn: *Method of Calibration* QTHC/KT3 78: 2018 Máy đo độ ồn - Quy trình hiệu chuẩn *Sound Level Meters - Calibration Procedure*
8. Chuẩn sử dụng/*Standards Used*:

ID	Description	Traceable to	Cal. Date	Due Date
DE1958	Multifunction Acoustic Calibrator	VMI - VIỆT NAM	05/2018	05/2020

9. Môi trường hiệu chuẩn/*Calibration Environment*: [23 ± 2] °C [50 ± 10] %RH
10. Hiệu chỉnh phương tiện đo/*Adjustment*: ☑ Không/*No* ☐ Có/*Yes*
11. Ngày hiệu chuẩn/*Date of Calibration*: 23/10/2018
12. Tem hiệu chuẩn/*Calibration Label*: KT3-1766ADE8/2

TL. TRƯỞNG PĐL ĐIỆN
PP. HEAD OF ELECTRICAL MEAS. LAB.

Nguyễn Thanh Tùng

TL. GIÁM ĐỐC/ *PP. DIRECTOR*
TRƯỞNG PHÒNG ĐO LƯỜNG
HEAD OF MEASUREMENT LAB.

Nguyễn Anh Triết

KT3-1766ADE8/2

GIẤY CHỨNG NHẬN HIỆU CHUẨN
CERTIFICATE OF CALIBRATION

23/10/2018
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13. Kết quả hiệu chuẩn (*Results of calibration*)
13.1. Đáp ứng tần số (*Frequency response test*)

Frequency (Hz)		31,5	63	125	250	500	1000	2000	4000	8000
94 Inv.A	DUT (dB)	95,1	94,2	94,1	94,0	94,0	94,0	93,8	93,3	93,7
	Ref. (dB)	94,0	94,0	94,0	94,1	94,0	94,0	94,0	94,0	93,8
	Error (dB)	1,1	0,2	0,1	-0,1	0,0	0,0	-0,2	-0,7	-0,1
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Lin. A 94	DUT (dB)	55,3	68,0	78,0	85,4	90,8	94,0	95,1	94,3	92,6
	Ref. (dB)	54,5	67,8	77,9	85,4	90,8	94,0	95,2	94,9	92,7
	Error (dB)	0,8	0,2	0,1	0,0	0,0	0,0	-0,1	-0,6	-0,1
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Lin. A 104	DUT (dB)	65,3	78,0	88,0	95,4	100,8	104,0	105,0	104,2	102,6
	Ref. (dB)	64,5	77,8	87,9	95,4	100,8	104,0	105,2	104,9	102,7
	Error (dB)	0,8	0,2	0,1	0,0	0,0	0,0	-0,2	-0,7	-0,1
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Lin. A 114	DUT (dB)	75,3	88,0	98,0	105,3	110,8	114,0	115,0	114,2	112,6
	Ref. (dB)	74,5	87,8	97,9	105,4	110,8	114,0	115,2	114,9	112,7
	Error (dB)	0,8	0,2	0,1	-0,1	0,0	0,0	-0,2	-0,7	-0,1
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Lin. C 94	DUT (dB)	91,1	93,3	93,8	93,9	93,9	94,0	93,5	92,3	90,6
	Ref. (dB)	90,9	93,2	93,8	94,0	94,0	94,0	93,8	93,1	90,8
	Error (dB)	0,2	0,1	0,0	-0,1	-0,1	0,0	-0,3	-0,8	-0,2
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Lin. C 104	DUT (dB)	101,1	103,3	103,8	103,9	103,9	104,0	103,5	102,3	100,6
	Ref. (dB)	100,9	103,2	103,8	104,0	104,0	104,0	103,8	103,1	100,8
	Error (dB)	0,2	0,1	0,0	-0,1	-0,1	0,0	-0,3	-0,8	-0,2
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1
Lin. C 114	DUT (dB)	111,1	113,3	113,8	113,9	113,9	114,0	113,5	112,3	110,6
	Ref. (dB)	110,9	113,2	113,8	114,0	114,0	114,0	113,8	113,1	110,8
	Error (dB)	0,2	0,1	0,0	-0,1	-0,1	0,0	-0,3	-0,8	-0,2
	U (dB)	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1

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13.2. Kiểm tra độ tuyến tính (*Linearity Test*)

Frequency (Hz)	31,5	63	125	250	500	1000	2000	4000	8000
94 dB	55,3	68,0	78,0	85,4	90,8	94,0	95,1	[illegible]	92,6
104 dB	65,3	78,0	88,0	95,4	100,8	104,0	105,0	104,2	102,6
114 dB	75,3	88,0	98,0	105,3	110,8	114,0	115,0	114,2	112,6
(104-94-10) dB	0,0	0,0	0,0	0,0	0,0	0,0	-0,1	-0,1	0,0
(114-104-10) dB	0,0	0,0	0,0	-0,1	0,0	0,0	0,0	0,0	0,0

13.3. Trọng số thời gian (*Time weighting test*) và *Crest factor (C.F)*

Time weighting	F	S	C.F
Nominal Value (dB)	106	106	100
DUT (dB)	105,1	102,0	99,9
Ref. (dB)	105,0	102,0	100,0
Error (dB)	0,1	0,0	-0,1

Ghi chú/*Notes* :

- DUT: Thiết bị cần hiệu chuẩn/*Device Under Test*
- Ref.: Giá trị chuẩn/ *Reference Value*
- U: Độ không đảm bảo đo mở rộng/ *Expanded Uncertainty*

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14. Thông tin khác/*Other Informations*

14.1 Độ không đảm bảo đo/*Uncertainty*

Độ KĐBĐ là độ không đảm bảo đo mở rộng được tính từ độ không đảm bảo đo chuẩn nhân với hệ số phủ k = 2, phân bố chuẩn tương ứng với 95 % độ tin cậy. Xác định độ không đảm bảo đo chuẩn theo tài liệu **JCGM 100:2008 Evaluation of measurement data - Guide to the expression of uncertainty in measurement (GUM); EA-4/02 & NIST TN 1297**.

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95 %. The standard uncertainty of measurement has been determined in accordance with above documents.

14.2 Liên kết chuẩn/*Traceability*

Giấy chứng nhận hiệu chuẩn này thể hiện việc liên kết chuẩn đến chuẩn quốc gia, với đơn vị đo tuân thủ theo hệ đơn vị đo quốc tế SI. Nơi sử dụng thiết bị cần phải hiệu chuẩn lại thiết bị theo định kỳ phù hợp.

This calibration certificate documents the traceability to national standards, which realize the units of measurement according to the International System of Units (SI). The user is obliged to have the object recalibrated at appropriate intervals.

14.3 Phương pháp hiệu chuẩn/*Calibration Method*

a. Phương tiện đo được hiệu chuẩn bằng cách so sánh trực tiếp với các chuẩn của Trung tâm Kỹ thuật 3 được nêu tại Mục 8.

The equipment under calibration was calibrated by direct comparison with standards of Quatest 3 as description at Item 8.

b. Các kết quả hiệu chuẩn được thực hiện với bốn lần đo để tính giá trị trung bình và sai số.

All calibration results are based on four time measurements, from which the average and errors are calculated.

14.4 Điều kiện/*Conditions*

a. Các giá trị có đơn vị đo không thuộc hệ SI, được chuyển đổi từ hệ SI theo các bảng trong tài liệu **NĐ 86/2012/NĐ-CP; BIPM SI Brochure & NIST SP 811**.

All non-SI values were converted from SI units via conversion factors in above documents.

b. Kết quả hiệu chuẩn chỉ có giá trị tương ứng với điều kiện theo phương pháp hiệu chuẩn nêu ở Mục 7.

Calibration results are valid with respect to the procedure conditions as description at Item 7. only.

14.5 Hiệu chuẩn lại/*Recalibration*

Ngày đề nghị hiệu chuẩn lại theo yêu cầu của khách hàng: **23/10/2019**

Recommended recalibration date as request of customer.

APPENDIX B IBAT RISK SCREENING REPORT

Integrated Biodiversity Assessment Tool

WORLD BANK GROUP BIODIVERSITY RISK SCREEN

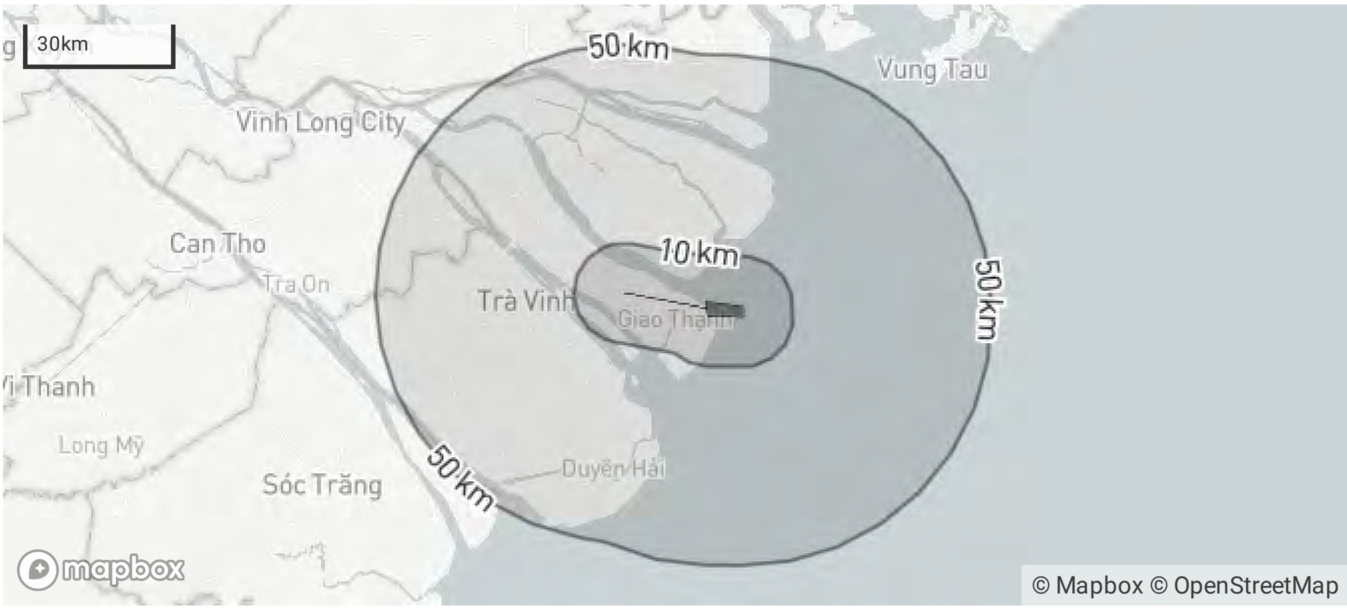
Report generated on 13/11/2019 by David Nicholson under the license number 523-5176 held by Environmental Resources Management. www.ibat-alliance.org

Project Name: Thanh Hai Wind Farm Vietnam

Location: [9.9, 106.7]

Overlaps with:

Protected Areas	2
Key Biodiversity Areas	4
IUCN Red List	43
Critical Habitat	Likely



Displaying project location and buffers: 10.0 km, 50.0 km

WORLD BANK GROUP

This report is based on IFC Performance Standard 6 (PS6) but applies to World Bank Environmental and Social Standard 6 (ESS6)

About this report

IBAT provides initial screening for critical habitat values. Performance Standard 6 (PS6) defines these values for critical habitat (PS6: para. 16) and legally protected and internationally recognized areas (PS6: para. 20). PS6 will be triggered when IFC client activities are located in modified habitats containing "significant biodiversity value," natural habitats, critical habitats, legally protected areas, or areas that are internationally recognized for biodiversity. References to PS6 and Guidance Note 6 (GN6) are provided to guide further assessment and detailed definitions where necessary. Please see https://www.ifc.org/ps6 for full details on PS6 and GN6.

The report screens for known risks within a standard 50km buffer of the coordinates used for analysis. This buffer is not intended to indicate the area of impact. The report can be used to:

- Scope risks to include within an assessment of risks and impacts
- Identify gaps within an existing assessment of risks and impacts
- Prioritize between sites in a portfolio for further assessment of risks and impacts
- Inform a preliminary determination of critical habitat
- Assess the need for engaging a biodiversity specialist
- Identify additional conservation experts or organizations to inform further assessment or planning

WARNING: IBAT aims to provide the most up-to-date and accurate information available at the time of analysis. There is however a possibility of incomplete, incorrect or out-of-date information. All findings in this report must be supported by further desktop review, consultation with experts and/or on-the-ground field assessment as described in PS6 and GN6. Please consult IBAT for any additional disclaimers or recommendations applicable to the information used to generate this report.

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Priority Species

Habitat of significant importance to priority species will trigger critical habitat status (See PS6: para 16). IBAT provides a preliminary list of priority species that could occur within the 50km buffer. This list is drawn from the IUCN Red List of Threatened Species (IUCN RL). This list should be used to guide any further assessment, with the aim of confirming knownor likely occurrence of these species within the project area. It is also possible that further assessment may confirm occurrence of additional priority species not listed here. It is strongly encouraged that any new species information collected by the project be shared with species experts and/or IUCN wherever possible in order to improve IUCN datasets.

IUCN Red List of Threatened Species - CR & EN

The following species are potentially found within 50km of the area of interest.
For the full IUCN Red List please refer to the associated csv in the report folder.

Species name	Common name	IUCN Category	Group
Crocodylus siamensis	Siamese Crocodile	CR	REPTILIA
Indotestudo elongata	Elongated Tortoise	CR	REPTILIA
Pangasianodon gigas	Mekong Giant Catfish	CR	ACTINOPTERYGII
Pangasius sanitwongsei	Giant Pangasius	CR	ACTINOPTERYGII
Probarbus jullieni	Jullien's Golden Carp	CR	ACTINOPTERYGII
Carcharhinus hemiodon	Pondicherry Shark	CR	CHONDRICHTHYES
Pristis zijsron	Green Sawfish	CR	CHONDRICHTHYES
Rhina ancylostoma	Bowmouth Guitarfish	CR	CHONDRICHTHYES
Rhynchobatus australiae	Bottlenose Wedgefish	CR	CHONDRICHTHYES
Glaucostegus thouin	Clubnose Guitarfish	CR	CHONDRICHTHYES
Batagur affinis	Southern River Terrapin	CR	REPTILIA

Species name	Common name	IUCN Category	Group
Catlocarpio siamensis	Giant Carp	CR	ACTINOPTERYGII
Datnioides pulcher	Siamese Tiger Perch	CR	ACTINOPTERYGII
Pristis pristis	Largetooth Sawfish	CR	CHONDRICHTHYES
Gyps bengalensis	White-rumped Vulture	CR	AVES
Sarcogyps calvus	Red-headed Vulture	CR	AVES
Pseudibis davisoni	White-shouldered Ibis	CR	AVES
Emberiza aureola	Yellow-breasted Bunting	CR	AVES
Glaucostegus typus	Giant Guitarfish	CR	CHONDRICHTHYES
Balaenoptera musculus	Blue Whale	EN	MAMMALIA
Lutra sumatrana	Hairy-nosed Otter	EN	MAMMALIA
Orcaella brevirostris	Irrawaddy Dolphin	EN	MAMMALIA
Rhincodon typus	Whale Shark	EN	CHONDRICHTHYES
Scleropages formosus	Golden Dragon Fish	EN	ACTINOPTERYGII
Isurus oxyrinchus	Shortfin Mako	EN	CHONDRICHTHYES
Sphyrna lewini	Scalloped Hammerhead	EN	CHONDRICHTHYES
Sphyrna mokarran	Great Hammerhead	EN	CHONDRICHTHYES
Anoxypristis cuspidata	Narrow Sawfish	EN	CHONDRICHTHYES

Species name	Common name	IUCN Category	Group
Fluvitrygon oxyrhyncha	Longnose Marbled Whipray	EN	CHONDRICHTHYES
Aetomylaeus maculatus	Mottled Eagle Ray	EN	CHONDRICHTHYES
Aetomylaeus vespertilio	Ornate Eagle Ray	EN	CHONDRICHTHYES
Isurus paucus	Longfin Mako	EN	CHONDRICHTHYES
Porites eridani		EN	ANTHOZOA
Anacropora spinosa		EN	ANTHOZOA
Hydnophora bonsai		EN	ANTHOZOA
Alveopora excelsa		EN	ANTHOZOA
Lamiopsis temminckii	Broadfin Shark	EN	CHONDRICHTHYES
Holothuria scabra	Golden Sandfish	EN	HOLOTHUROIDEA
Holothuria lessoni	Golden Sandfish	EN	HOLOTHUROIDEA
Pangasianodon hypophthalmus	Striped Catfish	EN	ACTINOPTERYGII
Urogymnus polylepis		EN	CHONDRICHTHYES
Sterna acuticauda	Black-bellied Tern	EN	AVES
Platalea minor	Black-faced Spoonbill	EN	AVES

Restricted Range Species

	Common name	IUCN Category	Group

	Common name	IUCN Category	Group
Pseudibis davisoni	White-shouldered Ibis	CR	AVES
Platalea minor	Black-faced Spoonbill	EN	AVES

IBAT

Biodiversity features which are likely to trigger Critical Habitat

Protected Areas

The following protected areas are found within 10.0 km and 50.0 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

Area name	Distance	Recommendation
Thanh Phu	10.0 km	Assess for biodiversity risk
Can Gio Mangrove	50.0 km	Assess for biodiversity risk

Key Biodiversity Areas

The following key biodiversity areas are found within 10.0 km and 50.0 km of the area of interest.
For further details please refer to the associated csv file in the report folder.

Area name	Distance	Recommendation
Ba Tri	10.0 km	Assess for critical habitat
Binh Dai	50.0 km	Assess for critical habitat
Chua Hang	50.0 km	Assess for critical habitat
Tra Cu	50.0 km	Assess for critical habitat

Species with potential to occur

Area Taxonomic group	Total assessed species	Total (CR, EN & VU)	CR	EN	VU	NT	LC	DD

Area Taxonomic group	Total assessed species	Total (CR, EN & VU)	CR	EN	VU	NT	LC	DD
REPTILIA	79	7	3	0	4	0	64	8
ACTINOPTERYGII	791	21	5	2	14	10	706	54
CHONDRICHTHYES	73	38	7	11	20	16	6	13
AVES	340	14	4	2	8	24	301	1
MAMMALIA	91	14	0	3	11	3	69	5
ANTHOZOA	246	65	0	4	61	78	89	14
HOLOTHUROIDEA	38	7	0	2	5	0	18	13
HYDROZOA	5	1	0	0	1	1	3	0
LILIOPSIDA	57	1	0	0	1	1	54	1
MAGNOLIOPSIDA	76	0	0	0	0	2	70	4
AMPHIBIA	13	0	0	0	0	0	13	0
INSECTA	76	0	0	0	0	0	75	1
MALACOSTRACA	32	0	0	0	0	0	22	10
GASTROPODA	120	0	0	0	0	0	118	2
POLYPODIOPSIDA	6	0	0	0	0	0	6	0
BIVALVIA	31	0	0	0	0	0	23	8
ARACHNIDA	4	0	0	0	0	0	4	0

Area Taxonomic group	Total assessed species	Total (CR, EN & VU)	CR	EN	VU	NT	LC	DD
CLITELLATA	1	0	0	0	0	0	1	0

Country-level summary

Coming soon

Recommended Experts and Organizations

For projects located in critical habitat, clients must ensure that external experts with regional expertise are involved in further assessment (GN6: GN22). Clients are encouraged to develop partnerships with recognized and credible conservation organizations and/or academic institutes, especially with respect to potential developments in natural or critical habitat (GN6: GN23). Where critical habitats are triggered by priority species, species specialists must be involved. IBAT provides data originally collected by a large network of national partners, while species information is sourced via the IUCN Red List and affiliated Species Specialist Groups. These experts and organizations are listed below. **Please note that this is not intended as a comprehensive list of organizations and experts. These organizations and experts are under no obligation to support any further assessment and do so entirely at their discretion and under their terms. Any views expressed or recommendations made by these stakeholders should not be attributed to the IFC or IBAT for IFC partners.**

Relevant national or regional organizations

IBAT integrates information developed by a global network of conservation agencies, organizations and experts. These efforts are coordinated by the IBAT Alliance (BirdLife International, Conservation International, IUCN and UNEP-WCMC) who compile and maintain this information as globally standardized databases. The local partners most relevant to the area of analysis are:

Wild Bird Society of Japan Address: Maruwa Building, 3-9-23 Nishi-Gotanda, Shinagawa-ku, Tokyo 141-0031, JapanWeb: http://www.wbsj.org/

BirdLife Asia Regional Office Address: 354 Tanglin Road, #01-16/17, Tanglin International Centre, Singapore 247672 Email: singapore.office@birdlife.org Web: http://www.birdlife.org/asia

Directory for Species Survival Commission (SSC) Specialist Groups and Red List Authorities

URL: http://www.iucn.org/about/work/programmes/species/who_we_are/ssc_specialist_groups_and_red_list_authorities_directory/

APPENDIX C LIST OF MIGRATORY SPECIES

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book
68.	*Gallinago stenura*	Pintail Snipe	LC	-
69.	*Gallinula chloropus*	Common Moorhen	LC	-
70.	*Gelochelidon nilotica*	Common Gull-billed Tern	LC	-
71.	*Geokichla citrina*	Orange-headed Thrush	LC	-
72.	*Glareola maldivarum*	Oriental Pratincole	LC	-
73.	*Halcyon coromanda*	Ruddy Kingfisher	LC	-
74.	*Halcyon pileata*	Black-capped Kingfisher	LC	-
75.	*Hierococcyx sparverioides*	Large Hawk-cuckoo	LC	-
76.	*Himantopus himantopus*	Black-winged Stilt	LC	-
77.	*Hirundapus cochinchinensis*	Silver-backed Needletail	LC	-
78.	*Hirundo rustica*	Barn Swallow	LC	-
79.	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	LC	-
80.	*Hypothymis azurea*	Black-naped Monarch	LC	-
81.	*Ixobrychus cinnamomeus*	Cinnamon Bittern	LC	-
82.	*Ixobrychus eurhythmus*	Schrenck's Bittern	LC	-
83.	*Ixobrychus flavicollis*	Black Bittern	LC	-
84.	*Ixobrychus sinensis*	Yellow Bittern	LC	-
85.	*Jynx torquilla*	Eurasian Wryneck	LC	-
86.	*Lalage melaschistos*	Black-winged Cuckooshrike	LC	-
87.	*Larus brunnicephalus*	Brown-headed Gull	LC	-
88.	*Larus ridibundus*	Black-headed Gull	LC	-
89.	*Larvivora cyane*	Siberian Blue Robin	LC	-
90.	*Leptoptilos javanicus*	Lesser Adjutant	VU	VU
91.	*Limnodromus semipalmatus*	Asian Dowitcher	NT	-
92.	*Limosa limosa*	Black-tailed Godwit	NT	-
93.	*Locustella lanceolata*	Lanceolated Warbler	LC	-
94.	*Loriculus vernalis*	Vernal Hanging-parrot	LC	-
95.	*Lymnocryptes minimus*	Jack Snipe	LC	-
96.	*Merops leschenaulti*	Chestnut-headed Bee-eater	LC	-
97.	*Merops orientalis*	Asian Green Bee-eater	LC	-
98.	*Merops philippinus*	Blue-tailed Bee-eater	LC	-
99.	*Merops viridis*	Blue-throated Bee-eater	LC	-
100.	*Milvus migrans*	Black Kite	LC	-

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book
101.	*Monticola gularis*	White-throated Rock-thrush	LC	-
102.	*Monticola solitarius*	Blue Rock-thrush	LC	-
103.	*Motacilla alba*	White Wagtail	LC	-
104.	*Motacilla cinerea*	Grey Wagtail	LC	-
105.	*Muscicapa dauurica*	Asian Brown Flycatcher	LC	-
106.	*Muscicapa ferruginea*	Ferruginous Flycatcher	LC	-
107.	*Muscicapa sibirica*	Dark-sided Flycatcher	LC	-
108.	*Nettapus coromandelianus*	Cotton Pygmy-goose	LC	EN
109.	*Numenius arquata*	Eurasian Curlew	NT	-
110.	*Nycticorax nycticorax*	Black-crowned Night-heron	LC	-
111.	*Oriolus chinensis*	Black-naped Oriole	LC	-
112.	*Otus sunia*	Oriental Scops-owl	LC	-
113.	*Pandion haliaetus*	Osprey	LC	-
114.	*Pelecanus philippensis*	Spot-billed Pelican	NT	EN
115.	*Pericrocotus cantonensis*	Brown-rumped Minivet	LC	-
116.	*Pericrocotus divaricatus*	Ashy Minivet	LC	-
117.	*Pericrocotus roseus*	Rosy Minivet	LC	-
118.	*Pernis ptilorhynchus*	Oriental Honey-buzzard	LC	-
119.	*Phalacrocorax carbo*	Great Cormorant	LC	-
120.	*Phylloscopus coronatus*	Eastern Crowned Warbler	LC	-
121.	*Phylloscopus inornatus*	Yellow-browed Warbler	LC	-
122.	*Phylloscopus plumbeitarsus*	Two-barred Warbler	LC	-
123.	*Phylloscopus schwarzi*	Radde's Warbler	LC	-
124.	*Pitta moluccensis*	Blue-winged Pitta	LC	-
125.	*Platalea minor*	Black-faced Spoonbill	EN	-
126.	*Plegadis falcinellus*	Glossy Ibis	LC	-
127.	*Rallina fasciata*	Red-legged Crake	LC	-
128.	*Riparia chinensis*	Asian Plain Martin	LC	-
129.	*Saxicola caprata*	Pied Bushchat	LC	-
130.	*Saxicola torquatus*	Common Stonechat	LC	-
131.	*Spatula clypeata*	Northern Shoveler	LC	-
132.	*Spatula querquedula*	Garganey	LC	-
133.	*Sternula albifrons*	Little Tern	LC	-

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book
134.	*Streptopelia tranquebarica*	Red Turtle-dove	LC	-
135.	*Sturnia sinensis*	White-shouldered Starling	LC	-
136.	*Surniculus dicruroides*	Fork-tailed Drongo-cuckoo	LC	-
137.	*Tachybaptus ruficollis*	Little Grebe	LC	-
138.	*Terpsiphone affinis*	Oriental Paradise-flycatcher	LC	-
139.	*Terpsiphone incei*	Chinese Paradise-flycatcher	LC	-
140.	*Threskiornis melanocephalus*	Black-headed Ibis	NT	VU
141.	*Treron curvirostra*	Thick-billed Green-pigeon	LC	-
142.	*Tringa erythropus*	Spotted Redshank	LC	-
143.	*Tringa glareola*	Wood Sandpiper	LC	-
144.	*Tringa guttifer*	Nordmann's Greenshank	EN	EN
145.	*Tringa nebularia*	Common Greenshank	LC	-
146.	*Tringa ochropus*	Green Sandpiper	LC	-
147.	*Tringa stagnatilis*	Marsh Sandpiper	LC	-
148.	*Tringa totanus*	Common Redshank	LC	-
149.	*Turdus obscurus*	Eyebrowed Thrush	LC	-
150.	*Turnix tanki*	Yellow-legged Buttonquail	LC	-
151.	*Upupa epops*	Common Hoopoe	LC	-
152.	*Xenus cinereus*	Terek Sandpiper	LC	-
153.	*Zapornia fusca*	Ruddy-breasted Crake	LC	-
154.	*Zapornia paykullii*	Band-bellied Crake	NT	-
155.	*Zapornia pusilla*	Baillon's Crake	LC	-
156.	*Zosterops palpebrosus*	Oriental White-eye	LC	-
157.	*Pangasius krempfi*	-	VU	-
158.	*Anguilla bicolor*	Shortfin Eel	NT	VU
159.	*Favonigobius reichei*	Indo-pacific Tropical Sand Goby	LC	-
160.	*Nematalosa nasus*	Bloch's Gizzard Shad	LC	VU
161.	*Caranx sexfasciatus*	Bigeye Trevally	LC	-
162.	*Ambassis urotaenia*	Bleeker's Glass Perchlet	LC	-
163.	*Scatophagus argus*	Spotted Scat	LC	-
164.	*Ostorhinchus lateralis*	Humpback Cardinal	LC	-
165.	*Glossogobius giuris*	Bareye Goby	LC	-
166.	*Nematalosa galatheae*	Galathea Gizzard Shad	LC	-

S/N	Scientific Name	Common Name	IUCN Category	Vietnam Red Data Book
167.	*Minyclupeoides dentibranchialus*	-	LC	-
168.	*Ophiocara porocephala*	Spangled Gudgeon	LC	-
169.	*Morone saxatilis*	Striped Bass	LC	-
170.	*Apogon hyalosoma*	Mangrove Cardinalfish	LC	-
171.	*Glossogobius aureus*	Golden Flathead Goby	LC	-
172.	*Zenarchopterus gilli*	-	LC	-
173.	*Anodontostoma chacunda*	Shortnose Gizzard Shad	LC	VU
174.	*Megalops cyprinoides*	Indo-Pacific Tarpon	DD	VU

Source: BirdLife International, 2019f; IUCN & IBAT, 2019.

Note: *EN – Endangered*
VU – Vulnerable
NT – Near Threatened
LC – Least Concern
DD – Data Deficient

APPENDIX C LIST OF INVASIVE SPECIES

S/N	Scientific Name	Class	System
1.	*Abrus precatorius*	Dicot	Terrestrial
2.	*Acacia farnesiana*	Dicot	Terrestrial
3.	*Acacia mangium*	Dicot	Terrestrial
4.	*Acanthogobius flavimanus*	Ray-finned fish	Freshwater
5.	*Acanthophora spicifera*	Red algae	Marine
6.	*Achatina fulica*	Gastropod	Terrestrial
7.	*Acridotheres tristis*	Bird	Terrestrial
8.	*Adenanthera pavonina*	Dicot	Terrestrial
9.	*Aedes aegypti*	Insect	Terrestrial
10.	*Ageratum conyzoides*	Dicot	Terrestrial
11.	*Alpinia zerumbet*	Monocot	Terrestrial
12.	*Alternanthera sessilis*	Dicot	Terrestrial
13.	*Anas platyrhynchos*	Bird	Freshwater and Terrestrial
14.	*Annona glabra*	Dicot	Terrestrial
15.	*Anoplolepis gracilipes*	Insect	Terrestrial
16.	*Anoplophora chinensis*	Insect	Terrestrial
17.	*Anser anser*	Bird	Freshwater and Terrestrial
18.	*Ardisia crenata*	Dicot	Terrestrial
19.	*Avian Influenza Virus*	-	Terrestrial
20.	*Azolla pinnata*	Fern	Terrestrial
21.	*Bacopa monnieri*	Dicot	Terrestrial
22.	*Banana bunchy top virus (BBTV)*	-	Terrestrial
23.	*Bidens pilosa*	Dicot	Terrestrial
24.	*Bothriochloa pertusa*	Monocot	Terrestrial
25.	*Brontispa longissima*	Insect	Terrestrial
26.	*Caesalpinia decapetala*	Dicot	Terrestrial
27.	*Carassius auratus*	Ray-finned fish	Freshwater
28.	*Cardamine flexuosa*	Dicot	Terrestrial
29.	*Casuarina equisetifolia*	Dicot	Terrestrial
30.	*Cenchrus echinatus*	Monocot	Terrestrial
31.	*Ceratophyllum demersum*	Dicot	Terrestrial
32.	*Cervus nippon*	Mammal	Terrestrial
33.	*Channa argus*	Ray-finned fish	Freshwater
34.	*Channa marulius*	Ray-finned fish	Freshwater

S/N	Scientific Name	Class	System
35.	*Chromolaena odorata*	Dicot	Terrestrial
36.	*Cinnamomum camphora*	Dicot	Terrestrial
37.	*Cipangopaludina chinensis*	Gastropods	Freshwater
38.	*Clarias batrachus*	Ray-finned fish	Freshwater
39.	*Clarias gariepinus*	Ray-finned fish	Freshwater
40.	*Coccinia grandis*	Dicot	Terrestrial
41.	*Colubrina asiatica*	Dicot	Terrestrial
42.	*Columba livia*	Bird	Terrestrial
43.	*Commelina benghalensis*	Monocot	Terrestrial
44.	*Ctenopharyngodon idella*	Ray-finned fish	Freshwater
45.	*Cynodon dactylon*	Monocot	Terrestrial
46.	*Cyperus rotundus*	Monocot	Terrestrial
47.	*Cyprinus carpio*	Ray-finned fish	Freshwater
48.	*Diaphorina citri*	Insect	Terrestrial
49.	*Dioscorea bulbifera*	Monocot	Terrestrial
50.	*Eichhornia crassipes*	Monocot	Terrestrial
51.	*Epipremnum pinnatum*	Monocot	Terrestrial
52.	*Ficus microcarpus*	Dicot	Terrestrial
53.	*Gallus gallus*	Bird	Terrestrial
54.	*Gambusia affinis*	Ray-finned fish	Freshwater
55.	*Gracilaria salicornia*	Red algae	Marine
56.	*Gracilaria vermiculophylla*	Red algae	Marine
57.	*Hemidactylus frenatus*	Reptile	Terrestrial
58.	*Herpestes javanicus*	Mammal	Terrestrial
59.	*Hygrophila polysperma*	Dicot	Terrestrial
60.	*Hypophthalmichthys molitrix*	Ray-finned fish	Freshwater
61.	*Hypophthalmichthys nobilis*	Ray-finned fish	Freshwater
62.	*Kappaphycus spp.*	Red algae	Marine
63.	*Leucaena leucocephala*	Dicot	Terrestrial
64.	*Ligustrum sinense*	Dicot	Terrestrial
65.	*Limnophila sessiliflora*	Dicot	Terrestrial
66.	*Lutjanus kasmira*	Ray-finned fish	Marine
67.	*Lygodium japonicum*	Fern	Terrestrial
68.	*Lygodium microphyllum*	Fern	Terrestrial
69.	*Macaca mulatta*	Mammal	Terrestrial

APPENDIX D LIST OF INVASIVE SPECIES

S/N	Scientific Name	Class	System
70.	*Maconellicoccus hirsutus*	Insect	Terrestrial
71.	*Melastoma candidum*	Dicot	Terrestrial
72.	*Mimosa diplotricha*	Dicot	Terrestrial
73.	*Mimosa pigra*	Dicot	Terrestrial
74.	*Mimosa pudica*	Dicot	Terrestrial
75.	*Misgurnus anguillicaudatus*	Ray-finned fish	Freshwater
76.	*Monomorium floricola*	Insect	Terrestrial
77.	*Monopterus albus*	Ray-finned fish	Freshwater
78.	*Neyraudia reynaudiana*	Monocot	Terrestrial
79.	*Nypa fruticans*	Dicot	Terrestrial
80.	*Oreochromis*	Ray-finned fish	Freshwater
81.	*Oreochromis mossambicus*	Ray-finned fish	Freshwater
82.	*Oryctes rhinoceros*	Insect	Terrestrial
83.	*Oxalis corniculata*	Dicot	Terrestrial
84.	*Paederia foetida*	Dicot	Terrestrial
85.	*Panicum repens*	Monocot	Terrestrial
86.	*Paratrechina longicornis*	Insect	Terrestrial
87.	*Paspalum vaginatum*	Monocot	Terrestrial
88.	*Passiflora foetida*	Dicot	Terrestrial
89.	*Pheidole megacephala*	Insect	Terrestrial
90.	*Pistia stratiotes*	Monocot	Terrestrial
91.	*Poecilia reticulata*	Ray-finned fish	Freshwater
92.	*Pomacea canaliculata*	Gastropod	Freshwater
93.	*Pomacea insularum*	Gastropod	Freshwater
94.	*Porphyrio porphyrio*	Bird	Freshwater and Terrestrial
95.	*Prosopis*	Dicot	Terrestrial
96.	*Prunus campanulata*	Dicot	Terrestrial
97.	*Psidium guajava*	Dicot	Terrestrial
98.	*Psittacula krameri*	Bird	Terrestrial
99.	*Pterois volitans*	Ray-finned fish	Marine
100.	*Pterygoplichthys multiradiatus*	Ray-finned fish	Freshwater
101.	*Pterygoplichthys pardalis*	Ray-finned fish	Freshwater
102.	*Pterygoplichthys spp.*	Ray-finned fish	Freshwater
103.	*Pueraria montana var. lobata*	Dicot	Terrestrial
104.	*Pycnonotus cafer*	Bird	Terrestrial

S/N	Scientific Name	Class	System
105.	*Pycnonotus jocosus*	Bird	Terrestrial
106.	*Pyrus calleryana*	Dicot	Terrestrial
107.	*Python bivittatus*	Reptile	Terrestrial
108.	*Quadrastichus erythrinae*	Insect	Terrestrial
109.	*Rhodomyrtus tomentosa*	Dicot	Terrestrial
110.	*Rottboellia cochinchinensis*	Monocot	Terrestrial
111.	*Rubus moluccanus*	Dicot	Terrestrial
112.	*Rubus niveus*	Dicot	Terrestrial
113.	*Rusa unicolor*	Mammal	Terrestrial
114.	*Sagittaria sagittifolia*	Monocot	Terrestrial
115.	*Solenopsis geminata*	Insect	Terrestrial
116.	*Striga asiatica*	Dicot	Terrestrial
117.	*Syzygium cumini*	Dicot	Terrestrial
118.	*Tapinoma melanocephalum*	Insect	Terrestrial
119.	*Terminalia catappa*	Dicot	Terrestrial
120.	*Trachemys scripta elegans*	Reptile	Freshwater and Terrestrial
121.	*Trapa natans*	Dicot	Terrestrial
122.	*Tubastraea coccinea*	Sea anemone and coral	Marine
123.	*Urochloa maxima*	Monocot	Terrestrial
124.	*Urochloa mutica*	Monocot	Terrestrial
125.	*Viverricula indica*	Mammal	Terrestrial
126.	*Xanthomonas axonopodis pv.citri*	Bacteria	Undefined
127.	*Xylosandrus compactus*	Insect	Terrestrial
128.	*Yersinia pestis*	Bacteria	Terrestrial
129.	*Zizania latifolia*	Monocot	Terrestrial
130.	*Zostera japonica*	Monocot	Terrestrial
131.	*Zosterops japonicus*	Bird	Terrestrial

Source: GISD, 2019

APPENDIX D SUBCONTRACTORS' REPORTS

(SEPARATE FILE)

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APPENDIX E CRITICAL HABITAT SCREENING ASSESSMENT

S/N	Class Name	Scientific Name	Common Name	IUCN	Criterion			Species Information	CH Screening Results
					1	2	3		
1.	Bird	*Accipiter badius*	Shikra	LC OR LR/LC			X	This migratory species occurs in a variety of habitat types including savannah, grassland, shrub land and forest. It occurs in countries such as Angola, Zimbabwe and Malawi in the non-breeding season. In the breeding season the species is known to occur in Afghanistan, Azerbaijan, Bangladesh, Bhutan, Cambodia, China, India, Kazakhstan, Kyrgyzstan, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Tajikistan, Thailand, Turkmenistan, Uzbekistani. It is also found throughout Vietnam. Species distribution includes the Project Area. The EOO is 62,500,000km2. The global population of mature individuals is estimated to be between 500,000 and 999,999 mature individuals and is considered stable.	Considering the very large EOO in comparison to the proportionally small Project EAA and the large and stable population size, it is unlikely that the Project EAA would sustain, on a cyclical or otherwise regular basis, ≥ 1 % of the global population or support ≥10 % of the global population of a species during periods of environmental stress. Therefore, the Project EAA is unlikely to contain critical habitat for this species.
2.	Bird	*Accipiter gularis*	Japanese Sparrowhawk	LC OR LR/LC			X	This migratory species occurs in a variety of habitat types including forest, shrub land and inland wetlands. This species winters in Vietnam. In the breeding season the species is known to occur in China, Japan, Korea, Mongolia and the Russian Federation.	Considering the very large EOO in comparison to the proportionally small Project EAA and the stable population, it is unlikely that the Project EAA would sustain, on a cyclical or otherwise regular basis, ≥ 1 % of the global population or support ≥10 % of the global population of a species during

APPENDIX E BIODIVERSITY SURVEY REPORT – WET SEASON

Biodiversity survey for Thanh Hai Windfarm Project, Thanh Phu District, Ben Tre Province, Vietnam

Prepared for:

Environmental Resources Management Vietnam Ltd. (ERM)

Hochiminh City, October 2019

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Acknowledgement

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- Mrs. Tram Le for an amazing field coordinating;
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- Mr Phat Tran for joining the bird and bat survey;
- ERM team for coordinating this study.

1 Introduction

1.1 Background

Environmental Resources Management Vietnam Ltd. (ERM) is preparing an Environmental and Social Impact Assessment (ESIA) for Thanh Hai Windfarm Project at Thanh Phu District, Ben Tre Province. Following the scope of this work, a Critical Habitat Assessment (CHA) has been undertaken to identify critical habitats for flora and fauna in the Project area. The preliminary CHA identified the coast mangrove, intertidal mudflats and near shore sea in the project area and its vicinity are potentially accommodating a significant biodiversity, as well as providing important ecological service for local communities. This triggers further investigation on the current status of windfarm-sensitive fauna (such as birds and bats) and special CHA concerned species (such as Hairy-nosed otter, Southern river Terrapin). Additionally, because the project will take place in a sea area, benthic and pelagic ecosystems can potentially be disturbed. Information on indicating fauna, such as marine megafauna (sea turtles, sharks and rays, marine mammals) and macrobenthos, are also needed for CHA and ESIA process.

On the request of Environmental Resources Management Vietnam Ltd. (ERM), the Conservation In Motion Social Enterprise Ltd. (CIM) have conducted an multidisciplinary survey to acquire baseline data for concerned ecological groups.

The survey was conducted in accordance with IFC PS 6 standard to identify the presence, distribution and current status of the species within the Project area. This will serve as a baseline for biodiversity impact assessment of the ESIA.

1.2 Objectives

The objectives of this surveys are to:

- Providing a brief literature review on distribution of birds, bats, marine megafauna and macrobenthic community in the project area and its vicinity;
- Acquiring baseline data on the distribution and abundance of birds, bats, marine megafauna and macrobenthos in the project area and its vicinity;
- Acquiring baseline data on the intensive of birds and bats activities in the project area to aid the impact assessment process;
- Rapidly assessing the vegetation coverage and identifying critical flora habitat in the project area and under the transmission line;
- Preparing for the development of potential mitigation measures.

1.3 Study Area

The Thanh Hai windfarm project is a nearshore windfarm development which will take place in Thanh Phu District of Ben Tre Province, Vietnam. The turbine cluster will be constructed at less than 01km from the shoreline (Figure 1).

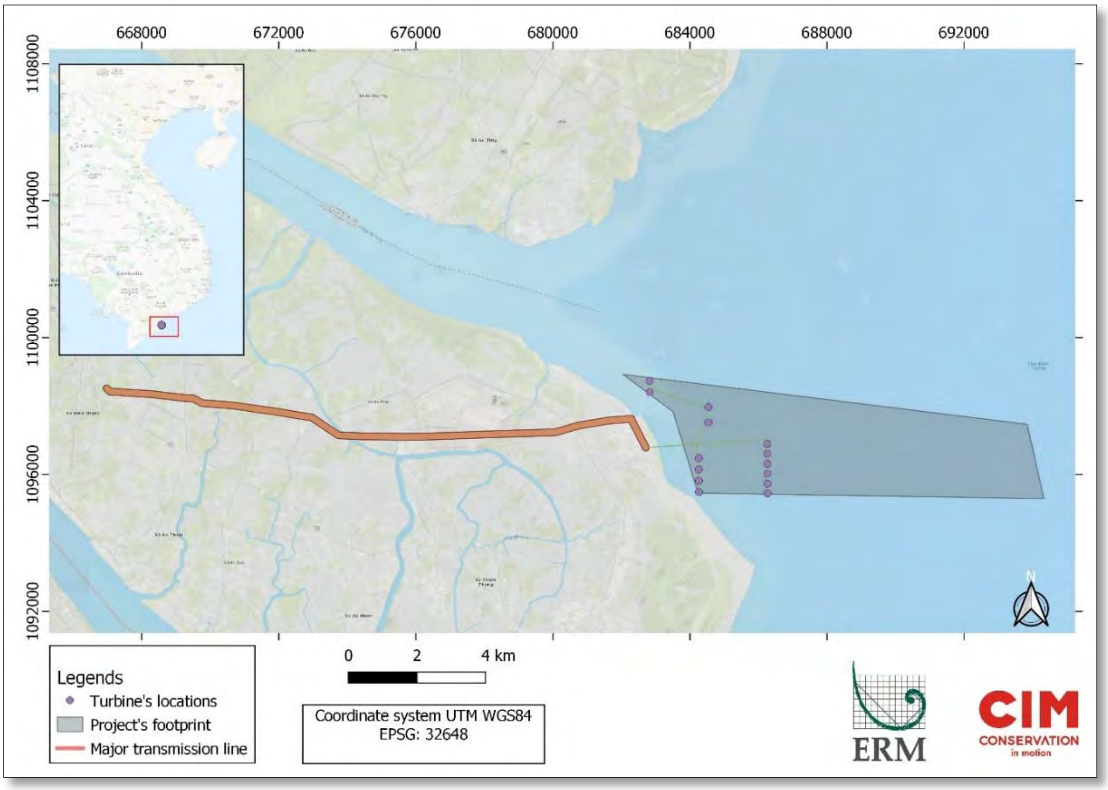


Figure 1: Overview of Thanh Hai windfarm project

2 Methods

2.1 Desktop Study

2.1.1 Systematic search

For assessing the potential impacts of the project on concerned taxa, systematic searching was performed to assess and extract relevant information on available literatures. Relevant information regarding distribution and abundance of birds, bats, marine megafauna and benthic were acquired from both peer-reviewed articles and grey literatures.

Search were performed in both Vietnamese and English languages. For peer-reviewed articles, English search strings were used for multiple international (e.g. Wed of Science, Science Direct, Willey Online Library, NRC Research Press), while Vietnamese ones were used for domestically academia databases (e.g. Tap chi Sinh hoc-Academia Journal of Biology). For grey literature, only articles from creditable organizations that have been recognized in field of bat science or biodiversity studies (Bat Conservation International, Fauna and Flora International - FFI, International Union for Conservation of Nature -IUCN, World Wild Fund for Nature – WWF, Wildlife Conservation Society – WCS…) were included. Additionally, published reports or articles of local authorities, namely Department of Agriculture and Rural Development (DARD), Department on Nature Resources and Environment (DONRE), Department of Science and Technologies.

When possible, grey literatures were located on organization database using similar search strings that were used for peer-reviews database. Otherwise, they were manually located through scanning the websites.

Articles returned from databases were scanned for species names, location (or coordinates) of the records, location of stored specimen (if applicable), pictures and author notes on encountered situation. Attempts will be made to filter and validate data and information. Impact assessment will only be develop based on creditable information.

2.1.2 Database review

The three most reliable and most updated biodiversity databases were scanned to obtain relevant information regarding the potential occurrences, distribution and abundance of concerned taxa in the project area and its vicinity. Those databases were:

- Database of species distribution range of species from the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species" (available at: https://www.redlist.org/)
- Occurrence database of the Global Biodiversity Information Facility- GBIF (available at: https://www.gbif.org/)
- Bird Of The World – BOTW database (available at: http://www.BirdLife.org/)

As the IUCN Redlist and BOTW provide data in form of distribution range (polygons in ESRI shape files format), attempt is made to identify all species that have their known distribution range extended to the project area (up to the level of Thanh Phu District of Ben Tre Province province) (Figure 2 and Figure 3). Since IUCN and BOTW provide the very same data for birds, this report only uses the BOTW were used to comprehend the potentially occurrence of birds in Thanh Hai area. In contrast to the IUCN Redlist data, GBIF data is provided in points format, in which each point represents a location where specimen is collected, or an expert successfully identified a species (e.g. through photographs or acoustic record). To extract relevant data, three circles with radius of 25km, 50km and 100km were drawn around the project area. Species which were recorded within 25km radius from the project are most likely also present in the project area. Species which were recorded within 25km to 50km range from the project have relatively high probability to also occur in the project area, but their occurrence need to be clarified. Finally, species which were recorded within 50km to 100km range from the project will be considered as potential occurred species.

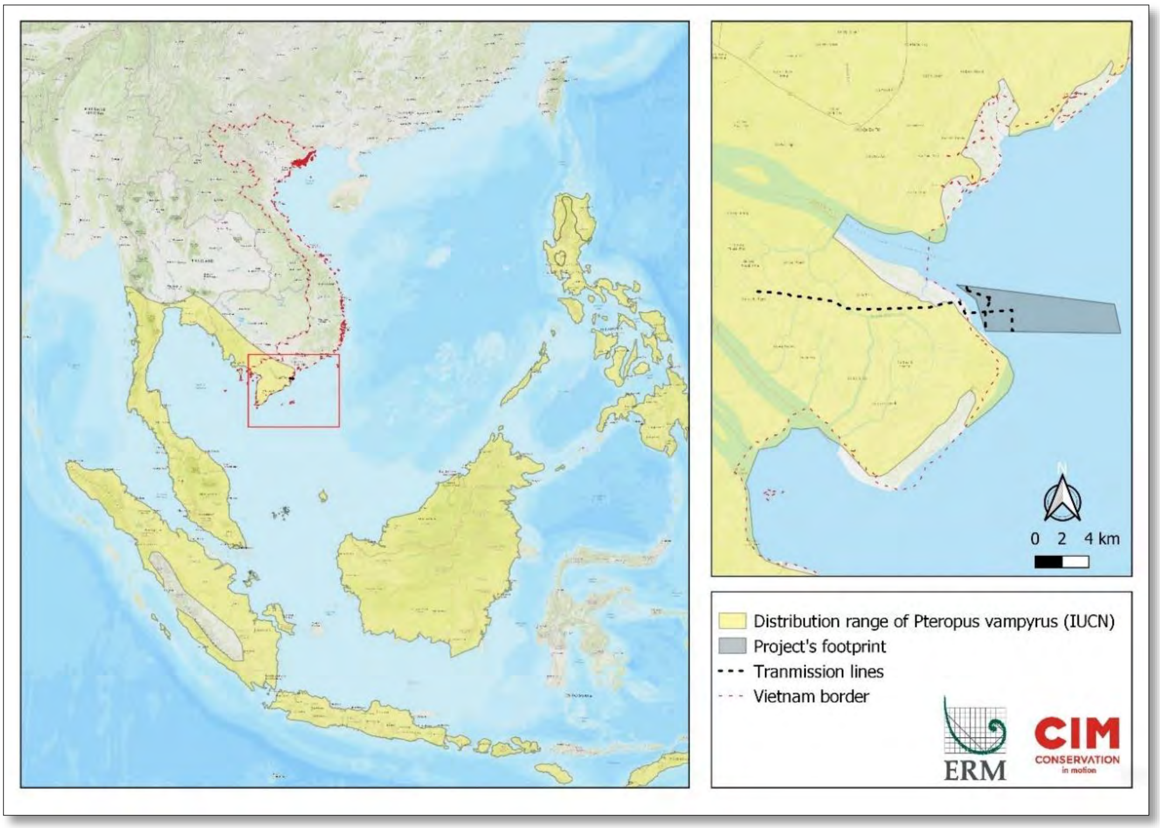


Figure 2: IUCN-published distribution range of Pteropus vampyrus overlapping with the project area

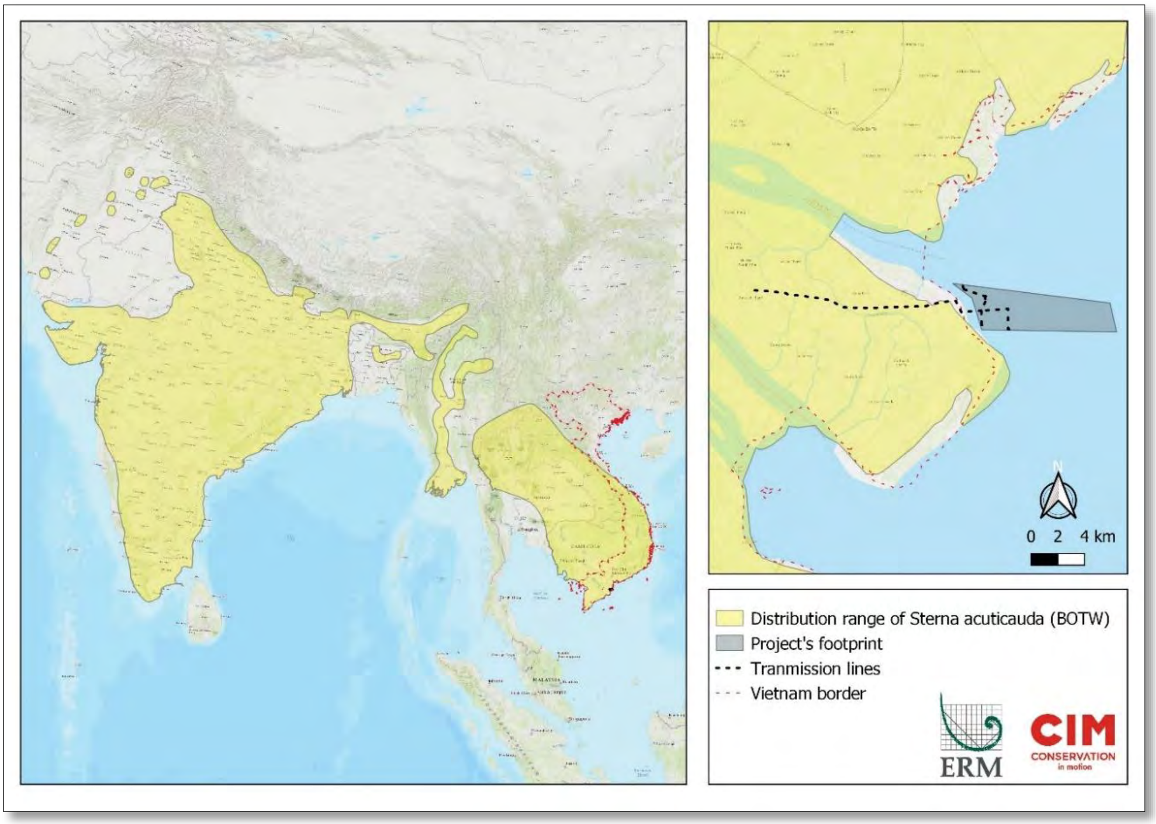


Figure 3: BOTW-published distribution range of Sterma acuticaudata overlapping with the project area

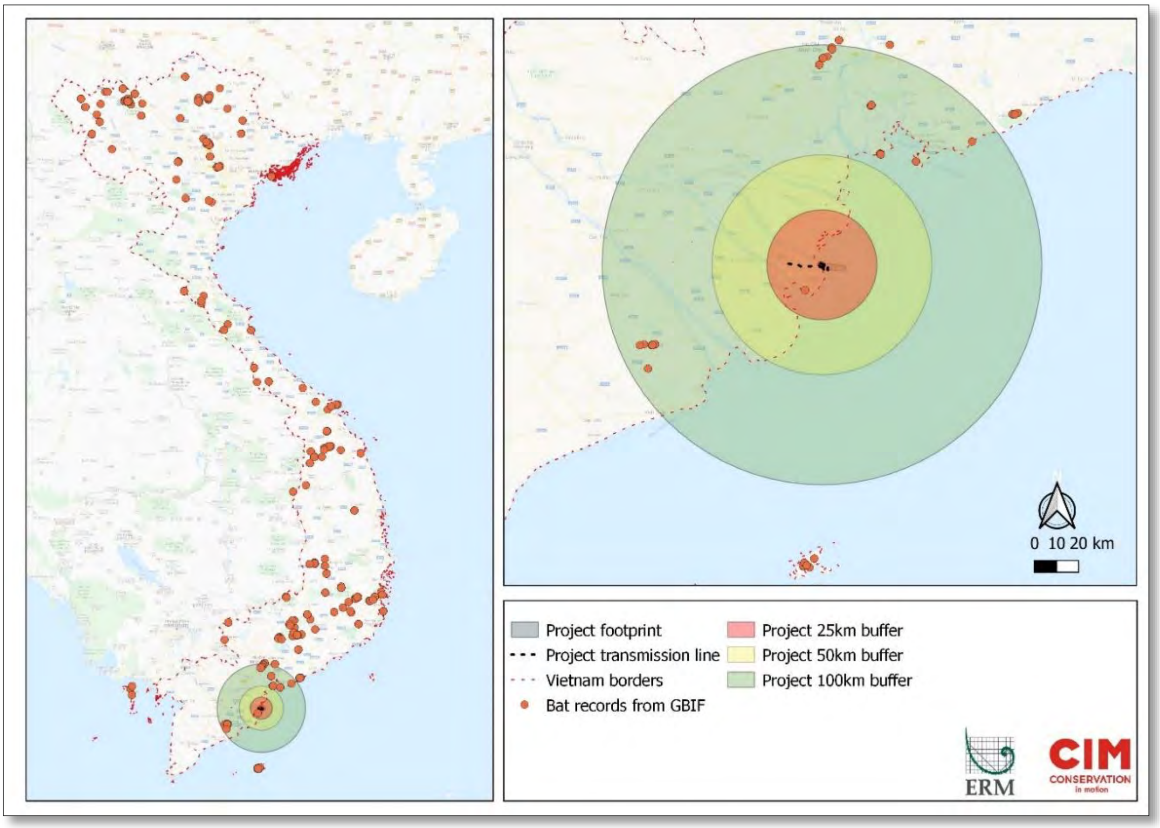


Figure 4: Bat records in GBIF database

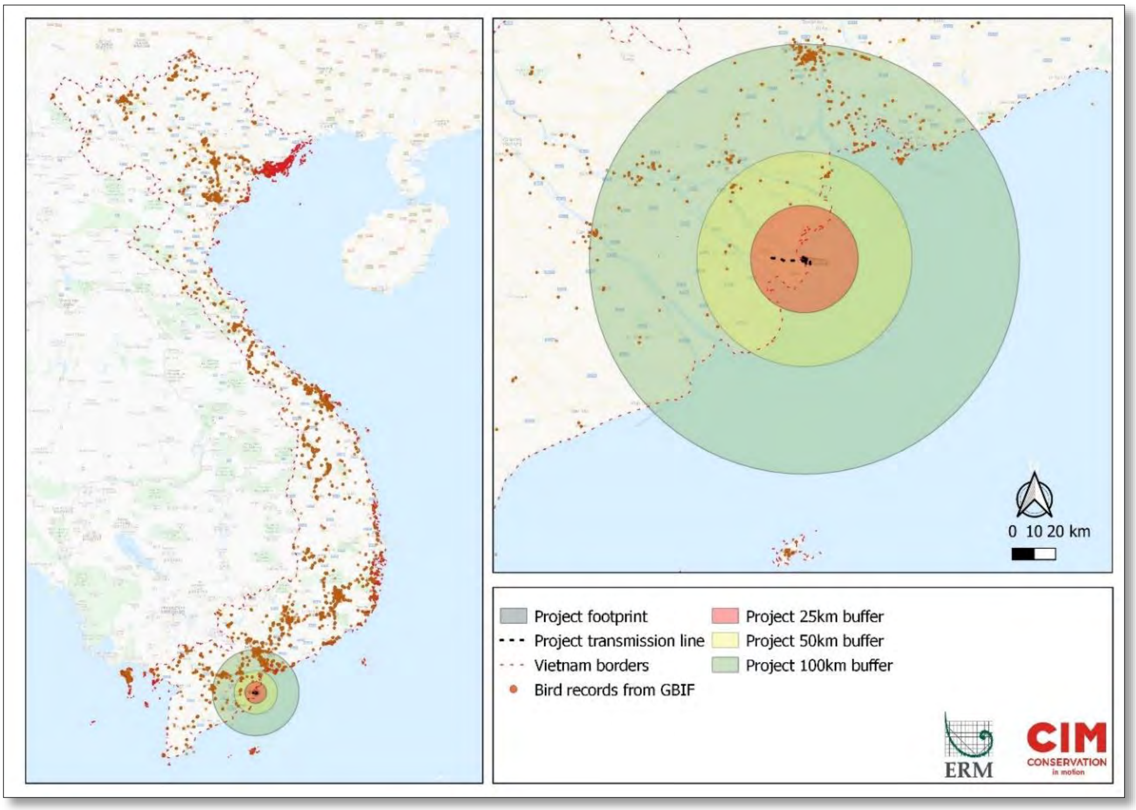


Figure 5: Bird records from GBIF database

2.2 Remote sensing

Remote sensing approach were used to comprehend vegetation cover proposed transmission line. To assess the thickness or healthiness of vegetation canopy within the project area vicinity, we used Landsat 8 satellite image with resolution 30m per pixel acquired prior to this study (Figure 6). Eight bands included were 5 visible and near-infrared (VNIR) bands and 2 short-wave infrared (SWIR) bands processed to orthorectified surface reflectance, and two thermal infrared (TIR) bands processed to orthorectified brightness temperature. Normalized difference vegetation index (NDVI), which represent the vegetation cover, was calculated from the Landsat data by the following formula:

NDVI = (NIR-Red)/(NIR+RED)

where Red and NIR present the reflectance measurements of red (visible) and near infrared spectrums, respectively (NASA 2000). Calculated NDVI will resulted in a raster which each pixel has assigned value from -1 to 1, where values within -1 to 0 range are unlikely vegetation cover, and values within 0 to 1 represent vegetation cover. The healthier vegetation cover is, the thicker canopy it has. Thicker canopy will have higher NDVI value. Special examination was given the area of 100m buffer from the transmission line.

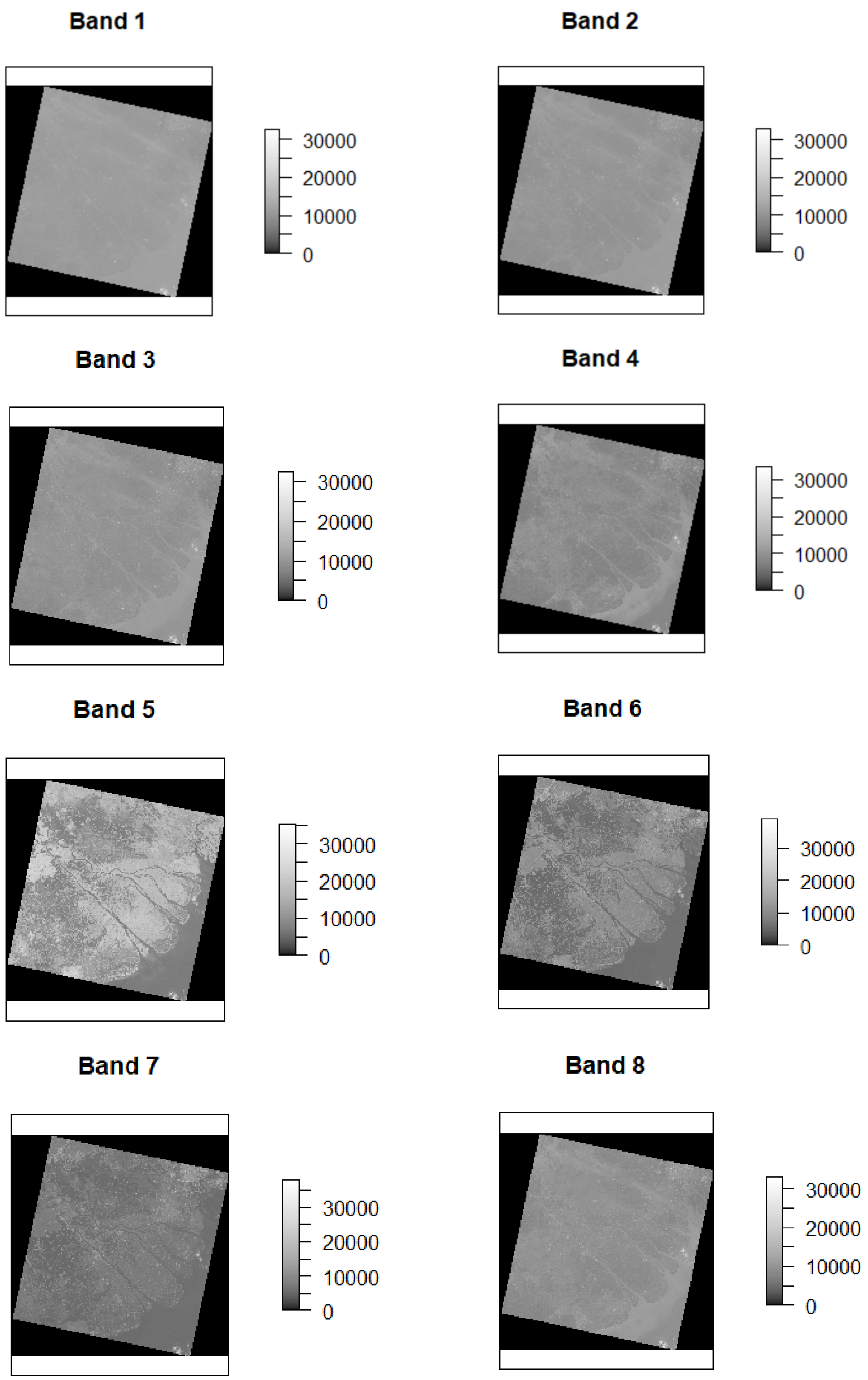


Figure 6: Eight-band Landsat satellite image acquired from Earth Explorer Platform

In addition to NDVI analysis, QGIS version 3.2 with Semi-Automatic Classification (SAC) plugin was used to discriminate different land types based on the flora survey data and infrared reflections calculated from acquired Landsat 08 image. Minimum likelihood algorithm was used to automatically classify all pixel within the 100m buffer zone of transmission line into predetermined categories based on the spectral values stored in Landsat image. Algorithm training were performed manually by selecting different region of interest (ROI) which associated with different land type or vegetation cover. The reliability of SAC model was validated by comparing with data from rapid field visisting (also known as ground-truing process).

2.3 Field survey

The field survey was designed to rapidly acquired reliable baseline data on concerned organisms. The whole field survey was divided into three main components which were vantage point survey for birds (focused on shorebirds), boat-based line transect survey (for seabirds and marine megafauna) and macrobenthos survey. The overall survey design was presented in Figure 7.

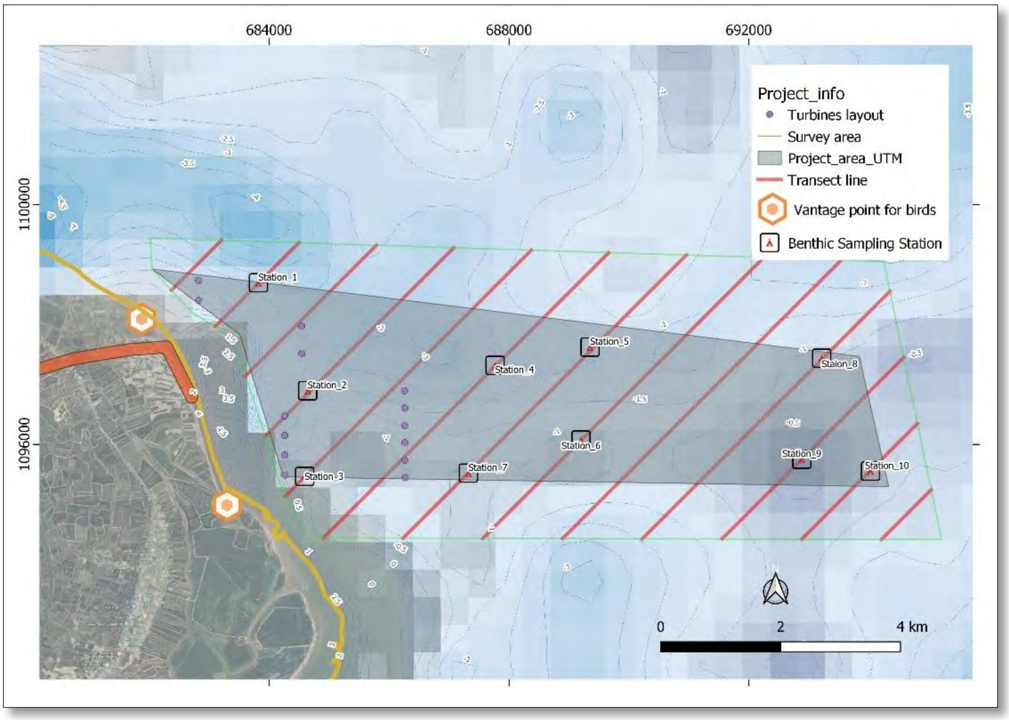


Figure 7: Different surveys designs used for assessing baseline data on the biodiversity in the project

2.3.1 Vantage point survey for birds

Vantage points survey was used to investigate overlap between avifauna's movements and the project area. Two vantage points, namely V1 and V2, were located in the lower border of the project area (Figure 8 and Table 1). Views at each vantage point are showed in Figure 9. At each point, one experienced bird observer equipped with 7x50 built-in-compass-and-reticle binocular and high-magnification 20x80 binocular would station and actively scan the whole area within 02km radius from the vantage point for avifauna's activity. Once a bird or group of birds were sighted, the observer would draw the flight path, relative to the ground as if looking down on the site from above into a pre-printed record sheet. For each sighting, observed birds were identified to lowest-as-possible taxonomic level. Information on species, number of birds in the flight; start time and end time of flight; height of the flight in 15 second intervals; type of flight (flapping, soaring, gliding) and notes on activity/behaviour were all recorded. Height of each observed flight was categorised in three height bands: band 1 (below rotor height, <35m), band 2 (at rotor height, 35-150m) and band 3 (above rotor height, >150m). Total flying times were calculated for all bands in each vantage point.

Table 1: Two vantage points for avifauna in September 2019

No.	Sites	Easting	Northing
1	V1	681874.042	1098094.683
2	V2	683296.58	1094986.744

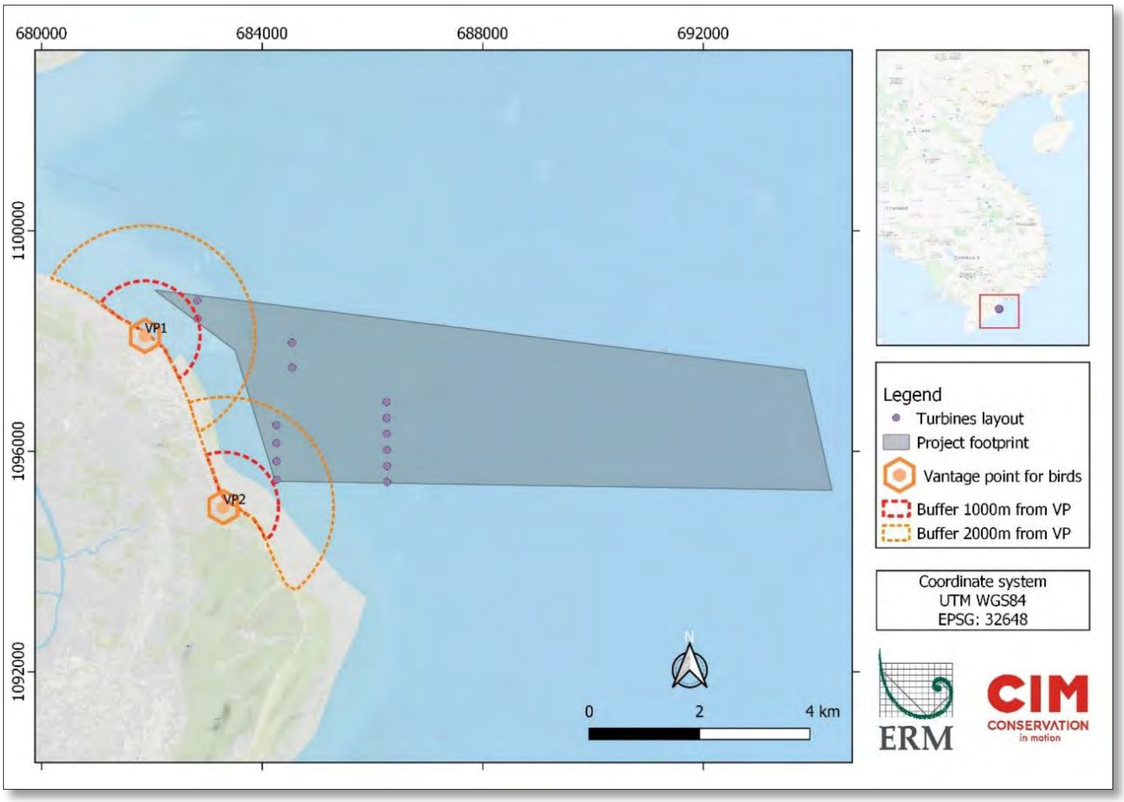


Figure 8: Locations of two vantage points used in rainy season 2019 survey

Figure 9: Views at vantage points used for this survey

All flying paths were digitigized into shape files (.shp) for further analysis in QGIS 3.6.1. To visualize the density of bird traffic in the project area and its vicinity, a coveraage grid with 250m x250m cells were generated over the effectively observing area. Total length of bird flying paths (in meter) that intercepted with each cells were calculated using the “Sum line length” function in the Vector analysis toolkit of QGIS 3.6. Number of birds observed in each record were used to weight the avian traffic caculation. For example, the flock of 100 birds will have more influence on the final results rather than a folck of 02. Cells with higher value were presented with darker red color, while those with lower values were showed with lighter red shades. The result was a trafic density map that shows the traffic of birds (measured by meter) in the observed area.

2.3.2 Boat-based line transect survey for seabirds and marine megafauna

The DISTANCE sampling (Buckland et al. 1993) was used to assess distribution and abundance of seabirds and marine megafauna (marine mammals, sea turtles, sharks and rays) in the project area. Data were collected using visual boat-based surveys following predefined line transects, a form of distance sampling (Buckland et al. 1993, 2001, 2015; Dawson et al. 2008). Parallel line transects were designed to systematically cover the study area, over a variety of depths intervals (Figure 10 and Figure 11). Start points of each transects will be randomly generated using DISTANCE software (Buckland et al. 2001). The research vessel will follow these predesigned transect lines to fully cover the whole study area. During the survey, a minimum of three observers will be stationed at the bow, port and starboard sides of the boat to scan the surrounding for birds. Search speed will be maintained below 15km/h at a consistent speed.

For each flock of birds, each schools of dolphins or each sea turtle encountered during the line transect survey (refer to as “on-effort sighting”), observers will record location, radial distance between the boat and the group, as well as the angle to the group, and group composition (e.g. the number of animals, height of their flight etc.). Sightings recorded when the boat is not on predetermined transects were categorized as off effort sightings and were not used for abundance estimation or modelling.

For all on-effort sighting, the perpendicular distances between the observed animals (Figure 10) were calculated from the radial distance between the survey vessel to the animals and the angle form by the transect line with the line drawn from the boat to the animal using conventional geometry formula: Perpendicular distance = Distance to group x sin (angle).

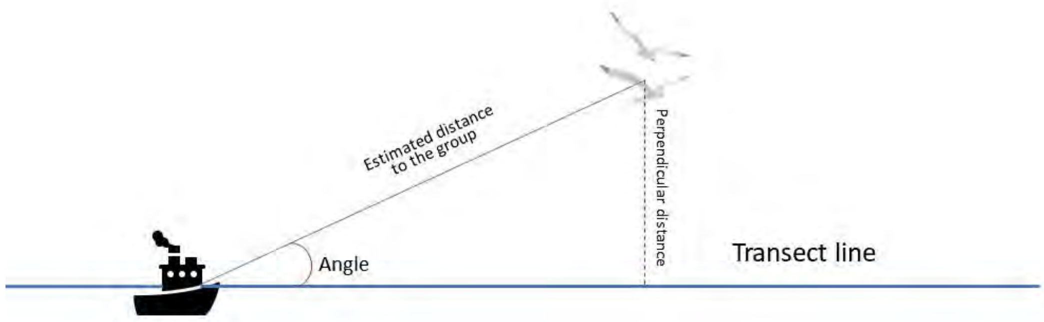


Figure 10: Data were collected using visual boat-based surveys following predefined line transects

All calculated perpendicular distances and their associated sighting information (e.g. group size, length of the transect lines where sighting was made…) were used to fit a detection function, which allow estimating abundance of seabird in the survey area (Buckland et al. 2001). This method based on the assumption that the probability of detecting the animal will decrease as perpendicular distance from the animal to the transect line increase. A detecting function allows estimation of the average detection probabilities in the surveyed area. Based on the combination of the number of detected animals, the average detection probabilities in surveyed area and survey design, we can reliably estimate the abundances of seabird in study area for the study period (Buckland et al. 2001, 2015).

To simplify the model fitting process, we only use two most major models in Distance sampling, which were the Half-normal model with cosine adjustment and Hazzard- rate model with cosine adjustment, to fit seabird sighting data. Model selection was based on AICc (Pan 2004). All model fittings were conducted in DISTANCE software version 7.0 (Thomas et al. 2010).

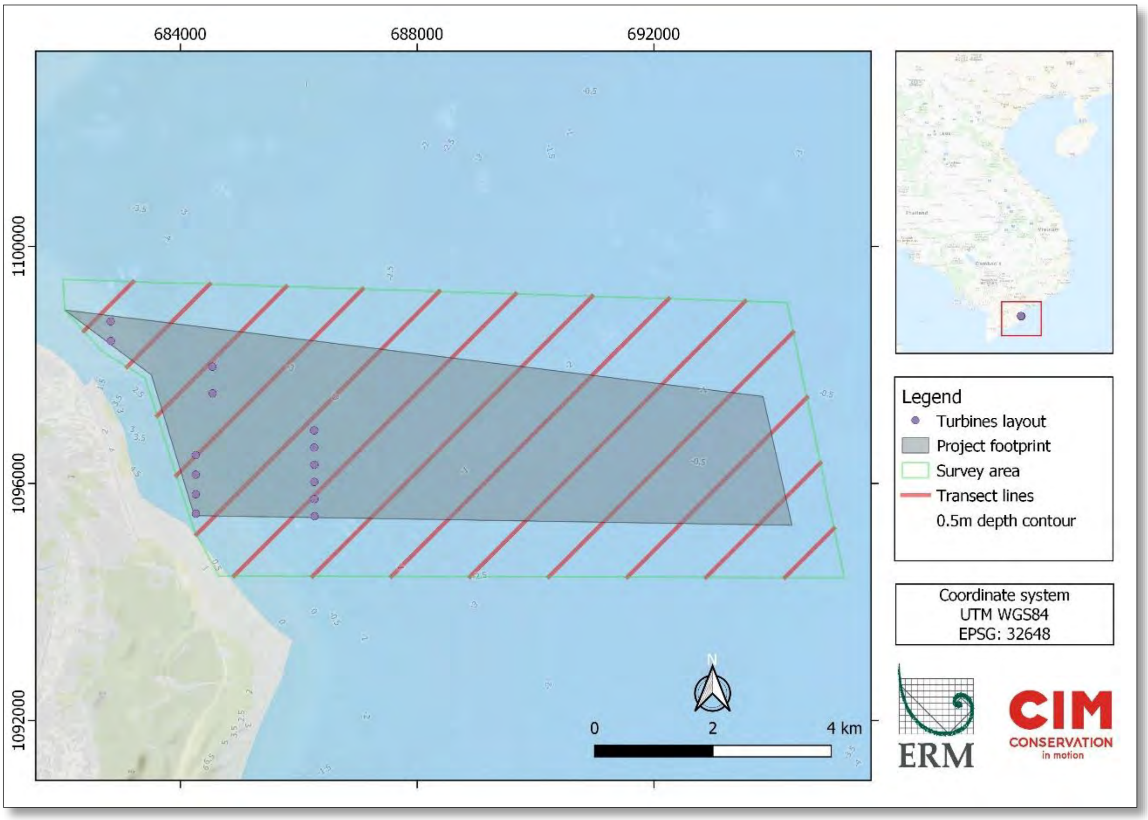


Figure 11: Pre-designed parallel line transects used for the survey.

Best fitted detected function was later used to construct Densitiy Surface Model (DSM), which allows predicting spatial distribution of bird density within the survey area (Miller et al. 2013b). Model construction was done in R version 3.5.1 software (R Core Team 2018) with DSM package (Miller et al. 2019). In this study, we only constructed the simplest model, using best detecting function and geographical coordinates (in UTM WGS84/ Zone 48P) to identify and visualize potential hotspot for seabird distribution within the survey area. Specifically, the survey area was divided into 1112 grid-cells (400m x 400m size). Central coordinate (Northing and Easting, or X and Y in UTM WGS84/ Zone 48P) of each cell was extracted and used as covariates for model fitting. Seabird density for each cell were predicted by the best fitted DSM model.

2.3.3 Macrobenthos survey

To collected baseline data regarding the macrobenthic community in the project area, a sampling design will be used to understand the variety in macrobenthic community diversity and abundance in the project footprint, Thanh Hai, Ben Tre province (Figure 1). Sampling stations were designed to represent different depth intervals, different distance to the shore and different distance to the river mouth.

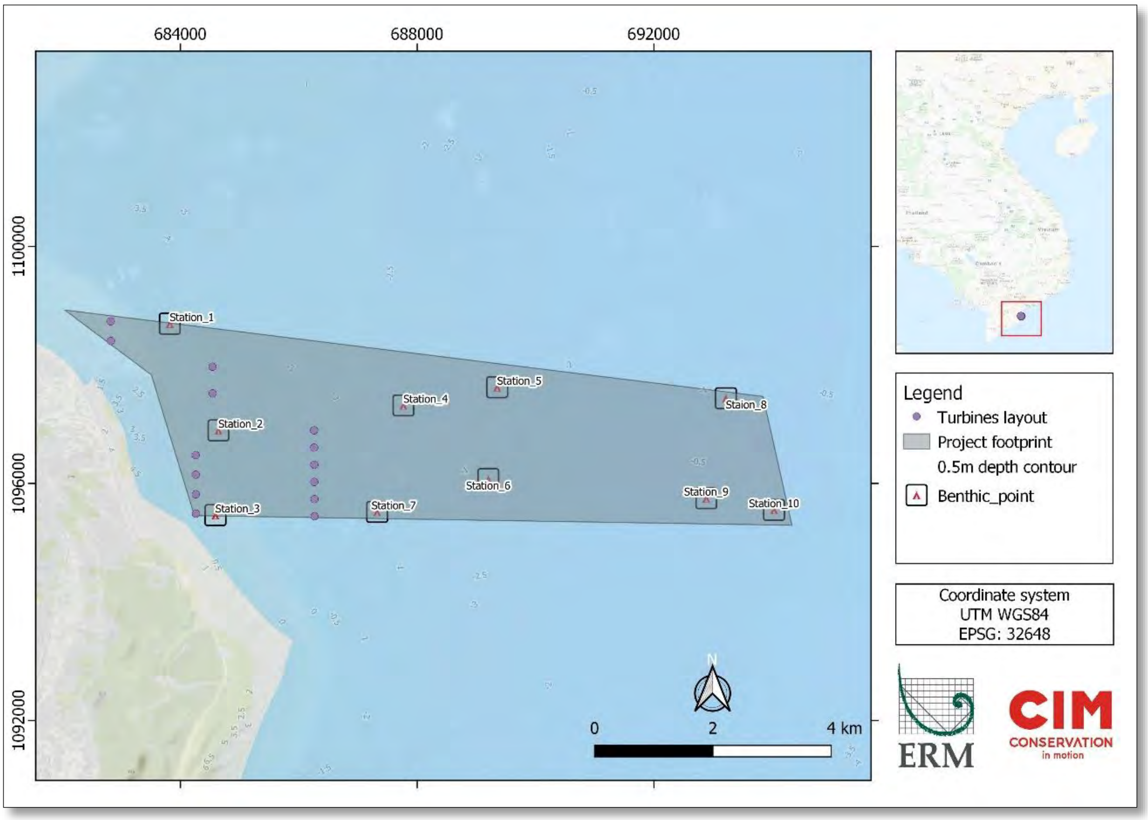


Figure 12: Map of benthic sampling stations

Sampling: Macrobenthos were sampled using Ponar grab (sampling footprint 225cm^2, Figure 2). For each predetermined sampling station, three grabs will be taken at each station to increase the probability of collecting representative benthic samples. Qualified grab sample must be filled at least two-thirds of the grab volume.

Due to the time and resources constrains, grab samples were sieved on the boat. A sieve with mesh 10µm were used to retain macrobenthic organisms. Sediment particle that passed through the sieve were discarded after sieving. The remained materials were fixed in 7% formalin solution and dyed with Lugol. Samples were transferred back to Ho Chi Minh city for analyzing. All macrobenthic organisms recorded from samples were identified to the furthest taxonomic group as possible. Number of species, number of individuals of each species, and wet biomass measurements will be recorded for each grab. Total number of species, total abundance of (number of individual of each species per 225cm^2), and total biomass (g/225cm^2) were calculated for each station.

Figure 13: Ponar grab (footprint 15cm x 15 cm) used for macrobenthic sampling

Data analyzing:

Benthic community description: To scientifically describe the macrobenthic community of the project area, species or taxon richness (number of species per 0.0675m^2) and density (number of species per 0.0675m^2) will be calculated for each station. Additionally, biodiversity indices will be calculated for pooled benthic assemblages in each station to condense a complex community dataset into comparably univariate valued. This process would reveal two important aspects of community structure (i) species or taxon richness, (ii) abundance macrobenthos and (iii) comparable biodiversity of the assemblage (diversity, evenness or equability). For each station, three commonly used biodiversity indices, including:

- ***Shannon-Wiener information function, H(s)***

$$H(s) = \frac{C}{N} \times \left\{ N \log_{10}(N) - \sum_{i=1}^{s} n_i \log_{10}(n_i) \right\}$$

Where

C	:	=3.321928 (constant used in converting $\log_{10}$ to $\log_2$)
N	:	The total number of individual
n_i	:	The number of individuals in the ‘ith’ species
s	:	The total number of species

- ***Pielou’s evenness index, J***

$$J = \frac{H_S}{H_{\max}}$$

Where	H(s)	:	The Shannon-Wiener information function
	H(max) :		The theoretical maximum value for H(s) if all species in the sample are equally abundant.

- ***Simpson’s Dominance Index, C***

$$C = \sum_{i=1}^{s} \left(\frac{n_i}{N} \right)^2$$

Where n_i : The number of individuals in the 'ith' species

N : Total number of individuals

s : Total number of species

The Simpson's index was chosen because of its sensitivity to changes of most abundant species. High Simpson's dominance index (more than 0.5) reflects that certain species dominated. The Shannon-Weiner index was chosen because it gives less common species greater weight (Peet 1971 in Spencer et al. 1998). More diverse macrobenthic assemblages would have higher Shannon-Wiener index. Finally, The Pielou's index of evenness refers to how close in numbers each species in an assemblage is. The higher Pielou's index is, the closer abundances of each species within the assemblages are.
In addition to biodiversity indices, The SIMPER (similarity percentages) analysis will be used to identify which taxa contributed the most to the similarity (cut-off set of 70% contribution to total similarity) of benthos community within each depth category (Warwick & Clarke 1991).

Similarity analysis: To better informing the ESIA process, it is important to understand the variability of macrobenthic in the project area and the environmental factor that contribute to such variation. For that multivariate statistical Cluster analysis, using Bray-Curtis similarity matrix, will be performed on the abundance data of sampling stations. The process involved calculating Bray-Curtis similarity index for each station, arranging calculated similarity indices into a resemblance matrix, and a dendrogram will be constructed based on their similarity. In conjunction with cluster analysis, non-metric Multidimensional Scaling (nMDS) ordination were used to visualize the similarity in structures of macrobenthic assemblages at different stations.

Characteristics of benthic community were related to the environmental parameters measured (Kaiser et al. 2004) at each station using BIO-ENV procedure (Warwick & Clarke 1991). BEST package using Spearman Rank correlation method will be applied to match environmental similarity matrix constructed from single (depth, distance to shoreline and distance to the river mouth) or different combinations of environmental variables with the biological similarity matrix generated from abundance data (Warwick & Clarke 1991; Seiderer & Newell 1999). BEST's result reveal which environmental parameters were responsible for the dissimilarity observed in the dataset.
All of the mentioned analysis were performed in R 3.6.2 (R core team 2019), using package 'Vegan' (Oksanen et al. 2019).

Mapping: After identifying the key environmental parameter(s) that were responsible for the benthic variations, attempt was made to map the benthic abundance in the project area base on the available environmental data (e.g. depth). Spatial modelling process will be used to predict macrobenthic distribution and abundance in the project area, thus producing benthic prediction maps that can be used to inform ESIA process.

2.3.4 Bat survey

Acoustic transect, monitoring station and mist-netting methods were used in combination to records bat's activities in the project area and its vicinity.

Transect survey: Four transect lines were used to survey bat's activities and activities in Thanh Hai Windfarm Project's area and its vicinity (Figure 14). Because the survey area was heavily divided by ponds and channels, transects could only follow existed trails. Surveyors followed the transects and carried the EchoMeter Pro (Wildlife Acoustic, USA) that synchronized with smartphone GPS (FIGURE). This full spectrum recorder system recorded the time-stamped and georeferenced echolocation signals of bats. Summary of survey efforts were presented in Table 2. By this approach, the echolocation signals emitted by bat are used as cues to detect the presence of bats along the transect thus allow calculation of relative activities of bats within survey site. Bats encountered on transect was identified the to the lowest possible taxonomic level by analyzed their echolocation signal with BatExplorere software (Elekon AG, Switzerland), which utilizing minimum, maximum and peak frequencies of the call for species identification (Borisenko & Kruskop 2003; Furey 2009; Hughes et al. 2011; Thong et al. 2012; Kruskop 2013; Francis 2019). Relative activities of bats were calculated by the following formula:

$$A = N/L$$

Where A: Relative activities of bats in in the coastal area (calls/m)

N: Total of bat's call recorded

L: Total transect length (m)

Table 2: Summary of acoustic transect survey effort

Transect name	Transect length (m)	Date of survey	Time of survey	Survey effort (h)
Transect 1	3811.4	24th Oct 2019	18:00 to 20:28	2.5
Transect 2	1934.8	25th Oct 2019	18:00 to 20:23	2.5
Transect 3	2440.5	26th Oct 2019	18:00 to 20:30	2.5
Transect 4	665.2	27th Oct 2019	18:00 to 19:00	1

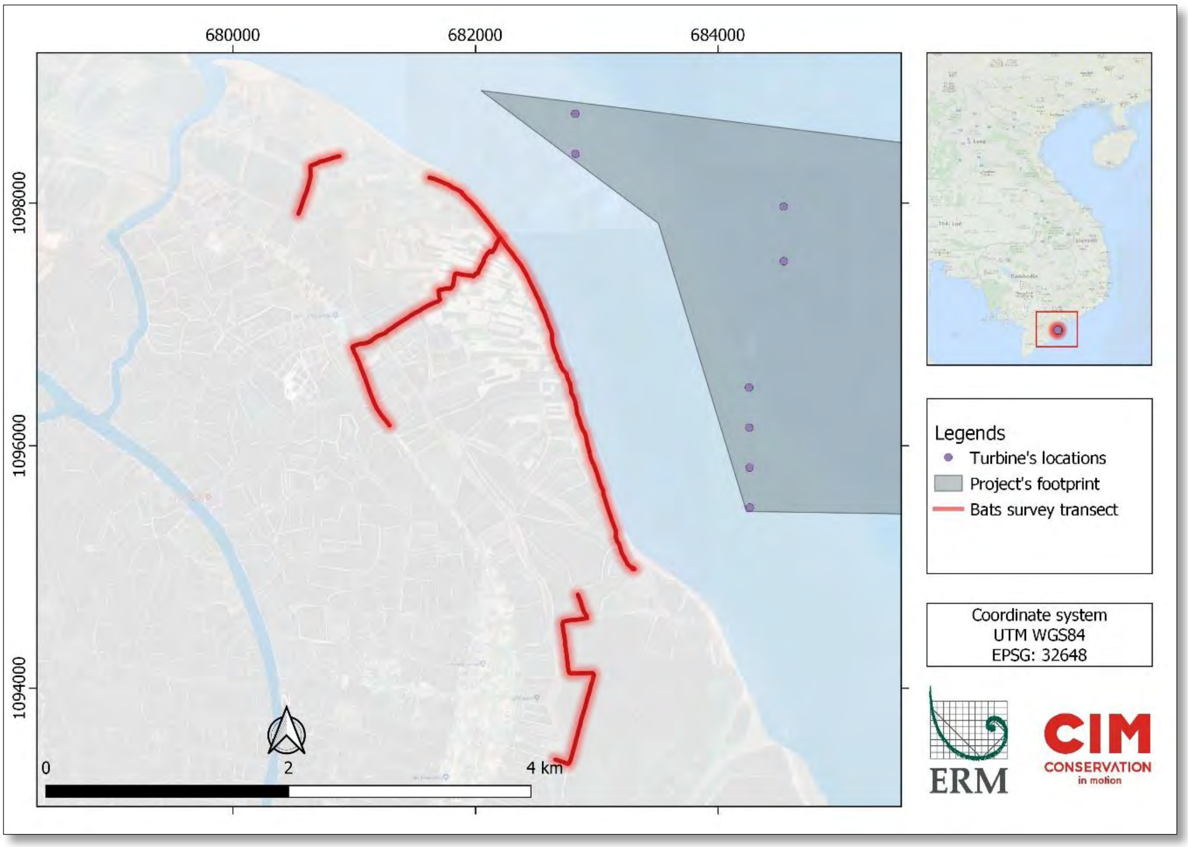


Figure 14: Location of four acoustic transect lines

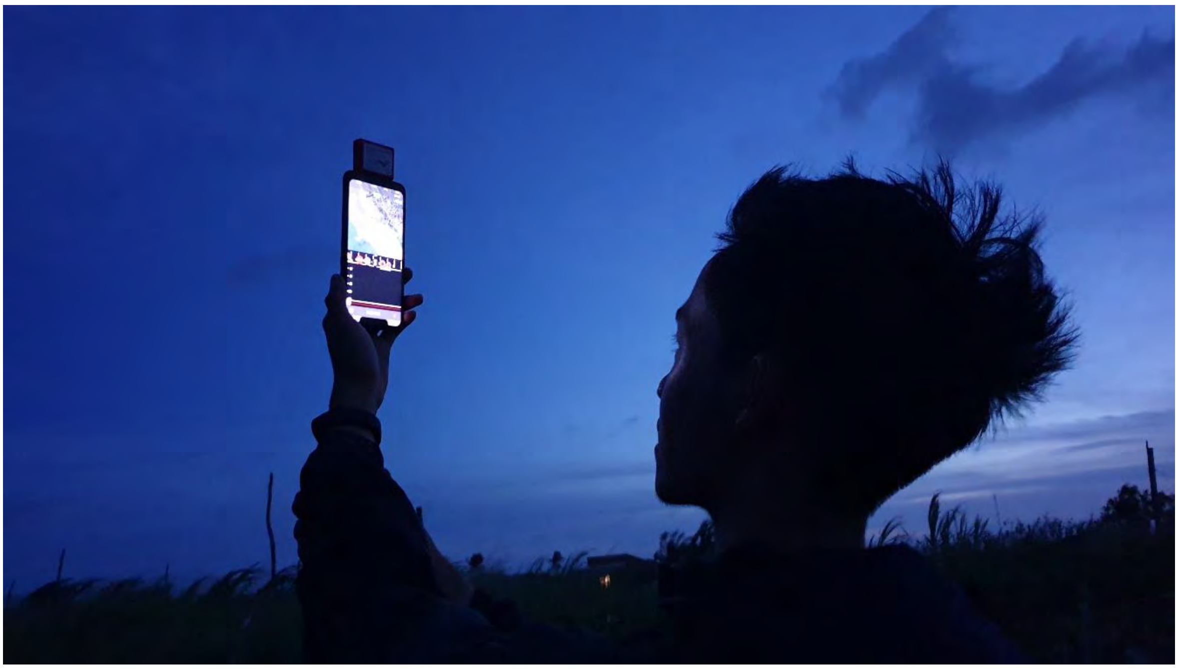


Figure 15: Using Echometer Pro bat recorder

Acoustic monitoring stations: To understand the spatiotemporal patterns of bat's activities within Thanh Hai Windfarm project area, seven stationary acoustic monitoring stations were deployed in strategic points inside the area (Figure 16). At each station, a high-sensitive recording system BATLOGGER A: CHF 900 (Elekon AG, Switzerland) was deployed to record bat's acoustic signals from sunset (local time 17:30, in October 2019) to sunrise (local time 6:00, in October 2019). Deployment time and monitoring efforts at each station were summarized in Table 3. This approach allows simultaneously monitoring different areas of interest for bat's activities, thus provide data on bat's distributional pattern within the project area. Statistically comparing bat activities/distribution patterns between different strategic points allows identifying important area for bats, if present, inside project area.

Similar to acoustic transect approach, raw data records of bat collected from the BATLOGGER A: CHF900 were processed in BatExplorer 2.0 (Elekon AG, Switzerland) following identical approach. Species identification was based on Borisenko & Kruskop 2003; Furey 2009; Hughes et al. 2011; Thong et al. 2012; Kruskop 2013; Francis 2019.

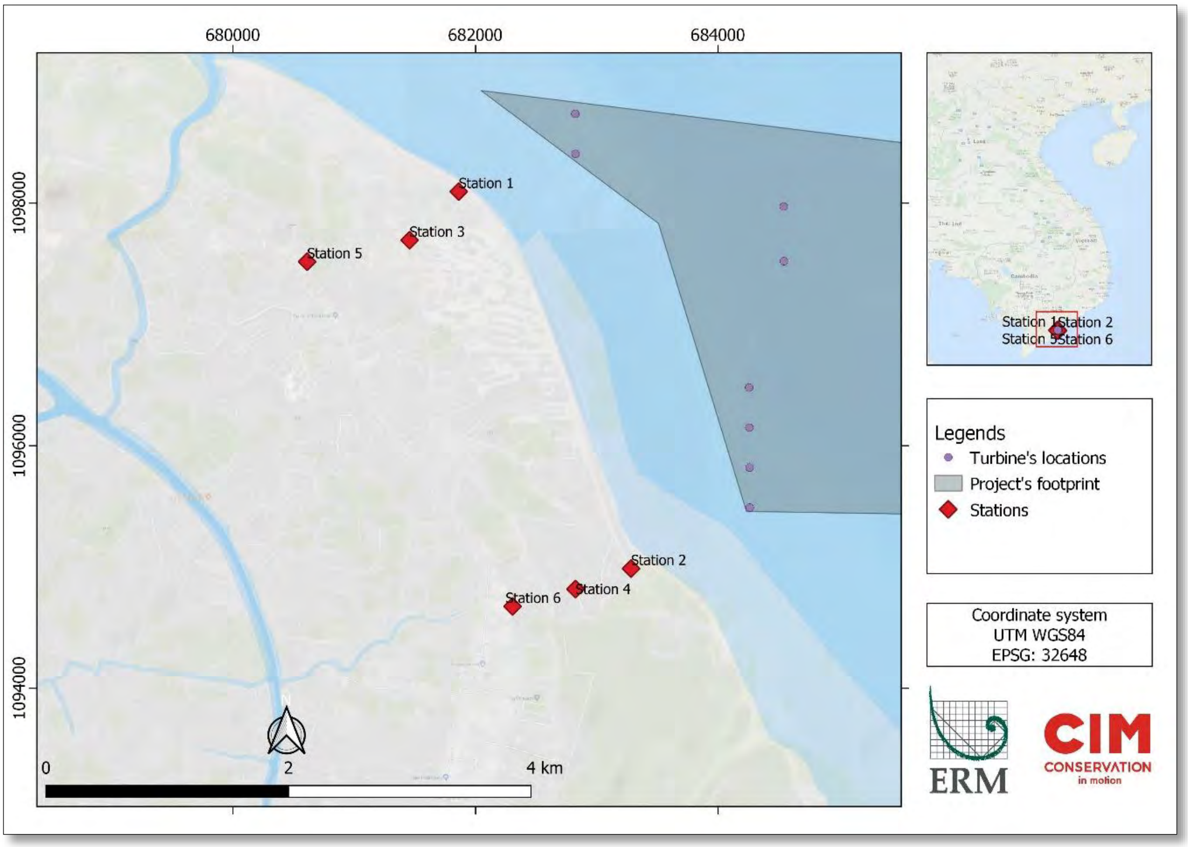


Figure 16: Location of acoustic monitoring stations

Table 3: Deployment time and monitoring effort at seven acoustic stations

Station	Easting	Northing	Deploying date	Deploying time	Monitoring time (hours)
Station #1	681861.342	1098095.401	24th Oct 2019	17:30 to 6:00	12.5
Station #2	683282.157	1094986.565	24th Oct 2019	17:30 to 6:00	12.5
Station #3	681456.096	1097694.687	25th Oct 2019	17:30 to 6:00	12.5
Station #4	682824.037	1094817.556	25th Oct 2019	17:30 to 6:00	12.5

Station #5	680611.048	1097517.18	26th Oct 2019	17:30 to 6:00	12.5
Station #6	682305.111	1094674.606	26th Oct 2019	17:30 to 6:00	12.5

It is noticed that the survey could not be conducted in a larger scale and more systematic manner (e.g. deploying all 06 stations at the same time and monitoring the area for three continuous days) due to the time and resources constrains. However, during the survey time, during 03 nigh of deploying, the survey conditions (no rains, no moon, slight wind) were visually unchanged. Thus, this survey design would still able to capture reliable baseline data on the spatiotemporal variations of bat's activities in the project area.

Mist-net sampling: A series of mist-net (special net designed to capture bats and birds) were set up in strategic points inside the project area to collect bat samples . Once the nets are deployed, the mist-netting team sits quietly away from the netting area (about 10 – 20 m) and checks for entangled bats in every ten minutes for minimum three hours. Sampling effort were summarized in Table 4.

Table 4: Mist-netting effort

Mist-net	**Total net length** (m)	**Net height** (m)	**Deploying date**	**Deploying time**	**Sampling effort (hours)**
Mist-net 1	30	4	24th Oct 2019	17:30 to 22:30	5
Mist-net 2	30	4	24th Oct 2019	17:30 to 22:30	5
Mist-net 3	30	4	25th Oct 2019	17:30 to 22:30	5
Mist-net 4	30	3.5	25th Oct 2019	17:30 to 22:30	5
Mist-net 5	30	4	26th Oct 2019	17:30 to 22:30	5
Mist-net 6	30	4	26th Oct 2019	17:30 to 22:30	5

Relative abundance of bats in the survey area is calculated by the following formula:

$$A = N/S$$

Where A: Relative abundance of bats in in the coastal area (Individual/meter-net-hour)

N: Total of bats recorded from acoustic cues (Individuals)

S: Total sampling effort (meter-net-hour)

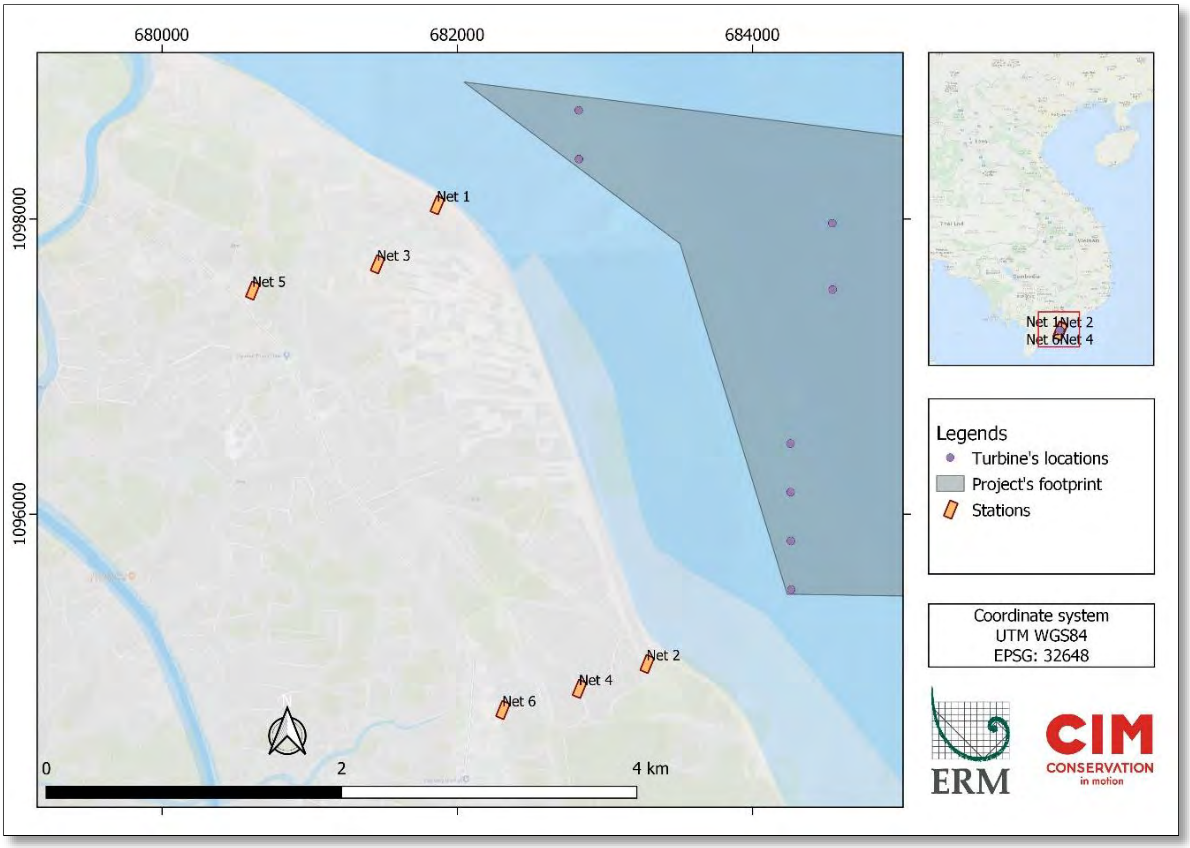


Figure 17: Location of mist-nets

Figure 18: Setting up a mist net

Roosting sites investigation: Attempts were made to interview local communities to acquire information regarding charismatic bat species (e.g. flying foxes – *Pteropus* sp.). Detail information on interview survey were presented in Section 2.4 of this report. If the roosting site were located by the interview team, the bat specialists will come to visit the site during daytime and count the number of bats in the colony. The Helion XP38 Thermal image scope (Pulsar Inc.) were used to aid the counting. Helion XP38 Thermal scope allows the survey team to detect heat signatures of each bat roosting in dark area, thus enable them to accurately count the number of individuals within the colony.

2.4 Interview Surveys

Semi-structured interview survey will be conducted in local communities within the project area and its vicinity to collect additional information on the presence of concerned species such as birds, bats (flying foxes mainly), marine mammals, sea turtles, otter, Southern river tapirine. Two interviewers would approach local peoples (especially fishermen, , farmers, and traders who live and work in the project areas) and show them a series of colored photographs of marine megafauna (sea turtles, dolphins, whales, whale shark, manta ray), flying foxes, charismatic water birds (Painted stocks, Ibis, Pelican), otters and fresh water turtles (e.g. Southern-river terrapin). Interviewees were all asked if they ever encountered any species from the photo catalogue. If the responder said they encountered a species from the list, a series of questions regarding the biological details of such species would be asked to ensure the responder were providing reliable information. When the interviewers were confident about the reliability of the information, they would ask the responders to provide more information on time, location, situation of each encountering cases that the responders have experienced within past 05 years. Questions on potentially important habitats for concerned taxa (e.g. for roosting sites for bats, nesting site for sea turtles) and any visible changes in the species' populations (e.g. more common, less common compared to 5 years ago) were also asked.

To facilitate data collection, we will also develop a smartphone app to synchronize field-collected data with our online database, thus reducing the data input bottleneck. Instead of using printed questionnaire to collect information, our interviewers will enter responder's answers directly in the app, which will utilize capabilities of modern smartphone such as recording GPS coordinates and taking photographs and videos to supplement the quality and reliability of interview data.

Our interview survey will also integrate "participatory geographic information system" (PGIS) (DeWalt 1994; Dunn 2007; Levine & Feinholz 2015) to collect spatial information on where locals previously encountered any concerned species. A map of the area was also showed to each interviewee, so they can point out the approximate location where they encountered the concerned animals. Interviewer also asked for information on time and frequency of encountering. Any evidences, such as pictures, skulls, skins, bones… that related to the information provided by the responders was examined to clarify the reliability of given information. If passed the information clarification process, the drawing will later be digitized and mapped with GIS software.

3 Results

3.1 Desktop study results

3.1.1 Bats

Peer-review publications: Peer-review publications on bats or related to bats in the project area and its vicinity are rare due to the very small number of surveys or expeditions have ever been conducted in this location. Systematic searches on various scientific publication databases reveal no peer-reviewed papers on bats in Ben Tre province, let alone the project area. These findings emphasized the gap of information regarding bats diversity within Thạnh Hai windfarm project, as well as in Ben Tre province and Lower Mekong delta regions.

Reports/grey-literature: There was one article that held useful information about bat near the project area was found on one the website of the Center for Applying Scientific and Technological Advancements, an organization under DOST Ben Tre. In this article, it is mentioned that the Center for Applying Scientific and Technological Advancements had developed a "bat farming" project to collect bat guano in 2017. It showed artificial roosting structures for bats were constructed in Mo Cay Bac District (60km from the project area) and information on the quantity (3kg) of guano can be collected at each site. Prior to the submission of this report, the original link of this guano/bat framing article became unavailable, but the assessible article can still be accessed in the following link: https://www.facebook.com/permalink.php?story_fbid=1950755025171905&id=1744634515783958.

It is unclear what bat species roost in these artificial structures. The amount of guano collected at each structure (3kg) suggested medium size colonies may roosted in these structures (Figure 19). Based on the information available on the Center for Applying Scientific and Technological Advancements document, providing artificial roosting sites for bats in exchange to guano is common practice in Mo Cay Bac district of Ben Tre province. This practice can potentially attract large number of bats to the area.

Figure 19: Artificial roosting structure for bat to collect bat guano

IUCN Redlist database: Species' distribution data from IUCN Redlist suggested 36 bat species (of 07 families) may occur in the project area and its vicinity. This information was interpolated from previous records and ecological assumptions of each species distribution ranges, biogeographical conditions and expert opinions. Detail species check-list from IUCN Redlist database was presented in Table 5.

Table 5: Bat species that may occur in the project area and its vicinity based on species distribution ranges of IUCN Redlist

Family	English name	Scientific name	IUCN status
Pteropodidae	Greater short-nosed fruit bat	*Cynopterus sphinx*	LC
	Leschenault's rousette	*Rousettus leschenaultii*	LC
	Common rousette	*Rousettus amplexicaudatus*	LC
	Lesser short-nosed fruit bat	*Cynopterus brachyotis*	LC
	Common dawn bat	*Eonycteris spelaea*	LC
	Long-tongued fruit bat	*Macroglossus sobrinus*	LC
	Northern tailless fruit-bat	*Megaerops niphanae*	LC
	Large flying foxes	*Pteropus vampyrus*	NT
Emballonuridae	Theobald's tomb-bat	*Taphozous theobaldi*	LC

Family	English name	Scientific name	IUCN status
	Black-bearded tomb bat	*Taphozous melanopogon*	LC
Hipposideridae	Diadem leaf-nosed bat	*Hipposideros diadema*	LC
	Great roundleaf bat	*Hipposideros armiger*	LC
	Intermediate roundleaf bat	*Hipposideros larvatus*	LC
	Pomona roundleaf bat	*Hipposideros pomona*	LC
	Cantor's roundleaf bat	*Hipposideros galeritus*	LC
Rhinolophidae	Indochinese brown horseshoe bat	*Rhinolophus microglobosus*	LC
	Intermediate horseshoe bat	*Rhinolophus affinis*	LC
	Malayan horseshoe bat	*Rhinolophus malayanus*	LC
	Rhinolophus acuminatus	*Rhinolophus acuminatus*	LC
	Lesser brown horseshoe bat	*Rhinolophus stheno*	LC
Megadermatidae	Lesser false vampire bat	*Megaderma spasma*	LC
	Greater false vampire bat	*Megaderma lyra*	LC
Miniopteridae	Large bent-winged bat	*Miniopterus magnater*	LC
	Common bent-wing bat	*Miniopterus schreibersii*	NT
Vespertilionidae	Javan pipistrelle	*Pipistrellus javanicus*	LC
	Whiskered myotis	*Myotis muricola*	LC
	Indian pipistrelle	*Pipistrellus coromandra*	LC
	Lesser bamboo bat	*Tylonycteris pachypus*	LC
	Common thick-thumbed bat	*Glischropus tylopus*	LC
	Hardwicke's woolly bat	*Kerivoula hardwickii*	LC
	Lesser Asiatic Yellow House Bat	*Scotophilus kuhlii*	LC
	Least pipistrelle	*Pipistrellus tenuis*	LC
	Round-eared Tube-nosed Bat	*Murina cyclotis*	LC
	Painted bat	*Kerivoula picta*	LC
	Thick-thumbed Myotis	*Myotis rosseti*	LC
	Horsfield's Myotis	*Myotis horsfieldii*	LC

GBIF database: Data from GBIF database showed only one bat specimen that were collected within 25km radius from the project area. That specimen was a Greater bamboo bat (*Tylonycteris robustula*) collected from 1929. Now, the mentioned specimen was stored in Museum of Comparative Zoology, Harvard University under the voucher number CC_BY_NC_4_0. There was no bat specimen or record from 25km to 50km from the project area. Within the radius of 100km from the project area, 104 bats specimen were collected from 1929 until 2013 (Table 6).

Table 6: GBIF records of bat specimens collected near in the project's vicinity from 1929 to 2013.

Family	English name	Scientific name	Number of specimens	Distance range to the project
Emballonuridae (24 specimens)	Long-winged tomb bat	*Taphozous longimanus*	1	50-100km
	Black-bearded tomb bat	*Taphozous melanopogon*	23	50-100km
Pteropodidae (50 specimens)	Leser short-nosed fruit bat	*Cynopterus brachyotis*	10	50-100km
	Greater short-nosed fruit bat	*Cynopterus sphinx*	8	50-100km
	Lesser short-nosed fruit bat	*Eonycteris spelaea*	1	50-100km
	Dagger-toothed long-nosed fruit bat	*Macroglossus minimus*	10	50-100km
	Island flying fox	*Pteropus hypomelanus*	1	50-100km
	Lyle's flying fox	*Pteropus lylei*	13	50-100km
	Large flying fox	*Pteropus vampyrus*	4	50-100km
	Leschenault's rousette	*Rousettus leschenaultii*	3	50-100km
Vespertilionidae (13 specimens)	Hasselt's myotis	*Myotis hasseltii*	1	50-100km
	Whiskered myotis	*Myotis muricola*	1	50-100km
	Javan pipistrelle	*Pipistrellus javanicus*	6	50-100km
	Greater Asiatic yellow bat	*Scotophilus heathii*	2	50-100km
	Lesser Asiatic yellow House Bat	*Scotophilus kuhlii*	6	50-100km
	Greater bamboo bat	*Tylonycteris robustula*	2	25km
Grand Total			**104 specimens**	

3.1.2 Birds

Peer-review publications: Peer-review journal that relevant to avian fauna in project area or Ben Tre province did not appeared on Google Scholar, ScienceDirect and Wiley database (no matching results).

Reports/grey-literature: The great diversity of bird fauna in Ben Tre province, especially Van Ho Bird Sanctuary (25km from the Thanh Hai windfarm project), has been mentioned in the following papers:

- BTDARD, 2009, Status and orientation of agricultural and rural development of three coastal districts of Ben Tre province to adapt to climate change. Ben Tre Department of Agriculture and Rural Development, Presented in Conservation Forum for the Mekong Delta, Can Tho City, (in Vietnamese);
- BTDARD, 2010.Te implementing process of 5 million ha of afforestation from 1998 to 2010, Ben Tre (Tình hình thực hiện Dự án trồng mới 5 triệu ha rừng từ năm 1998 đến 2010). Department of Agriculture and Rural Development unpublished report, (in Vietnamese);
- BTDARD, 2011a, Salinity intrusion situation in Ben Tre (Diễn biến xâm nhập mặn trên địa bàn tỉnh Bến Tre), Ben Tre Department of Agriculture and Rural Development, unpublished report, (in Vietnamese);
- BTDARD, 2011b, Damages by natural hazards in Ben Tre (Tiệt hại thiên tai do bão trên địa bàn tỉnh Bến Tre), Ben Tre Department of Agriculture and Rural Development, unpublished report, (in Vietnamese);
- BTDARD, 2011c, Role of mangrove forest in responding to climate change in Ben Tre (Vai trò của rừng ngập mặn trong việc ứng phó với biến đổi khí hậu ở Bến Tre), Ben Tre Department of Agriculture and Rural Development, unpublished report, (in Vietnamese);
- BTDST, 2008, Researching and evaluating biodiversity and aquaculture sources at river mouth of Ben Tre,developing logical managing and using solutions, Ben Tre Department of Science and Technology, unpublished report, (in Vietnamese);
- CEE-CESC, 2009, Research, survey on current situation of coastal environmental resources and solution recommendation of Ben Tre province (Khảo sát hiện trạng tài nguyên môi trường vùng biển ven bờ tỉnh Ben Tre và đề xuất giải pháp bảo vệ môi trường), Centre of Environmental Engineering – Cadastre and Engineering Survey Company, provincial scientific unpublished report, (in Vietnamese).

However, none of those above were able to provide a comprehensive check-list of avian species that may occurs in Thanh Hai area and vicinity, or any information on the status of endangered birds species.

BOTW: 343 species belong to 77 families of 21 orders have their distribution range overlap with the Thanh Hai windfarm project area. Among those, there were 04 Critically Endangered (CR) species, 02 Endangered species (EN), 07 Vulnerable (VU) species and 24 Near-threatened (NT) species that are listed in IUCN Redlist. The remaining species were Low-Risk/Least Concerned (LC)species or Dada Deficient (DD) species. Bird species that have their distribution range overlap with the footprint of the Thanh Hai windfarm project were listed in Table 7. Among the four CR bird species, the Spoon-billed Sandpiper (*Calidris pygmaea*) have been recently sighted by a local group of local bird researchers in

Ba Tri beach of Ben Tre Province , which is only 7km from the Thanh Hai project area (Hao Quang Nguyen, personal communication, Oct 26th, 2019).

Order	Family	Scientific name	Common name	IUCN
ACCIPITRIFORMES	ACCIPITRIDAE	*Accipiter badius*	Shikra	LC
		Accipiter gularis	Japanese Sparrowhawk	LC
		Aviceda leuphotes	Black Baza	LC
		Butastur indicus	Grey-faced Buzzard	LC
		Butastur liventer	Rufous-winged Buzzard	LC
		Circus melanoleucos	Pied Harrier	LC
		Circus spilonotus	Eastern Marsh-harrier	LC
		Clanga clanga	Greater Spotted Eagle	VU
		Elanus caeruleus	Black-winged Kite	LC
		Gyps bengalensis	White-rumped Vulture	CR
		Haliaeetus leucogaster	White-bellied Sea-eagle	LC
		Haliastur indus	Brahminy Kite	LC
		Icthyophaga humilis	Lesser Fish-eagle	NT
		Icthyophaga ichthyaetus	Grey-headed Fish-eagle	NT
		Lophotriorchis kienerii	Rufous-bellied Eagle	NT
		Milvus migrans	Black Kite	LC
		Pernis ptilorhynchus	Oriental Honey-buzzard	LC
		Sarcogyps calvus	Red-headed Vulture	CR
		Spilornis cheela	Crested Serpent-eagle	LC
	PANDIONIDAE	*Pandion haliaetus*	Osprey	LC
ANSERIFORMES	ANATIDAE	*Anas crecca*	Common Teal	LC
		Anas poecilorhyncha	Indian Spot-billed Duck	LC
		Dendrocygna javanica	Lesser Whistling-duck	LC
		Nettapus coromandelianus	Cotton Pygmy-goose	LC
		Spatula clypeata	Northern Shoveler	LC
		Spatula querquedula	Garganey	LC
BUCEROTIFORMES	BUCEROTIDAE	*Anthracoceros albirostris*	Oriental Pied Hornbill	LC
		Buceros bicornis	Great Hornbill	VU
		Rhyticeros undulatus	Wreathed Hornbill	VU
	UPUPIDAE	*Upupa epops*	Common Hoopoe	LC
CAPRIMULGIFORMES	APODIDAE	*Aerodramus fuciphagus*	Edible-nest Swiftlet	LC
		Apus nipalensis	House Swift	LC
		Cypsiurus balasiensis	Asian Palm-swift	LC
		Hirundapus cochinchinensis	Silver-backed Needletail	LC

		Hirundapus giganteus	Brown-backed Needletail	LC
	CAPRIMULGIDAE	*Caprimulgus asiaticus*	Indian Nightjar	LC
		Caprimulgus jotaka	Grey Nightjar	LC
		Caprimulgus macrurus	Large-tailed Nightjar	LC
	HEMIPROCNIDAE	*Hemiprocne coronata*	Crested Treeswift	LC
CHARADRIIFORMES	CHARADRIIDAE	*Charadrius alexandrinus*	Kentish Plover	LC
		Charadrius dealbatus	White-faced Plover	DD
		Charadrius dubius	Little Ringed Plover	LC
		Charadrius leschenaultii	Greater Sandplover	LC
		Charadrius mongolus	Lesser Sandplover	LC
		Charadrius peronii	Malay Plover	NT
		Charadrius veredus	Oriental Plover	LC
		Pluvialis fulva	Pacific Golden Plover	LC
		Pluvialis squatarola	Grey Plover	LC
		Vanellus duvaucelii	River Lapwing	NT
		Vanellus indicus	Red-wattled Lapwing	LC
	GLAREOLIDAE	*Glareola maldivarum*	Oriental Pratincole	LC
	JACANIDAE	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	LC
		Metopidius indicus	Bronze-winged Jacana	LC
	LARIDAE	*Anous stolidus*	Brown Noddy	LC
		Chlidonias hybrida	Whiskered Tern	LC
		Chlidonias leucopterus	White-winged Tern	LC
		Gelochelidon nilotica	Common Gull-billed Tern	LC
		Larus brunnicephalus	Brown-headed Gull	LC
		Larus ridibundus	Black-headed Gull	LC
		Onychoprion anaethetus	Bridled Tern	LC
		Onychoprion fuscatus	Sooty Tern	LC
		Sterna acuticauda	Black-bellied Tern	EN
		Sterna aurantia	River Tern	NT
		Sterna dougallii	Roseate Tern	LC
		Sternula albifrons	Little Tern	LC
		Thalasseus bengalensis	Lesser Crested Tern	LC
		Thalasseus bergii	Greater Crested Tern	LC
	RECURVIROSTRIDAE	*Himantopus himantopus*	Black-winged Stilt	LC

	ROSTRATULIDAE	*Rostratula benghalensis*	Greater Painted-snipe	LC
	SCOLOPACIDAE	*Actitis hypoleucos*	Common Sandpiper	LC
		Arenaria interpres	Ruddy Turnstone	LC
		Calidris ferruginea	Curlew Sandpiper	NT
		Calidris pygmaea	Spoon-billed Sandpiper	CR
		Calidris ruficollis	Red-necked Stint	NT
		Calidris subminuta	Long-toed Stint	LC
		Calidris temminckii	Temminck's Stint	LC
		Gallinago gallinago	Common Snipe	LC
		Gallinago stenura	Pintail Snipe	LC
		Limnodromus semipalmatus	Asian Dowitcher	NT
		Limosa lapponica	Bar-tailed Godwit	NT
		Limosa limosa	Black-tailed Godwit	NT
		Lymnocryptes minimus	Jack Snipe	LC
		Numenius arquata	Eurasian Curlew	NT
		Numenius phaeopus	Whimbrel	LC
		Tringa erythropus	Spotted Redshank	LC
		Tringa glareola	Wood Sandpiper	LC
		Tringa nebularia	Common Greenshank	LC
		Tringa ochropus	Green Sandpiper	LC
		Tringa stagnatilis	Marsh Sandpiper	LC
		Tringa totanus	Common Redshank	LC
		Xenus cinereus	Terek Sandpiper	LC
	STERCORARIIDAE	*Stercorarius pomarinus*	Pomarine Jaeger	LC
	TURNICIDAE	*Turnix suscitator*	Barred Buttonquail	LC
		Turnix sylvaticus	Common Buttonquail	LC
		Turnix tanki	Yellow-legged Buttonquail	LC
CICONIIFORMES	CICONIIDAE	*Anastomus oscitans*	Asian Openbill	LC
		Ciconia episcopus	Asian Woollyneck	VU
		Leptoptilos javanicus	Lesser Adjutant	VU
		Mycteria leucocephala	Painted Stork	NT
COLUMBIFORMES	COLUMBIDAE	*Ducula aenea*	Green Imperial-pigeon	LC
		Ducula badia	Mountain Imperial-pigeon	LC
		Spilopelia chinensis	Eastern Spotted Dove	LC
		Streptopelia tranquebarica	Red Turtle-dove	LC
		Treron bicinctus	Orange-breasted Green-pigeon	LC

		Treron curvirostra	Thick-billed Green-pigeon	LC
		Treron phayrei	Ashy-headed Green-pigeon	NT
		Treron phoenicopterus	Yellow-footed Green-pigeon	LC
		Treron vernans	Pink-necked Green-pigeon	LC
CORACIIFORMES	ALCEDINIDAE	*Alcedo atthis*	Common Kingfisher	LC
		Alcedo meninting	Blue-eared Kingfisher	LC
		Ceryle rudis	Pied Kingfisher	LC
		Ceyx erithaca	Oriental Dwarf-kingfisher	LC
		Halcyon coromanda	Ruddy Kingfisher	LC
		Halcyon pileata	Black-capped Kingfisher	LC
		Halcyon smyrnensis	White-breasted Kingfisher	LC
		Pelargopsis capensis	Stork-billed Kingfisher	LC
		Todiramphus chloris	Collared Kingfisher	LC
	CORACIIDAE	*Coracias affinis*	Indochinese Roller	LC
		Eurystomus orientalis	Oriental Dollarbird	LC
	MEROPIDAE	*Merops leschenaulti*	Chestnut-headed Bee-eater	LC
		Merops orientalis	Asian Green Bee-eater	LC
		Merops philippinus	Blue-tailed Bee-eater	LC
		Merops viridis	Blue-throated Bee-eater	LC
CUCULIFORMES	CUCULIDAE	*Cacomantis merulinus*	Plaintive Cuckoo	LC
		Cacomantis sonneratii	Banded Bay Cuckoo	LC
		Centropus bengalensis	Lesser Coucal	LC
		Centropus sinensis	Greater Coucal	LC
		Chrysococcyx xanthorhynchus	Violet Cuckoo	LC
		Clamator coromandus	Chestnut-winged Cuckoo	LC
		Cuculus micropterus	Indian Cuckoo	LC
		Eudynamys scolopaceus	Western Koel	LC
		Hierococcyx sparverioides	Large Hawk-cuckoo	LC
		Phaenicophaeus tristis	Green-billed Malkoha	LC
		Surniculus dicruroides	Fork-tailed Drongo-cuckoo	LC
FAL CON	FALCONIDAE	*Falco severus*	Oriental Hobby	LC
		Falco tinnunculus	Common Kestrel	LC
GAL LIFO	PHASIANIDAE	*Gallus gallus*	Red Junglefowl	LC
		Synoicus chinensis	Asian Blue Quail	LC

GRUIFORMES	RALLIDAE	*Amaurornis phoenicurus*	White-breasted Waterhen	LC
		Fulica atra	Common Coot	LC
		Gallicrex cinerea	Watercock	LC
		Gallinula chloropus	Common Moorhen	LC
		Lewinia striata	Slaty-breasted Rail	LC
		Porphyrio porphyrio	Purple Swamphen	LC
		Zapornia fusca	Ruddy-breasted Crake	LC
		Zapornia paykullii	Band-bellied Crake	NT
		Zapornia pusilla	Baillon's Crake	LC
PASSERIFORMES	ACANTHIZIDAE	*Gerygone sulphurea*	Golden-bellied Gerygone	LC
	ACROCEPHALIDAE	*Acrocephalus bistrigiceps*	Black-browed Reed-warbler	LC
		Acrocephalus orientalis	Oriental Reed-warbler	LC
		Arundinax aedon	Thick-billed Warbler	LC
	AEGITHINIDAE	*Aegithina lafresnayei*	Great Iora	LC
		Aegithina tiphia	Common Iora	LC
	ALAUDIDAE	*Alauda gulgula*	Oriental Skylark	LC
		Mirafra erythrocephala	Indochinese Bushlark	LC
		Mirafra javanica	Horsfield's Bushlark	LC
	ARTAMIDAE	*Artamus fuscus*	Ashy Woodswallow	LC
	CAMPEPHAGIDAE	*Coracina javensis*	Large Cuckooshrike	LC
		Lalage melaschistos	Black-winged Cuckooshrike	LC
		Lalage polioptera	Indochinese Cuckooshrike	LC
		Pericrocotus cantonensis	Brown-rumped Minivet	LC
		Pericrocotus cinnamomeus	Small Minivet	LC
		Pericrocotus divaricatus	Ashy Minivet	LC
		Pericrocotus flammeus	Scarlet Minivet	LC
		Pericrocotus roseus	Rosy Minivet	LC
	CHLOROPSEIDAE	*Chloropsis aurifrons*	Golden-fronted Leafbird	LC
	CISTICOLIDAE	*Cisticola exilis*	Golden-headed Cisticola	LC
		Cisticola juncidis	Zitting Cisticola	LC
		Orthotomus atrogularis	Dark-necked Tailorbird	LC
		Orthotomus sutorius	Common Tailorbird	LC

		Prinia flaviventris	Yellow-bellied Prinia	LC
		Prinia hodgsonii	Grey-breasted Prinia	LC
		Prinia inornata	Plain Prinia	LC
		Prinia rufescens	Rufescent Prinia	LC
	CORVIDAE	*Cissa hypoleuca*	Indochinese Green Magpie	LC
		Corvus macrorhynchos	Large-billed Crow	LC
		Crypsirina temia	Racquet-tailed Treepie	LC
		Dendrocitta vagabunda	Rufous Treepie	LC
	DICAEIDAE	*Dicaeum agile*	Thick-billed Flowerpecker	LC
		Dicaeum chrysorrheum	Yellow-vented Flowerpecker	LC
		Dicaeum cruentatum	Scarlet-backed Flowerpecker	LC
		Dicaeum minullum	Plain Flowerpecker	LC
	DICRURIDAE	*Dicrurus aeneus*	Bronzed Drongo	LC
		Dicrurus annectens	Crow-billed Drongo	LC
		Dicrurus hottentottus	Hair-crested Drongo	LC
		Dicrurus leucophaeus	Ashy Drongo	LC
		Dicrurus macrocercus	Black Drongo	LC
		Dicrurus paradiseus	Greater Racquet-tailed Drongo	LC
	EMBERIZIDAE	*Emberiza aureola*	Yellow-breasted Bunting	CR
	ESTRILDIDAE	*Amandava amandava*	Red Avadavat	LC
		Lonchura atricapilla	Chestnut Munia	LC
		Lonchura maja	White-headed Munia	LC
		Lonchura oryzivora	Java Sparrow	EN
		Lonchura punctulata	Scaly-breasted Munia	LC
		Lonchura striata	White-rumped Munia	LC
	HIRUNDINIDAE	*Cecropis daurica*	Red-rumped Swallow	LC
		Delichon dasypus	Asian House Martin	LC
		Delichon lagopodum	Eastern House Martin	LC
		Hirundo javanica	House Swallow	LC
		Hirundo rustica	Barn Swallow	LC
	IRENIDAE	*Irena puella*	Asian Fairy-bluebird	LC
	LEIOTRICHIDAE	*Garrulax chinensis*	Black-throated Laughingthrush	LC
	LOCUSTELLIDAE	*Locustella lanceolata*	Lanceolated Warbler	LC
	MONARCHIDAE	*Hypothymis azurea*	Black-naped Monarch	LC

		Terpsiphone affinis	Oriental Paradise-flycatcher	LC
		Terpsiphone incei	Chinese Paradise-flycatcher	LC
	MOTACILLIDAE	*Anthus cervinus*	Red-throated Pipit	LC
		Anthus hodgsoni	Olive-backed Pipit	LC
		Anthus richardi	Richard's Pipit	LC
		Anthus rufulus	Paddyfield Pipit	LC
		Dendronanthus indicus	Forest Wagtail	LC
		Motacilla alba	White Wagtail	LC
		Motacilla cinerea	Grey Wagtail	LC
		Motacilla tschutschensis	Eastern Yellow Wagtail	LC
	MUSCICAPIDAE	*Calliope calliope*	Siberian Rubythroat	LC
		Copsychus saularis	Oriental Magpie-robin	LC
		Cyanoptila cyanomelana	Blue-and-white Flycatcher	LC
		Cyornis hainanus	Hainan Blue-flycatcher	LC
		Enicurus leschenaulti	White-crowned Forktail	LC
		Eumyias thalassinus	Verditer Flycatcher	LC
		Ficedula albicilla	Red-throated Flycatcher	LC
		Monticola solitarius	Blue Rock-thrush	LC
		Muscicapa dauurica	Asian Brown Flycatcher	LC
		Muscicapa ferruginea	Ferruginous Flycatcher	LC
		Saxicola caprata	Pied Bushchat	LC
		Saxicola torquatus	Common Stonechat	LC
	NECTARINIIDAE	*Aethopyga siparaja*	Crimson Sunbird	LC
		Anthreptes malacensis	Brown-throated Sunbird	LC
		Arachnothera hypogrammica	Purple-naped Spiderhunter	LC
		Arachnothera longirostra	Little Spiderhunter	LC
		Arachnothera magna	Streaked Spiderhunter	LC
		Chalcoparia singalensis	Ruby-cheeked Sunbird	LC
		Cinnyris asiaticus	Purple Sunbird	LC
		Cinnyris jugularis	Olive-backed Sunbird	LC
		Leptocoma brasiliana	Maroon-bellied Sunbird	LC
		Leptocoma calcostetha	Copper-throated Sunbird	LC
	ORIOLIDAE	*Oriolus chinensis*	Black-naped Oriole	LC

		Oriolus xanthornus	Black-hooded Oriole	LC
	PACHYCEPHALIDAE	*Pachycephala cinerea*	Mangrove Whistler	LC
	PASSERIDAE	*Passer flaveolus*	Plain-backed Sparrow	LC
		Passer montanus	Eurasian Tree Sparrow	LC
	PHYLLOSCOPIDAE	*Phylloscopus coronatus*	Eastern Crowned Warbler	LC
		Phylloscopus inornatus	Yellow-browed Warbler	LC
		Phylloscopus plumbeitarsus	Two-barred Warbler	LC
		Phylloscopus reguloides	Blyth's Leaf-warbler	LC
		Phylloscopus schwarzi	Radde's Warbler	LC
		Phylloscopus tenellipes	Pale-legged Leaf-warbler	LC
	PITTIDAE	*Pitta moluccensis*	Blue-winged Pitta	LC
	PLOCEIDAE	*Ploceus hypoxanthus*	Asian Golden Weaver	NT
		Ploceus manyar	Streaked Weaver	LC
		Ploceus philippinus	Baya Weaver	LC
	PYCNONOTIDAE	*Pycnonotus aurigaster*	Sooty-headed Bulbul	LC
		Pycnonotus blanfordi	Streak-eared Bulbul	LC
		Pycnonotus goiavier	Yellow-vented Bulbul	LC
		Pycnonotus jocosus	Red-whiskered Bulbul	LC
	RHIPIDURIDAE	*Rhipidura javanica*	Sunda Pied Fantail	LC
	SITTIDAE	*Sitta frontalis*	Velvet-fronted Nuthatch	LC
	STENOSTIRIDAE	*Culicicapa ceylonensis*	Grey-headed Canary-flycatcher	LC
	STURNIDAE	*Acridotheres grandis*	Great Myna	LC
		Acridotheres leucocephalus	Vinous-breasted Myna	LC
		Acridotheres tristis	Common Myna	LC
		Agropsar sturninus	Purple-backed Starling	LC
		Ampeliceps coronatus	Golden-crested Myna	LC
		Aplonis panayensis	Asian Glossy Starling	LC
		Gracula religiosa	Common Hill Myna	LC
		Gracupica nigricollis	Black-collared Starling	LC
		Sturnia malabarica	Chestnut-tailed Starling	LC
		Sturnia sinensis	White-shouldered Starling	LC
	TURDIDAE	*Geokichla citrina*	Orange-headed Thrush	LC
		Turdus obscurus	Eyebrowed Thrush	LC
	VANGIDAE	*Hemipus picatus*	Bar-winged Flycatcher-shrike	LC

		Tephrodornis pondicerianus	Common Woodshrike	LC
		Tephrodornis virgatus	Large Woodshrike	LC
	ZOSTEROPIDAE	*Zosterops palpebrosus*	Oriental White-eye	LC
PELECANIFORMES	ARDEIDAE	*Ardea alba*	Great White Egret	LC
		Ardea cinerea	Grey Heron	LC
		Ardea intermedia	Intermediate Egret	LC
		Ardea purpurea	Purple Heron	LC
		Ardea sumatrana	Great-billed Heron	LC
		Ardeola bacchus	Chinese Pond-heron	LC
		Ardeola speciosa	Javan Pond-heron	LC
		Bubulcus ibis	Cattle Egret	LC
		Butorides striata	Green-backed Heron	LC
		Egretta eulophotes	Chinese Egret	VU
		Egretta garzetta	Little Egret	LC
		Egretta sacra	Pacific Reef-egret	LC
		Ixobrychus cinnamomeus	Cinnamon Bittern	LC
		Ixobrychus eurhythmus	Schrenck's Bittern	LC
		Ixobrychus flavicollis	Black Bittern	LC
		Ixobrychus sinensis	Yellow Bittern	LC
		Nycticorax nycticorax	Black-crowned Night-heron	LC
	PELECANIDAE	*Pelecanus philippensis*	Spot-billed Pelican	NT
	THRESKIORNITHIDAE	*Plegadis falcinellus*	Glossy Ibis	LC
		Threskiornis melanocephalus	Black-headed Ibis	NT
PICIFORMES	MEGALAIMIDAE	*Psilopogon cyanotis*	Blue-eared Barbet	LC
		Psilopogon faiostrictus	Green-eared Barbet	LC
		Psilopogon haemacephalus	Coppersmith Barbet	LC
		Psilopogon lagrandieri	Red-vented Barbet	LC
		Psilopogon lineatus	Lineated Barbet	LC
	PICIDAE	*Chrysocolaptes guttacristatus*	Greater Flameback	LC
		Chrysophlegma flavinucha	Greater Yellownape	LC
		Dendrocopos analis	Freckle-breasted Woodpecker	LC
		Dinopium javanense	Common Flameback	LC

		Dryocopus javensis	White-bellied Woodpecker	LC
		Gecinulus grantia	Pale-headed Woodpecker	LC
		Jynx torquilla	Eurasian Wryneck	LC
		Micropternus brachyurus	Rufous Woodpecker	LC
		Mulleripicus pulverulentus	Great Slaty Woodpecker	VU
		Picoides canicapillus	Grey-capped Woodpecker	LC
		Picumnus innominatus	Speckled Piculet	LC
		Picus chlorolophus	Lesser Yellownape	LC
		Picus erythropygius	Black-headed Woodpecker	LC
		Picus guerini	Black-naped Woodpecker	LC
		Picus vittatus	Laced Woodpecker	LC
		Picus xanthopygaeus	Streak-throated Woodpecker	LC
PODICIPEDIFORMES	PODICIPEDIDAE	*Tachybaptus ruficollis*	Little Grebe	LC
PROCELLARIIFORMES	HYDROBATIDAE	*Hydrobates monorhis*	Swinhoe's Storm-petrel	NT
	PROCELLARIIDAE	*Bulweria bulwerii*	Bulwer's Petrel	LC
		Calonectris leucomelas	Streaked Shearwater	NT
PSITTACIFORMES	PSITTACIDAE	*Loriculus vernalis*	Vernal Hanging-parrot	LC
		Psittacula alexandri	Red-breasted Parakeet	NT
		Psittacula eupatria	Alexandrine Parakeet	NT
		Psittacula roseata	Blossom-headed Parakeet	NT
STRIGIFORMES	STRIGIDAE	*Athene brama*	Spotted Owlet	LC
		Glaucidium cuculoides	Asian Barred Owlet	LC
		Ketupa flavipes	Tawny Fish-owl	LC
		Ketupa ketupu	Buffy Fish-owl	LC
		Ketupa zeylonensis	Brown Fish-owl	LC
		Ninox scutulata	Brown Boobook	LC
		Otus lettia	Collared Scops-owl	LC
		Otus sunia	Oriental Scops-owl	LC

		Strix seloputo	Spotted Wood-owl	LC
	TYTONIDAE	*Phodilus badius*	Oriental Bay-owl	LC
		Tyto alba	Common Barn-owl	LC
		Tyto longimembris	Eastern Grass-owl	LC
SULIFORMES	ANHINGIDAE	*Anhinga melanogaster*	Oriental Darter	NT
	FREGATIDAE	*Fregata ariel*	Lesser Frigatebird	LC
		Fregata minor	Great Frigatebird	LC
	PHALACROCORACIDAE	*Microcarbo niger*	Little Cormorant	LC
		Phalacrocorax carbo	Great Cormorant	LC
		Phalacrocorax fuscicollis	Indian Cormorant	LC
	SULIDAE	*Sula leucogaster*	Brown Booby	LC
TROGONIFORMES	TROGONIDAE	*Harpactes oreskios*	Orange-breasted Trogon	LC

Table 7: List of bird species that have distribution range overlap with Thanh Hai windfarm project based on IUCN Redlist database

GBIF database: A total 145 of bird species were recorded within 100km buffer from the Thanh Hai-Ben Tre area and later reported to GBIF database. Among those, there were 01 Critically Endangered (CR) species, 03 Endangered species (EN), 02 Vulnerable (VU) species and 10 Near-threatened (NT) species that are listed in IUCN Redlist. GBIF data showed that most bird records were made within the 25-50km area (1107 records). Only two bird records were made in the 25km radius area from the project footprint. Most of records took place in 50-100km area from the project.

Table 8: GBIF birds records in and near the project area

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
ACCIPITRIFORMES	ACCIPITRIDAE	*Elanus caeruleus*	Black-winged Kite	LC			9
	PANDIONIDAE	*Pandion haliaetus*	Osprey	LC			2

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
CAPRIMULGIFORMES	APODIDAE	*Aerodramus brevirostris*	Himalayan Swiftlet	LC			1
		Aerodramus fuciphagus	Edible-nest Swiftlet	LC		2	22
		Apus nipalensis	House Swift	LC		3	10
		Cypsiurus balasiensis	Asian Palm-swift	LC		1	6
		Hirundapus cochinchinensis	Silver-backed Needletail	LC			1
		Hirundapus giganteus	Brown-backed Needletail	LC			1
CHARADRIIFORMES	CHARADRIIDAE	*Charadrius alexandrinus*	Kentish Plover	LC		3	27
		Charadrius dubius	Little Ringed Plover	LC			4
		Charadrius leschenaultii	Greater Sandplover	LC			22
		Charadrius mongolus	Lesser Sandplover	LC		1	26
		Charadrius peronii	Malay Plover	NT			5
		Pluvialis fulva	Pacific Golden Plover	LC			5
		Pluvialis squatarola	Grey Plover	LC			11
	LARIDAE	*Chlidonias hybrida*	Whiskered Tern	LC			15
		Gelochelidon nilotica	Common Gull-billed Tern	LC			12
		Hydroprogne caspia	Caspian Tern	LC		1	20
		Larus crassirostris	Black-tailed Gull	LC			2
		Sterna hirundo	Common Tern	LC			4

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
		Sterna sumatrana	Black-naped Tern	LC			1
		Sternula albifrons	Little Tern	LC			6
	RECURVIROSTRIDAE	*Himantopus himantopus*	Black-winged Stilt	LC		1	3
	SCOLOPACIDAE	*Actitis hypoleucos*	Common Sandpiper	LC			18
		Arenaria interpres	Ruddy Turnstone	LC			1
		Calidris alba	Sanderling	LC			11
		Calidris falcinellus	Broad-billed Sandpiper	LC			9
		Calidris ferruginea	Curlew Sandpiper	NT			16
		Calidris pygmaea	Spoon-billed Sandpiper	CR			7
		Calidris ruficollis	Red-necked Stint	NT			15
		Calidris subminuta	Long-toed Stint	LC			1
		Calidris temminckii	Temminck's Stint	LC			3
		Calidris tenuirostris	Great Knot	EN			10
		Limnodromus semipalmatus	Asian Dowitcher	NT			2
		Limosa lapponica	Bar-tailed Godwit	NT			17
		Limosa limosa	Black-tailed Godwit	NT			3
		Numenius arquata	Eurasian Curlew	NT			21
		Numenius madagascariensis	Far Eastern Curlew	EN			7
		Numenius phaeopus	Whimbrel	LC			16
		Tringa glareola	Wood Sandpiper	LC		1	2

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
		Tringa guttifer	Spotted Greenshank (Nordmann's Greenshank)	EN			14
		Tringa nebularia	Common Greenshank	LC			26
		Tringa ochropus	Green Sandpiper	LC			1
		Tringa stagnatilis	Marsh Sandpiper	LC			12
		Tringa totanus	Common Redshank	LC			2
		Xenus cinereus	Terek Sandpiper	LC		2	26
COLUMBIFORMES	COLUMBIDAE	*Columba livia*	Rock Dove	LC		1	9
		Columba punicea	Pale-capped Pigeon	VU			1
		Geopelia striata	Zebra Dove	LC			23
		Spilopelia chinensis	Eastern Spotted Dove	LC		1	22
		Streptopelia tranquebarica	Red Turtle-dove	LC	1		20
		Treron sphenurus	Wedge-tailed Green-pigeon	LC			1
CORACIIFORMES	ALCEDINIDAE	*Alcedo atthis*	Common Kingfisher	LC		2	15
		Alcedo meninting	Blue-eared Kingfisher	LC			2
		Ceryle rudis	Pied Kingfisher	LC			2
		Halcyon pileata	Black-capped Kingfisher	LC			1
		Halcyon smyrnensis	White-breasted Kingfisher	LC			10

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
		Todiramphus chloris	Collared Kingfisher	LC		1	34
	MEROPIDAE	*Merops orientalis*	Asian Green Bee-eater	LC			12
		Merops philippinus	Blue-tailed Bee-eater	LC			1
CUCULIFORMES	CUCULIDAE	*Cacomantis merulinus*	Plaintive Cuckoo	LC			16
		Cacomantis sonneratii	Banded Bay Cuckoo	LC			1
		Centropus bengalensis	Lesser Coucal	LC			1
		Centropus sinensis	Greater Coucal	LC		1	16
		Eudynamys scolopaceus	Western Koel	LC		1	2
		Phaenicophaeus tristis	Green-billed Malkoha	LC			1
GALLIFORMES	PHASIANIDAE	*Gallus gallus*	Red Junglefowl	LC			1
GRUIFORMES	RALLIDAE	*Amaurornis phoenicurus*	White-breasted Waterhen	LC			1
		Gallinula chloropus	Common Moorhen	LC			2
		Porphyrio porphyrio	Purple Swamphen	LC			1
PASSERIFORMES	ACANTHIZIDAE	*Gerygone sulphurea*	Golden-bellied Gerygone	LC		1	16
	ACROCEPHALIDAE	*Acrocephalus orientalis*	Oriental Reed-warbler	LC			5

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
	AEGITHINIDAE	*Aegithina tiphia*	Common Iora	LC			4
	CHLOROPSEIDAE	*Chloropsis aurifrons*	Golden-fronted Leafbird	LC	1		1
	CISTICOLIDAE	*Cisticola juncidis*	Zitting Cisticola	LC			2
		Orthotomus atrogularis	Dark-necked Tailorbird	LC			3
		Orthotomus ruficeps	Ashy Tailorbird	LC			7
		Orthotomus sutorius	Common Tailorbird	LC			3
		Prinia flaviventris	Yellow-bellied Prinia	LC			5
		Prinia inornata	Plain Prinia	LC			21
	CORVIDAE	*Corvus macrorhynchos*	Large-billed Crow	LC		2	3
		Crypsirina temia	Racquet-tailed Treepie	LC		1	4
		Dendrocitta vagabunda	Rufous Treepie	LC			1
	DICAEIDAE	*Dicaeum cruentatum*	Scarlet-backed Flowerpecker	LC			1
	DICRURIDAE	*Dicrurus hottentottus*	Hair-crested Drongo	LC			1
		Dicrurus leucophaeus	Ashy Drongo	LC		1	2
		Dicrurus macrocercus	Black Drongo	LC		1	3
	ESTRILDIDAE	*Lonchura atricapilla*	Chestnut Munia	LC			1
		Lonchura punctulata	Scaly-breasted Munia	LC		2	13

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
		Lonchura striata	White-rumped Munia	LC			2
	HIRUNDINIDAE	*Cecropis daurica*	Red-rumped Swallow	LC		1	1
		Hirundo rustica	Barn Swallow	LC		2	23
		Hirundo tahitica	Tahiti Swallow	LC			4
	LANIIDAE	*Lanius cristatus*	Brown Shrike	LC			22
	LOCUSTELLIDAE	*Megalurus palustris*	Striated Grassbird	LC		1	1
	MOTACILLIDAE	*Anthus rufulus*	Paddyfield Pipit	LC			5
		Motacilla cinerea	Grey Wagtail	LC			2
	MUSCICAPIDAE	*Muscicapa dauurica*	Asian Brown Flycatcher	LC			1
		Niltava grandis	Large Niltava	LC			1
	NECTARINIIDAE	*Anthreptes malacensis*	Brown-throated Sunbird	LC			6
		Arachnothera longirostra	Little Spiderhunter	LC			1
		Cinnyris asiaticus	Purple Sunbird	LC			1
		Cinnyris jugularis	Olive-backed Sunbird	LC			12
	PACHYCEPHALIDAE	*Pachycephala cinerea*	Mangrove Whistler	LC		1	1
	PARIDAE	*Parus cinereus*	Cninereus Tit	LC			1
		Parus minor	Japanese Tit	LC		1	1
	PASSERIDAE	*Passer domesticus*	House Sparrow	LC			10
		Passer flaveolus	Plain-backed Sparrow	LC			15
		Passer montanus	Eurasian Tree Sparrow	LC		5	23

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
	PELLORNEIDAE	*Pellorneum ruficeps*	Puff-throated Babbler	LC			1
	PHYLLOSCOPIDAE	*Phylloscopus fuscatus*	Dusky Warbler	LC			3
		Phylloscopus inornatus	Yellow-browed Warbler	LC			1
	PLOCEIDAE	*Ploceus philippinus*	Baya Weaver	LC			1
	PYCNONOTIDAE	*Pycnonotus aurigaster*	Sooty-headed Bulbul	LC			2
		Pycnonotus blanfordi	Streak-eared Bulbul	LC		1	20
		Pycnonotus goiavier	Yellow-vented Bulbul	LC			31
	RHIPIDURIDAE	*Rhipidura albicollis*	White-throated Fantail	LC			1
		Rhipidura aureola	White-browed Fantail	LC			1
		Rhipidura javanica	Sunda Pied Fantail	LC		1	24
	STURNIDAE	*Acridotheres tristis*	Common Myna	LC		2	3
		Sturnia sinensis	White-shouldered Starling	LC			1
	ZOSTEROPIDAE	*Zosterops palpebrosus*	Oriental White-eye	LC			1
PELECANIFORMES	ARDEIDAE	*Ardea alba*	Great White Egret	LC		2	11
		Ardea intermedia	Intermediate Egret	LC			5

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
		Ardea purpurea	Purple Heron	LC			2
		Ardeola bacchus	Chinese Pond-heron	LC			21
		Ardeola speciosa	Javan Pond-heron	LC			5
		Bubulcus ibis	Cattle Egret	LC			5
		Butorides striata	Green-backed Heron	LC			10
		Egretta eulophotes	Chinese Egret	VU			1
		Egretta garzetta	Little Egret	LC		1	29
		Egretta sacra	Pacific Reef-egret	LC			2
		Ixobrychus cinnamomeus	Cinnamon Bittern	LC			4
		Ixobrychus sinensis	Yellow Bittern	LC			2
		Nycticorax nycticorax	Black-crowned Night-heron	LC		1	4
	PELECANIDAE	*Pelecanus philippensis*	Spot-billed Pelican	NT			3
	THRESKIORNITHIDAE	*Threskiornis melanocephalus*	Black-headed Ibis	NT			1
PICIFORMES	MEGALAIMIDAE	*Psilopogon haemacephalus*	Coppersmith Barbet	LC		1	2
	PICIDAE	*Dendrocopos macei*	Fulvous-breasted Woodpecker	LC			2
STRIGIFORMES	TYTONIDAE	*Tyto alba*	Common Barn-owl	LC		1	1
SULI FOR	ANHINGIDAE	*Anhinga melanogaster*	Oriental Darter	NT			1

ORDER	FAMILY	Species	Common name (BOTW)	IUCN	25km	25-50km	50-
	PHALACROCORACIDAE	*Microcarbo niger*	Little Cormorant	LC		2	26
		Phalacrocorax fuscicollis	Indian Cormorant	LC			1

3.2 Remote sensing

NDVI calculated for showed the low vegetation quality in the project area. The proposed transmission line will mainly pass through area with relatively thin vegetation covers (NDIV from 0.5 to 0.8 were considered as dense vegetation). The details on NDVI along the transmission line (within 100m buffer from the line) were showed in Figure 20 and Figure 21.

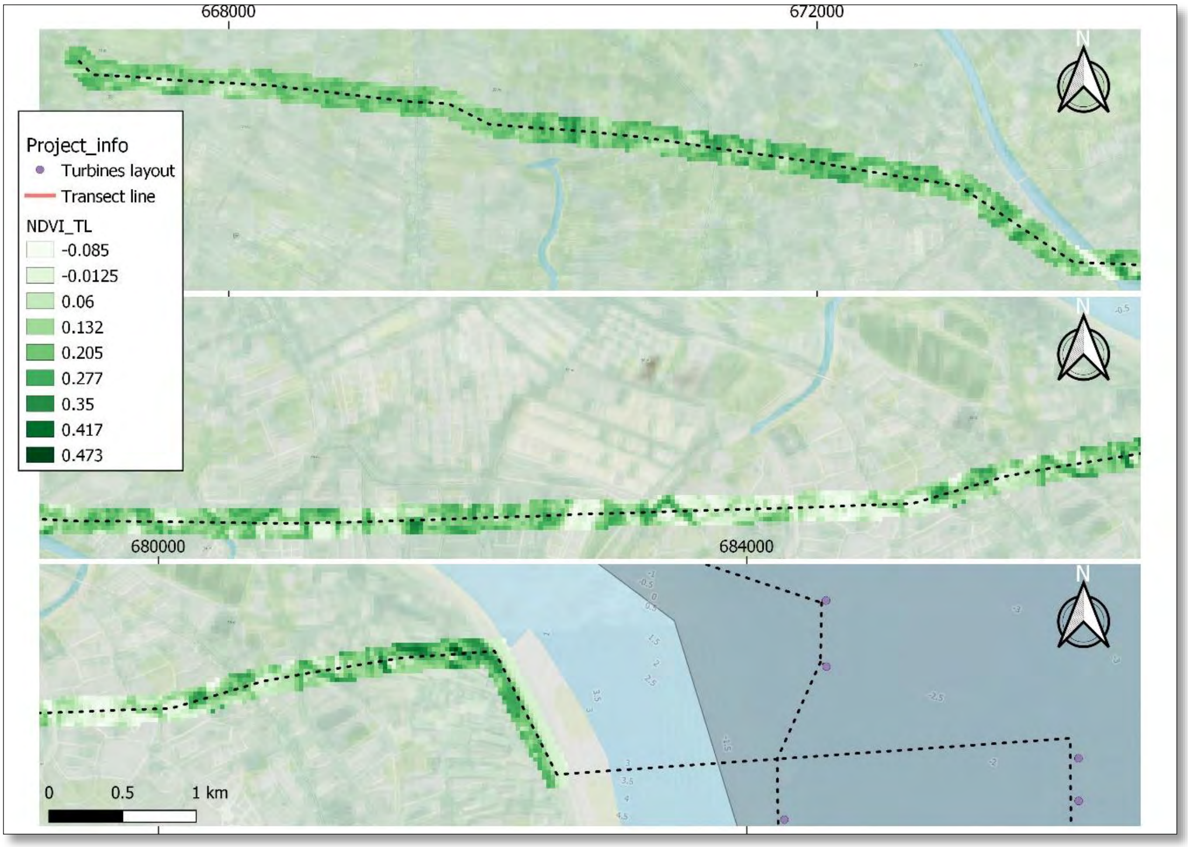


Figure 20: NDVI within 100m buffer from the transmission line

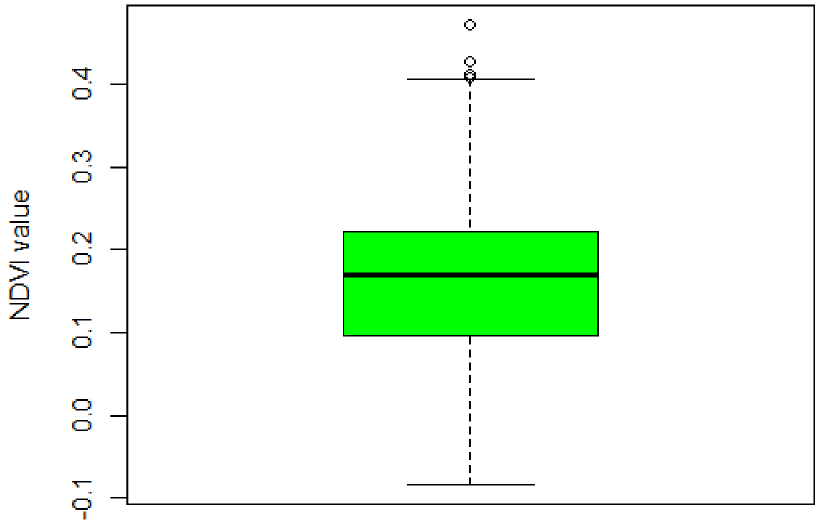


Figure 21: Distribution of NDVI value calculated for the 100m buffer area from the transmission line

The land classification process suggested that the transmission line will mainly pass through grassland and aquaculture land. Within the 100m buffer from the transmission line (which have total area of 336ha), the aquaculture lands, grass lands and building-agriculture land accounted for 52%, 31% and 8.4%, respectively. Land types under within the 100m buffer from the transmission line were summarized in Figure 22 and Table 9 below.

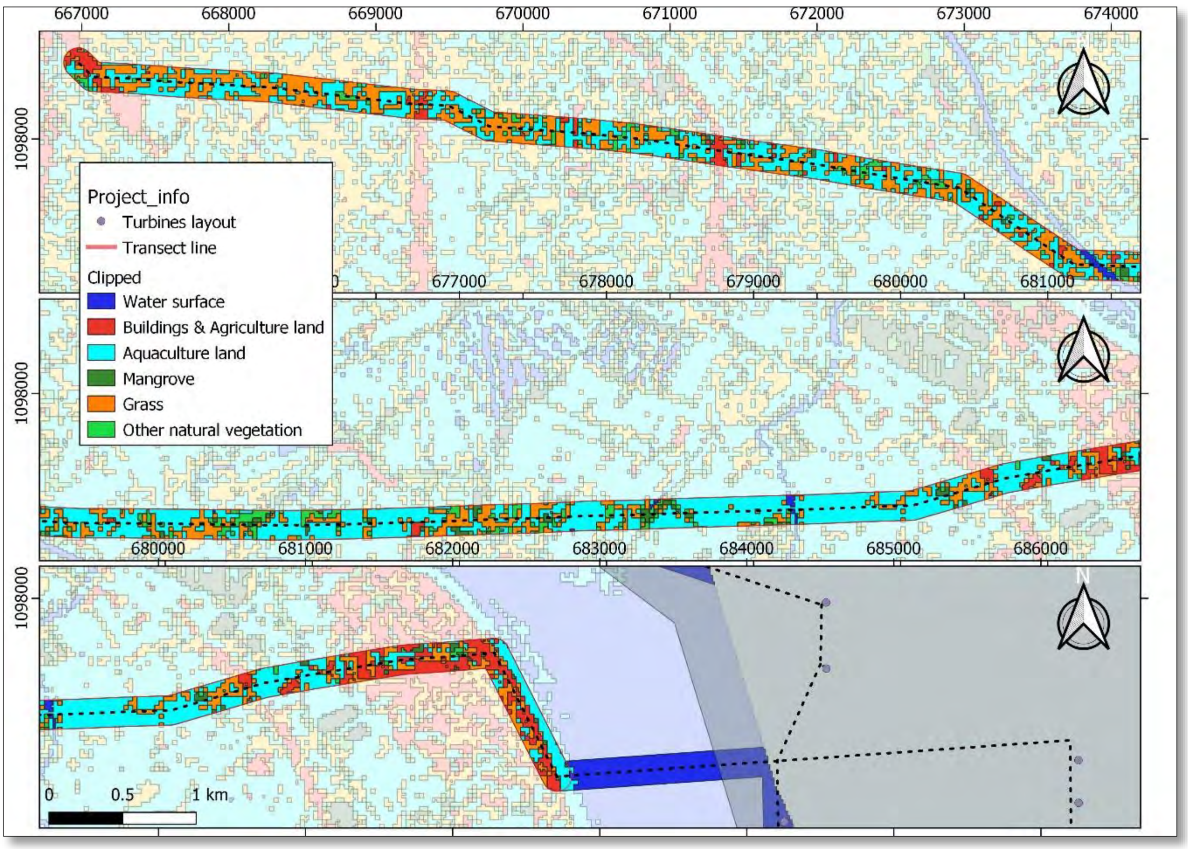


Figure 22: Land/habitat types in the 100m buffer area from the transmission line

Table 9: Total area of each land/habitat type within 100m buffer area from the transmission line

	Total area (ha)	Percentage
Water surface	2.0903	0.62%
Buildings & Agriculture	28.075	8.38%
Aquaculture land	174	51.94%
Mangrove	7.3256	2.18%
Grass	104.077	31.06%
Other vegetation	20.5286	6.127%

3.3 Field survey

3.3.1 Vantage point survey

Species diversity at vantage points: a total of 35 bird species (of 08 order, 14 families) was observed in two vantage points during this October 2019 survey (Table 10). Among those, the Oriental Darter *Anhinga melanogaster* and the Eurasian Curlew *Numenius arquata* were Near-threatened (NT) species in the IUCN Redlist.

Table 10: List of bird species that were observed flying in two vantage points

	Common name	Taxa	IUCN status
	Order	**CAPRIMULGIFORMES**	
	Family	**APODIDAE**	
1	Germain's Swiftlet	*Aerodramus* sp.	LC
2	Fork-tailed Swift	*Apus* sp.	LC
	Order	**CHARADRIIFORMES**	
	Family	**CHARADRIIDAE**	
3	Kentish Plover	*Charadrius alexandrinus*	LC
4	Greater Sandplover	*Charadrius leschenaultii*	LC
5	Lesser Sandplover	*Charadrius mongolus*	LC
6	Pacific Golden Plover	*Pluvialis fulva*	LC
	Family	**LARIDAE**	
7	Gull-billed Tern	*Gelochelidon nilotica*	LC
8	Caspian Tern	*Hydroprogne caspia*	LC
9	Common Tern	*Sterna hirundo*	LC
10	Unidentified tern	*Unidentified tern*	LC
	Family	**SCOLOPACIDAE**	
11	Common Sandpiper	*Actitis hypoleucos*	LC
12	Sanderling	*Calidris alba*	LC
13	Eurasian Curlew	*Numenius arquata*	NT
14	Whimbrel	*Numenius phaeopus*	LC

	Common name	Taxa	IUCN status
15	Common Greenshank	*Tringa nebularia*	LC
16	Green Sandpiper	*Tringa ochropus*	LC
17	Marsh Sandpiper	*Tringa stagnatilis*	LC
18	Terek Sandpiper	*Xenus cinereus*	LC
	Order	**COLUMBIFORMES**	
	Family	**COLUMBIDAE**	
19	Zebra Dove	*Geopelia striata*	LC
20	Spotted Dove	*Spilopelia chinensis*	LC
	Order	**CORACIIFORMES**	
	Family	**ALCEDINIDAE**	
21	Collared Kingfisher	*Todiramphus chloris*	LC
	Family	**MEROPIDAE**	
22	Green Bee-eater	*Merops orientalis*	LC
23	Blue-tailed Bee-eater	*Merops philippinus*	LC
	Order	**PASSERIFORMES**	
	Family	**DICRURIDAE**	
24	Black Drongo	*Dicrurus macrocercus*	LC
	Family	**HIRUNDINIDAE**	
25	Barn Swallow	*Hirundo rustica*	LC
	Family	**STURNIDAE**	
26	Common Myna	*Acridotheres tristis*	LC
27	White-shouldered Starling	*Sturnia sinensis*	LC
	Order	**PELECANIFORMES**	
	Family	**ARDEIDAE**	
28	Great Egret	*Ardea alba*	LC
29	Grey Heron	*Ardea cinerea*	LC
30	Chinese Pond-heron	*Ardeola bacchus*	LC
31	Striated Heron	*Butorides striata*	LC
32	Little Egret	*Egretta garzetta*	LC
	Order	**SULIFORMES**	
	Family	**ANHINGIDAE**	
33	Oriental Darter	*Anhinga melanogaster*	NT
	Family	**PHALACROCORACIDAE**	
34	Little Cormorant	*Microcarbo niger*	LC
	Order	**ACCIPITRIFORMES**	
35	Unidentified raptor		

Bird activities: A total of 19,005 seconds of bird flying was observed from the two vantage points during October 2019 survey. All observed flights took place in band 1 (<35m). No observed flight occurred in band 2 (35-150m) or band 3 (>150m). Figure 23 Figure 23 summarized the total flying time observed in each vantage points. Detail flying time of each species at each height bands were summarised in Figure 24 and Figure 26 below.

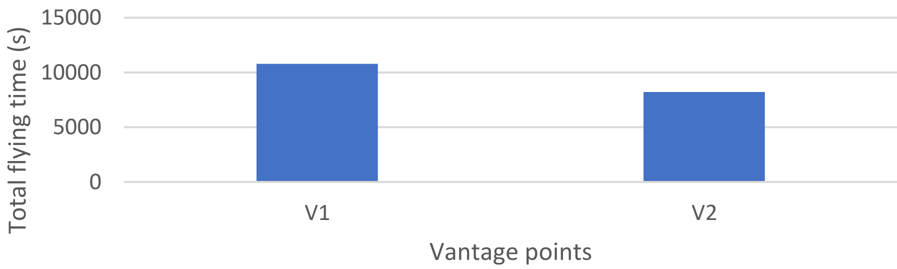
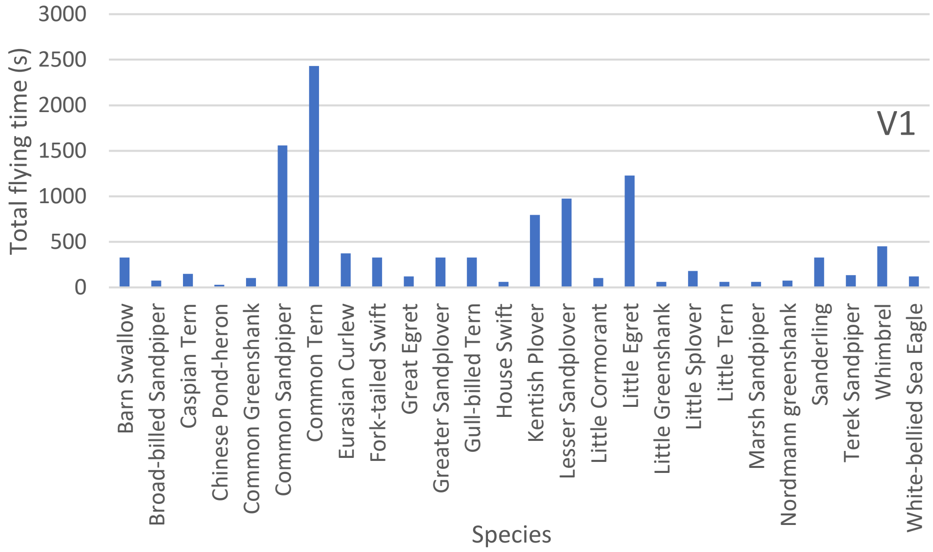


Figure 23: Flying time at in each band at two vantage points

In this survey, bird flying was observed more frequently in V1 comparing to V2. A total 10800 seconds of flights were recorded V1, while only 8205 seconds were recorded in V2 (Figure 23). However, the number of species recorded in V2 (36 species) were higher than those recorded in V1 (26 species). In V1, the most active (most-frequently flying) species were the Common tern *Sterna hirundo*, while the Little egret *Egretta garzetta* were the most active species observed in V2.



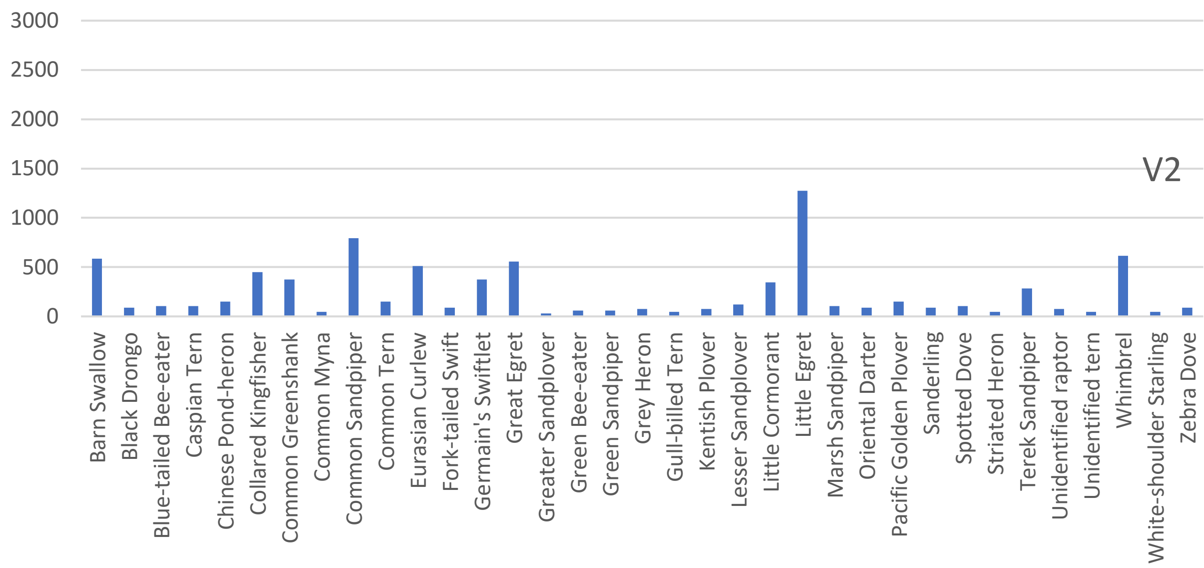


Figure 24: Flying time of different species in each band at two vantage points

Bird activities were different at different time in a day. In both points, most observed flying activates took place in the early morning (from 6:00 to 8:00), then reduced (Figure 25). This pattern are predictable as most avian species are actives during early morning and before sunset (Ermy Azziaty Rozali & Othman 1998). However, we observed the increase in bird activities at both vantage point during the 11:00 to 13:00 period, following up by a slight reduction. Species that actives during this time period were shorebirds (or wader) such as Common Sandpiper (*Actitis hypoleucos*) or Eurasian Curlew (*Numenius arquata*) (Figure 26). Despite of variation in species activities, no fly that higher than 35m were observed during 36 hours of vantage point survey.

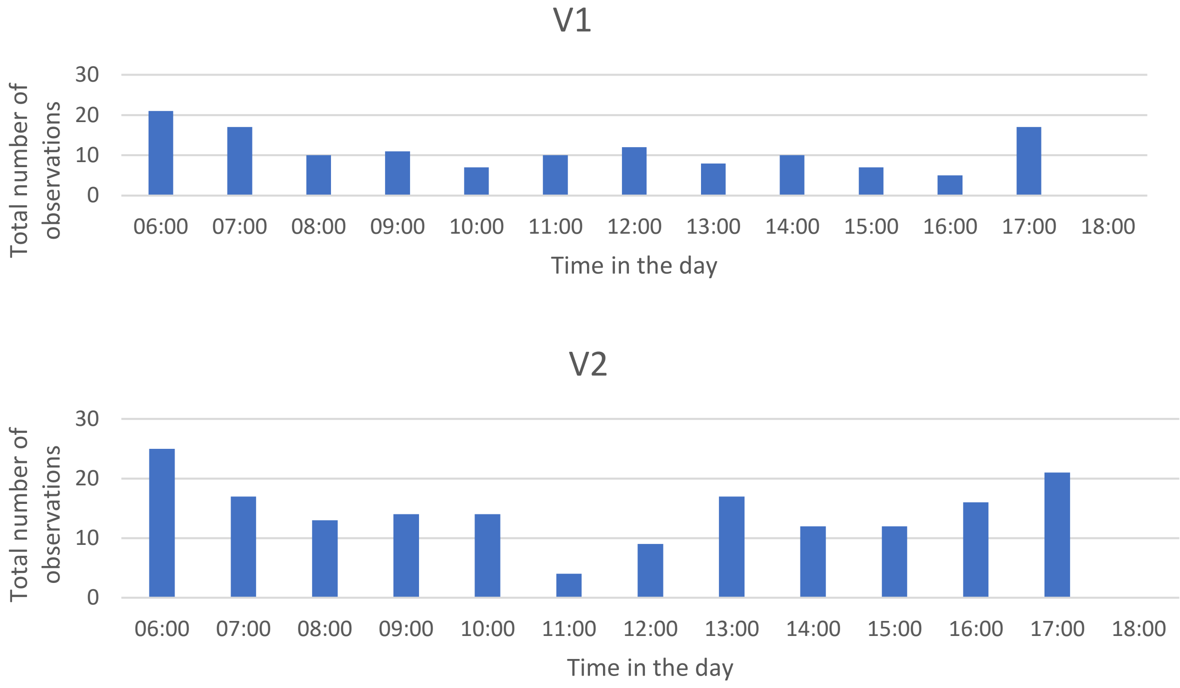


Figure 25: Bird activity at different time in day

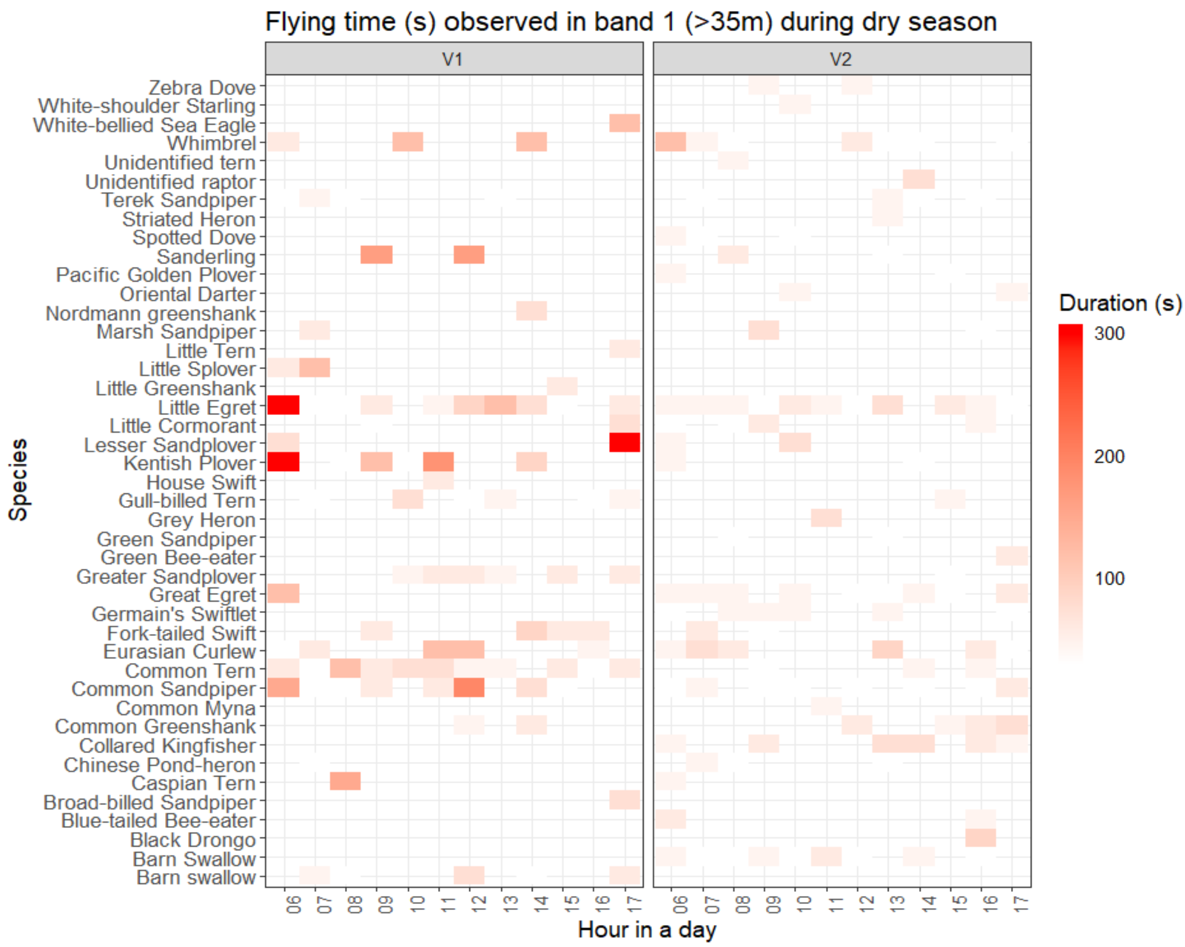


Figure 26: Duration of bird flights observed in two vantage points

Bird traffic: The vantage point survey conducted in October 2019 showed busier avian traffic in vantage point V1 (Figure 28). This pattern was a direct result of bigger flocks that were observed in the V1 area. The average number of individuals in a flock recorded in two vantage points were similar, as showed in Figure 27.

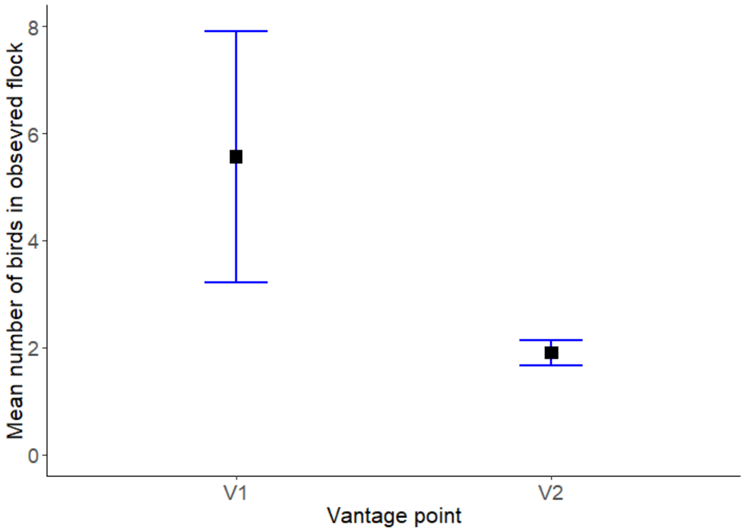


Figure 27: Average number of birds observed in a record in two points, with 95% confidence interval.

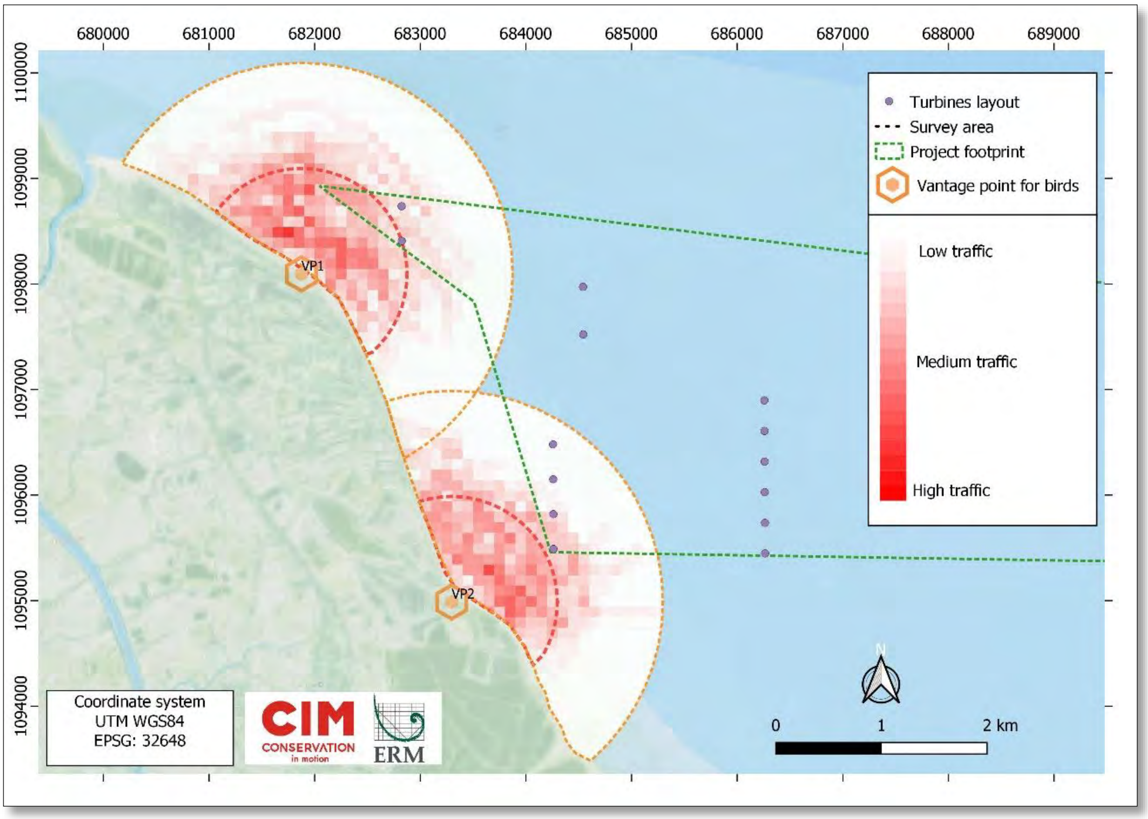


Figure 28: Avian traffic in the project area, recorded in rainy season, October 2019

Summary of findings: vantage point survey recorded fair amount of bird traffics in the coastal area of Thanh Hai Windfarm project. No flight in band 2 (in which the collision risk needs to be considered) were observed during this survey. There were spatiotemporal variations in birds traffics. Bird traffic were busier in V1 (North of the site) than in V2 (South of the site). In both site bird traffics were busier in the early morning. Two IUCN's NT species, the Oriental Darter *Anhinga melanogaster* and the Eurasian Curlew *Numenius arquata* were recorded in this survey.

3.3.2 Boat-based line transect survey

The boat-base line transect survey using DISTANCE sampling method survey has covered a sea area of 53.9km^2, including the proposed footprint of the Thanh Hai wind farm project and its vicinities. During the survey, the survey vessel has traveled a total distance of 138.645km, in which 58.9km was on-effort sampling (the survey vessel was on transects). A total of 34 on-effort and 16 off-effort seabird sightings were made in the survey area. Information of ten species of seabirds recorded during the survey were summarized in Table 11. No dolphin, whale, sea turtle was recorded during this survey. As there are no marine megafauna had been observed during this survey, the report would focus on seabird from this point.

Table 11: Summary of sightings made during boat-based survey

Order	Family	Scientific name	Common name	IUCN	On-effort sightings	Off-effort sightings
APODIFORMES	APODIDAE	*Aerodramus* sp.	Germain's Swiftlet	LC	0	1
CHARADRIIFORMES	LARIDAE	*Chlidonias hybrida*	Common Tern	LC	28	5
		Chlidonias leucopterus	Little Tern	LC	7	2
		Hydroprogne caspia	Caspian Tern	LC	0	1
	SCOLOPACIDAE	*Calidris alba*	Sanderling	LC	0	19
PELICANIFORMES	PELECANIDAE	*Pelecanus philippensis*	Spot-billed Pelican	NT	0	1
PASSERIFORMES	HIRUNDINIDAE	*Hirundo rustica*	Barn Swallow	LC	22	5
CORACIIFORMES	ALCEDINIDAE	*Todiramphus chloris*	Collared Kingfisher	LC	0	1
SULIFORMES	ANHINGIDAE	*Anhinga melanogaster*	Oriental Darter	NT	0	1
	PHALACROCORACIDAE	*Microcarbo niger*	Little Cormorant	LC	0	1

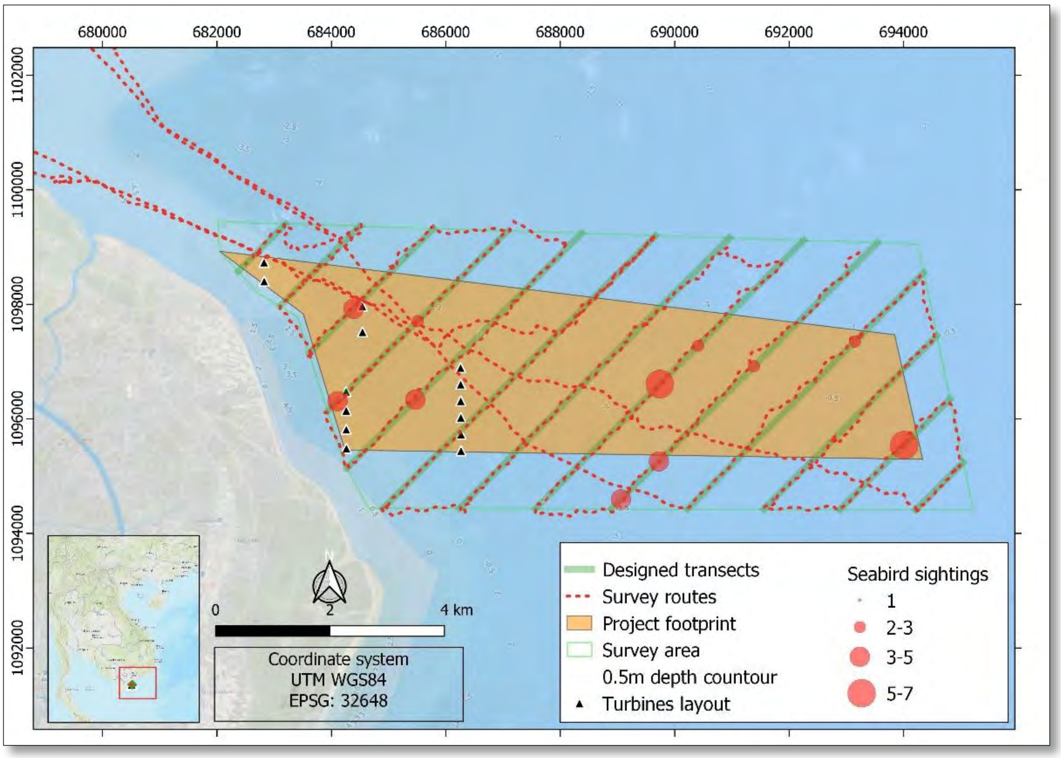


Figure 29: Map of seabirds on-effort sightings

All seabirds observed in the boat-based survey flew lower than 35m. The most common species in the survey area was the common tern *Sterna hirundo*. All birds were observed within 150m perpendicular distance measured from the observed bird to the surveyed transect (Figure 30A). Seabirds in the survey area were usually travel alone or in small group (Figure 30 B). There was no clear relationship between perpendicular distance with group sizes of sightings, suggesting group size did not heavily affect the detection probability (Figure 30C). Most of the sightings were made in Beaufort scale 3 and higher (Figure 30D).

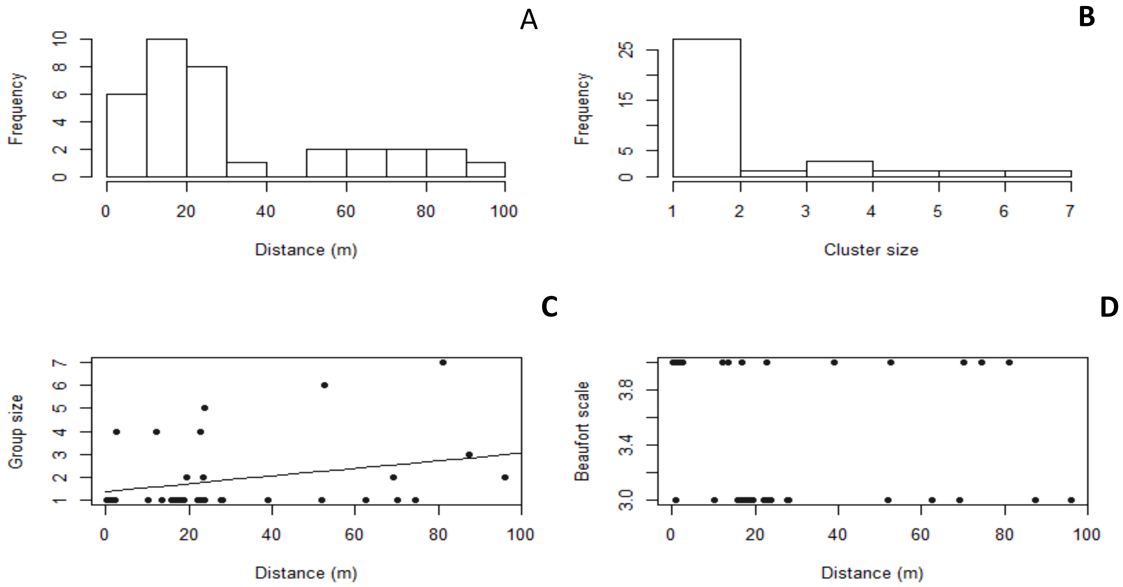


Figure 30: Descriptive statistics of distance sampling data collected from this survey

Model with Half-normal function and cosine adjustment appeared to be the best fitted model (Lower AICs, Table 2). Figure 31 present the fitting of Half-normal curve to observed perpendicular distances. Overall, this model performed well in explaining the collected data. According to this model, averaged seabird density in the survey area was 1.61 individuals per 01km^2. Total number of seabirds within the survey area were estimated as 87 individuals (CV=0.242) (
Table 12). This seabird density is considered low.

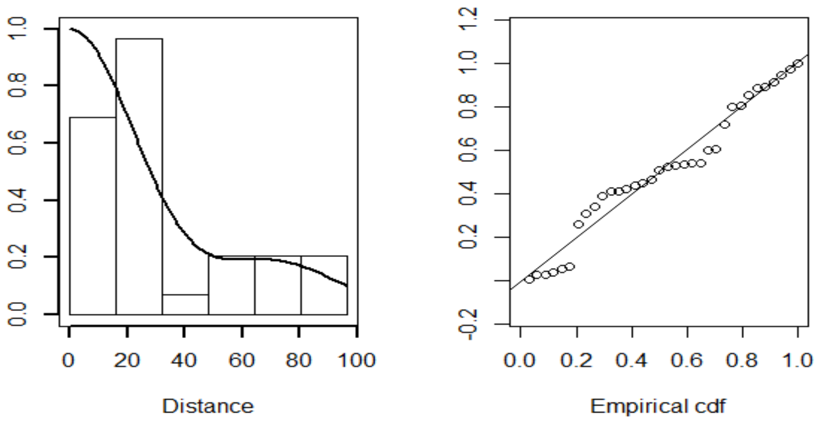


Figure 31: Detecting function using Half-normal key function and cosine adjustment

Table 12: Results of different Distance models, and seabird density estimation

Model	Model definition	AICc	N	NCV	D (individual/km^2)
M1	Half-normal + cosine	267.10	87	0.242	1.61
M2	Hazzard rate + cosine	299.09	84	0.252	1.40
M3	Half-normal + cosine ~ covariate (Beaufort scale)	297.99	59	0.16	1.09

M4	Hazzard rate + cosine ~ covariate (Beaufort scale)	304.09	198	0.767	3.67

The best fitted model, which have lowest AICc value (Pan 2004), was the one with Half-normal key function. This detecting function were used to construct the Density Surface Model (Miller et al. 2013a). The simplest DSM model, with Half-normal detecting function and spatial coordinates, was able to explain 36.1% of data deviance. The result of this DSM model was summarized in Figure 32. Area with high seabird abundance predicted detected by this model were as showed as bright red areas in Figure 32, while the CV of prediction (represent the level of uncertainty) was illustrated in Figure 33. The result showed an uneven distribution of seabirds within the survey area. Within the project footprint, the near shore (river mouth) and the easternmost part have greater seabird abundances than in the middle of the project footprint. Current wind turbines layout overlapping with area that has high seabird abundance.

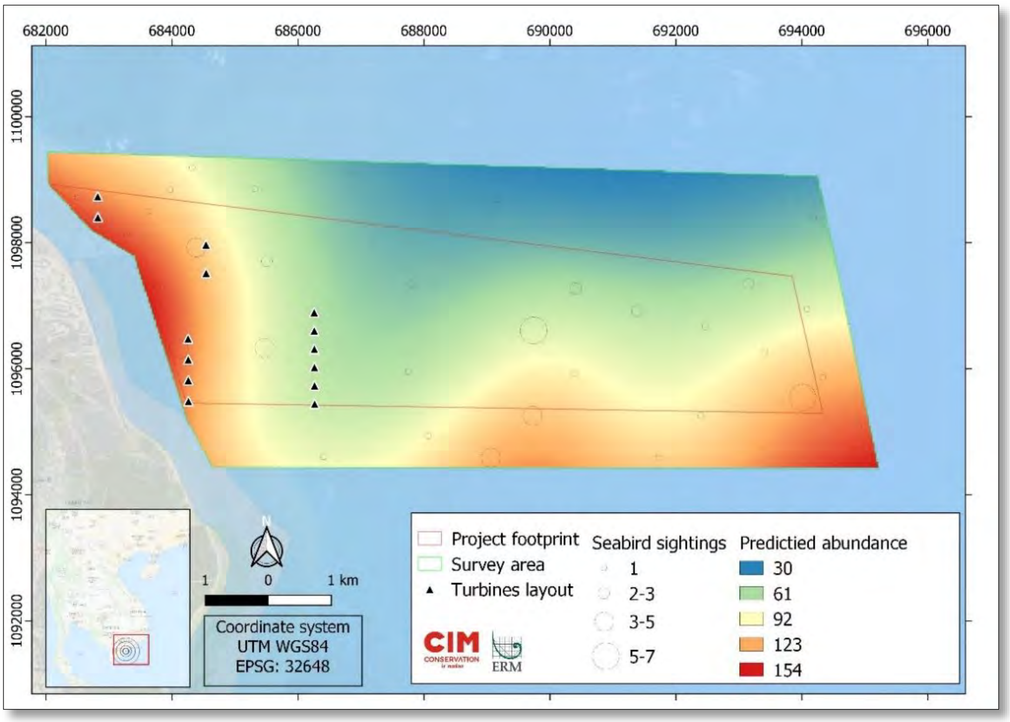


Figure 32: Distribution of seabird density within the survey area

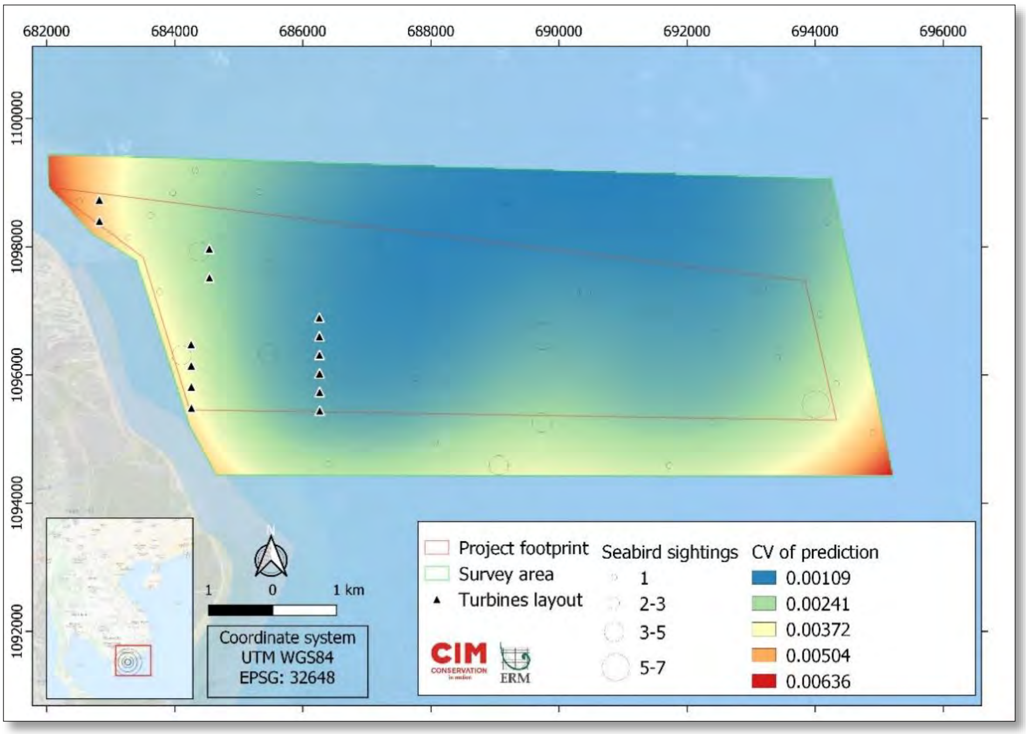


Figure 33: Distribution of CV for the DSM model used to map seabird's density

Summary of findings: the boat-based line transect survey using DISTANCE sampling were only able to detect seabirds in the project's footprint. Seabirds were predicted to be more abundance in the near-shore/river mouth area and easternmost point of the project's footprint. Current wind turbine layout overlaps with the area with high bird abundance. This survey recorded no bird that flew higher than 35m from the sea level.

3.3.3 Macrobenthos survey

A total of 35 macrobenthic taxa, belong to 06 group have been recorded during this survey. Among those, the Mollusk contributed the most for number of species in macrobenthic community (18 identified taxa), while the Crustacean contributed the most for the number of species recorded. Checklist of the macrobenthos species recorded in the survey was presented in Table 13. Brief description of macrobenthic assemblages at each station were summarized in Figure 34. Overall, the most common macrobenthos found in the project footprint area were benthic crab of superfamily Ocypodidae. A total of 126 individuals of this taxa have been recorded in the survey area. No IUCN concerned species has been recorded during this survey.

Table 13: Summary of macrobenthos assemblage recorded in the survey area

Higher taxonomic classification	Taxa	Abundance
CLITELLATA	Oligochaeta	1
	Sternaspis scutata	6
	Chaetopteridae	1
	unidentified Polychactea	1
	Nereididae	4
	Paraonidae	1
	Oweniidae	23
	Oenonidae	2
	Orbiniidae	1
POLYCHAETA	Nephtyidae	1
PHASCOLOSOMATIDEA	Phascolosomatidea	1
ERCHINODERMATA	Ophiodermatidae	1
	Abra alba	1
	Tellinidae	4
	Marginellidae	3
	Turritellidae	30
	Buccinidae	1
	Veneridae	15
	Semelidae	1
	Arcidae	4
	Glyceridea	1
	Nassariidae	1
	Ostreidae	1
	Olividae	3
	Mactridae	16
	Cardiidae	2
	Mangeliidae	1
	Pyramidellidae	5
	Naticidae	1
MOLLUSCA	Mytilidae	1
	Cirolanidae	1
	Ocypodidae	126
	Balanidae	4
CRUSTACEA	Leptocheliidae	1

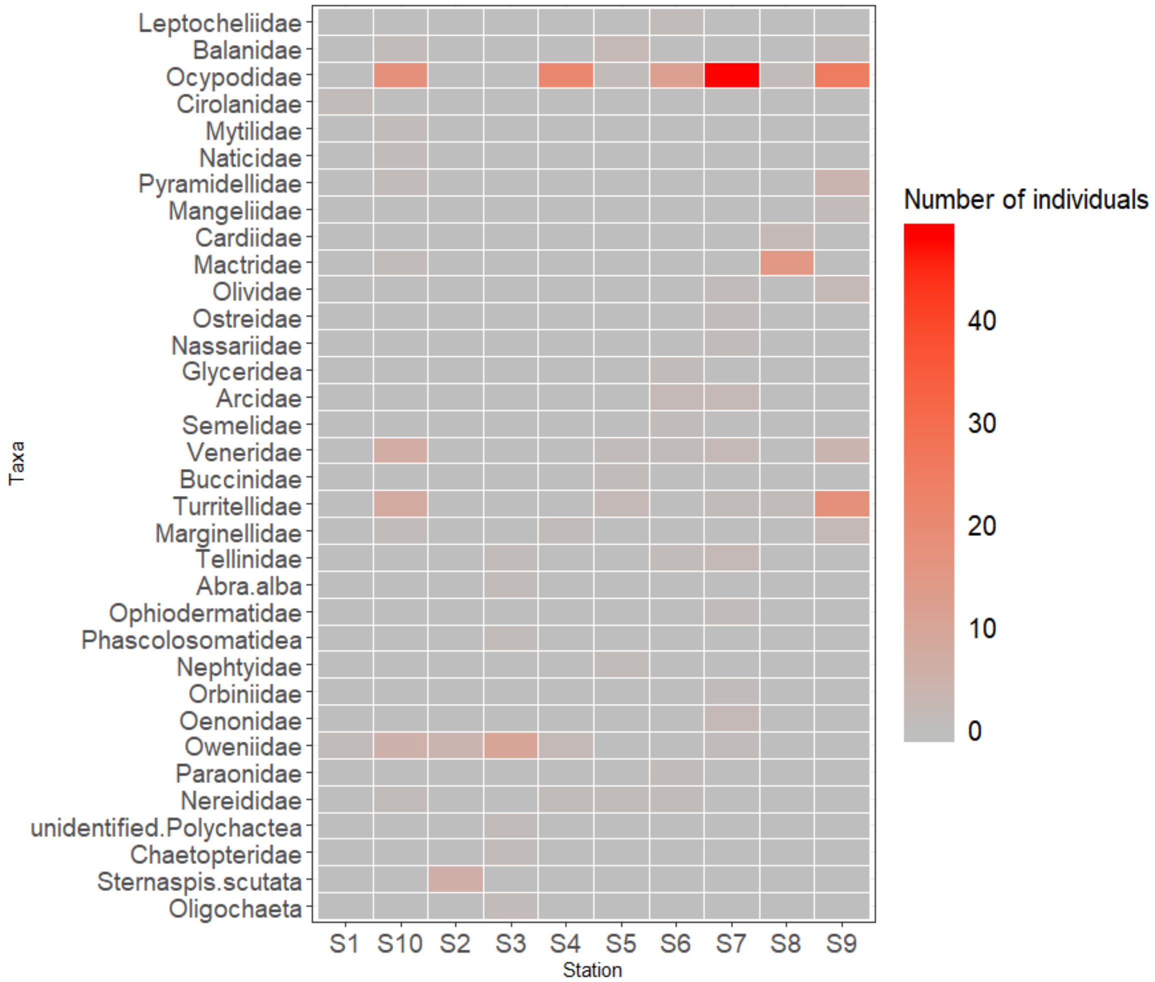


Figure 34: Macrobenthic assemblages in different stations

Figure 35:The Ocypodidae found in the survey area

Biodiversity indices calculated for each station were presented in Table 14 below. All calculated diversity indices suggested the presence of relatively diverse macrobenthic fauna in station S5 (6.27) and station S10 (5.97). Within the project area, the diversity of macrobenthic assemblage were greatly varied.

Table 14: Summary of biodiversity indices for macrobenthic communities at each station

Station	Number of species	Abundance (individual)	H(log2)	J	C	Biomass (g)
S1	2	2	2.302585	1	0.5	0.17
S2	2	10	2.235696	0.970951	0.52	0.322
S3	7	16	4.429701	0.68527	0.414063	1.771
S4	4	25	2.013172	0.437155	0.7152	17.012
S5	7	9	**6.275651**	**0.970836**	**0.160494**	6.243
S6	9	21	5.17743	0.709332	0.351474	10.481
S7	12	63	3.672822	0.444938	0.586294	18.27
S8	4	19	2.436773	0.529139	0.639889	3.452
S9	8	56	4.771977	0.690814	0.315051	31.47
S10	11	45	**5.977184**	**0.750371**	**0.231605**	13.44

Cluster analysis using Bray-Crutis matrix of similarity revealed that macrobenthic assemblages in stations can be grouped based on their similarity. Macrobenthic assemblages in station S1 were very similar to station S5; in station S3 were very similar to station S8; in station S2 were very similar to station S6 (Figure 36). The nMDS ordination reveal similar patterns, where macrobenthic assemblages in station S1 and S5 closely grouped to each other (Figure 37).

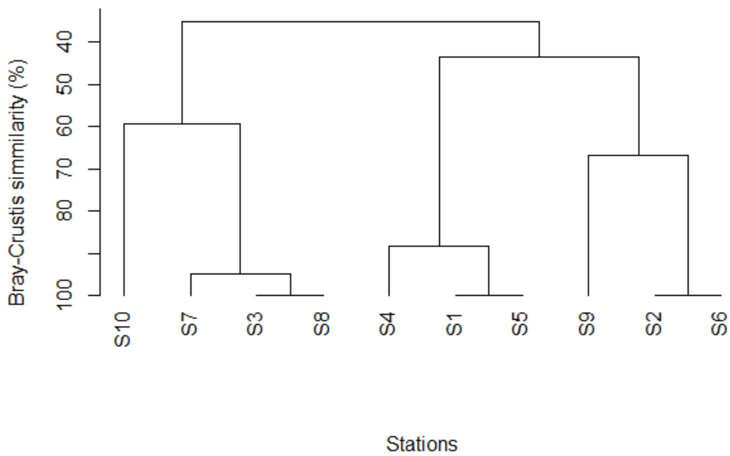


Figure 36: Cluster dendrogram using Bray-Curtis similarity matrix

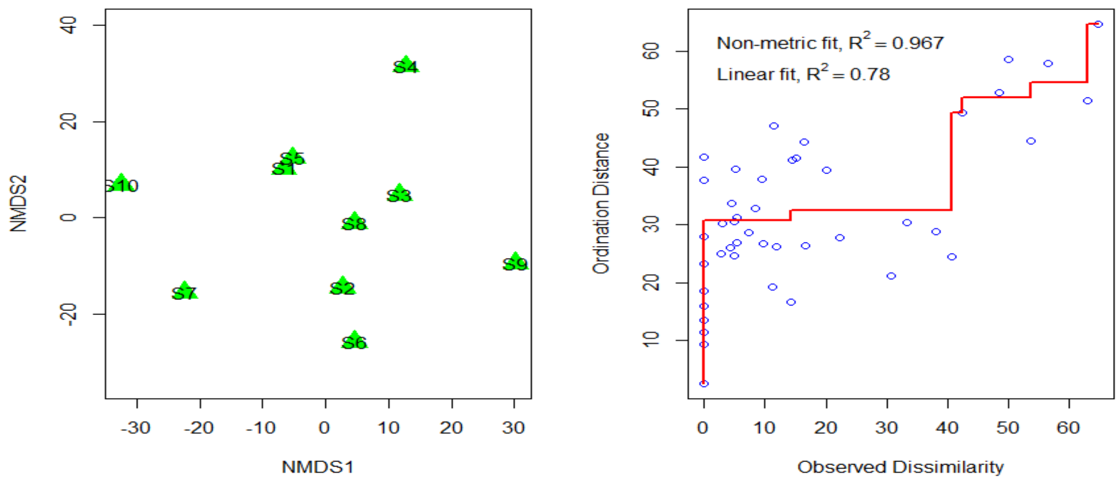


Figure 37: nMDS ordinate based on the similarity in macrobenthic composition

BIO-ENV procedure using Spearman Rank correlation method revealed that depth alone did not explain well the observed biological pattern in collected samples (Spearman rank correlation = -0.047). Combination of depth, distance to river mouth and distance to shore explain the macrobenthos composition better. However, even such combination could only achieve Spearman rank correlation = -0.214 (Spearman rank correlation >0.5 or Spearman rank correlation <- 0.5 indicate a good fit). Therefore, depth, distance to river mouth and distance to shore have weak influences on the macrobenthos communities in the project area.

Table 15: Highest Spearman rank correlation values resulted from BIOENV approach

Number of variables	**Variables**	**Spearman rank correlation**
1	Depth	-0.047
4	Depth + Distance to river mouths	-0.126
3	Depth + Distance to shore +Distant to river mouth	-0.214

Mapping: As the used environmental parameters could not explained well the structure of the macrobenthos within the project area, the mapping process could not depend on ecological-statistical model. The remain practical approach for mapping was to using Kriging interpolation to visualize the hotspot for macrobenthos diversity in the project footprint. The Shannon-Weiner H(Log2) at each station were used to use to construct a Kernel density surface in the project area. Kernel shape was configured as "quadric", with decay rate at 50%. Kernel density interpolating were conducted via plugin Heatmap in QGIS 3.0. The result was presented in Figure 38 and Figure 39 below.

Summary of findings: the macrobenthic communities in the project area were relative diver and unevenly distributedun. The benthic assemblages in the survey area were dominated by Crustacean (in term of biomass) station and Mollusk (in term of species number). The current turbines layout did not appear to overlap with macro benthic hotpot.

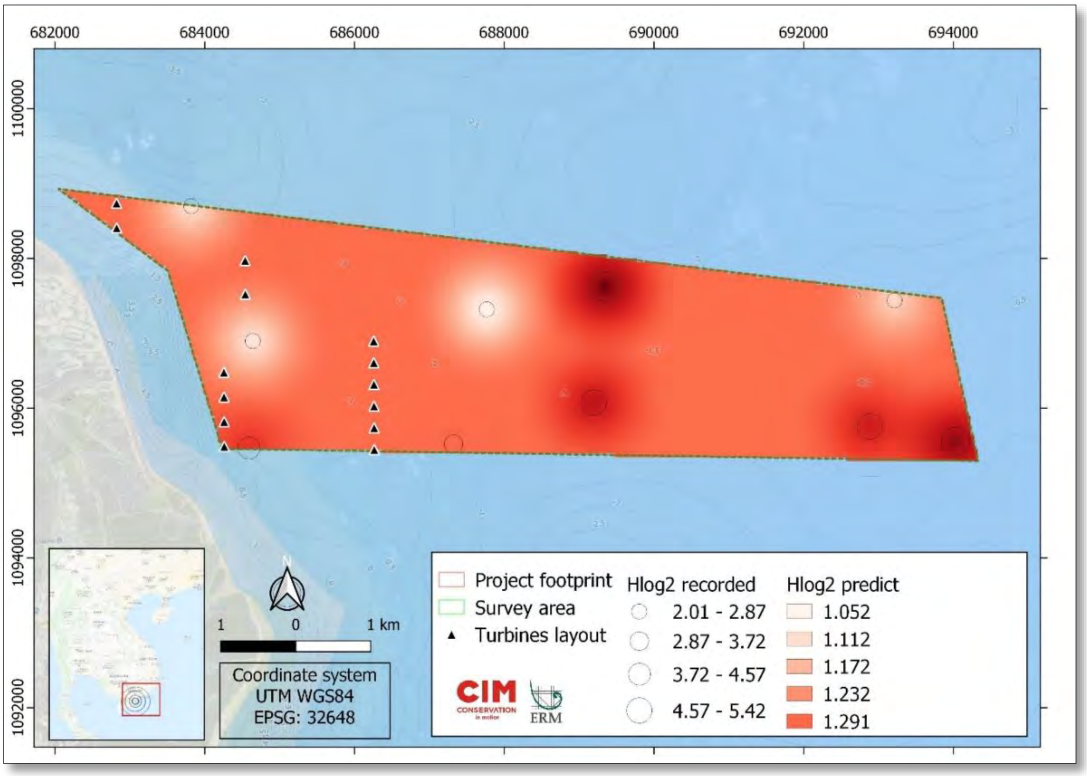


Figure 38: Prediction of Shanon-Weiner H(Log2) biodiversity index for macrobenthos in the project footprint.

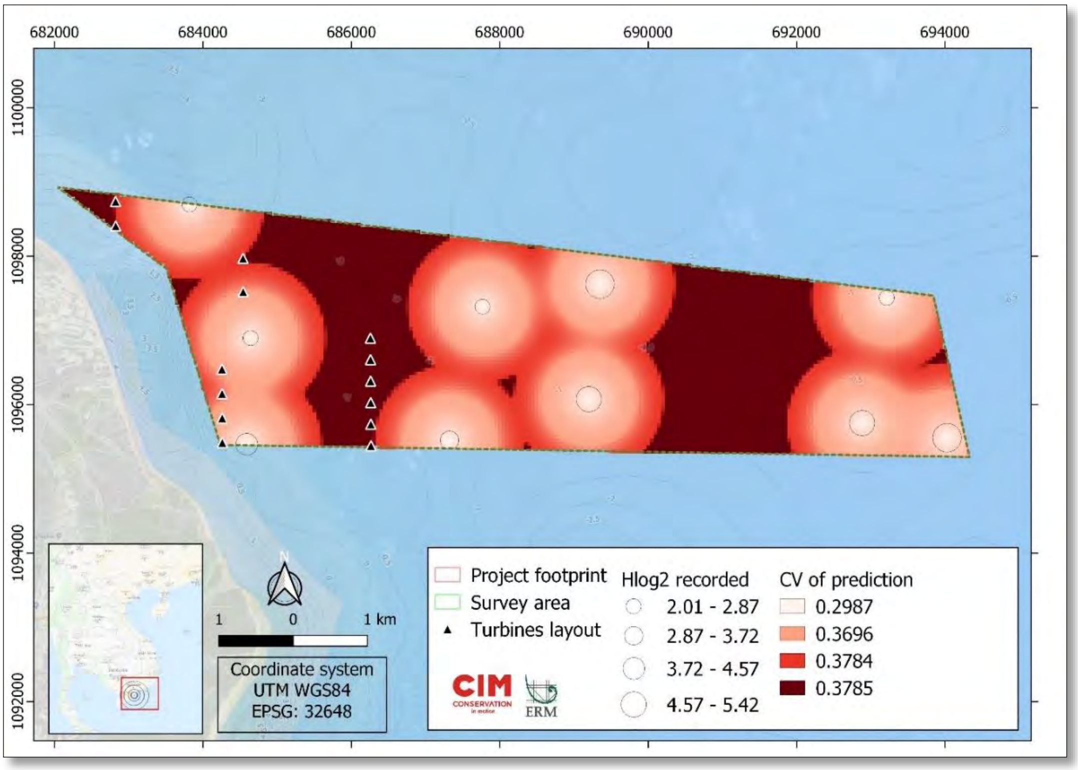


Figure 39: CV of Shannon-Weiner H(log2) predictions

3.3.4 Bat survey

Acoustic transect survey: during 8,825m transects, a total of 5,412 signals were recorded. Among those, 673 signals were further identified as bat's calls. Bats were relatively more active along the Transect 4, which was the shortest transect but had highest number of bat's calls recorded. The transect survey was able to detect a spatial variation in bat activities in the coastal Thanh Hai area. Overall more bat's calls were recorded when the transects moved further into the in-land area. There were 218 bat's calls recorded right in the beach (transect 1), which suggested several bat species can fly to the open sea and go to the wind turbines area (Figure 40).

Table 16: Relative bat's activities along 04 transect

Transect	Total number of calls	Calls per km
Transect 1	218	51
Transect 2	42	40
Transect 3	456	99
Transect 4	128	239

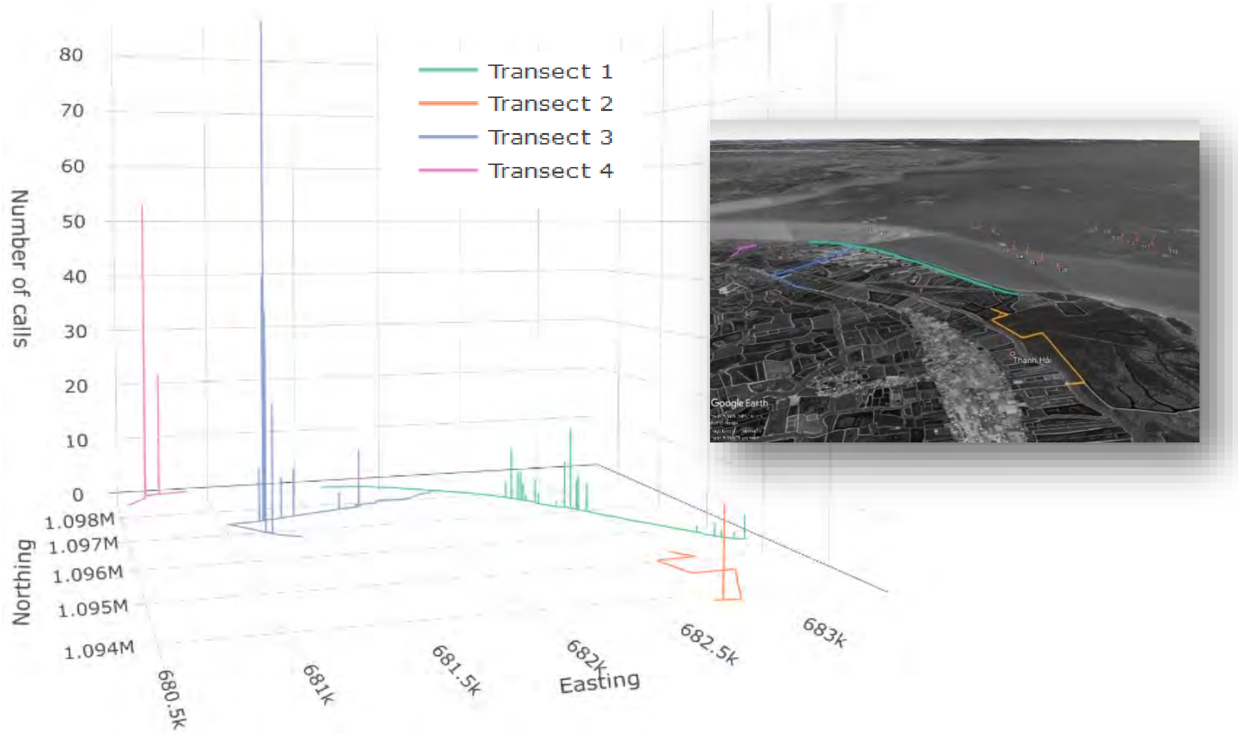


Figure 40: Number of bat's calls along 04 transects

Bat species recorded along the transects were:

- Black-bearded tomb-bat *Taphozous melanopogon*, with low peak frequency (below 25 kHz, generally at 19kHz) and long call's length (average call's length at 15ms)(Heller 1989).
- A Myotis species, with FM calls, peak frequency above 55 kHz, start frequency higher than 60kHz (but lower than 90kHz), then decrease to around 55kHz, average call duration 03 ms). This species is unlikely the Rickett's Big-footed

Myotis *Myotis pilosus*, which is the only IUCN's Near-threatened Myotis that distribute in the area.

- Lesser Asiatic Yellow House Bat *Scotophilus kuhlii* with start frequency within 64kHz to 89kHz range, peak frequency within 39kHz to 45kHz ranges, end frequency can go as low as 12.8kHz (Zhu et al. 2012)
- Javan Pipistrelle *Pipistrellus javanicus* with signature quasi-constant-frequency (QCF) call pattern and high start frequency (>75kHz)(Hughes et al. 2011)

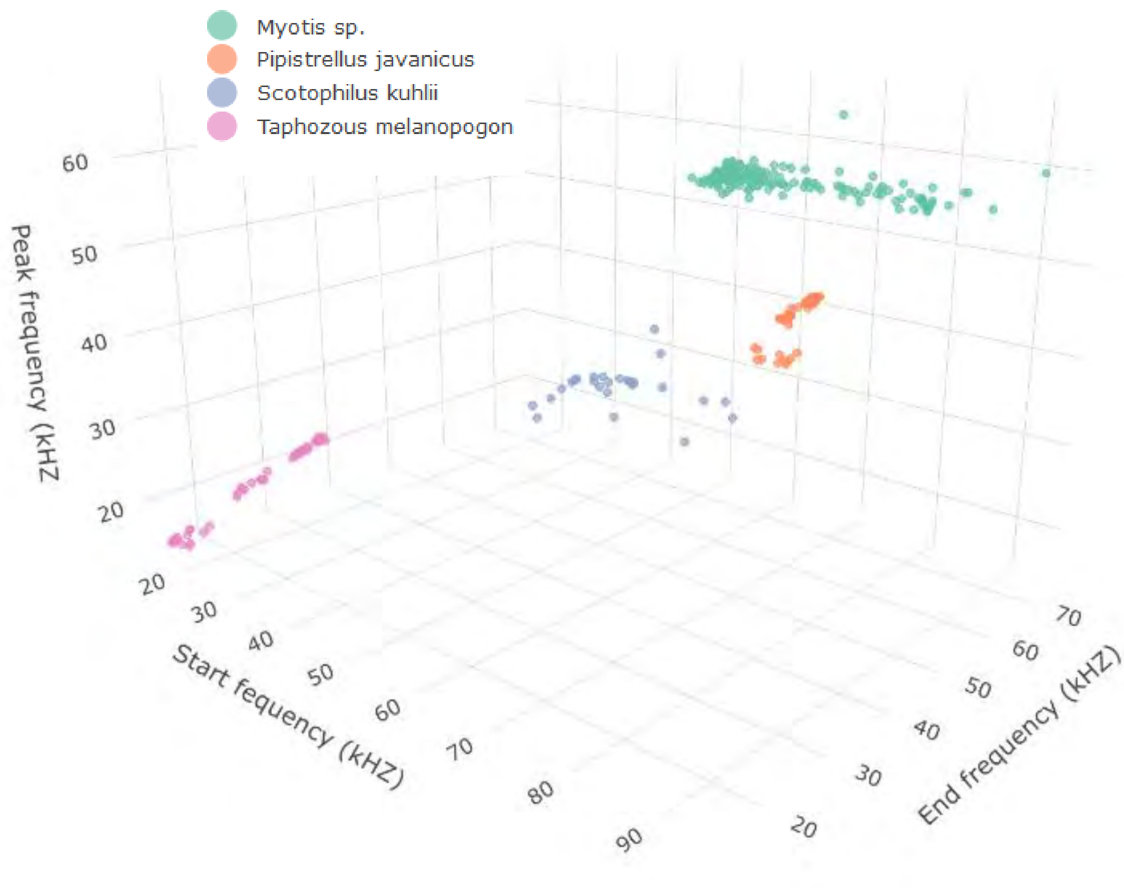
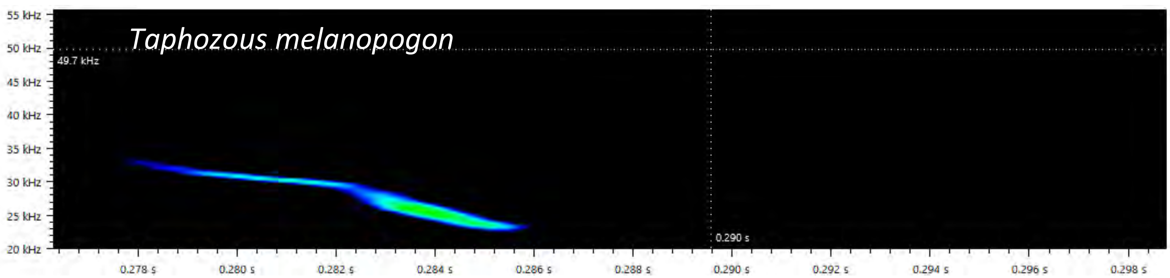


Figure 41: Classifications of bat's call recorded along transects



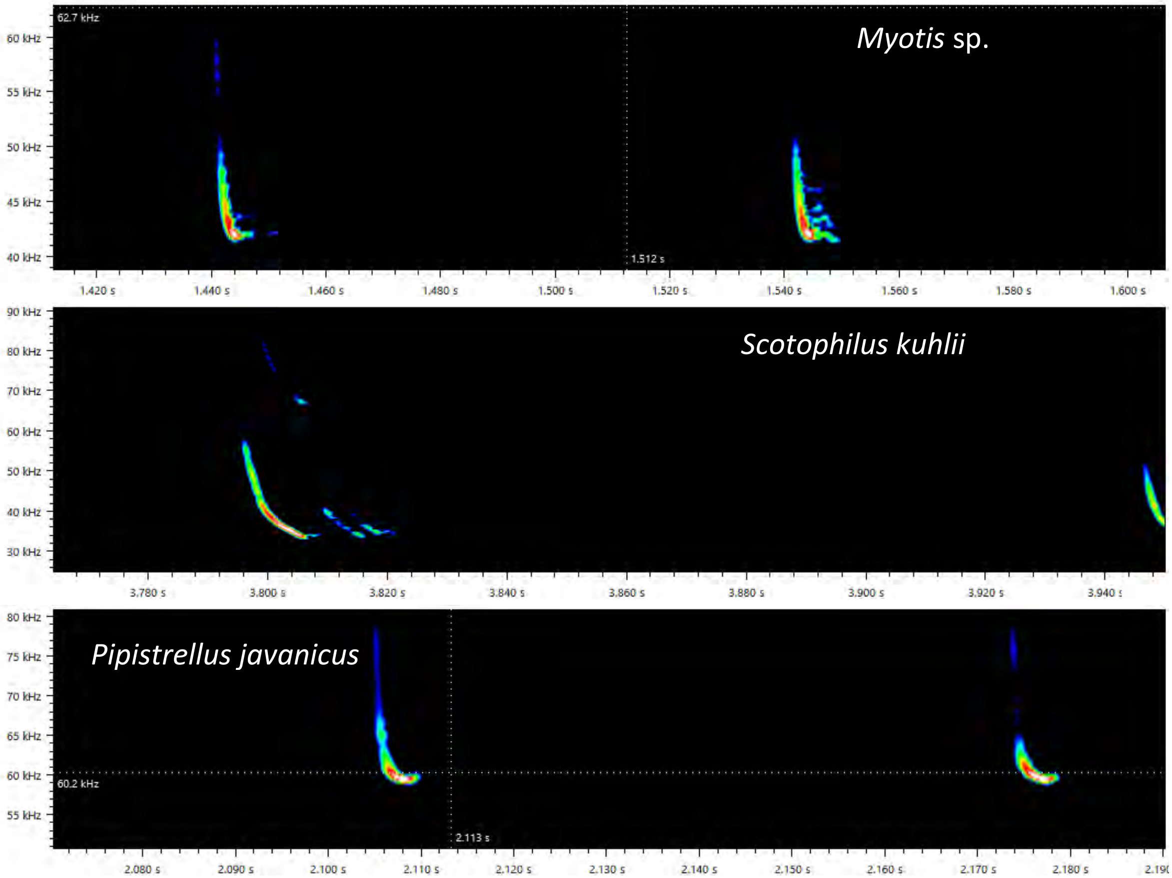


Figure 42: Example bat's calls of species recorded along transects

Station monitoring: A total of 4510 bat's calls had been recorded in 06 monitoring stations during the October 2019 survey. There was a spatiotemporal variation in bat activities between stations (Figure 43). Since the survey conditions were unchanged during three night of deployment, the observed spatiotemporal variation in bat activities were unlikely to be affected by short-term conditions.

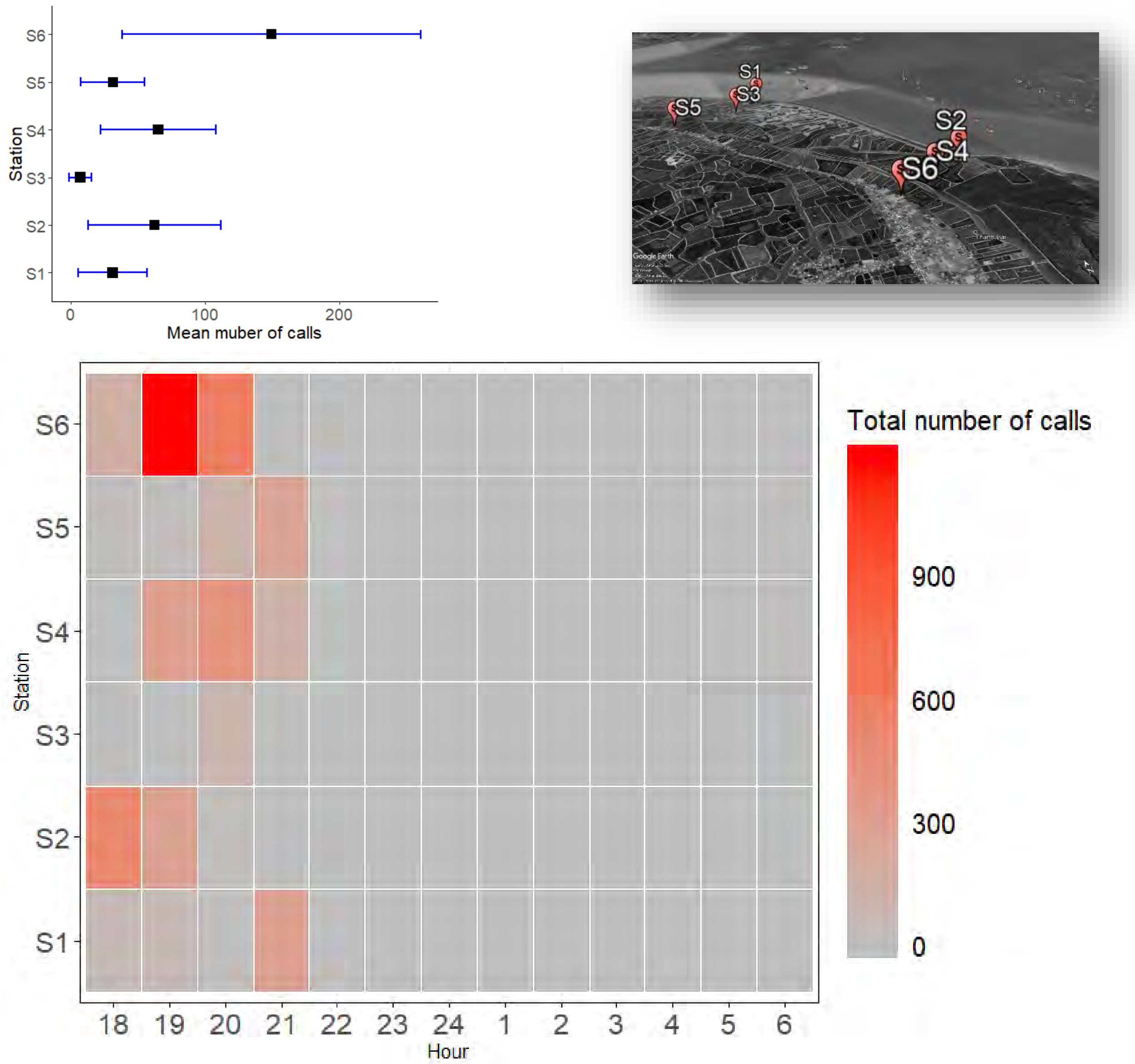


Figure 43: Spatiotemporal variation of bat's activities in the study area

Bat species recorded in the stations were:

- Black-bearded tomb-bat *Taphozous melanopogon*, with low peak frequency (below 25 kHz, generally at 19kHz) and long call's length (average call's length at 15ms)(Wei et al. 2008).
- A Myotis species, with FM calls, peak frequency above 55 kHz, start frequency higher than 60kHz (but lower than 90kHz), then decrease to peak frequency around 55kHz, average call duration 03 ms). This species is unlikely the Rickett's Big-footed Myotis *Myotis pilosus*, which is the only IUCN's Near-threatened Myotis that distribute in the area.
- Lesser Asiatic Yellow House Bat *Scotophilus kuhlii* with start frequency within 64kHz to 89kHz range, peak frequency within 39kHz to 45kHz ranges (Zhu et al. 2012)

- Javan Pipistrelle *Pipistrellus javanicus* with signature quasi-constant-frequency (QCF) call pattern and high start frequency (>75kHz)(Hughes et al. 2011)

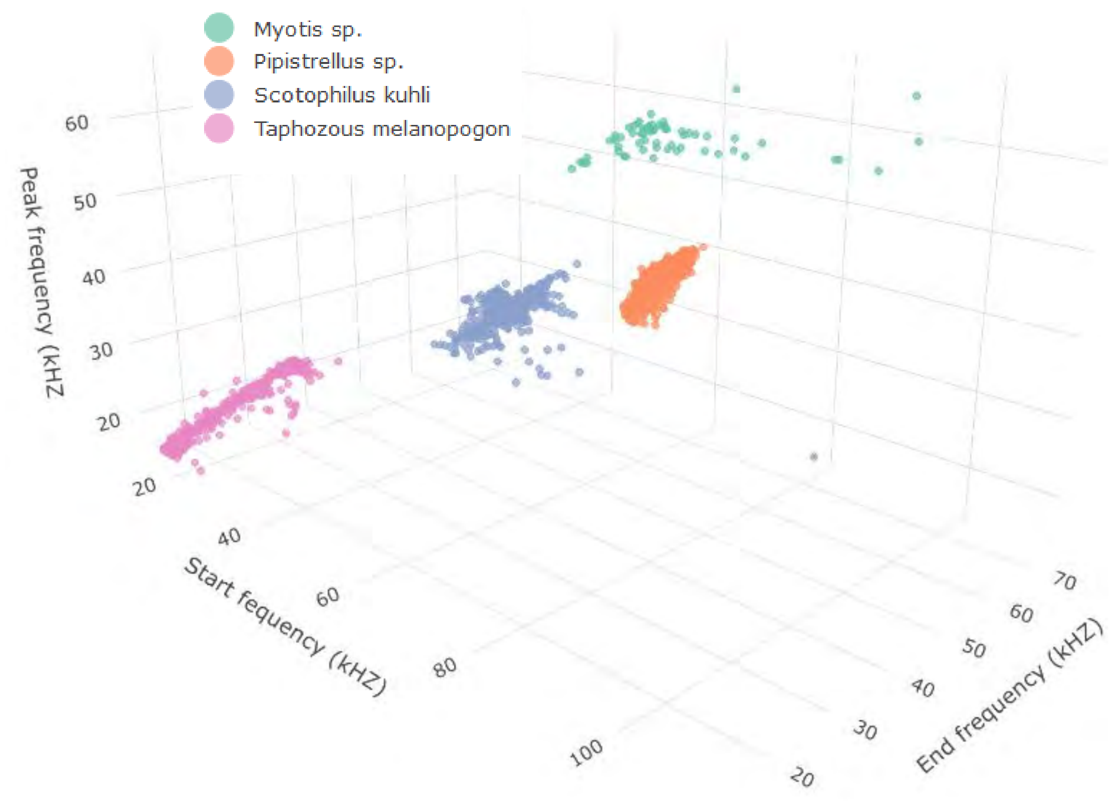


Figure 44: Classification of bat's calls recorded in monitoring stations

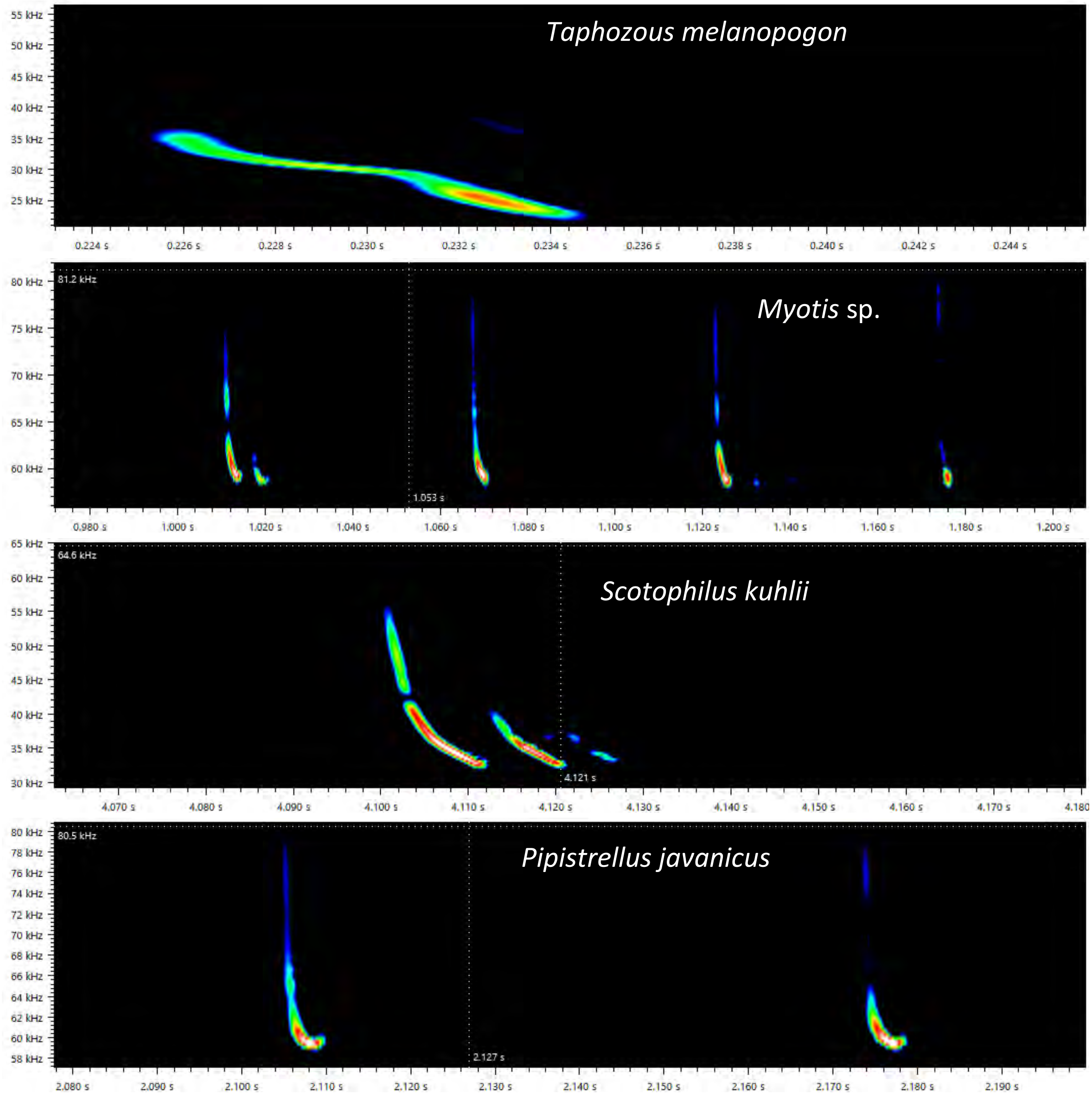


Figure 45: Examples of bat's calls recorded in monitoring stations

Mist-netting: during the survey period, no bat was captured in the deployed nets. This result suggested bat species in the survey area flew higher than 4m. In an open area like in the survey area, deploying 4m-high mist-net were potentially ineffective to capture high-flying bat species.

Roosting-site investigation: Interview results identified no roosting sites for flying foxes in the project area. However, 20 over 30 responders claimed they observed the flying foxes foraged in the fruit farms (mainly Longan fruit). Little information on other bat species can be collected from local communities, as the locals paid little attention on small-bodied species.

Summary of findings: The diversity of bats was not great in the study area, at least during the survey time. Bat's activities were higher in the inland area than in the beach area of the study site. Bats activities were recorded in the open sea/ beach area of the project, which suggested several species can move to the turbines area, which only located about 01km from the beach. Within a night, bats were highest from 18:00 to 21:00. No roosting site could be found in the study area during this survey.

3.4 Interview survey

We conducted 30 interviews in local communities who live near the project area (Figure 46). All the interviewees were long-term residents who have lived in the project area for more than 10 years. Most responders were middle age people who were older than 50 (Figure 47), which guarantee their experiences regarding the wildlife in the project area.

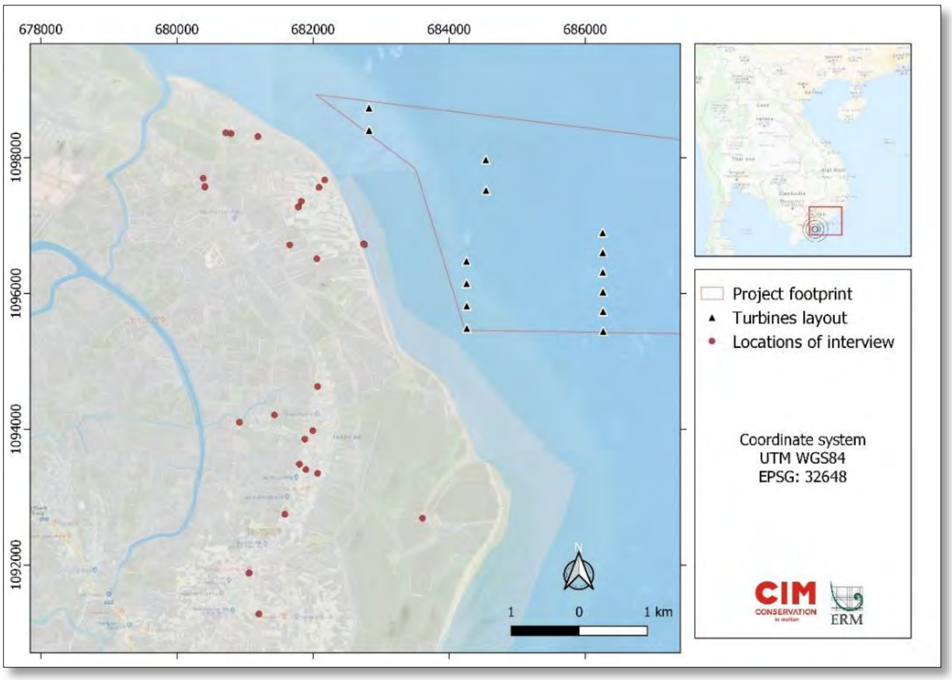


Figure 46: Interview locations

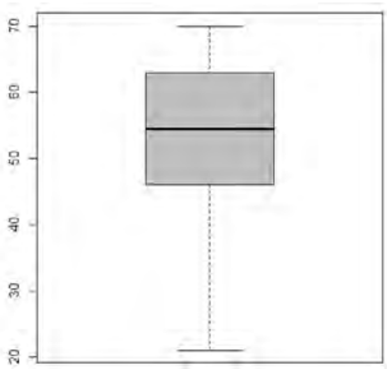


Figure 47: Age distribution of the responders who provide information during the interview survey

The majority of responders have jobs that required them to spend most of their time in the riverine, the sea or the mangrove near Thanh Hai project. A large proportion of interviewees works in aquaculture sector (Figure 48), which directly translated into fishes and shrimps farming. In the context of Thanh Hai area, having a fish farm or shrimp farm also mean the owner need to spend most of their time working in the farm. Therefore, those people will also have plenty of opportunities to encounter wildlife during their work. There were also a significant proportion of responder have unspecific jobs. Those people were classified themselves as contract labour, who work in wide variety of jobs (e.g. cutting grass, transporting, collecting fishes and shrimps in farm) that their client hide them to do. In the context of Thanh Hai area, these contracted workers also spent a large amount of their time in the field.

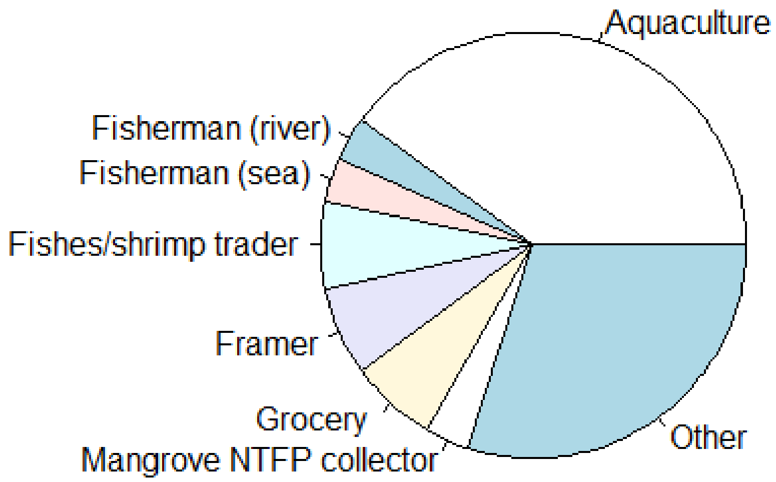
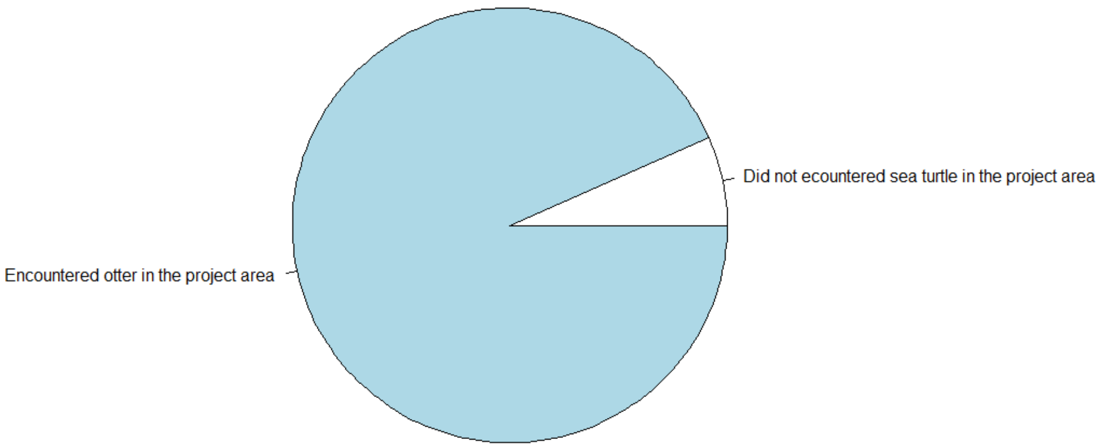


Figure 48: Jobs of responders in Thanh Hai area

Previous encountered with concerned wildlife: Of the 30 locals who were interviewed, 28 claimed that they encountered otter in the transmission line area versus 02 people who said they never saw an otter. This suggested the locals frequently encountered at least one otter species in near the project area.

More than half (17 vs 13) of the interviewees claimed to encounter marine megafauna frequently in the sea area of Thanh Hai project. In contrast, most interviewees said they did not encounter sea turtles in the Thanh Hai sea. None of the responders said they saw freshwater turtle (such as Southern River terrapin) in the project area. Note that in this study, “Encounter” includes direct catch, bycatch, personal observation, stranding observation of sea turtles and marine mammals.



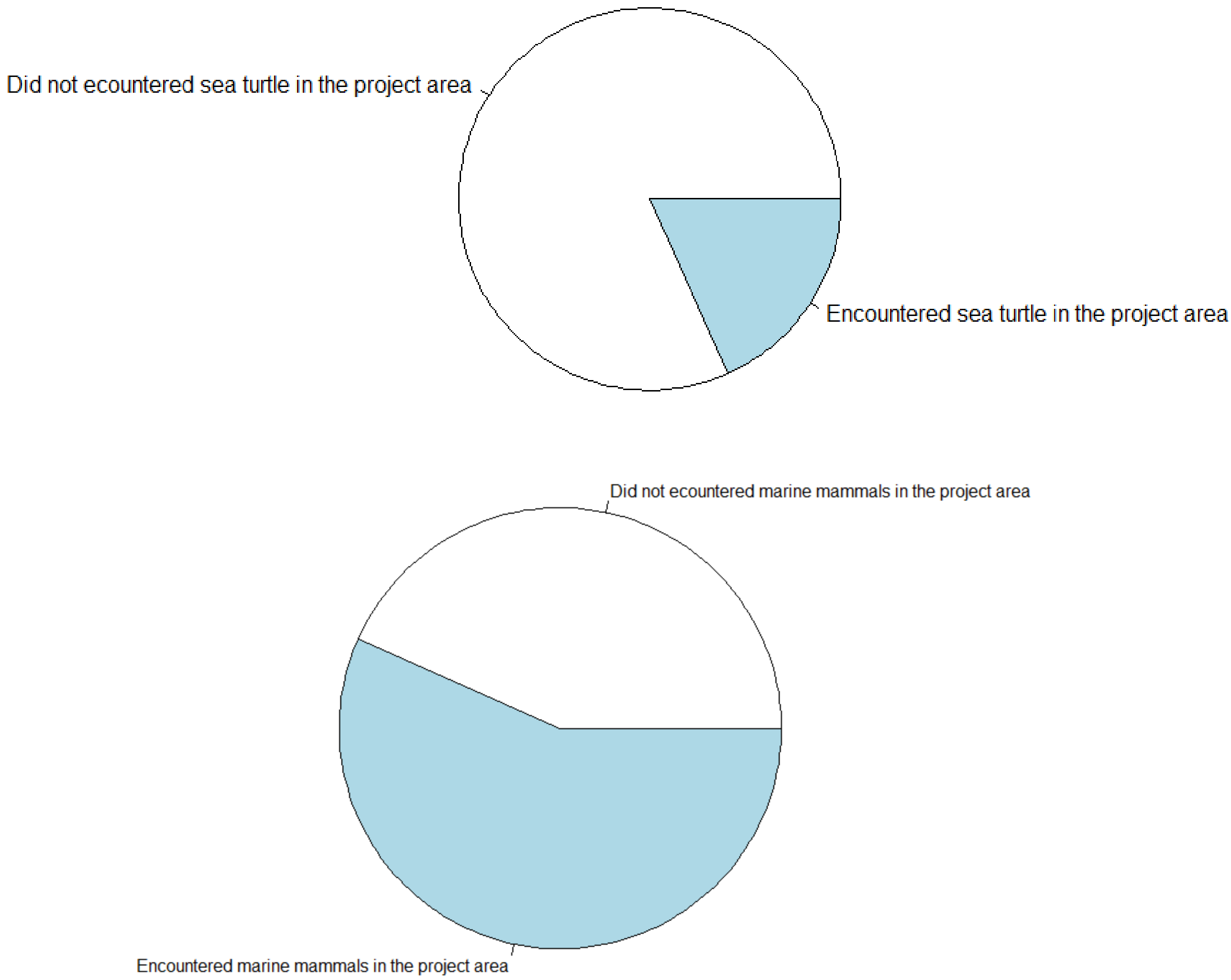


Figure 49: Percentage of interviewees encountered concerned wildlife

For otter, all interviewees who claimed to saw otter were not able to tell the differences of 04 other species (Hairy-nose otters, Smooth-coated otters, Eurasian otter and Small-clawed otter) that can potentially present in the project site. However, these local people could easily tell the difference between an otter an apparently similar carnivorous species such as mongoose or weasel. Among those responders who encountered otters, most of them saw and observed wild otters in their nature habitats in Thanh Hai area (Figure 50). While most otter encounters happen more than 05 years ago, there were several freshly encounters had been recorded during this interview survey, which imply at least one species of otter still present in the project area. Especially, one responder showed the interview team the photographs of a pair of otters (which resemble the Small-clawed otter) that his family captured and sold in the local market in August 2019 (Figure 52).

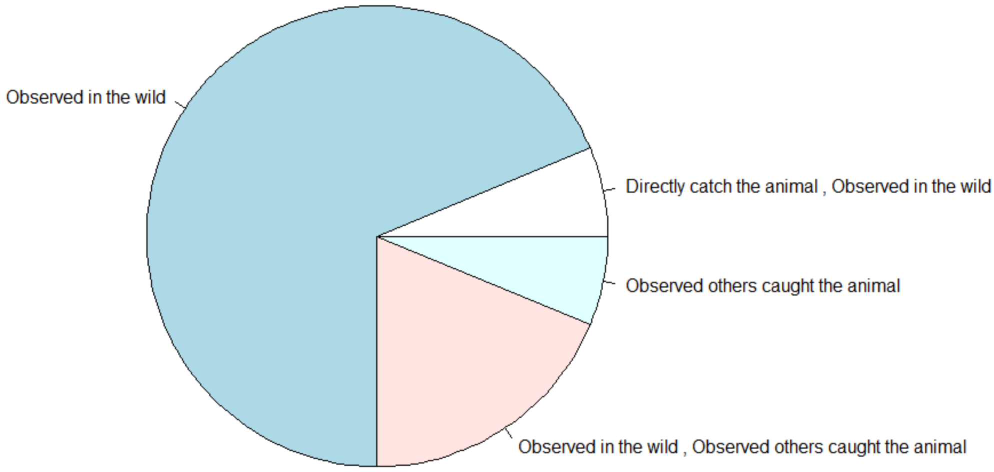


Figure 50: Proportion of otter encountering situation

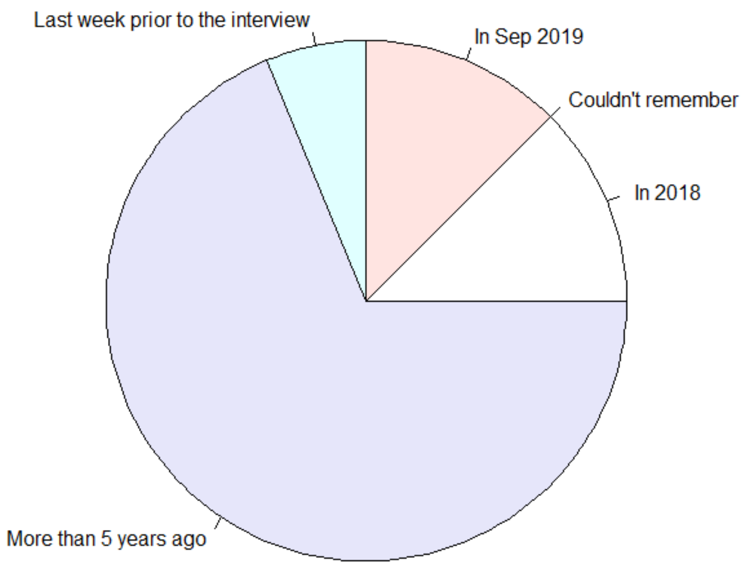


Figure 51: Proportion of otter encounter period

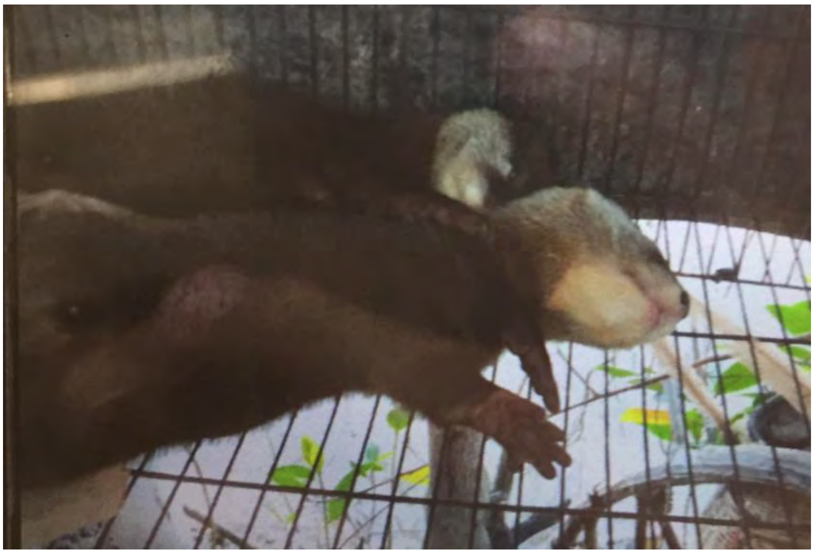


Figure 52: Photograph of a pair of otters captured by locals , and being sold in local market

For sea turtle, interviewees who claimed to see the sea turtle before were able to tell the differences between the Leatherback sea turtle from the Green and Hawksbill sea turtles. However, they often confused the Hawksbill sea turtle with the Green sea turtle that can potentially present in the project site. Among those responders who encountered sea turtle, most of them catch the turtle themselves or observed other catching sea turtle. Sea turtle encounters were quite uncommon in the area, as no encounter happen in 2019, and most responder couldn't remember the exact time of their turtle encounter.

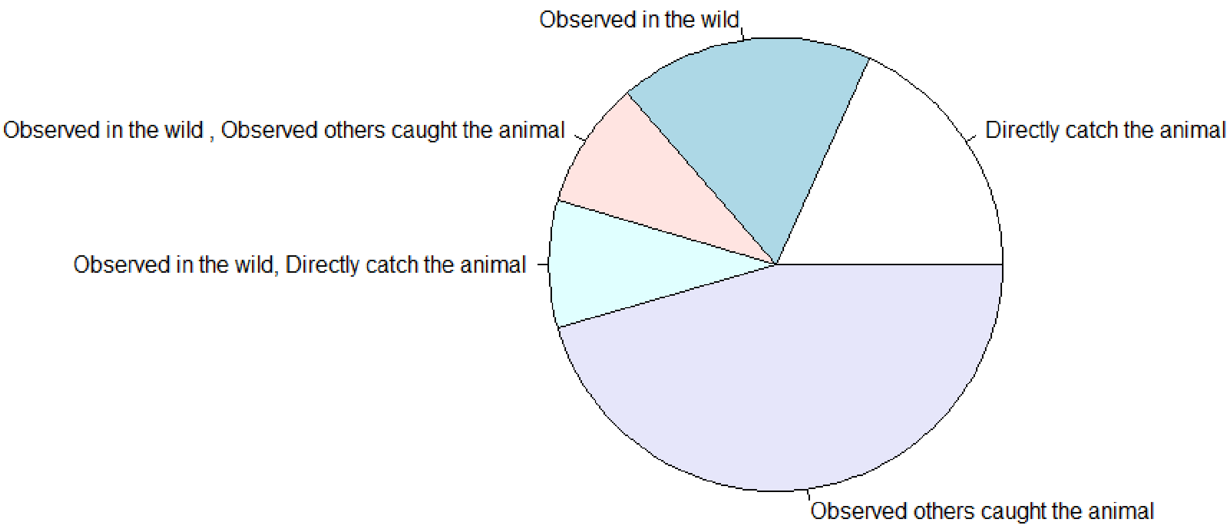


Figure 53: Proportion of sea turtle encounter situation

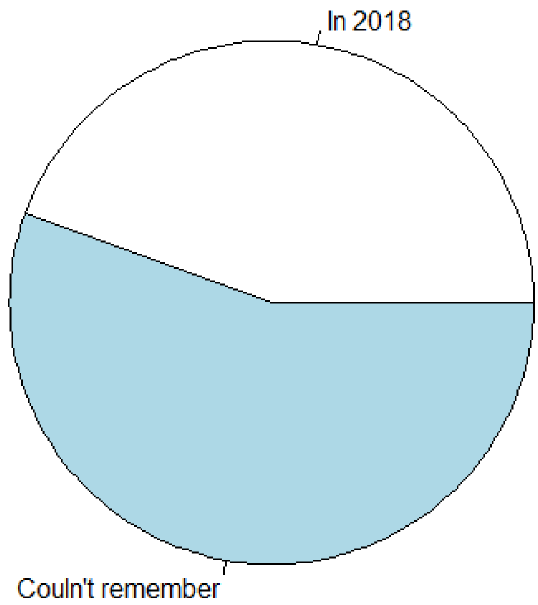


Figure 54: Proportion of sea turtle encounter period

For marine mammals, those responders who claimed to saw marine mammal in the project area can tell the different between marine mammals and other marine megafauna (e.g. sharks) very well. It is understandable, as all 17 of them were fishermen (either retired or working) who spent times on the sea. They are aware of the existent of marine mammal in the project area and can even describe behaviors of several dolphin species (e.g. the Irrawaddy dolphins *Orcaella brevirostris*, Finless porpoise *Neophocoena phocaenoides*) correctly when the interview team showed them many pictures of marine mammals to validate their knowledge. The responders were also able to pinpoint the locations of a local whale temple in Con Bung village (the community structures where local fishermen keep the bones of stranded marine mammals because of local belief) in Thanh Hai area Figure 57. Following the information provided by the responders, interview team was able to document a case of stranded whale in Con Bung beach in 2004. The remains of this stranded whale are now kept at the local whale temple (a local museum where fishermen keep the remains of large whale as a practice of their traditional belief). Examining the remaining teeth and bones reveal this stranded animal was a sperm whale (*Physeter macrocephalus*).

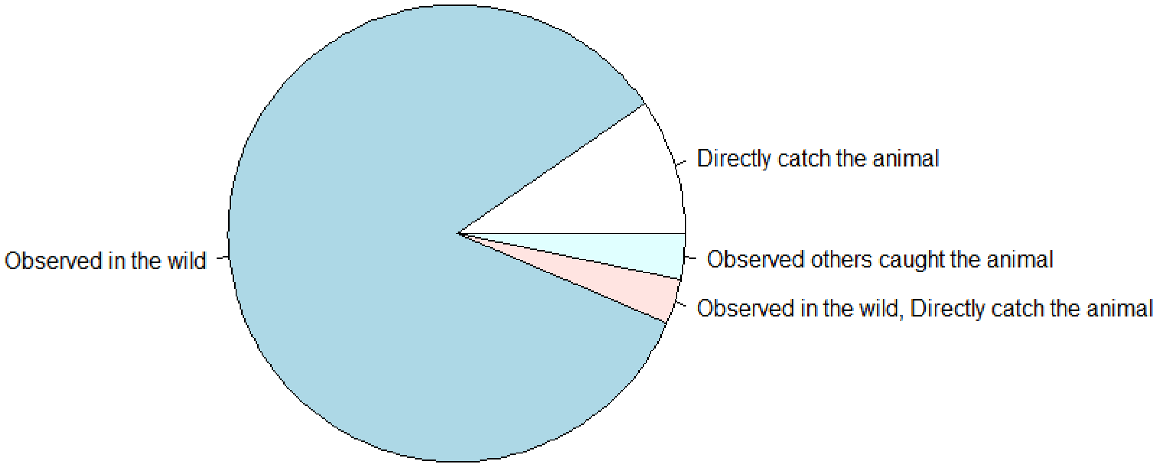


Figure 55: Proportion of marine mammal encounter situation

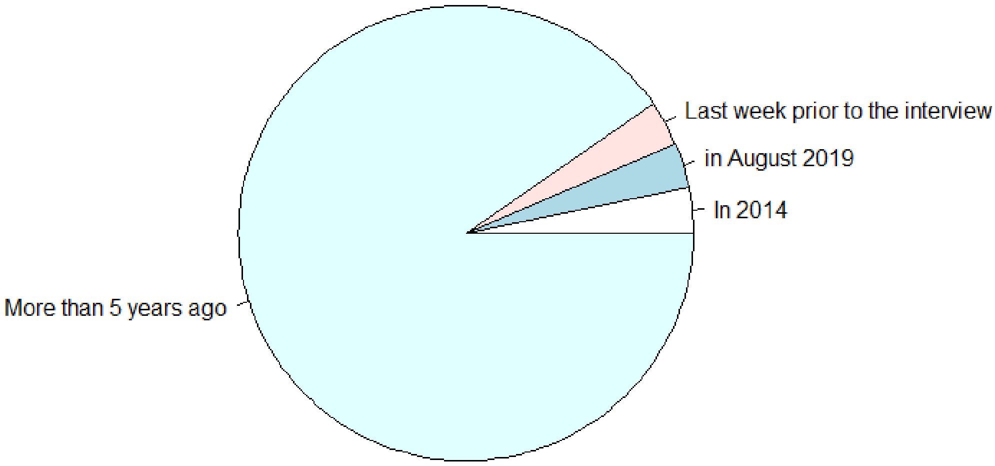


Figure 56: Proportion of marine mammal encountered period

Figure 57: Whale temples located in the project area

Summary of findings: the interview survey suggested the presence of several IUCN concerned taxa in the project vicinity. At least one other species was frequently encountered by locals in regular basis. Sea turtles, marine megafauna, endangered freshwater turtles were not sighted by local communities as frequently as the otter. The presence of several marine mammals in the sea near the project were very likely, as locals were able to provide evidences (bones, tooths) from stranded animals.

3.5 Additional information on terrestrial fauna

During the vantage point survey, the observer opportunistically observed the Ngo Van Tri's Lady Butterfly Lizard (*Leiolepis ngovantrii*) in the vantage point V2 (Figure. This species is listed as Vulnerable (VU) in IUCN Redlist. The presence of this species in the project area require attentions in future planning. The current distribution range of this species in IUCN Redlist is restricted in Binh Thuan province. However, such information was under revision. Our experts could only identify this species based on external morphology (e.g. color patterns near the eyes, yellow-stripped connected from neck to tail, median strip on the back), as no specimen were collected. Independently to this survey, the Southern Institute of Ecology also recorded this species in Hiep Thanh area (Tra Vinh province), which were about 20km from Thanh Hai project area. According to the SIE survey team (SIE, personal communication, Sep 30, 2019), several specimens of the Ngo Van Tri's Lady Butterfly Lizard were recorded in Hiep Thanh area.

Figure 58: Photograph of the Ngo Van Tri's Lady Butterfly Lizard (Leiolepis ngovantrii) taken at vantage point V2

4 Conclusion and recommendations

This multidisciplinary survey created a baseline for biodiversity, especially on windfarm-sensitive taxa such as birds, bats, that occur in the Thanh Hai project area and its vicinity.

4.1 Potential impacts

Although no birds (both seabirds and shorebirds) were observed flying higher than 35m (suggesting a low collision risk with wind turbines), considerations for birds are specially needed for this project. The diversity of shorebird and the presence of several

IUCN concerned seabird requires attentions in future planning and project's implication. The current wind turbine layout overlaps with the area with high bird abundance, which may cause disturbance or dislocation of seabird population.

Bats diversity in the project area were not high. Except for the flying foxes which were recorded through interview only, the other bats were not concerned species in IUCN Redlist. For the flying foxes, no roosting site could be found in the study area during this survey. However, flying foxes are known to move between different roosting sites according to seasonal changes. Thus, the project can still pose significant impacts for those species

The offshore construction of the project can disturb the macrobenthos community and marine megafauna, thus lead to unwanted chain reactions that affect the food web and related ecological services. For macrobenthic community, the turbine layout was not overlapping with area of high benthic diversity, suggesting a low level of impacts. For marine megafauna, which occasionally presence in the area, project's impact may not serve based on current information.

The transmission line can disturb the terrestrial vegetations nearby. On-land constructions can also disturb the remained habitats of vulnerable species such as otters. Vegetation clearance and increase human accesses to animals are two main potential impacts that need to be considered.

4.2 Potential mitigation Measures

For shorebirds and seabirds: Reflective materials should be applied to strategic points (depend on the final design of the wind farm) to deterrent birds. Also, as most bird activity take place in the morning, wind farm operators can place large sound sources (e.g. horn, loudspeaker, air gun) and set them up to routinely emit loud noises to scare the bird away from the rotor.

For bats: It is important to study the accumulation impacts of this project and numerous windfarm developments that took place in the lower Mekong delta. On-site monitoring for flying foxes is necessary precautions.

For other biodiversity: Like other development, the Thanh Hai windfarm project will impact local biodiversity. Compensating the potential impacts of the project can be achieve by supporting local biodiversity conservation effort. The developers can consider financially supporting the nearest projected area, which were Thanh Phu Nature Reserve, as a potential mitigation measure.

5 Reference

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Appendices

Appendix 1: Photographs of birds recorded during the survey

Common Sandpiper (*Actitis hypoleucos*)

Collared Kingfisher (*Todiramphus chloris*)

Common Greenshank (*Tringa nebularia*)

Common Tern (*Sterna hirundo*)

Eurasian Curlew (*Numenius arquata*)

Caspian Tern (*Hydroprogne caspia*)


Greater Egret (*Ardea alba*)


Greater Sandplover (*Charadrius leschenaultii*)


Grey Heron (*Ardea cinerea)*


Grey-tailed Tattler (*Tringa brevipes*)


Gull-billed Tern (*Gelochelidon nilotica*)


Kentish Plover (*Charadrius alexandrinus*)


Lesser Sandplover (*Charadrius mongolus*)


Little Cormorant (*Microcarbo niger*)

Little Egret (*Egretta garzetta*)

Pacific Golden Plover (*Pluvialis fulva*)

Sanderling (*Calidris alba*)

Striated Heron (*Butorides striata*)

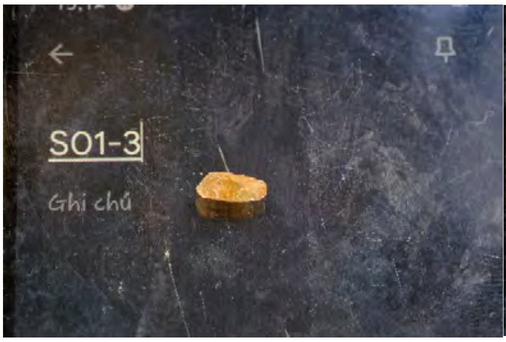
Terek Sandpiper (*Xenus cinereus*)

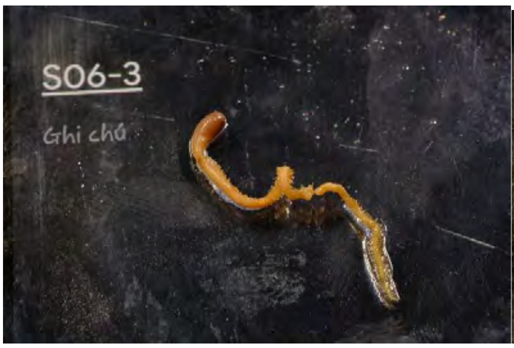
Whimbrel (*Numenius phaeopus*)

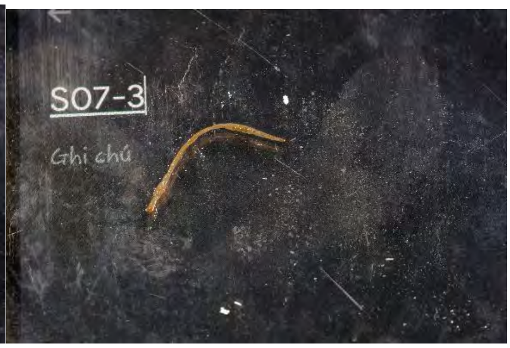
Spotted-billed pelican (*Pelecanus philippensis*)

Barn Swallow (*Hirundo rustica*)

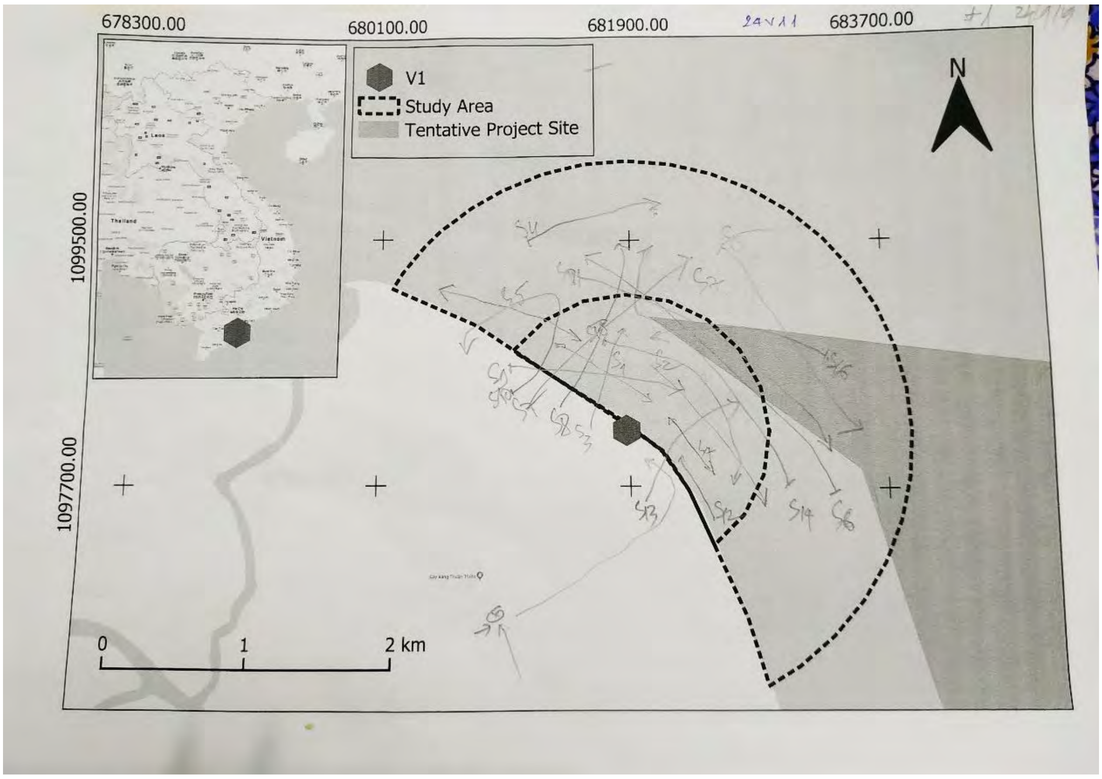
Appendix 2: Macrobenthos collected during the survey

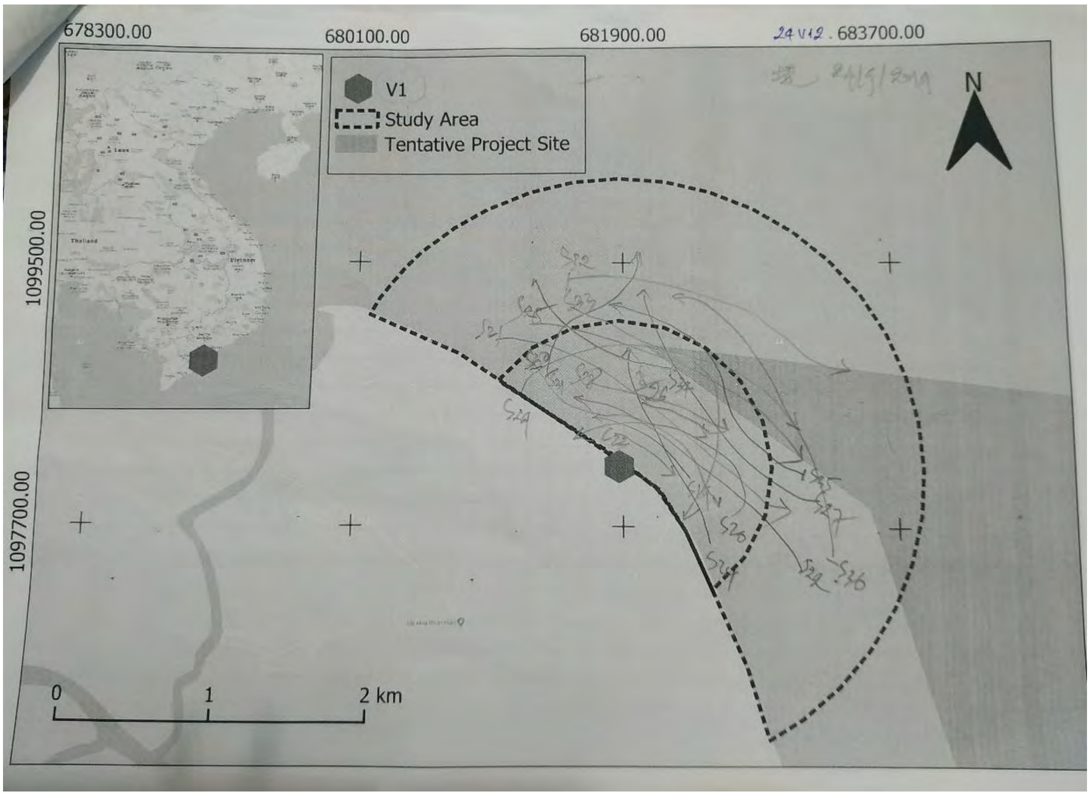


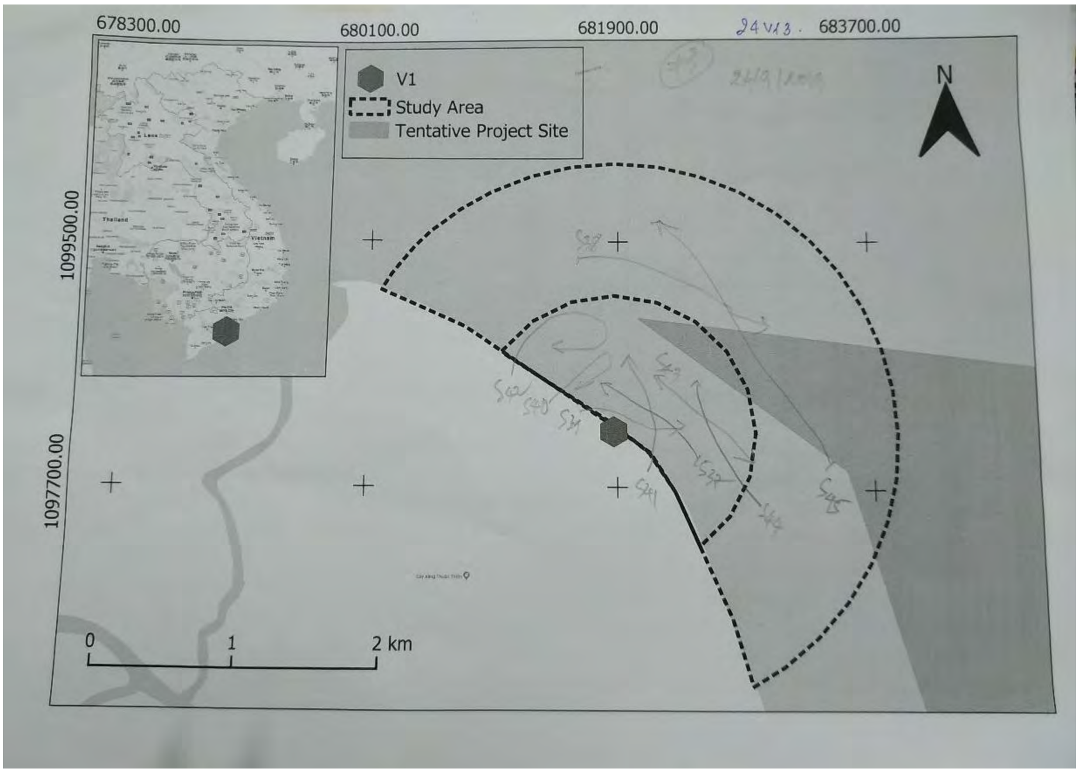




Appendix 3: Raw vantage point datasheet



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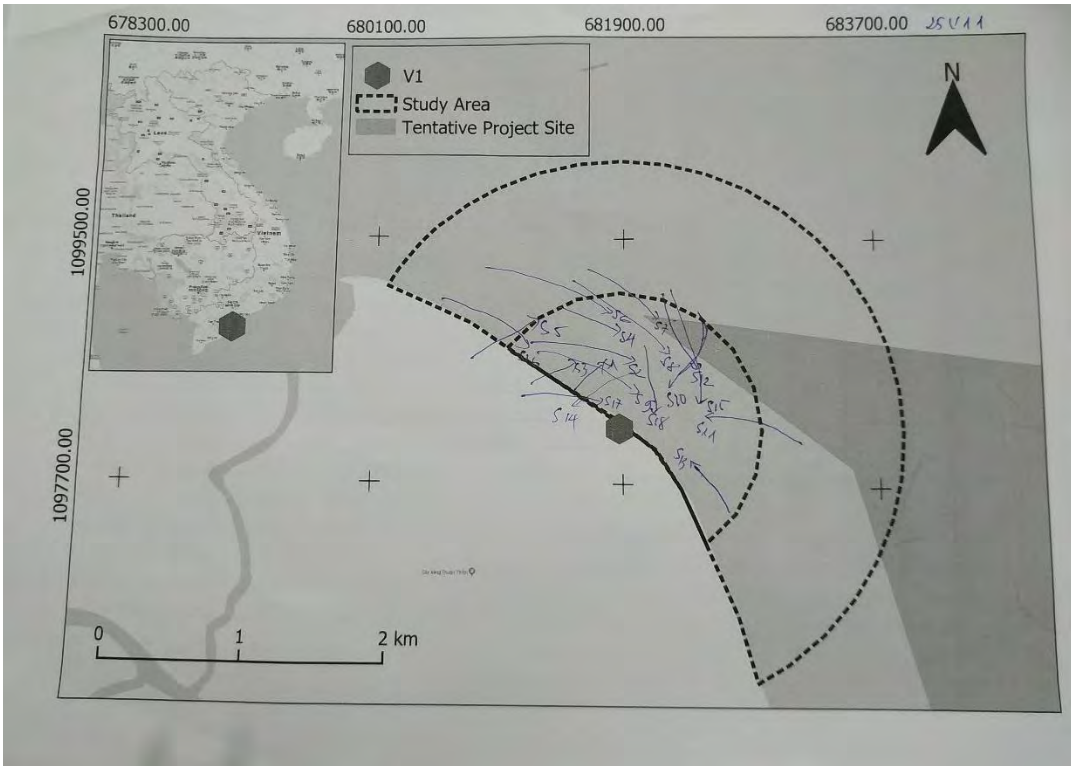
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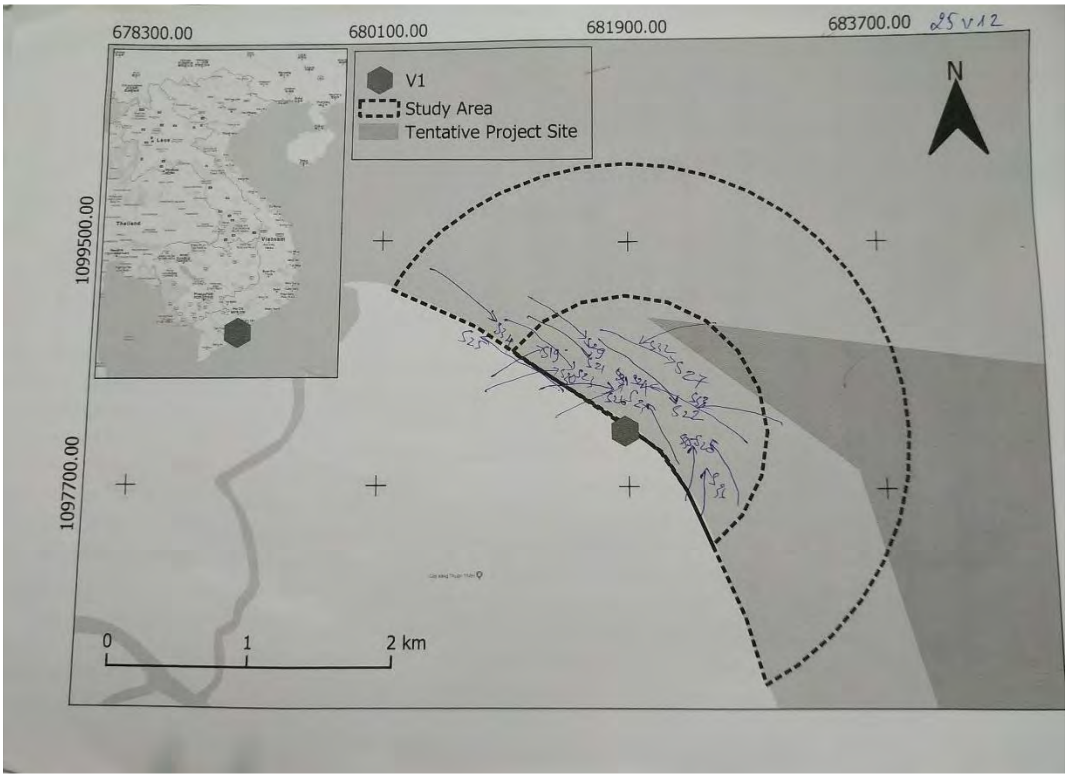
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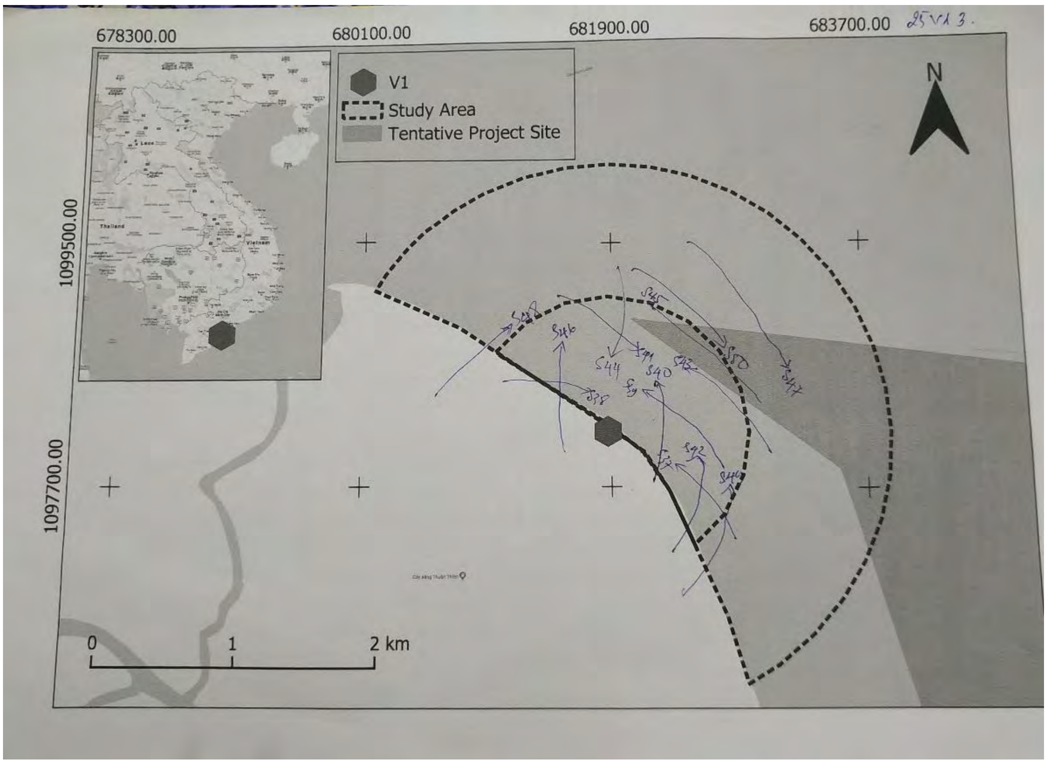
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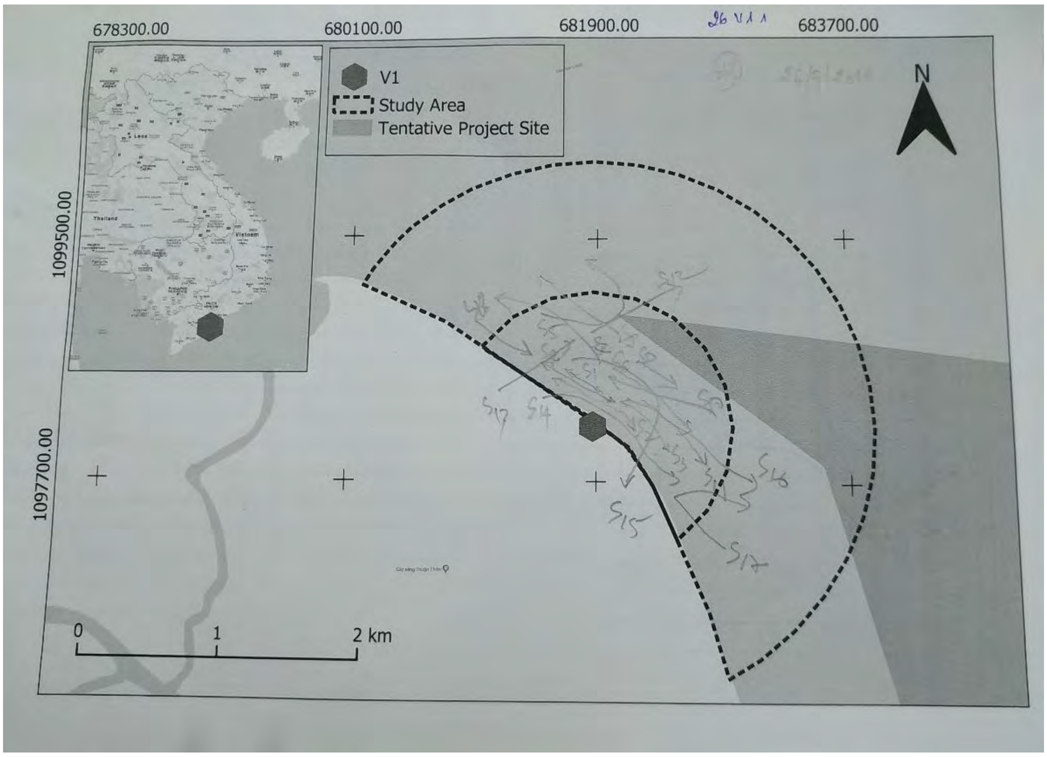
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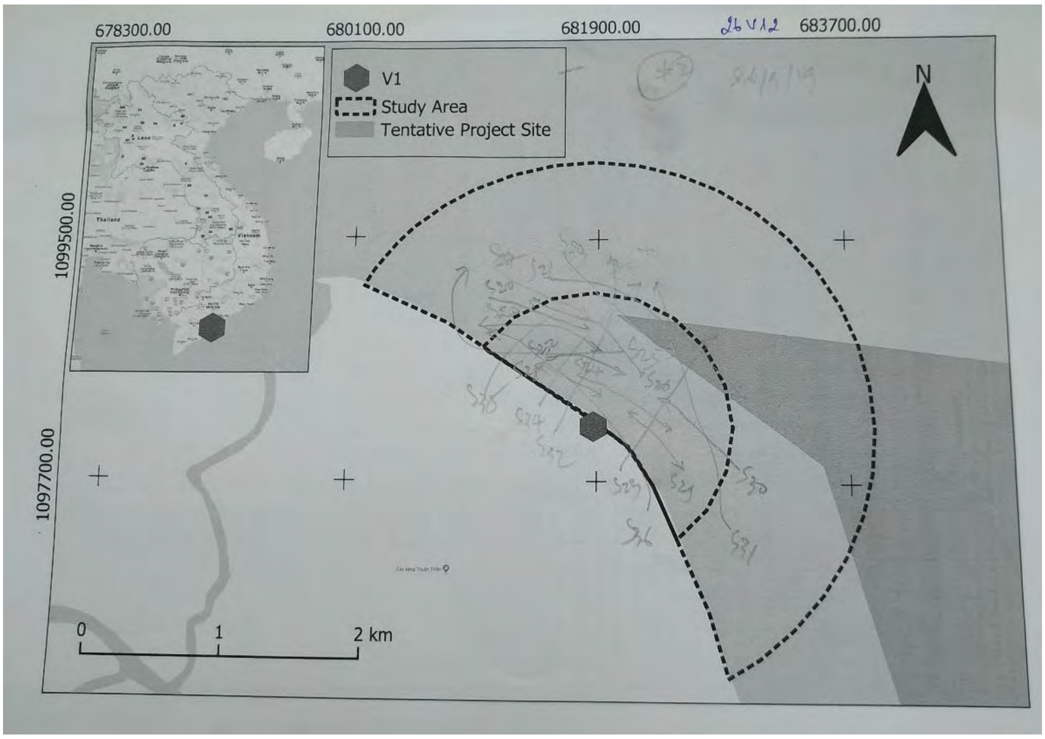
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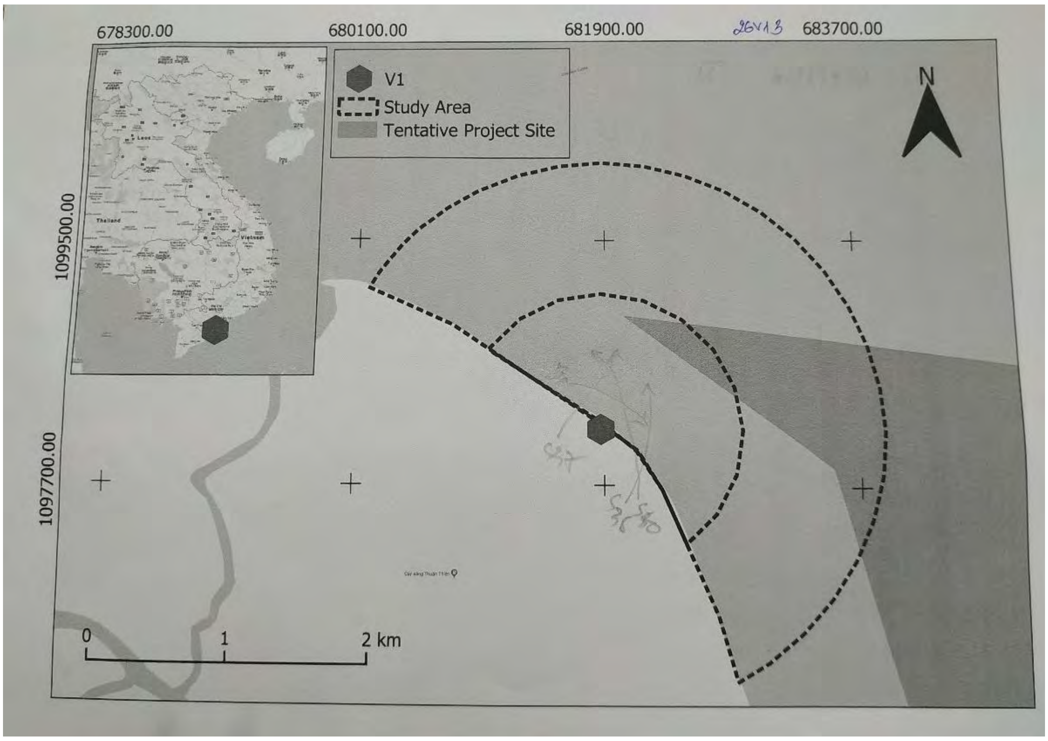
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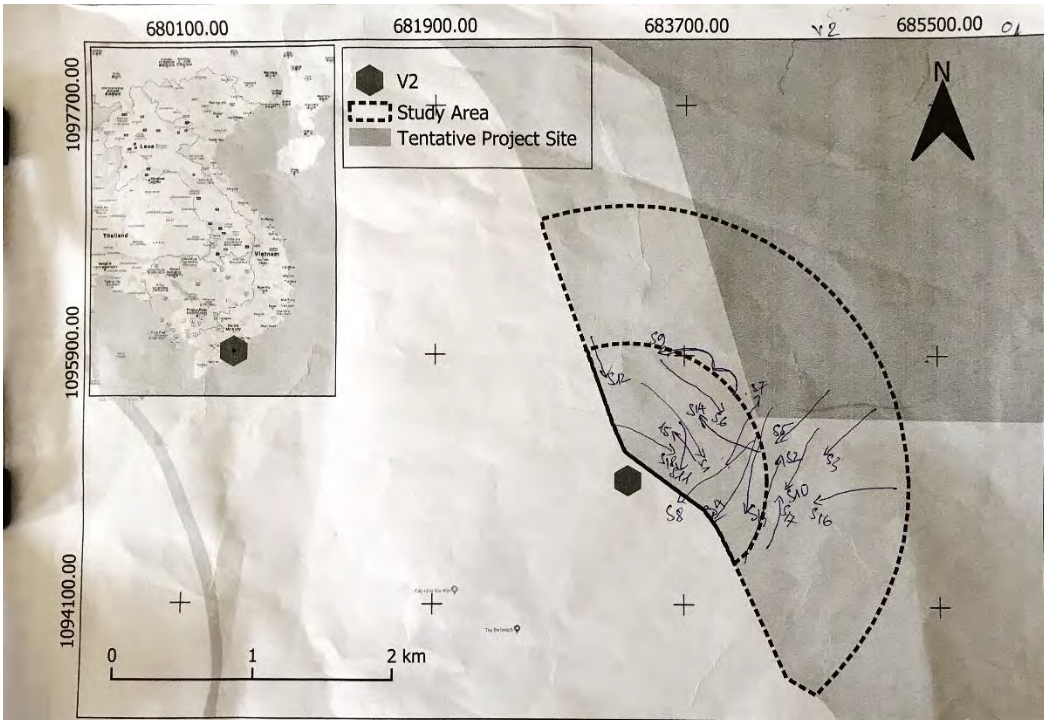
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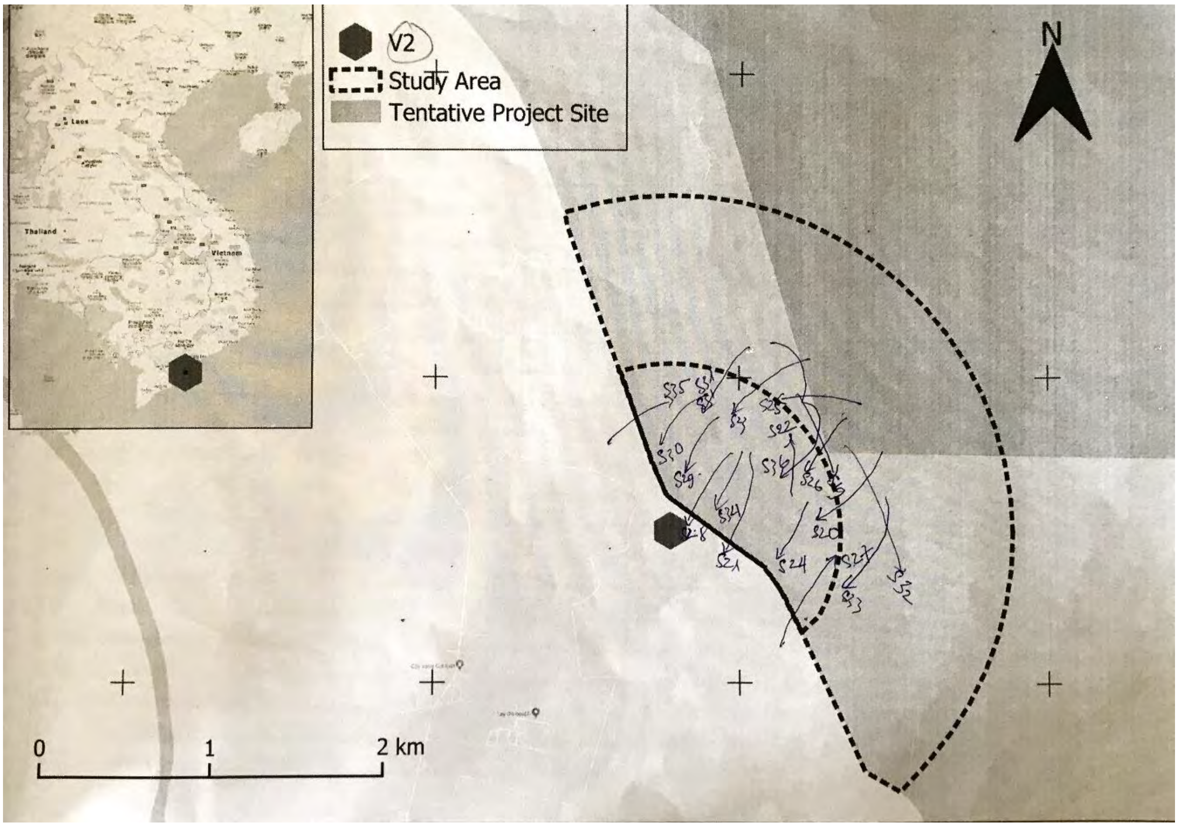
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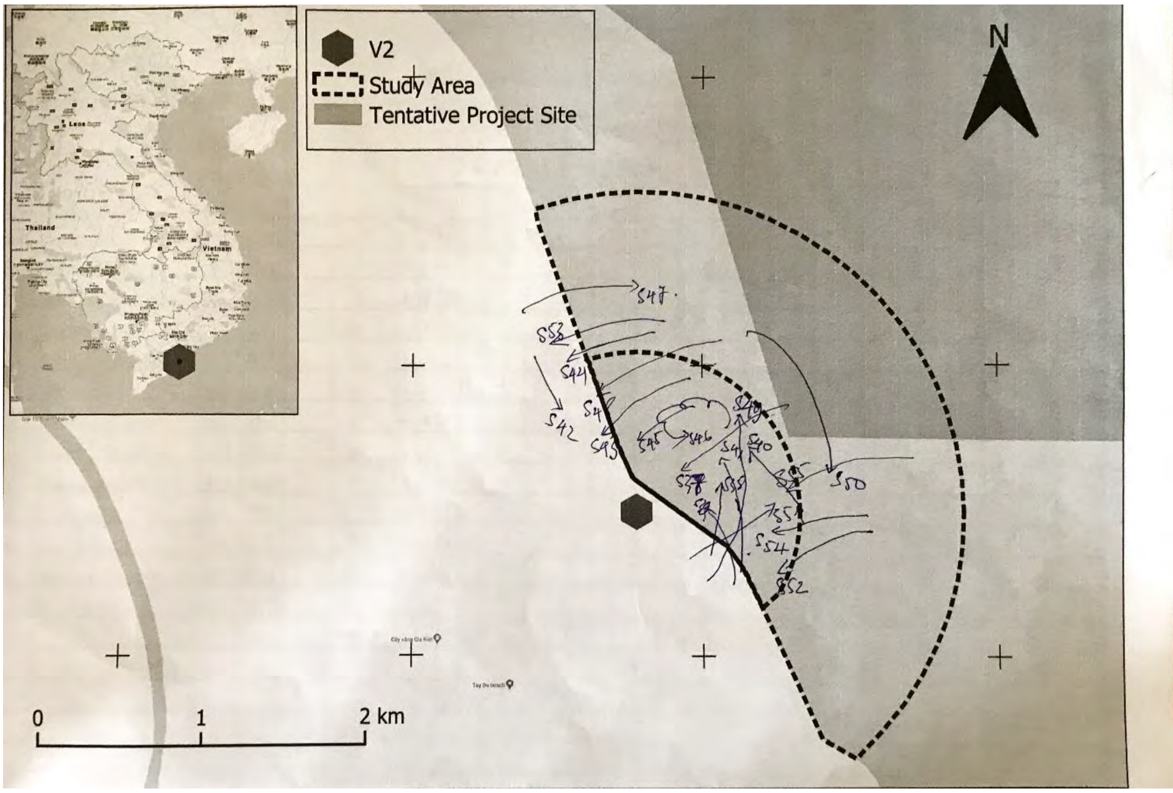
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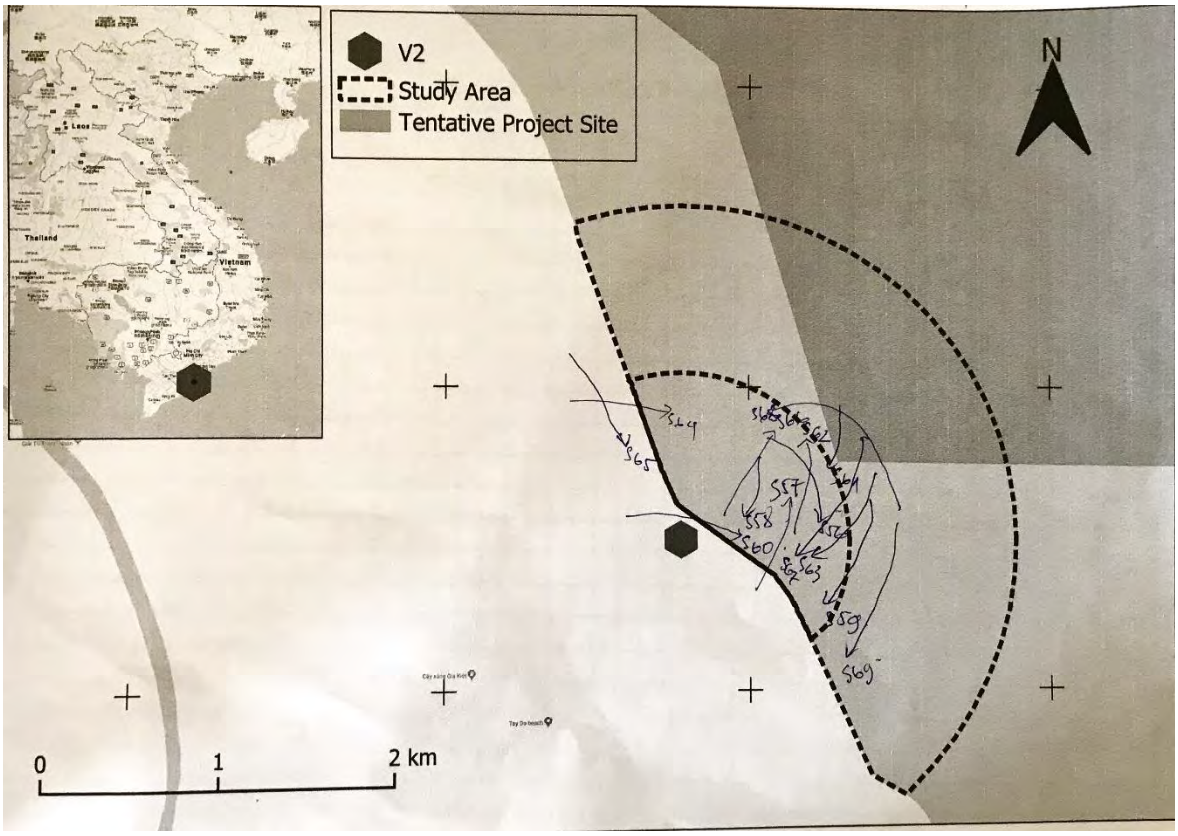
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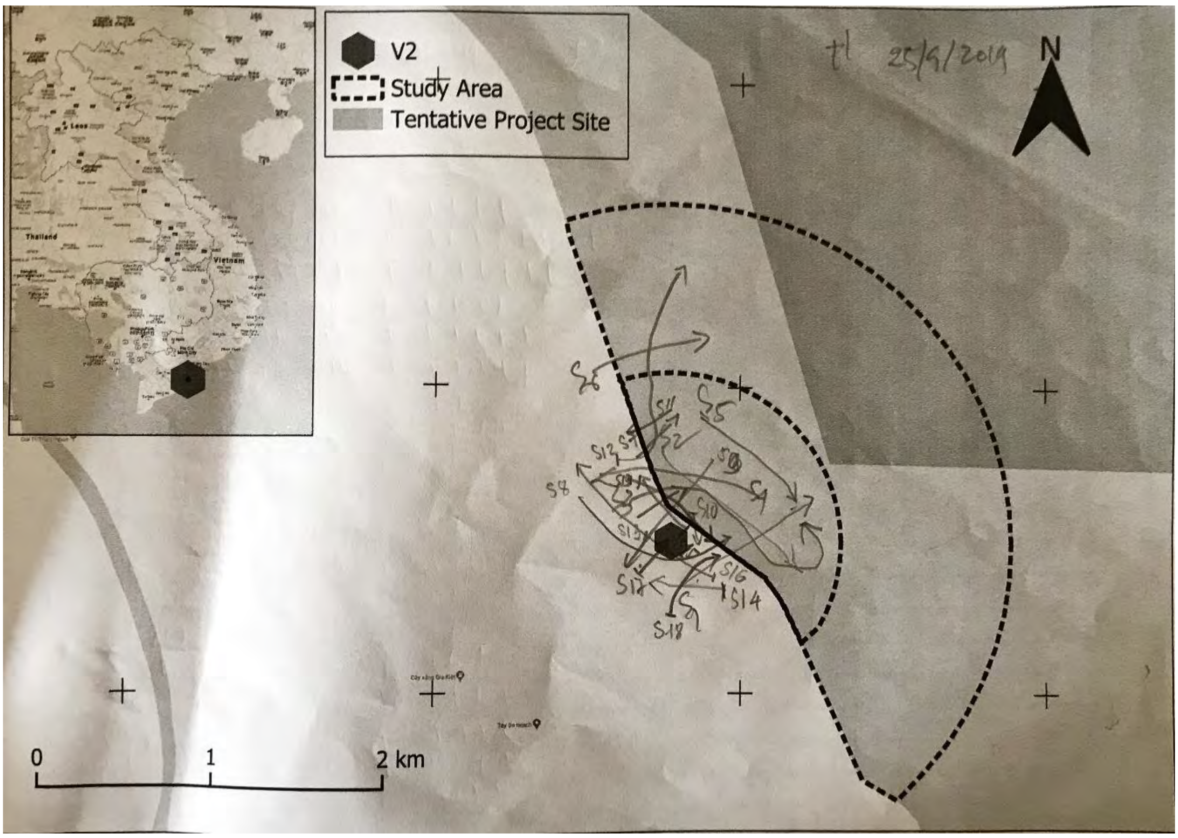
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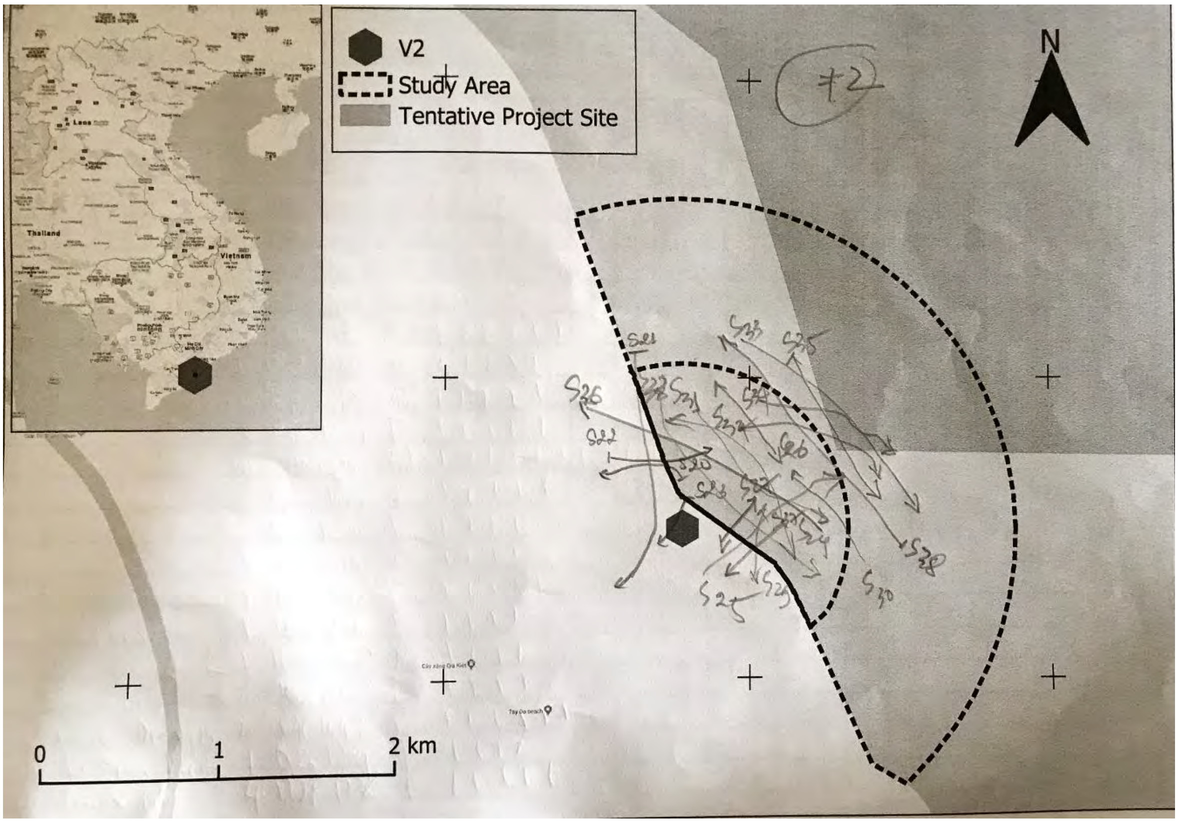
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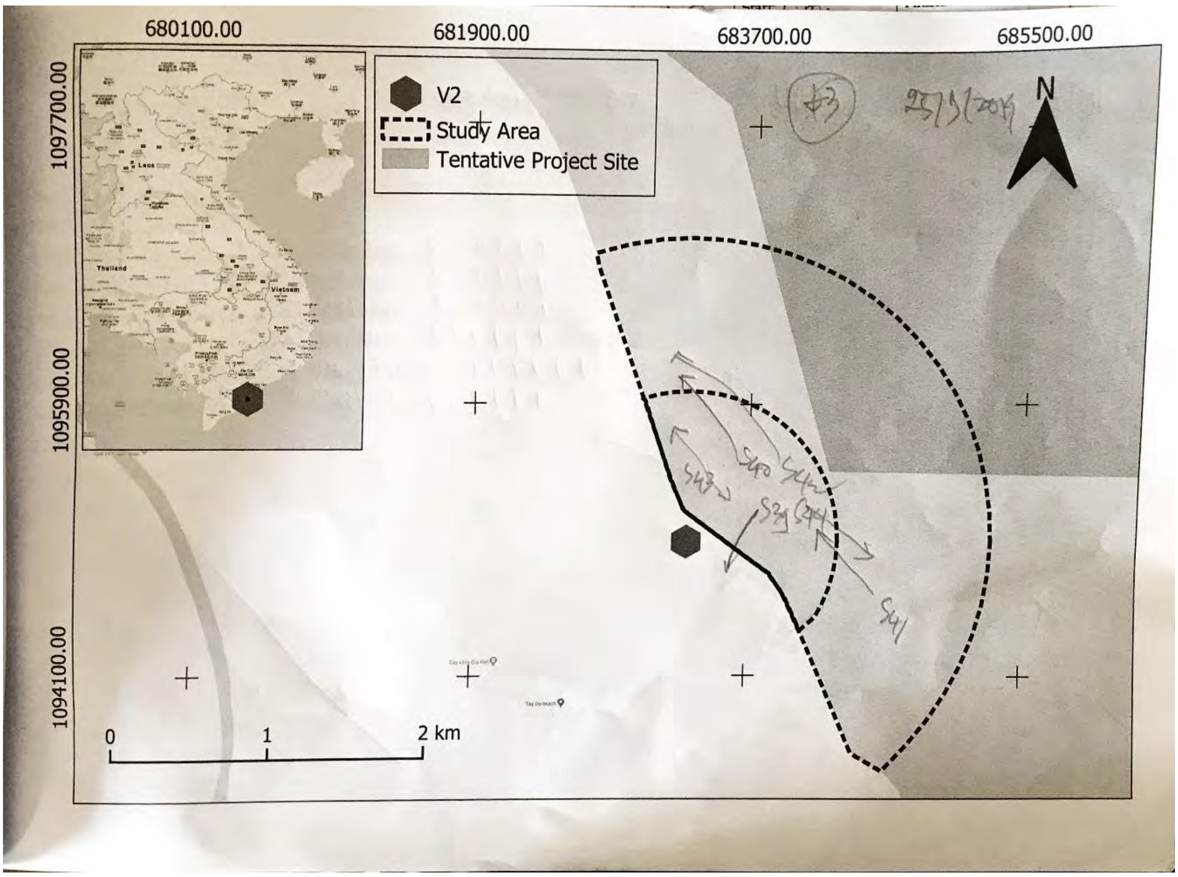
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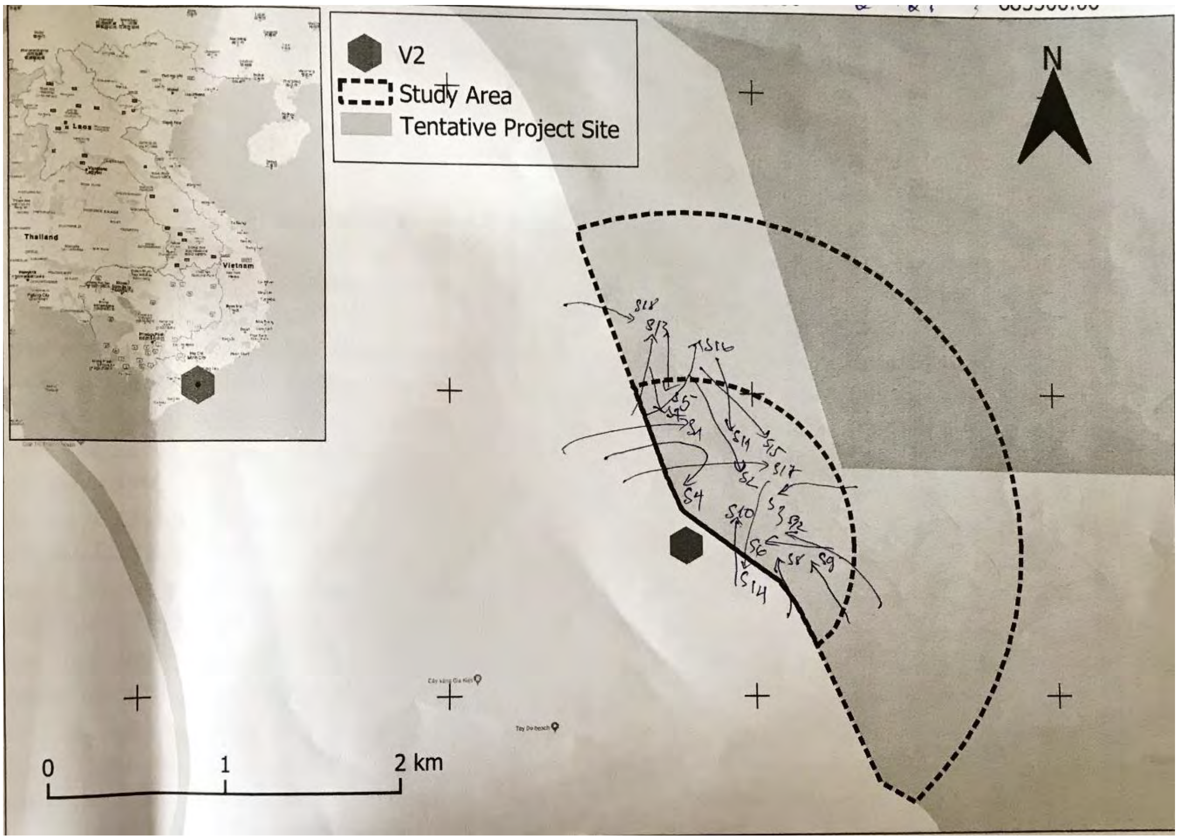
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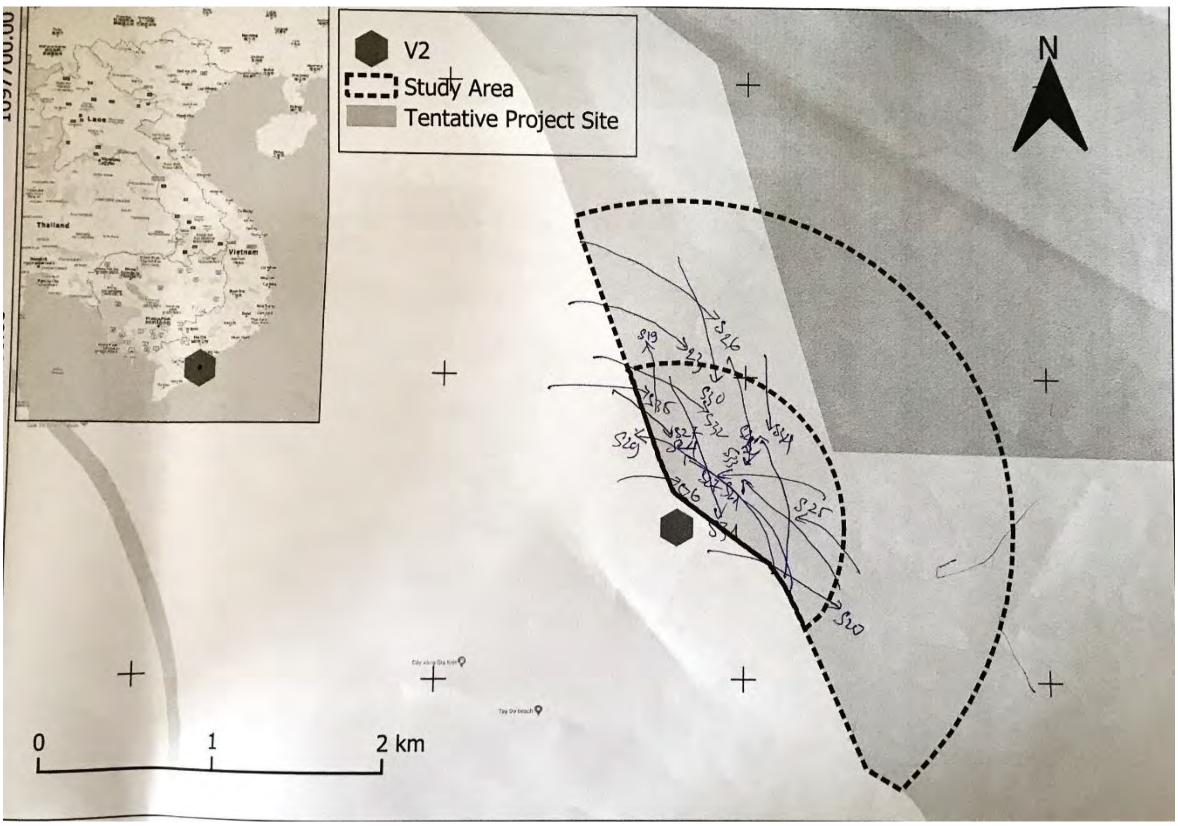
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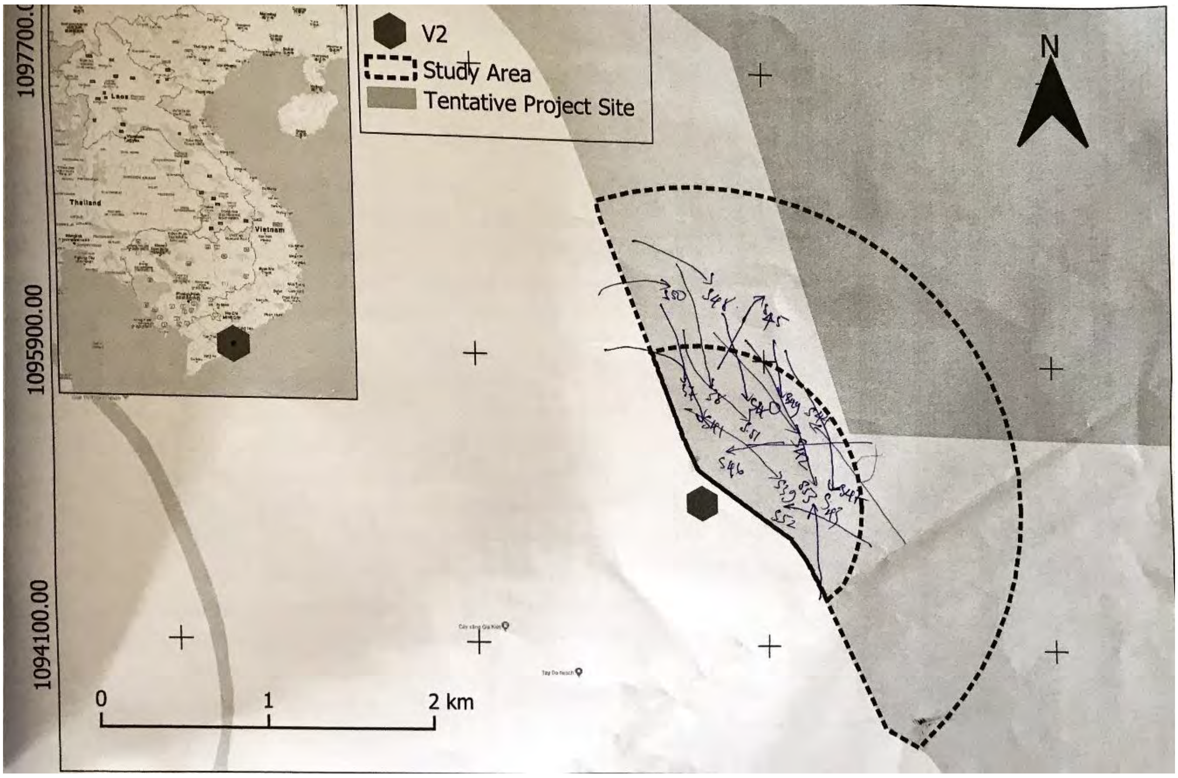
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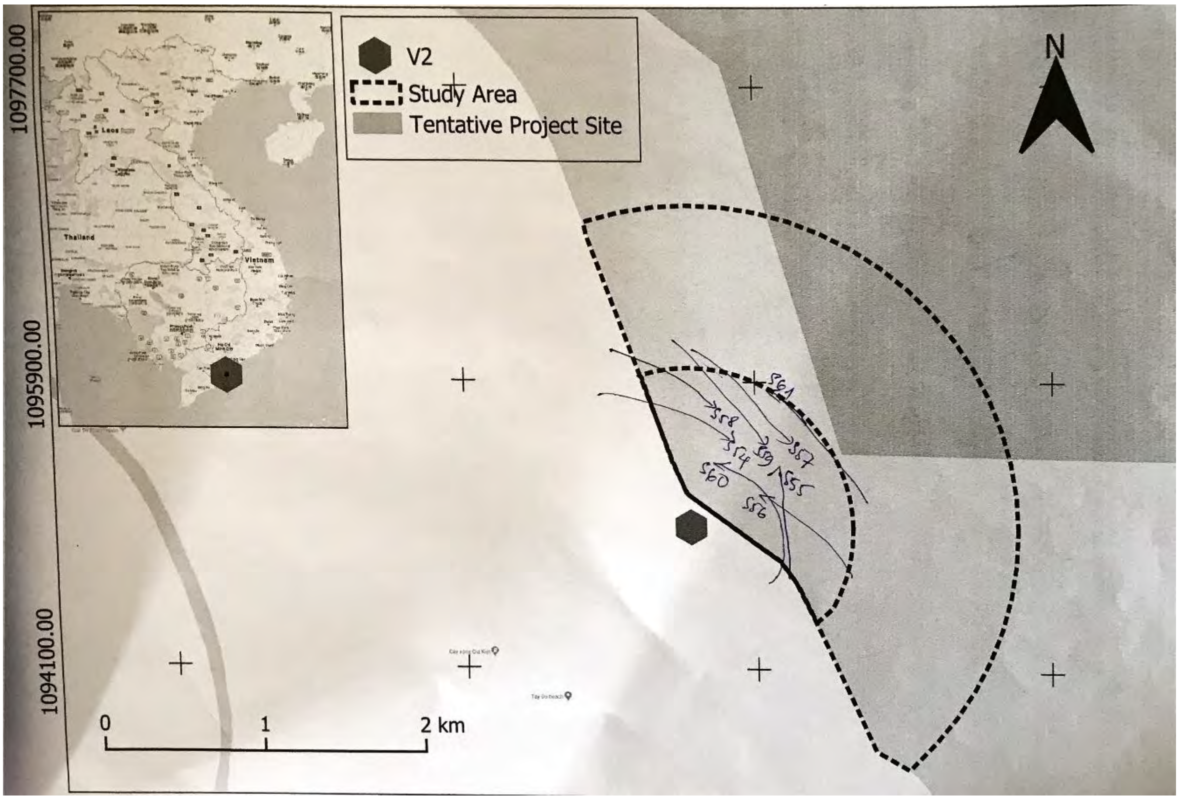
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APPENDIX F BIODIVERSITY SURVEY REPORT - DRY SEASON

Birds and Marine Megafauna survey (Dry Season)

Thanh Hai Windfarm Project, Thanh Phu District, Ben Tre Province, Vietnam

Tan Hoan Cau

28 January 2020

Project No.: 0523473

The business of sustainability

ERM

Document details	
Document title	Birds and Marine Megafauna survey (Dry Season)
Document subtitle	Thanh Hai Windfarm Project, Thanh Phu District, Ben Tre Province, Vietnam
Project No.	0523473
Date	28 January 2020
Version	1.0
Author	Vu Long Le Khac Quyet Truong Anh Tho
Client Name	Tan Hoan Cau

Signature Page

28 January 2020

Birds and Marine Megafauna survey (Dry Season)

Thanh Hai Windfarm Project, Thanh Phu District, Ben Tre Province, Vietnam

ERM Vietnam

3th Floor, Saigon Finance Centre

09 Dinh Tien Hoang, Dakao Ward

District 1, Ho Chi Minh City

Vietnam

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Acronyms and Abbreviations

Name	Description
IUCN	International Union for Conservation of Nature, the global authority on the status of the natural world and the measures needed to safeguard it.
ERM	Environmental Resources Management Vietnam Ltd.
CIM	Conservation in Motion Ltd.
CHA	Critical Habitat Assessment
EISA	Environmental and Social Impact Assessment

1. INTRODUCTION

Environmental Resources Management Vietnam Ltd. (ERM) is preparing an Environmental and Social Impact Assessment (ESIA) for Thanh Hai Windfarm Project at Thanh Phu District, Ben Tre Province. Following the scope of this work, a Critical Habitat Assessment (CHA) has been undertaken to identify critical habitats for flora and fauna in the Project area. The preliminary CHA identified the coast mangrove, intertidal mudflats and near shore sea in the project area and its vicinity are potentially accommodating a significant biodiversity, as well as providing important ecological service for local communities. This triggers further investigation on the current status of windfarm-sensitive fauna (such as birds and bats) and special CHA concerned species (such as Hairy-nosed otter, Southern river Terrapin). Additionally, because the project will take place in a sea area, benthic and pelagic ecosystems can potentially be disturbed. Information on indicating fauna, such as marine megafauna (sea turtles, sharks and rays, marine mammals) and macrobenthos, are also needed for CHA and ESIA process.

On the request of Environmental Resources Management Vietnam Ltd. (ERM), the Conservation In Motion Social Enterprise Ltd. (CIM) have conducted an multidisciplinary survey to acquire baseline data for concerned ecological groups.

The survey was conducted in accordance with IFC PS 6 standard to identify the presence, distribution and current status of the species within the Project area. This will serve as a baseline for biodiversity impact assessment of the ESIA.

1.1 Objective

The objectives of this surveys are to:

- Acquiring baseline data on the distribution and abundance of birds and marine megafauna during the Dry season (December) of 2019
- Acquiring baseline data on the intensive of birds' activities in the project area in Dry season (December) 2019 to aid the impact assessment process;
- Acquiring baseline data on the variation on birds' activities between Dry season and Rainy season to aid the impact assessment process.

1.2 Study area

The Thanh Hai windfarm project is a nearshore windfarm development which will take place in Thanh Phu District of Ben Tre Province, Vietnam. The nearest turbine cluster will be constructed at less than 01km from the shoreline.

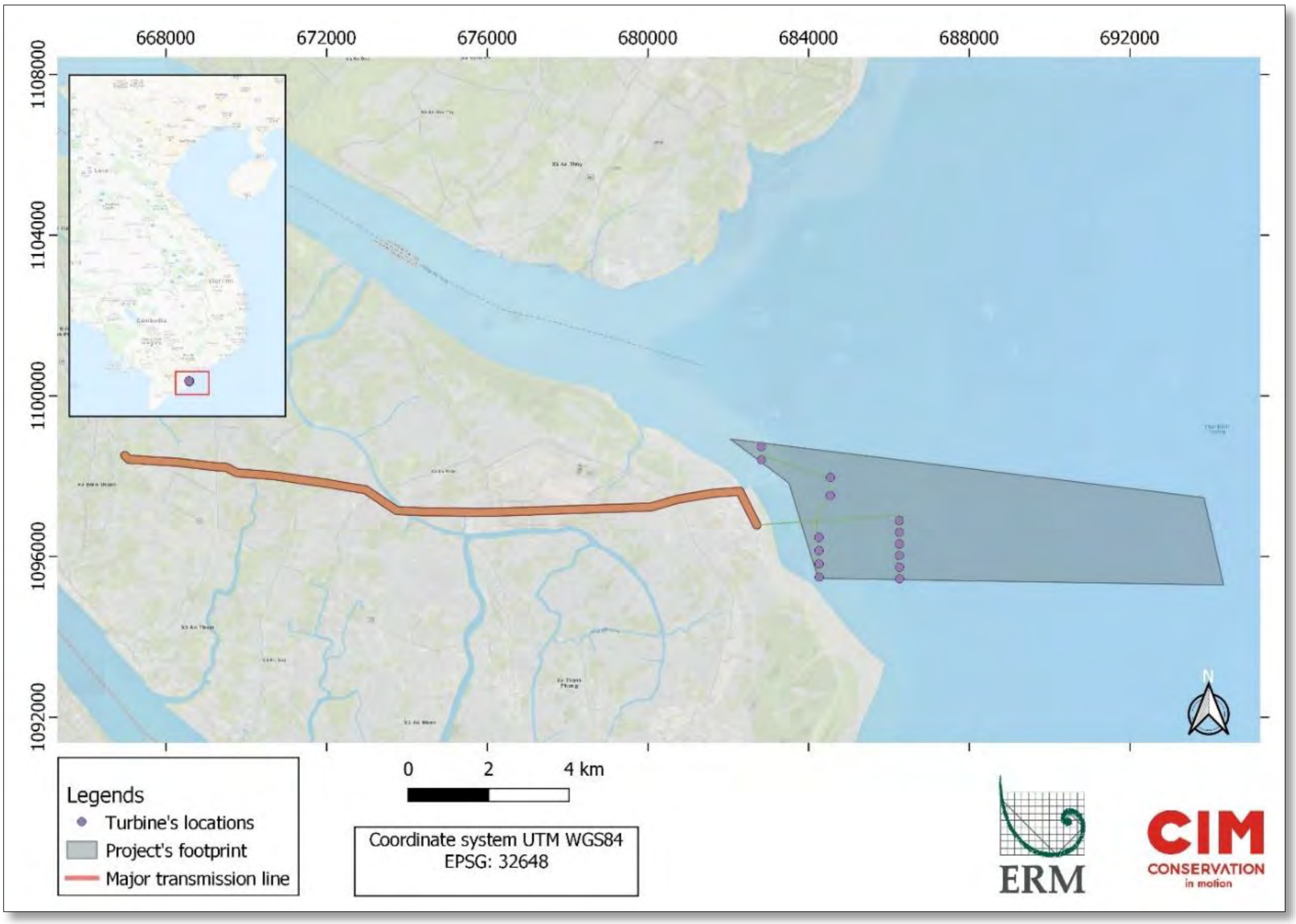


Figure 1-1 Location of Thanh Hai Windfarm Project

2. METHODOLOGY

2.1 Survey time

This survey was conducted from 19th December 2019 to 22nd December 2019, which take place in the middle of dry season of Ben Tre province. It was the second survey conducted in the project's area, followed the first survey that were conducted September 2019 (rainy season in Ben Tre province).

2.2 Vantage point survey

Vantage points survey was used to investigate overlap between avifauna's movements and the project area. Two vantage points, namely V1 and V2, were located in the west border of the project area (Figure 1-1and Table 2-1). Views at each vantage point are showed in Figure 2-2. At each point, one experienced bird observer equipped with 7x50 built-in-compass-and-reticle binocular and high-magnification 20x80 binocular would station and actively scan the whole area within 02km radius from the vantage point for avifauna's activity. Once a bird or group of birds were sighted, the observer would draw the flight path, relative to the ground as if looking down on the site from above into a pre-printed record sheet. For each sighting, observed birds were identified to lowest-as-possible taxonomic level. Information on species, number of birds in the flight; start time and end time of flight; height of the flight in 15 second intervals; type of flight (flapping, soaring, gliding) and notes on activity/behaviour were all recorded. Height of each observed flight was categorised in three height bands: band 1 (below rotor height, <35m), band 2 (at rotor height, 35-150m) and band 3 (above rotor height, >150m). Total flying times were calculated for all bands in each vantage point.

Table 2-1 Two vantage points for avifauna in December 2019

No.	Sites	Easting (UTM WGS84)	Northing (UTM WGS84)
1	V1	681874.042	1098094.683
2	V2	683296.58	1094986.744

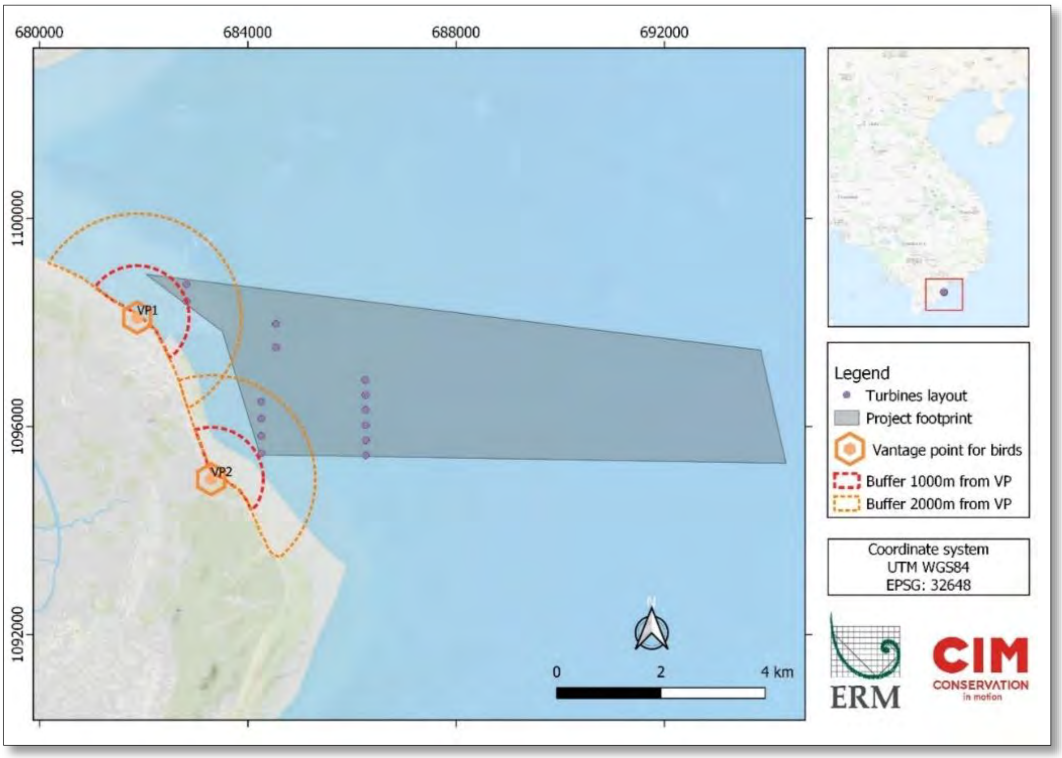


Figure 2-1 **Locations of two vantage points used in rainy season 2019 survey**

Figure 2-2 **Views at vantage points used for this survey**

All flying paths were digitigized into shape files (.shp) for further analysis in QGIS 3.6.1. To visualize the density of bird traffic in the project area and its vicinity, a coveraage grid with 250m x250m cells were generated over the effectively observing area. Total length of bird flying paths (in meter) that intercepted with each cells were calculated using the "Sum line length" function in the Vector analysis toolkit of QGIS 3.6. Number of birds observed in each record were used to weight the avian traffic caculation. For example, the flock of 100 birds will have more influence on the final results rather than a folck of 02. Cells with higher value were presented with darker red color, while those with lower values were showed with lighter red shades. The result was a trafic density map that shows the traffic of birds (measured by meter) in the observed area.

2.3 Boat-based line transect survey for seabirds and marine megafauna

The DISTANCE sampling (Buckland et al. 1993) was used to assess distribution and abundance of seabirds and marine megafauna (marine mammals, sea turtles, sharks and rays) in the project area. Data were collected using visual boat-based surveys following predefined line transects, a form of distance sampling (Buckland et al. 1993, 2001, 2015; Dawson et al. 2008). Parallel line transects were designed to systematically cover the study area, over a variety of depths intervals (Figure 2-3and Figure 2-4). Start points of each transects will be randomly generated using DISTANCE software (Buckland et al. 2001). The research vessel will follow these predesigned transect lines to fully cover the whole study area. During the survey, a minimum of three observers will be stationed at the bow, port and starboard sides of the boat to scan the surrounding for birds. Search speed will be maintained below 15km/h at a consistent speed.

For each flock of birds, each schools of dolphins or each sea turtle encountered during the line transect survey (refer to as "on-effort sighting"), observers will record location, radial distance between the boat and the group, as well as the angle to the group, and group composition (e.g. the number of animals, height of their flight etc.). Sightings recorded when the boat is not on predetermined transects were categorized as off effort sightings and were not used for abundance estimation or modelling.

For all on-effort sighting, the perpendicular distances between the observed animals (Figure 2-3) were calculated from the radial distance between the survey vessel to the animals and the angle form by the transect line with the line drawn from the boat to the animal using conventional geometry formula: Perpendicular distance = Distance to group x sin (angle).

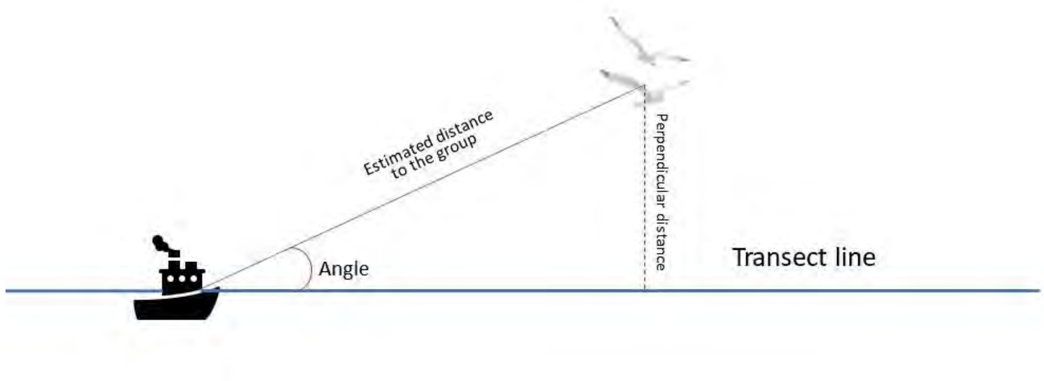


Figure 2-3 Acquiring perpendicular distance from boat-based line transect survey

All calculated perpendicular distances and their associated sighting information (e.g. group size, length of the transect lines where sighting was made, etc.) were used to fit a detection function, which allow estimating abundance of seabird in the survey area (Buckland et al. 2001). This method based on the assumption that the probability of detecting the animal will decrease as perpendicular distance from the animal to the transect line increase. A detecting function allows estimation of the average detection probabilities in the surveyed area. Based on the combination of the number of detected animals, the average detection probabilities in surveyed area and survey design, we can reliably estimate the abundances of seabird in study area for the study period (Buckland et al. 2001, 2015).

To simplify the model fitting process, we only use two most major models in Distance sampling, which were the Half-normal model with cosine adjustment and Hazzard- rate model with cosine adjustment, to fit seabird sighting data. Model selection was based on AICc (Pan 2004). All model fittings were conducted in DISTANCE software version 7.0 (Thomas et al. 2010).

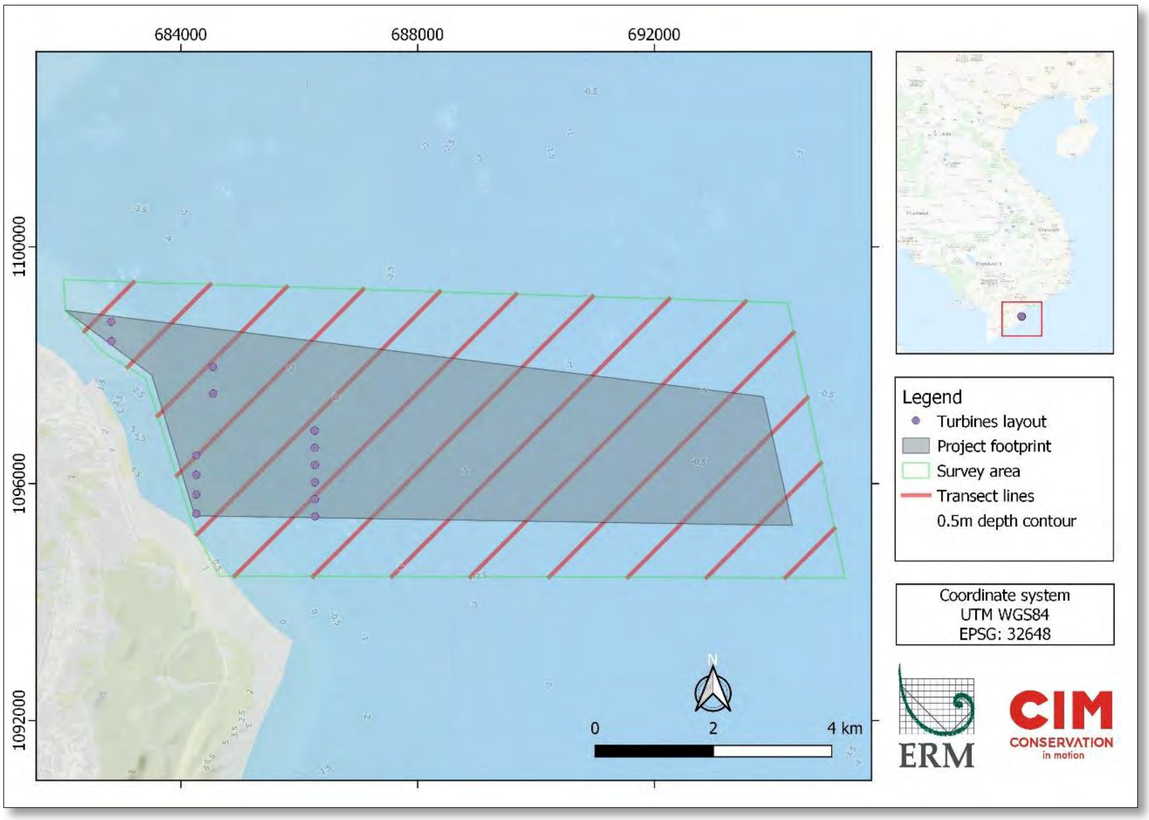


Figure 2-4: Pre-designed parallel line transects used for the survey.

Best fitted detected function was later used to construct Density Surface Model (DSM), which allows predicting spatial distribution of bird density within the survey area (Miller et al. 2013b). Model construction was done in R version 3.5.1 software (R Core Team 2018) with DSM package (Miller et al. 2019). In this study, we only constructed the simplest model, using best detecting function and geographical coordinates (in UTM WGS84/ Zone 48P) to identify and visualize potential hotspot for seabird distribution within the survey area. Specifically, the survey area was divided into 1112 grid-cells (400m x 400m size). Central coordinate (Northing and Easting, or X and Y in UTM WGS84/ Zone 48P) of each cell was extracted and used as covariates for model fitting. Seabird density for each cell were predicted by the best fitted DSM model.

3. RESULTS

3.1 Vantage point survey

3.1.1 Species diversity

Flying birds observed in two vantage points during this December 2019 survey (Table 3-1). Among those, the Oriental Darter *Anhinga melanogaster*, Eurasian Curlew *Numenius arquata*, Black-tailed Godwit *Limosa limosa*[1] and were Near-threatened (NT) species in the IUCN Red list 2019. Only the Oriental Darter was listed (as VU: Vulnerable) in the Vietnam Red Databook 2007. Comparing to the previous survey in rainy season (which recorded 35 species of 08 order and 14 families), the avian diversity in the dry season of 2019 showed reduction (discussed further in section 3.3.1). More photographs of recorded species during vantage point survey can be found in Appendix A.

Table 3-1 List of bird species that were observed flying in to vantage points

	Taxa	English name	IUCN status	Recorded at
	Order ACCIPITRIFORMES			
	Family PANDIONIDAE			
1	*Pandion haliaetus*	Osprey	LC	V1, V2
	Order CHARADRIIFORMES			
	Family CHARADRIIDAE			
2	*Charadrius alexandrinus*	Kentish Plover	LC	V1
3	*Charadrius dubius*	Little Ringed Plover	LC	V1
4	*Charadrius leschenaultii*	Greater Sandplover	LC	V1, V2
5	*Charadrius mongolus*	Lesser Sandplover	LC	V1, V2
6	*Pluvialis fulva*	Pacific Golden Plover	LC	V2
	Family LARIDAE			
7	*Gelochelidon nilotica*	Gull-billed Tern	LC	V1, V2
8	*Hydroprogne caspia*	Caspian Tern	LC	V1, V2
9	*Larus crassirostris*	Black-tailed Gull	LC	V1

[1] We observed two Black-tailed Godwit in 22nd December in the V1, but the animals were too fast and no photographs could be taken.

	Taxa	English name	IUCN status	Recorded at
10	*Sterna hirundo*	Common Tern	LC	V1, V2
	Family SCOLOPACIDAE			
11	*Actitis hypoleucos*	Common Sandpiper	LC	V1, V2
12	*Calidris alba*	Sanderling	LC	V1, V2
13	*Limosa lapponica*	Bar-tailed Godwit	LC	V1
14	*Limosa limosa*	Black-tailed Godwit	NT	V1
15	*Numenius arquata*	Eurasian Curlew	NT	V1, V2
16	*Numenius phaeopus*	Whimbrel	LC	V1, V2
17	*Tringa nebularia*	Common Greenshank	LC	V1, V2
18	*Xenus cinereus*	Terek Sandpiper	LC	V1
	Order COLUMBIFORMES			
	Family COLUMBIDAE			
19	*Spilopelia chinensis*	Spotted Dove	LC	V2
	Order CORACIIFORMES			
	Family ALCEDINIDAE			
20	*Todiramphus chloris*	Collared Kingfisher	LC	V2
	Order PASSERIFORMES			
	Family HIRUNDINIDAE			
21	*Hirundo rustica*	Barn Swallow	LC	V1, V2
	Order PELECANIFORMES			
	Family ARDEIDAE			
22	*Ardea alba*	Great Egret	LC	V2
23	*Ardeola bacchus*	Chinese Pond-heron	LC	V2

	Taxa	English name	IUCN status	Recorded at
24	*Egretta garzetta*	Little Egret	LC	V1, V2
	Order SULIFORMES			
	Family ANHINGIDAE			
25	*Anhinga melanogaster*	Oriental Darter	NT	V2
	Family PHALACROCORACIDAE			
26	*Microcarbo niger*	Little Cormorant	LC	V2

Figure 3-1 The Oriental Darter recorded during vantage point survey

Figure 3-2 The Eurasian Curlew recorded during the vantage point survey

3.1.2 Bird activities

A total of 13440 seconds of bird flying was observed from the two vantage points during December 2019 survey. All observed flights took place in band 1 (<35m). No observed flight occurred in band 2 (35-150m) or band 3 (>150m). Figure 3-3 summarized the total flying time observed in each vantage points. Detail flying time of each species at each height bands were summarised in Figure 3-4 below.

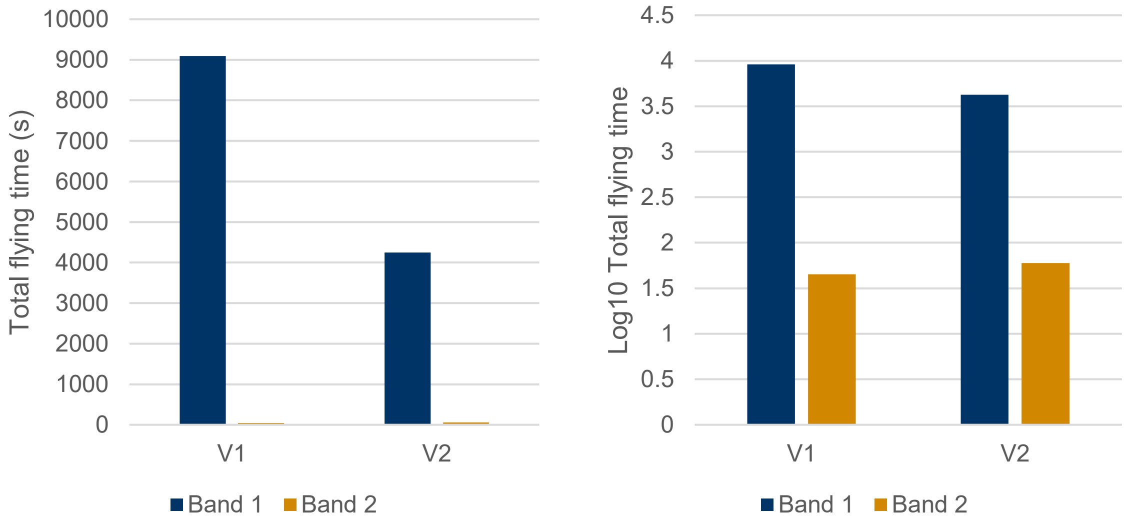
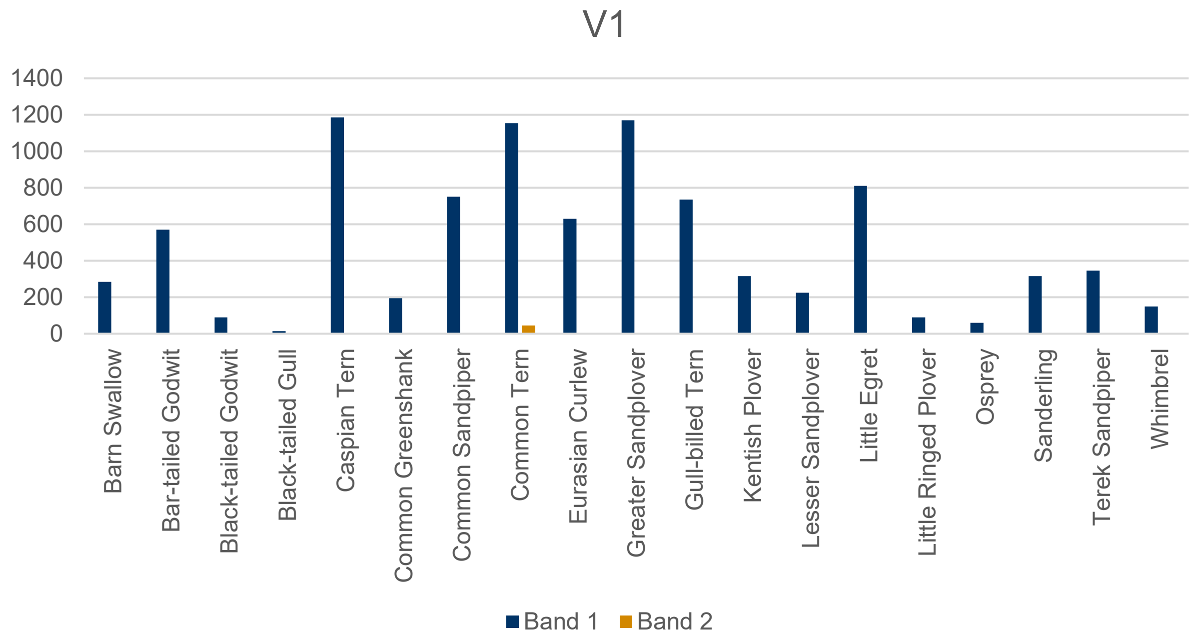


Figure 3-3: Flying time at in each band at two vantage points

In this survey, bird flying was observed more frequently in V1 comparing to V2. A total 9135 seconds of flights were recorded V1, while only 4305 seconds were recorded in V2 (Figure 3-3). However, the number of species recorded in V2 (20 species) were higher than those recorded in V1 (19 species). In V1, the most active (most-frequently flying) species were the Common tern *Sterna hirundo* (1200s of observed flying), while the Caspian Tern *Hydroprogne caspia* were the most active species observed in V2 (570s of observation).



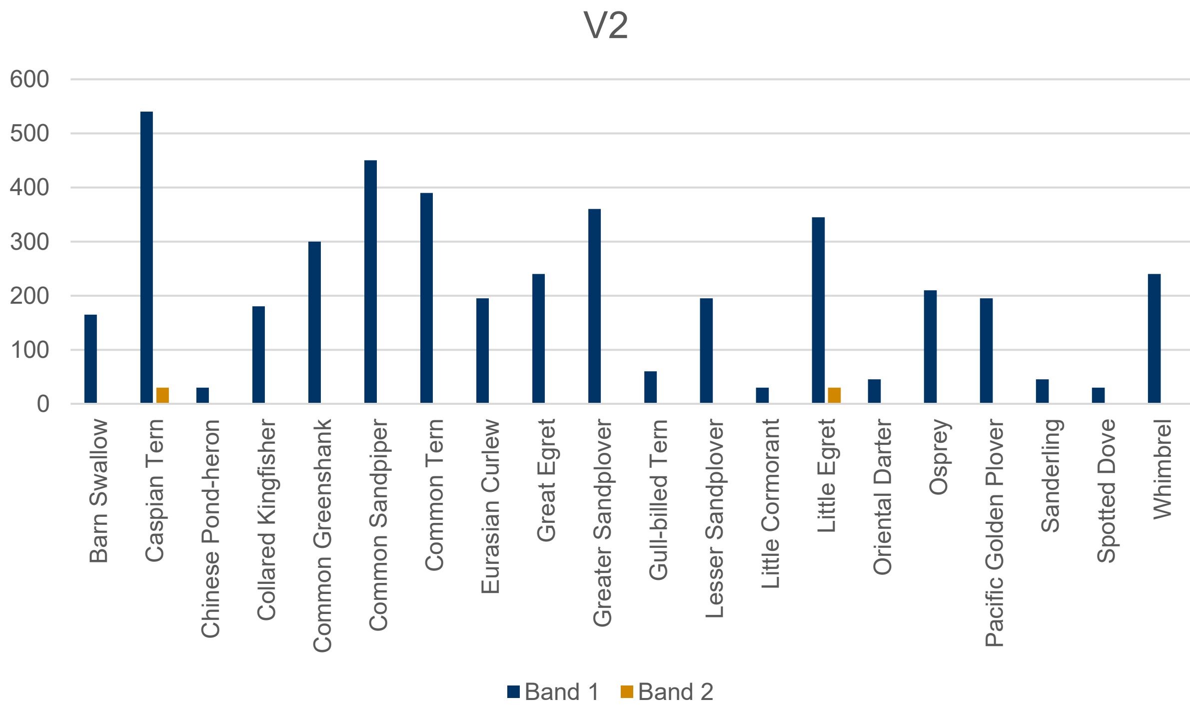


Figure 3-4: Flying time of different species in each band at two vantage points

In both points, bird's flights could be observed all day, from 6:00 to 17:50. There were slight reduction in bird's flights at 10:00 and 11:00 in V1 and V2, respectively. However, the amount observed bird's flights increased in follow-up hours (Figure 3-5). Different species had different flying time, but most of them flew all day.

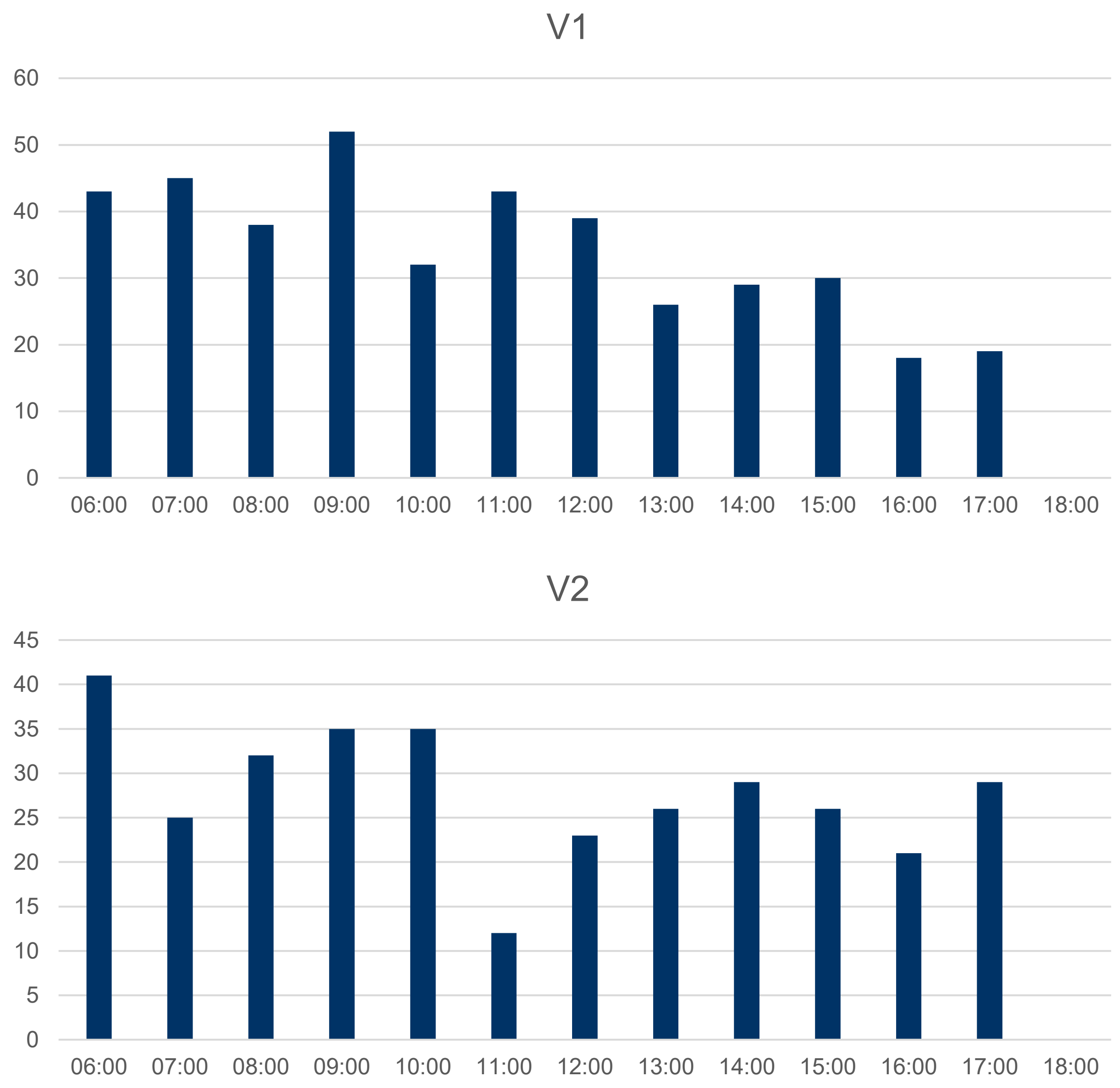


Figure 3-5: Bird activity at different time in day

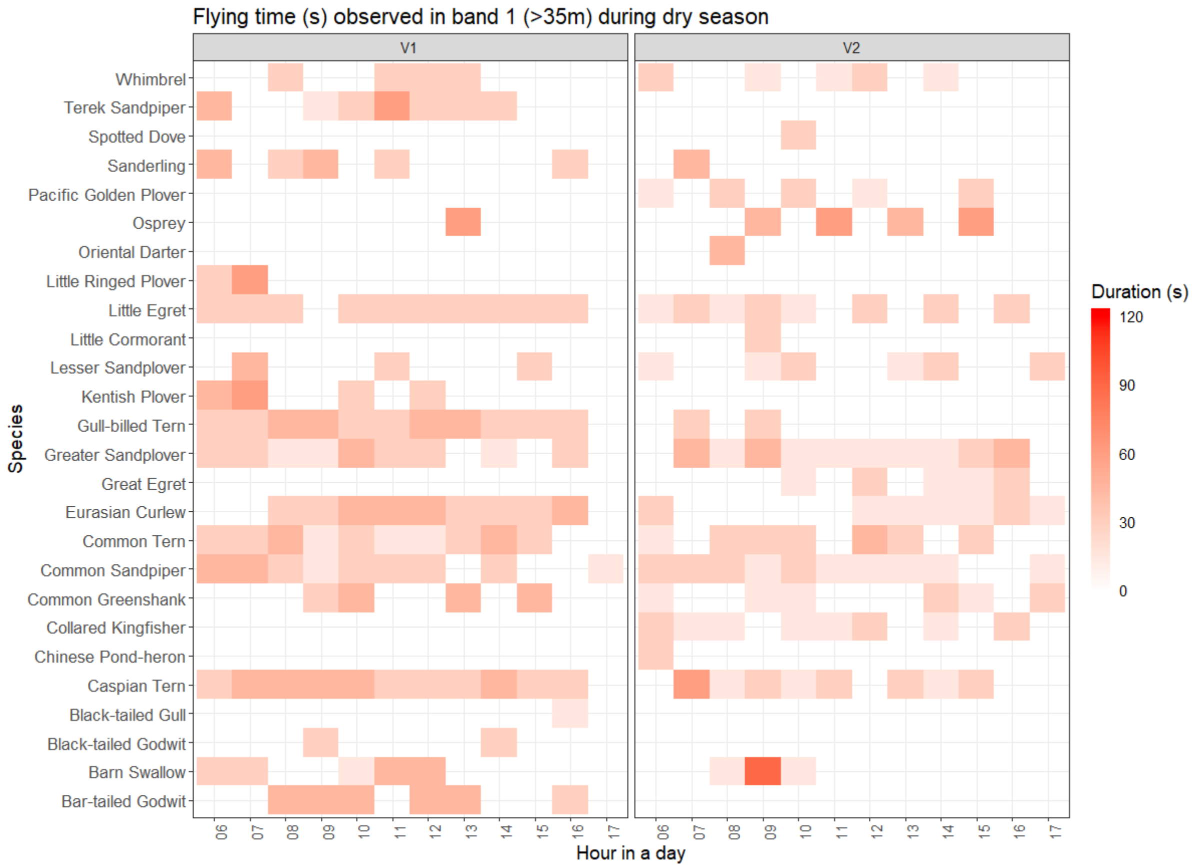


Figure 3-6: Variation of bird flight observed in band 1 in two vantage points

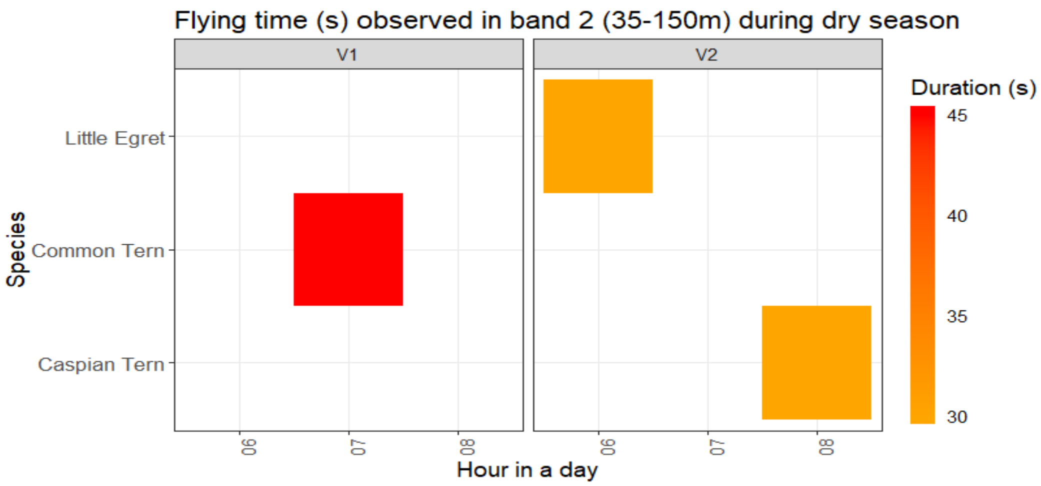


Figure 3-7: Variation of bird flight observed in band 1 in two vantage points

3.1.3 Bird traffic

The vantage point survey conducted in December 2019 showed busier avian traffic in vantage point V1 (Figure 3-9). This pattern could be the result of bigger flocks observed in the V1 area. The average number of individuals in a flock recorded in V1 appeared to be greater than in V2 (Figure 3-8)

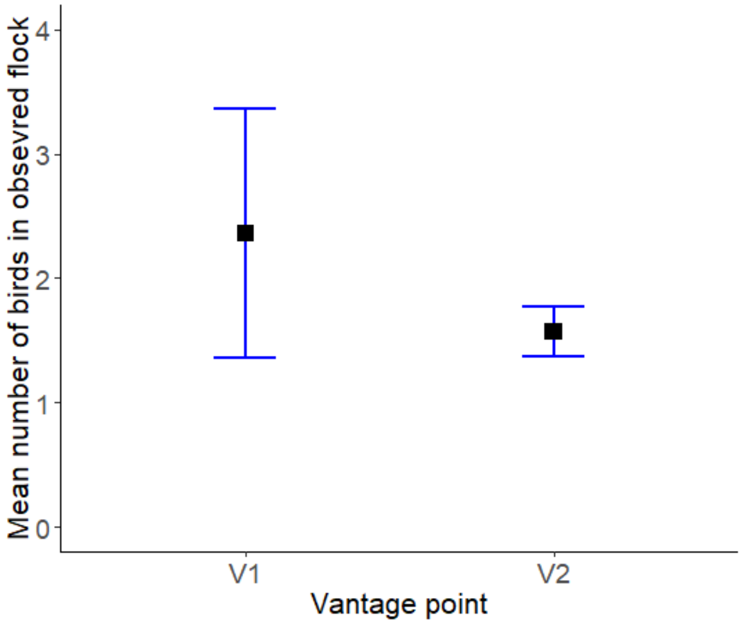


Figure 3-8: Average number of birds observed in a record in two points, with 95% confidence interval

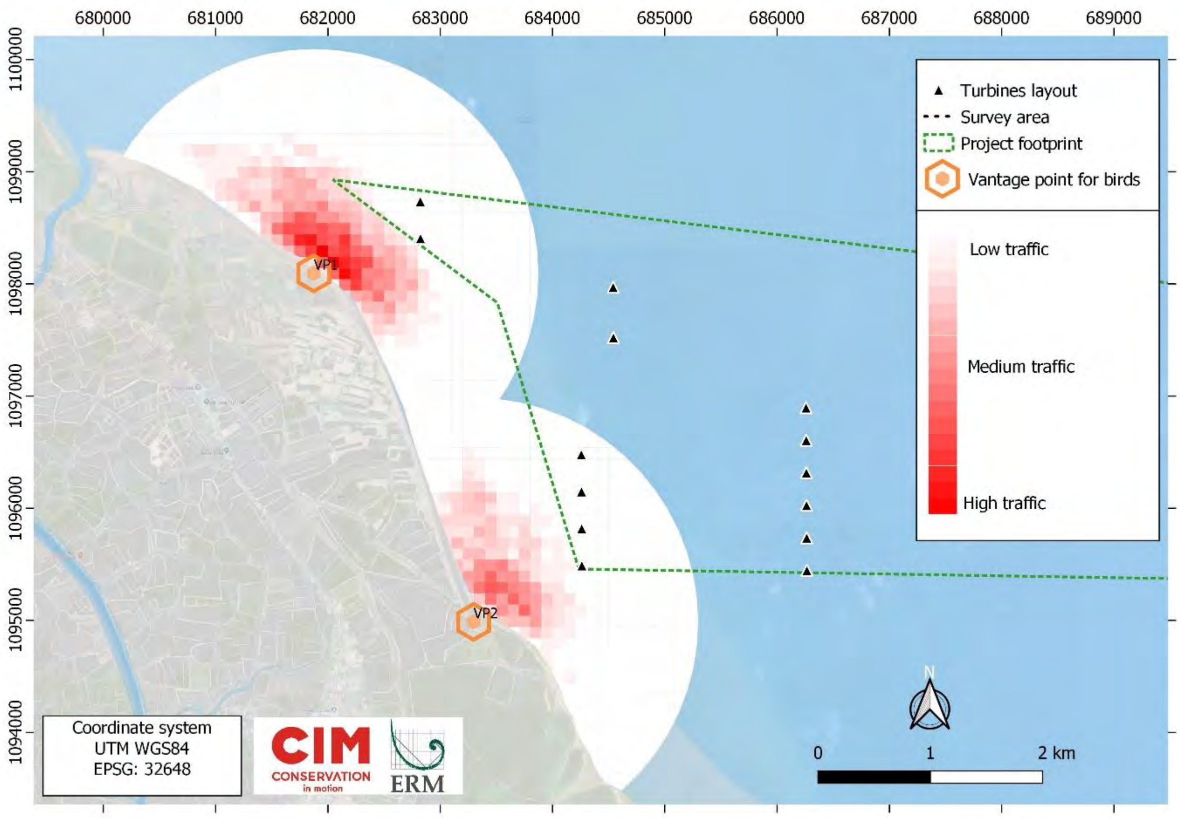


Figure 3-9: Avian traffic in the project area, recorded in dry season, December 2019

Summary of findings: vantage point survey recorded fair amount of bird traffics in the coastal area of Thanh Hai Windfarm project. Few flights in band 2 (in which the collision risk needs to be considered) were observed during this survey. Species that flew in band 2 were Common Tern, Caspian Tern and Little Egret. There were spatiotemporal variations in birds traffics. Bird traffic were busier in V1 (North of the site) than in V2 (South of the site). In both site, bird traffics were busy for the whole day. Three IUCN's NT species, the Oriental Darter *Anhinga melanogaster,* Black-tailed Godwit *Limosa limosa* and the Eurasian Curlew *Numenius arquata* were recorded in this survey.

3.2 Boat-based line transect survey

The boat-base line transect survey using DISTANCE sampling method survey has covered a sea area of 53.9km^2, including the proposed footprint of the Thanh Hai wind farm project and its vicinities. During the survey, the survey vessel has travelled a total distance of 180.645km (Figure 3-11), in which 55.3km was on-effort sampling (the survey vessel was on transects). A total of 27 on-effort and 24 off-effort seabird sightings were made in the survey area. Information of 06 species of seabirds recorded during the survey were summarized in Table 3-2. No dolphin, whale, sea turtle was recorded during this survey. As there are no marine megafauna had been observed during this survey, the report would focus on seabird from this point.

Table 3-2 Summary of sightings made during boat-based survey

	Taxa	English name	IUCN status	On-effort sightings	Off-effort sighting
	Order ACCIPITRIFORMES				
	Family PANDIONIDAE				
1	*Pandion haliaetus*	Osprey	LC	0	4
	Order CHARADRIIFORMES				
	Family SCOLOPACIDAE				
2	*Calidris alba*	Sanderling	LC	0	1 (01 flocks of 25)
	Family LARIDAE				
3	*Sterna hirundo*	Common Tern	LC	21	5
4	*Hydroprogne caspia*	Caspian Tern	LC	2	12
	Order PASSERIFORMES				
	Family HIRUNDINIDAE				
5	*Hirundo rustica*	Barn Swallow	LC	2	5

	Order PELECANIFORMES				
	Family ARDEIDAE				
6	*Egretta garzetta*	Little Egret	LC	1 (01 flocks of 33)	1

Figure 3-10 Flock of Little Egret sighted during the boat-based survey

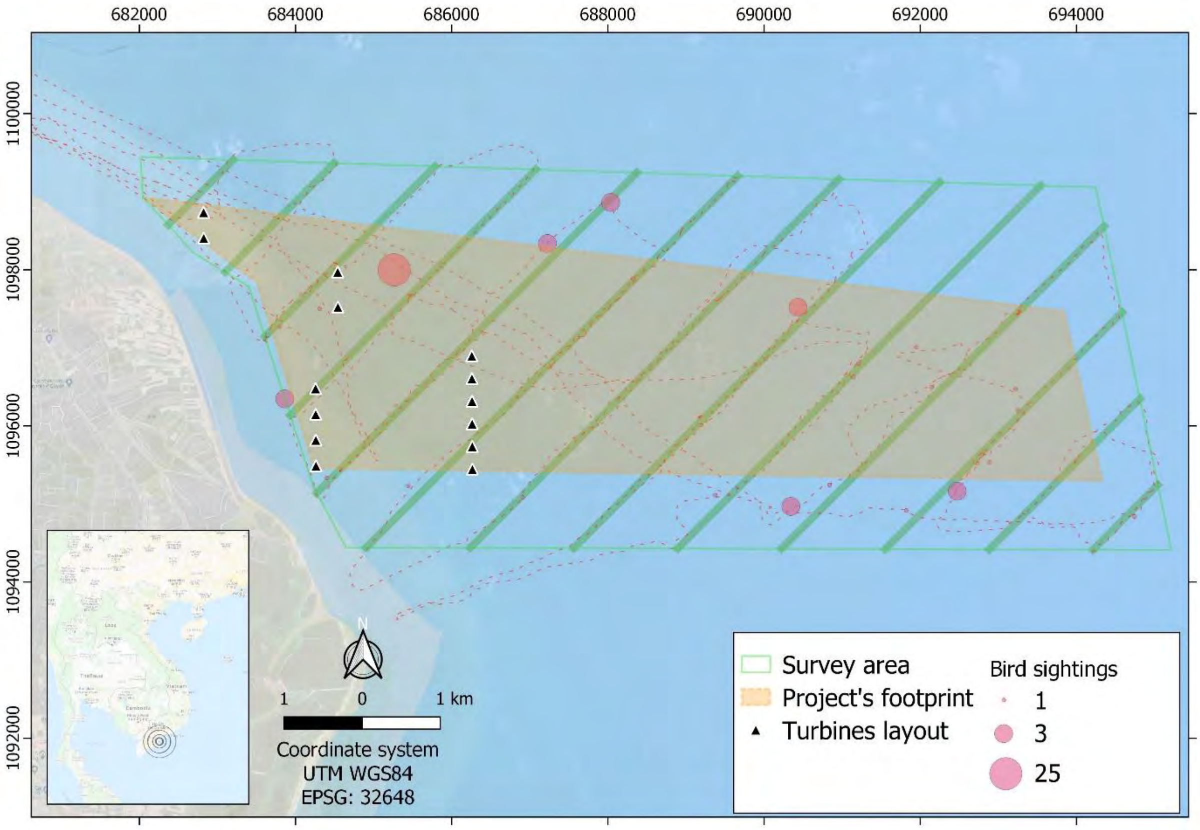


Figure 3-11 Locations of on-effort sightings made during the boat-based survey

All seabirds observed in the boat-based survey flew lower than 35m. The most common species in the survey area was the common tern *Sterna hirundo*. All birds were observed within 400m perpendicular distance measured from the observed bird to the surveyed transect (Figure 3-12 A). Seabirds in the survey area were usually travel alone or in small group (Figure 3-12 B). There was no clear relationship between perpendicular distance with group sizes of sightings, suggesting group size did not heavily affect the detection probability (Figure 3-12 C). All sightings were made in Beaufort scale 2 and 3 (Figure 3-12 D).

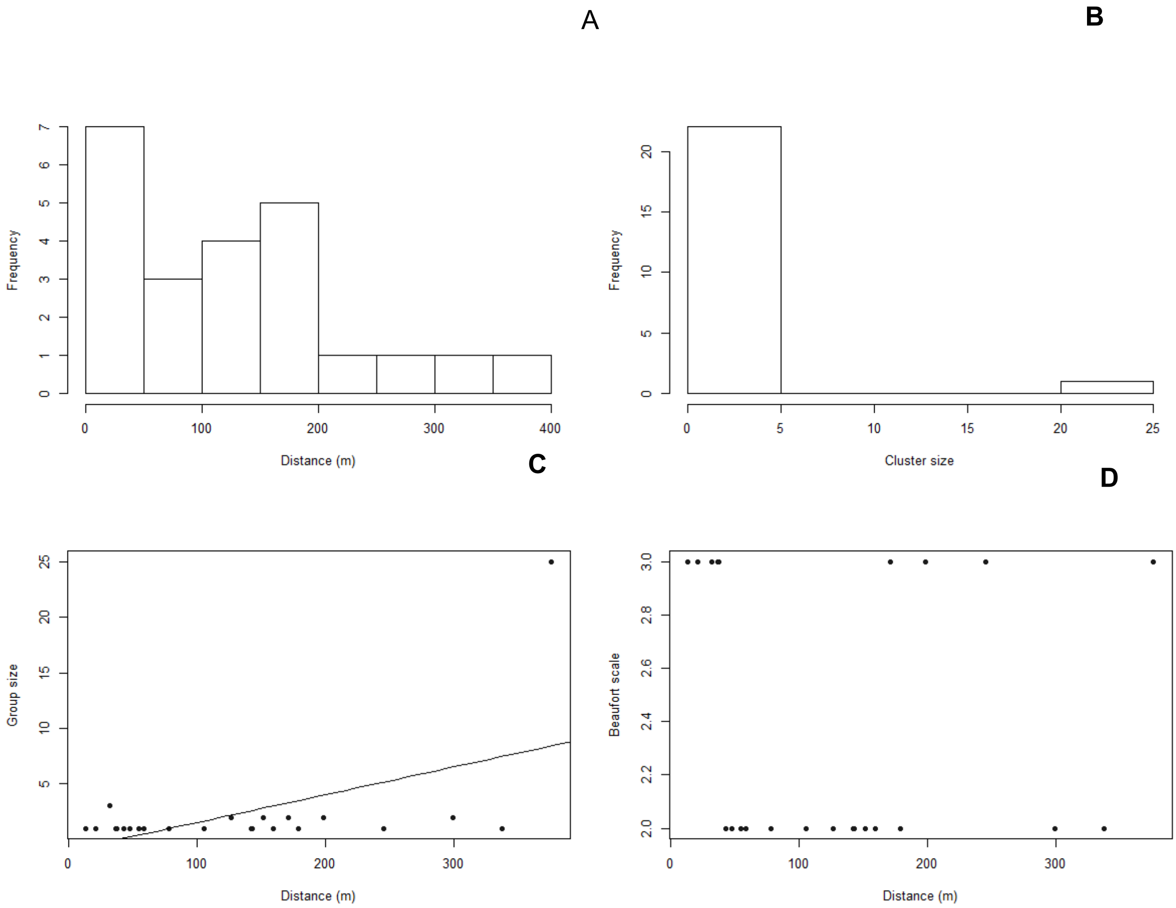


Figure 3-12 Descriptive statistics of distance sampling data collected from this survey

Model with Half-normal function and cosine adjustment appeared to be the best fitted model (Lower AICs, Table 3-3). Figure 3-13Figure 3-13 present the fitting of Half-normal curve to observed perpendicular distances. Overall, this model performed well in explaining the collected data. According to this model, averaged seabird density in the survey area was 0.7 individuals per 01km2. Total number of seabirds within the survey area were estimated as 38 individuals (CV=0.2) (Table 3-3). This seabird density was lower than the previous survey in September 2019.

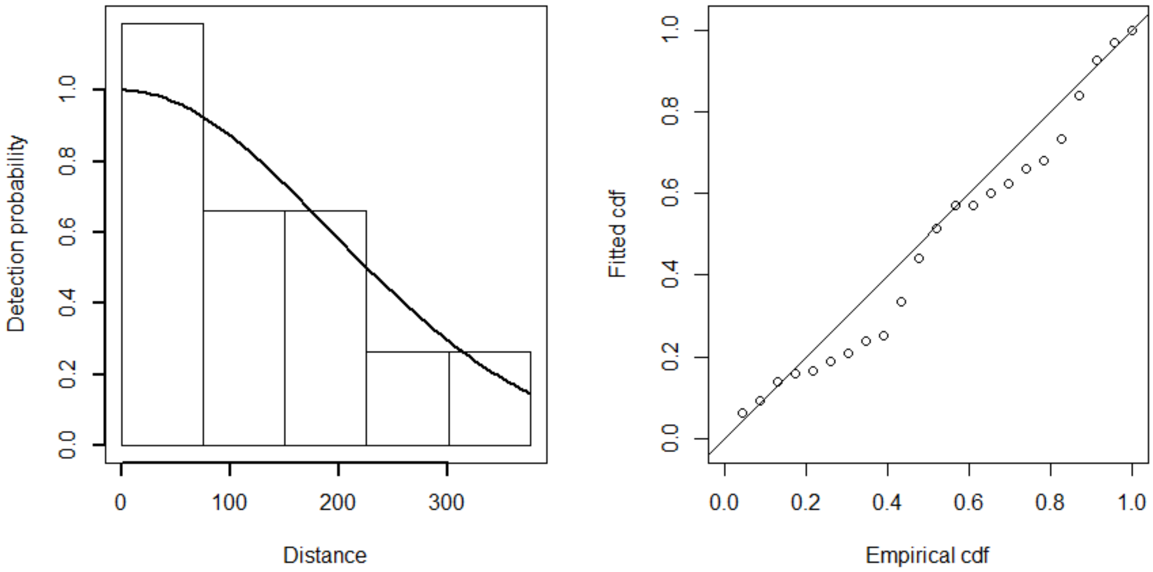


Figure 3-13: Detecting function using Half-normal key function and cosine adjustment

Table 3-3: Results of different Distance models, and seabird density estimation

Model	Model definition	AICc	N	NCV	D (individual/km^2)
M1	Half-normal + cosine	269.34	38	0.2	0.7
M2	Hazzard rate + cosine	270.3	47	0.4	0.9
M3	Hazzard rate + cosine ~ covariate (Beaufort scale)	270.7	56	0.6	1.05
M4	Half-normal + cosine ~ covariate (Beaufort scale)	271.26	37	0.2	3.69

The best fitted model, which have lowest AICc value (Pan 2004), was the one with Half-normal key function. This detecting function were used to construct the Density Surface Model (Miller et al. 2013). The simplest DSM model, with Half-normal detecting function and spatial coordinates, was able to explain 58.7% of data deviance. The result of this DSM model was summarized in Figure 3-14. Area with high seabird abundance predicted detected by this model were as showed as bright red areas in Figure 3-14, while the CV of prediction (represent the level of uncertainty) was illustrated in Figure 3-15. The result showed an uneven distribution of seabirds within the survey area. Within the survey area, seabirds were predicted to be concentrated in one hotspot that located in the west side of the project's footprint (Figure 3-14). Current wind turbine layout does not overlap with this hotspot. However, the distance between planned turbines and bird hotspot were close (about 1km) enough to cause disturbances.

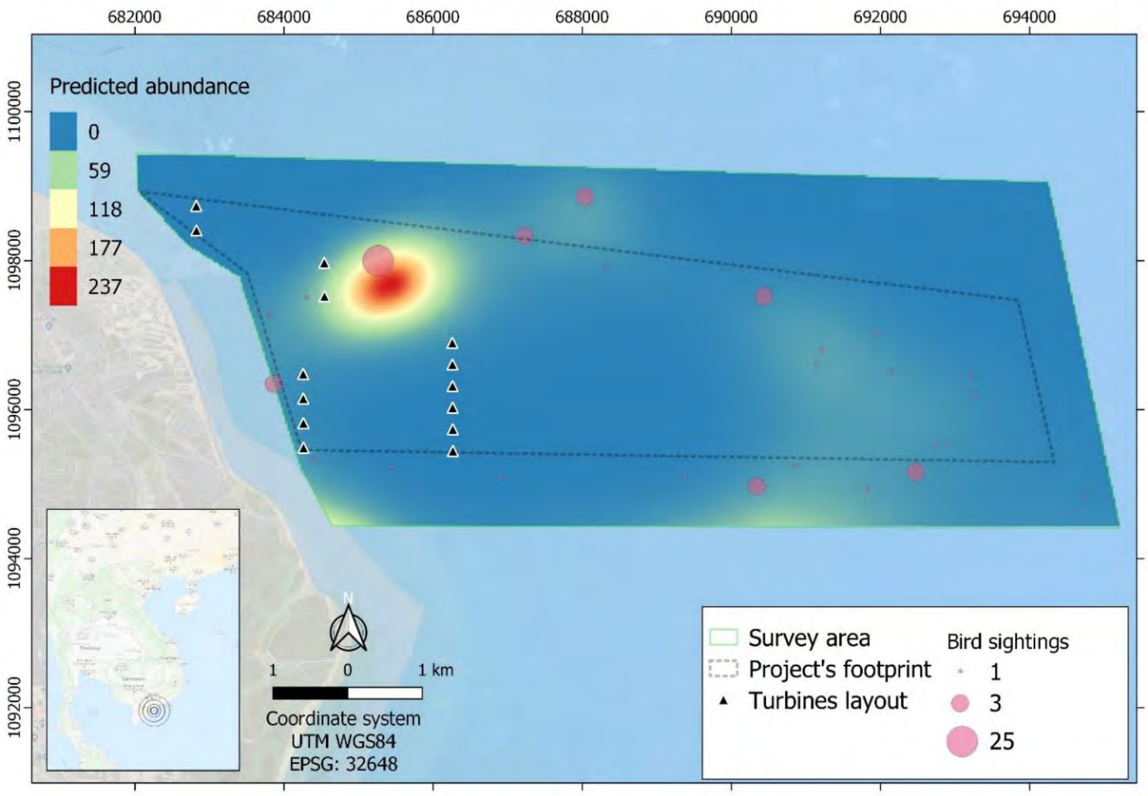


Figure 3-14: Distribution of seabird density within the survey area

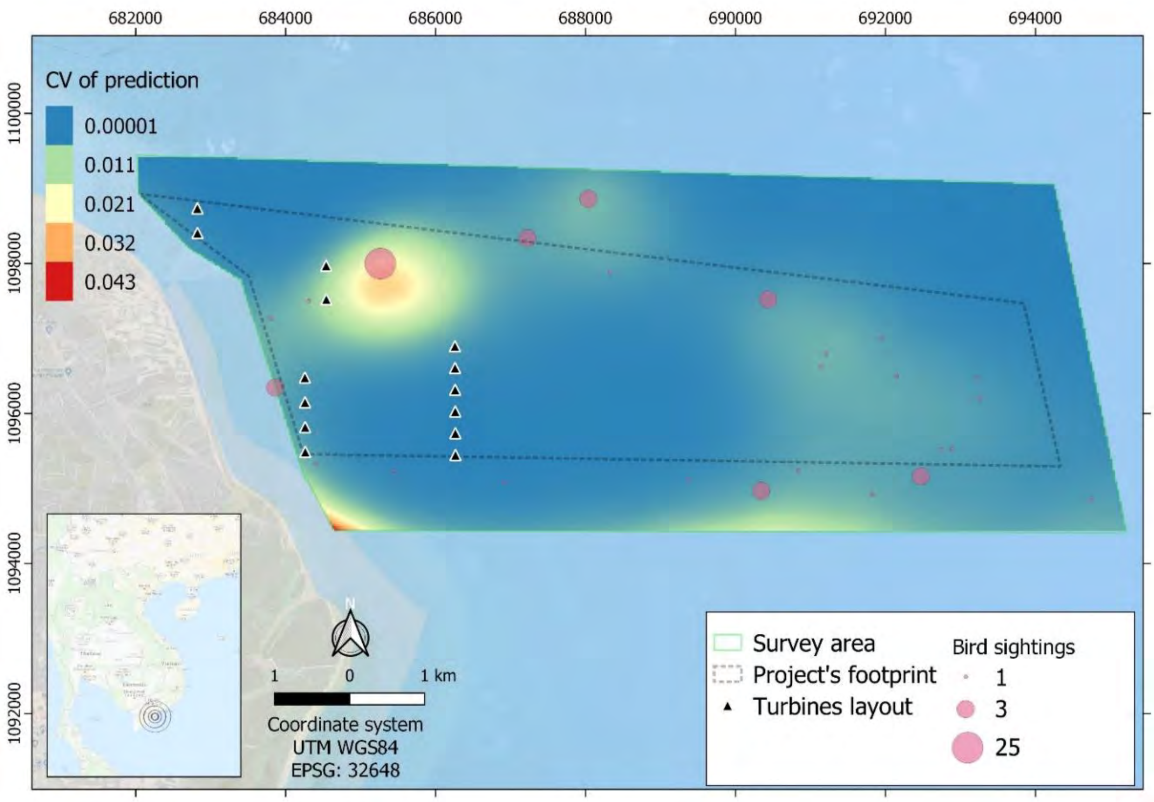


Figure 3-15: Distribution of CV for the DSM model used to map seabird's density

Summary of findings: the boat-based line transect survey using DISTANCE sampling were able to collect bird data to run DISTANCE analysis. In the dry season, seabirds were predicted to be concentrated in one hotspot that located in the west side of the project's footprint (Figure 3-14). Current wind turbine layout does not overlap with this hotspot. This survey recorded no bird that flew higher than 35m from the sea level, suggesting a relatively low collision risk for sea birds

3.3 Two seasons comparations

3.3.1 Around 02 vantage points

Bird diversity: Comparing to the previous survey in rainy season (which recorded 35 species of 08 order and 14 families), the avian diversity in the dry season of 2019 showed reduction. During the survey in dry season of December 2019, no swiftlet (order CAPRIMULGIFORMES, family Apodidae) were observed around two vantage points. Additionally, the presentative of families Dicruridae (drongos), Meropidae (bee-eater) and Sturnidae (starlings), which were recorded in previous survey of rainy season 2019, had not been recorded in this dry season survey. This dry season survey recorded the Black-tail Godwit The variation in bird diversity around two vantage points were summarized in Table 3-4 below.

Table 3-4: Variation in bird species recorded from two survey

Row Labels	English name	IUCN status	Recorded at	Recorded season
ACCIPITRIFORMES				
PANDIONIDAE				
Pandion haliaetus	Osprey	LC	V1, V2	Dry, Rainy
CAPRIMULGIFORMES				
APODIDAE				
Aerodramus fuciphagus	Germain's Swiftlet	LC	V2	Rainy
Apus nipalensis	House Swift	LC	V1	Rainy
CHARADRIIFORMES				
CHARADRIIDAE				
Charadrius alexandrinus	Kentish Plover	LC	V1, V2	Dry, Rainy
Charadrius dubius	Little Ringed Plover	LC	V1	Dry, Rainy
Charadrius leschenaultii	Greater Sandplover	LC	V1, V2	Dry, Rainy

Charadrius mongolus	Lesser Sandplover	LC	V1, V2	Dry, Rainy
Pluvialis fulva	Pacific Golden Plover	LC	V2	Dry, Rainy
LARIDAE				
Gelochelidon nilotica	Gull-billed Tern	LC	V1, V2	Dry, Rainy
Hydroprogne caspia	Caspian Tern	LC	V1, V2	Dry, Rainy
Larus crassirostris	Black-tailed Gull	LC	V1	Dry
Sterna hirundo	Common Tern	LC	V1, V2	Dry, Rainy
Sternula albifrons	Little Tern	LC	V1	Rainy
SCOLOPACIDAE				
Actitis hypoleucos	Common Sandpiper	LC	V1, V2	Dry, Rainy
Calidris alba	Sanderling	LC	V1, V2	Dry, Rainy
Calidris falcinellus	Broad-billed Sandpiper	LC	V1	Rainy
Limosa lapponica	Bar-tailed Godwit	NT	V1	Dry
Limosa limosa	Black-tailed Godwit	NT	V1	Dry
Numenius arquata	Eurasian Curlew	NT	V1, V2	Dry, Rainy
Numenius phaeopus	Whimbrel	LC	V1, V2	Dry, Rainy
Tringa nebularia	Common Greenshank	LC	V1, V2	Dry, Rainy
Tringa ochropus	Green Sandpiper	LC	V2	Rainy
Tringa stagnatilis	Marsh Sandpiper	LC	V2, V1	Rainy
Xenus cinereus	Terek Sandpiper	LC	V1, V2	Dry, Rainy
COLUMBIFORMES				
COLUMBIDAE				
Geopelia striata	Zebra Dove	LC	V2	Rainy
Spilopelia chinensis	Spotted Dove	LC	V2	Dry, Rainy

CORACIIFORMES				
ALCEDINIDAE				
Todiramphus chloris	Collared Kingfisher	LC	V2	Dry, Rainy
MEROPIDAE				
Merops orientalis	Green Bee-eater	LC	V2	Rainy
Merops philippinus	Blue-tailed Bee-eater	LC	V2	Rainy
PASSERIFORMES				
DICRURIDAE				
Dicrurus macrocercus	Black Drongo	LC	V2	Rainy
HIRUNDINIDAE				
Hirundo rustica	Barn Swallow	LC	V1, V2	Dry, Rainy
STURNIDAE				
Acridotheres tristis	Common Myna	LC	V2	Rainy
Sturnia sinensis	White-shouldered Starling	LC	V2	Rainy
PELECANIFORMES				
ARDEIDAE				
Ardea alba	Great Egret	LC	V2, V1	Dry, Rainy
Ardea cinerea	Grey Heron	LC	V2	Rainy
Ardeola bacchus	Chinese Pond-heron	LC	V2, V1	Dry, Rainy
Butorides striata	Striated Heron	LC	V2	Rainy
Egretta garzetta	Little Egret	LC	V1, V2	Dry, Rainy
SULIFORMES				
ANHINGIDAE				
Anhinga melanogaster	Oriental Darter	NT	V2	Dry, Rainy

PHALACROCORACIDAE				
Microcarbo niger	Little Cormorant	LC	V2, V1	Dry, Rainy

Bird activities: There was a seasonal difference in bird activities between dry and rainy season. Compare to the previous survey in rainy season, bird activities during the dry season in both points reduced. In both seasons, most birds were actives below 35m. Much fewer bird activities were observed in height band 35-150m (Figure 3-16). No bird activity had been observed in higher 150m. There was also a seasonal difference in bird traffic two seasons. Compare to the dry season, the amount of bird traffic during the rainy season in V1 and V2 increased while bird traffic in V3 became more concentrated (Figure 3-18). The busy bird traffic in point V3 were consistently higher than in other point in both seasons.

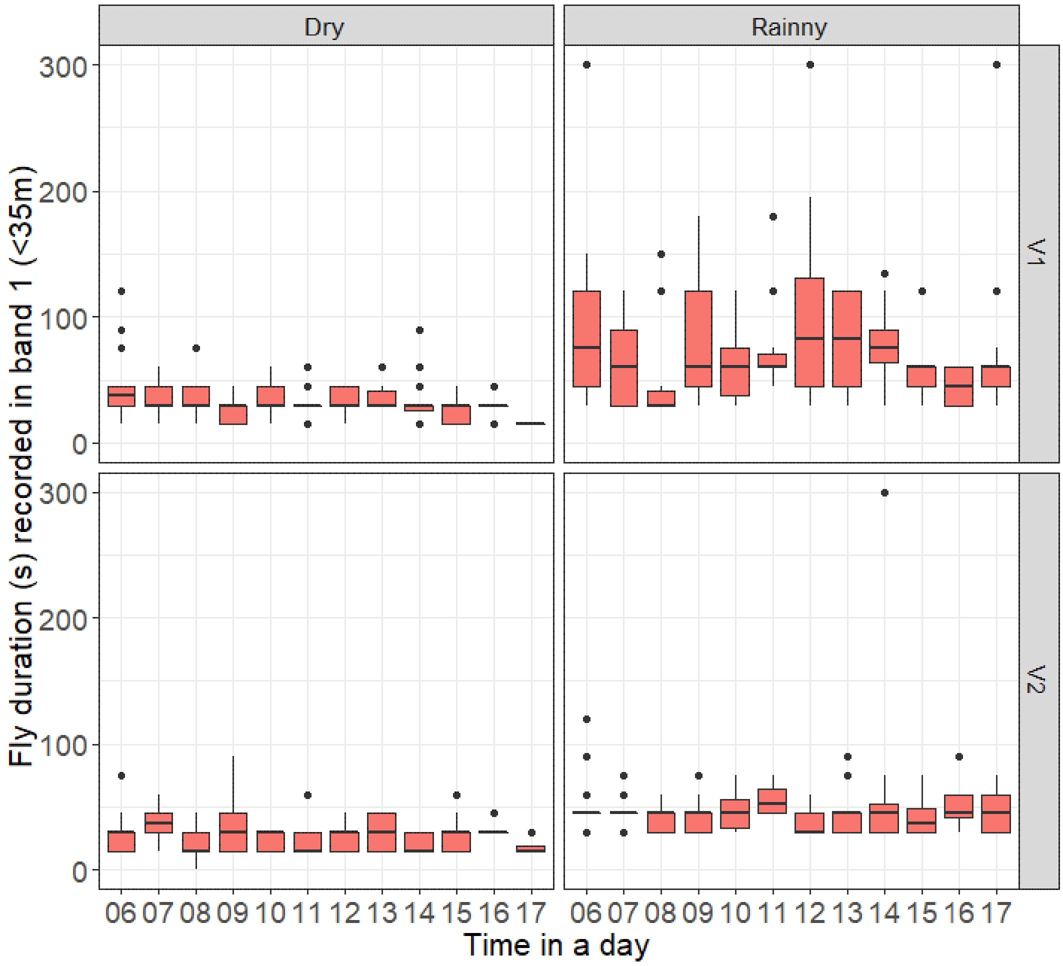


Figure 3-16: Seasonal variabilities in bird activities in band 1 between two seasons

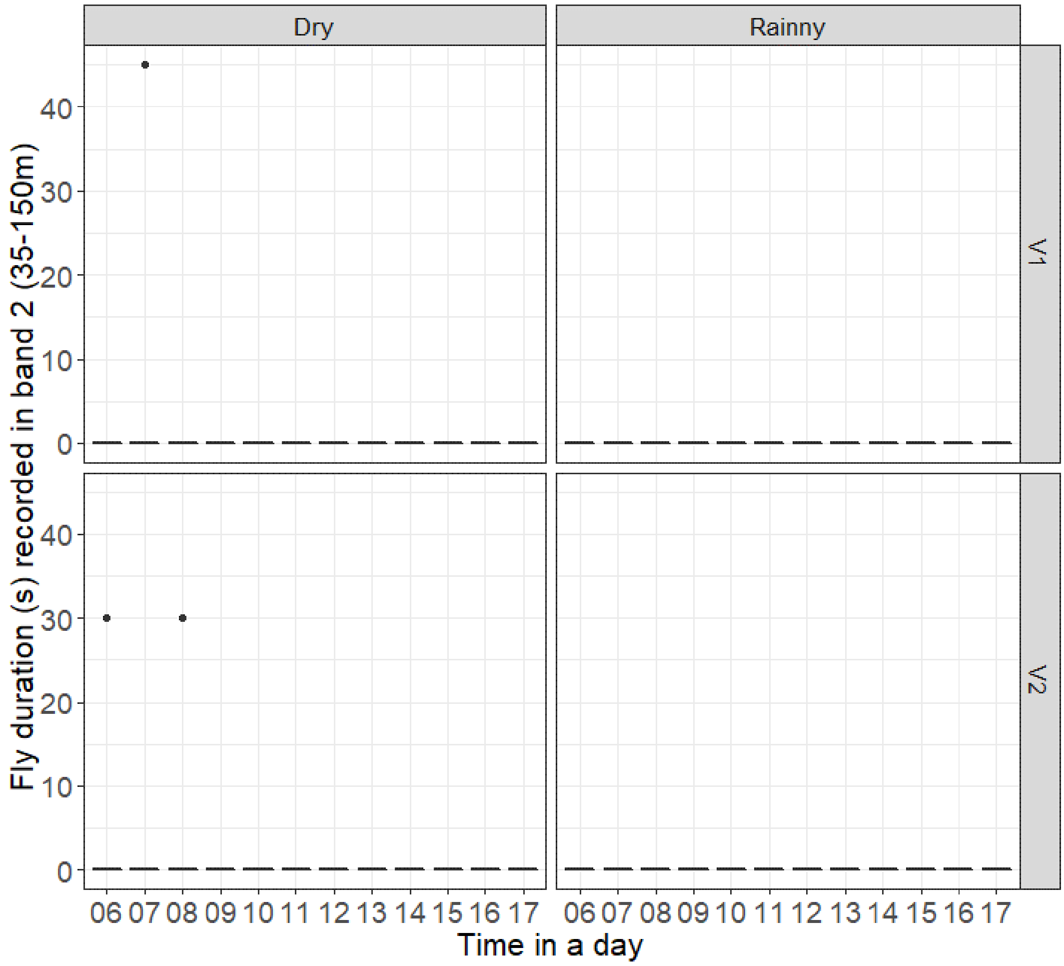


Figure 3-17: Seasonal variabilities in bird activities in band 2 between two seasons

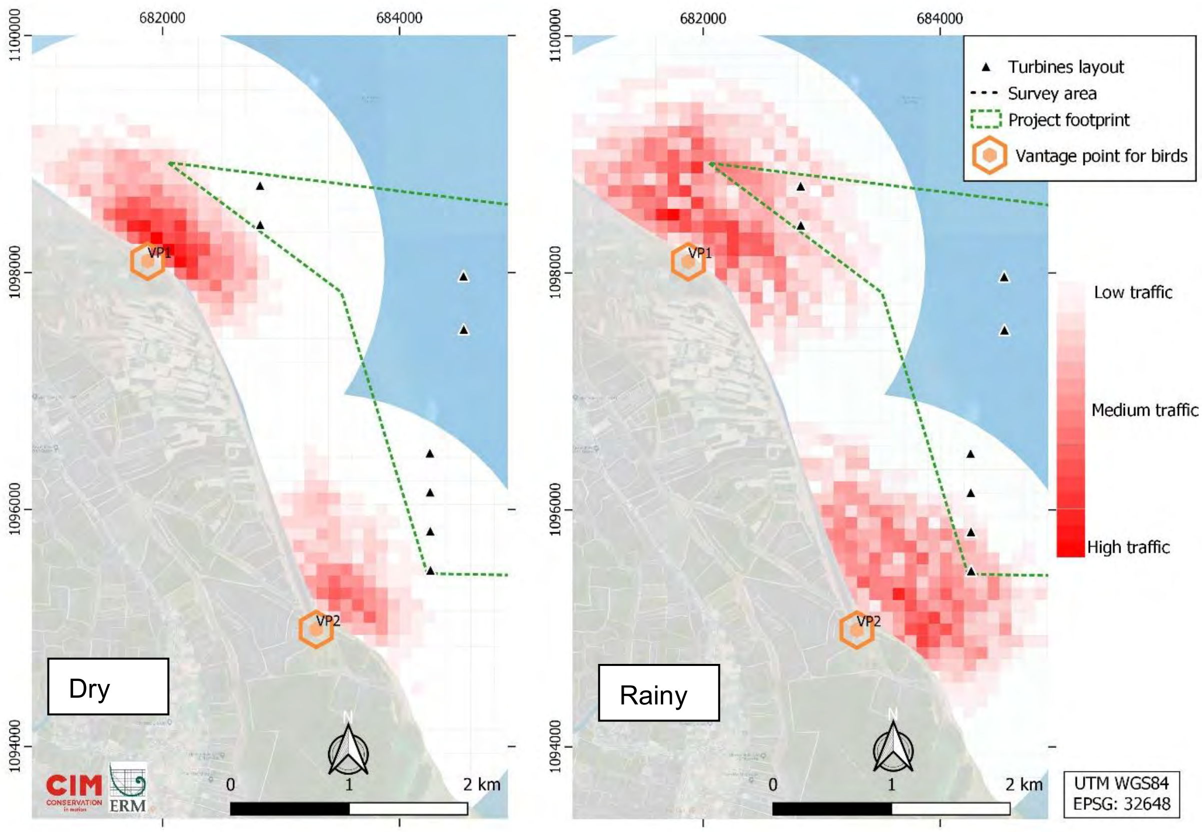


Figure 3-18: Difference in bird traffic in the project area between two seasons

3.3.2 On the sea

Comparing to the previous survey in the rainy season2019, this survey recorded lesser number of seabird sightings (27 on-effort sightings comparing to 34 of rainy season survey). There was a reduction in number of recorded species (06 species comparing to 10 species in rainy season). Estimation for seabird's abundance for the dry season survey also reduced (from 1.61 birds/km^2 in rainy season to 0.7 birds/km^2 in dry season). Overall, the seabird's distribution was more spreading in rainy season, comparing to dry season 2019 (Figure 3-14). In the dry season 2019, seabirds appeared to retreat into a single hotspot in the west site of the project area. This hotspot does not overlap with current wind turbine layout. This finding showed a temporal (or seasonal) variation in bird's distribution and abundance in the project area.

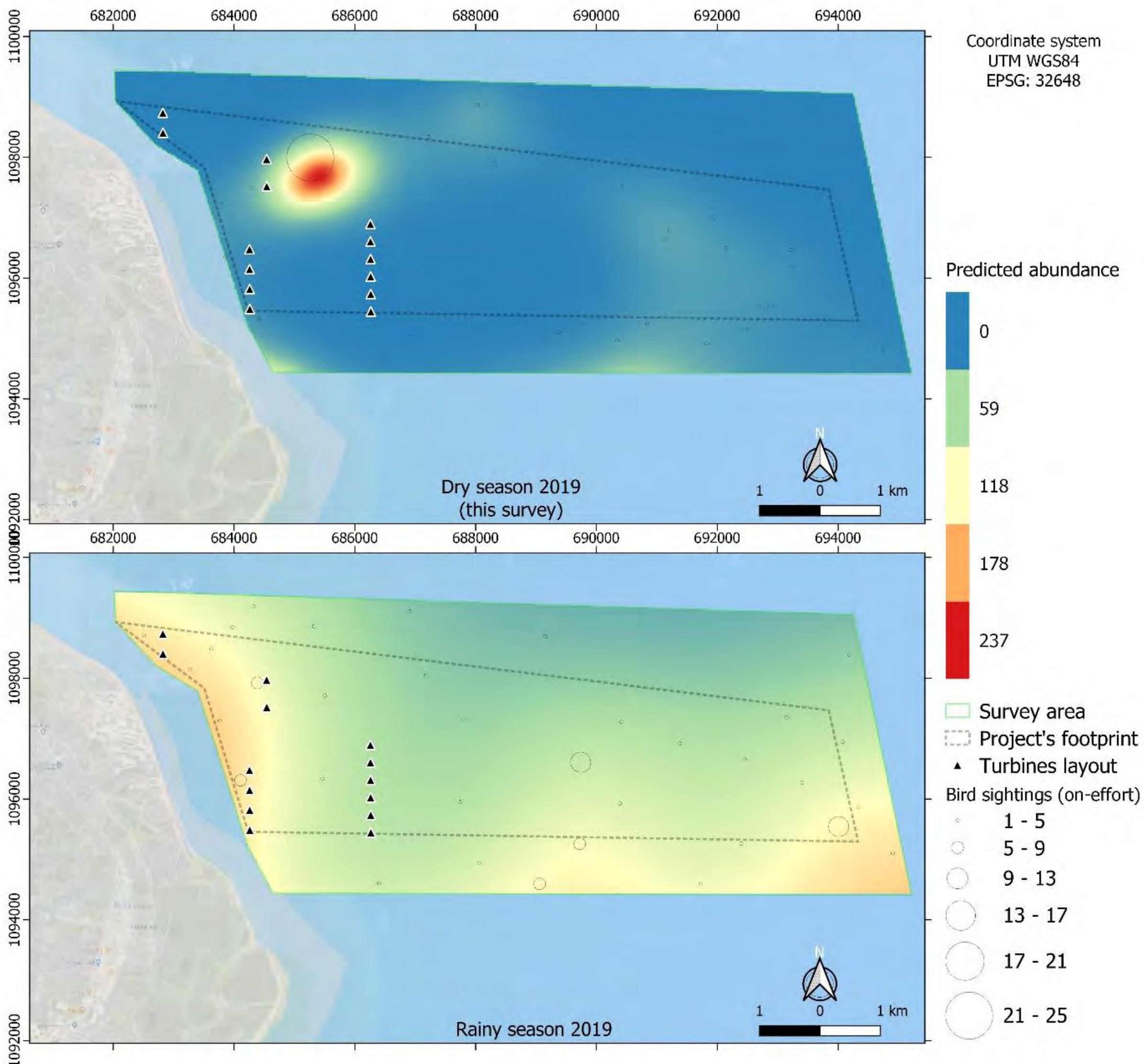


Figure 3-19 Temporal variation in bird's distribution and abundance in the project area

4. CONCLUSIONS AND RECOMMENDATIONS

At this survey mainly targeted birds (and marine megafauna), the following conclusions applied for the concerned taxa only. For other taxa (flora, bats, marine macrobenthos), information can be found in the rainy season 2019 report.

4.1 Conclusions draw from current data

Vantage point survey in dry season 2019 recorded fair amount of bird traffics in the coastal area of Thanh Hai Windfarm project. Few flights in band 2 (in which the collision risk needs to be considered) were observed during this survey. Species that flew in band 2 were Common Tern, Caspian Tern and Little Egret. There were spatiotemporal variations in birds traffics. Bird traffic were busier in V1 (North of the site) than in V2 (South of the site). In both site, bird traffics were busy for the whole day. Three IUCN's NT species, the Oriental Darter *Anhinga melanogaster,* Black-tailed Godwit *Limosa limosa* and the Eurasian Curlew *Numenius arquata* were recorded in this survey.

Boat-based line transect survey in dry season 2019 recorded 06 species of bird in the whole project area. The Distance modelling suggested average bird density in the survey area in dry season 2019 were relatively low (less than 01 individual/km^2). However, the DSM suggested there were a bird hotspot in the project area, where the bird's density can reach up to 237 individual/km^2. This hotspot was located 01km away from the nearest turbine cluster.

Data from two-seasons surveys suggested most bird (the most concerned faunal group) flew under 35m, which were below the blade's high of most commercial windfarm turbines. There was no bird flew in band 2 in rainy season 2019, while very few were observed flew in this band in the following-up dry season survey. The combination results of two continuous vantage point survey (with total 72 hours allocated in two seasons) suggested the number of birds suffer from the collision risk were too low for fitting a statistical collision risk model (Band 2012). The combination of two boat-based line transect surveys recorded no bird flew higher than 35m, which also support the vantage point survey's results. Although boat-based survey with DISTANCE sampling protocols had been conducted for 02 seasons in 2019, no marine megafauna was detected in the project area. This result suggested the very low density of those species in concerned area and implied the project's impacts on marine megafauna should be low.

There was spatiotemporal variation in bird abundance, distribution and activities between dry and rainy season. In dry season, bird appeared to be more spatially concentrated in the coast and one offshore hotspot of the project's area. Such variation should be considered in designing and implementing further management plans.

4.2 Potential impacts

Although few birds were observed flying higher than 35m (suggesting a low collision risk with wind turbines), there were a relatively heavy bird traffic near turbine locations. Planned wind turbines were located about 1km from a bird hotspot identified by dry season boat-based survey. Therefore, the project can potentially cause disturbance and dislocation to birds during its construction and operation phases.

4.3 Potential mitigation measures

The spatiotemporal variations in bird diversity, distribution, abundance and activities in the project area requires adaptive mitigation measures. As patterns on bird distribution, abundance and activities changes, mitigating measure that works on rainy season may become ineffective in the dry season and vice versa. Therefore, the long-term monitoring scheme is recommended for this project area to better inform adaptive mitigation plans. Based on the available literatures, deterrent approaches (reflective materials, horn, loudspeaker, air gun) can be considered to drive the bird away from the wind turbines to reduce collision risk (which apparently low in this area). However, the disturbance effect that the project can potentially cause cannot be easily mitigated. Therefore, compensating the potential impacts of the project can be achieve by supporting local biodiversity conservation efforts. The developers can consider financially supporting the nearest projected area, which were Thanh Phu Nature Reserve, as a potential mitigation measure.

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APPENDIX A PHOTOGRAPHS OF BIRDS RECORDED DURING VANTAGE POINT SURVEY

Bar-tailed Godwit *Limosa lapponica*

Common Greenshank *Tringa nebularia*

Common Sandpiper *Actitis hypoleucos*

Eurasian Curlew *Numenius arquata*

Pacific Golden Plover *Pluvialis fulva*

Lesser Sandplover *Charadrius mongolus*

Greater Sandplover *Charadrius leschenaultii*

Caspian Tern *Hydroprogne caspia*

Gull-billed Tern *Gelochelidon nilotica*

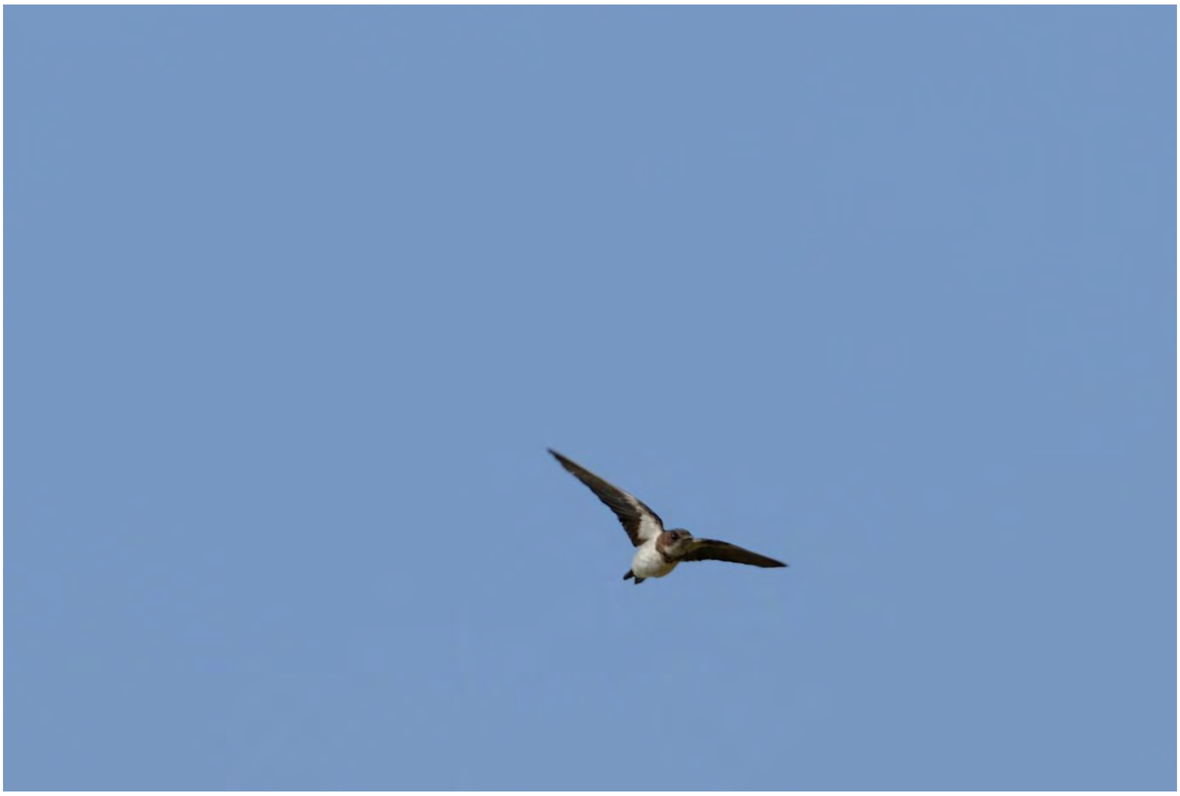
Common Tern (juvenile) *Sterna hirundo*

Whimbrel *Numenius phaeopus*

Little Egret *Egretta garzetta*

Oriental Darter *Anhinga melanogaster*

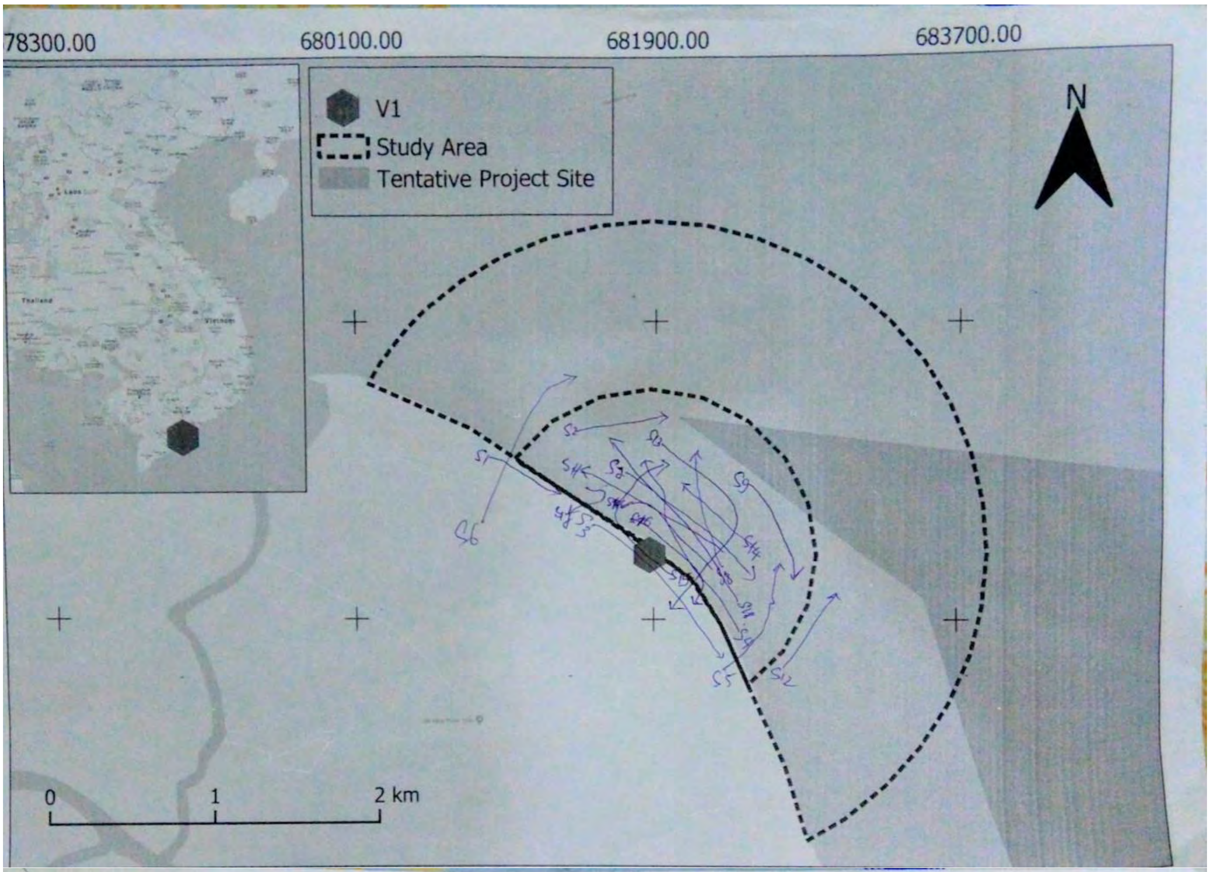
Asian Green Bee-eater *Merops orientalis*

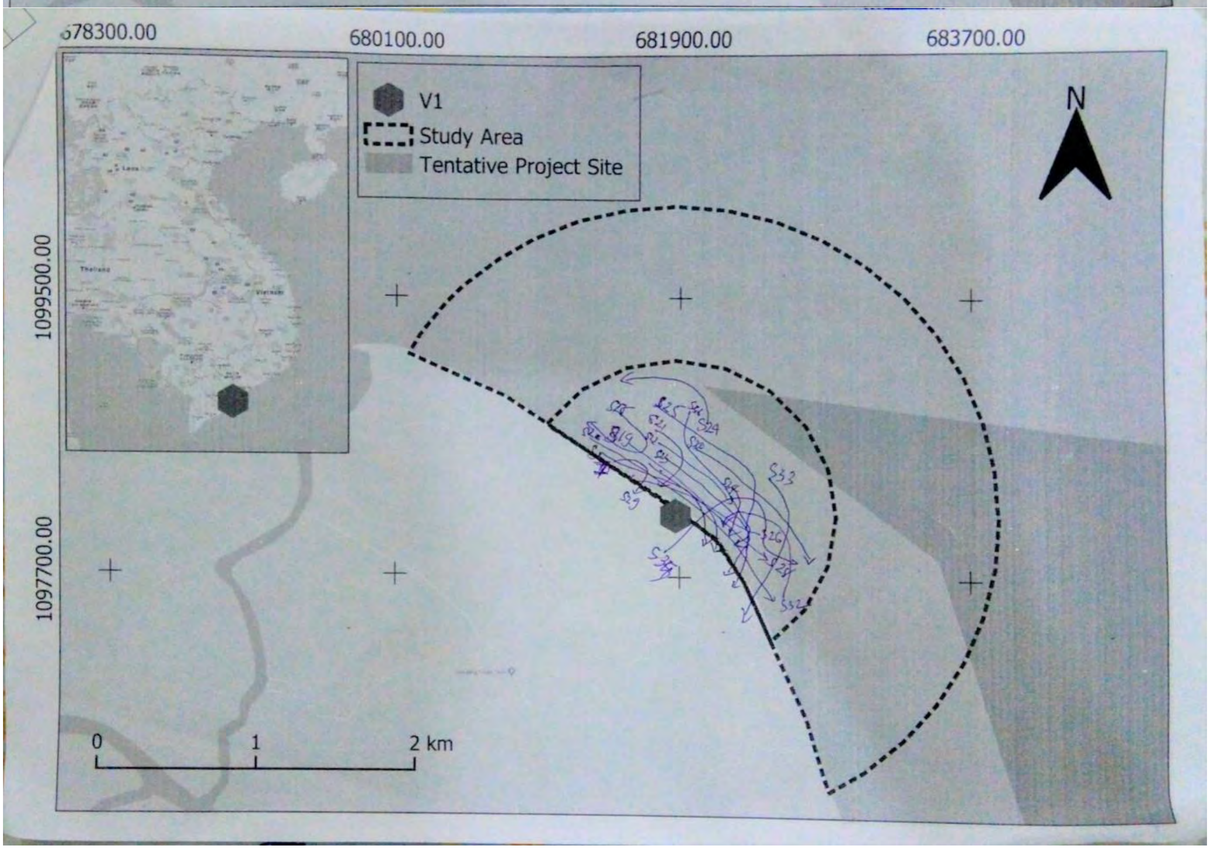


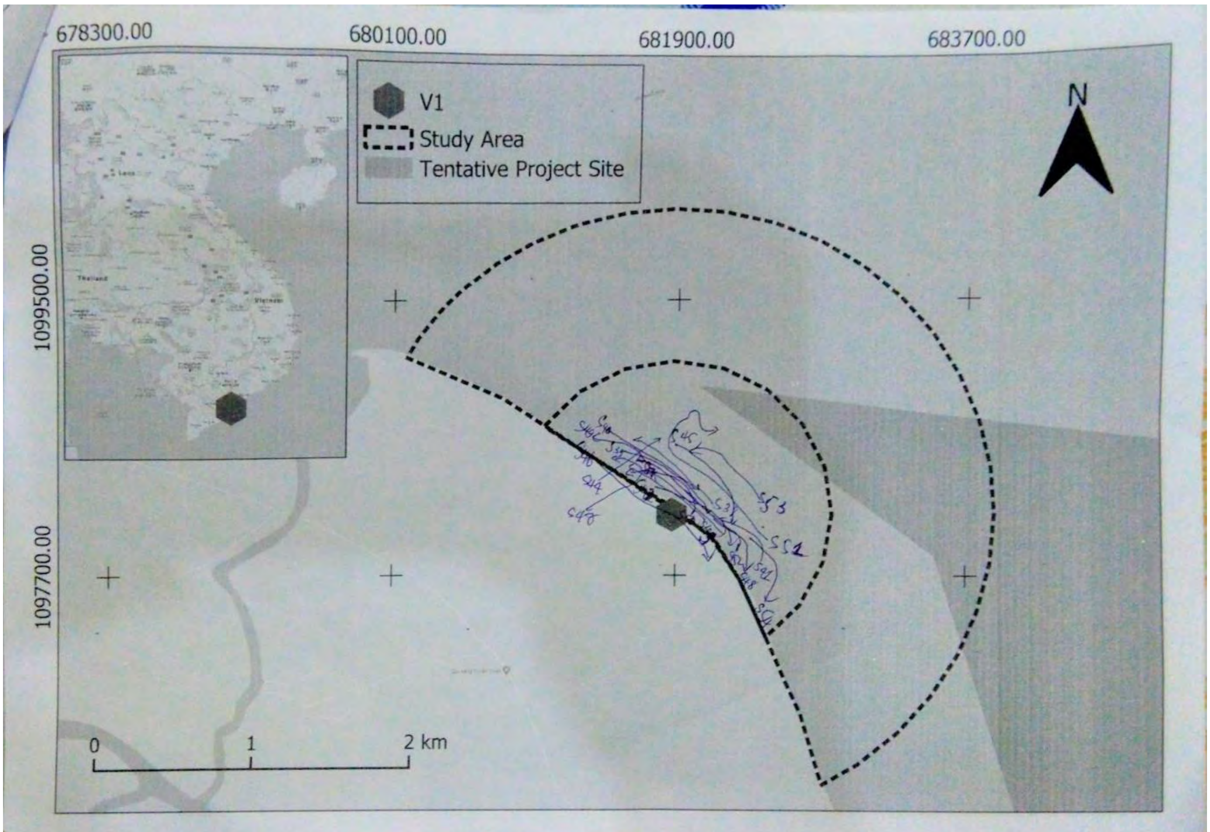
Barn Swallow *Hirundo rustica*

APPENDIX B RAW DATASHEET FROM VANTAGE POINT SURVEY

V1, 19/12/2019



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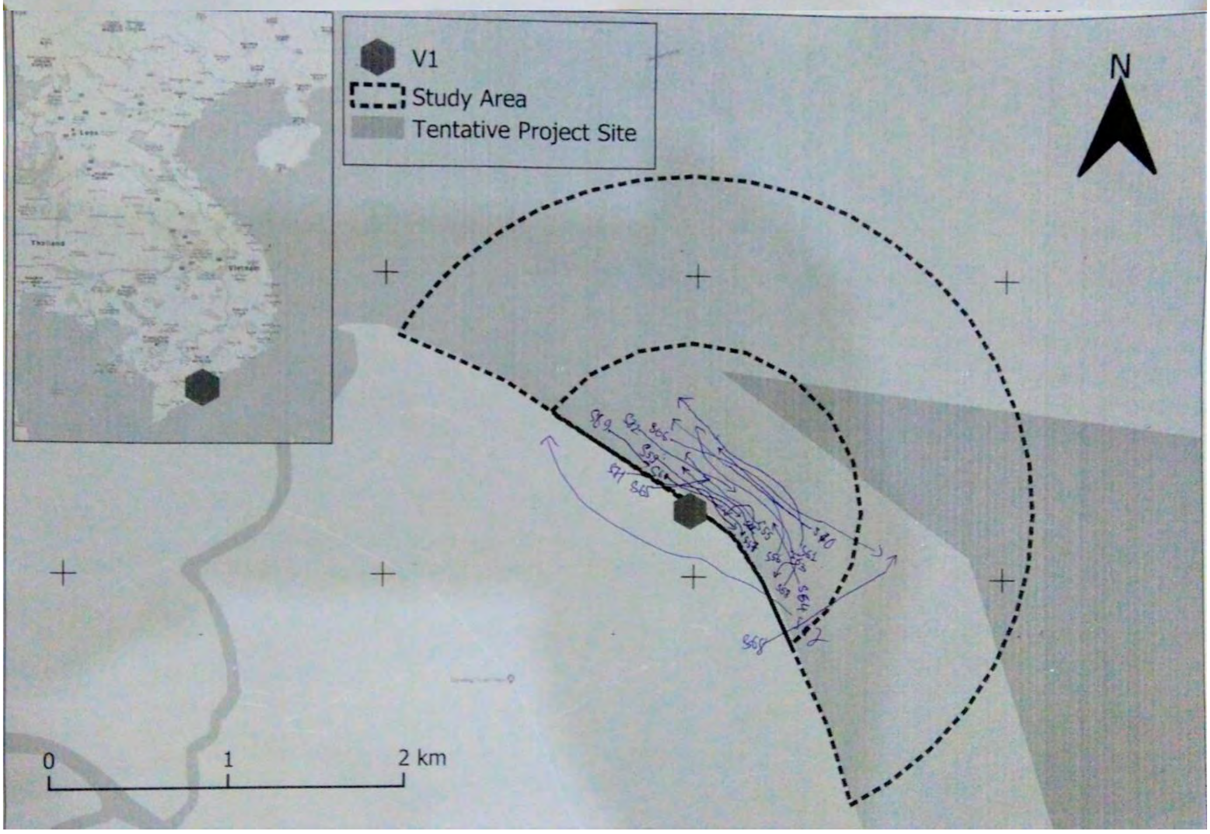
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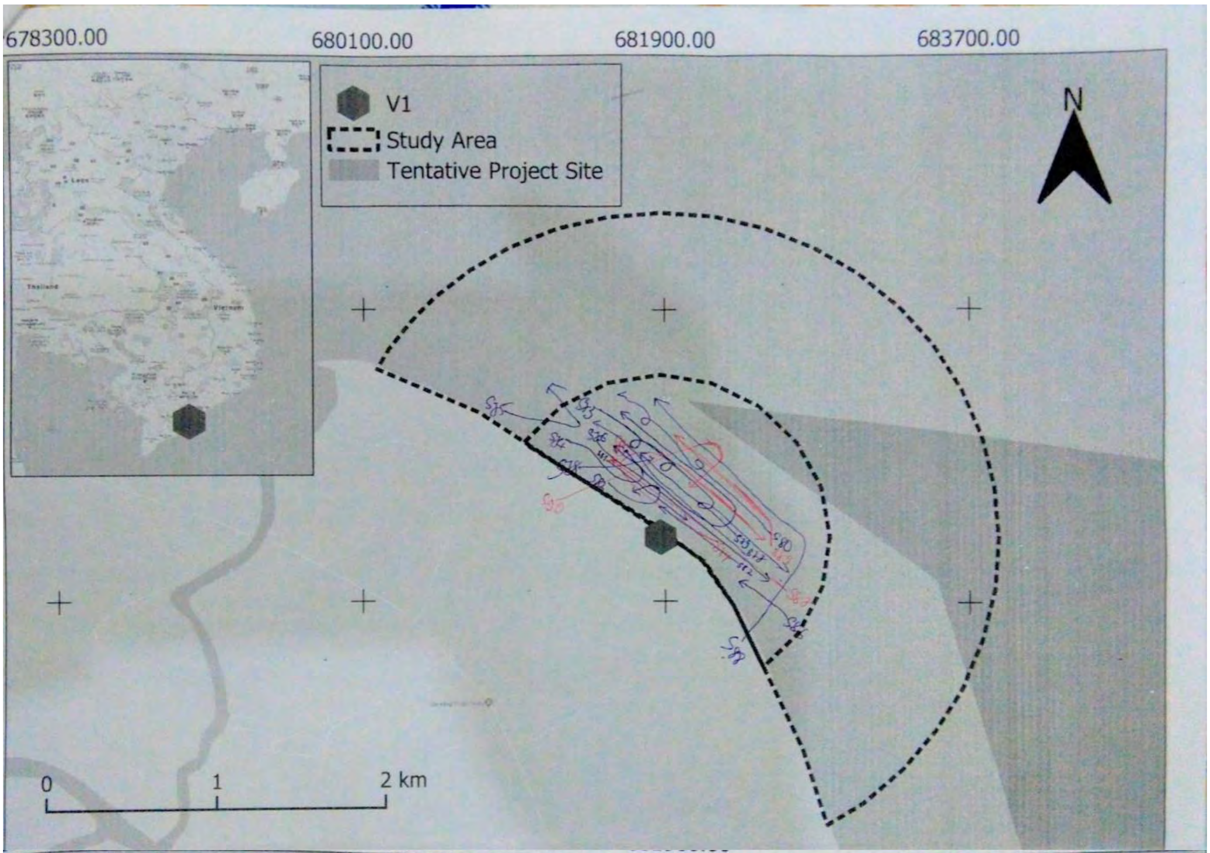
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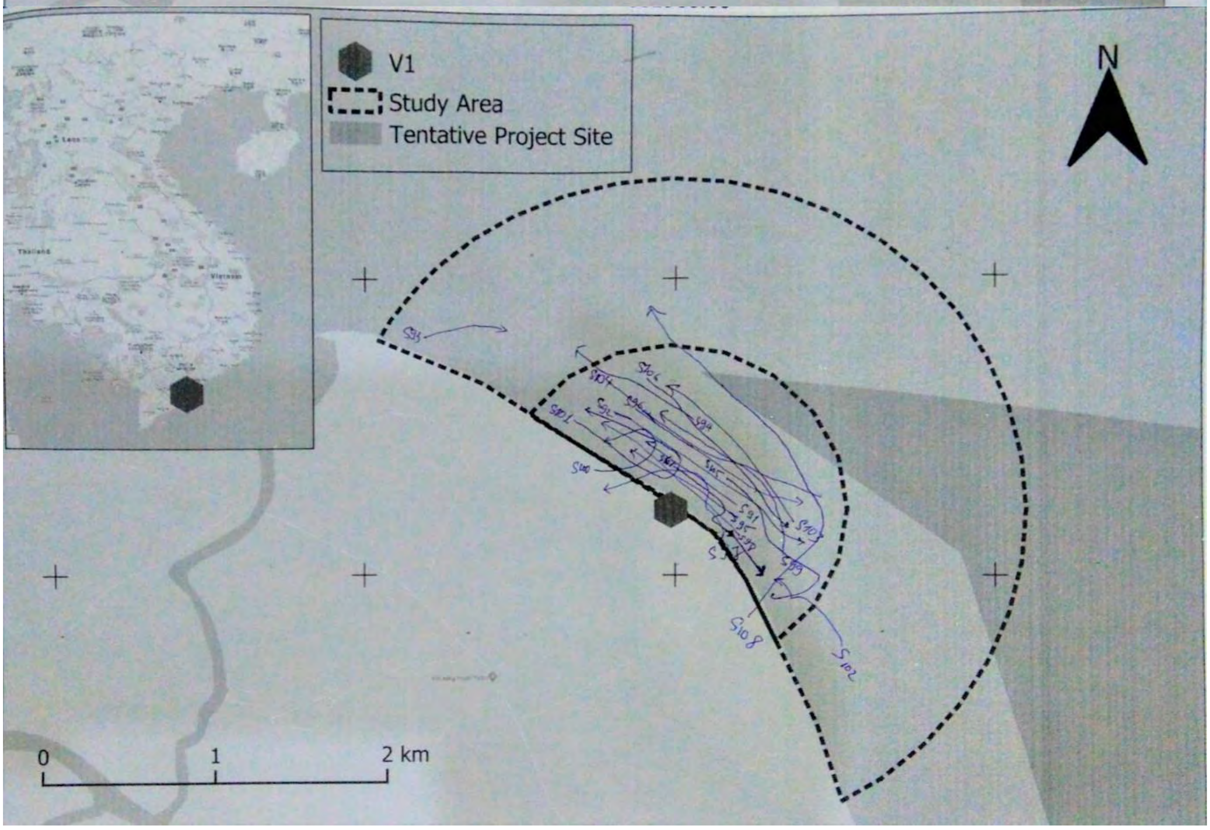
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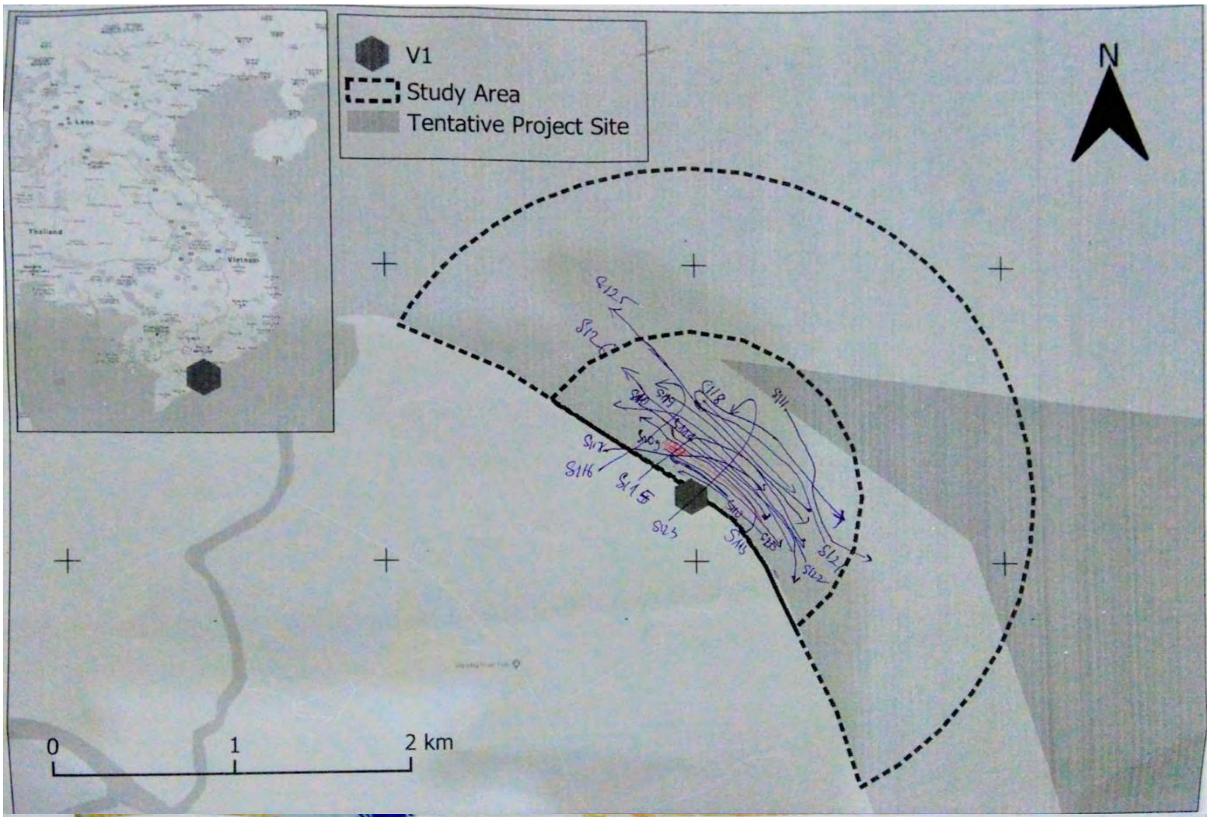
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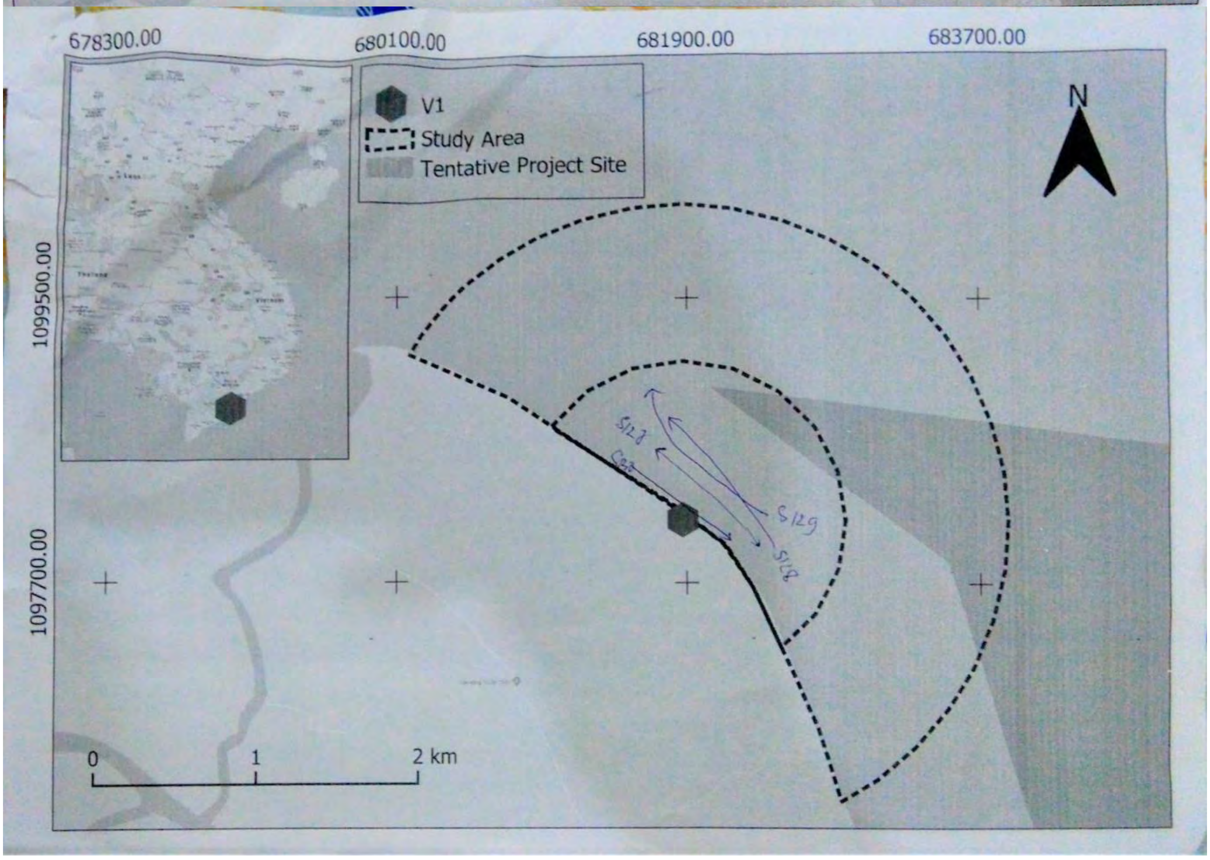
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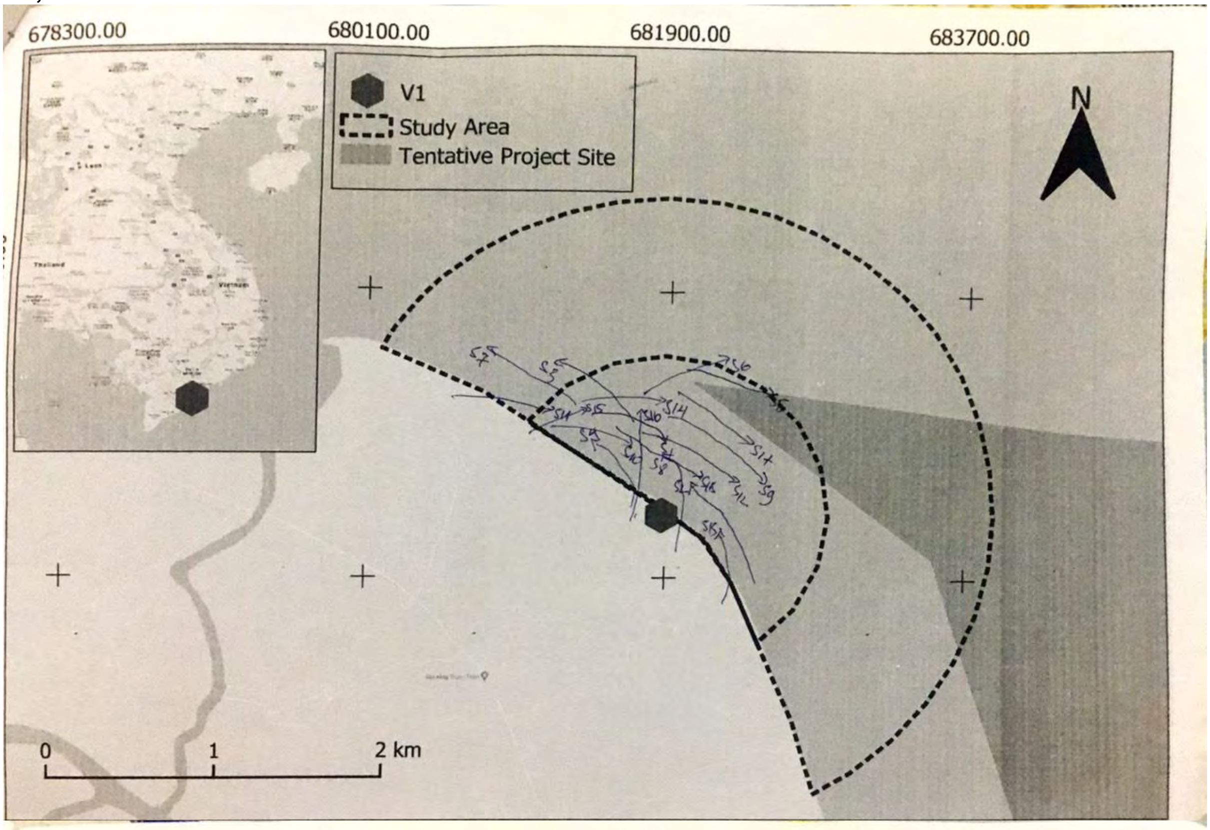
V1, 20/12/2019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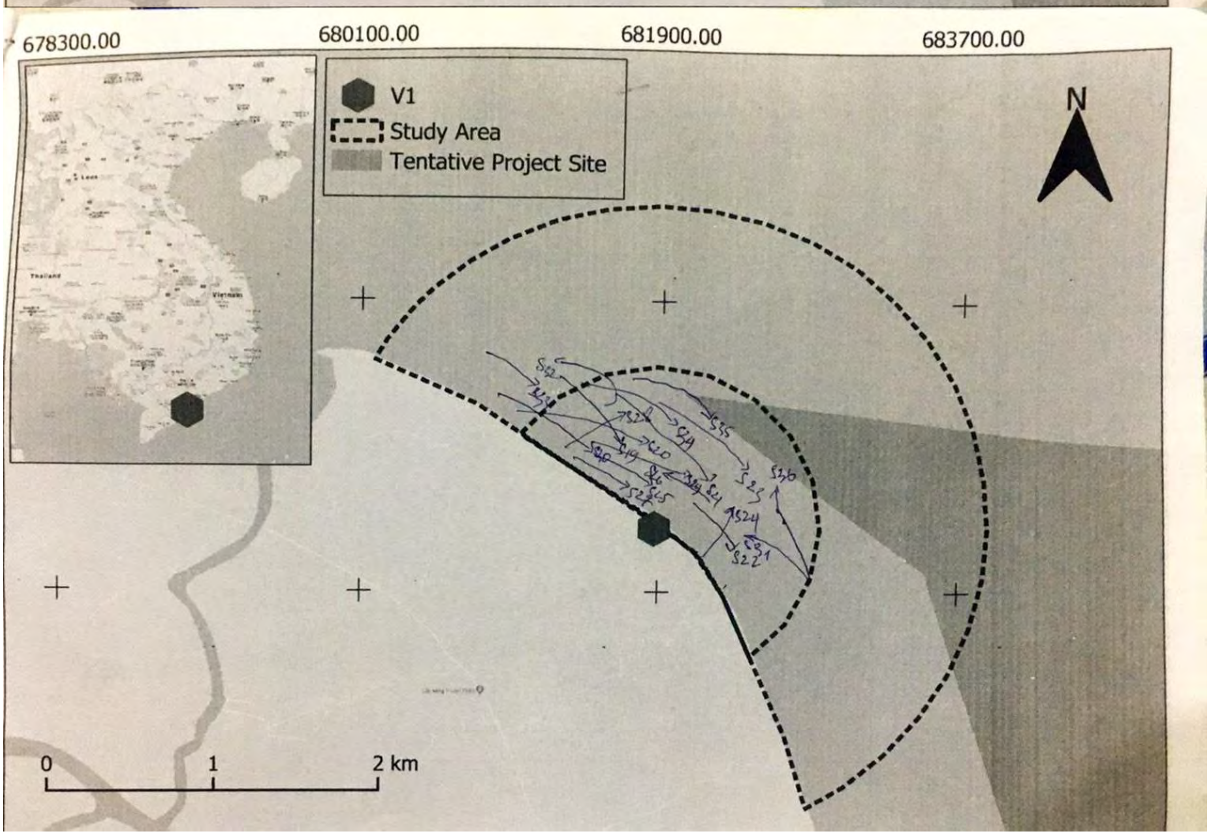
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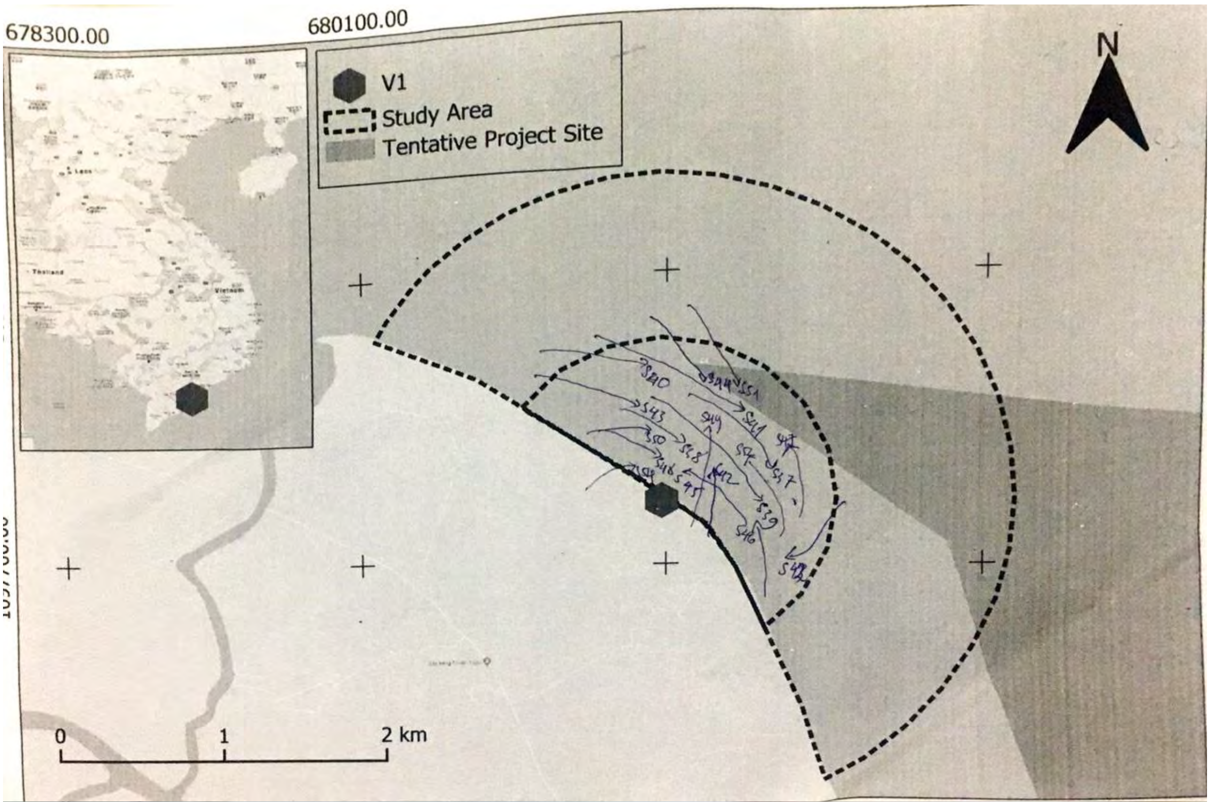
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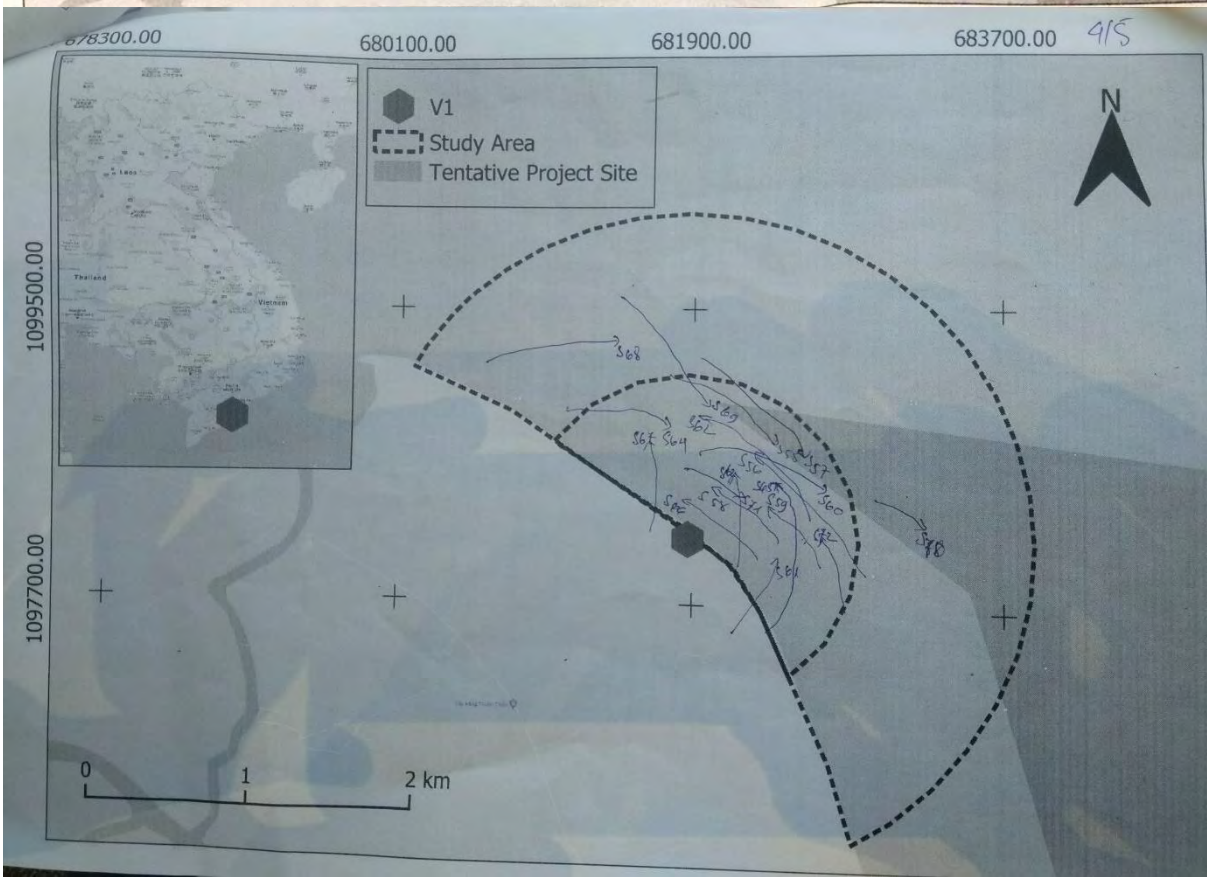
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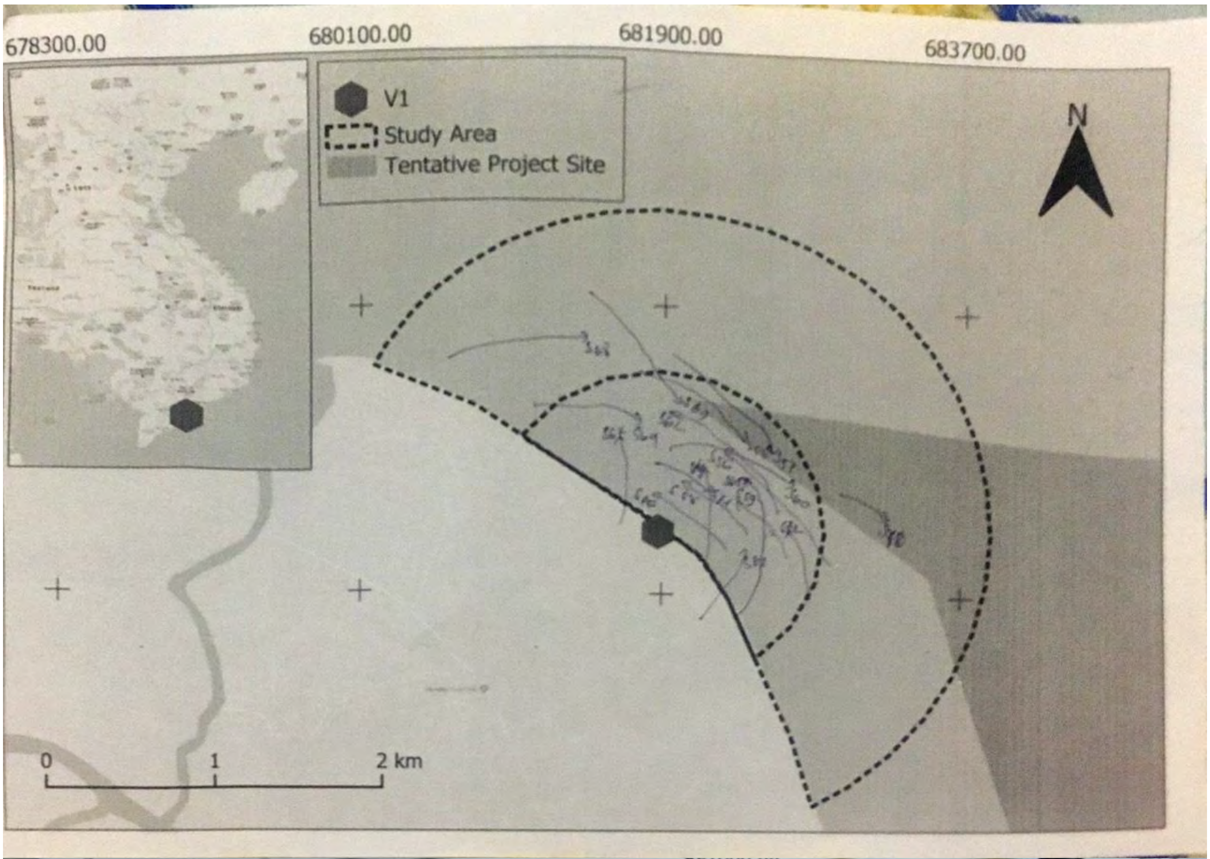
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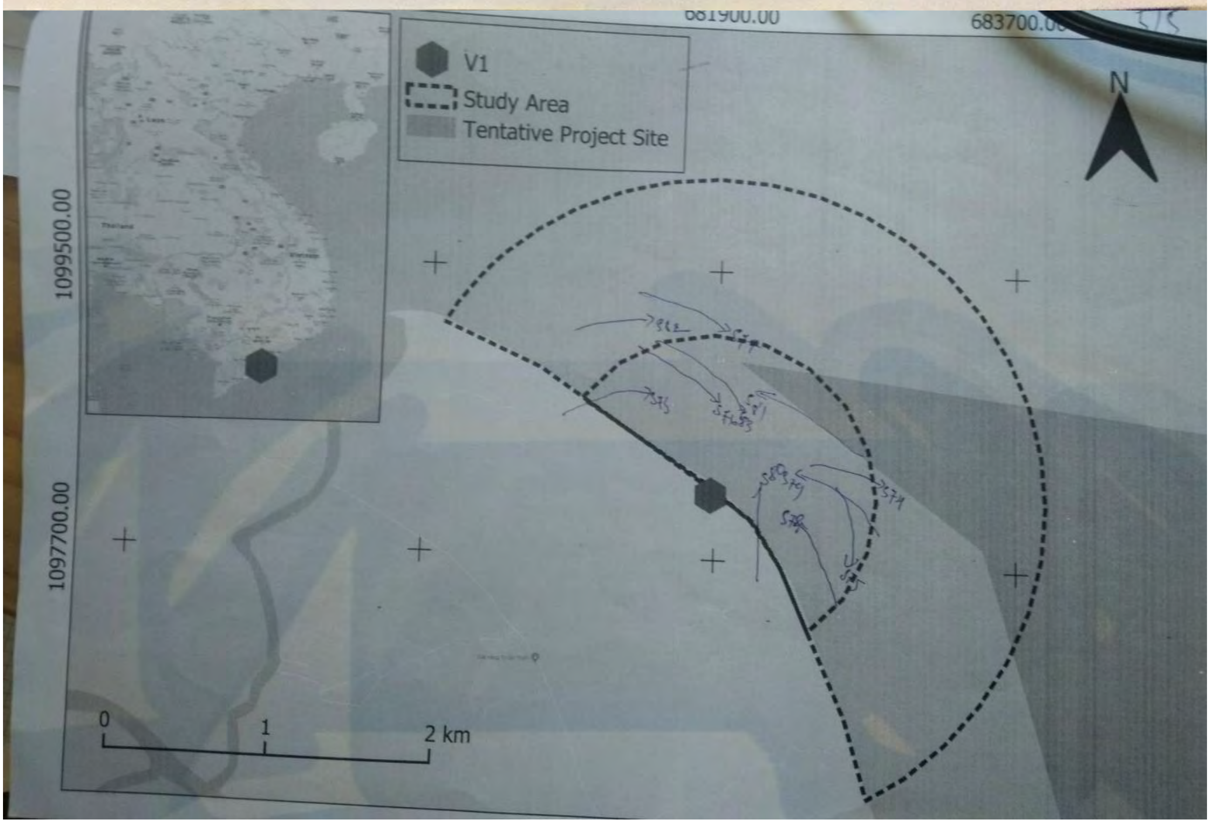
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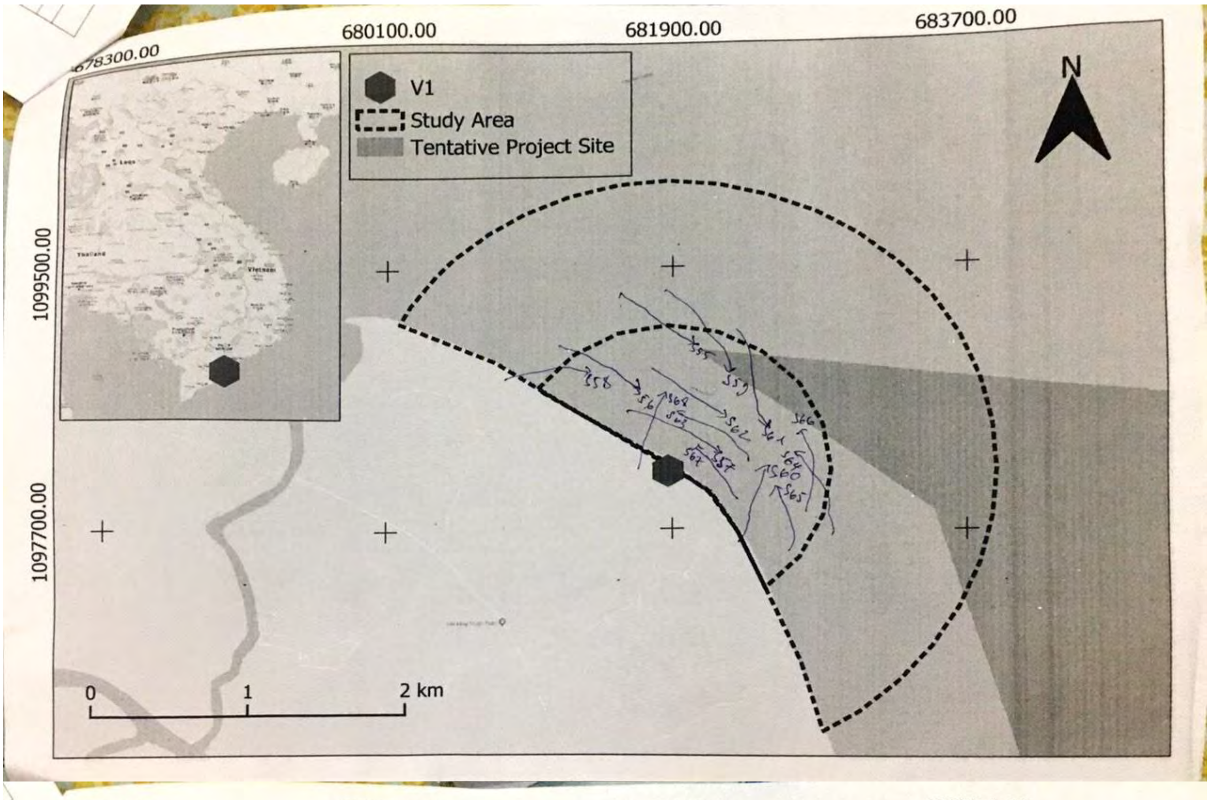
V1, 21/12/2019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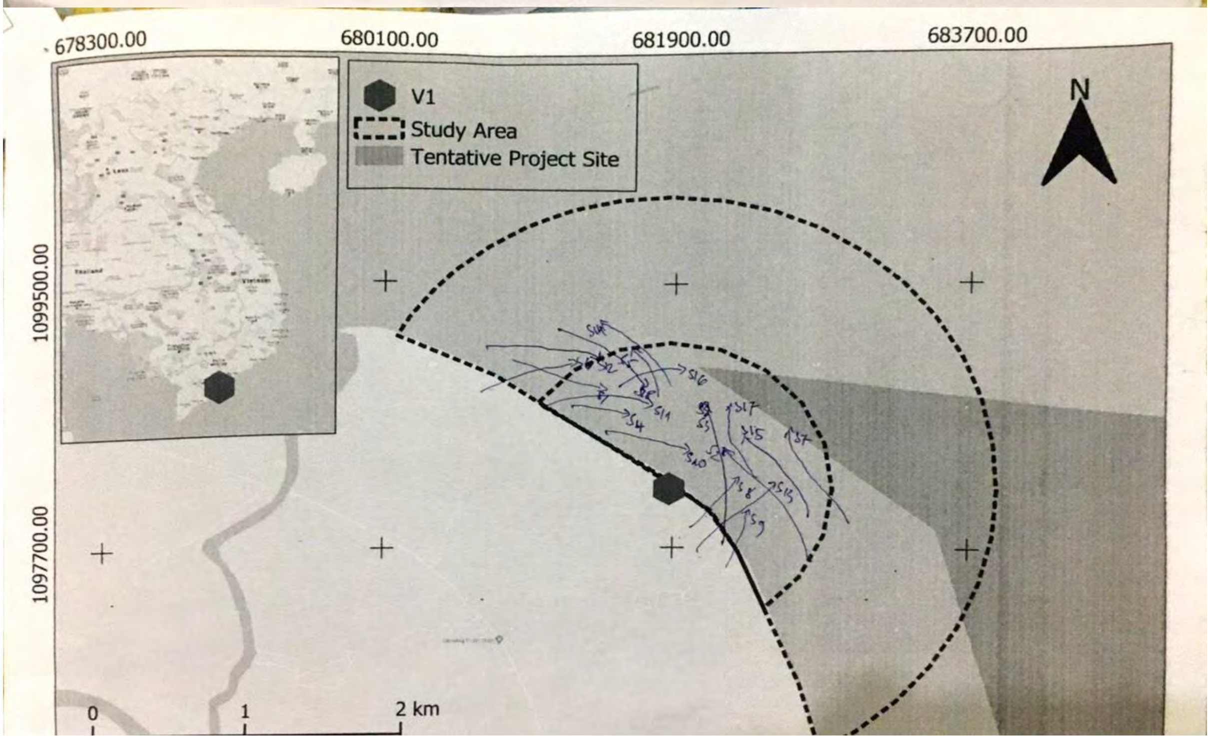
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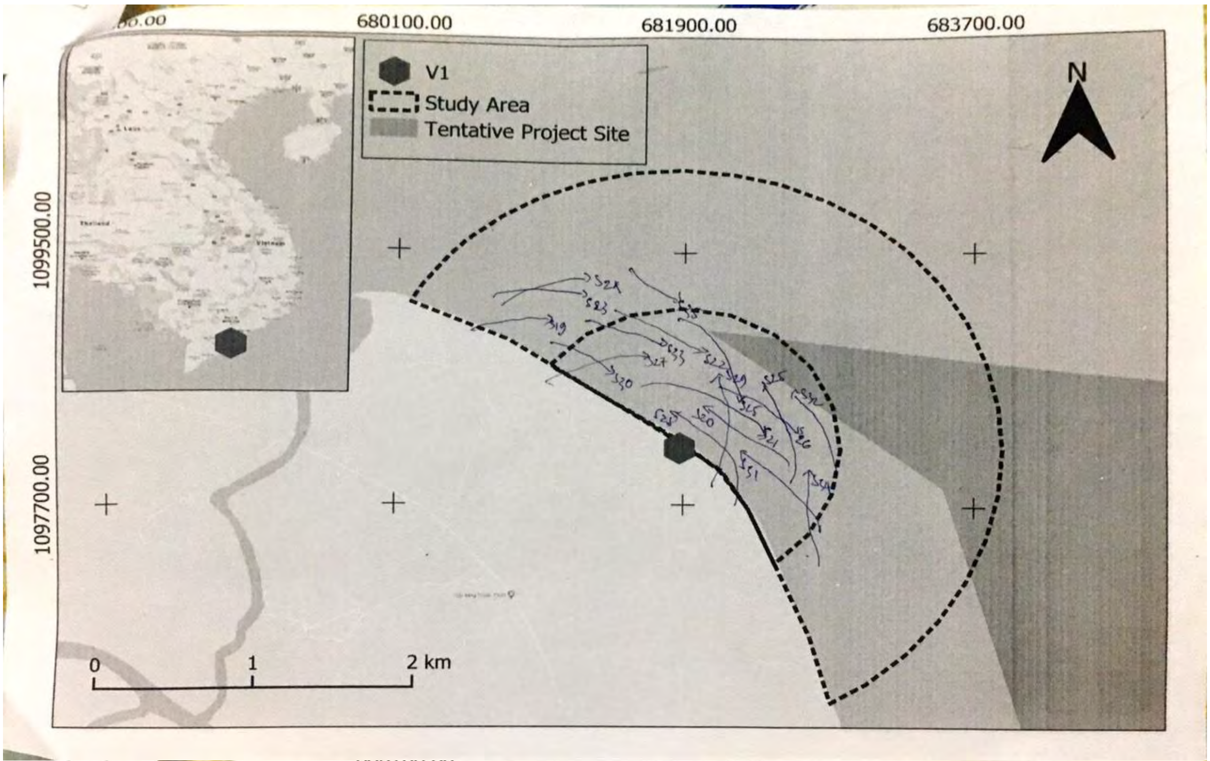
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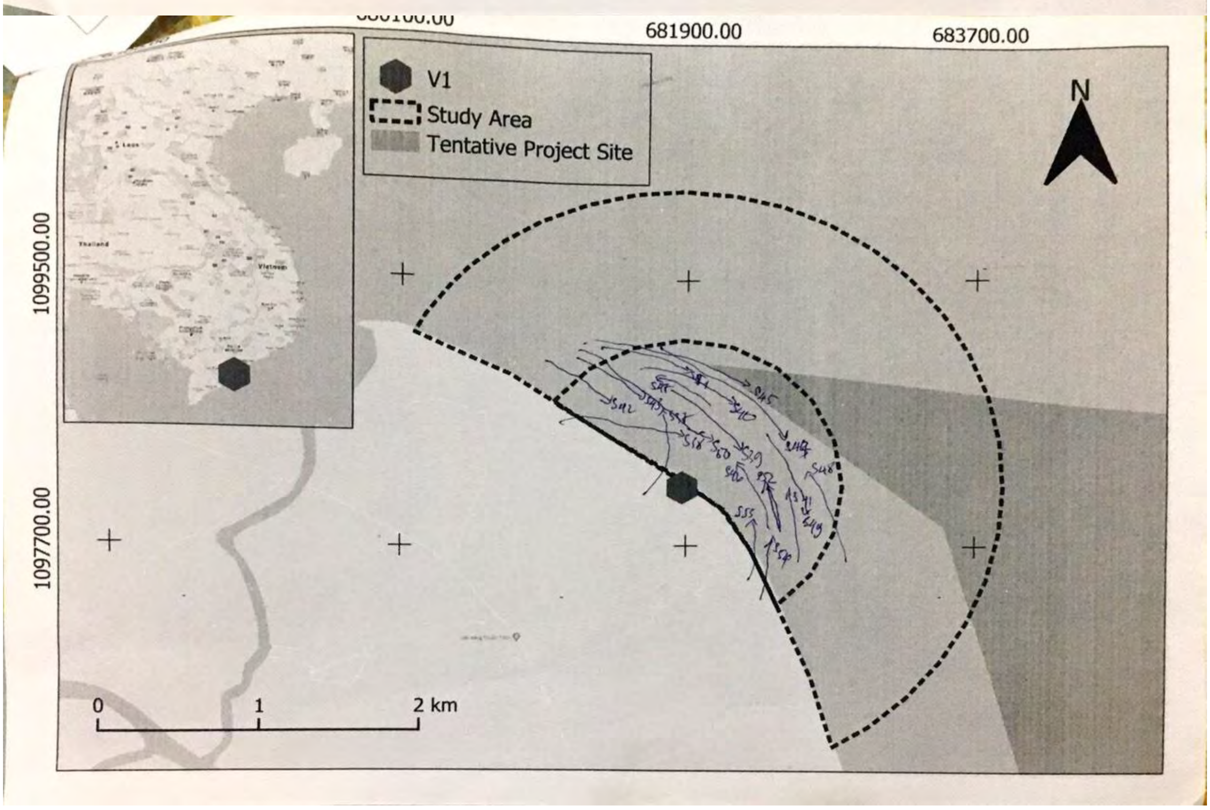
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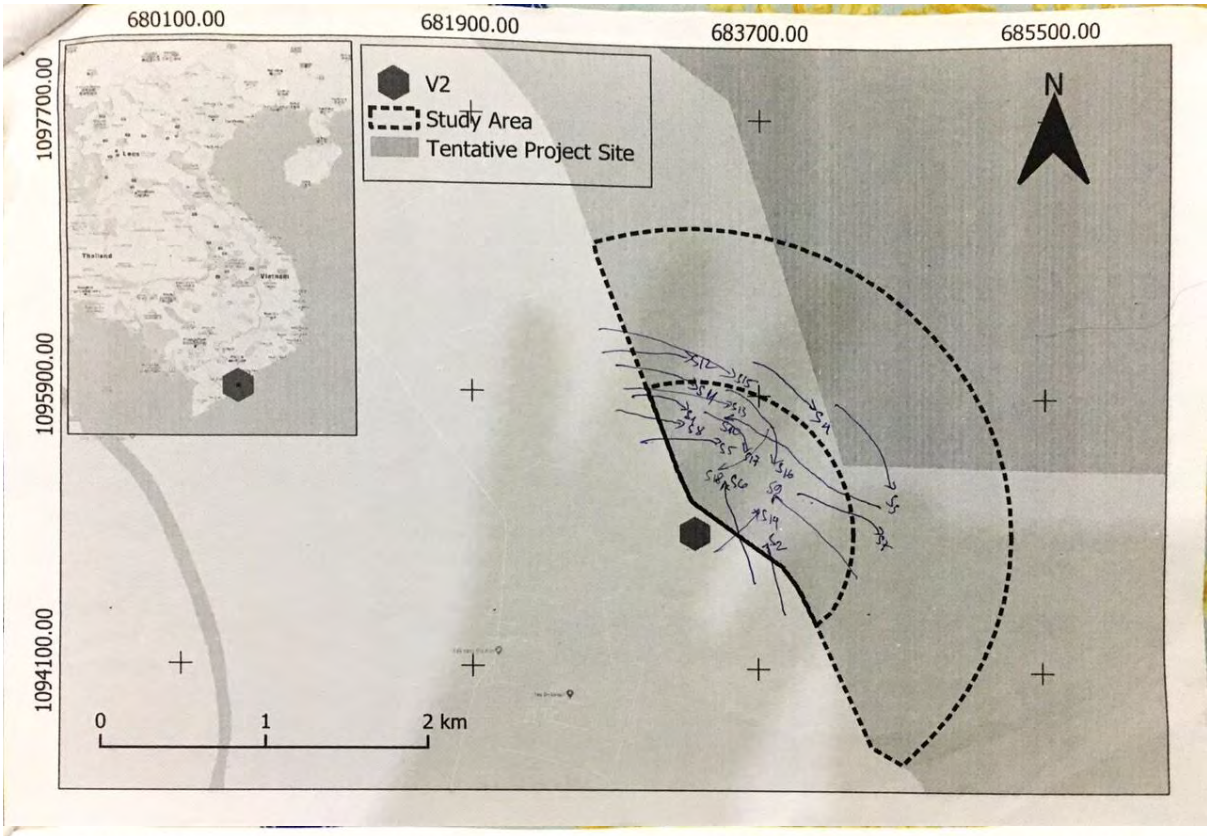
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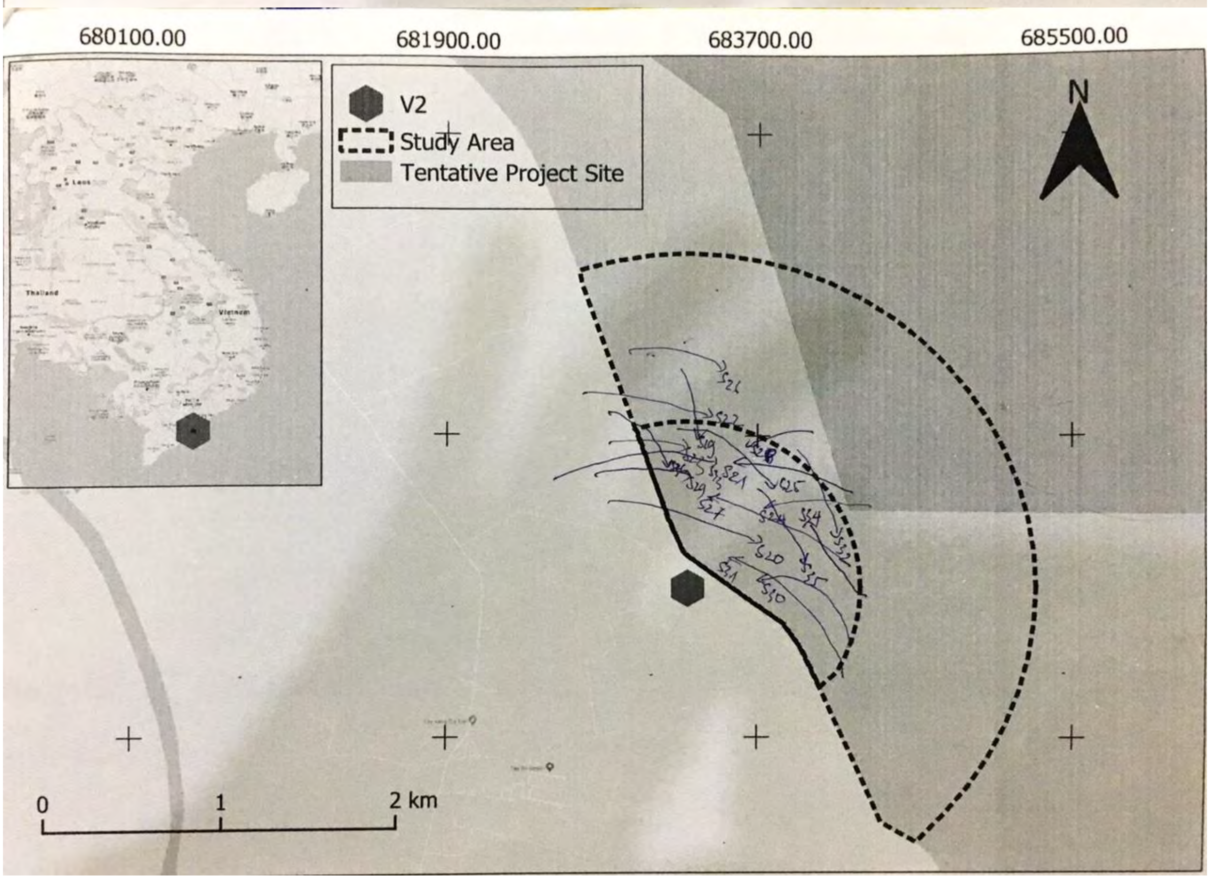
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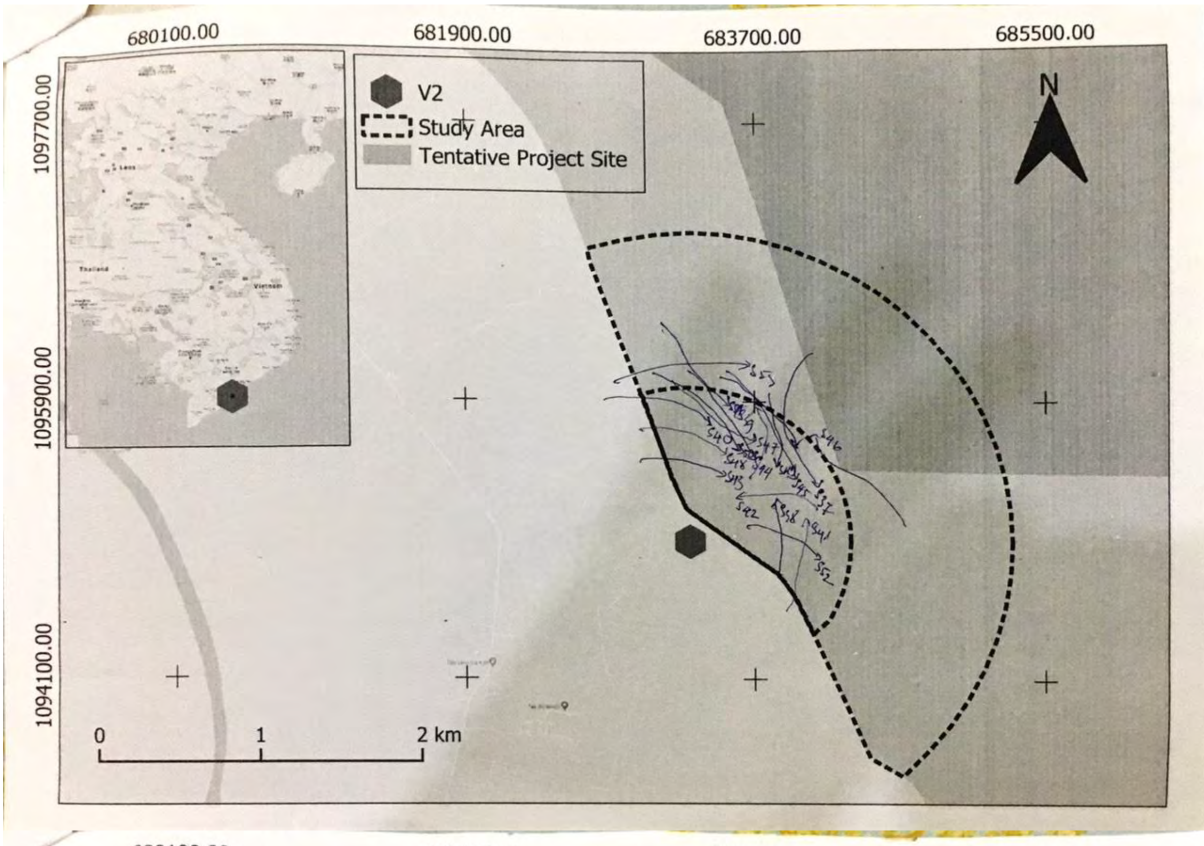
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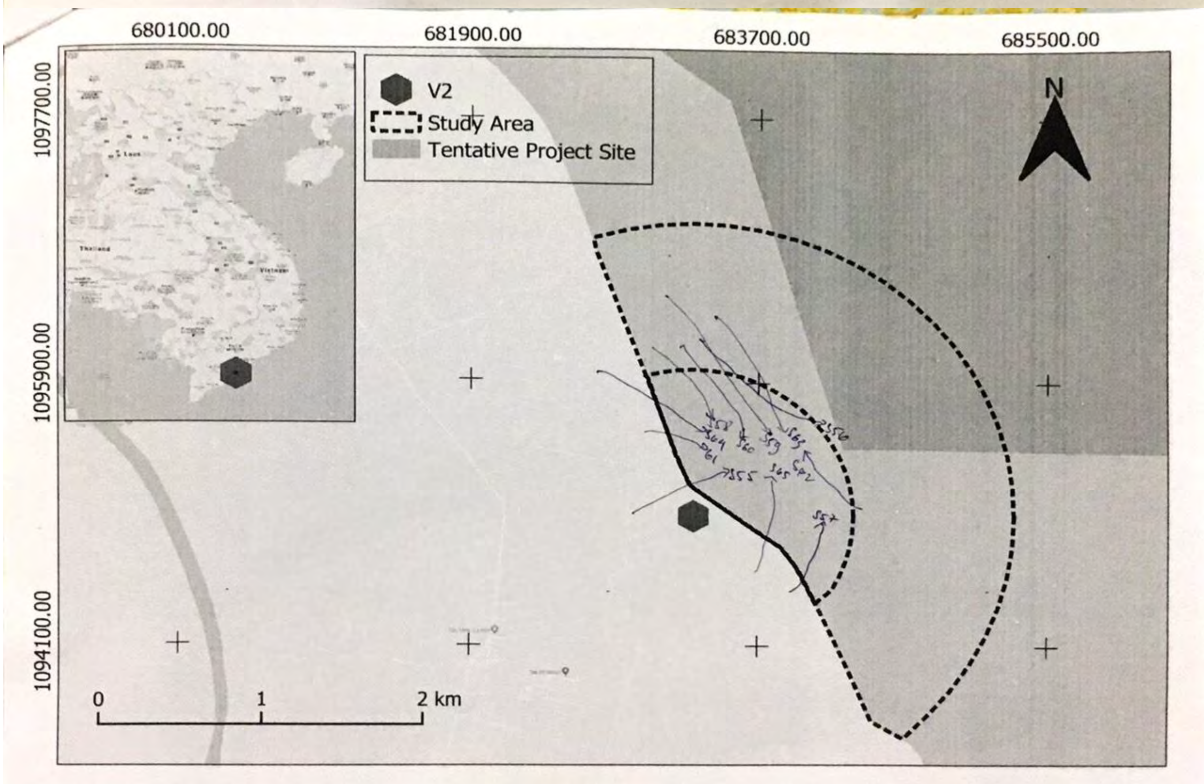
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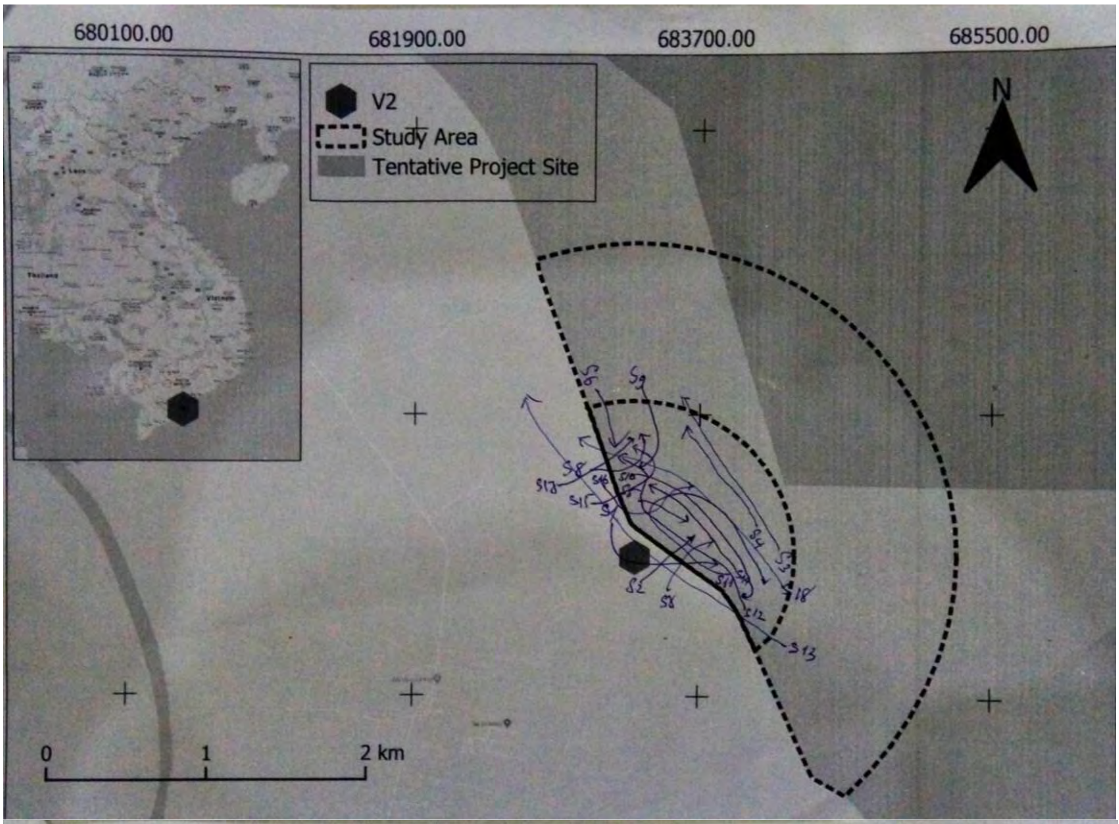
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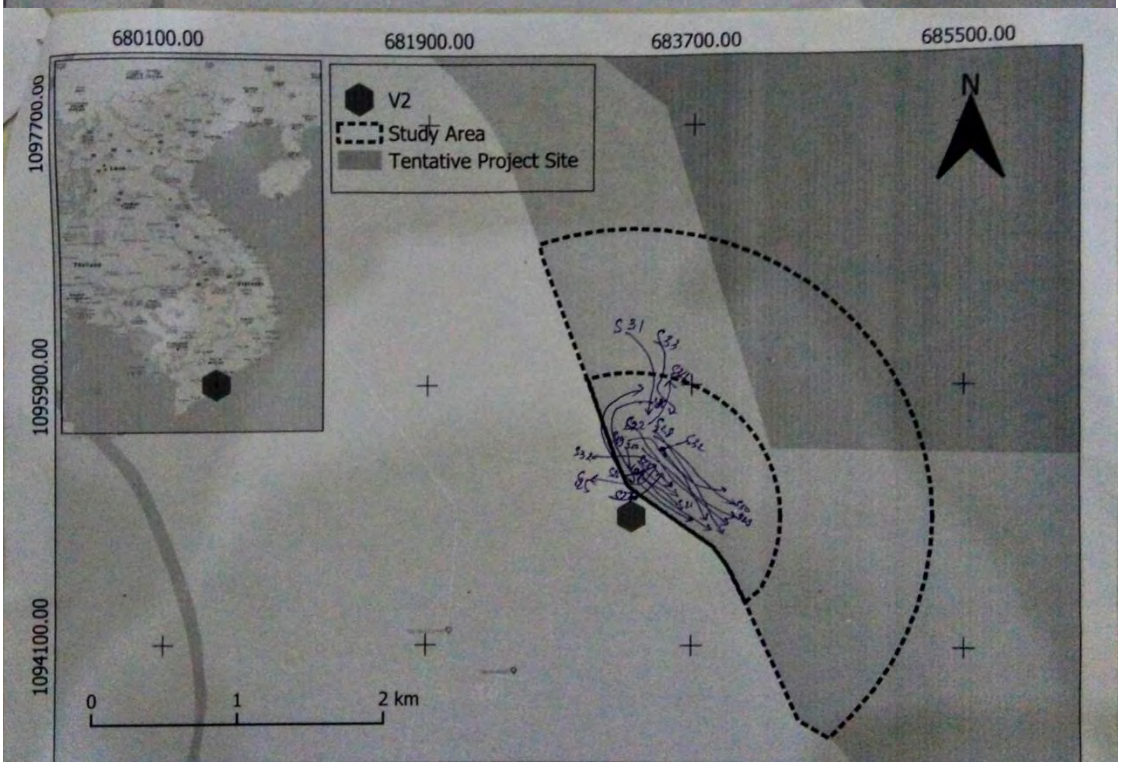
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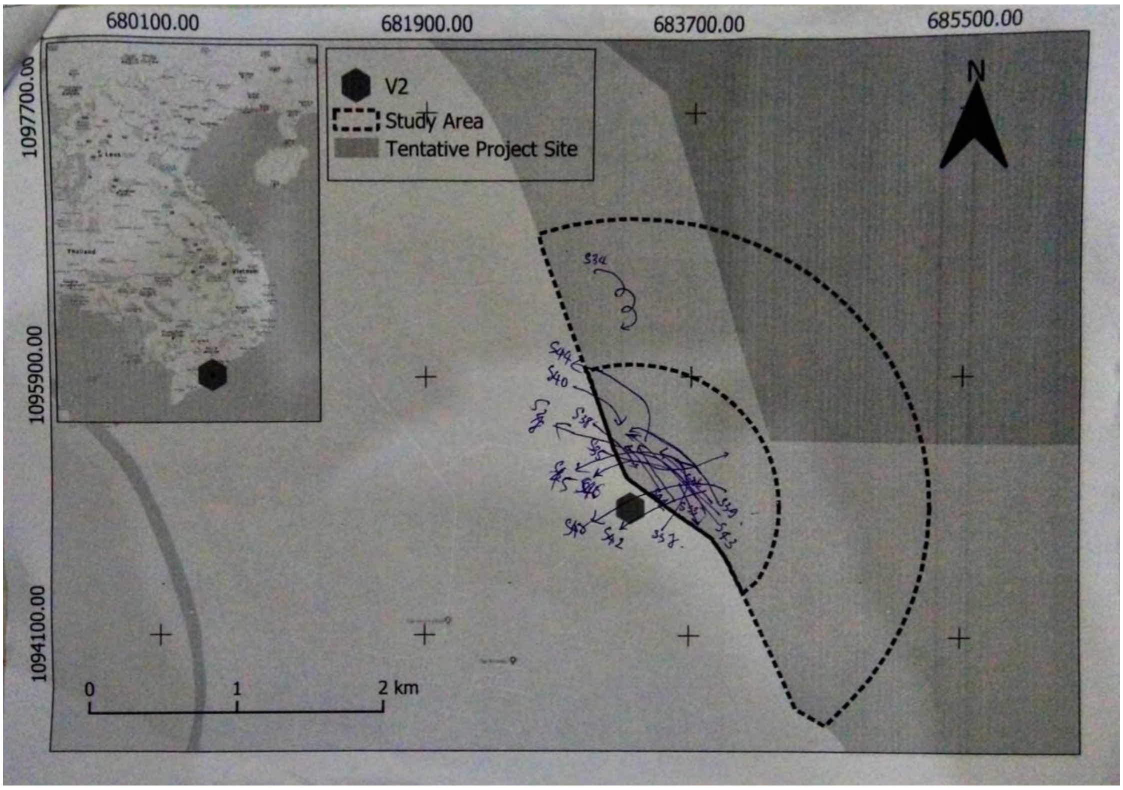
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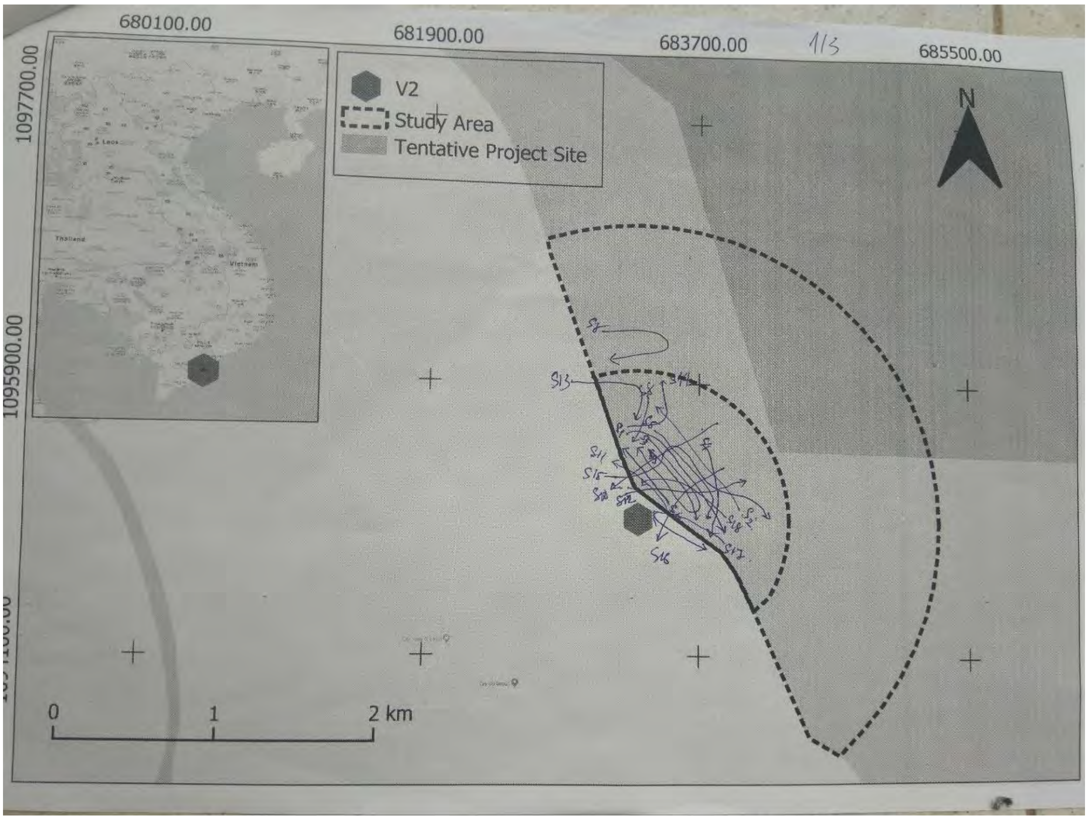
V2, 21/12/2019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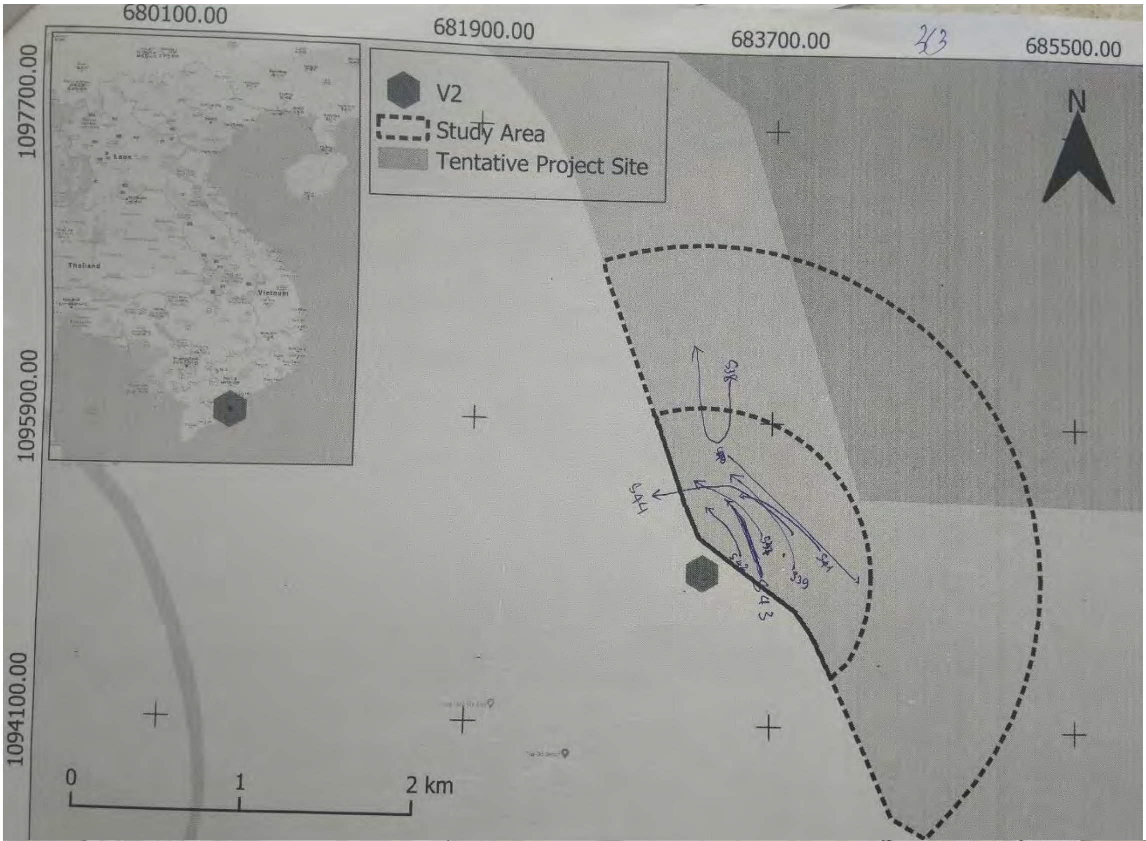
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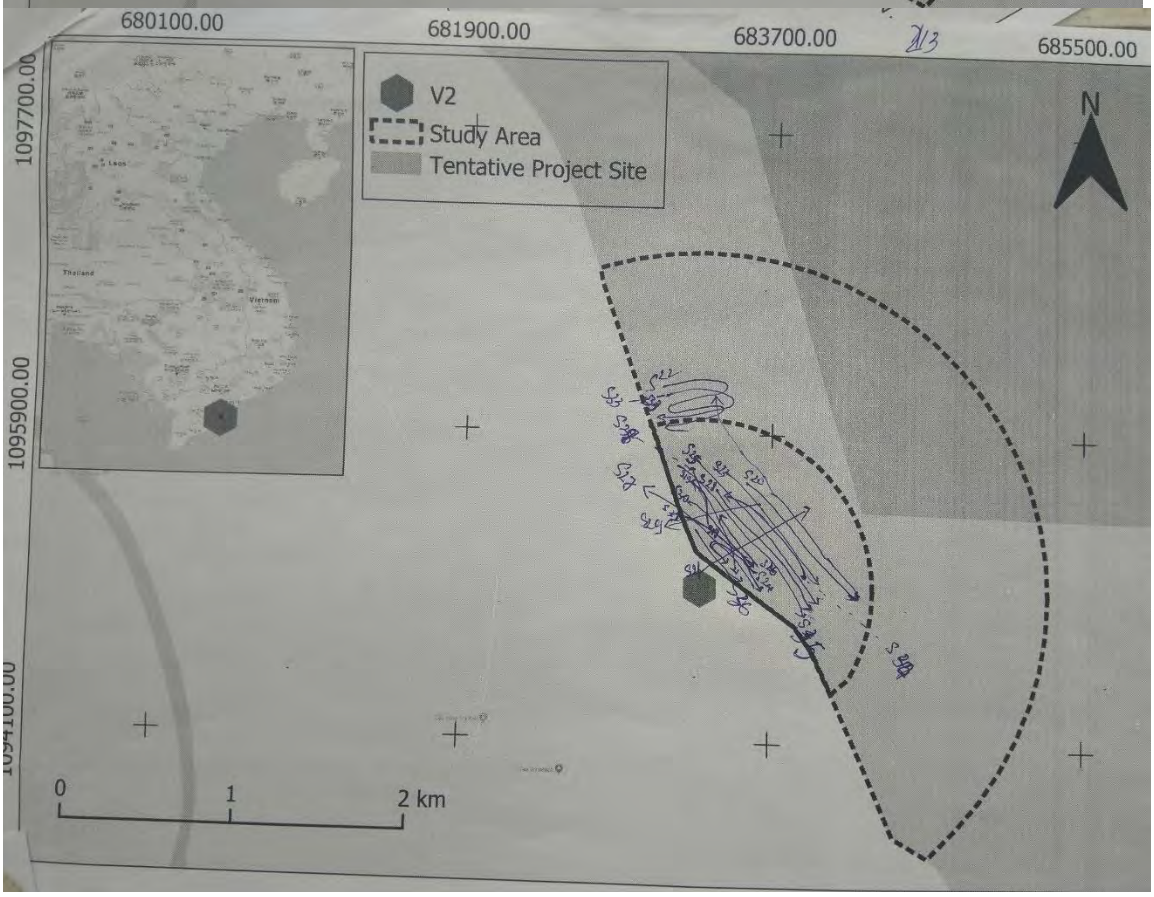
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V2
Study Area
Tentative Project Site
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2 km

APPENDIX C BIRD PHOTOGRAPHS FROM BOAT-BASED SURVEY

Caspian Tern *Hydroprogne caspia*

Osprey *Pandion haliaetus*

ERM has over 160 offices across the following countries and territories worldwide

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Australia	New Zealand
Belgium	Norway
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Canada	Peru
Chile	Poland
China	Portugal
Colombia	Puerto Rico
France	Romania
Germany	Russia
Hong Kong	Singapore
India	South Africa
Indonesia	South Korea
Ireland	Spain
Italy	Sweden
Japan	Switzerland
Kazakhstan	Taiwan
Kenya	Thailand
Malaysia	UAE
Mexico	UK
Mozambique	US
Myanmar	Vietnam

ERM Vietnam

7th Floor, Saigon Finance Centre

09 Dinh Tien Hoang, Dakao Ward

District 1, Ho Chi Minh City

Vietnam

T: +84 28 3914 7800

F: +84 28 3914 7801

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APPENDIX G PHOTOLOG

PHOTO LOGS

Beach area near the Project substation

Relic site of Ho Chi Minh trail in Thanh Hai Commune

Local whale temple in Thanh Hai Commune

Primary school in Thanh Hai Commune

ERM noise monitoring survey

Local people received decision letter on land acquisition and compensation from local authorities

Local people preapared for interview

ERM interviewed affected household

Assets of one affected household

APPENDIX H VALUED ECOSYSTEM COMPONENTS MATRIX

Step 1 tab

Key	**Definition**
P	Permanent affect
T	Temporary affect
N	No affect
NA	Not Applicable
LOP	Life of Project

Step 2 tab

Key		**Definition**
C	Construction phase	From first plant and workforce mobilization to completion of commissioning of all project and associated infrastructure
O	Operation phase	From acceptance of commissioning completion to final down-turn of LNG trains
D	Decommissioning phase	From final-down turn of LNG trains (plant) to removal of all surface plant and equipment as per the agreed rehabilitation and remediation plan
N	Negligible / Managed risk	Risk will not have a detrimental impact to the existing environmental or social baseline.
?	Uncertain / unknown	Risk as not yet been analyzed for an allocation to be determined with any scientific or economic certainty
	Large scale negative	Loss of VEC and/or integrity of the VEC; severe damage to key characteristics, features or elements (Negative). Permanent / irreplaceable change, which is certain to occur.
	Small scale negative	Minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; measurable change in attributes, quality or vulnerability (Negative). Long- term though reversible change, which is likely to occur.
	Positive	Possible improvement to, or addition of, one (maybe more) characteristic, feature or element; possible improvement to attribute quality (Beneficial).

Alternative

Very High	Loss of VEC and/or integrity of the VEC; severe damage to key characteristics, features or elements (Negative). Permanent / irreplaceable change, which is certain to occur. Large scale improvement of resource or attribute quality; extensive restoration or enhancement (Beneficial).
High	Loss of VEC, but not affecting integrity of the resource; partial loss of or damage to key characteristics, features or elements (Negative). Permanent / irreplaceable change, which is likely to occur. Improvement to, or addition of, key characteristics, features or elements of the VEC; improvement of attribute quality (Beneficial).
Medium	Minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; measurable change in attributes, quality or vulnerability (Negative). Long- term though reversible change, which is likely to occur. Minor improvement to, or addition of, one (maybe more) key characteristics, features or elements of the VEC; minor improvement to attribute quality (Beneficial).
Low	Very minor loss of, or alteration to, one (maybe more) key characteristics, features or elements; noticeable change in attributes, quality or vulnerability (Negative). Short- to medium-term though reversible change, which could possibly occur. Very minor improvement to, or addition of, one (maybe more) key characteristic, feature or element; very minor improvement to attribute quality (Beneficial).
Very Low	Temporary or intermittent very minor loss of, or alteration to, one (maybe more) characteristic, feature or element; possible change in attributes, quality or vulnerability (Negative). Short-term, intermittent and reversible change, which is unlikely to occur. Possible very minor improvement to, or addition of, one (maybe more) characteristic, feature or element; possible improvement to attribute quality (Beneficial).

			Capacity (MW)	Land Area (ha)	Development Status at the time of CIA	Expected start of construction	Tentative schedule for operation	Distance			EIA Available	Natural resources		Physical environment						Biodiversity			Socio-economic and health							
	Project	Description						Turbines (km)	Subtation (km)	Transmission Line (km)		Natural Capital	Land Use	Landscape	Soil	Surface water	Marine Water	GW	Contribution to GHG emissions in VN	Terrestrial habitats	Avifauna	Marine habitats	Land use	Economy and Employment	Community Health and Safety	Infrastructure and public services		Traffic	Cultural heritage	Visual Amendity
	Proposed developments																		Scope 1											
1	Wind Farm Project in V1-4 Area	Nearshore windfarm	48	1,200	Planning	NA	NA	43,304.0	45,310.0	45,041.0	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
2	Wind Farm Project in V1-2 Area	Nearshore windfarm	48	1,220	Planning	NA	NA	20,741.0	23,581.0	22,875.0	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
3	Wind Farm Project in V1-3 Area	Nearshore windfarm	48	1,225	Planning	NA	NA	15,907.0	18,828.0	18,070.0	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
4	Hiep Thanh Wind Farm	Nearshore windfarm	78	2,747	Technical design	Q4 2019	Q3 2020	10,603.0	12,030.0	12,120.0	Y	N	CO	N	N	N	C	N	O	C	CO	C	N	CO	N	N	O	N	N	O
5	Thanh Phong Wind Farm	Nearshore windfarm	125	3,000	Permitting	NA	NA	1,245.0	3,735.0	3,526.0	Y	N	CO	N	N	N	C	N	O	C	CO	C	N	O	C	C	O	C	N	O
7	Nexif Wind Farm	Nearshore windfarm	30	2,000	Construction	In construction	Q4 2020	8,303.0	7,157.0	3,506.0	Y	N	CO	N	N	N	C	N	O	C	CO	C	N	CO	C	C	O	C	N	O
8	Wind Farm Project in Ben Tre (3)	Nearshore windfarm	140	3,800	Planning	NA	NA	1,704.0	2,849.0	2,209.0	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
9	Wind Farm Project in Ben Tre (4)	Nearshore windfarm	120	3,800	Planning	NA	NA	5,468.0	5,670.0	4,580.0	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
10	Binh Dai Windfarm	Nearshore and offshore windfarm	160	4,900	Permitting	2020	2021	21598	20754	18103	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	C	N	N	O	N	N	O
11	Tra Vinh Windfarm	Nearshore windfarm	48	1,208	Technical design	Q1 2020	Q1 2021	25054	27784	27139	Y	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
12	Wind Farm Project in Ben Tre (9)	Nearshore windfarm	140	3,700	Planning	NA	NA	25039	24510	18944	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
13	Wind Farm Project in Ben Tre (10)	Nearshore windfarm	190	4,900	Planning	NA	NA	31940	35855	26101	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O
14	Wind Farm Project in Ben Tre (11)	Nearshore windfarm	120	3,200	Planning	NA	NA	36029	35987	30310	NA	N	CO	N	N	N	C	N	O	C	CO	C	N	O	N	N	O	N	N	O

APPENDIX I BIBLOGRAPHY

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