FINAL EIA REPORT

The Hongkong Electric Co., Ltd.
香港電燈有限公司

Renewable Energy by a Wind Turbine System on Lamma Island:

Final Environmental Impact Assessment

September 2004

Environmental Resources Management
21/F Lincoln House
Taikoo Place 979 King's Road
Island East Hong Kong
Telephone 2271 3000
Facsimile 2723 5660

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The Hongkong Electric Co Ltd

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Final Environmental Impact Assessment Report

September 2004

Ref.: C2701

For and on behalf of	
Environmental Resources Management	
Approved by:	Freeman Cheung
Signed:	
Position:	Executive Director
Date:	1st September 2004

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Annex B Noise Assessment Information

Annex C List of Floral and Faunal Species recorded within the Study

Annex D Implementation Schedule

1 INTRODUCTION

1.1 INTRODUCTION

This Environmental Impact Assessment (EIA) Report addresses the potential environmental impacts associated with the construction and operation of a project entitled "Renewable Energy by a Wind Turbine System on Lamma Island" (hereinafter referred to as the Project).

The Project is classified as a Designated Project by virtue of Item D.1 of Part I of Schedule 2 (ie public utility electricity power plant) under the *Environmental Impact Assessment Ordinance (Cap. 499) (EIAO).*

This report has been prepared by ERM-Hong Kong, Limited (ERM) in association with, and on behalf of, The Hongkong Electric Co Ltd (HEC), in accordance with the *EIA Study Brief* (No. ESB-112/2004) and the *Technical Memorandum of the Environmental Impact Assessment Process* (*EIAO-TM*). The Study Area for the Project is presented in *Figure 1.1*.

1.2 BACKGROUND

The Hongkong Electric Co Ltd (HEC) is committed to providing a high quality power supply to its customers with due care for the environment. Recognizing the importance of sustainable development, HEC is proposing to install a wind turbine of capacity ranging from 600 to 850kW as a demonstration project to utilize wind energy for renewable power generation on Lamma Island, Hong Kong.

Following the completion of a 12-month wind power monitoring exercise on Lamma Island in November 2002, a wind atlas was developed to assess the wind potential of the island. A number of areas were identified as having wind power density over 150W/m^2, equivalent to an average wind speed of about 5.5m/s, and generally considered suitable for wind energy utilization. The existing power supply to Lamma Island residents and businesses is through 11kV power lines, transformer pillars and low voltage distribution cables from the existing Lamma Power Station.

The wind turbine is proposed to be located at Tai Ling Tsuen (*Figure 1.1*) and the output will be connected to the existing power grid for supplying renewable energy to HEC customers. The operation of the wind turbine will be monitored and controlled through a central monitoring system located in a control room of the Lamma Power Station. The wind turbine site will be unmanned and will only require attendance of operational personnel during routine maintenance (or in emergency).

1.3 PURPOSE AND OBJECTIVES OF THIS EIA REPORT

The purpose of the EIA is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the Project and related activities that take place concurrently, to contribute to decisions on:

- The overall acceptability of any adverse environmental consequences that are likely to arise as a result of the Project;
- The conditions and requirements for the detailed design, construction and operation of the Project to mitigate against adverse environmental consequences wherever practicable; and
- The acceptability of residual impacts after the proposed mitigation measures are implemented.

The detailed requirements of the EIA Study are set out in the *EIA Study Brief*. The objectives of the EIA Study are:

i. To describe the Project and associated works and phases of development together with the requirements and environmental benefits for carrying out the Project;

ii. To provide information on the consideration of alternative sites to avoid and minimize the potential adverse environmental impacts, and to provide justifications and constraints for selecting the proposed option and to describe the part environmental factors played in the selection process;

iii. To identify and describe the elements of the community and environment likely to be affected by the Project and/or likely to cause adverse impacts to the Project, including both the natural and man-made environment and the associated environmental constraints;

iv. To identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

v. To identify and quantify any potential losses or damage to flora, fauna and natural habitats;

vi. To identify and quantify any potential landscape and visual impacts and to propose measures to mitigate these impacts;

vii. To identify the negative impacts and propose the provision of mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operation of the Project;

viii. To investigate the feasibility, practicability, effectiveness and implications of the proposed mitigation measures;

ix. To identify, predict and evaluate the residual environmental impacts (i.e. after practicable mitigation) and the cumulative effects expected to arise during the construction and operation phases of the Project in relation to the sensitive receivers and potential affected uses;

x. To identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project which are necessary to mitigate these environmental impacts and cumulative effects and reduce them to acceptable levels;

xi. To identify constraints associated with the mitigation measures recommended in the EIA study, as well as the provision of any necessary modification; and

xii. To design and specify the environmental monitoring and audit requirements to ensure the effective implementation of the recommended environmental protection and pollution control measures.

As specified by the *EIA Study Brief*, the EIA has addressed the following key environmental issues associated with the construction and operation of the Project.

- The potential noise pollution impacts on nearby sensitive receivers during construction and operation of the Project;
- The potential ecological impact arising from the construction and operation of the Project, including loss of habitats and disturbance to wildlife, and the potential risk to any animal(s), including birds during the operation of the wind turbine system;
- The potential landscape and visual impacts on existing and planned sensitive receivers during the construction and operation of the Project; and
- The potential air and water quality impacts during the construction stage of the Project.

1.4 STRUCTURE OF THIS REPORT

The remainder of this EIA Report comprises the following sections.

Section 2 Provides information on the consideration of alternatives for the siting, design and operation of the Project.

Section 3 Provides a description of the Project highlighting the key infrastructure for the Project and the operation activities.

Section 4 Presents the findings of the noise impact assessment

Section 5 Presents the findings of the ecology impact assessment

Section 6	Presents the findings of the landscape and visual impact assessment
Section 7	Presents the findings of the air quality impact assessment.
Section 8	Presents the findings of the water quality impact assessment.
Section 9	Presents the environmental monitoring and audit (EM&A) requirements for the construction and operation of the Project.
Section 10	Provides a summary of the conclusions and environmental outcomes drawn from the detailed assessment of the Project.
Annex A	*Site Search Report*
Annex B	*Noise Assessment Information*
Annex C	*List of Floral and Faunal Species recorded within the Study Area*
Annex D	*Implementation Schedule*

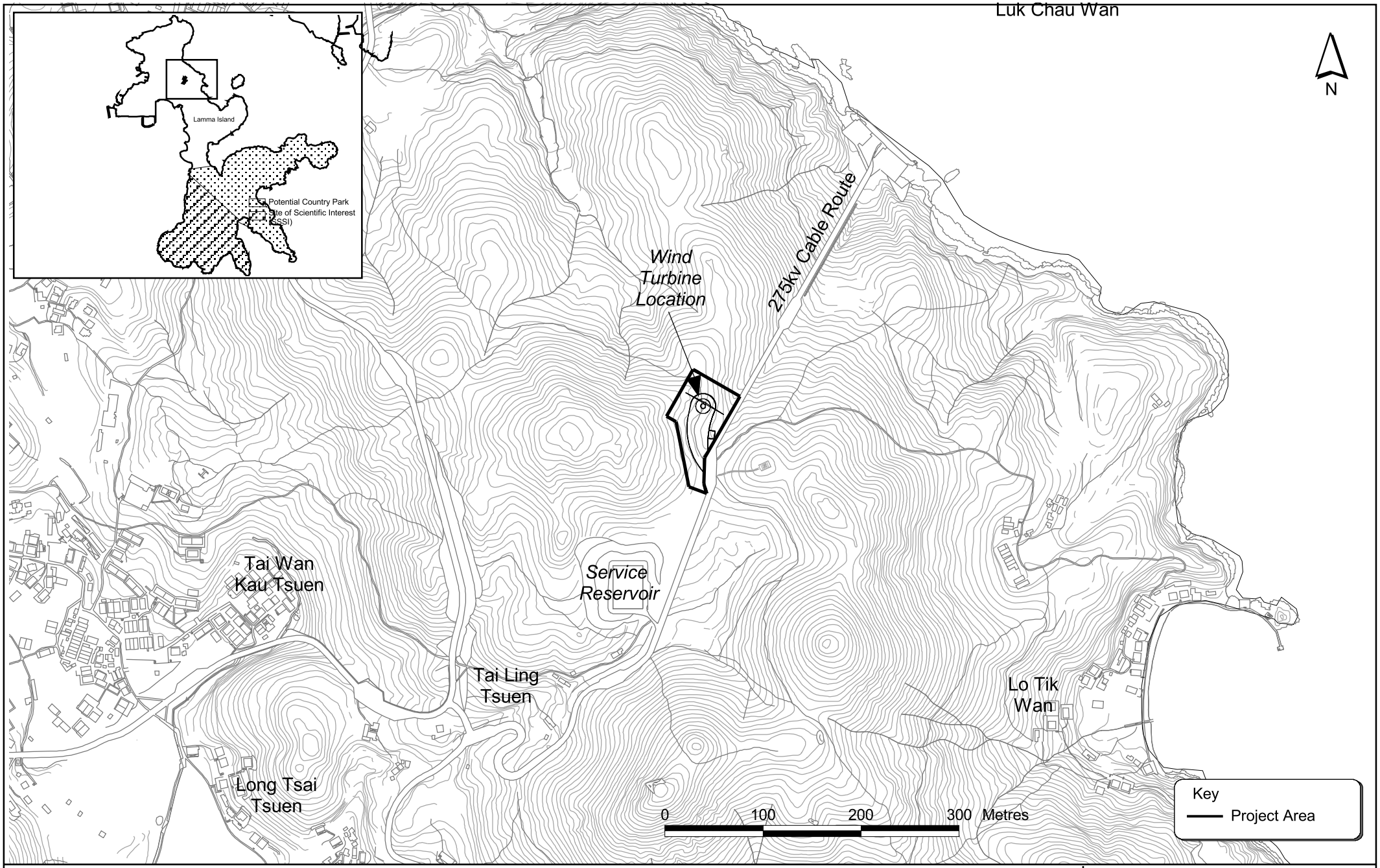

FIGURE 1.1

Location of The Proposed Wind Turbine

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2 CONSIDERATION OF ALTERNATIVES

2.1 BACKGROUND TO THE PROJECT

Wind energy has been the world's fastest growing sector of the energy industry over the past two decades. Technological developments have made wind energy a promising renewable source of power in the near term. The many benefits wind energy offers the world are compelling: pollution-free, technological innovation, rapid development, diversity, security of supply, etc. Globally, this was about 40,000MW of installed capacity of wind energy at the end of 2003 and it is one of the faster growing, reliable and competitive sources of renewable energy.

As a continual commitment to promoting environmental protection and sustainable development, the Hongkong Electric Co Ltd (HEC) commenced a feasibility study in April 1999 to collect wind data on Po Toi and Lamma Island to evaluate the wind potential for utilization of wind energy on these two outlying islands. The colleted wind data revealed that Po Toi and Lamma have similar wind potential and are both suitable for power generation.

After careful consideration of the technical, economic and environmental factors pertinent to the best choice for utilizing wind energy, HEC is proposing to install a 600-850kW wind turbine at Tai Ling of Lamma Island as a demonstration of the potential for wind utilization in generating power. The wind turbine will be built in a grid connection scheme for supplying "green" electricity to HEC customers. The objectives of the project are as follows:

- *Demonstration of utilizing wind energy for power generation*: The proposed wind turbine will be the first utility scale and grid-connected wind project in Hong Kong. Based on the wind potential on Lamma, the proposed wind turbine will harvest about 700MWh of electricity per annum, helping to avoid the use of up to 240 tonnes of coal and reduce the associated emissions every year.

- *Education purpose*: Visitors' facilities such as display boards and guided tour will be provided at the wind turbine site to explain the principle of power generation by wind and the benefits of renewable energy. The wind turbine project will serve as educational use for promotion of green awareness among the public, in particular with students.

- *Wider application of renewable energy*: The project will provide invaluable local experience on the design, construction, operation and maintenance of wind turbines. Future utilization of wind energy in Hong Kong can be explored based on the information collected and experience gained, keeping pace with Government's policy, and the publics expectation of the promotion of renewable energy and improvement in air quality.

2.2 *THE FUTURE PLAN*

The proposed wind turbine project will be planned and implemented by HEC's in-house staff together with consultants and contractors. Site erection will commence in early 2005 and commissioning of the project is scheduled for early 2006. The design life of the wind turbine is 20 years. A project area of about 4,400 m^2 is being applied through short term tenancy (STT) for an initial term of 5 years and renewal of the STT will be made subject to further evaluation of the situation at that time.

The wind turbine project will serve as a pilot project for demonstration of power generation by wind and grid-connection with renewable energy. The performance of the wind turbine will be monitored and evaluated during the operational phase including:

- *Amount of electricity generated*: The annual electricity harvested by the wind turbine will be compared with design figures to verify the site specific performance of the wind turbine at Lamma where the terrain is complicated and air turbulences are hard to predict.

- *Quality of power:* As wind is time and season dependent and fluctuating in nature, the interaction between the wind turbine and the existing 11kV power grid will be monitored to assess the effects of connecting the electricity generated by the wind turbine to the grid.

- *Resistance to wind load*: Hong Kong is situated in a typhoon-affected zone and it is essential to ascertain that the wind turbine can be designed to withstand strong winds.

Subject to the result of evaluation on various technical, environmental and commercial aspects and data collected during operational phase of the project, HEC will evaluate the potential for wider application of wind energy in Hong Kong. Any further plan for installation of additional wind turbine will be subject to approval by the Government.

2.3 *JUSTIFICATION FOR CHOOSING THE PRESENT SITE*

The *EIAO* Study Brief issued for this Project requires the justification for choosing the present site (*Clause 3.3.3*) with a view to avoiding or minimising the potential environmental impacts of the Project, specifically intrusion into Country Parks and other environmentally sensitive areas.

As a demonstration project for renewable energy, the study envelope was confined to locations away from densely populated areas. Po Toi and Lamma Islands were subsequently identified for assessment of wind potential. Two wind monitoring stations, one on Po Toi and another on Lamma, were set up in April and November 2001 respectively to record one-year wind profile. The wind monitoring was completed at the end of 2002 and the data were fed into computer software for analysis.

Desktop screening and site surveys were subsequently conducted after completion of wind data logging to identify potential sites for a wind turbine of suitable size on Lamma and Po Toi Island based on the criteria recommended in the guidelines for wind energy development issued by reputable international organizations of wind energy. The site search was confined to Lamma and Po Toi where reliable wind data are available.

2.3.1 Po Toi Island

Po Toi Island is an ecologically sensitive area which has been identified as a potential Country Park. As there is no vehicular access on Po Toi, a properly paved access road with a minimum width of 5m and a maximum inclination of not greater than 15° has to be constructed to link up the pier and sites of favourable wind potential for construction of a 600-850kW wind turbine. Access roads meeting the above criteria on Po Toi would have a length of approximately 1,000m and cross the hill- slopes on western part of the island (*Figure 2.1*). The new access road and the associated extensive reinforcement works would inevitably change the natural landscape (mainly shrub cover hillside) and disturb the habitat of resident species. Construction of new road in a hilly island was therefore not considered suitable due to the potential adverse environmental impacts.

Alternatively the wind turbine equipment and construction tools will have to be transported to the wind turbine site on Po Toi by helicopters. Considering the limited payload of local helicopter services, the maximum capacity of a wind turbine on Po Toi would be restricted to about 50 kW.

Moreover, electricity generated on Po Toi could only be transmitted to the HEC grid through the use of submarine cables. The shortest possible route of the proposed submarine cable extended from Hong Kong Island would have a length over 5km. It would not be cost effective without a large capacity of output (e.g. a wind farm of less than 20MW). Given that the marine waters between Po Toi, Hong Kong and Lamma Island are already quite congested with seabed utilities, finding an acceptable route for a cable may prove technically challenging. Although not expected to be unacceptable, the installation of a submarine cable would introduce additional environmental impacts.

At present, electricity supply on Po Toi is by means of an independent and autonomous grid. Currently two 50 kW diesel generators installed by EMSD are operated during the night-time and residential tee-off points are connected to the nearest lampposts to take power from the grid. To cater for the mismatch of wind profile and demand pattern on the island, a costly hybrid control system and battery bank will be required for synchronization of the wind turbine with the existing diesel generator. Worldwide experience in the wind-diesel power generating system is rather limited and there are very few suppliers that can offer a reliable hybrid control system.

In view of the accessibility considerations and absence of a power grid, Po Toi is considered neither technically feasible nor environmentally and economically attractive for a demonstration project with commercial scale wind turbine. The aerial photograph of West Po Toi Island where the wind potential is sufficient for wind turbine is presented in *Figure 2.1*.

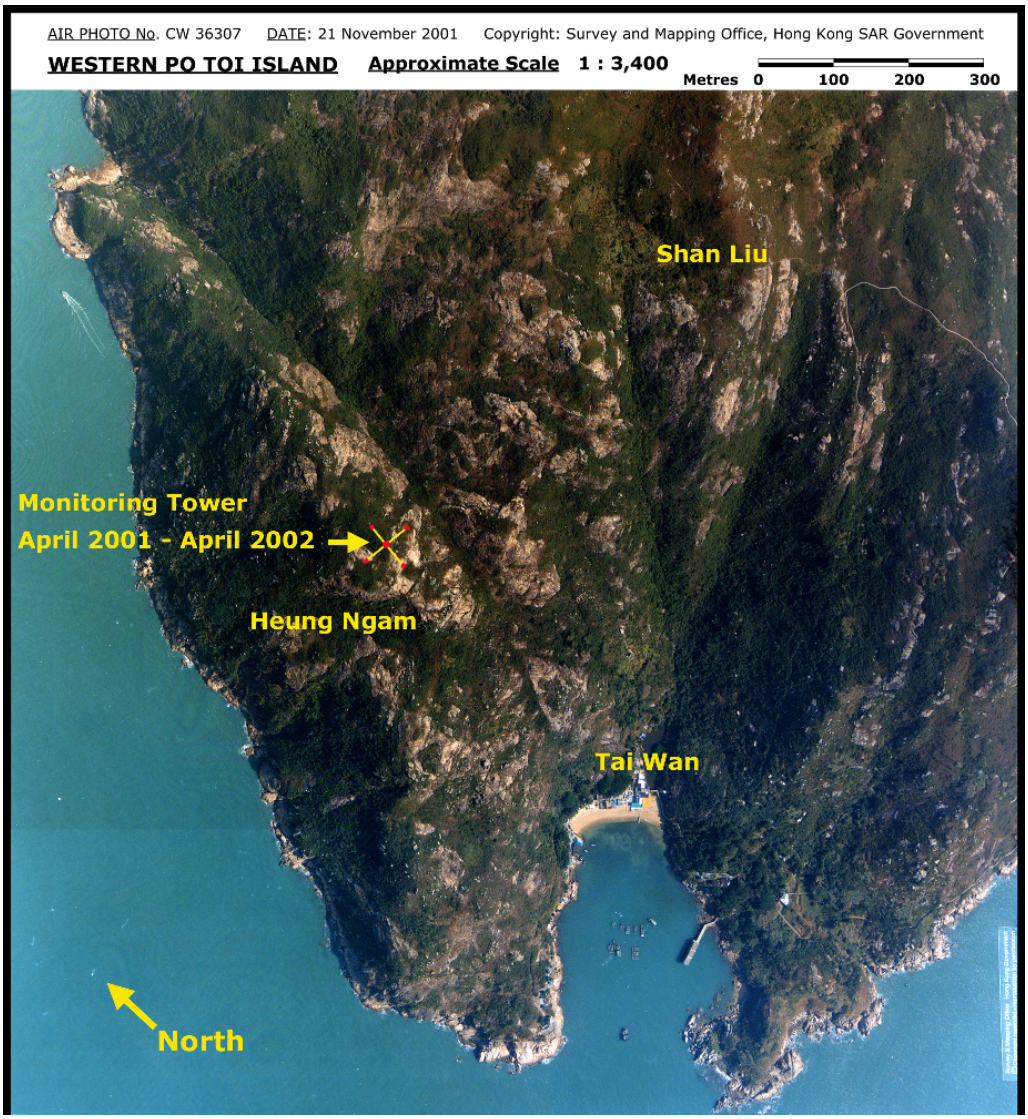


Figure 2.1 *Aerial Photo of West Po Toi Island*

2.3.2 *Lamma Island*

Once the above considerations had been accounted for, site selection was focussed on Lamma Island. The wind turbine site was then examined against engineering requirements and environmental concerns and further refined using the following site screening criteria.

Wind Potential

Following completion of a 12-month wind power monitoring at Lamma in November 2002, a wind atlas was developed to assess the wind potential of

Lamma Island. *Figure 2.1* shows the "isovent" map of equal power density in terms of energy per swept area of wind turbine blades.

Areas of wind power density over 150 W/m^2, equivalent to the average wind speed of about 5.5 m/s, are considered suitable for wind energy utilization and warrant further evaluation (1) (2) (3). Modern wind turbines have the cut-in wind speed of approximately 2.5 to 4 m/s and sites with annual wind speed below 5.5 m/s are in general not considered economically viable due to low electricity output of wind turbine. Areas of high wind potential are in general found on hilltops and areas of high elevation. Most of the potential areas are concentrated in South Lamma island.

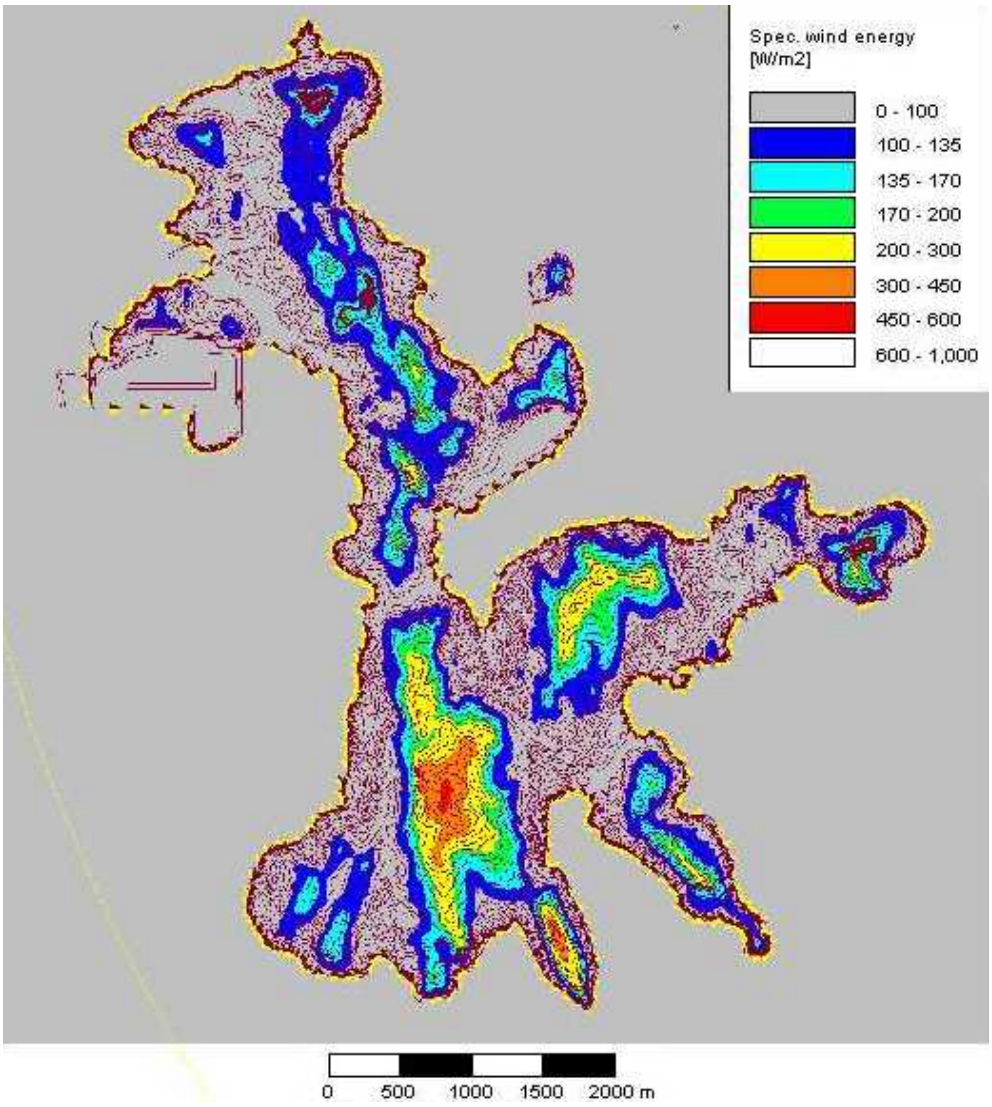


Figure 2.2 Wind Source Map of Lamma Island

(1) Wind Energy - The Facts, European Wind Energy Association, 2004. http://www.ewea.org/06projects_events/proj_WEfacts.htm

(2) Wind Force 12, European Wind Energy Association, May 2004. http://www.ewea.org/03publications/WindForce12.htm

(3) Assessing the World's Wind Resources, Dennis Elliott, IEEE Power Engineering Review, Vol. 22(9), Sept 2002 & NREL National Wind Technology Center Publications 2002

Site Access

For Lamma Island, the vehicular roads that allow passage of heavy vehicles and mobile equipment are the 275kV Cable Routes built by HEC (*Figure 2.2*). Since building a new access road leading to a remote site is not recommended from environmental and economical viewpoints, potential sites on Lamma Island for the wind turbine are limited to areas along HEC's cable routes or closed to existing berthing facilities. South Lamma Island, which consists of Site of Special Scientific Interest (SSSI) and potential Country Park and frequent records of the Romer's Tree Frog was therefore avoided.

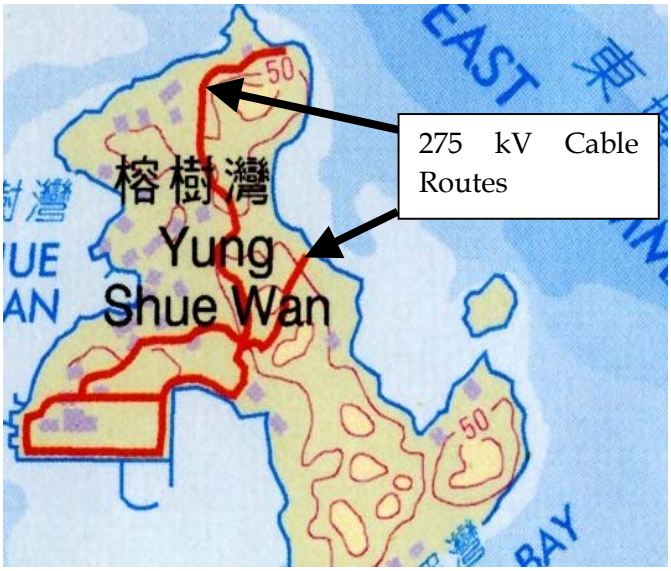


Figure 2.3 Vehicle Access Road on Lamma Island

Height Restriction

The Civil Aviation Department (CAD) has imposed height restriction for all permanent structures on Lamma Island in accordance with the *Hong Kong Airport Control of Obstructions Ordinance*. Most areas in North Lamma along the 275 kV Cable Routes fall between the restricted heights of 160 to 165 m above the Hong Kong Principal Datum (PD) respectively (*Figure 2.3*). Taking consideration of the regulations as well as the topography of North Lamma, the design and height of the wind turbine will be restricted. In selection of suitable sites for a wind turbine of the appropriate capacity, consideration should be given to the maximum tip height of about 68 m and 90 m for a 600kW and 1MW wind turbine respectively.

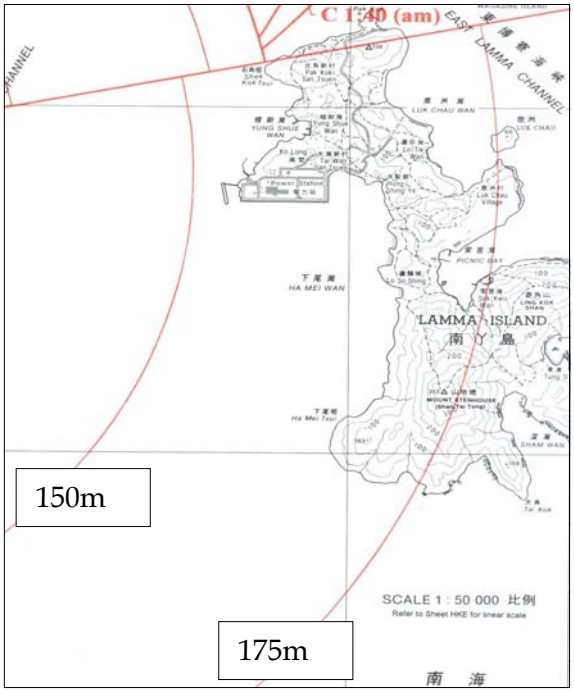


Figure 2.4 Height Restriction Map for Lamma Island

Electrical Connection

Electricity generated from the wind turbine will have to be transmitted to the load center or connected to the main power grid. Lamma Island has presently a network of the 11 kV network allowing connection by the wind turbine via new power cables and transformer. The distance and routing of the transmission cable connecting the potential sites to the main power grid are evaluated from technical, environmental and cost considerations.

Area and Land-use

South Lamma is of high ecological value consisting of SSSI, potential Country Park, Restricted Area and conservation area. However, Lamma Island is not an identified/ reported important site for migratory birds. Lands along the 275 kV Cable Routes are located on North Lamma which are well away from areas of ecological importance such as green turtle's nesting site in Sham Wan, and have been zoned mainly as agricultural and green belt areas and are therefore compatible.

A working platform of about 30 m x 20 m including the 15 m x 15 m wind turbine foundation is required for erection of a 600kW class wind turbine. Areas meeting the above requirement along the 275 kV Cable Routes were further identified taking into account the landownership, present and future land-use with reference to the latest Lamma Island Outline Zoning Plan.

2.3.3 *Preferred Sites on Lamma Island*

Taking into account the above criteria, six potential sites were identified with the application of constraint mapping techniques (*Figure 2.4*). The details are presented in the Site Search Report (*Annex A*). The six long-listed sites are:

Site 1 - *Lamma Power Station Extension*

Site 2 - *Tai Ling*

Site 3 - *Yung Shue Long*

Site 4 - *Tai Peng*

Site 5 - *Pak Kok Tsui*

Site 6 - *Lamma Quarry*

All of the sites avoided ecologically sensitive areas, SSSI and the potential Country Park at South Lamma. The six identified sites are situated away from the ecological sensitive areas and along the existing 275 kV Cable Routes which are the only vehicular roads on Lamma island.

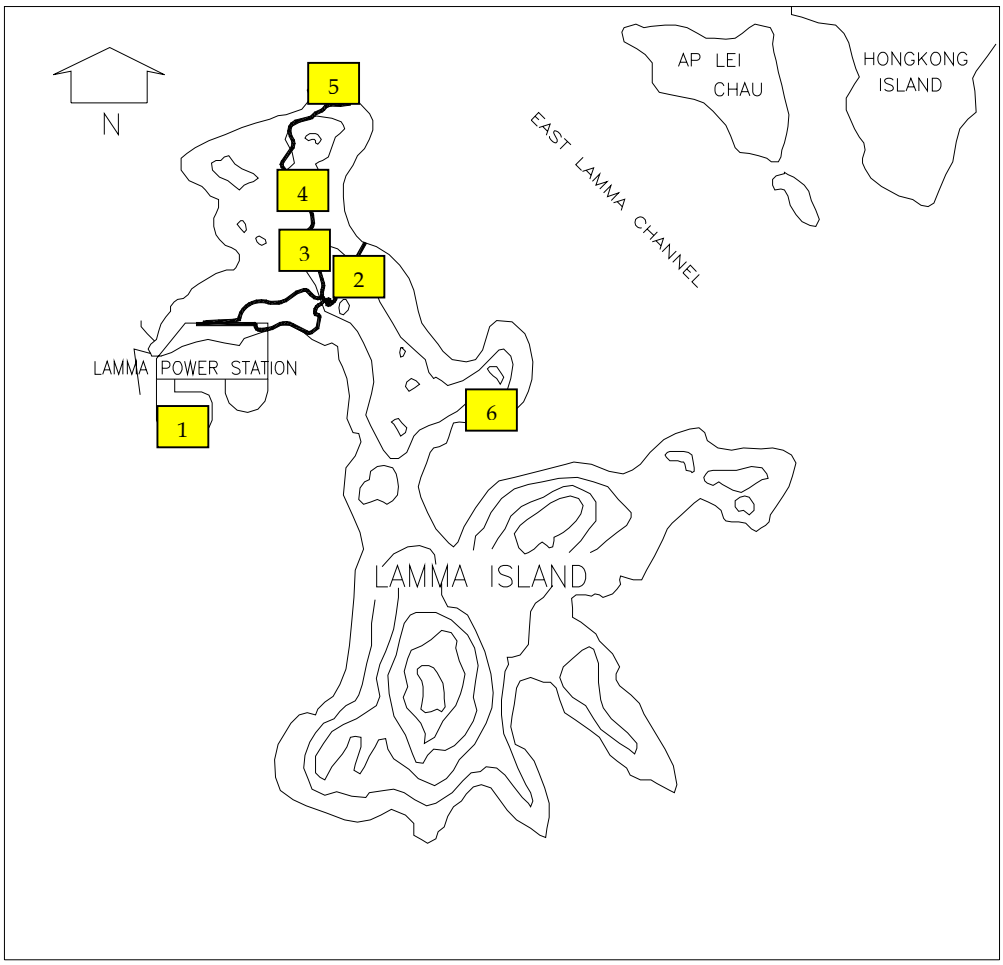


Figure 2.5 ***Long-listed Sites for Wind Turbine Installation***

Having identified sites that meet the broad environmental and engineering criteria, a site-specific appraisal has been conducted to establish a short-list of feasible sites for further detailed investigation.

Qualitative approaches have been adopted to identify potential conflicts with the development of the wind turbine. Each potential site was scrutinized more closely with engineering criteria on wind potential, geological considerations and electrical connection; and environmental criteria concerning visual, noise and ecological impacts. Of the 6 long-listed sites within the areas of least constraints, four sites have been excluded due to principal conflicts identified (*Annex A*), leaving the following two sites for the final comparative assessment:

Site 2 - Tai Ling

Site 4 - Tai Peng

The two sites have been evaluated and compared according to the potential impacts likely to arise as a sequence of construction and operation of the wind turbine system. Site 2 – Tai Ling is identified as the overall preferred site due to its distinct merits in site access, ground conditions, noise and visual impact compared with Site 4 – Tai Peng (*Annex A*). The site at Tai Ling is also the more remote of the two in terms of proximity to village houses.

The preferred site at Tai Ling is a relatively level platform to the east of joint bay of HEC's existing cable route. Taking advantage of the joint bay area as part of the works area for erection of the wind turbine, the landtake requirement can be optimized. Moving the wind turbine site further north away from the noise sensitive receivers are not preferred due to the need for extensive excavation of the hill slope to form access road for the wind turbine, and the terrain around Tai Ling site is indicated in *Figure 2.6.*

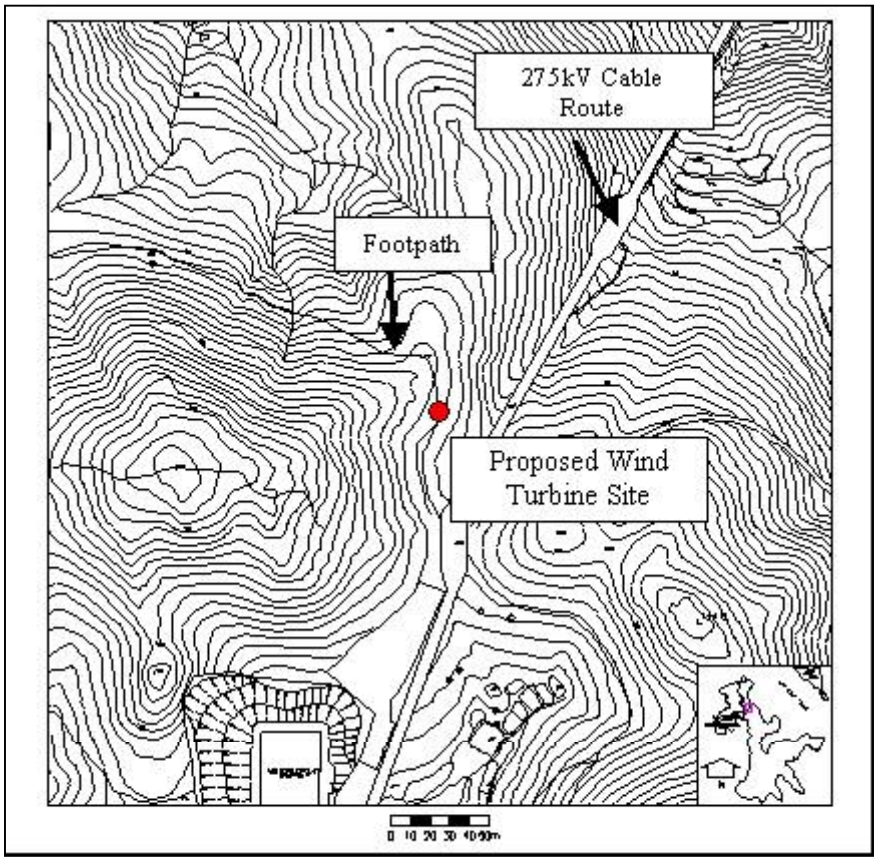


Figure 2.6 *The existing terrain around Tai Ling site*

2.4 *POTENTIAL CAPACITY FOR THE WIND TURBINE*

The planned capacity of the wind turbine at Tai Ling is 600 to 850 kW depending on the model sizes available from respective suppliers. The wind turbine capacity is selected based on the following considerations:

- 600 kW class wind turbine is of proven design with a large number of installations worldwide.
- 600 kW class wind turbine is now becoming the smallest size available from the majority of the suppliers due to the worldwide trend for large capacity machines.
- 600 kW class wind turbine is the maximum size of machine complying with the height restriction at Tai Ling Site.

The wind turbine design, construction methods and Project programme are further discussed in *Section 3*.

3 PROJECT DESCRIPTION

3.1 THE PROJECT

The works that are the subject of the EIA Study include the construction and operation phases of the Project. This section describes the key components of the Project.

The Project is the construction and operation of a 600-850 kW wind turbine and associated equipment at Tai Ling Tsuen on Lamma Island. The development and operation of the proposed Project will comprise the following:

i. Erection of a wind turbine (hub height approximately 45m and rotor blade diameter of approximately 52 m, overall height of the wind turbine approximately 71 m);

ii. Excavation and construction of the wind turbine foundation (affected area approximately 15 m by 15 m);

iii. Construction of a site platform and retaining wall (affected area approximately 25 m by 60 m);

iv. Construction of one stainless steel hut as high voltage distribution pillar (HVDP) (size approximately 4.6 m length, 2.5 m width, 2.8 m height) for housing of switchgear and power conditioning devices. Transformer will be installed at the bottom of the wind turbine tower;

v. Laying of underground distribution cables for connecting to the nearby existing cable route (approximately 50 m in length); and

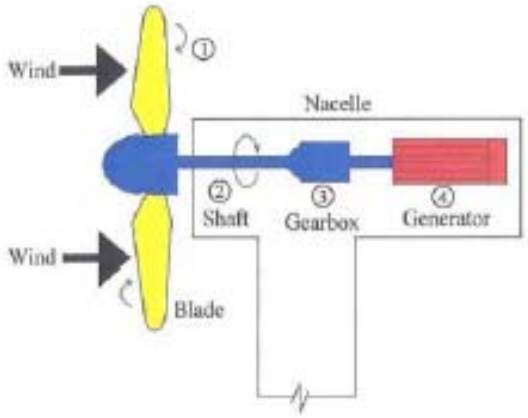
vi. Operation and maintenance of the wind turbine system.

The project site will be located adjacent to the existing 275kV cable road at a ground level of approximately 92 mPD.

3.2 PROJECT DESIGN

The information presented in this section is taken from HEC's design and may be subject to minor modification.

The proposed wind turbine is a "horizontal axis" machine which consists of three rotor blades turning around a horizontal hub. The hub is connected to a gearbox and a generator which are located inside a nacelle. The nacelle houses the mechanical and electrical components and is mounted on the top of a tubular tower. The mechanism and components of power generation by wind turbine are illustrated in *Figure 3.1*.



Key:
(1) Wind blowing over the blades causes the blades to rotate
(2) Rotating blades keep the shaft turning
(3) & (4) The gearbox will increase the rotational speed of the shaft and drive the generator to produce electricity

Figure 3.1 Mechanics of Electricity Generation by Wind Turbine

The specification of the wind turbine is summarized in *Table 3.1*.

Table 3.1 Wind Turbine Specification

Parameters	Specification
Capacity	600 – 850 kW
Cut-in Wind Speed	2.5 – 4 m/s
Rated Wind Speed	13.5 – 15 m/s
Cut-out Wind Speed	25 m/s
Blade Rotating Speed	14 – 31 rpm
Blade Rotating Direction	Clockwise
Average Wind Speed at Tai Ling	5.5 m/s
Annual Production of Electricity	700 MWh
Hub Height	45 m
Rotor Diameter	43 – 52 m
Ground Level of the Project Site	+92 mPD
Tip Height (from sea level)	+159 – 163 mPD

A transformer will be installed at the bottom of the wind turbine tower. Switchgear and power conditioning devices will be housed inside a high voltage distribution pillar (HVDP) made of stainless steel (4.6m L x 2.5m W x 2.8 m H) installed within the site boundary of wind turbine. Power cables will be buried underground for connecting the wind turbine, HVDP and the nearby 11kV power grid on the 275kV cable route. As illustrated in the schematic diagram (*Figure 3.2*), the output from the wind turbine is transmitted to the existing power grid. The synchronous generators of the grid system supply magnetizing current for the induction generator of the wind turbine. An Auto-synchronous Controller will be required to control the operation of a Synchronizing Breaker with respect to the wind turbine output voltage and frequency.

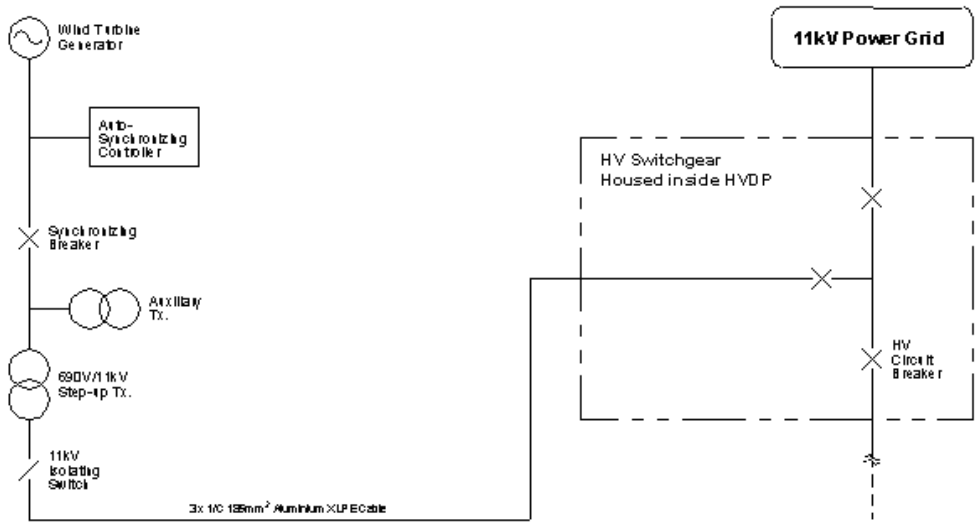


Figure 3.2 Schematic Diagram of Proposed Wind Turbine Installation

3.3 WIND TURBINE CONSTRUCTION & OPERATION

3.3.1 Construction

The facilities required at the wind turbine site are as described in *Section 3.2*. Most of the equipment will be delivered to the site via the existing 275kV Cable Route. The wind turbine site covers an area of about 4,400 m^2 and is situated adjacent to the existing 275kV cable road. All the construction activities will be restricted within the Project Area. A flat area for siting the wind turbine, the associated electrical transformer and access platform will be formed by cutting back the hill slope (*Figure 3.3*). The site platform will be formed by excavation with minor retaining wall constructed around the perimeter of the site. A circular concrete footing will be constructed for supporting the wind turbine. The construction work on site is minimal and will not result in adverse impacts to the environment.

The main activities and construction sequence are:

- Excavate the site by cutting and filling to form a site platform (affected area is approximately 3,100 m^2 and excavated materials is approximately 1,300 m^3);
- Construct retaining wall around site perimeter;
- Backfill and level site (nearly 95% of the excavated materials could be used for backfilling, the remaining materials will be transported by trucks to the HEC Power Station for offsite disposal);
- Construct circular concrete footing for wind turbine foundation;
- Reinstate ground;
- Erect wind turbine using one heavy duty mobile crane, one light duty mobile crane, and transformer pillars as depicted in *Figure 3.4*;
- Lay cables;
- Landscaping works including planting of trees and shrubs.

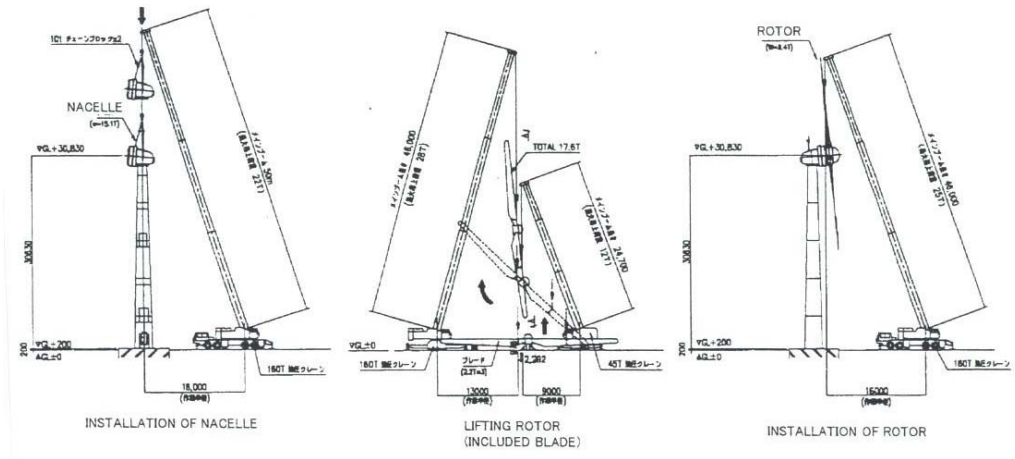


Figure 3.4 Construction of the Wind Turbine

3.3.2 Operation

The wind turbine will be designed for fully automatic start up, synchronization to the 11kV power grid, power regulation, disconnection from the grid and shut down. It will produce electricity when the wind speeds are in the range of 2.5 to 25 m/s. The rotor blade will rotate from 14 to 31 rpm approximately under normal circumstances. The wind turbine will cut-off from the grid when wind speeds are below 2.5 m/s or above 25 m/s.

The operation of the wind turbine will be monitored and controlled through a central monitoring system located in a control room of the Lamma Power Station. The wind turbine site will be unmanned and require attendance of operational personnel only during emergency or routine maintenance.

3.3.3 Project Programme

The construction of the Project is scheduled to commence in the first quarter of 2005 and will be completed within about 12 months, 8 months for civil works including site preparation, formation and foundation, and 4 months for electrical and mechanical works (such as installation & erection of the wind turbine).

3.4 CONCURRENT PROJECTS

At present there are no planned projects to be constructed in sufficient proximity to the Project to cause cumulative effects. Therefore, cumulative impacts are not expected to occur.

3.5 SCOPING OF ENVIRONMENTAL ISSUES

The impacts associated with the Project are summarised in *Table 3.2* and are described in further detail in the following sections. The intention of installing the wind turbine is to demonstrate the ability to utilise wind energy

(renewable power) for power generation in order to facilitate sustainable development. From an operational standpoint, the wind turbine is not expected to cause unacceptable adverse effects; operational impacts are principally related to ecology and, landscape and visual issues.

Table 3.2 ***Potential Sources of Environmental Impacts***

Type of Potential Impact	Construction	Operation	Remarks
Noise generation	√	√	See *Section 4*
Night time operations	√	√	See *Section 4*
Impacts on Ecological Resources	√	√	See *Section 5*
Landscape and visual impacts	√	√	See *Section 6*
Gaseous emissions	√	X	See *Section 7*
Dust	√	X	See *Section 7*
Liquid effluents	√	X	See *Section 8*
Disposal of spoil material	√	X	See Notes
Generation of waste or by-products	√	X	below
Disruption of water movement or bottom sediment	X	X	
Risk of accidents which would result in pollution or hazard	X	X	
Endangerment of cultural heritage resources	X	X	
Traffic generation	X	X	
Storage, handling, transport, or disposal of hazardous materials or wastes	X	X	

√ = Possible X = Not expected

Notes:

The construction works will involve some site formation which will necessitate the removal of small quantities of spoil. Therefore, the number of trucks is expected to be minimal. It is expected that minimal excavated spoil material (approximately 1,300 m^3 of excavated materials) will be generated from the construction of the tower foundation, site platform and retaining wall during the construction of the Project. The quantity of waste materials arising from the construction phase is not expected to be high as most of the spoil (95% of the excavated materials) will be used as backfill, but practical measures will be taken to avoid, minimise and recycle wastes. Good construction practices, including limiting activities within the site boundary and avoiding of filling and illegal dumping by site management and audit, are recommended to ensure that adverse environmental impacts are prevented.

The site selection exercise has resulted in a wind turbine location that has avoided impacts to high ecological value habitats and to both the archaeological sites (eg Sham Wan) and areas of heritage interest (such as the Tin Hau temple in Sok Kwu Wan). The small footprint of the wind turbine and the short connection to the nearby 11 kV power grid on the existing 275 kV cable route has minimised direct disturbances to the ecological resources of Lamma Island. Reducing the potential for impacts and maintaining the existing environmental conditions as far as possible has been a major objective of the assessment and selection of the wind turbine location.

The alternatives assessment (*Section 2*) and the previous components of *Section 3* present the most preferable option environmentally as well as in terms of programme and operational aspects. Subsequent sections of this report demonstrate that the Project can be constructed and operated in an environmentally acceptable manner.

3.6 ENVIRONMENTAL CONDITIONS IN ABSENCE OF THE PROJECT

The existing environmental conditions, including the general natural habitats and landscape of the Project Area, could be retained in the absence of the Project, however, the demonstration of the potential for wind utilization in generating power as well as the potential reduction in air pollutant emissions would not be materialised without this proposed Project.

4 NOISE

4.1 INTRODUCTION

This Section presents the potential noise impacts associated with the construction and installation of the wind turbine and the operational noise impacts associated with maintenance and operation of the wind turbine.

4.2 RELEVANT LEGISLATION AND GUIDELINES

4.2.1 Construction Noise

The principal legislation relating to the control of construction noise is the *Noise Control Ordinance (Cap. 400)* (*NCO*). Various Technical Memoranda (TMs), which stipulate control approaches and criteria, have been issued under the *NCO*. The following TMs are applicable to the control of noise from construction activities:

- *Technical Memorandum on Noise from Percussive Piling* (*PP-TM*);
- *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (*GW-TM*); and
- *Technical Memorandum on Noise from Construction Work in Designated Areas* (*DA-TM*).

Apart from the above, the *Environmental Impact Assessment Ordinance* (*EIAO*) *(Cap. 499)* also provides means to assess construction noise impacts. The *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*), issued under the *EIAO*, provides guidelines and noise criteria for evaluating construction noise impacts.

Percussive Piling

Percussive piling is prohibited at any time on Sundays and public holidays and during the weekday evening and night-time hours (1900-0700 hours, Monday through Saturday). A Construction Noise Permit (CNP) is required for such works during weekday daytime hours (0700-1900 hours, Monday through Saturday).

When assessing a CNP application for carrying out percussive piling, the Environmental Protection Department (EPD) is guided by the *PP-TM*. The EPD will consider the difference between the Acceptable Noise Levels (ANLs), as promulgated in the *PP-TM*, and the Corrected Noise Levels (CNLs) in conjunction with the proposed piling activities. Depending on the level of noise impact on nearby Noise Sensitive Receivers (NSRs), the EPD may allow 3, 5 or 12 hours of daily piling time (see *Table 4.1*).

Table 4.1 ***Permitted Hours of Operation for Percussive Piling (Not Involving the Use of Diesel, Pneumatic and/or Steam Hammers)***

Amount by which CNL exceeds ANL	Permitted hours of operation on any day not being a holiday
more than 10 dB(A)	0800 to 0900 and 1230 to 1330 and 1700 to 1800
between 0 dB(A) and 10 dB(A)	0800 to 0930 and 1200 to 1400 and 1630 to 1800
no exceedance	0700 to 1900

The issue of a CNP by the Noise Control Authority for percussive piling is governed by the procedures laid down in the *PP-TM*. However, as percussive piling is not required for this Study, the noise criteria stipulated under the *PP-TM* are not applicable in this Study.

General Construction Works

Under the *EIAO*, noise impact arising from general construction works during normal working hours (i.e. 0700 to 1900 hours on any day not being a Sunday or public holiday) at the openable windows of buildings is to be assessed in accordance with the noise criteria as given in the *EIAO-TM*. The *EIAO-TM* noise standards are presented in *Table 4.2*.

Table 4.2 ***EIAO-TM Daytime Construction Noise Standard ($L_{eq, 30\ min}$ dB(A))***

Use	Noise Standard
Domestic Premises	75
Educational Institutions (normal periods)	70
Educational Institutions (during examination periods)	65

When assessing a CNP application for the use of Powered Mechanical Equipment (PME) during restricted hours, the Noise Control Authority will compare the ANLs, as promulgated in *GW-TM*, and the CNLs (after accounting for factors such as barrier effects and reflections) associated with the proposed PME operations. The ANLs are related to the noise sensitivity of the area in question and different Area Sensitivity Ratings have been established to reflect the background characteristics of different areas. The relevant ANLs are shown in *Table 4.3*.

The Noise Control Authority will consider a well-justified Construction Noise Permit (CNP) application, once filed, for construction works within restricted hours as guided by the relevant Technical Memorandum issued under the *NCO*. The Noise Control Authority will take into account adjoining land uses and any previous complaints against construction activities at the site before making a decision in granting a CNP. Nothing in this EIA Report shall bind the Noise Control Authority in making his decision. The Noise Control Authority may include any conditions in a CNP that it considers appropriate. Failure to comply with any such conditions may lead to cancellation of the CNP and prosecution action under the *NCO*.

Table 4.3 Acceptable Noise Levels (ANL, $L_{eq, 5\ min}$ dB(A))

Time period	Area Sensitivity Rating		
	A	B	C
All days during the evening (1900-2300 hours) and general holidays (including Sundays) during the day and evening (0700-2300 hours)	60	65	70
All days during the night-time (2300-0700 hours)	45	50	55

In addition to the general controls on the use of PME during restricted hours, the EPD has implemented a more stringent scheme via the *DA-TM*. The *DA-TM* regulates the use of five types of Specified Powered Mechanical Equipment (SPME) and three types of Prescribed Construction Work (PCW), which are non-PME activities, in primarily densely populated neighbourhoods called Designated Areas (DAs). The SPME and PCW are:

SPME:

- hand-held breaker;
- bulldozer;
- concrete lorry mixer;
- dump truck; and
- hand-held vibratory poker.

PCW:

- erection or dismantling of formwork or scaffolding;
- loading, unloading or handling of rubble, wooden boards, steel bars, wood or scaffolding material; and
- hammering.

A CNP will be required for works during the time between 1900 and 0700 hours and any time on a general holiday, including Sunday, and the noise criteria for evaluating noise impact laid down in relevant *TM* issued under the *NCO* must be met.

4.2.2 Operational Noise

The *EIAO-TM* and *Technical Memorandum on Noise From Places Other than Domestic Premises, Public Places or Construction Sites* (*IND-TM*) specifies the applicable Acceptable Noise Levels (ANLs) for operational noise of the wind turbine system. The ANLs are dependent on the Area Sensitivity Rating (ASR) and the time of the day and are presented in *Table 4.4.*

Table 4.4 ANLs to be used as Operation Noise Criteria

Time Period	$L_{Aeq\ 30min}$ (dB(A))		
	ASR "A"	ASR "B"	ASR "C"
Daytime 0700-1900	60	65	70
Evening 1900-2300	60	65	70
Night-time 2300-0700	50	55	60

Fixed Plant Noise

Fixed plant noise is controlled under *Section 13* of the *NCO* and the predictions will be undertaken in accordance with the *IND-TM*. The criteria noise limits are set out in the *EIAO-TM* as follows:

- the total fixed source noise level at the facade of the nearest NSR is at least 5 dB(A) lower than the appropriate ANL (as shown in *Table 4.4*) as specified in the *Technical Memorandum on Noise from Places other than Domestic Premises, Public Places or Construction Sites* (*IND-TM*); or,

- where the prevailing noise level in the area is 5 dB(A) or more below the appropriate ANL, the total fixed source noise level must not exceed this noise level.

The criteria noise limits stipulated in the *IND-TM* are dependent on the Area Sensitivity Rating (ASR) of the NSRs as shown in *Table 4.4*.

As the site is located in a rural area and no influencing factors affect the NSRs, an ASR "A" has been assumed for the NSRs located within 300 m of study boundary. Background noise measurements have been conducted by HEC during 2004 to investigate the prevailing noise level in the study area. The 48-hour continuous measurements of prevailing free field noise levels in the vicinity of No. 1 Tai Ling Tsuen are in the range of 45 – 80 dB(A) $L_{Aeq,\ 30min}$. With the inclusion of façade correction, the measured prevailing noise level will be higher than the (ANL-5) criterion, and therefore the (ANL – 5) criterion, i.e. 45 dB(A) $L_{Aeq,\ 30min}$ for night-time period will be considered as the stipulated noise limit for the assessment of operational noise impact. Detail of the noise measurement will be further discussed in *Section 4.3.2*.

In any event, the Area Sensitive Rating assumed in this Report is for indicative assessment only given that there are currently no influencing factors assumed in the vicinity of the NSRs. It should be noted that fixed noise sources are controlled under Section 13 of the *NCO*. At the time of investigation, the Noise Control Authority shall determine noise impact from concerned fixed noise sources on the basis of prevailing legislation and practices being in force, and taking account of contemporary conditions / situations of adjoining land uses. Nothing in this Report shall bind the Noise Control Authority in the context of law enforcement against all the fixed noise sources being assessment.

4.3 BASELINE ENVIRONMENTAL CONDITIONS AND NOISE SENSITIVE RECEIVERS

4.3.1 Baseline Environmental Conditions

The proposed wind turbine system is located on the north-eastern side of Lamma Island. The Study Area is rural in nature and is characterised by predominantly low-rise/village type houses. Background noise is generally low and there are no private vehicles or industrial facilities within the Study Area. The major noise source is identified as the community noise from the residents.

4.3.2 Prevailing Noise Measurement

To investigate the prevailing noise levels at the NSRs, a continuous 48-hour noise measurement has been conducted from 1200 hours on 25 May 2004 to 1200 hours on 27 May 2004. As there were problems in gaining access to the nearest NSR (N1), free-field noise measurement has been made at a close proximity to N1. In addition, as the measurements are conducted off-site from the nearest NSR N1, potential community noise associated with the residents will not be included in the measurement. Therefore, the measured levels are considered to represent the lowest ambient noise levels.

The chirps of the insect "cicadas" were identified as the dominant noise sources during the noise measurement. Although the chirps are seasonal in nature, the cicadas only chirps in early morning and day-time, such that the measured noise levels during night-time would not be affected by the chirps. Therefore the background noise measurement would represent the typical acoustic environment in the vicinity of the NSRs. The noise measurement report is presented in *Annex B1* and the measurement results are summarised in *Table 4.5*. Since the measurement is a free field measurement, an appropriate façade correction of 3dB(A) has been applied to the noise measurement results. A timeline chart showing the prevailing noise levels is presented in *Figure 4.1*.

Table 4.5 Measured Prevailing Free-field Noise Level (with Façade Correction)

Period	$L_{Aeq, 30min}$ dB(A)		
	Minimum	Average	Maximum
0700 – 2300 hours	49.8	65.8	81.9
2300 – 0700 hours	47.6	60.8	82.5

4.3.3 Noise Sensitive Receivers

All NSRs, as defined by *EIAO-TM,* have been identified within an area of 300 m of the Study Area boundary. For NSRs outside the 300m Study Area boundary, such as Tai Wan Kau Tsuen and Lo Tik Wan are also identified. The locations of the NSRs are shown in *Figure 4.2*. No planned NSRs are identified in the study boundary.

Table 4.6 Identified Noise Sensitive Receivers

NSR	Location	Type of Uses
N1	No. 1 Tai Ling Tsuen	Residential (2-Storey)
N2	No. 2 Tai Ling Tsuen	Residential (1-Storey)
N3	No. 3 Tai Ling Tsuen	Residential (1-Storey)
N4	Tai Wan Kau Tsuen	Residential (3-Storey)
N5	Lo Tik Wan	Residential (1-Storey)

4.4 POTENTIAL SOURCES OF IMPACT

4.4.1 Construction Phase

The main construction activities associated with the Project that may cause noise impacts to the nearby NSRs are:

- Site formation - excavation by cutting and filling to form a site platform; construction of retaining wall around site perimeter; and construction of concrete footing for wind turbine foundation;
- E & M Erection - erection of wind turbine and high voltage distribution pillar; and
- Landscaping works - planting of trees and shrubs.

The construction works for Site Formation, E&M Erection and Landscape work will be carried out in phases without overlapping according to planned project programme, i.e. E&M works will be carried out after completion of site preparation and foundation work; and landscaping work will follow the completion of E&M erection.

The use of PME during the construction phase will be the main source of noise impact. For excavation activities associated with the site formation, the use of PMEs such as crane lorry, excavator, hand-held breaker, concrete lorry mixer, and vibratory poker have been considered in the noise impact assessment.

For the erection of wind turbine and high voltage distribution pillars, the use of PMEs such as heavy duty tracked crane, mobile crane and truck have been considered in the noise impact assessment.

Annex B2 presents a detailed list of PMEs, which are provided by the Project Proponent, assumed for each construction activity considered in the noise impact assessment. Project Proponent has confirmed that the plant inventory is practicable for the construction of wind turbine.

The normal working hours of the contractor will be between 0700 and 1900 hours from Monday to Saturday (except public holidays) and construction activities during restricted hours are not expected. Should evening and night works between 1900 and 0700 hours or on public holidays (including Sunday)

be required, the contractor should submit a CNP application and will be assessed by the Noise Control Authority. Conditions stipulated in CNPs should be strictly followed.

4.4.2 Operational Phase

Sources of Wind Turbine Noise

The sources of noise emitted from the operating wind turbine include the rotation of mechanical and electrical equipment and aerodynamic noise originating from the flow of air around the blade. The mechanical and electrical equipment that may have potential noise producing effects are gearbox, transformer and generator.

Aerodynamic noise is produced by the flow of air over the blades, and it generally increases with rotor speed. Aerodynamic broadband noise is typically the largest source of wind turbine noise. The mechanisms of aerodynamic noise can be divided in the following:

- Low frequency noise - It is generated when rotating blade encounters localized flow deficiencies due to the flow around a tower and wind speed changes;
- Inflow turbulence noise - It depends on the amount of atmospheric turbulence. The atmospheric turbulence results in local force or local pressure fluctuations around the blade; and
- Airfoil self noise - It includes the noise generated by the air flow right along the surface of the airfoil.

With reference to the recent study(1) , it is anticipated that vibration introduced by the modern wind turbine will not be a concern as the components of the wind turbine are attached in such a way that vibrations are either not transmitted or are damped. In fact, wind turbine manufactures nowadays use computer aided model in wind turbine design and fabrication to ensure that the vibration of different components do not interact to amplify noise.

It is now a standard practice for the wind turbine manufacturers to incorporate the low-noise design into their standard products. Sound insulation materials will be used in the nacelle to totally enclose the generator, shaft and gearbox so as to minimize medium and high frequency noise. Airfoil blades are purposely designed to reduce aerodynamic noise generated during wind turbine operation. Commercial products of wind turbine available in the market are already standard products of low-noise design.

For the proposed wind turbine, the transformer will be installed inside the tower; while the gearbox and generator will be located inside the nacelle and

(1) Wind Turbine Issues, March 2004. A White Paper prepared by the Renewable Energy Research Laboratory, Centre for Energy Efficiency and Renewable Energy Department of Mechanical and Industrial Engineering, University of Massachusetts at Amherst.

the switchgear and power conditioning devices will be installed in stainless steel huts with 20-30 mm thickness. It is envisaged that the noise from the mechanical and electrical equipment will be comparatively lower than the aerodynamic noise.

Some wind turbines, usually older models with higher rotational speed, may have tonal characteristics and can produce thumping noise. This can be caused by mechanical components or usual wind currents interacting with turbine blades. Pure tone have generally been eradicated in modern wind turbine design

Wind Turbine Noise Source Term

Different wind turbine suppliers offer products of slightly different noise data depending on their equipment specifications and site specific requirements. The proposed wind turbine system has a capacity of 600 – 850kW, with a design maximum blade rotating speed of 31 rpm (refer to *Table 3.1*). This design limits the noise generation, and hence it will also limit the noise impact to the nearby NSRs. In addition, modern wind turbines have already incorporated many designs to reduce the noise emissions.

The information sourced from wind turbine suppliers reveals that the typical maximum sound power levels of 600 – 850kW wind turbine fall approximately in the range of 98 to 104 dB(A) inclusive of the rotation of mechanical parts, sound of electrical components and aerodynamic noise. There has been at least one no. of the prospective suppliers providing Type Approval [1] confirming their 600 - 850kW class wind turbines can be designed to a maximum sound power level of 100dB(A).

The maximum sound power level of wind turbines covers full range of operation including start-up, shut-down, cut-in, cut-out, braking and yawing and full range of wind speeds. The standard design features of modern wind turbines for lowing noise emission levels are described below:

- Designing for Low Mechanical Noise from Wind Turbines

  Mechanical noise is induced from the metal components moving or knocking against each other may originate in the gearbox, in the drive train (the shafts), and in the generator of a wind turbine. The better engineering practices described below can reduce the mechanical noise.

  (i) Quieting Wind Turbine Gearboxes

  Gearboxes for wind turbines are no longer standard industrial gearboxes, but they have been adapted specifically for quiet operation of wind turbines. One way of achieving this is to ensure that the steel wheels of the gearbox have a semi-soft, flexible core, but a hard surface to ensure strength and long time wear.

[1] The Type Approval has been performed in accordance with "*Technical Criteria for Type Approval and Certification of Wind Turbines in Denmark*" of 1 August 1996 incl. Amendment of 1 March 1997.

The gear wheels are heated up after their teeth have been ground, and then cool off slowly while they are packed in a special high carbon-content powder. The carbon will then migrate into the surface of the metal. This ensures a high carbon content and high durability in the surface of the metal, while the steel alloy in the interior remains softer and more flexible.

(ii) Structural Dynamics Analysis

An important consideration, which enters into the turbine design process, is the fact that the rotor blades may act as membranes that may retransmit noise vibrations from the nacelle and tower. Wind turbine manufactures nowadays use computer aided model in wind turbine design and fabrication to ensure that the vibration of different components do not interact to amplify noise.

In addition, holes are drilled into the chassis frame so as to ensure that the frame will not vibrate in step with the other components in the turbine.

- Designing for Low Aerodynamic Noise from Wind Turbines

(i) Rotor Blade Sound Emission

Rotor blades must brake the wind to transfer energy to the rotor. In the process they will cause some emission of white noise. If the surfaces of the rotor blades are very smooth (which indeed they must be for aerodynamic reasons), the surfaces will emit a minor part of the noise. Most of the noise will originate from the trailing (back) edge of the blades. Careful design of trailing edges and very careful handling of rotor blades while they are mounted, have become routine practice in the industry for noise control. In addition, most modern wind turbine systems are pitch controlled, ensuring continuous and optimal adjustment of the angles of the blades in relation to the prevailing wind, so as to maximize the power output yet maintaining low noise levels.

(ii) Rotor Blade Tip Design

Since the tip of the blade moves substantially faster than the root of the blade, great care is taken in the design of the rotor tip. Research has been undertaken for performance reasons, since most of the torque (rotational moment) of the rotor comes from the outer part of the blades. In addition, the airflows around the tip of rotor blades are extremely complex, compared to the airflow over the rest of the rotor blade. Specific rotor blade tip design may be conducted in order to fulfill the site specific requirement.

In conclusion, it is technically feasible and practicable to limit the sound power level for wind turbine to 100 dB(A) by applying the above standard

plant design features. The noise data presented represents a typical noise spectrum of a 600 - 850kW class wind turbine which is technically achievable.

For the tonal quality, there are now standard accepted conditions which are imposed on wind turbine supplier which ensure the absence of tonal content in the wind turbine noise spectra. These conditions are set out in warranty agreements with wind turbine and tonal character is controlled by the compliance level imposed on the wind turbine system. There has been at least one prospective supplier providing certificates confirming their 750kW wind turbine is of pure tone free design. Moreover, the Danish Wind Industry Association and American Wind Energy Association have indicated that pure tones have generally been eradicated completely for modern wind turbines manufactured by a number of the major suppliers.

The Project Proponent has committed to adopt a wind turbine with an overall sound power level of not more than 100 dB(A) and free of pure tones, which will be included as part of their tender specification of wind turbine. The Project Proponent will be requesting all the potential tenderers to confirm the noise performance of their wind turbines before deciding on the wind turbine to be used in the project. The maximum overall noise levels and free of pure tones will be guaranteed by the plant supplier and verified on site during commissioning and testing of the plant in accordance to international standard procedures such as IEC 61400-11.

An overall sound power level of 100 dB(A) with no tonal correction has been assumed in this noise assessment.

When the wind speeds are below and above the cut-in and cut-out wind speed, the wind turbine will become stationary and therefore no noise impacts are expected below or above the cut-in and cut-out wind speed.

Description of Wind Turbine Operation

Normally the rotor speed of proposed wind turbine will vary from 14 to 31 rpm in the range of effective wind speed, i.e. 2.5 to 25 m/s. The rotors will reach the maximum speed when wind speed reaches about 9 – 10 m/s and keep steady up to 25 m/s. Exceeding wind speed of 25 m/s, the wind turbine will cut-off, i.e. the rotating parts of wind turbine including rotor, blades and shaft will all stop, and hence the wind turbine will not cause for the increase in noise level. It should also be noted that in high wind speeds exceeding 10 m/s, the background noise generated by tree, shrub, terrain and wind itself will gradually exceed and mask the wind turbine noise.

Based on the information from various wind turbine suppliers, the sound power levels of wind turbines will reach the maximum when the wind speed is at about 9 m/s, where rotor speed reaches the maximum. The sound power levels in octave bands are presented in Annex B3, which present the maximum noise emission of the wind turbine operating at 9 m/s.

Based on the wind monitoring data, the proposed wind turbine site will have high wind speeds exceeding 9 m/s for less than 10% of time per year. In

view of the low percentage of time in high wind speed, it is anticipated that the wind turbine would be operating for about 90% of the time below 100dB(A).

4.5 *ASSESSMENT METHODOLOGY*

4.5.1 *Construction Phase*

The methodology for the noise impact assessment is in accordance with the procedures outlined in the *GW-TM,* which is issued under the *NCO* and the *EIAO-TM*. In general, the methodology is as follows:

- locate representative NSRs that may be affected by the works;
- determine the plant teams for corresponding activities, based on agreed plant inventories;
- assign sound power levels (SWLs) to the PME proposed based on the *GW-TM* or other sources;
- calculate the correction factors based on the distance between the NSRs and the notional noise source position of the work sites;
- apply corrections in the calculations such as potential screening effects and acoustic reflection, if any; and
- predict the construction noise levels at NSRs in the absence of any mitigation measures.

The total SWL associated with each activity was based on an assumed plant inventory, agreed with the Project Proponent. The notional source position of the work site was established in accordance with the procedures stated in the *GW-TM*. Noise impacts at NSRs were subsequently evaluated by comparing the predicted noise levels with the *EIAO-TM* daytime construction noise limits ($L_{eq, 30min}$ dB(A)), as outlined in *Section 4.2.1*.

4.5.2 *Operational Phase*

The methodology for the noise impact assessment is in accordance with the procedures outlined in the *ISO 9613*[1] and *IND-TM*, which is issued under the *NCO* and the *EIAO-TM*. The assessment will take into account the distance attenuation, atmospheric absorption and corrections of tonality, impulsiveness and intermittency, if any, in accordance with the IND-TM.

To assess the worst-case noise impact from the wind turbine, maximum noise emission of the wind turbine has been taken in the assessment.

(1) ISO 9613 Acoustics - Attenuation of Sound during Propagation Outdoors.

4.6 EVALUATION OF IMPACTS

4.6.1 Construction Phase

Based on the notional source position as identified in accordance with the procedures stated in the *GW-TM*, the source-to-NSR distances are presented in *Table 4.7*.

Table 4.7 Noise Sensitive Receivers

NSR	Location	Approx. Horizontal Distance to Source (m)
N1	No. 1 Tai Ling Tsuen	260
N2	No. 2 Tai Ling Tsuen	313
N3	No. 3 Tai Ling Tsuen	357
N4	Tai Wan Kau Tsuen	450
N5	Lo Tik Wan	460

Based on existing topography, none of the NSRs will have direct line of sight to the construction site (*Annex B5*). Therefore, with reference to the *GM-TM*, a negative correction of 10 dB(A) has been included in the construction noise assessment.

Without the use of mitigation measures, predicted construction noise levels at all NSRs in all stages comply with the stipulated criterion. Details of the calculations are presented in *Annex B2*. A summary of the construction noise levels is presented in *Table 4.8*. As confirmed by the Project Proponent, there will not be overlapping periods between each construction activities. Hence cumulative noise impact during the construction period will not be a concern. Given that the predicted construction noise levels are well within the stipulated noise criterion, mitigation measures are not required to alleviate the noise impacts.

Table 4.8 Construction Noise Levels - Unmitigated ($L_{eq, 30\ min}$ dB(A))

NSRs	Construction Noise Levels at Different Stages, $L_{eq, 30\ min}$ dB(A)		
	Site Formation	Electrical & Mechanical erection	Landscaping
N1	61	54	49
N2	59	52	47
N3	58	51	46

As NSRs N4 and N5 are located further away from the construction site, it is anticipated that the NSRs located in Tai Wan Kau Tsuen and Lo Tik Wan would not be affected by the construction noise.

4.6.2 Operational Phase

Based on the maximum sound power level of 100 dB(A) for a typical wind turbine system, the facade noise levels at the identified NSRs are predicted and summarised in *Table 4.9*. Results indicate that the nearest NSR will be subject to noise level of 45 dB(A), therefore N4 and N5, which are located further away and are shielded by the existing topography, will be subject to

even lower noise level than N1. N4 and N5 are therefore not expected to be affected by the operation of wind turbine.

A 5 dB(A) screening effect is taken into account for the N2 and N3 due to topography shielding and no direct line of sight to the whole swept area of the rotors of the wind turbine (see *Annex B5*). The terrain profiles presented in *Annex B5* are derived by Digital Elevation Model (DEM) basing on the Land Information Centre (LIC) data from the Lands Department. Details of the calculations are presented in *Annex B4*.

Table 4.9 Predicted Facade Noise Levels at NSRs

NSRs	Description	Predicted Facade Noise Level, dB(A)
N1	No. 1 Tai Ling Tsuen	45
N2	No. 2 Tai Ling Tsuen	38
N3	No. 3 Tai Ling Tsuen	37

Results indicated that the predicted facade noise levels will comply with the night-time (ANL-5) noise criterion at all NSRs.

It should be noted that the assessment are on a conservative side as hemispherical propagation model has been assumed in the assessment. Also, based on the methodology outlined in the *ISO 9613,* the predicted noise levels are the maximum worst-case as the assessment has assumed 100% downwind propagation. In reality, NSRs N1 to N3 are not located along the favourable propagation path as Lamma Island is dominant by easterly wind and NSRs N1 to N3 are located to the south-west of the wind turbine. In addition, although the wind turbine will be partially screened by the topography (as shown in *Annex B5*) when viewed from N1, the potential noise screening effect has not been taken into account in the assessment as a conservative approach.

Moreover, the assessment are based on the worst-case scenario whereby the wind turbine is operating at a worst-case wind speed with a maximum sound power levels of 100 dB(A) is assumed. With reference to the wind monitoring data, this worst-case will only happen for less than 10% of time per year. It should also be noted that in this assessment, the worst-case noise directivity effect associated with the wind turbine have been assumed in the direction of the NSRs N1 to N3. In view of the above, the noise assessment, in particular to NSR N1, is considered to be on the conservative side.

The Project Proponent has committed to adopt a wind turbine with an overall sound power level of not more than 100 dB(A) and free of pure tones, which will be included as part of their tender specification of wind turbine. The maximum noise level shall cover full range of operation including start-up, shut-down, cut-in, cut-out, braking and yawing; and full range of wind speeds. The supplier shall guarantee this noise level by providing certificate of measurement and verify the overall noise level during commissioning and testing in accordance to international standard procedures such as IEC 61400-11. Whenever necessary, the supplier shall apply attenuation measures to achieve the guaranteed noise level during detailed design stage.

4.7 MITIGATION MEASURES

4.7.1 Construction Phase

Though the predicted construction noise levels comply with the stipulated noise criterion, good site practice and noise management is recommended for minimising the construction noise impact on nearby NSRs.

It is difficult to quantify the reduction in noise impact that can be expected by adhering to good site practice, however the following measures are recommended to be followed during construction phase to reduce noise impacts:

- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works;
- Machines and plant that may be use intermittently, such as vibratory poker, should be shut down between work periods or should be throttled down to a minimum;
- Plant known to emit noise strongly in one direction, should, where possible, be orientated to direct noise away from nearby NSRs; and
- Mobile plant should be sited as far away from NSRs as possible.

4.7.2 Operation Phase

The noise assessment indicated that, based on a worst-case scenario, with a maximum sound power level of 100 dB(A) and a tone free wind turbine, the predicted facade noise levels will comply with the night-time noise criterion at all NSRs. Hence, no further mitigation measures are required.

4.8 ENVIRONMENTAL MONITORING AND AUDIT

4.8.1 Construction Phase

Given the compliance with the stipulated noise criterion, noise monitoring is not required during the construction stage. Though site audit will be conducted to ensure that the plant inventory used on site are consistent with the assumptions used in the EIA report.

4.8.2 Operation Phase

During the operational phase, noise monitoring is recommended to ensure the compliance with the stipulated noise criterion at the nearby NSRs. A noise monitoring location is proposed at No. 1 Tai Ling Tsuen (N1). It is proposed noise monitoring shall be carried out during the night-time period at the agreed monitoring location once every fourteen days for a period of six consecutive months. Details of monitoring schedule and plan are presented in the separate EM&A Manual.

4.9 CONCLUSION

Unmitigated construction activities associated with the Project will not cause adverse noise impact to the nearby NSRs with the predicted construction noise levels in the range of 46 – 61 dB(A), which comply with the stipulated noise criterion. The mitigation measure of adopting good site practices is proposed to further minimise the construction noise impact to the environment. Regular site audits will be conducted during construction to ensure the plant inventory used on site is consistent with the assumptions in the EIA report.

With the adoption of a maximum sound power level of 100 dB(A) and a pure tone free wind turbine, the predicted facade noise levels will comply with the night-time noise criterion at all NSRs. The Project Proponent has committed to adopt a wind turbine with an overall sound power level of not more than 100 dB(A) and free of pure tones, which will be included as part of their tender specification of wind turbine. Noise monitoring during the operational phase is recommended so as to ensure the compliance with the stipulated noise criterion at the nearby NSRs.

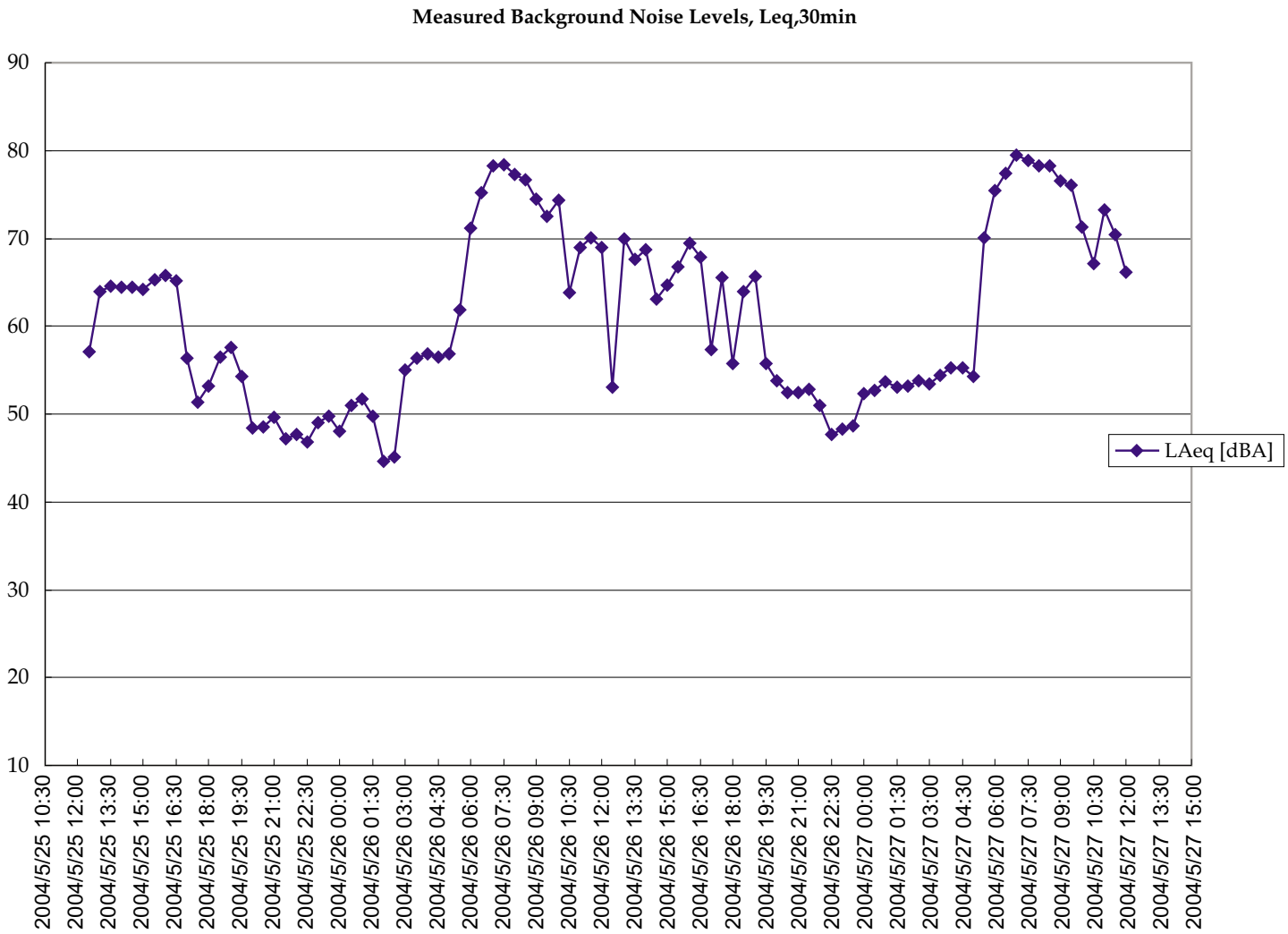


Figure 4.1

MEASURED BACKGROUND NOISE LEVELS

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DATE: 05/07/04

Environmental Resources Management

ERM

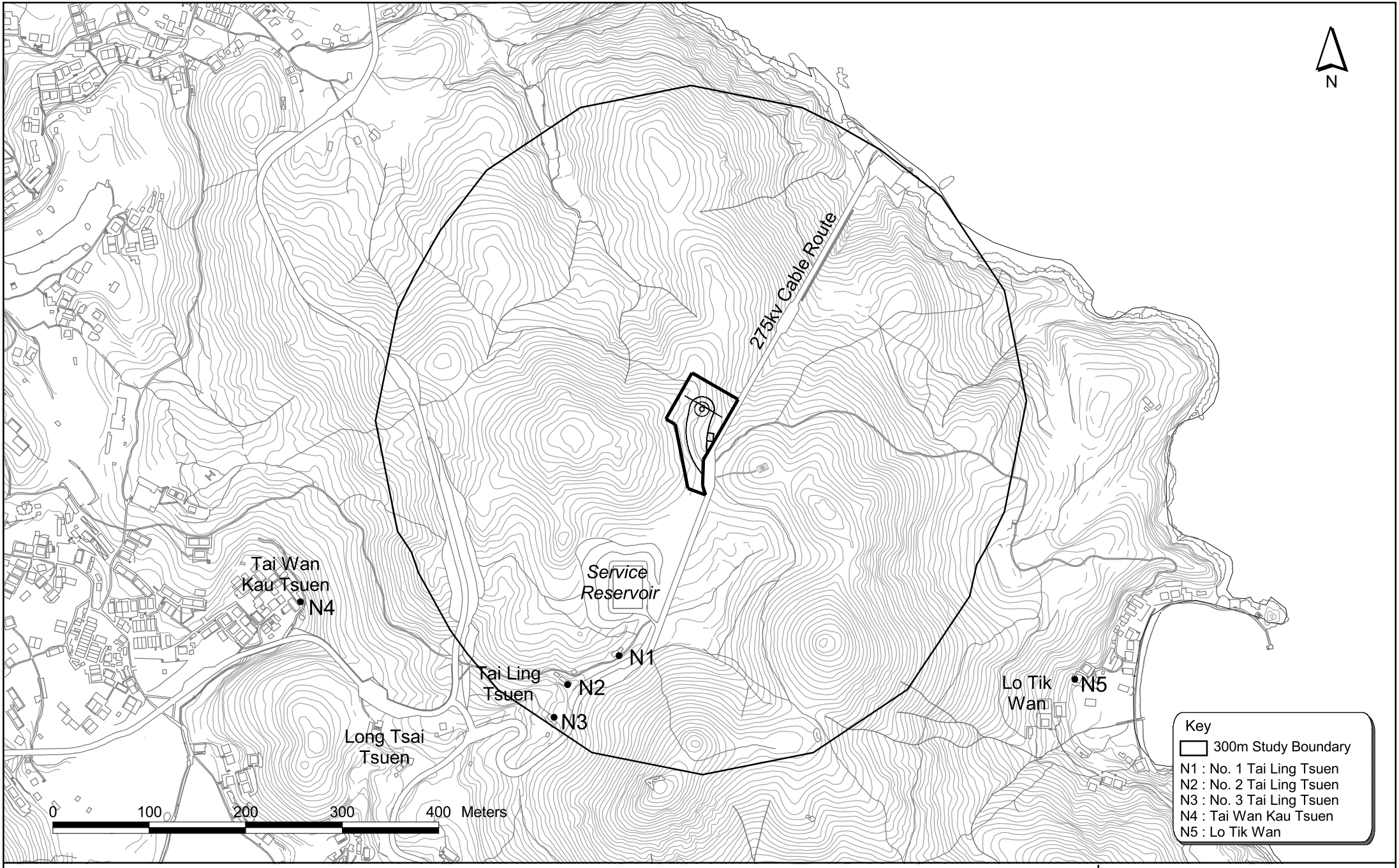

FIGURE 4.2

Location of Noise Sensitive Receivers (NSRs)

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Date: 20/07/04

Environmental Resources Management

ERM

5 ECOLOGY

5.1 INTRODUCTION

This section presents the baseline conditions of ecological resources within the Study Area, results of the assessment of ecological value of the habitat and the potential impacts from the construction and operation of the wind turbine, on ecological resources in the Study Area (*Figure 5.1*). Baseline conditions for each ecological component of the terrestrial environment are evaluated based on information from the literature and focussed field studies conducted for the purposes of this EIA. Measures required to mitigate identified adverse impacts are recommended, where appropriate.

5.2 RELEVANT LEGISLATION AND GUIDELINES

A number of international conventions and local legislation and guidelines provide the framework for the protection of species and habitats of ecological importance. Those related to the Project are:

- *Forests and Countryside Ordinance* (Cap 96);
- *Wild Animals Protection Ordinance* (Cap 170);
- *Animals and Plants (Protection of Endangered Species) Ordinance* (Cap 187);
- *Town Planning Ordinance* (Cap 131);
- *Hong Kong Planning Standards and Guidelines Chapter 10* (HKPSG);
- *The Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO TM)*;
- *United Nations Convention on Biodiversity* (1992); and
- *PRC Regulations and Guidelines*.

The *Forests and Countryside Ordinance* prohibits felling, cutting, burning or destroying of trees and growing plants in forests and plantations on Government land. The subsidiary *Forestry Regulations* prohibit the picking, felling or possession of listed rare and protected plant species. The list of protected species in Hong Kong which comes under the *Forestry Regulations* was last amended on 11 June 1993 under the *Forestry (Amendment) Regulation 1993* made under Section 3 of the *Forests and Countryside Ordinance*.

Under the *Wild Animals Protection Ordinance*, designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals including all cetaceans are protected under this Ordinance, as well as certain reptiles, amphibians and invertebrates. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1997.

The purpose of the *Animals and Plants (Protection of Endangered Species) Ordinance* is to restrict the import and export of scheduled species. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them.

The recently amended *Town Planning Ordinance* provides for the designation of areas such as "Coastal Protection Areas", "Sites of Special Scientific Interest (SSSIs)", "Green Belt" and "Conservation Area" to promote conservation or protection or protect significant habitat.

Chapter 10 of the *HKPSG* covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong, and Government departments involved in conservation.

Annex 16 of the *EIAO TM* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating ecological impacts.

The Peoples' Republic of China (PRC) is a Contracting Party to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The Government of the Hong Kong Special Administrative Region has stated that it will be "committed to meeting the environmental objectives" of the Convention (PELB 1996).

The PRC in 1988 ratified the *Wild Animal Protection Law* of the PRC, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 96 animal species in Class I and 156 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

5.3 LITERATURE REVIEW OF ECOLOGICAL CHARACTERISTICS OF LAMMA ISLAND

5.3.1 Methodology

A literature review was conducted to determine the existing ecological conditions within the Study Area and to identify habitats and species of potential importance that may be affected by the Project. The review of the existing conditions also covered the entire Lamma Island. The local literature review included:

- EIA for Outlying Islands Sewerage Stage 1 Phase 1 (Maunsell 1997);
- Hong Kong Bird Reports;
- *Porcupine!* (Newsletter of Department of Ecology & Biodiversity, University of Hong Kong);
- Hong Kong Amphibians and Reptiles (Karsen *et al* 1998);
- Avifauna of Hong Kong (Carey *et al* 2001);
- Memoirs of Hong Kong Natural History Society;
- EIA for 1800MW Gas-Fired Power Station at Lamma Extension: Terrestrial Ecological Impact Assessment (ERM 1998);
- Ecological Survey for Additional Transmission Route from Lamma Power Station to Pak Kok Tsui Landing Point (ERM 2001);
- EIA for Outlying Islands Sewerage Stage 1, Phase II Package J - Sok Kwu Wan Sewage Collection, Treatment & Disposal Facilities (Maunsell 2003);
- Service on Providing Information on the Suitability of South Lamma, Tung Lung Chau and Po Toi Islands to be Established as Country Park, Report to AFCD (Department of Geography, The Chinese University of Hong Kong 1999);
- Ecology and Biodiversity of a Degraded Landscape: Lamma Island, Hong Kong, HKU PhD. Thesis (Wong 1999); and
- Wind Monitoring Station on Lamma Island: Monthly Report of Bird Strike Incidents (FOE 2001-2002).

5.3.2 Results

Lamma Island

Habitat and Vegetation

The most comprehensive habitat and vegetation surveys on Lamma Island were undertaken by Wong (1999) and Department of Geography, The Chinese University of Hong Kong (1999). Wong (1999) revealed that Lamma Island is an outlying island of an area of approximately 13.7 km^2 and of different habitats including forests, shrublands, grassland, urbanized area, cultivation field, bare soil and water body. The details of the habitat types recorded on Lamma Island are presented in *Table 5.1*.

Table 5.1 Habitat Type of Lamma Island

Habitat Type	Area (km^2)	Percentage Cover (%)
Forest	0.943	6.90
Ravine Forest	0.113	0.84
Forest Plantation	0.4	2.97
Tall Shrubland	0.994	7.37
Tall Shrubland with Grass	1.453	10.77
Low Shrubland	0.413	3.06
Low Shrubland with Grass	2.954	21.89
Grassland	3.873	28.69
Urbanized/Developed Area	1.448	10.73
Cultivation Field	0.251	1.86
Abandoned Cultivation Field	0.263	1.95
Bare Soil	0.495	3.67
Water Body	0.08	0.60

(Information extracted from Wong 1999)

Lamma Island was dominated by grasslands and shrublands which occupied 71.8% of the island. The Island has very limited size water bodies. Grassland and shrubland are mostly found in the north of the Island and north of Ling Kok Shan and Ngai Tau. Urbanized areas and cultivation were mainly located on the north of Lamma Island, around Yung Shue Wan. Small patches of urbanized areas were found around Sok Kwu Wan, Lo Tik Wan and Lo So Shing.

According to Wong's study (1999), 648 plant species were recorded on Lamma Island and 151 of those were classified as either very rare or rare and most of them were located at the fringe or within the forests, despite the small forest area on the island. The representative rare and very rare plant species are listed in *Annex C Table 1*.

Birds

There has been no systematic study of the avifauna on Lamma Island and the majority of the information available comes largely from anecdotal records. A total of 102 bird species have been sighted over time on Lamma Island from published literature and bird watchers' unpublished data since 1970s and the sightings were reported from different seasons (*Annex C Table 2*). Among the recorded bird species, 12 species were listed either as Class II protected species in PRC or Appendix II of CITES or in China Red China Book including White-bellied Sea Eagle *Haliaeetus leucogaster*, Black Kite *Milvus migrans* and Crested Goshawk *Accipiter trivirgatus* (*Table 5.2*).

Table 5.2 Protected Bird Species Recorded on Lamma Island (from Literature Review)

Species*	Habitat	PRC Protection Status	China Red Data Book	CITES Appendix
Pacific Reef Egret	Coastal area of Hong Kong	II	Rare	
Black-eared Kite	Found in many types of habitat	II		
Common Buzzard	Found in many types of habitat	II		
Crested Goshawk	Usually found in wooded hillsides	II	Rare	II
Chinese Goshawk	Usually in marshes or lightly-wooded hillsides	I		
White-bellied Sea Eagle	Hong Kong's coastal area, much scarcer in other parts of China	II	Rare	II
Bonelli's Eagle	Found in many types of habitats, but usually in lightly-wooded hillsides	II	Rare	II
Kestrel	Found in many types of habitats	II		
Greater Coucal	Mainly found in shrubland and woodland edge	II		
Lesser Coucal	Mainly found in shrubland	II		
Emerald Dove	Mainly found in woodland		Vulnerable	
Hill Myna	Mainly found in woodland and woodland edge		Vulnerable	III

Note: * All birds are protected in Hong Kong under the *Wild Animals Protection Ordinance (Cap. 170).*

South Lamma Island was designated as a Site of Special Scientific Interest (SSSI) in 1980, aiming to protect the nesting habitats of White-bellied Sea Eagle *Haliaeetus leucogaster* and Bonelli's Eagle *Hieraetus fasciatus* near Mount Stenhouse. However, neither White-bellied Sea Eagle nor Bonelli's Eagle nesting records have been reported in the SSSI in recent years.

During monthly monitoring of bird strike incidents for a Wind Monitoring Station on Lamma Island (located at Ngau Tau, approximately 4 km from the Study Area), Black Kite were frequently recorded and White-bellied Sea Eagle was occasionally recorded (FOE 2001-2002). No bird strike incident was recorded during the monitoring period from October 2001 to July 2002.

Nearly half of the previously recorded bird species are summer visitors, residents or species present in Hong Kong all year round (48 out of 102 species). Thirteen out of the 102 previously recorded species are migrants that utilise the open water areas (usually in East Lamma Channel). More than 25 species out of the 102 previously recorded species either utilise coastal or wetland habitats.

Herpetofauna

Aside from the Romer's Tree Frog *Philautus romeri*, all of the amphibian species recorded in Lamma Island, including Asian Common Toad *Bufo melanostictus*, Gunther's Frog *Rana guentheri*, Paddy Frog *Rana limnocharis*, Brown Tree Frog *Polypedates megacephalus*, Asiatic Painted Frog *Kaloula pulchra* and Ornate Pigmy Frog *Microhyla ornate,* are common and widespread in Hong Kong (Lau and Dudgeon 1999). Romer's Tree Frog is endemic to Hong Kong and is considered as a rare species. The Romer's Tree Frog was first

recorded in Lamma in 1952, and the species was rediscovered there in 1984 (Karsen *et al* 1998). The species was recorded near caves and cultivated fields on the island, mostly near Sok Kwu Wan or south Lamma (ibid.). Romer's Tree Frog also occurs on several other islands, including Lantau and Po Toi (ibid.), and since then has been introduced to Hong Kong Island and the New Territories under a conservation program.

Reptiles recorded in terrestrial habitats of Lamma Island included Checkered Keelback *Xenochrophis piscator,* Bamboo Snake *Trimeresurus albolabris,* Plumbeous Water Snake *Enhydris plumbea,* Taiwan Kukri Snake *Oligodon formosanus,* Burmese Python *Pythonmolurus bivittatus,* Reeves' Terrapins *Chinemys reevesii,* Red-eared Sliders *Trachemys scripta* and Three-banded Box Terrapin *Cuora trifasciata* (Anon 1996, 1997; Karsen *et al* 1998; Maunsell 2003). Burmese Python is listed in Appendix II of CITES and is a Class I protected species of the PRC (Zhao 1998). Three-banded Box Terrapin is a Class II protected species of the PRC and is considered as "endangered" by IUCN (Zhao 1998). All terrapins and Burmese Python are protected in Hong Kong under the *Wild Animals Protection Ordinance*.

Dragonflies and Butterflies

Forty butterfly species were reported in Lamma Island previously (Maunsell 2003). All the species are presented in *Annex C Table 3*. The reported butterflies included 6 rare and 10 uncommon species, including the protected species Birdwing *Troides helena*. There were only two dragonfly species, *Orthetrum sabina* and *Pantala flavescens*, recorded previously (Maunsell 2003).

Mammals

Mammals recorded on Lamma Island included Javan Mongoose *Herpestes javanicus,* Japanese Pipistrelle *Pipistrellus abramus*, Lesser Bent-winged Bat *Miniopterus pusillus* and Bi-coloured Round-leaf Bat *Hipposideros pomona* (Ades 1999; Maunsell 2003). All bats are protected in Hong Kong under the *Wild Animals Protection Ordinance*.

Stream Fauna

There is limited information on aquatic fauna available on Lamma Island.

Study Area

The literature review revealed that limited published information on flora and fauna was available within the Study Area.

5.4 EFFECTS OF WIND FARMS ON ECOLOGICAL RESOURCES (OVERSEAS EXPERIENCE)

It has been acknowledged in the international literature that the operation of wind turbines and wind farms have limited effects on ecological resources. The exception to this has been reported effects on migratory birds. Poor site selection has lead to the siting of windfarms on bird migration routes leading

to subsequent bird strikes. An overseas literature review was subsequently undertaken to determine the effects of wind power projects on ecological resources and in particular birds. The major overseas literature review included:

- Lochelbank Wind Farm: Environmental Statement (ERM-UK 2004)
- Heemskirk Wind Farm: Development Proposal and Environmental Management Plan (Hydro Tasmania 2003)
- Windfarms and Birds: An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues (BirdLife International 2003)
- Avian Collisions with Wind Turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States (Erickson *et al* 2001)
- Potential Impacts of Wind Turbines on Birds at North Cape, Prince Edward Island (Kingsley & Whittam 2001)
- Wind Farms and Birds (RSBP 2004)

It should be noted that the above aspects are concerned with windfarms and are thus larger scale than the proposed single wind turbine on Lamma Island.

Habitat loss, habitat fragmentation/isolation and disturbance to wildlife are the typical ecological impacts due to the development projects including wind farm/ turbine. In addition to such typical ecological impacts, the wind farm could result in the following impacts on birds and their movement (Erickson *et al* 2001; Kingsley & Whittam 2001; Hydro Tasmania 2003; BirdLife International 2003; ERM-UK 2004):

- Habitat avoidance/ disturbance;
- Creation of a barrier effect to bird movement; and
- Bird injuries or death through collision with operating turbines and wires or as a result of being attracted to the turbine at night time by lighting used for safety reasons to mark the turbine location.

BirdLife International recently reviewed and analysed the effects of windfarms on birds with the following recommendation:

- The effects attributable to wind farms are variable and are species-, season- and site-specific.
- There is some indication that wind turbines may be barriers to bird movement. Whether this is a problem will depend on the size of the wind farm, spacing of turbines, the extent of displacement of flying birds and their ability to compensate for increased energy expenditure.

- The majority of studies have quoted low collision mortality rates per turbine, but in many cases these are based only on found corpses, leading to under-recording of the actual number of collisions.

- Relatively high collision mortality rates have been recorded at several large, poorly sited wind farms in areas where large concentrations of birds are present, especially migrating birds, large raptors or other large soaring species, eg Altamont Pass in California, USA, Tarifa and Navarra in Spain. In these cases, actual deaths resulting from collision are high, notably of golden eagle *Aquila chrysaetos* and griffon vulture *Gyps fulvus*, respectively.

- The weight of evidence to date indicates that locations with high bird use, especially by species of conservation concern, are not suitable for wind farm development (eg in Spain, regional recovery plans prohibit wind farms in areas important for the breeding and feeding of imperial eagles *Aquila heliaca*). Site selection is crucial to minimizing collision mortality. The precautionary principle is advocated where there are concentrations of species of conservation importance. It is, therefore, very important that alternative locations are proposed for the potentially most hazardous wind farms.

On the basis of the literature review, conservation status of bird species and more than 10 years collective experience of BirdLife International (2003) a number of indicative bird groups which are considered to be particularly sensitive, or potentially so, to wind farms have been identified and these are listed in *Table 5.3*.

The bird species recorded in Lamma Island (from the literature review) were consequently evaluated in *Table 5.3* in order to classify the primary species which are considered to be more vulnerable to wind turbine collisions during operation.

Table 5.3 ***Bird Species Identified to be Sensitive to Wind Farm (Collisions) (Extracted from BirdLife International 2003)***

Species Group	Local Status
Gaviidae divers	Recorded in Hong Kong but not in Lamma Island.
Podicipedidae grebes	Recorded in Hong Kong but not in Lamma Island.
Sulidae gannets & boobies	Recorded in Hong Kong but not in Lamma Island.
Ciconiiformes herons & storks	Recorded in Hong Kong. Species recorded in Lamma Island (mainly wetland and coastal habitats) included Pacific Reef Egret (*Egretta sacra*), Purple Heron (*Ardea purpurea*), Striated Heron (*Butorides striatus*), Little Egret (*Egretta garzetta*), Black-crowned Night Heron (*Nycticorax nycticorax*), Chinese Pond Heron (*Ardeola bacchus*), Cattle Egret (*Bubulcus ibis*), Grey Heron (*Ardea cinerea)* and Yellow Bittern (*Ixobrychus sinensis*).
Anserini swans and geese	Recorded in Hong Kong but not in Lamma Island.
Anatinae ducks	Recorded in Hong Kong but not in Lamma Island.
Accipitridae raptors	Recorded in Hong Kong. Species recorded in Lamma Island (mainly resident) included Black Kite (*Milvus lineatus*), Common Buzzard (*Buteo buteo*), Bonelli's Eagle (*Hieraaetus fasciatus*), White-bellied Sea Eagle (*Haliaeetus leucogaster*), Crested Goshawk (*Accipiter trivirgatus*) and Chinese Goshawk (*Accipiter soloensis*).
Stenidae terns	Recorded in Hong Kong. Species recorded in Lamma Island (mainly in the open waters) included Black-napped Tern (*Sterna sumatrana*), Common Tern (*Sterna hirundo*), Roseate Tern (*Sterna dougallii*), Aleutian Tern (*Sterna aleutica*) and Gull-billed Tern (*Gelochelidon nilotica*).
Alcidae alcids/suks	Recorded in Hong Kong but not in Lamma Island.
Strigiformes owls	Recorded in Hong Kong but not in Lamma Island.
Tetraonidae	No records in Hong Kong.
Gruidae cranes	Recorded in Hong Kong but not in Lamma Island.
Otididae bustards	No records in Hong Kong.
Passeriformes especially nocturnal migrants	Recorded in Hong Kong and some species (mainly non- nocturnal migrants) can also be found in Lamma Island.

In addition to the above recommendations of BirdLife International (2003), the definitions below have been used in this study to classify all the previously recorded bird species in Lamma Island into primary (most at risk from impacts) or secondary species:

Primary Species

- Study Area comprised suitable foraging or breeding habitats for the species, and the flight heights and paths of their usual activities fall within the height of the proposed wind turbine (approximately 19 - 71 m above ground level); and
- Aerial foragers, including all raptors, swifts, swallows, which spend a large proportion of their behaviour flying.

Secondary Species

- The species has been recorded on Lamma Island, but the areas within and in the vicinity of the Project Area do not provide suitable habitat for the species; and

- The species usually does not fly over the Study Area at similar height of the proposed wind turbine (approximately 19 - 71 m above ground level).

Details and results of the evaluation are presented in *Annex C Table 4*.

5.5 IDENTIFICATION OF INFORMATION GAP

5.5.1 Introduction

Lamma Island is generally dominated by grassland and shrubland, and lacks wetland habitats (ie marsh). The majority of the habitat types within the Study Area, based on the recent aerial photographs (CW39442 dated 17th April 2002 at 3500 ft and CW48755 dated 3rd July 2003 at 4000 ft) and the reconnaissance survey undertaken on 17th May 2004, are hilly shrubby grassland, shrubland, and lowland woodland.

5.5.2 Scope of Field Surveys

In accordance with the literature review discussed in *Section 5.3* (since 1970s) and the site condition of the Project Area as well as the Study Area, the habitat characteristics of hilly areas, dominated by shrubby grassland and shrubland with relatively low ecological value, indicates that few migratory birds are expected to utilise the area. Lamma Island is not considered to be located along/within the major flight paths of migratory birds due to the lack of their preferred habitats (ie wetlands and marshes). The literature review also indicated that the seasonality of the bird population in Lamma Island is not significant. From the bird reports it was apparent that raptors would therefore be considered to be the major bird species that could be influenced by the wind turbine during operation (bird sensitivities to wind turbines are discussed in *Section 5.4* and *Table 5.3*). Since the raptors including the Black Kite and White-bellied Sea Eagle are mainly resident and could be recorded all year round, bird surveys focussing on the raptors can be undertaken at any time of the year.

With consideration of the listed issues as discussed above and the bullet points below, six months of ecological baseline surveys were not considered necessary:

- only one wind turbine to be constructed;

- proposed site avoided known ecologically sensitive areas;

- small areas to be affected;

- habitats within the Project Area as well as the Study Area dominated by hilly shrubby grassland and shrubland with relatively low ecological value;
- lack of preferred habitats for migratory birds within the Study Area; and
- low seasonality of bird population.

As a consequence, a number of wet season ecological baseline surveys (recommended in the following section) were conducted to collect ecological baseline information for the construction and operational impact assessment.

The surveys were conducted during May-June 2004 (ie wet season), which is expected to be adequate to collate sufficient ecological baseline data for the impact assessment due to the nature of the project (only one turbine), small size of Project and Works Areas (approximately 0.5 ha in total) and the ecological characteristics of the Study Area (areas avoided ecological sensitive areas including potential Country Parks and SSSI during site selection, with relative low ecological significance). The surveys included habitat/vegetation, bird, invertebrates (butterfly and dragonfly), herpetofauna, mammal and stream fauna surveys.

5.6 ASSESSMENT METHODOLOGY

5.6.1 Ecological Baseline Survey

The Study Area was defined as the area within 500 m of either side and along the Project boundary. Following a literature review of available ecological data characterising the Study Area, reconnaissance survey was undertaken in May 2004 to update and field check the validity of the information gathered in the review. A number of more focused baseline field surveys were then identified and carried out to characterise the existing ecological conditions. The surveys were designed to fill data gaps identified in *Section 5.5* in order to facilitate a compliant assessment of the Project's impacts upon ecology and the development of appropriate mitigation measures. Special attention was paid to those areas which will be directly impacted by the proposed construction works.

The following baseline surveys were identified as being required:

- Habitat and vegetation surveys;
- Bird survey;
- Other wildlife including invertebrates, mammals and herpetofauna survey (including night surveys); and,
- Stream fauna survey.

Habitats and Vegetation

Field surveys were focused on the habitats within the Study Area and were performed on 17th and 20th May 2004. The aim was to record ecological data within the Study Area and establish the ecological profile.

Habitats were mapped based on government aerial photographs (year 2002 and 2003) and field ground truthing. Representative areas of each habitat type were surveyed on foot. Plant species of each habitat type encountered and their relative abundance were recorded with special attention to rare or protected species. Nomenclature and conservation status of plant species follow Xing *et al* (2000) and Wu and Lee (2000).

Birds

Habitats and areas of potential ecological importance for avifauna within the Study Area were identified in a reconnaissance survey. Baseline surveys of bird populations were undertaken within those selected habitats using two quantitative methods (point count and vantage point methods). Bird surveys were carried out on 20th, 23rd, 26th, 29th & 30th May, and 6th June 2004. Night surveys were undertaken on 29th and 30th May 2004.

Point Count Method

Bird communities in each habitat type recorded within the Study Area, including mainly young woodland, shrubland and shrubby grassland, were surveyed using the point count method. A total of 9 sampling points were selected and their locations are shown in *Figure 5.1*. Ten minutes were spent counting birds at each sampling point. All birds seen or heard within 30 m of the sampling points were counted. Activities of the birds were categorized into 4 classes: perching/preening (P), foraging (Fr), flying above (Fl) and engaging in breeding activities (Br). Signs of breeding (e.g. nests, recently fledged juveniles) within the Study Area were also recorded. Observations were made using 8X binoculars and photographic records were taken if possible. Bird abundance in each type of habitat was expressed in number of birds per hectare (total birds counted divided by total surveyed area).

Bird species encountered outside counting points but within the Study Area were also recorded to produce a complete species list. Signs of breeding (e.g. nests, recently fledged juveniles) were also recorded. Ornithological nomenclature followed Carey *et al* (2001).

Vantage Point Method

The aim of the vantage point method was to determine flight activity patterns over the proposed Project site in order to (1) identify areas of critical importance to birds and (2) estimate collision likelihood at wind turbine sites with reference to the recorded flight path of the potentially affected bird species (ERM-UK 2004). Two vantage points (VPs) were identified to observe the entire Study Area. It is noted that the wide coverage of the two

VPs meant that ~ 90% of the Study Area was visible. Watches were undertaken by a single observer (bird specialist) in any weather conditions except poor visibility (<300m). Weather conditions (wind direction, precipitation and visibility) were recorded at start of each watch, then at every subsequent hour. At each vantage point the observer spent at least 3 hours for each survey. The Study Area was divided into five zones, Zone 1-5, to facilitate the data recording (*Figure 5.1*). During each watch, 2 hierarchical recording methods were used to record data as follows:

(a) The arc visible from the VP was scanned constantly until a *primary species* (ie raptors, terns and herons) was detected in flight. Once detected, the bird was followed until it ceased flying or was lost from view. The time of the bird detected was recorded to the nearest minute. The route followed by the bird was plotted in the field on to 1:5 000 scale maps, regardless of whether or not the bird was within the Study Area. For each flying bout the time spent within the Study Area was recorded to the nearest second. The bird's flying height was estimated at the point it entered the Zone 5 (interval 0) and at 15 sec intervals thereafter, and classified as flying height > 10 m, < 100 m or > 100 m above ground level. Due to the topography of the Study Area, the bird's flying height cannot be estimated outside Zone 5. These observations had priority over method (b).

(b) At the end of each 5-min period, flight activity within the Study Area by *secondary species* (ie rails, bulbuls, cuckoos, and white eyes) were summarised. Data recorded included the number of flying birds, i.e. the minimum number of individuals that could account for the activity observed, details of notable movements, e.g. number, height and direction of secondary species flights.

Nest Searches

Searches for evidence of avian breeding activity within the Study Area were undertaken during the surveys. Species targeted for nest searches were raptors and waterbirds. Searches for raptor nests involved roaming around areas of high raptor activity (e.g. coastal cliffs) and other areas of suitable nesting habitat (e.g. woodlands). Searches for waterbird breeding activity involved roaming along the coastal areas. In addition to visually searching for nests, any observations of bird behaviour that might indicate a nest in the vicinity were noted.

Other Wildlife

Surveys of other wildlife (herpetofauna, dragonfly, butterfly and mammals) within the Study Area were carried out on 27th May, 2nd and 7th June 2004. Night surveys for the wildlife, particularly amphibians and mammals, were carried out on 7th June 2004.

Invertebrate Survey

Surveys of terrestrial invertebrates (butterflies and Odonate) were undertaken within the Study Area. The invertebrate survey was designed to search for and to record dragonfly and butterfly species, as well as their relative abundance in each habitat type within the Study Area. Nomenclature for butterflies follows Walthew (1997) and dragonfly nomenclature followed Wilson (2003).

Herpetofauna Survey

Herpetofauna surveys were conducted through direct observation and active searching in potential hiding places such as among leaf litter, inside holes, under stones and logs within the Study Area. Dip-netting was used to survey tadpoles in aquatic habitats such as streams and pools. Auditory detection of species-specific advertisement calls was also used to survey frogs and toads. All major habitat types within the Study Area were surveyed. No quantification of abundance of herpetofauna in the Study Area will be made, due to the secretive nature of these fauna. Therefore, efforts were made to produce a species list in the Study Area through active searching. During the surveys, all reptiles and amphibians sighted and heard were recorded. Night time surveys for amphibians were also undertaken. Nomenclature used in this report for reptiles follows Karsen *et al* (1998) while that of amphibians follows Lau and Dudgeon (1999).

Mammal Survey

As most mammals occur at low densities, all sightings, tracks, and signs of mammals were actively searched. Night time survey was also undertaken during the survey. Nomenclature for mammals followed Reels (1996) and Wilson and Reeder (1992). No quantification of abundance of mammals in the Study Area was made, due to the difficulties in translating sights and tracks (eg burrows) to actual abundance.

Stream Fauna Survey

Streams identified within the Study Area were visited. The stream fauna were studied by direct observation and active searching.

5.6.2 Assessment Methodology

The information presented in the following sections has been based on the findings of baseline surveys performed during the period May to June 2004. The importance of potentially impacted ecological resources identified within the Study Area was assessed using the *EIAO TM*. The potential impacts due to the construction and operation of the wind turbine and associated construction were then assessed (following the *EIAO TM Annex 16* guidelines) and the impacts evaluated (based on the criteria in *EIAO TM Annex 8*).

5.7 ECOLOGICAL BASELINE CONDITION

5.7.1 Existing Habitat and Vegetation

Most of the Study Area remained natural with some areas partly disturbed by rural/village developments. Habitats found within the Study Area include secondary woodland, shrubland, shrubby grassland, village/developed area and streams (*Figure 5.2*). Colour photographs of all recorded habitat types, as well as other features and species of conservation interest, are presented in *Figures 5.3 to 5.7*.

A total of 122 plant species were recorded (*Annex C Table 5).* A locally protected species *Pavetta hongkongensis* was recorded within the Study Area (*Figure 5.8*). The number of plant species and the size of each identified habitat type are presented in *Table 5.4*.

Table 5.4 Habitat Types Recorded Within the Study Area

Habitat type	Area (hectare)/ Length (Km)	Number of Plant Species Recorded
Secondary Woodland	20.5 ha	64
Shrubland	49.4 ha	74
Shrubby Grassland	5.7 ha	25
Stream		42
Stream S1	0.03 km	
Stream S2	0.38 km	
Stream S3	0.46 km	
Stream S4	0.23 km	
Village/Developed Area	3.8 ha	18

Secondary Woodland

Secondary woodlands were found mainly at the east and southwest of the Study Area. A total of 64 plant species were recorded in the secondary woodlands.

The secondary woodlands located at the southwest of the Study Area were semi-natural with exotic plantation at the fringe of the woodland and the understory was dominated by native plant species. The secondary woodlands were fragmented by the 275 kV Cable Route, which was covered by cement and grass-crete acting as a concrete road connecting to other areas on Lamma Island. The exotic plantation was found mainly at the fringe of the woodland and along the 275 kV Cable Route at Tai Wan Kau Tsuen, Long Tsai Tsuen and Tai Ling Tsuen. Village houses were scarcely located within the woodland, which were mainly on both sides of the 275 kV Cable Route. The canopy species were 10 to 14 m in height and dominated by *Acacia confusa*, *Albizia labbeck*, *Leucaena leucocephala* and *Melaleuca leucadendron*. The understory was occupied by native trees and shrubs, which can be divided into a middle layer 4 to 8 m in height and a lower layer 1 to 3 m in height. The middle layer of understory was dominated by *Cinnamomum camphora, Macaranga tanarius* and *Schefflera octophylla* while the lower layer of understory was dominated by *Ilex asprella, Litsea glutinosa* and *Sterculia lanceolata*.

Secondary woodland found in the east of the Study Area near Lo Tik Wan was a large patch of woodland dominated by native tree species. Village houses were scarcely located within the woodland and some of them were abandoned. The woodland was dominated by climax species such as *Cinnamomum camphora*, *Mallotus paniculatus*, *Sterculia lanceollata*, *Macaranga tanarius* and *Dimocarpus longan*. Canopy species reached a height of 12-15 m. The understorey was densely vegetated and dominated by woody species including *Litsea rotundifolia*, *Ligustrum sinensis, Eurya nitida* and the climbers *Gnetum montanum* and *Uvaria microcarpa*. A locally protected species *Pavetta hongkongensis* were found within the secondary woodland (*Figures 5.7 & 5.8*). This woodland is remote from the turbine location.

Shrubland

Shrubland was the dominant habitat type within the Study Area and was 1 to 4 m in height. It was dominated by several native shrub species including *Rhodomrytus tomentosa*, *Cratoxylum cochinchinensis*, *Dalbergia benthami*, *Eurya nitida*, *Embelia laeta*, *Embelia ribes* and *Gordonia axillaries*. Shrubland patches in the valleys were usually taller with an average 2 to 4 m in height while those on the hill slope and ridge of the hills were 1 to 2.5 m in height. A total of 74 plant species were recorded within the shrublands.

Shrubby Grassland

Shrubby grasslands were mainly found in the middle of the Study Area and close to the Project Area, which was located at the north of Yung Shue Long Old Village and next to the WSD Service Reservoir. The area was expected originally to have been shrublands but has been disturbed due to hill fires leading the area to become dominated by grass species. The area had been burnt a short period of time before the surveys. A total of 25 plant species were recorded within the shrubland and dominated by *Ischaemum aristatum* and *Eriachne pallescens*.

Streams

Three partially modified and one less disturbed streams, S1 to S4, were found within the Study Area (*Figure 5.2*). Forty-two plant species were recorded along the streams and no rare/protected species were found during the surveys.

Stream S1 is a drainage channel running along with the 275 kV Cable Route (*Figure 5.2*). The lower course of stream S1 was cemented while the upper course was an underground channel. Only limited water flow was recorded in Stream S1 during the survey.

Stream S2 was partially channelized in the upper and middle courses (from the Service Reservoir to Tai Ling Tsuen). Stream S2 has natural bottom, particularly in the middle and lower courses, dominated by medium to small sized boulders and sand. The upper and middle courses were covered by the close canopy of the adjacent woodland while the lower course of the stream

was more open with limited shading by the shrubs and grasses in the vicinity. Only limited water flow was recorded in lower course and no water flow recorded in the upper and middle courses during the survey.

Stream S3, located at the north-west of the Study Area, was relatively less disturbed. Water flow in stream S3 was low and the stream bank was natural with medium-sized boulders and sand bottom. The riparian vegetation of the stream was integrated with the surrounding shrubland with semi-open canopy.

Stream S4 was partially channelized in the lower course but the upper and middle courses remained natural, with relative steep slope. The bottom of Stream S4 remains natural, composed of sand and small to medium sized boulders. No water was found in the upper course. The middle course has several small pools filled with water but the water flow was limited. The close canopy of secondary woodland covered the whole section of the stream with limited open space in the middle and lower courses.

Village/Developed Areas

Village/developed areas, comprising village houses, 275 kV Cable Route and the Service Reservoir, were scattered within the Study Area. The Service Reservoir was located close to the Project Area. All of the vegetation recorded within this habitat type, such as *Michelia alba* and *Ficus microcarpus*, were planted for landscaping purposes. Fruit trees such as *Musa paradisiacal, Dimocarpus longan, Citrus sinensis* and *Clausena lansium* were also recorded in this habitat. This habitat was highly developed in nature with limited ecological significance. A total of 18 plant species were found in this habitat and no rare plant species were found.

5.7.2 Wildlife

Birds

Thirty-eight bird species were recorded during the surveys (*Annex C Table 6*). There were five bird species of conservation interest, including Black Kite *Milvus migran*, Greater Coucal *Centropus sinensis,* Lesser Coucal *Centropus bengalensis,* Emerald Dove *Chalcophaps indica* and White-bellied Sea Eagle *Haliaeetus leucogaster*, encountered during the surveys. Black Kite, Greater Coucal and Lesser Coucal are recognized as Class II protected species in PRC. Emerald Dove is classified as vulnerable species in the China Red Data Book. White-bellied Sea Eagle, encountered during the vantage point survey, is listed as rare species in the China Red Data Book, Class II protected species in PRC and CITES Appendix II.

Point Count Surveys

A total of 35 species of birds were recorded during the point count surveys, with a total of 578 birds counted. Sixteen of the species encountered were resident to Hong Kong. Large Hawk Cuckoo (*Cuculus sparverioides*) and

Plain Prinia (*Prinia inornata*) were recorded outside the point count and the vantage point locations. White-bellied Sea Eagle *Haliaeetus leucogaster* was recorded only during the vantage point survey. Estimated bird abundance and recorded number of bird species in each type of habitat are summarised in *Table 5.5*. The highest bird abundance and total number of species was recorded in the woodland.

Table 5.5 Mean Abundance and Number of Species of Bird Community of Different Types of Habitat in the Study Area

Habitat	Secondary Woodland	Shrubland	Shrubby Grassland
Abundance (no. of individuals ha^{-1})	53.5	42.3	17.5
No. of species	30	19	18

Among the recorded species, the most frequently counted birds were the Black Kites, a total number of 178 birds were counted, representing 30.8% of all birds. Red-whiskered Bulbul *Pycnonotus jocosus*, Chinese Bulbul *P. sinensis* and Sooty-headed Bulbul *P. aurigaster* were also frequently recorded. Rankings of the most common 10 species are summarized in *Table 5.6*. The details of bird species recorded at each point count location are summarised in *Annex C Tables 7a-c*.

Table 5.6 Most Common Birds Recorded in the Surveys and Their Relative Abundance

Ranking	Common Name	Scientific Name	Category	Total number of counts	Relative abundances (%) of total counts (578)
1	Black Kite	*Milvus migrans*	Primary Species	178	30.8
2	Red-whiskered Bulbul	*Pycnonotus jococus*	Primary Species	52	9.0
3	Chinese Bulbul	*Pycnonotus sinensis*	Primary Species	51	8.8
4	Sooty-headed Bulbul	*Pycnonotus aurigaster*	Primary Species	25	4.3
5	Magpie Robin	*Copsychus saularis*	Secondary Species	23	4.0
6	Crested Myna	*Acridotheres cristatellus*	Primary Species	21	3.6
7	Lesser Coucal	*Centropus bengalensis*	Primary Species	20	3.5
8	Spotted Dove	*Streptopelia chinensis*	Primary Species	19	3.3
9	Greater Coucal	*Centropus sinensis*	Primary Species	18	3.1
10	Common Tailorbird	*Orthotomus sutorius*	Secondary Species	17	2.9

Vantage Point Survey

A total of 17 species (all primary species) were observed during the vantage point surveys, with a total of 1,290 flight attempts observed within the Study Area. Apart from the two raptors (Black Kite (1,214 attempts) and White-bellied Sea Eagle (4 attempts)) observed, all the bird species recorded during the vantage point surveys were summarized in *Table 5.7*.

Table 5.7 Results of Vantage Point Surveys (Excluding the Black Kite and White-bellied Sea Eagle)

Location Recorded	Height Level*	Flight paths (if any)	Species and Flight attempts (in bracket) observed
Within Zone 3	Not applicable	Not applicable	Crested Myna (3), Red-rumped Swallow (2), Barn Swallow (4)
Within Zone 4	Not applicable	Not applicable	Black Drongo (1), Large-billed Crow (3), Little Swift (2), Pacific Swift (2)
Within Zone 5	<10 m above ground level	East to west	Sooty-headed Bulbul (11), Chinese Bulbul (4), Black-collared Starling (2)
		West to East	Spotted Dove (1), Sooty-headed Bulbul (7), Black-collared Starling (2), Common Magpie (1), Crested Myna (1)
		South to North	White-throated Kingfisher (1), Greater Coucal (1), Spotted Dove (1), Common Magpie (1), Black-collared Starling (2), Crested Myna (7)
		North to South	Sooty–headed Bulbul (2), Spotted Dove (4), Crested Myna (2)
	>10 m and < 100 m above ground level	East to west	Barn Swallow (3), Little Swift (1)
		West to East	Little Swift (1)
	> 100 m above ground level	West to East	Barn Swallow (1)
Total			**73**

Note: * Due to the topography of the Study Area, the bird's flying height can only be estimated within Zone 5.

Most of the recorded bird species were observed flying over the Study Area during the vantage point surveys. Only Barn Swallow, Red-rumped Swallow, Little Swift, Pacific Swift and Black Kite were observed foraging within the Study Area. The flight attempts of most of the recorded species (excluding Black Kite and White-bellied Sea Eagle) were generally < 10 m above the ground level within Zone 5 (*Figures 5.9 & 5.10, Annex C Table 8*). Only Barn Swallow and Little Swift were recorded flying over Zone 5 crossing the location of the proposed wind turbine at a height > 10 m and <100 m above the ground level during the surveys (*Figure 5.11*). The utilization rates of Barn Swallow and Little Swift recorded within Zone 5 during the vantage point surveys were low.

Black Kite

The Black Kite was the most frequently observed species during the Vantage Point Surveys, with a total of 1,214 flight attempt records (94% of the total records, but only 23 individuals were recorded within the Study Area during the vantage point surveys) (*Table 5.8, Annex C Table 8*). Most of the Black Kites flied at a height < 100 m above ground level (1,040 attempts, more than 85% of total records), and only approximately 14% of the flight attempts were

recorded > 100m above ground level (174 attempts) (*Figure 5.12*). The most frequently observed flight attempts were found in Zone 4, the hill-side above Lo Tik Wan (633 attempts, 52% of total records). A total of 167 attempts (144 attempts recorded < 100 m and 23 attempts > 100 m above ground level) were recorded within Zone 5, the location of the proposed wind turbine.

Table 5.8 Results of Vantage Point Surveys for Black Kite

Height Level	Location Recorded	Flight paths	Number of Flight attempts recorded (% of total flight attempts of Black Kite observed)
< 100 m above ground level	Within Zone 1	Soaring	151 (12.4%)
	Within Zone 2	Soaring	63 (5.2%)
	Within Zone 3	Soaring	129 (10.6%)
	Within Zone 4	Soaring	553 (45.6%)
	Within Zone 5	Soaring	24 (2.0%)
		East to west	50 (4.1%)
		West to East	48 (4.0%)
		South to North	18 (1.5%)
		North to South	4 (0.3%)
Subtotal			***1040 (85.7%)***
> 100 m above ground level	Within Zone 1	Soaring	30 (2.5%)
	Within Zone 2	Soaring	0 (0%)
	Within Zone 3	Soaring	41 (3.4%)
	Within Zone 4	Soaring	80 (6.6%)
	Within Zone 5	Soaring	9 (0.7%)
		East to west	4 (0.3%)
		West to East	6 (0.5%)
		South to North	4 (0.3%)
		North to South	0 (0%)
Subtotal			***174 (14.3%)***
Total			**1214**

White-bellied Sea Eagle

The White-bellied Sea Eagle was recorded, on 26th & 30th May and 6th June 2004, during the vantage point surveys. One individual was observed on 26th May 2004 flying from Hung Shing Ye Wan to Tai Ping at a height > 100 m above ground level. The second record was reported on 30 May 2004 indicating one individual flying from Lo Tik Wan to Tai Ping crossing over Zone 5 at a height > 100 m above ground level. The third record was of two individuals of White-bellied Sea Eagle (considered to be 2 attempts) that were observed flying over Lo Tik Wan (at Zone 3) at a height > 100 m above sea level. The flight paths of the White-bellied Sea Eagle recorded within the Study Area are presented in *Figure 5.13*.

Nest Search Survey

Neither raptor nor waterbird nests were found during the survey. A Black Kite's roosting site was recorded at the south of the Study Area (Zone 4) (*Figure 5.8*), at least 10 individual observed to roost on the trees (*Acacia confusa*) during the survey.

At least 11 recorded bird species had shown different degrees of potential breeding behaviours such as courtship display, collecting nesting materials and territorial behaviour (*Table 5.9*). However, neither eggs, chicks nor juveniles of any bird species were observed during the survey.

Table 5.9 Birds with 'Suspected Breeding' Status

Common Name	Scientific Name	Suspected Breeding Behaviour
Chinese Francolin	*Francolinus pintadeanus*	Courtship calls
Common Koel	*Eudynamis scolopacea*	Courtship calls
Large Hawk Cuckoo	*Cuculus sparverioides*	Courtship calls
Chestnut-winged Cuckoo	*Clamator coromandus*	Courtship calls
Indian Cuckoo	*Cuculus micropterus*	Courtship calls
Tree Sparrow	*Passer montanus*	Collecting nesting materials
Red-whiskered Bulbul	*Pycnonotus jocosus*	Collecting nesting materials
Chinese Bulbul	*Pycnonotus sinensis*	Collecting nesting materials
Oriental Magpie Robin	*Copsychus saularis*	Territorial defence, courtship calls
Hwamei	*Garrulax canorus*	Territorial calls
White-rumped Munia	*Lonchura striata*	Collecting nesting materials

The results of the recent surveys further prove that the Study Area, particularly the Project Area and areas in the vicinity, are not major bird habitats, with relative low bird species diversity (35 species) recorded during the survey. Only 14 out of 35 species were found to forage within the Study Area (mainly in the secondary woodland habitat). Most of the recorded bird species were found flying and passing over the shrubby grassland and shrubland (including the Project Area) during the surveys. The surveys concluded that only a few bird species utilise the Project Area and areas in the vicinity.

Invertebrates

Butterflies

A total of 63 species of butterflies were recorded in the surveys (*Annex C Table 9*). Woodland habitat has the highest number of butterfly species recorded (61 out of the 63 species). The two missing species in the secondary woodland were Common Five-ring *Ypthima baldus* and Lime Butterfly *Papilio demoleus*. The number of butterfly species recorded in shrubland and grassy shrubland was similar, with 26 and 23 species respectively. Village/ developed areas had the lowest number butterfly species (only 3 species) recorded during the survey. The number of butterfly species recorded in each habitat of the Study Area is summarised in *Table 5.10.*

Table 5.10 Butterfly Species Recorded in Each Habitat of the Study Area

Habitat	Secondary Woodland	Shrubland	Shrubby Grassland	Village/ Developed Area	Stream
No. of species	61	26	23	3	-
No. of uncommon species	8	-	-	-	-

Among the 63 butterfly species, 8 species, all recorded in the secondary woodland (*Figure 5.8*), are found to be uncommon in Hong Kong and recognized as species of conservation interest, including Red Lacewing *Cethosia bibles,* Bush Hopper *Ampittia dioscorides,* Common Duffer *Discophora sondaica*, White-edged Blue Baron *Euthalia phemius,* Tree Flitter *Hyarotis adrastus*, Yellow Orange Tip *Ixias pyrene,* Swallowtail *Papilio xuthus* and Small Cabbage White *Pieris rapae.*

Dragonflies

Five dragonfly species, *Orthetrum glaccum*, *Orthetrum pruinosum*, *Orthetrum chrysis*, *Pantala flavescens* and *Zyxomma petiolatum*, were recorded in the Study Area during the survey (*Annex C Table 10*). All the species recorded are common in Hong Kong. Low abundance of the dragonfly species was recorded during the survey which is probably due to the lack of wetland habitats within the Study Area.

Herpetofauna

A total of eight species of herpetofauna were recorded in the Study Area including five species of amphibian, Romer's Tree Frog *Philautus romeri*, Asiatic Common Toad *Bufo melanostictus*, Brown Tree Frog *Polypedates megacephalus*, Asiatic Painted Frog *Kaloula pulchra* and Ornate Pigmy Frog *Microhyla ornate*, and three species of reptile, Bowring's Gecko *Hemidactylus bowringii*, Four-clawed Gecko *Gehyra mutilata* and Longtailed Skink *Mabuya longicaudata*. Calling males and/or tadpoles of Brown Tree Frog, Asiatic Painted Frog and Ornate Pigmy Frog bred were recorded within the Study Area. Among the eight species of herpetofauna, only the protected and endemic frog Romer's Tree Frog is considered to be the species of conservation interest.

The protected and endemic frog, Romer's Tree Frog *Philautus romeri* (Zhao & Adler, 1993; Lau & Dudgeon, 1999), was recorded in the Project Area and several habitats of the Study Area. Detailed records of Romer's Tree Frog are presented in *Table 5.11.*

Table 5.11 Romer's Tree Frog Recorded in the Study Area and Project Area

Habitat	Romer's Tree Frog	Location of Record	Remarks
Project Area – Shrubby grassland	3 calling males	Abandoned container and PVC water pipe	The container and water pipe served as the breeding ground for male to attract female. No Romer's Tree Frog tadpoles recorded during the survey. The site is not a sustainable habitat once the water within the containers dries up.
Shrubland – at the north of the Project Area	>25 calling males, 1 female	Catch pits (2 no.) located within the shrubland	The catch pits served as the breeding ground for male to attract female. The catch pits maintained sufficient clear water for the frog's breeding site and expected to be important for the Romer's Tree Frog.
Shrubland – at the south of the Project Area	5 calling male	Pot	The pot served as the breeding ground for male to attract female. The site is not a sustainable habitat once the water within the pot dries up.
Stream S4 – middle course	>10 calling males, many tadpoles	Stream pools	The stream has limited water flow and a number of pools provided ideal habitats for the Romer's Tree Frog. No fish recorded in the pools. The stream pools served as sustainable breeding ground for Romer's Tree Frog.
Stream S2 – middle course	>5 calling males	Stream pools	The stream pools served as sustainable breeding ground for Romer's Tree Frog. Tadpoles are expected to be found in the stream pools. Mosquito Fishes were recorded in the lower course of the Stream S2.
Village/ developed area near Tai Wan Kau Tsuen	>5 calling males	Pool	The pool served as the breeding ground for male to attract female.
Secondary Woodland near Tai Ling Tsuen	>10 calling males	Pots	The pots served as the breeding grounds for male to attract female. The site is not sustainable habitat once the water within the pots dries up.

The survey indicated that the Study Area supported a rather high population of Romer's Tree Frog. The important breeding sites recorded within the Study Area are the streams at Lo Tik Wan (middle course of S4) and Long Tsai Tsuen (middle course of S2), and the catch pits (located within the shrubland) near the 275kV cable route leading down to Luk Chau Wan. Among those sites, the middle course of S4 is considered to be the most critical breeding habitat for the Romer's Tree Frog as the area is ideal for the frog and a large number of tadpoles were recorded. Since Romer's Tree Frog inhabits moist litter when not breeding (Lau 1998), the secondary woodland and shrubland close to Lo Tik Wan are believed to be important foraging ground for this endemic tree frog.

Stream Fauna

Except Mosquito fish *Gambusia affinis* (exotic species) and shrimp *Macrobrachium* sp. recorded in the Stream S2, and Romer's Tree Frog tadpoles recorded in Stream S4 (discussed in the *Section 5.7.2 Herpetofauna*), no other aquatic fauna were recorded in the stream habitats during the survey. The low species and abundance of aquatic fauna recorded within the Study Area are probably due to the limited water flow during the survey.

5.7.3 Existing Conditions of the Proposed Project Area

The habitats recorded in the Project Area were mainly shrubland with a small patch of shrubby grassland (*Figures 5.14 & 5.15*). The shrubland and shrubby grassland were under human disturbance such as littering, dumping and hill fire. The shrubland has a canopy of about 1.5 meters in height dominated by native species such as *Rhodomyrtus tomentosa*, *Embelia laeta* and *Cratoxylum cochinchinensis*. The shrubby grassland was 1 m in height and dominated by *Ischaemum aristatum*. A total of 25 plant species were recorded within the Project Area. All of the recorded plant species are common or very common in Hong Kong.

A total of 3 calling males of Romer's Tree Frog were recorded within the Project Area during the night survey. All of the three individuals were found near a rain-filled plastic container and a discarded PVC U-shaped water pipe. No tadpoles were recorded during the survey. In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area, as well as the areas in the vicinity, do not provide optimal habitats for Romer's Tree Frog.

The Project Area and the areas in the vicinity are unlikely to be important bird habitats. Most of the recorded bird species were found flying and passing over the Project Area during the surveys. Only a few bird species were found to utilise the Project Area.

5.8 ECOLOGICAL EVALUATION

In this section the ecological importance of the habitats and wildlife identified within the Study Area are evaluated in accordance with the *EIAO TM Annex 8* criteria. The evaluation is based upon the information presented in the previous *Section 5.7*. The ecological importance of each habitat type within the Study Area and the habitats within the Project Area are presented in *Tables 5.12-5.17*.

Table 5.12 Ecological Evaluation of Secondary Woodland

Criteria	Secondary Woodland
Naturalness	Semi-natural with exotic plantation at the fringe.
Size	Two major patches of secondary woodland were recorded within the Study Area with the overall size of 20.5 ha. No woodlands located within the Project Area.
Diversity	Medium diversity of plant (64 species) and birds (30 species), moderate structural complexity. High butterfly diversity (61 species) but low other faunal diversity.
Rarity	A local protected plant species *Pavetta honkongensis* found. Protected faunal species included Romer's Tree Frog, Greater Coucal, Common Duffer, Tree Filtter, Swallowtail, Dark Evening Brown, Bush Hopper, Small Cabbage White, White-edged Blue Baron and Red Lacewing.
Re-creatability	Habitat characteristics and species composition are difficult to recreate. It will take more than 20 years for the secondary woodlands to be re-created.
Fragmentation	Medium, the secondary woodlands were fragmented by the 275 kV Cable Route, footpaths and villages.
Ecological Linkage	Limited.
Potential Value	Moderate to high, becoming mature woodland if given time and protection from disturbance.
Nursery/ Breeding Ground	Breeding ground for Romer's Tree Frog was recorded during the survey.
Age	Semi-mature (>20 years) based on tree size, woodland structure and species composition.
Abundance/ Richness of Wildlife	High abundance for avifauna and butterfly.
Overall Ecological Value	**Moderate to High**

Table 5.13 Ecological Evaluation of Shrubland

Criteria	Shrubland
Naturalness	Natural habitat with limited human disturbance.
Size	Shrubland was the dominant habitat within the Study Area with overall size of approximately 49.4 ha.
Diversity	Moderate for vegetation (totally 74 species for the whole area, mostly native shrubs and climbers), low faunal diversity.
Rarity	Species of conservation interest included Romer's Tree Frog and Greater Coucal.
Re-creatability	Readily creatable.
Fragmentation	Shrubland mainly exists as a continuous patch.
Ecological Linkage	Acting as wildlife corridor in particular for Romer's Tree Frog linking with the secondary woodland, as well as the optimal Romer's Tree Frog habitats, in close proximity.
Potential Value	Medium
Nursery /Breeding Ground	The catch pits located within the shrubland provided breeding habitats for Romer's Tree Frog.
Age	Young.
Abundance/ Richness of Wildlife	Moderate to high for avifauna and low for dragonfly butterfly.
Overall Ecological Value	**Low to Moderate**

Table 5.14 Ecological Evaluation of Shrubby Grassland

Criteria	Shrubby Grassland
Naturalness	Highly disturbed.
Size	Small size of approximately 5.7 ha. Only 0.4 ha of the shrubby grassland located within the Project Area.
Diversity	Low for vegetation (totally 25 species for the whole area) and fauna.
Rarity	Calling male of Romer's Tree Frog was recorded within the proposed Project Area.
Re-creatability	Readily creatable.
Fragmentation	Not applicable.
Ecological Linkage	Not functionally linked to any highly valued habitat in close proximity.
Potential Value	Low.
Nursery/ Breeding Ground	No significant breeding ground recorded. Calling male of Romer's Tree Frog was recorded, but the habitat is not suitable for their breeding.
Age	Young.
Abundance/ Richness of Wildlife	Abundance of avifauna was low.
Overall Ecological Value	**Low**

Table 5.15 Ecological Evaluation of Natural and Modified Streams

Criteria	Middle Course of Stream S4	Lower and Middle Course of Stream S2, Upper Course of Stream S4 and Whole Section of Stream S3	Whole Section of Stream S1, Upper Course of Stream S2 and Lower Course of Stream S4
Naturalness	Natural.	Natural.	Man-made
Size	The length of the mentioned section was less than 100 m.	The total length of the mentioned sections was approximately 0.7 km.	The total length of the mentioned sections were approximately 0.3 km.
Diversity	Low for plants and aquatic fauna.	Low for plants and aquatic fauna.	Low for plants and aquatic fauna.
Rarity	Calling males and tadpoles of Romer's Tree Frog were recorded.	Calling males of Romer's Tree Frog were recorded in middle course of Stream S2.	None recorded.
Re-creatability	Re-creatable.	Re-creatable.	Readily re-creatable.
Fragmentation	Not applicable.	Not applicable.	Not applicable.
Ecological linkage	Functionally linked to shrubland and woodland in close proximity.	Functionally linked to shrubland and woodland in close proximity.	Not functionally linked to any highly valued habitat in close proximity.
Potential value	High ecological potential.	Moderate ecological potential.	Low ecological potential.
Nursery/ breeding ground	Critical breeding ground of Romer's Tree Frogs.	Suspected breeding ground for Romer's Tree Frogs.	No significant nursery or breeding ground recorded.
Age	Not applicable.	Not applicable.	Not applicable.
Abundance/ Richness of wildlife	Low for avifauna and aquatic fauna.	Low for avifauna and aquatic fauna.	Low for avifauna and aquatic fauna.
Overall Ecological value	**High**	**Low to Moderate**	**Low**

Table 5.16 Ecological Evaluation of Village/Developed Areas

Criteria	Urbanized/Disturbed Area
Naturalness	Man-made habitat.
Size	The overall size was approximately 3.9 ha. This habitat type was not located within the Project Area.
Diversity	Low for flora (25 species recorded, mostly fruit trees) and fauna.
Rarity	Calling males of Romer's Tree Frog were recorded.
Re-creatability	Readily re-creatable.
Fragmentation	Not applicable.
Ecological Linkage	Not functionally linked to any highly valued habitat in close proximity.
Potential Value	Low.
Nursery/Breeding Ground	None.
Age	Not applicable.
Abundance/Richness of Wildlife	Low.
Overall Ecological Value	**Low**

Table 5.17 Ecological Evaluation of Project Area

Criteria	Project Area
Naturalness	Under certain degree of disturbance, ie littering and dumping.
Size	Approximately 0.40 ha of the shrubby grassland and 0.04 ha of shrubland recorded within the Project Area.
Diversity	Low for vegetation (totally 25 species for the whole area) and fauna.
Rarity	Calling males of Romer's Tree Frog was recorded within the proposed Project Area.
Re-creatability	Readily creatable.
Fragmentation	Not applicable.
Ecological Linkage	Not functionally linked to any highly valued habitat in close proximity.
Potential Value	Low.
Nursery/Breeding Ground	No significant breeding ground recorded. Although calling male of Romer's Tree Frog recorded, the habitat is not suitable for their breeding.
Age	Young.
Abundance/Richness of Wildlife	Abundance of avifauna was low.
Overall Ecological Value	**Low**

The list and evaluation of the floral and faunal species of ecological interest recorded within the Study Area, according to the *EIAO TM*, are given in *Tables 5.18* and *5.19*.

Table 5.18 Evaluation of Floral Species With Ecological Interest Within the Study Area

Species	Growth Form	Location	Protection Status	Distribution	Rarity
Pavetta *Pavetta hongkongensis*	Shrubs	Woodland close to Lo Tik Wan	Local protected species	Widely disturbed in Hong Kong woodlands	Common

Table 5.19 Evaluation of Faunal Species With Ecological Interest Within the Study Area

Species	Location	Protection Status	Distribution	Rarity
Bird				
Emerald Dove *Chalcophaps indica*	Woodland	*Wild Animals Protection Ordinance (Cap 170);* Vulnerable species in RDB	Distribute widely in Hong Kong	Uncommon/ rare in Hong Kong
Lesser Coucal *Centropus bengalensis*	Woodland, shrubland and shrubby grassland	*Wild Animals Protection Ordinance (Cap 170);* Class 2 Protected Animal of PRC	Occur in a wide range of habitats in Hong Kong	Common resident in Hong Kong
White-bellied Sea Eagle *Haliaeetus leucogaster*	Pass-over the Study Area	*Wild Animals Protection Ordinance (Cap 170);* Vulnerable species in RDB, Class 2 Protected Animal of PRC, CITES Appendix II	Hong Kong's coastal areas, only recorded in Hong Kong and nowhere else in China	Uncommon/ rare resident
Greater Coucal *Centropus sinensis*	Woodland and shrubland	*Wild Animals Protection Ordinance (Cap 170);* Class 2 Protected Animal of PRC	Occur in a wide range of habitats in Hong Kong	Common resident in Hong Kong
Black Kite *Milvus lineatus*	Roosting site located at the shrubland in the south of the Study Area. Soaring in the sky within the Study Area.	*Wild Animals Protection Ordinance (Cap 170);* *Appendix 2* of CITES; Class 2 Protected Animals of PRC	Widespread, found in many types of habitats	Common resident in Hong Kong
Butterfly				
Bush Hopper *Ampittia dioscorides*	Woodland in the east of the Study Area	Not protected	Found in Wu Kau Tang, Luk Keng, Uk Tau, Pak Sha O and Lung Kwu Tan	Uncommon

Species	Location	Protection Status	Distribution	Rarity
Yellow Orange Tip *Ixias pyrene*	Woodlands in the east and southwest of the Study Area	Not protected	Found in Lung Kwu Tan, Shing Mun Reservoir, Yung Shue O, Sha Lo Wan and Po Tai Island.	Uncommon
White-edged Blue Baron *Euthalia phemius*	Woodlands in the east and southwest of the Study Area	Not protected	Widespread, found in most rural places.	Uncommon
Common Duffer *Discophora sondaica*	Woodlands in the east and southwest of the Study Area	Not protected	Widespread, can be seen in most places.	Uncommon
Red Lacewing *Cethosia bibles*	Woodland in the southwest of the Study Area	Not protected	Found in Lung Kwu Tan, San Tau, Mount Nicholson, Tong Fuk and Pui O.	Uncommon
Tree Flitter *Hyarotis adrastus*	Woodland in the east of the Study Area	Not protected	Found in Wong Chuk Yeung, Nam Chung, Shan Liu, Yung Shue O and Fung Yuen.	Uncommon
Swallowtail *Papilio xuthus*	Woodland in the east of the Study Area	Not protected	Found in Kap Lung, Wu Kau Tang, Sha Lo Wan, Kat O and Lung Kwu Tan.	Uncommon
Small Cabbage White *Pieris rapae*	Woodland in the east of the Study Area	Not protected	Found in Ngong Ping, Fan Lau, Kam Tin, Ho Chung and Luk Keng.	Uncommon
Amphibian				
Romer's Tree Frog *Philautus romeri*	Calling males and tadpoles were found in woodland, shrubland, stream and the Project Area.	*Wild Animals Protection Ordinance (Cap 170)*	Found on Lamma, Lantau, Po Toi and Chek Lap Kok Islands	Restricted and endemic

5.9 POTENTIAL IMPACTS

The overall height of the wind turbine is approximately 71m with the hub height of approximately 45 m and the rotor blade diameter of approximately 52 m. The Project involves excavation and construction of the wind turbine foundation, construction of two stainless steel huts for installation of transformer, switchgear and power condition devices and laying of underground distribution cables for connecting to the nearby existing cable route. The potential ecological impact arising from the wind turbine, based on the results of the recent baseline surveys, layout drawings and construction methods discussed in *Section 3,* may arise from the construction and operational phase impacts detailed below.

5.9.1 *Construction Phase*

- Direct habitat loss and habitat fragmentation resulting from land take for the construction activities for the wind turbine;
- Direct loss of inactive/less mobile/habitat-specific wildlife nesting/inhabiting the affected area;
- Direct and indirect impacts to watercourses, including deterioration of water quality, silty run-off and sedimentation effect, as a result of construction activities and discharge;
- Associated impacts to wildlife, including restriction of wildlife utilisation (ie transit, feeding and roosting), degradation of habitat quality/ ecological function, as a result of temporary and permanent loss, isolation and fragmentation of ecological habitat; and
- Impacts to the surrounding habitat and associated wildlife due to physical disturbance of this habitat including noise, increased human activity, inappropriate storage or dumping of construction material, or hill fire.

5.9.2 *Operational Phase*

- Impacts to the surrounding habitat and associated wildlife due to increased human activities and disturbance (ie noise) associated with the operation of the proposed Project;
- Creation of a barrier effect to bird movement; and
- Bird injuries or death through collision with operating turbine or as a result of being attracted to the turbine at night time by lighting used for safety reasons to mark the turbine location.

The total size of the area to be affected will only be approximately 0.31 ha (*Figure 5.15*). The construction works will be completed within 12 months. The major impacts on the ecological resources will be direct habitat loss and potential bird collision.

5.10.1 Construction Phase

The construction of the proposed wind turbine including excavation, construction of wind turbine foundation and transformer, a short maintenance access and laying of underground distribution cables (all located within the Project Area), will lead to the loss of existing habitats, particularly shrubby grassland. All of the construction materials will be transported to the Project Area through the existing 275 kV Cable Route, no haul road or temporary access will be required.

The potential impacts during the construction phase will be:

Habitat Loss

- Permanent loss of shrubby grassland (approximately 0.17 ha) due to the construction of the wind turbine foundation and transformer, a short maintenance access and laying of underground distribution cables (details refer to *Figures 5.15* and *Table 5.20*);
- Temporary loss of the existing habitats including shrubby grassland (approximately 0.14 ha) within the Project Area (the habitats will be resumed after the construction, details refer to *Figures 5.15* and *Table 5.20*); and
- Loss of foraging and feeding ground of the associated wildlife, particularly birds.

Table 5.20 Overall Habitat Loss due to the Wind Turbine

	Impacted Habitats	Permanent loss (Land Take for the Structures)	Temporary loss (will be resumed after the construction)	Ecological Value of the Affected Habitat
Project Area	Shrubby grassland	0.17 ha	0.14 ha	Low

Impacts on Romer's Tree Frog

- **Direct impact on the Romer's Tree Frog inhabiting the affected Project Area.** In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area and areas in the vicinity do not provide optimal habitats for Romer's Tree Frog. The calling males recorded in the Project Area were mainly due to the existence of the discarded and rain-filled plastic container and PVC U-shaped water pipe;

- **Loss of breeding ground of Romer's Tree Frog.** A total of three calling males of Romer's Tree Frog were recorded within the Project Area during the night survey. All of the three individuals were found near a rain-filled plastic container and a discarded PVC U-shaped water pipe, but no tadpoles were recorded during the survey; and

- **Deteriorating the quality of the breeding grounds of Romer's Tree Frog**. The two catch pits with >25 calling males and 1 female recorded during the survey were located within the shrubby grassland and beside the 275 kV Cable Route at the north of the Project Area, and in the stream pools in the middle course of Stream S2 at the south of the Project Area. Since the two catch pits and the stream pools in the middle course of Stream S2 are situated below the Project Area, deterioration of water quality, silty run-off and sedimentation effect, as a result of uncontrolled construction activities and discharge have the potential to affect the breeding grounds of Romer's Tree Frog.

Habitat Fragmentation and Isolation

- The shrubland habitat is fragmented by the existing 275 kV Cable Route and the shrubby grassland is expected to be originated from the shrubland after hill fire. Minimal effects of habitat fragmentation and isolation due to the loss of the small size of shrubby grassland and shrubland will be expected.

Other Impacts

- Secondary impacts to the surrounding habitats (generally with low ecological value) and associated wildlife may arise from the potential for increased noise impact, human activities and disturbance such as hill fire, import, storage or dumping of construction material and construction site runoff. The impacts are expected to be low owing to the temporary nature and small scale of the construction works, and given that regular checks on good construction practice (ie prohibit open fire) will be conducted.

5.10.2 Operational Phase

Aside from the impacts on birds, no operational impacts are expected as the wind turbine is located in shrubby grassland and shrubland, which have been identified as low quality habitat, and the operation of the wind turbine (including the noise produced during operation) would not disturb the surrounding natural habitats, or the associated wildlife. The non-reflectiveness colour scheme of the wind turbine would not cause glare or any impacts to the wildlife during operation. The turbine will be unmanned and hence no on site waste or wastewater will be produced.

During operation, the wind turbine could result in the following impacts on birds and their movement:

- Habitat avoidance/ disturbance due to the noise produced by and the presence of the wind turbine;
- Creation of a barrier effect to bird movement; and
- Bird injuries or death through collision with operating turbine or as a result of being attracted to the turbine at night time by lighting used for safety reasons to mark the turbine location.

The results of the literature review and baseline surveys indicated that the Project Area, as well as the areas in the vicinity, are not important bird habitats. The impacts of habitat avoidance/ disturbance on birds due to the noise produced by and the presence of the wind turbine, and the creation of barrier effect to bird movement are expected to be low and not significant.

Bird collisions are the major concern of the operational impacts of the wind turbine. Barn Swallow, Little Swift and Black Kite, recorded to utilise the Project Area in this study (*Section 5.7.2 Birds*), are the confirmed potential species that may be affected by the wind turbine during operation.

5.10.3 Cumulative Impact

At present there are no planned projects in the vicinity of the wind turbine that could have cumulative impacts with the construction of the wind turbine. The cumulative permanent habitat loss is negligible as the areas affected are small and have low to moderate ecological value.

5.10.4 Impact Evaluation

Habitat Loss

Potential impacts to ecology have been evaluated according to *Table 1* of *Annex 8* of the *EIAO TM*. *Table 5.21* present an evaluation of the habitat loss due to the Project.

Table 5.21 Overall Impact Evaluation for Shrubby Grassland within the Project Area

Evaluation Criteria	Shrubby Grassland
Habitat quality	Low.
Species	The potential exists for direct and indirect impacts to the wildlife, particularly Romer's Tree Frog inhabiting the areas. In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area and areas in the vicinity do not provide optimal habitats for Romer's Tree Frog. The calling males recorded in the Project Area were mainly from a discarded and rain-filled plastic container and a PVC U-shaped water pipe.
Size/Abundance	Area loss is small in size: approximately 0.17 ha permanent loss and 0.14 ha temporary loss.
Duration	The impact will persist during the construction and operational phases. But the temporarily affected areas will be reinstated after the completion of the works.
Reversibility	The shrubby grassland is expected to be originated from the shrubland after hill fire.
Magnitude	The scale of the habitat loss is small in the context of the surrounding similar habitats.
Overall Impact Conclusion	**Low**

In conclusion, with the exception of potential impact to the Romer's Tree Frog and its breeding grounds (discussed in the following section), the direct ecological impact due to the construction of the wind turbine is expected to be low, and will not contribute to any potential cumulative impact.

Impacts on Romer's Tree Frog

In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area and areas in the vicinity do not provide optimal habitats for the Romer's Tree Frog. The calling male Romer's Tree Frogs recorded in the Project Area were present in a discarded and rain-filled plastic container and a PVC U-shaped water pipe, but the site was not a sustainable habitat or breeding ground for the Romer's Tree Frog. No Romer's Tree Frog can be expected to be found within the Project Area once the water within the container/water pipe dries up or the containers have been removed. The impacts on Romer's Tree Frog are expected to be low given that pre-construction translocation of Romer's Tree Frog (adult and tadpoles, if any) will be conducted.

Since no construction waste water will be generated during the works (refer to *Section 8*) and no serious construction runoff will be anticipated given that regular checks on good construction practice will be conducted, deterioration of the water quality of the breeding grounds of Romer's Tree Frog in the vicinity would not be expected. The overall impact evaluation for Romer's Tree Frog is presented in *Table 5.22*.

Table 5.22 Overall Impact Evaluation for Romer's Tree Frog

Evaluation Criteria	Romer's Tree Frog
Habitat quality	In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area do not provide optimal habitats for the Romer's Tree Frog. The calling male Romer's Tree Frogs recorded in the Project Area were present in a discarded and rain-filled plastic container and a PVC U-shaped water pipe, but the site was not a sustainable habitat or breeding ground for the Romer's Tree Frog.
Species	Romer's Tree Frog *Philautus romeri*.
Size/Abundance	A total of three calling male of Romer's Tree Frog were recorded in the Project Area. No Romer's Tree Frog can be expected to be found within the Project Area once the water within the container/water pipe dries up or the containers have been removed.
Duration	The impact will persist during the construction and operational phases.
Reversibility	Relatively easy to create breeding habitat for Romer's Tree Frog. Due to the poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area and areas in the vicinity do not provide optimal habitats for the Romer's Tree Frog.
Magnitude	The impacts on Romer's Tree Frog are expected to be low given that pre-construction translocation of Romer's Tree Frog (adult and tadpoles, if any) will be conducted. Since no construction waste water will be generated during the works and no serious construction runoff will be anticipated given that regular checks on good construction practice will be conducted, deterioration of the water quality of the breeding grounds of Romer's Tree Frog in the vicinity would not be expected.
Overall Impact Conclusion	**Low**

Other Associated Impacts

Habitat Fragmentation and Isolation – Given that the wind turbine will be located beside the existing 275 kV Cable Route and the scale of the habitat loss is small in the context of the surrounding similar habitats, the impact of habitat fragmentation and isolation are considered to be minimal.

Water Quality – No construction waste water will be generated during the works (refer to *Section 7*). No serious construction runoff affecting the downhill habitats and associated aquatic fauna will be anticipated given that regular checks on good construction practice will be conducted.

Other Impacts – Increased human activities and disturbance due to the Project during construction may affect the surrounding natural habitats and the associated wildlife. The impacts are expected to be low owing to the temporary nature and small scale of the construction works, and given that regular checks on good construction practice (ie prohibit smoking and open fire) will be conducted.

Operational Impact

In upland wind farm sites in the UK, bird collision rates from surveys to date have been found to be very low (extracted from ERM-UK 2004). Work carried out to date on collision risk suggests that for a significant impact to occur, large numbers of turbines would need to be located within an area used by a major population concentration of a species which is known to be sensitive to collision and at risk from the additional mortality which would result. A very high number of birds would need to be passing regularly through a wind farm area at a suitable height for significant mortality to occur. Evidence does suggest that the risk of collision increases during periods of bad weather and poor visibility.

The air space of the wind turbine is approximately 0.2 ha ($\pi r^2 = 3.14 \times 26$ m $\times$ 26 m = 2,123 m^2, the maximum diameter of the rotor is 52 m). Bird collisions may occur only when the flight path of the birds goes straight to the rotor (of total surface area approximately 0.2 ha) with the right angle/ direction and height (19 m – 71 m, assuming the largest rotor will be used). It should also be noted that the blade rotating speed is relatively slow (14 – 31 rpm). In view of the current condition of the Project Area, as well as the Study Area, the site is not an important bird habitat or flight path of migratory birds. The most sensitive areas, the SSSI near Mount Stenhouse (designated to protect the nesting habitats of White-bellied Sea Eagle and Bonelli's Eagle) and potential Country Park in South Lamma Island, have also been avoided during the planning and site selection stage (details refer to *Section 2*).

Individuals of the Black Kite were frequently observed soaring or foraging within the Study Area during the recent surveys. The most frequently observed flight attempts of Black Kite were found at Zone 4, the hill-side above Lo Tik Wan and at the south-west of the Project Area (52% of the total attempts, *Section 5.7.2 Birds*). Only 12% of the total attempts were recorded within Zone 5, the location of the proposed wind turbine, at a height < 100 m above ground level. Other bird species including Barn Swallow, Red-rumped Swallow, Little Swift and Pacific Swift, as well as bird species of conservation (including Greater Coucal, Lesser Coucal, Emerald Dove and White-bellied Sea Eagle) were found to be infrequently utilising the Project Area during the surveys. Monitoring of operating wind farms to date has shown that birds do exhibit a degree of avoidance behaviour, although the extent of this behaviour by specific species at operating wind farms is not yet fully understood as only limited data are available (ERM-UK 2004). As a consequence, the risks of collision of the bird species are not considered to be significant, particularly considering that only one turbine will be operating.

There is extensive literature documenting the effects on birds of lights on tall structures, particularly on song birds that migrate at night (ERM-UK 2004; Kingsley and Whittam 2001). Many birds are attracted to the lights and can collide with them. Such effects can be influenced further during periods of bad weather and poor visibility. Aviation warning lights of red, steady and 24-hour in operation, are proposed to be installed on top of the nacelle of the

turbine to alert aircraft in case of poor visibility. The impacts due to the light of the turbine are expected to be minimal as the Project Area and areas in the vicinity are not important bird habitats and have relatively low utilisation.

The noise produced by the operating wind turbine will be a low, constant and predictable sound level. Since the wind turbine site is not considered to be a highly important bird habitat, the significance of the noise impacts are expected to be low.

In view of the small scale (one wind turbine) and low magnitude of impacts as discussed above, the overall operational impacts on birds are therefore considered to be of low significance and summarized in *Table 5.23*.

Table 5.23 Overall Operational Impact Evaluation for Birds

Evaluation Criteria	**Birds**
Habitat quality	In view of the present condition of the Project Area, as well as the Study Area, the site is not an important bird habitat or flight path of migratory birds.
Species	Bird species of conservation interest recorded within the Study Area included Black Kite, Greater Coucal, Lesser Coucal, Emerald Dove and White-bellied Sea Eagle. Black Kite, Barn Swallow, Red-rumped Swallow, Little Swift and Pacific Swift showed flight attempts within Zone 5, the location of the proposed wind turbine, during the surveys.
Size/Abundance	Bird species were found to be infrequently utilising the Project Area during the surveys.
Duration	The impact will persist during the operational phases.
Reversibility	The impacts will persist with the existence of the wind turbine.
Magnitude	The risks of collision of the bird species and operational noise impacts to birds are not considered to be significant, particularly considering that only one turbine will be operating.
Overall Impact Conclusion	**Low**

5.11 MITIGATION MEASURES

Annex 16 of the *EIAO TM* states that the general policy for mitigation of significant ecological impacts, in order of priority, is:

Avoidance: Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives;

Minimisation: Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on intensity of works operations or timing of works operations; and

Compensation: The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.

At each stage, residual impacts are to be re-assessed to determine whether there is a need to proceed to the next stage of mitigation. The following measures have been developed in accordance with this approach to mitigate the impacts.

5.11.1 Avoidance

As a demonstration project for renewable energy, the Islands within HEC's supplying territory and of reliable wind energy (as well as available wind data), included Po Toi and Lamma. Tai Ling, Lamma Island was identified as the preferred wind turbine site based on the following consideration:

- Avoid environmental impacts due to the construction of a new access road for the construction and maintenance of the wind turbine;
- Avoid impacts due to the construction of a lengthy link to the existing transmission system;
- Avoid the SSSI at South Lamma Island;
- Avoid the potential Country Park at South Lamma Island; and
- Avoid impacts to natural habitats of high ecological value (ie woodland).

The proposed wind turbine site is located beside the existing 275 kV Cable Route near Tai Ling on Lamma Island. No new access road is required and only low quality habitats (woodlands have been avoided) will be affected.

Site selection is crucial to minimizing wind turbine bird collision (BirdLife International 2003). The precautionary principle is advocated where there are concentrations of species of conservation importance. The Project Area (mainly shrubby grassland and shrubland), as well as the whole of Study Area, were considered not to be either important bird habitat or major flying route of migratory birds. Further, due to the relatively low ecological value habitats of the proposed wind turbine site, impacts due to wind turbine bird collision are expected to be minimal.

5.11.2 Minimisation

The previous discussion in *Section 5.10* has indicated that the significance of the impacts on ecological resources due to the construction and operation of the proposed Project are generally expected to be low. The following mitigation measures to minimise impacts and disturbance to the surrounding habitats, are recommended.

Measures for Romer's Tree Frog

- Undertake Romer's Tree Frog surveys within the Project Area just before the construction works commence. Due to the small size of the Project Area and given that there are no optimal habitats for Romer's Tree Frog, one day-time and one night-time survey is considered sufficient. The

surveyor(s) should actively search within the Project Area paying special attention to the water bodies (ie abandoned containers). All recorded Romer's Tree Frog (adults and tadpoles) must be caught by hand and translocated to the stream pools of middle course of Stream S4 near Lo Tik Wan, the critical natural habitats for Romer's Tree Frog within the Study Area, immediately after the survey. The Romer's Tree Frog surveys and translocation works shall be undertaken by a qualified ecologist with at least five years of relevant experience in faunal translocation works.

Measures for Construction Runoff

- Surface run-off from the construction site should be directed into existing stream channel via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities.

Good Construction Practice

- Erect fences along the boundary of the works area before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel onto adjacent areas.

- Avoid any damage and disturbance, particularly those caused by filling and illegal dumping, to the remaining and surrounding natural stream habitats.

- Regularly check the work site boundaries to ensure that they are not breached and that no damage occurs to surrounding areas.

- Prohibit and prevent open fires within the site boundary during construction and provide temporary fire fighting equipment in the Project Area.

- Treat any damage that may have occurred to individual major trees in the adjacent area and along the 275 kV Cable Route (used to transport the construction materials) with surgery.

- Reinstate temporary disturbed areas, particularly the shrubby grassland, immediately after completion of the construction works, ie through on-site tree/shrub planting. Tree/shrub species used should make reference from those in the surrounding area and/or *Annex C*.

5.11.3 Compensation

No compensation is required for this Project.

5.12 RESIDUAL IMPACTS

There will be the permanent loss of approximately 0.17 ha and temporary loss of 0.14 ha of shrubby grassland shrubby grassland. With the consideration of the small scale of the Project (one wind turbine and small size), loss of low quality habitats (shrubby grassland of low ecological value), and the Project Area avoiding ecologically sensitive areas (ie potential Country Park and SSSI) during the site selection process, the residual impacts are not considered to be significant. No adverse residual impact due to the construction of the wind turbine is expected after the implementation of the proposed mitigation measures. Since the wind turbine site has avoided the known important bird sites (ie the SSSI in South Lamma) and is located on low ecological value habitats, the impacts due to wind turbine bird collision, as well as operational noise generation effects on birds, are considered to be minor and of low magnitude and significance.

5.13 ENVIRONMENTAL MONITORING AND AUDIT

5.13.1 *Construction*

The implementation of the ecological mitigation measures stated in *Section 5.11* should be checked as part of the environmental monitoring and audit procedures during the construction period as presented in the separate *Environmental Monitoring and Audit Manual*.

5.13.2 *Operation*

Monitoring for bird collision during operation is required. The purpose of the monitoring is to assess the impact (via collisions) of the wind farm on birds, with a particular focus on species of conservation interest (ie Black Kite). During the operation of the wind turbine, monitoring will be undertaken at monthly intervals for a period of 12 months. An area of 50 m radius will be searched around the base of the turbine. After this 12-month period, the monitoring results will be reviewed. Should any bird mortality or injury be confirmed as due to the wind turbine, relevant government departments (ie Environmental Protection Department (EPD) and Agriculture, Fisheries and Conservation Department (AFCD)) would be notified. If the bird collision event persists more than 3 times, HEC will discuss remedial action with government and implement any agreed actions to solve the event such as adjustment of wind turbine lighting and the colour of the wind turbine. The effectiveness of the proposed remedial action will be verified and evaluated with discussion with EPD/AFCD.

A simple Event and Action Plan during the first 12 months of operation of the wind turbine is recommended in *Table 5.24*.

Table 5.24 Event and Action Plan during Operation of Wind Turbine

Monitoring Criteria	Event	Action	
		Environmental Team Leader/ Environmental Manager (employed by HEC)	**HEC**
Bird Collision	Bird injury or mortality recorded in the vicinity of the wind turbine (50 m radius from the turbine) and confirmed due to the wind turbine.	1. Notify HEC and check the wind turbine site to find out the cause of the event(s).	1. Identify and report the cause(s) of the event if bird mortality or injury confirmed due to the wind turbine.
		2. Undertake weekly bird monitoring (observing the influence of the wind turbine on the behaviour of birds). The normal monitoring schedule will be resumed if the cause(s) of the event have been identified.	2. Submit proposals to relevant government departments (ie EPD and AFCD) for remedial action and implement the action to solve the event if the collision event persists more than 3 times.
		3. If the collision event persists more than 3 times, discuss and develop remedial actions with HEC such as adjustment of wind turbine lighting and the colour of the wind turbine.	3. Verify and evaluate the effectiveness of the remedial action with Environmental Team Leader/ Environmental Manager and EPD/AFCD.

If, after the 12-months monitoring period, insignificant number of bird collisions have been reported then monitoring will cease as it will have been demonstrated that the wind turbine is not having an adverse impact on bird species.

5.14 CONCLUSION

The ecological resources recorded within the Study Area included secondary woodland, shrubland, shrubby grassland, stream and village/ developed areas, as well as associated wildlife. Of these habitats, secondary woodland and the middle course of a stream near to Lo Tik Wan (Stream S4) have moderate to high and high ecological value respectively. The remaining habitats are of low or low to moderate ecological value. A total of 14 species of conservation interest were recorded within the Study Area, including five bird species (Black Kite, Greater Coucal, Lesser Coucal, Emerald Dove and White-bellied Sea Eagle), eight uncommon butterfly species (Red Lacewing, Bush Hopper, Common Duffer, White-edged Blue Baron, Tree Flitter, Yellow Orange Tip, Swallowtail and Small Cabbage White) and one amphibian (Romer's Tree Frog). Three calling male Romer's Tree Frog were recorded within and adjacent to the Project Area during the surveys. A total of 17 bird species were observed during the vantage point surveys, with a total of 1,290 flight attempts in the Study Area. The flight attempts of most of the recorded species were generally flying < 10 m above the ground level near the Project

Area. Only Black Kite (144 attempts, the maximum number of individuals recorded was 23 during the surveys), Barn Swallow (3 attempts) and Little Swift (2 attempts) were recorded flying over and crossing the location of the proposed wind turbine at a height > 10 m and <100 m above the ground level during the surveys.

In conclusion, the direct ecological impact due to the construction of the wind turbine is expected to be low, and will not contribute to any potential cumulative impact. In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area and areas in the vicinity do not provide optimal habitats for the Romer's Tree Frog. The impacts on the Romer's Tree Frog are expected to be low given that pre-construction translocation of Romer's Tree Frogs (adult and tadpoles, if any) present at the site will be conducted.

Bird collisions are the main concern of the operational impacts of any wind turbine development. Barn Swallow, Little Swift and Black Kite, recorded as utilising the Project Area in this study, are the confirmed potential species that may be affected by the wind turbine during operation. Site selection is crucial to minimizing wind turbine bird collision. Since the wind turbine site is not considered to be either within important bird habitat or on the flight path of migratory birds, the impacts due to bird collision are of low magnitude and therefore not considered to be unacceptable.

No adverse residual impact is expected after the implementation of the recommended mitigation measures. One year bird monitoring will be undertaken to demonstrate that the wind turbine is having low magnitude of and not having an unacceptable impact on bird species.

REFERENCES

Ades, G.W.J. 1999. The species composition, distribution and population size of Hong Kong bats. *Memoirs of the Hong Kong Natural History Society* 22: 183-209.

Anon. 1996. Wildlife Windows. Three. p. 23. Porcupine! Number 15. Newsletter of the Department of Ecology and Biodiversity, Hong Kong University.

Anon. 1997. Wildlife Windows. Two. p. 25. Porcupine! Number 16. Newsletter of the Department of Ecology and Biodiversity, Hong Kong University.

Andrea Kingsley and Becky Whittam (2001) *Potential Impacts of Wind Turbines on Birds at North Cape, Prince Edward Island*.

BirdLife International (2003) *Windfarms and Birds : An analysis of the effects of windfarms on birds, and guidance on environmental assessment criteria and site selection issues*. Paper presented in Convention On The Conservation Of European Wildlife And Natural Habitats.

Carey, G. J., Chalmers, M. L., Diskin, D. A., Kennerley, P. R., Leader, P. J., Leven, M. R., Lewthwaite, R. W., Melville, D. S., Turnbull, M. and Young, L. (2001) *The Avifauna of Hong Kong*. Hong Kong Bird Watching Society, Hong Kong.

Department of Geography, The Chinese University of Hong Kong 1999) *Service on Providing Information on the Suitability of South Lamma, Tung Lung Chau and Po Toi Islands to be Established as Country Park*, Report to AFCD.

Erickson, W. P., Johnson, G. D., Strickland, M. D., Young Jr., D.P., Sernka, K.J. & Good, R.E. (2001) *Avian Collisions with Wind Turbines: A summary of existing studies and comparisons to other sources of avian collision mortality in the United States.* Western EcoSystems Technology Inc. National Wind Coordinating Committee (NWCC) Resource Document.
http://www.nationalwind.org/pubs/avian_collisions.pdf.

ERM HK (1998) *EIA for 1800MW Gas-Fired Power Station at Lamma Extension: Terrestrial Ecological Impact Assessment*.

ERM HK (2001) *Ecological Survey for Additional Transmission Route from Lamma Power Station to Pak Kok Tsui Landing Point: Pre-construction Ecological Survey*.

ERM-UK. (2004) *Lochelbank Wind Farm: Environmental Statement. Report for National Wind Power*.

Friends of the Earth (2001-2002) *Wind Monitoring Station on Lamma Isaland: Monthly Report of Bird Strike Incidents*.

Gauthreaux, S. A. and Belser C. G. (1999) The behavioural responses of migrating birds to different lighting systems on tall towers. *In* Proceedings of *Avian Mortality at Communications Towers Workshop (*A. Manville, editor), 11 August 1999.

Hydro Tasmania (2003) *Heemskirk Wind Farm: Development Proposal and Environmental Management Plan*.
http://www.hydro.com.au/environment/www_heemskirk_dpemp/

Karsen, S.J., Lau, M.W.-N. & Bogadek, A. (1998) *Hong Kong Amphibians and Reptiles*. Second Edition. Provisional Urban Council, Hong Kong.

Kingsley A. and Whittam B. (2001) Potential Impacts of Wind Turbines on Birds at North Cape, Prince Edward Island. A report for the Prince Edward Island Energy Corporation.

Lau, M. W. N. and D. Dudgeon (1999) Composition and distribution of Hong Kong Amphibian fauna. *Memoirs of the Hong Kong Natural History Society* 22: 1-80.

Lau, M.W.N. (1998) *Habitat Use by Hong Kong Amphibians, with Special Reference to the Ecology and Conservation of Philautus romeri*. Ph.D. Thesis, University of Hong Kong, Hong Kong.

Maunsell (1997) EIA for Outlying Islands Sewerage Stage 1 Phase 1.

Maunsell (2003) *EIA for Outlying Islands Sewerage Stage 1, Phase II Package J - Sok Kwu Wan Sewage Collection, Treatment & Disposal Facilities*.

Porcupine! Number 1-30 (Newsletter of Department of Ecology & Biodiversity, University of Hong Kong)

RSBP (2004) *Information: Wind Farms and Birds.*

Reels, G. (1996) *Distribution of large mammals in Hong Kong*. *Porcupine!* 15: 36-38.

United States Fish and Wildlife Service (USFWS) 2000. Service interim guidelines for recommendations on communications tower siting, construction, operation, and decommissioning. Unpublished memo to Regional Directors, available at:
http://migratorybirds.fws.gov/issues/towers/comtow.html.

Walthew, G. (1997.). "The status and flight periods of Hong Kong butterflies." *Porcupine!* 16: 34-37.

Wilson D. E. and Reeder, D. M. (1992). *Mammal Species of the World: A Taxonomic and Geographic Reference*. Smithsonian Institution Press, Washington & London.

Wilson, K.D.P. (2003). *Field Guide to the Dragonflies of Hong Kong*. Agriculture, Fisheries and Conservation Department, Hong Kong.

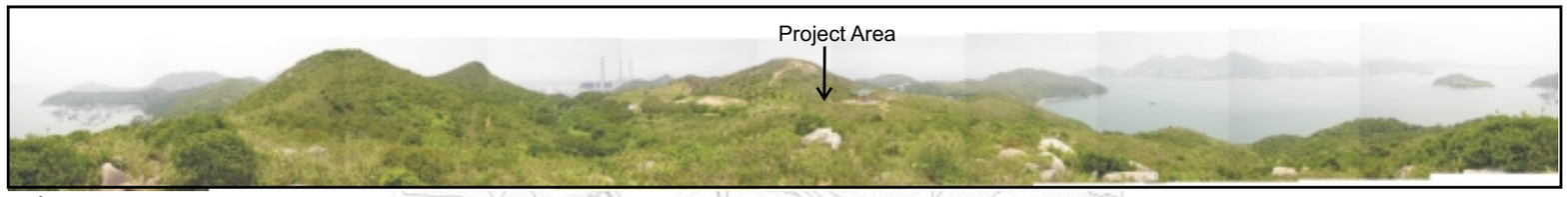
Wong Y W. (1999) *Ecology and Biodiversity of a Degraded Landscape: Lamma Island, Hong Kong*, HKU PhD. Thesis.

Wu, S. H. and W. T. C. Lee. (2000). "Pteridophytes of Hong Kong." *Memoirs of the Hong Kong Natural History Society* 23: 5-20.

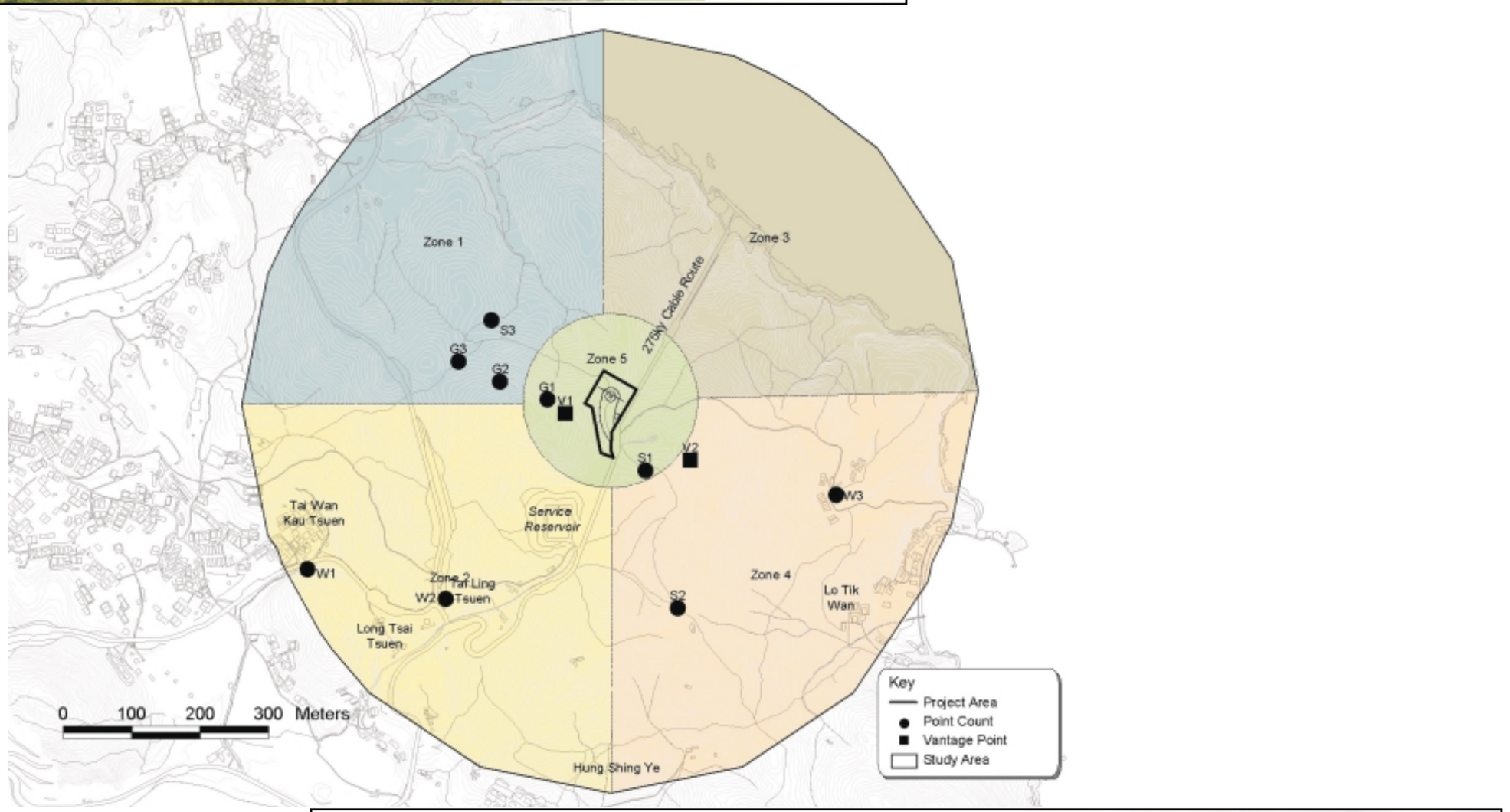
Xing, F.W., Ng, S.C., Chau, L.K.C. (2000) Gymnosperms and angiosperms of Hong Kong. *Memoirs of the Hong Kong Natural History Society*. 23: 21-136.

Zhao, E. M. (1998) *China Red Data Book of Endangered Animals: Amphibia & Reptiia*. Science Press, Beijing.

Zhao, E.-M. & Adler, K. (1993). *Herpetology of China*. Society for the Study of Amphibians and Reptiles, Oxford, Ohio.



360° View from Vantage Point V1



360° View from Vantage Point V2

Figure 5.1

Point Count and Vantage Point Location

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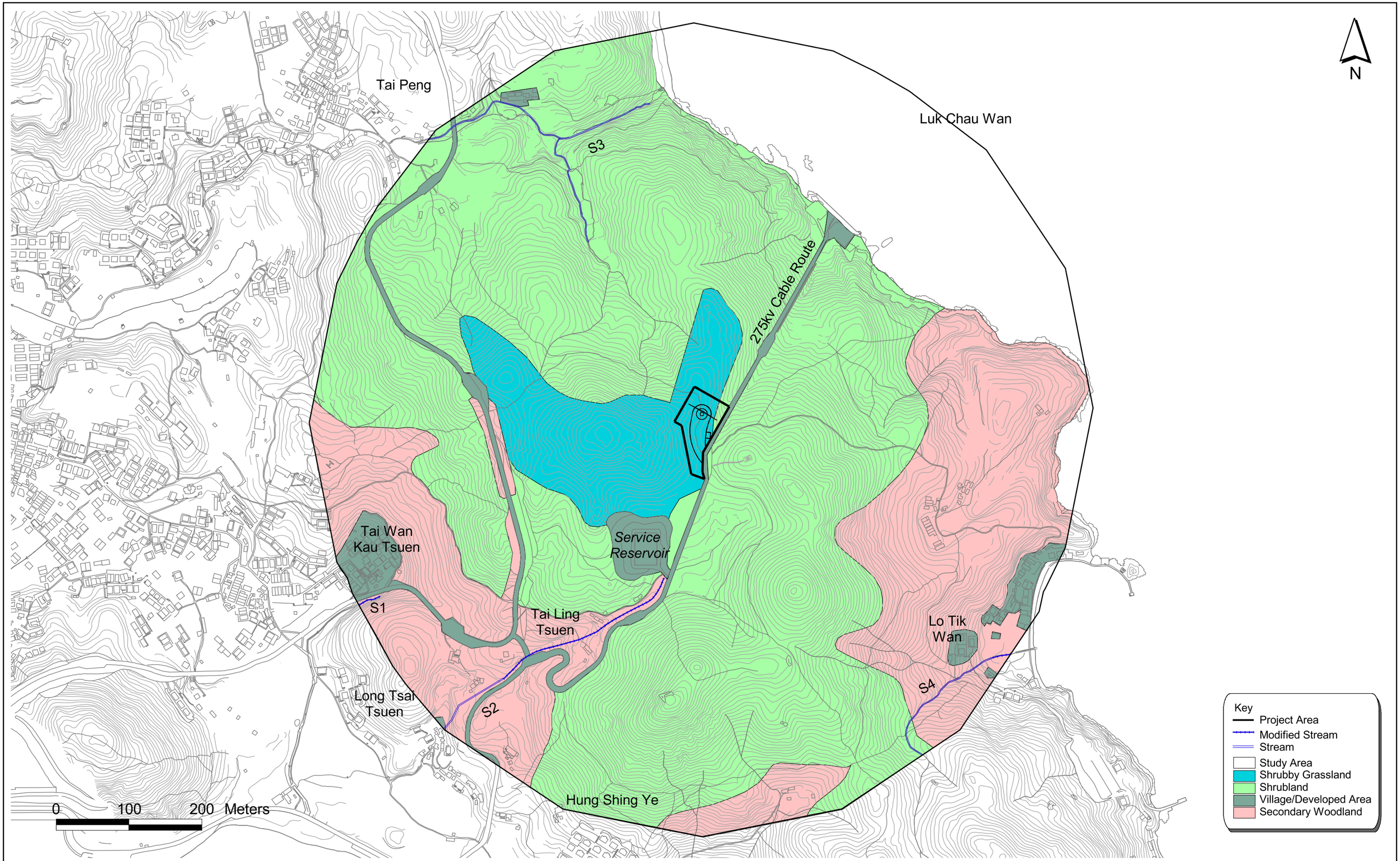

FIGURE 5.2

Habitat Map of the Study Area on Lamma Island

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Date: 20/07/2004

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Secondary Woodland

Village/Developed Area

Shrubby grassland, are expected to be originated from the shrubland, which located in the vicinity of the Project Area

Shrubland

Shrubby Grassland

Figure 5.3

Photographic Record of Different Habitats within the Study Area

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DATE: 14/06/04

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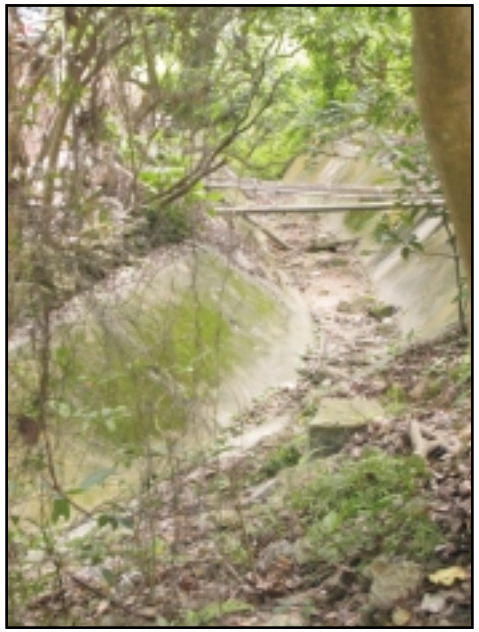
Stream 1



Stream 2 - Upper Course

Stream 2 - Middle Course

Stream 2 - Lower Course

Figure 5.4

Photographic Records of Stream Habitats within the Study Area

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DATE: 14/06/04

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Stream 3

Stream 4 - Upper Course

Stream 4 - Middle Course

Stream 4 - Lower Course

Figure 5.5

Photographic Record of Stream Habitats within the Study Area

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DATE: 14/-6/04

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Black Kite Roosting Site (see Figure C8 for location)

Black Kite

Common Duffer

Greater Coucal

Tree Flitter

Bush Hopper

Figure 5.6

Species of Conservation Interest Recorded within the Study Area

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Environmental Resources Management

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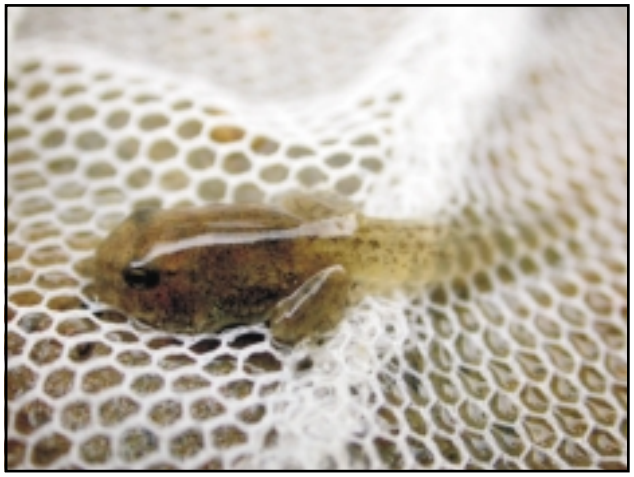
Pavetta

Romer's Tree Frog

White-edged Blue Baron



Romer's Tree Frog (tadpole)

White-bellied Sea Eagle

Figure 5.7

Species of Conservation Interest Recorded within the Study Area

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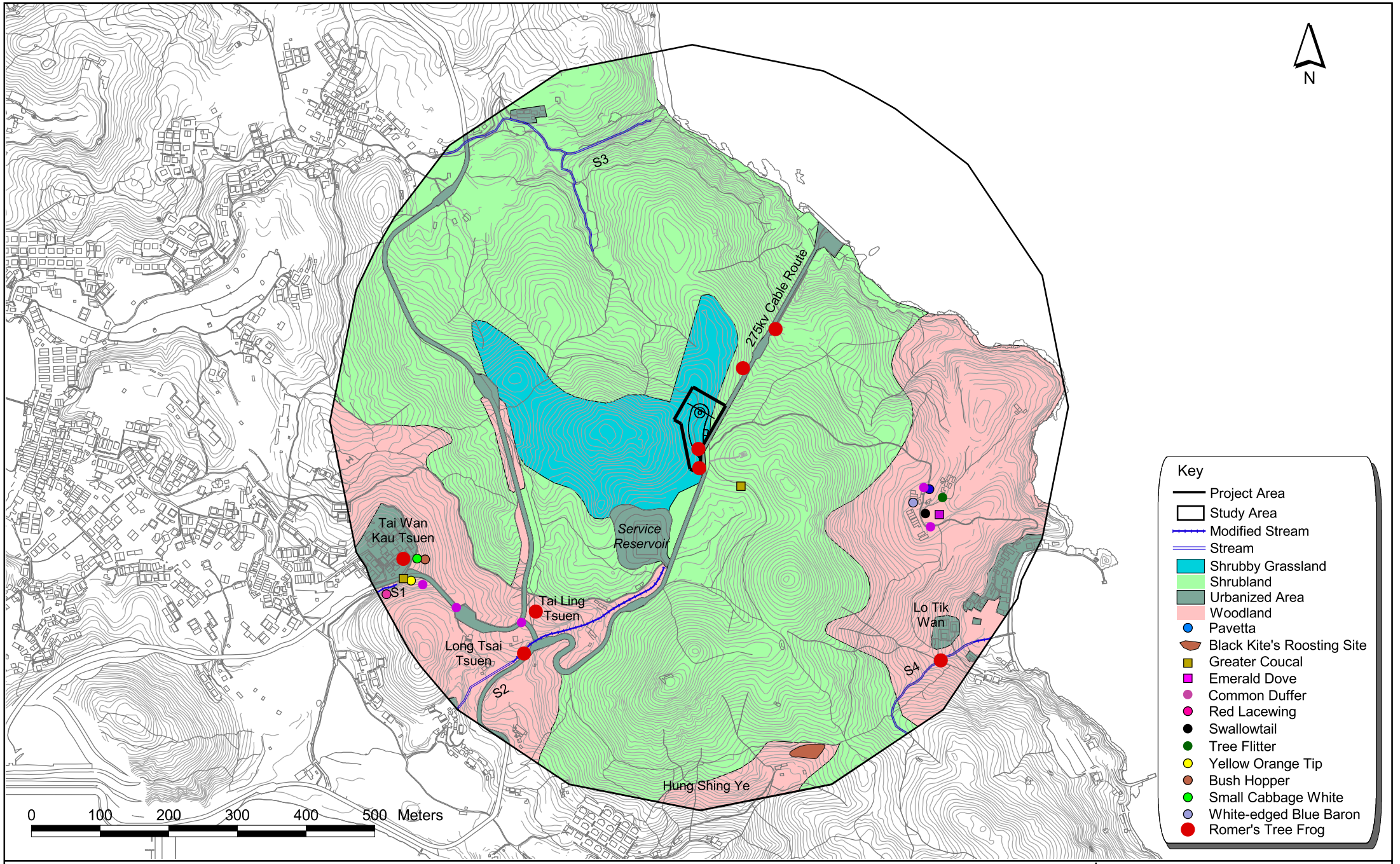

FIGURE 5.8

Location of Species of Conservation Interest (Excluding Black Kite and White-bellied Sea Eagle) Recorded During the Survey

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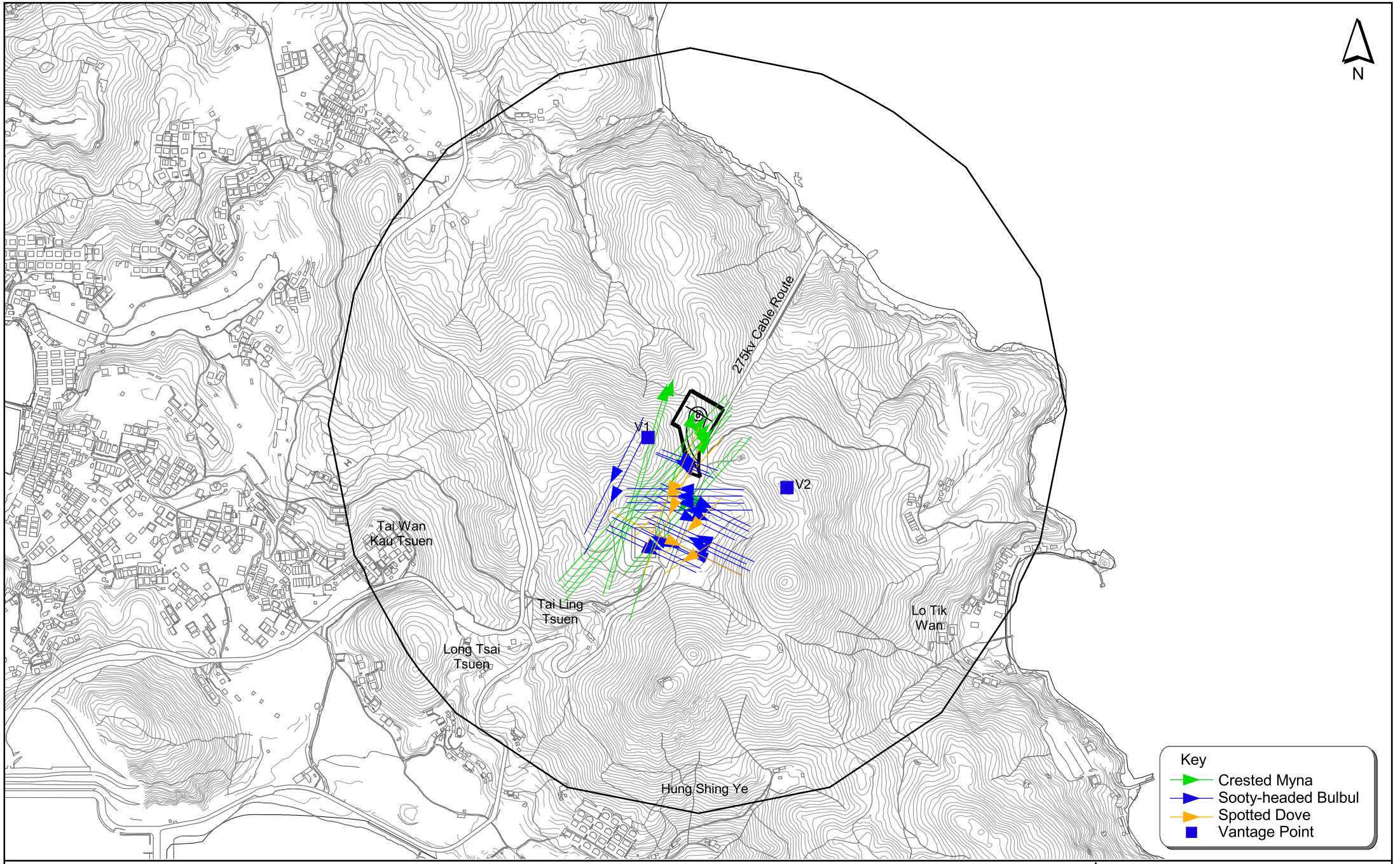

FIGURE 5.9

Flight Paths of Primary Species (Spotted Dove, Sooty-headed Bulbul and Crested Myna) Recorded <10m Above Ground Level in the Vicinity of the Proposed Wind Turbine (Recorded over 6 days of monitoring)

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Environmental Resources Management

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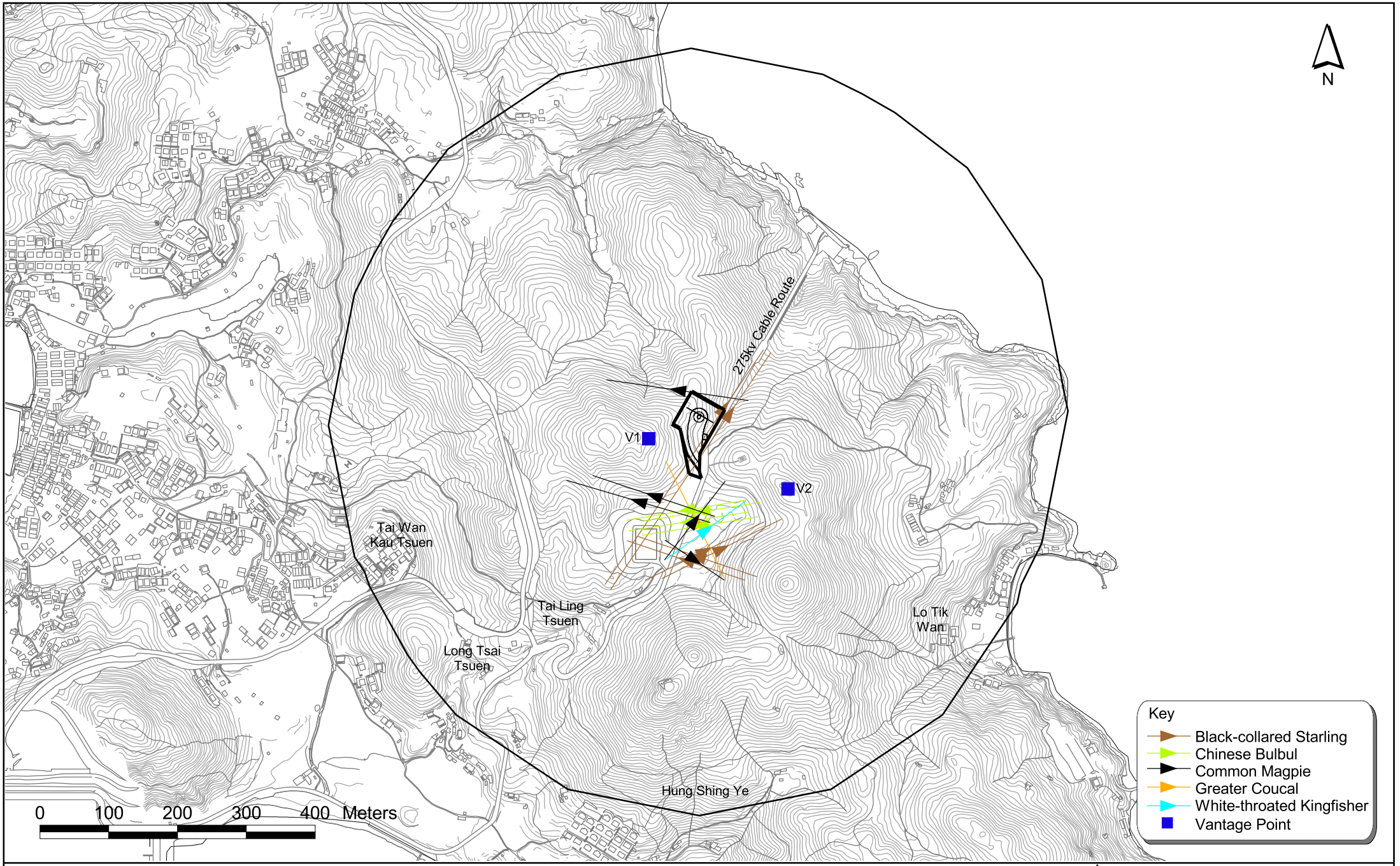

FIGURE 5.10

Flight Paths of Primary Species (Greater Coucal, White-throated Kingfisher, Barn Swallow, Common Magpie, Chinese Bulbul and Black-collared Starling)
Recorded <10m Above Ground Level in the Vicinity of the Proposed Wind Turbine
(Recorded over 6 days of monitoring)

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Date: 15/07/04

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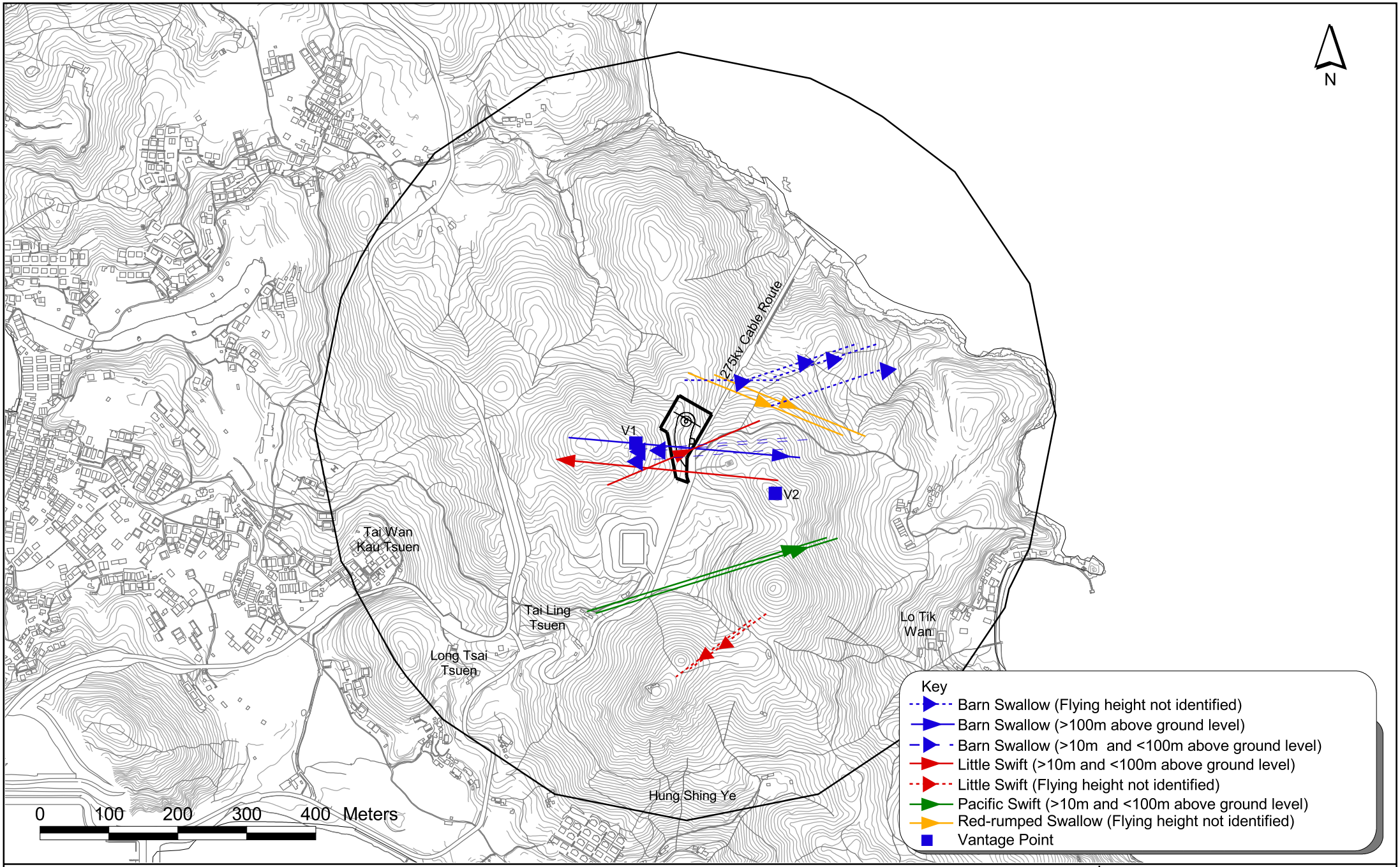

FIGURE 5.11

Flight Path of Primary Species Recorded >10m Above Ground Level
in the Vicinity of the Proposed Wind Turbine
(Recorded over 6 days of monitoring)

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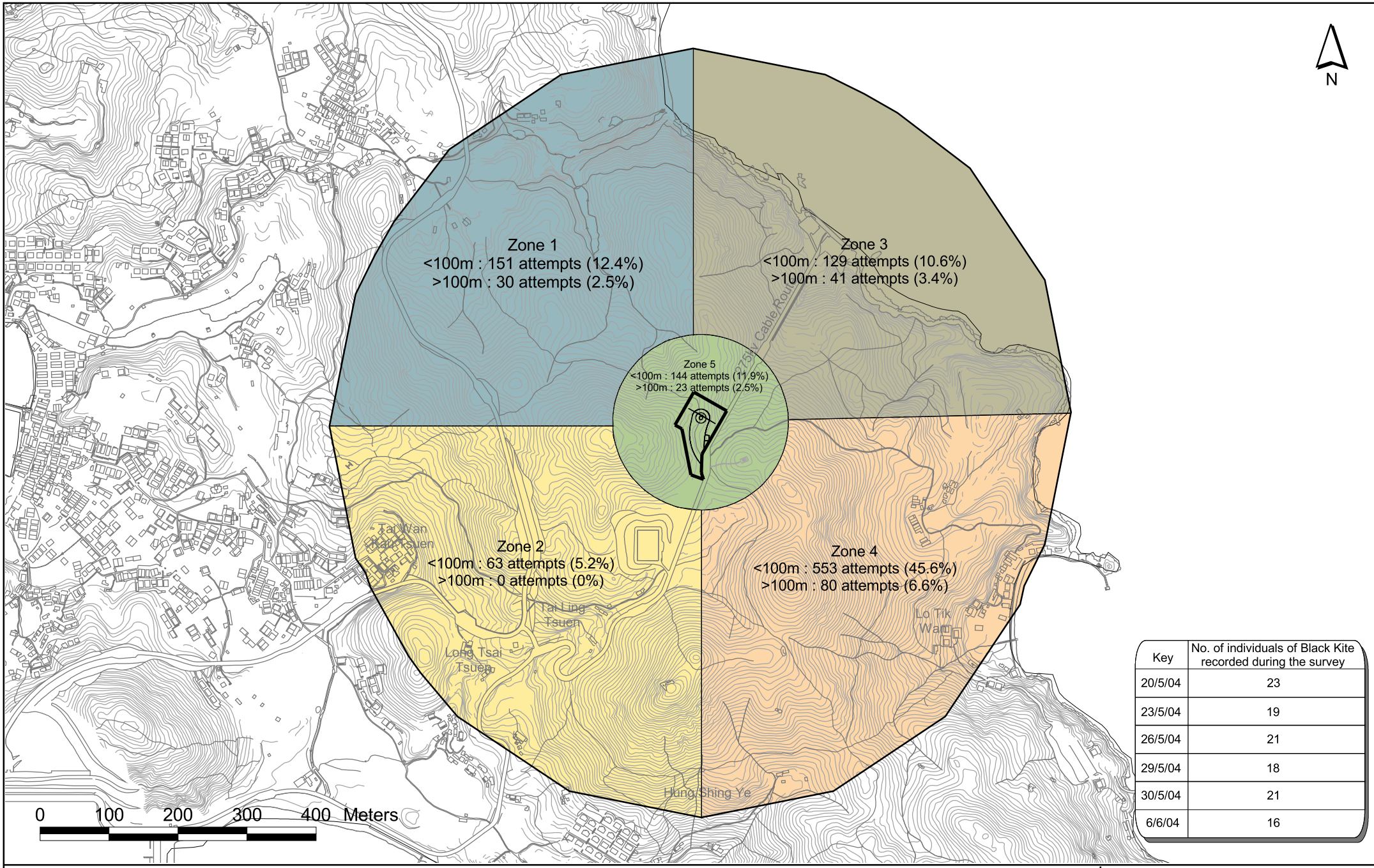

Key	No. of individuals of Black Kite recorded during the survey
20/5/04	23
23/5/04	19
26/5/04	21
29/5/04	18
30/5/04	21
6/6/04	16

FIGURE 5.12

Flight Attempts of Black Kite Recorded
within the Study Area (with a total of 1214 attempts)

File: C2701h_5.apr
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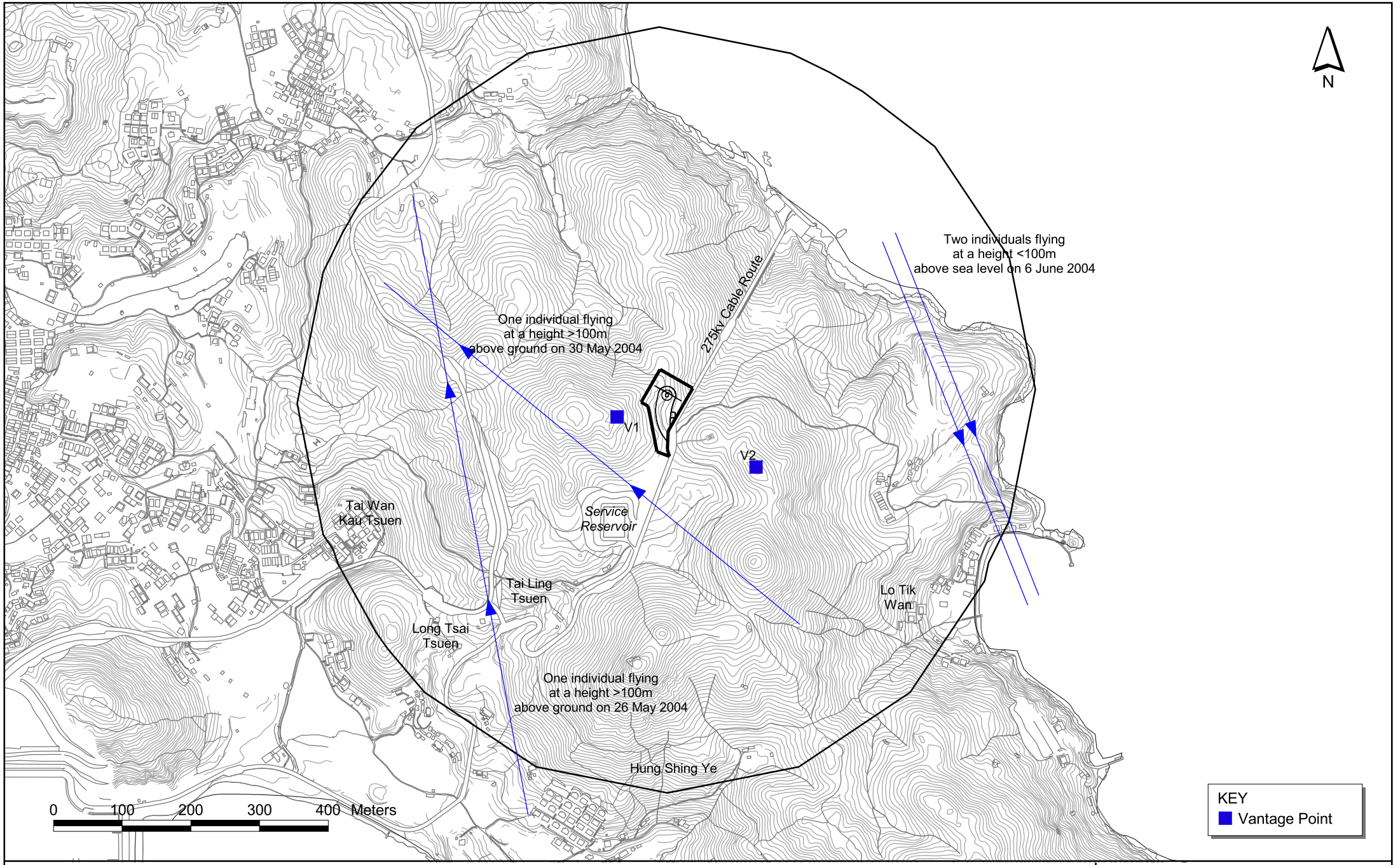

FIGURE 5.13

Flight Paths of White-bellied Sea Eagle within the Study Area
(Recorded over 6 days of monitoring)

File: C2701h_1.apr
Date: 24/06/04

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Project area located adjacent to the 275kV Cable Route

Project area was dominated by shrubby grassland. Littering and dumping was recorded on site

Shrubby grassland within the project area was dominated by *Ischaemum aristatum*

Project area dominated by shrubby grassland

Figure 5.14

Photographic Record of Present Condition of the Project Area and Work Areas

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DATE: 14/06/04

Environmental Resources Management

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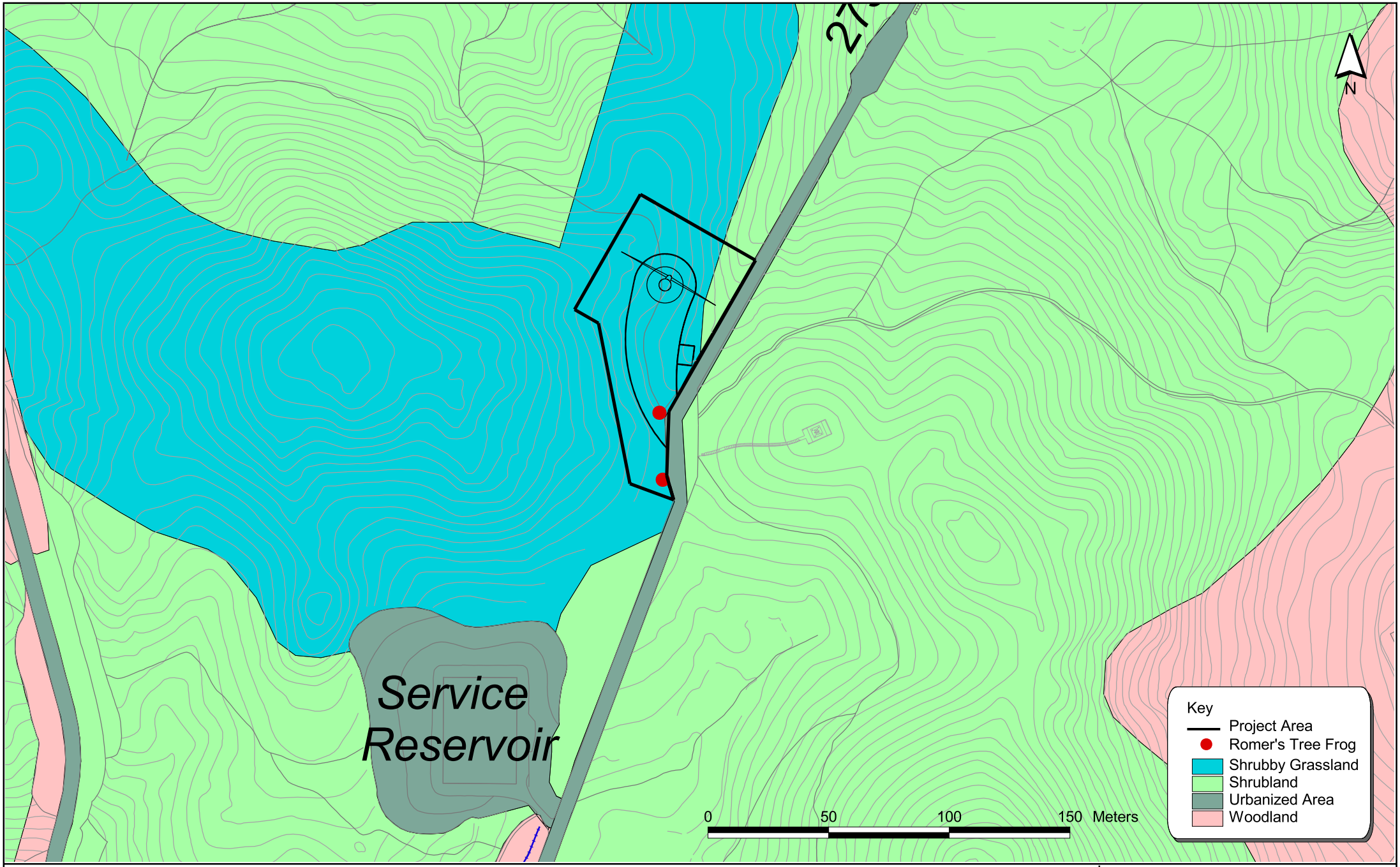

FIGURE 5.15

Habitat Map of The Project Area

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Date: 15/07/2004

Environmental Resources Management

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6 LANDSCAPE AND VISUAL IMPACT ASSESSMENT

6.1 INTRODUCTION

This section presents the findings of the landscape and visual impact assessment (LVIA) for the proposed wind turbine at Tai Ling in Lamma Island (hereafter described as "The Project") and outlines the potential impacts to the existing landscape and visual context of the area together with the mitigation measures proposed to alleviate those impacts.

6.2 RELEVANT LEGISLATION AND GUIDELINES

The methodology of the LVIA is based on *Annexes 10* and *18* in the Hong Kong SAR Government's *Technical Memorandum on the Environmental Impact Assessment Process* (*EIAO-TM)* under the *EIA Ordinance* (Cap.499, S16), entitled "Criteria for Evaluating Visual and Landscape Impact" and "Guidelines for Landscape and Visual Impact Assessment", respectively and the *EIAO Guidance Note No. 8/2002 "Preparation of Landscape and Visual Impact Assessment Under the Environmental Impact Assessment Ordinance."*

In addition, *The Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10 – Landscape and Conservation* outlines relevant design criteria that should be considered in this project.

6.3 ASSESSMENT METHODOLOGY

In accordance with the *EIAO Guidance Note No.8/2002*, the main components of the LVIA will be as follows:

- description of the Project;
- baseline study of landscape and visual resources;
- review of planning and development control framework;
- landscape impact assessment during construction and operation;
- visual impact assessment during construction and operation;
- recommendations for landscape and visual mitigation measures for both construction and operation stage; and
- assessment of residual impact and conclusion on the acceptability of the Project.

The *baseline study* is examined in *Section 6.4* of this report. It identifies and examines the existing landscape and visual resources within the study area. The baseline study describes the landscape resources by identifying broadly landscape character areas (LCAs) and key landscape elements within the

study area (refer to *Figure 6.1*). The landscape character was rated low, medium or high depending not only on the quality of elements present but also to its sensitivity to change and its importance at a local, district, regional or international level.

Visual resources considered were key viewpoints, location and direction of views towards the project. A visual envelope (refer to *Figures 6.2* and *6.3)* was established which approximately defined the extent of visual influence of the project and, therefore, of the potential visual impacts. Definition of the extent of the viewshed was based on desktop study and site investigation. The visual envelope/viewshed is generally formed by natural/man made features such as ridgeline or building blocks.

Visually Sensitive Receivers (VSRs) identified in here are "representative" in that individuals or groups that have a similar sensitivity to changes in the visual and landscape environment are grouped together within a single VSR that can represent the whole group. The *Hong Kong Planning Standards and Guidelines (HKPSG)* define sensitive users as "land uses which, by virtue of the nature of the activities thereon…. are susceptible to the influence of residual or physical changes generated by polluting uses".

The next stage was a *review of the planning and development control framework*. Landscape related zonings on the Outline Zoning Plan (OZP) and other relevant non-statutory layout plan were mapped and analyzed to provide an insight to the future outlook of the area affected and the way the Project would fit into its wider context. For the proposed works, the following document is reviewed:

- The Lamma Island Outline Zoning Plan (Plan no. S/I-LI/4, 2002)
- Hong Kong Planning Area No. 10 – Pok Fu Lam – Outline Zoning Plan (Plan no. S/H10/14)
- Hong Kong Planning Area No. 14 - The Peak Area – Outline Zoning Plan (Plan no. S/H14/6)
- Hong Kong Planning Area Nos. 15 & 16 – Aberdeen & Ap Lei Chau – Outline Zoning Plan (Plan no. S/H15/20)
- Hong Kong Planning Area No. 17 – Shouson Hill & Repulse Bay – Outline Zoning Plan (S/H17/7)
- Hong Kong Planning Area No. 19 – Stanley – Outline Zoning Plan (S/H10/14)

The following stage was to *assess impacts* on the landscape and visual resources during construction and operation. The impact assessments allow predictions to be made about the likely levels and significance of landscape and visual impacts.

The *sensitivity* of receivers for evaluation of *landscape impacts* will result from:

- quality of landscape characters/resources;
- importance and rarity of special landscape elements;
- ability of the landscape to accommodate change;
- significance of the change in local and regional context, and
- maturity of the landscape.

The degree of *sensitivity* is classified as follows:

- *High* – eg important components or landscape of particularly distinctive character susceptible to small changes;
- *Medium* – eg a landscape of moderately valued characteristics reasonably tolerant to change;
- *Low* – eg a relatively unimportant landscape which is able to accommodate extensive change.

The *magnitude of change* for assessing *landscape impacts* is based on:

- compatibility of the project with the surrounding landscape;
- duration of impacts under construction and operation phases;
- scale of development, and
- reversibility of change.

The *magnitude of change* is classified as follows:

- *Large* – notable change in the landscape characteristics over an extensive area ranging to very intensive change over a more limited area;
- *Intermediate* – moderate changes to a local area;
- *Small* – changes to components;
- *Negligible* – no perceptible changes.

The system for the assessment of landscape and visual impact is summarized in *Tables 6.1 and 6.2*. The significance threshold of landscape and visual impact is derived from the combined analysis of the *magnitude of change* and the *sensitivity of receivers*. The matrix in *Table 6.1* indicates how the significance threshold is derived. *Table 6.1* explains the terms used to in *Table 6.2*.

Table 6.1 Significance Threshold of Potential Landscape/Visual Impact

		Sensitivity of Receiver		
		Low	*Medium*	*High*
Magnitude of Change	*Large*	Moderate Impact	Moderate-Significant Impact	Significant Impact
	Intermediate	Slight-Moderate Impact	Moderate Impact	Moderate- Significant Impact
	Small	Slight Impact	Slight- Moderate Impact	Moderate Impact
	Negligible	Negligible	Negligible	Negligible

Table 6.2 Adverse / Beneficial Impacts of Landscape/Visual Impact

Significant:	*Moderate:*	*Slight:*	*Negligible*
Adverse / beneficial impact where the proposal would cause significant degradation or improvement in existing landscape baseline conditions or visual character of the setting	Adverse / beneficial impact where the proposal would cause noticeable degradation or improvement in existing landscape baseline conditions or visual character of the setting	Adverse /beneficial impact where the proposal would cause a barely noticeable degradation or improvement in existing landscape conditions or where the changes brought about by the project would not be apparent in visual terms	The proposal does not affect the existing landscape baseline conditions or visual character of the setting.

The assessment of potential *visual impacts* will result from:

- The *sensitivity of receivers* at VSR locations to change and visual intrusion;
- The *magnitude of change* to the visual baseline condition.

The *sensitivity of receivers* for evaluation of *visual impacts* will result from:

- value and quality of existing views;
- availability and amenity alternative views;
- type and estimated number of receiver population;
- duration or frequency of view, and
- degree of visibility.

The *sensitivity of receivers* at VSR locations will be classified as follows:

- *High* –
    i. The nature of the viewer groups expect a high degree of control over their immediate environment, (eg people residing in their homes); and
    ii. The viewer groups are in proximity to the Project.

- *Medium* -
    i. The nature of the viewer groups expect a high degree of control over their immediate environment, (eg people residing in their homes); or
    ii. The nature of the viewer groups expect some degree of control over their immediate environment, (eg teachers in schools); but
    iii. The viewer groups are not in proximity to the Project.

- *Low* –
    i. The nature of the viewer groups do not expect a high degree of control over their immediate environment, (eg people at their place of employment or temporarily in attendance at the VSR location); or
    ii. People in transit (eg drivers and passengers in vehicles).

The *magnitude of change* for assessing *visual impacts* is based on:

- compatibility of the project with the surrounding landscape;
- duration of impacts under construction and operation phases;
- scale of development;
- reversibility of change;
- viewing distance, and
- potential blockage of view.

The magnitude of change to the views will be classified as follows:

- *Large*: eg the majority of viewers affected / major change in view.
- *Intermediate*: eg many viewers affected / moderate change in view.
- *Small*: eg few viewers affected / minor change in view.
- *Negligible*: eg very few viewers affected / no discernible change in view.

The degree of visual impact or significance threshold has been rated in a similar fashion to the landscape impact described above, ie significant, moderate, slight and negligible. The impacts may be beneficial or adverse.

The significance threshold of visual impact is rated for the construction phase and for Day 1 and Year 10 of the operation phase and is illustrated in *Tables 6.1* and *6.2*.

The next stage of the study following impact assessment is to *recommend mitigation measures*. The identification of the landscape and visual impacts will highlight those sources of conflict requiring design solutions to reduce adverse impacts. Mitigation measures may include revisions/refinement to the engineering design and/or the implementation of landscape design measures including screen tree planting, hard landscape design to minimize adverse landscape and visual impacts.

The final stage of the LVIA study is to *assess the significance of the residual impacts* of the study assuming landscape and visual mitigation measures are incorporated into the design. In conclusion of the landscape and visual impacts were then classified into one of five levels of significance based on criteria in *Annex 10* of the *EIAO-TM*, as summarized below:

- The impact is <u>beneficial</u> if the project will complement the landscape and visual character of its setting, will follow the relevant planning objectives and will improve the overall and visual quality of the study area;

- The impact is <u>acceptable</u> if the assessment indicates that there will be no significant effects on the landscape, no significant visual effects caused by the appearance of the project, or no interference with key views;

- The impact is <u>acceptable with mitigation measures</u> if there will be some adverse effects, but these can be eliminated, reduced or offset to a large extent by specific measures;

- The impact is unacceptable if the adverse effects are considered too excessive and are unable to mitigate practically; and

- The impact is undetermined if significant adverse effects are likely, but the extent to which they may occur or may be mitigated cannot be determined from the study. Further detailed study will be required for the specific effects in question.

6.4 BASELINE CONDITIONS

6.4.1 Project Description

The aim of the installation of wind turbine by The Hongkong Electric Co., Ltd. is to supply renewable electric energy to the customers of The Hongkong Electric Co., Ltd. in order to provide quality power supply to customers with due care for the environment. The Project is described in detail in *Section 3* of the EIA. This section summarises the main elements of the proposed works affecting the landscape and visual baseline conditions.

The project will comprise of the construction and operation of a 600-850kW wind turbine and associated equipment. The wind turbine comprises basically of 3 rotor blades, a nacelle and a tapered monopole. Hub height and rotor blade diameter of a 600-850kW wind turbine are approx. 45 and approx. 52m respectively as shown in *Figure 6.23*. The overall height is approximately 71m. The aspects of the project elements that are likely to affect the landscape and visual baseline conditions during construction and operation will be activity associated with:

- site formation of the platform for the wind turbine and the two equipment huts including construction of retaining walls;
- laying of approx. 50m underground distribution cables;
- views of the wind turbine with rotating blades.

The proposed wind turbine is located adjacent to the existing concrete paved 275kV cable road at approximately 92m P.D. . The Project Site is approached on the cable road from the southwest which slopes gently upwards. To the immediate west and southeast of the Project Site are two knolls of 127m and 136mP.D. respectively. These two knolls form a natural visual screen for most viewers from the west and southeast such as those at Yung Shue Wan, Tai Wan San Tsuen, Tai Wan Kau Tsuen and Lo Tik Wan.

The topography slopes steeply towards the northeast from the site and as a result, the views from the east and north will be relatively open. Most viewers on the coastline of Hong Kong Island south and Ap Lei Chau will have an uninterrupted view across the Lamma East Channel. The existing view of Lamma Island from these viewers is generally a lush green island with gently undulating terrain. The three chimneys of the Lamma Power Station can be seen in the background behind the ridges of Lamma Island.

On a closer scale, the Project Site is dominated by grass with some small shrubs and occasional trees. East of the site a footpath is located leading up to Tai Ling Pavilion overlooking the northeastern part of Lamma Island. This pavilion is located less than 100m from the Wind Turbine at the level of approximately 104m P.D. half-way between the Wind Turbine platform and the top of the southeastern knoll. The pavilion is an important lookout point to Hong Kong Island. The view from this pavilion towards the proposed wind turbine is shown on *Figure 6.23*.

6.4.2 Limitation of the Study

For the purpose of assessing potential impacts on landscape resources, the study has included all areas within 500m from the proposed wind turbine.

The limits of the visual impact studies are the zones of visual influence (ZVIs) of the works during the construction and operation phases. For the purpose of assessing potential visual impacts of the proposed wind turbine, the study area comprises ZVIs extending to Ap Lei Chau, South-east Hong Kong and Lamma Island, ferry en-route to Lamma Island and popular walking trails on Lamma Island. This and the location of VSRs within it are shown in *Figures 6.2* and *6.3*.

6.4.3 Project Design and Construction

The design and construction of the proposed wind turbine and associated works are stipulated in *Section 3*.

6.4.4 Categorization of Landscape Character Areas and Landscape Resources

The Study Area is defined as the area within 500m of either side and along the site boundary and is located at Tai Ling on Lamma Island adjacent to the Joint Bay No. 8 along the 275kV Cable Route from Lamma Power Station to Cable Landing Point at Luk Chau Wan. It faces the Hong Kong Island to the northeast.

To assist in the assessment of landscape resources in the study area one (1) Landscape Character Area (LCA) have been identified and five (5) landscape resources (LRs) within the Study Area have been quantified .

The landscape character of North Lamma Island is typical of Hong Kong rural island coastal upland covered with shrubby grassland with scattered trees/tree clumps and a small amount of village settlements on exposed hilly slopes. The whole study area is considered to be covered under one single Landscape Character Area (LCA 1).

Landscape Resources found within the Study Area include secondary woodland, shrubland, shrubby grassland, village/developed area and streams (*Figure 6.1*). Colour photographs of these landscape resources types, as well as other features and species of conservation interest, are presented in *Figures 5.3* to *5.5*.

A total of 122 plant species were recorded. For details, please refer to *Annex C Table 5.* A locally protected species *Pavetta hongkongensis* was recorded within the Study Area (*Figure 5.8*). The number of plant species and the size of each identified Landscape Resources type are presented in *Table 6.3*.

Table 6.3 Landscape Resources Recorded Within the Study Area

Landscape Resources type	Number	Area (hectare)/ Length (Km)	Number of Plant Species Recorded
Secondary Woodland	LR1	20.5 ha	64
Shrubland	LR2	49.4 ha	74
Shrubby Grassland	LR3	5.7 ha	25
Stream	LR4		42
Stream S1		0.03 km	
Stream S2		0.38 km	
Stream S3		0.46 km	
Stream S4		0.23 km	
Village/Developed Area	LR5	3.8 ha	18
	Total	**79.4 ha**	

Details description of each of these Landscape Character Area and Landscape Resource are listed below:

North Lamma Coastal Uplands – LCA 1

North Lamma Coastal Uplands is a landscape character area consisting of coastal uplands and hillsides and is characteristic of most of Lamma Island except for urban peripheral village landscapes formed by settlements such as Pak Kok San Tsuen to Hung Shing Ye; Lo So Shing and Sok Kwu Wan; and Mo Tat Old Village and Tung O. Other identified landscape character areas of the island are quarry landscape around Luk Chau Village, the industrial urban landscape of the Power Station, and one unsettled valley and rural inland plains to the mid south of the island. As the Study Area is within the North Lamma Coastal Upland area the Landscape Character Area under discussion shall be focused on this landscape area type.

The topography of this area consists of rolling and sometimes hilly ridges, spurs and hillsides with isolated boulders and crags protruding above the scattered trees/tree clumps, woodland scrub and grasslands *(Figure 6.4)*. It tends to be steeper on the eastern slopes which fall directly to the east lamma channel. The area is undeveloped except for small villages at Lo Tik Wan *(Figure 6.5)*. Western slopes, in comparison, are criss-crossed by footpaths and a trail between Yung Shue Wan and Sok Kwu Wan. The slopes are also traversed by a 5.5m wide cable trench running from the power station to the sea off Luk Chau Wan in the south and Pak Kok in the north. Hills are of a similar height, ranging from 138mPD at Pak Kok Shan in the north to 135 mPD in the south. Landuse within the hills is characterised by pockets of semi-abandoned fields and village development *(Figure 6.6)*, a service reservoir in the centre and the Lamma Island Youth Hostel to the south.

Vegetation is dominated by emergent scrub and grassland with small pockets of trees located within sheltered seasonal stream courses. The uplands command open views across the East Lamma Channel to Aberdeen and Ap Lei Chau in the east.

The site is located at the valley form by two knolls in the central portions of north Lamma Island, some 200m north north-east of Tai Ling. The knolls are 127 – 136 mPD high and the Wind Turbine platform is to be at 92mPD. Hence the Wing Turbine is to be sited at a somewhat shelter position within the topography.

The aesthetic and perceptual quality of the landscape is of large, open, remote, and coherent characteristics with low diversity of landuse and high visual exposure to other landscape character areas. It is frequently visited by tourists and urban dwellers as an outing destination for its pleasant and tranquil natural qualities. It is considered to have an overall *high* landscape character value.

Secondary Woodland – LR1

Secondary woodlands were found mainly at the east and southwest of the Study Area. A total of 64 plant species were recorded in the secondary woodlands.

The secondary woodlands located at the southwest of the Study Area were semi-natural with exotic plantation at the fringe of the woodland and the understory was dominated by native plant species. The secondary woodlands were fragmented by the 275 kV Cable Route, which was covered by cement and grass-crete acting as a concrete road connecting to other areas on Lamma Island. The exotic plantation was found mainly at the fringe of the woodland and along the 275 kV Cable Route at Tai Wan Kau Tsuen, Long Tsai Tsuen and Tai Ling Tsuen. Village houses were scarcely located within the woodland, which were mainly on both sides of the 275 kV Cable Route. The canopy species were 10 to 14 m in height and dominated by *Acacia confusa*, *Albizia labbeck*, *Leucaena leucocephala* and *Melaleuca leucadendron*. The understory was occupied by native trees and shrubs, which can be divided into a middle layer 4 to 8 m in height and a lower layer 1 to 3 m in height. The middle layer of understory was dominated by *Cinnamomum camphora, Macaranga tanarius* and *Schefflera octophylla* while the lower layer of understory was dominated by *Ilex asprella, Litsea glutinosa* and *Sterculia lanceolata*.

Secondary woodland found in the east of the Study Area near Lo Tik Wan was a large patch of woodland dominated by native tree species. Village houses were scarcely located within the woodland and some of them were abandoned. The woodland was dominated by climax species such as *Cinnamomum camphora*, *Mallotus paniculatus*, *Sterculia lanceollata*, *Macaranga tanarius* and *Dimocarpus longan*. Canopy species reached a height of 12-15 m. The understorey was densely vegetated and dominated by woody species including *Litsea rotundifolia*, *Ligustrum sinensis, Eurya nitida* and the climbers

Gnetum montanum and *Uvaria microcarpa*. A locally protected species *Pavetta hongkongensis* were found within the secondary woodland (*Figures 5.7* and *5.8*). This woodland is remote from the turbine location.

This Landscape Resource LR1 - Secondary Woodland has an overall *medium* landscape sensitivity.

Shrubland – LR2

Shrubland was the dominant landscape resources type within the Study Area and was 1 to 4 m in height. It was dominated by several native shrub species including *Rhodomrytus tomentosa*, *Cratoxylum cochinchinensis*, *Dalbergia benthami*, *Eurya nitida*, *Embelia laeta*, *Embelia ribes* and *Gordonia axillaries*. Shrubland patches in the valleys were usually taller with an average 2 to 4 m in height while those on the hill slope and ridge of the hills were 1 to 2.5 m in height. A total of 74 plant species were recorded within the shrublands.

This Landscape Resource LR2 - Shrubland has an overall *medium* landscape sensitivity.

Shrubby Grassland – LR3

Shrubby grasslands were mainly found in the middle of the Study Area and close to the Project Area, which was located at the north of Yung Shue Long Old Village and next to the WSD Service Reservoir. The area was expected originally to have been shrublands but has been disturbed due to hill fires leading the area to become dominated by grass species. The area had been burnt a short period of time before the surveys. A total of 25 plant species were recorded within the shrubland and dominated by *Ischaemum aristatum* and *Eriachne pallescens*.

This Landscape Resource LR3 – Shrubby Grassland has an overall *medium* landscape sensitivity.

Streams – LR4

Three partially modified and one less disturbed streams, S1 to S4, were found within the Study Area (*Figure 5.2*). Forty-two plant species were recorded along the streams and no rare/protected species were found during the surveys.

Stream S1 is a drainage channel running along with the 275 kV Cable Route (*Figure 5.2*). The lower course of stream S1 was cemented while the upper course was an underground channel. Only limited water flow was recorded in Stream S1 during the survey.

Stream S2 was partially channelized in the upper and middle courses (from the Service Reservoir to Tai Ling Tsuen). Stream S2 has natural bottom, particularly in the middle and lower courses, dominated by medium to small sized boulders and sand. The upper and middle courses were covered by the

close canopy of the adjacent woodland while the lower course of the stream was more open with limited shading by the shrubs and grasses in the vicinity. Only limited water flow was recorded in lower course and no water flow recorded in the upper and middle courses during the survey.

Stream S3, located at the northwest of the Study Area, was relatively less disturbed. Water flow in stream S3 was low and the stream bank was natural with medium-sized boulders and sand bottom. The riparian vegetation of the stream was integrated with the surrounding shrubland with semi-open canopy.

Stream S4 was partially channelized in the lower course but the upper and middle courses remained natural, with relative steep slope. The bottom of Stream S4 remains natural, composed of sand and small to medium sized boulders. No water was found in the upper course. The middle course has several small pools filled with water but the water flow was limited. The close canopy of secondary woodland covered the whole section of the stream with limited open space in the middle and lower courses.

This Landscape Resource LR4 – Streams has an overall *medium* landscape sensitivity.

Village/Developed Areas – LR5

Village/developed areas, comprising village houses, 275 kV Cable Route and the Service Reservoir, were scattered within the Study Area. The Service Reservoir was located close to the Project Area. All of the vegetation recorded within this landscape resource type, such as *Michelia alba* and *Ficus microcarpus*, were planted for landscaping purposes. Fruit trees such as *Musa paradisiacal, Dimocarpus longan, Citrus sinensis* and *Clausena lansium* were also recorded. A total of 18 plant species were found in this landscape resource area and no rare plant species were found.

This Landscape Resource LR5 – Village/Developed Areas has an overall *medium* landscape sensitivity.

6.4.5 Visually Sensitive Receivers

In accordance with the study methodology, the Visually Sensitive Receivers (VSRs) within the visual envelope are identified. The representative viewpoints on Lamma Island and Hong Kong Island are identified from VSRs. (refer to *Table 6.4* and *6.5*).

In summary, the VSRs can be classified into 3 main groups.

- Resident and people at work VSRs on Lamma Islands where the proposed wind turbine would be visible
- Resident and people at work VSRs on Hong Kong Island south and Ap Lei Chau

- Visitors and viewers in transit such as those on hiking tracks on Lamma Island and along the ferry routes as well as those in Ocean Park

- Visitors to the Tai Ling Pavilion and cable road adjacent to the Project Site

People in transit are considered to be less sensitive to visual impact than people residing in their homes, although the visitors to the cable road and Tai Ling Pavilion immediately next to the site will be much more sensitive to the visual impact of the Wing Turbine.

The representative visual receiver groups on Lamma Island are identified in *Figure 6.2*. The natural topography of Lamma Island provides a visual barrier over the southern areas of the island. To the south, the proposed wind turbine would be visually screened from the villages around Lo Tik Wan Hung Sing Ye Beach, Lo So Shing Beach, Sok Kwu Wan Pier and Mo Tat Wan Pier by the Headland or the southeastern knoll near the site. To the west, the views from Yung Shue Long, Tai Wan San Tsuen and Tai Wan Kau Tsuen are screened by the natural steep terrain or the western knoll.

Along the waterfront of Yung Shue Wan including the future waterfront promenade and the dense settlements around Yung Shue Wan including Sha Po New Village, Sha Po Old Village and Tai Yuen Village, the view towards the wind turbine would be largely blocked by houses. The views from the upper storeys of the houses where a clear view towards the wind turbine is possible, would be similar to the view from Yung Shue Wan Pier.

To the northwest of the wind turbine at Tai Peng, most of the houses are orientated facing southwest and the views towards the Project Site are largely blocked by other houses or the relatively tall woodland at the fringe of the village.

All three houses at Tai Ling Tsuen face downhill while the wind turbine is on the uphill side.

However, the proposed wind turbine would be visible from the villages of Pak Kok San Tsuen, the beaches of Tai Wan To and the nearby Long Tsai Tsuen and the pier of Yung Shu Wan, with a middle ground view from a distance within 1.3 km. In addition, the proposed wind turbine would also be visible to the hikers on the relatively higher ridgelines of the Lamma Island hiking trails and one of the four pavilions along the hiking route between Yung She Wan and Sok Kwu Wan. Existing views are shown in *Figures 6.7* to *6.11*.

The proposed wind turbine would be most visible from visitors and hikers to the track and pavilion next to the site. From the track the entire wind turbine would be visible and from the pavilion the wind turbine shaft would be visible whilst the blades would be hidden from view by the pavilion roof. Existing view is shown in *Figure 6.23*.

The proposed wind turbine would be visible from a number of higher locations including The Peak and southern coastal areas on Hong Kong Island including Repulse Bay, Mount Davis, Pok Fu Lam Road, Wah Fu, Cyberport, Ocean Park, Ap Lei Chau and Chung Hom Kok. Representative visual receiver groups are shown in *Figure 6.3*. All of them are over 3 km away and the proposed wind turbine would be visible in relatively small scale from these long distant visual reference points.

In addition, similar views would be available to recreational boat users using the Lamma East Channel.

The existing views from the representative receiver groups are shown in *Figures 6.12* to *6.21*.

Table 6.4 Visually Sensitive Receivers on Lamma Island

VSR	*Name*	*Nature of Viewer Group/ no. of receivers*	*Distance to Proposed Works*	*Analysis of view towards proposed development Source of impact*	*Sensitivity to change and visual intrusion*
VSR 1	Pak Kok San Tsuen	Residents *Approximate number of receivers: small*	over 1km	Partially obstructed views with the rotor blades of the wind turbine protruding out on the ridgeline as illustrated in *Figure 6.7*. *Proposed wind turbine*	Medium
VSR 2	Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village	Residents, passenger & boat travellers *Approximate number of receivers: small*	over 1km	Partially obstructed views with the rotor blades of the wind turbine protruding out on the ridgeline as illustrated in *Figure 6.8*. *Rotor blades of wind turbine*	Medium
VSR 3	Tai Wan To/Long Tsai Tsuen	Hikers and residents in transit *Approximate number of receivers: small*	750m	Partially obstructed views with the rotor blades of the wind turbine protruding out on the ridgeline as illustrated in *Figure 6.9*. *Rotor blades of wind turbine*	Medium
VSR 4	Hiking Trail on Lamma Island (Pavilion)	Hikers *Approximate number of receivers: small*	over 1.5km	Partially obstructed views towards the rotor blades of the wind turbine at the relatively higher points of the trail as illustrated in *Figure 6.10* and fully obstructed views by the Lamma topographical headland along a large proportion of hiking trail. *Rotor blades of wind turbine*	Low
VSR 5	Hiking Trail on Lamma Island	Hikers *Approximate number of receivers: small*	over 2.5km	Partially obstructed views towards the rotor blades of the wind turbine at the relatively higher points of the trail as illustrated in *Figure 6.11* and fully obstructed views by the Lamma topographical headland along a large proportion of hiking trail. *Rotor blades of wind turbine*	Low

VSR	*Name*	*Nature of Viewer* *Group/ no. of receivers*	*Distance to Proposed Works*	*Analysis of view towards proposed development* *Source of impact*	*Sensitivity to change and visual intrusion*
VSR 16	Tai Ling Pavilion/adjacent cable road	Hikers *Approximate number of receivers: small*	Less than 100m	Dominant view of the wind turbine, the site platform and the retaining wall on a close scale. *Wind turbine, site platform and retaining wall*	High

Table 6.5 Visually Sensitive Receivers on Hong Kong Island & Lamma East Channel

VSR	*Name*	*Nature of Viewer Group/ no. of receivers*	*Distance to Proposed Works*	*Analysis of of view towards proposed development Source of impact*	*Sensitivity to change and visual intrusion*
VSR 6	Repulse Bay	Residents and tourists *Approximate number of receivers: Intermediate*	over 8km	Open and very distant views towards the upper part of wind turbine which would be relatively very small as illustrated in *Figure 6.12*. *Proposed wind turbine*	Medium
VSR 7	Pok Fu Lam Road	Residents *Approximate number of receivers: Many*	over 4km	Open, unobstructed and distant views towards the wind turbine which would be relatively small as illustrated in *Figure 6.13*. *Proposed wind turbine*	High
VSR 8	The Peak	Residents and tourists *Approximate number of receivers: Intermediate*	over 5km	Open, unobstructed and distant views towards the wind turbine which would be relatively small as illustrated in *Figure 6.14*. *Proposed wind turbine*	Medium
VSR 9	Wah Fu	Residents *Approximate number of receivers: Many*	over 3km	Open and unobstructed views towards the wind turbine which would be seen clearly situated near the top of the ridgeline as illustrated in *Figure 6.15*. *Proposed wind turbine*	High
VSR 10	Cyberport	Residents & office occupants *Approximate number of receivers: Many*	over 3km	Open and unobstructed views towards the wind turbine which would be clearly situated near the top of the ridgeline as illustrated in *Figure 6.16*. *Proposed wind turbine*	High

VSR	*Name*	*Nature of Viewer Group/ no. of receivers*	*Distance to Proposed Works*	*Analysis of of view towards proposed development Source of impact*	*Sensitivity to change and visual intrusion*
VSR 11	Ap Lei Chau	Residents *Approximate number of receivers: Many*	over 3km	Open and unobstructed views towards the wind turbine which would be clearly situated near the top of the ridgeline as illustrated in *Figure 6.17*. *Proposed wind turbine*	High
VSR 12	Mount Davis	Residents and tourists *Approximate number of receivers: Small*	over 5km	Open and very distant views towards the wind turbine against the backdrop of the Lamma hilly landscape behind. The wind turbine would be relatively small as illustrated in *Figure 6.18*. *Proposed wind turbine*	Medium
VSR 13	Chung Hom Kok	Residents and tourists *Approximate number of receivers: small*	over 8km	Open and very distant views towards the wind turbine which would be relatively very small as illustrated in *Figure 6.19*. *Proposed wind turbine*	Medium
VSR 14	Lamma East Channel	Ferry users *Approximate number of receivers: small*	over 1.5km	Open and unobstructed views towards the wind turbine which would be clearly situated in the headland as illustrated in *Figure 6.20*. *Proposed wind turbine*	Low
VSR 15	Ocean Park	Visitors/ Tourists *Approximate number of receivers: Many*	over 3km	Open and unobstructed views towards the wind turbine which would be clearly situated near the top of the ridgeline as illustrated in *Figure 6.21*. *Proposed wind turbine*	Medium

6.4.6 Review of Planning and Development Control Framework

The starting point for the review of the planning and development control framework was a review of the various statutory and non-statutory controls relevant to the proposed project, which affect landscape and visual impacts.

The review includes information on:

- The Lamma Island Outline Zoning Plan (Plan no. S/I-LI/4, 2002)
- Hong Kong Planning Area No. 10 – Pok Fu Lam – Outline Zoning Plan (Plan no. S/H10/14)
- Hong Kong Planning Area No. 14 - The Peak Area – Outline Zoning Plan (Plan no. S/H14/6)
- Hong Kong Planning Area Nos. 15 & 16 – Aberdeen & Ap Lei Chau – Outline Zoning Plan (Plan no. S/H15/20)
- Hong Kong Planning Area No. 17 – Shouson Hill & Repulse Bay – Outline Zoning Plan (S/H17/7)
- Hong Kong Planning Area No. 19 – Stanley – Outline Zoning Plan (S/H10/14)
- Plan showing Land Use Concept of Yung Shue Wan Reclamation Phase 2

Under the approved Lamma Island Outline Zoning Plan (Plan no. S/I-LI/4, 2002), the proposed wind turbine falls within the "Green Belt" (GB) zoning.

The Government intend to reclaim land in the Yung Shue Wan area to form a landscaped promenade in front of the existing one. The visual impact of the extended promenade has been discussed in Section 6.4.5.

Under the Outline Zoning Plans for South Hong Kong including plan no. S/H10/4, S/H14/6, S/H15/20, S/H17/7 and S/H10/14, there is no large development/reclamation planned for the future. Landuse within Hong Kong South Island would be foreseen to not have a significant change. The recently developed Cyberport has been included as one of the visual sensitive receivers in this assessment.

6.5 LANDSCAPE AND VISUAL IMPACT ASSESSMENT DURING CONSTRUCTION

6.5.1 Prediction and Evaluation of Landscape Impacts during Construction

The magnitude of the impacts, before implementation of mitigation measures, on the landscape resources and landscape character areas that would occur in the construction phase are described below and tabulated. All impacts are adverse unless otherwise stated.

Construction activities which will affect landscape and visual aspect include:

- Erection of a wind turbine (hub height approximately 45m and rotor blade diameter of approximately 52 m, overall height of the wind turbine approximately 71 m);
- Excavation and construction of the wind turbine foundation (affected area approximately 15 m by 15 m);
- Construction of a site platform and retaining wall (affected area approximately 3,100sq.m.);
- Construction of one stainless steel hut as high voltage distribution pillar (HVDP) (size approximately 4.6 m length, 2.5 m width, 2.8 m height) for housing of switchgear and power conditioning devices;
- Laying of underground distribution cables for connecting to the nearby existing cable route (approximately 50 m in length).

The total effect of all the above works would result in the disturbance of approximately 3,100 sq.m.. The whole of this is within the Project Site. The extent and location of these impacts are shown on *Figure 6.26*.

The quantification of the disturbances to the LCA1 and various LR types are presented in *Table 6.6*.

Table 6.6 Summary of Disturbance to LCA1 and Various Landscape Resources

LCA/LR	*Type of Landscape Resources Present in the LCA/LR*	*Quantification of Landscape Resources within the LCA/LR*	*Area in conflict with the proposed works*	*Magnitude of Change during Construction*
LCA1	North Lamma Coastal Uplands	Approx. 79.4 ha	Approx. 3,100 m^2	Small
LR1	Secondary Woodland	20.5 ha	0m^2	Negligible
LR2	Shrubland	49.4 ha	0m^2	Negligible
LR3	Shrubby Grassland	5.7 ha	Approx. 3,100 m^2	Small
LR4	Stream	Total 1.1 km	0 km	Negligible
LR5	Village/Developed Area	3.8 ha	0m^2	Negligible

Disturbance to North Lamma Coastal Uplands – LCA 1

The work areas as described above (approx. 3,100 sq.m.) fall within LCA1.

In the context of the study area, the possible affected area is considered *small (representing 0.39%)* and thus the magnitude of change to the overall landscape character of the area is *small.* As LCA1 is considered to have an overall *high* landscape character value, the significance threshold is *moderate/adverse*.

Disturbance to Shrubby Grassland – LR3

The whole work areas fall within LR3. During the construction works approximately 3,100 sq.m. of shrubby grassland need to be removed which represents 5.4% of the 5.7 ha of LR3. The magnitude of change is considered *small.* As LR3 has an overall *medium* landscape sensitivity, the significance threshold is *slight moderate/adverse.*

Disturbance to Stream – LR4

During construction activities the primary sources of water quality impacts will be from pollutants in site run-off. Pollutants, mainly suspended sediments, may also enter receiving waters if any pumped groundwater is not adequately controlled on-site.

The potential sources of impacts to water quality may be readily controlled by appropriate on-site measures to minimise potential impacts as described in *Section 8.6*. With the implementation of such measures adverse impacts to water quality are not expected to result from land based construction activities. The magnitude of change and the significance threshold are both *negligible*.

Disturbance to Other Landscape Resources Secondary Woodland – LR1, Shrubland – LR2 and Village/Developed Area – LR5

The construction activities do not confilict with these LRs and the magnitude of change and the significance threshold are *negligible* for all these LRs.

Landscape within the Project Site

A detailed tree survey has been conducted for the Project site. The survey identifies trees that are in or at the vicinity of the works area. The survey identifies 45 nos. of trees in which 2 nos. are within the Project site. All 45 trees are to be retained.

6.5.2 Prediction and Evaluation of Visual Impacts during Construction

The visual impact during construction will be arising from:

- site formation and construction activities for maintenance platform, mini-pile and pile cap;
- lifting of turbine components by crane;
- temporary hoarding.

The visual impacts during construction will be (refer to *Table 6.8* for summary):

- VSR1 Pak Kok San Tsuen, VSR2 Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village, VSR3 Tai Wan To/Long Tsai Tsuen, VSR4 Hiking Trail in Lamma Island (Pavilion) & VSR5 Hiking

Trail in Lamma Island – The construction plants would be dominant unsightly elements partially visible in the middleground seen by residents in their homes and hikers along trials. The magnitude of change during construction would be *intermediate* as the full view would be blocked by topography and existing trees/houses in the foreground.

Since the sensitivity to change for VSR 1 Pak Kok San Tsuen, VSR2 Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village and VSR3 Tai Wan To/Long Tsai Tsuen is *medium*, the significant threshold would be *moderate/adverse*. The sensitivity to change for the other VSRs is *low* and the corresponding significant threshold would be *slight-moderate/adverse*.

- VSR7 Pok Fu Lam Road, VSR9 Wah Fu, VSR10 Cyberport, VSR11 Ap Lei Chau, VSR14 Lamma East Channel and VSR15 Ocean Park – The construction plants and site formation works would be seen in the distant middleground from a distance of 1.5 to 5km by residents in their homes or commuters on ferries or tourists/visitors. However, these are not dominant elements and the magnitude of change during construction is considered *intermediate*.

  Since the sensitivity to change for VSR14 Lamma East Channel is *low*, the significant threshold would be *slight-moderate/adverse*. The sensitivity to change for VSR15 Ocean Park is *medium*, the significant threshold would be *moderate/adverse*. The sensitivity to change for the other VSRs is *high* and the corresponding significant threshold would be *moderate-significant/adverse*.

- VSR6 Repulse Bay, VSR8 The Peak, VSR12 Mount Davis, VSR13 Chung Hom Kok – The construction plants and site formation works would be seen in the distant background from a distance of over 5km. The construction work is not noticeable in this far distance. The magnitude of change during construction is considered *small*.

  Since the sensitivity to change for VSR6 Repulse Bay, VSR8 The Peak, VSR12 Mount Davis, VSR13 Chung Hom Kok is *medium*, the significant threshold would be *slight-moderate/adverse*.

- VSR16 Tai Ling Pavilion/adjacent cable road – The construction plants and site formation works would be seen upclose and would be dominating especially during the erection of the wind turbine when large scale cranes are used. The magnitude of change during construction is *large*.

  Since the sensitivity to change for VSR16 Tai Ling Pavilion/adjacent cable road is *high*, the significant threshold would be *significant/adverse*.

6.6 LANDSCAPE AND VISUAL IMPACT ASSESSMENT DURING OPERATION

6.6.1 Prediction and Evaluation of Landscape Impacts during Operation

Upon the completion of the construction, part of the new cut and fill slopes and other land affected by construction works would be reinstated to natural land form and topography of the natural slope as far as practical. New shrub land/grass land planting would be implemented in-keeping with the surrounding landscape character. In addition, appropriate landscape planting including trees, shrubs and grasses (approx. 1,400 sq.m.) will be provided to soften the ground level appearance resulting in a net loss of 1,700 sq.m.of vegetation. These mitigation measures are more described in more detail in section 6.7.

The extent and location of the loss of vegetation ie the landscape impact during operation is shown on *Figure 6.26*.

The quantification of the net loss to the LCA1 and various LR types are presented in *Table 6.7*.

Table 6.7 Summary of Net Loss to LCA1 and Various Landscape Resources

LCA/LR	*Type of Landscape Resources Present in the LCA/LR*	*Quantification of Landscape Resources within the LCA/LR*	*Net Loss in Area*	*Magnitude of Change during Construction*
LCA1	North Lamma Coastal Uplands	Approx. 79.4 ha	Approx. 1,700 m^2	Small
LR1	Secondary Woodland	20.5 ha	0m^2	Negligible
LR2	Shrubland	49.4 ha	0m^2	Negligible
LR3	Shrubby Grassland	5.7 ha	Approx. 1,700 m^2	Small
LR4	Stream	Total 1.1 km	0 km	Negligible
LR5	Village/Developed Area	3.8 ha	0m^2	Negligible

The net loss in Landscape Resources is considered *small* in LCA1 as it only represents 0.2% of the total Study Area. The significance threshold is *moderate/adverse*.

The magnitude of change to LR3 remains *small* and the significance threshold also remains at *slight moderate/adverse.*

The significance threshold for all other LR types remains as *negligible.*

6.6.2 Prediction and Evaluation of Visual Impacts during Operation

The operation of the proposed wind turbine will not consume fuel and generate waste or side products. Major impacts during operational phase are associated with the visual impact of the wind turbine with rotating blades and

other associated built structures including the platform, retaining wall at a closer scale.

The visual impact arising during operation will be:

- VSR1 Pak Kok San Tsuen, VSR2 Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village, VSR3 Tai Wan To/Long Tsai Tsuen, VSR4 Hiking Trail in Lamma Island (Pavilion) and VSR5 Hiking Trail in Lamma Island – The rotating blades of the proposed wind turbine would be permanently discernible against background, but is not conspicuous. The magnitude of change during operation would be *intermediate* as the views would be partially blocked by topography and existing trees/houses in the foreground.

  Since the sensitivity to change for VSR 1 Pak Kok San Tsuen, VSR2 Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village and VSR3 Tai Wan To/Long Tsai Tsuen is *medium*, the significant threshold would be *moderate/adverse*. The sensitivity to change for the other VSRs is *low* and the corresponding significant threshold would be *slight-moderate/adverse*.

- VSR7 Pok Fu Lam Road, VSR9 Wah Fu, VSR10 Cyberport, VSR11 Ap Lei Chau, VSR14 Lamma East Channel and VSR15 Ocean Park – The proposed wind turbine would be seen in the distant middleground from a distance of 1.5 to 5km. The proposed wind turbine would be prominent, but it is not dominating the whole view to the Lamma Island. The magnitude of change during operation is considered *intermediate*.

  Since the sensitivity to change for VSR14 Lamma East Channel is *low*, the significant threshold would be *slight-moderate/adverse*. The sensitivity to change for VSR15 Ocean Park is *medium*, the significant threshold would be *moderate/adverse*. The sensitivity to change for the other VSRs is *high* and the corresponding significant threshold would be *moderate-significant/adverse*.

- VSR6 Repulse Bay, VSR8 The Peak, VSR12 Mt. Davis, VSR13 Chung Hom Kok – The proposed wind turbine would be seen in the distant background from a distance of over 5km. The proposed wind turbine is not noticeable in this far distance. The magnitude of change during operation is considered *small*.

  Since the sensitivity to change for VSR6 Repulse Bay, VSR8 The Peak, VSR12 Mount Davis, VSR13 Chung Hom Kok is *medium*, the significant threshold would be *slight-moderate/adverse*.

- VSR16 Tai Ling Pavilion/adjacent cable road – The wind turbine with rotating blades and other associated built structures including the platform, retaining wall would be seen upclose and would be dominating. The magnitude of change during operation at this close distance is *large*.

  Since the sensitivity to change for VSR16 Tai Ling Pavilion/adjacent cable road is *high*, the significant threshold would be *significant*. There is no doubt that the visual impact of the wind turbine at this close distance would be significant. However, whether it is an adverse or beneficial impact would very much depend on the viewers acceptance towards the use of this kind of renewable energy as a substitute to coal burning.

  One of the objectives of this project is to educate the public and in particular students, for promotion of green awareness. With the gain in knowledge of the benefits of renewable energy such as the improvement of air quality, the likelihood of acceptance of the visual impact would be increased.

A summary of landscape and visual impacts during operation is given in *Table 6.8* and *6.9*.

6.7 RECOMMENDED LANDSCAPE AND VISUAL MITIGATION MEASURES

In order to mitigate these impacts, a number of soft landscape and colour scheme mitigation measures are recommended for incorporation into the Project. These mitigation measures are summarised in the following paragraphs and shown on *Table 6.11*. The extent and location is shown on *Figure 6.24* and a photomontage of the project with and without mitigation measures is shown on *Figure 6.25*.

Mitigation Measure 1 (MM1) – Partial Reinstatement of Disturbed Areas (To be completed with construction stage)

- New cut and fill slopes and other land affected by construction works would be reinstated to natural land form and topography of the natural slope as far as practical. Grading of these slopes to resemble a natural, rolling landform similar to that of adjacent topography would be carried out.

Approximately 1,400 sq.m. of disturbed areas would be reinstated.

Mitigation Measure 2 (MM2) – Compensatory Planting (To be completed with construction stage and maintained during operation)

In compensation for the disturbance to existing vegetation area of approximately 3,100 sq.m., appropriate landscape planting including trees, shrubs and grasses (approx. 1,400 sq.m.) will be provided to soften the ground level appearance of the proposed wind turbine site. These include hydroseeding of a grass mix similar to those found in the area, together with

the following native tree and shrub seeds included in the hydroseeding mix, to quickly re-establish any disturbed slopes.

Botanical Name	***Size***
Tree	
Acacia confusa	Light Standard
Schefflera heptaphylla	Light Standard
Ficus hispida	whip
Celtis sinensis	Light Standard
Cinnamomum camphora	Light Standard
Litsea glutinosa	whip
Microcos paniculata	whip
Sterculia lanceolata	whip
Sapium discolor	Light Standard
Notes: A mixture of the above trees will be planted at Standard to Heavy Standard size immediately in front of the retaining wall at the downside slope of the edge of the platform area, to mitigate the impact of the wall.	
Shrub	
Ilex pubescens	500-600mm Ht.
Melastoma candidum	500-600mm Ht.
Rhodomytrus tomentosa	500-600mm Ht.
Rhaphiolepis indica	500-600mm Ht.

Mitigation Measure 3 (MM3) – Colour Scheme and non-reflective paints (To be completed with construction stage)

A proper colour selection will be made to enable the proposed wind turbine to blend in well with natural surroundings and minimise the visual intrusion.

It is noted that in general practices the rotor blades, nacelle and pole are generally in white colour. In this case, as demonstrated in the photomontages from the different VSRs, the wind turbine would be seen either against a sky or greenery backdrop.

An investigation was carried out to find out the visual effect of various light colour tones on the wind turbine (see Fig. 6.22). In case of good visibility and weather conditions, the wind turbine in any light colour would be relatively prominent due to its special shape either against the sky or greenery. However, a light grey colour would render the wind turbine less intrusive in mid to low visibility conditions as the light grey colour is less contrasting to the grey sky backdrop comparing with other colours such as white, green or blue. The effect of reducing the intrusiveness would be particularly noticeable for the distant viewers.

As a colour mitigation measure, a light grey non-reflective colour is thus selected. The proposed colour is similar to the colour chip as shown in Fig. 6.23 (ICI colour code 1369 North Beach 50BG 72/011).

Mitigation Measure 4 (MM4) –Soil Conservation (To be completed with construction stage)

Soil conservation is a consideration in the management of the construction phase. Existing soil resources on site from the cut slope will be re-used for backfilling at site as far as practicable to minimize the need to import or export soils.

Mitigation Measure 5 (MM5) – Selection of low rotating speed machine (To be completed with construction stage)

In order to minimize the visual disturbance, a low rotating speed machine will be chosen.

In addition to the above, the following good site practices would also be implemented:

- Screening of site construction by means of temporary hoarding that is appropriate to its site context.
- Tree protective measures will be implemented to ensure the existing trees within the Project site identified as to be preserved are satisfactorily protected during the construction phase.

6.8 RESIDUAL IMPACTS

6.8.1 Residual Landscape Impacts

The incorporation of mitigation measures into the scheme will reduce the impacts in most cases as follows:

MM1 will ensure that new fill slope work will resemble a natural, rolling landform similar to that of adjacent topography. MM2 will compensate for the loss of vegetation through the implementation of planting of trees, shrubs and grasses as appropriate. MM4 will ensure that the valuable soil will be re-used where possible. The extent and location of these mitigation measures is shown on *Figure 6.24.*

Residual Landscape Impact to North Lamma Coastal Uplands – LCA 1 & Shrubby Grassland – LR3

With the implementation of the above mitigation measures, the magnitude of change to LCA1 and LR3 would be reduced from a net loss of 3,100 sq.m. to 1,700sq.m. ie from 0.39% to 0.2% for LCA1 and from 5.4% to 3.0% for LR3. While the overall effect of the mitigation measure towards the LCA1 is not significant, MM2 will result in a net increase in the quantity of vegetation at the Project Site and would reduce the significance threshold of the residual impact for LR3 from "*slight-moderate/adverse*" to "*slight/adverse*" during Year 1 of operation and "*slight/beneficial*" during Year 10 of operation.

A summary of residual landscape impacts is shown in *Table 6.8*.

6.8.2 Residual Visual Impacts

The incorporation of mitigation measures into the scheme will reduce the visual impacts in most cases as follows:

- VSR7 Pok Fu Lam Road, VSR9 Wah Fu, VSR10 Cyberport and VSR11 Ap Lei Chau and – MM3 would improve the visual appearance of the proposed wind turbine during operation with a light grey non-reflective colour scheme (MM3). Selection of low rotating speed machine (MM5) will render the wind turbine to be less conspicuous. This will lead to a reduction of "*moderate-significant/adverse*" unmitigated visual impact down to "*moderate/adverse*" residual visual impact during Year 1 and 10 years of operation.

- VSR 1 Pak Kok San Tsuen, VSR2 Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village, VSR 3 Tai Wan To/Long Tsai Tsuen and VSR15 Ocean Park – MM3 would improve the visual appearance of the proposed wind turbine during operation with a light grey non-reflective colour scheme (MM3). Selection of low rotating speed machine (MM5) will render the wind turbine to be less conspicuous. This will lead to a reduction of "*moderate/adverse*" unmitigated visual impact down to "*slight-moderate/adverse*" residual visual impact during Year 1 and 10 years of operation.

- VSR 4 Hiking Trail in Lamma Island (Pavilion) & VSR 5 Hiking Trail in Lamma Island, VSR6 Repulse Bay, VSR8 The Peak, VSR12 Mount Davis, VSR13 Chung Hom Kok and VSR14 Lamma East Channel – Similar to the VSRs above, MM3 and MM5 would improve the visual appearance of the proposed wind turbine during operation leading to a reduction of "*slight-moderate/adverse*" unmitigated visual impact down to "*slight/adverse*" residual visual impact during Year 1 and 10 years of operation.

- VSR16 Tai Ling Pavilion/adjacent cable road – As the VSR is very close to the Project, the mitigation measures would not reduce the visual impacts of the wind turbine. However, MM1 and MM2 would help to improve the visual impact by minimizing the apparent disturbance to the natural landscape and screening of the retaining wall. The significance threshold would remain as significant.

A summary of residual visual impacts is shown in *Table 6.10*.

6.9 CONCLUSION AND SUMMARY OF FINDINGS

The major findings of the LVIA are as follows:

- The Project would result in the disturbance of approximately 3,100 sq.m. of Landcape Character Area LCA1 - North Lamma Coastal Uplands and Landscape Resources LR3 – Shrubby Grassland out of which approximately 1,400 sq.m. will be reinstated resulting in a net loss of approximately 1,700 sq.m. With the implementation of appropriate mitigation measures including MM1 - Partial Reinstatement of Disturbed Areas, MM2 – Compensatory Planting and MM4 – Soil Conservation, the significance threshold of the residual landscape impacts are generally negligible and range from "*slight/adverse*" during Year 1 of operation and "*slight/beneficial*" during Year 10 of operation for LR3.

- The proposed wind turbine would be visible from various VSRs on Lamma Islands, Hong Kong Island south, Ap Lei Chau and visitors and viewers in transit such as those on hiking tracks on Lamma Island and along the ferry routes. The resultant significance threshold of the residual visual impact in slight to *moderate/adverse* residual visual impact on views from Lamma Island and Hong Kong Island during operation. The overall residual visual impacts are considered acceptable.

Based on the above findings, the landscape and visual impacts of the proposed wind turbine are considered to be acceptable with mitigation measures.

6.10 ENVIRONMENTAL MONITORING AND AUDIT

It is recommended that implementation and operational maintenance of proposed Landscape and Visual Mitigation Measures is included with the EM&A. The design stage EM&A will consist of auditing the detailed landscape designs. Construction and operational stage EM&A will comprise audit of the compensatory planting and planting establishment in the form of site inspection. Further details of the specific EM&A requirements are detailed in the EM&A Manual Section of this report. Summary Landscape and visual Mitigation Measures Programming, Funding, Implementation, Management and Maintenance Agents is given in *Table 6.11*.

Table 6.8 Summary of Landscape Impacts (with and without Landscape Mitigation Measures)

LCA/LR Name	• *Source of Impact* • *Resulting Disturbed Area*	*Proposed Mitigation Measures*	*Quality/ Sensitivity to Change*	*Landscape Impacts without Mitigation Measures*		*Landscape Impacts with Mitigation Measures*	
				Construction Phase	*Operation Phase (1 & 10 years)*	*Construction Phase*	*Operation Phase (1 & 10 years)*
				Magnitude of Change and Significance Threshold of Landscape Impact			
LCA1 North Lamma Coastal Uplands - Approx. 79.4 ha	• Transportation and construction activities including foundation and site formation (for details, please refer to Section 6.5.1) • disturbance of approximately 3,100 sq.m., 1,400 sq.m. of which would be reinstated. Resulting in a net loss of 1,700 sq.m. The whole of this is within the Project Site.	MM1 (1,400sq.m.)will ensure that new fill slope work will resemble a natural, rolling landform similar to that of adjacent topography. MM2 (1,400 sq.m.) will compensate for the loss of vegetation through the implementation of planting of trees, shrubs and grasses as appropriate. MM4 will ensure that the valuable soil will be re-used where possible. The extent and location of these mitigation measures is shown on *Figure 6.24.*	High	Small and Moderate / Adverse	Small and Moderate / Adverse	Small and Moderate / Adverse	Small and Moderate / Adverse for both 1 & 10 Years
LR1 Secondary Woodland – 20.5 ha	• Negligible impact and no disturbed area.		Medium	Negligible	Negligible	Negligible	Negligible
LR2 Shrubland – 49.4 ha	• Negligible impact and no disturbed area.		Medium	Negligible	Negligible	Negligible	Negligible

LCA/LR Name	• *Source of Impact* • *Resulting Disturbed Area*	*Proposed Mitigation Measures*	*Quality/ Sensitivity to Change*	*Landscape Impacts without Mitigation Measures*		*Landscape Impacts with Mitigation Measures*	
				Construction Phase	*Operation Phase (1 & 10 years)*	*Construction Phase*	*Operation Phase (1 & 10 years)*
				Magnitude of Change and Significance Threshold of Landscape Impact			
LR3 Shrubby Grassland – 5.7 ha	• Construction activities including foundation and site formation (for details, please refer to Section 6.5.1) • Disturbance of approximately 3,100 sq.m., 1,400 sq.m. of which would be reinstated. Resulting in a net loss of 1,700 sq.m. The whole of this is within the Project Site.	MM1 (1,400sq.m.)will ensure that new fill slope work will resemble a natural, rolling landform similar to that of adjacent topography. MM2 (1,400 sq.m.) will compensate for the loss of vegetation through the implementation of planting of trees, shrubs and grasses as appropriate. MM4 will ensure that the valuable soil will be re-used where possible. The extent and location of these mitigation measures is shown on *Figure 6.24.*	Medium	Small and Slight-Moderate/ Adverse	Small and Slight-Moderate/ Adverse for both 1 & 10 years	Small and Slight-Moderate/ Adverse	Small and Slight/ Adverse for 1 year Slight/ Beneficial for 10 years
LR4 Stream – Total 1.1km	• Negligible impact and no disturbed area.		Medium	Negligible	Negligible	Negligible	Negligible
LR5 Village/Developed Area – 3.8 ha	• Negligible impact and no disturbed area.		Medium	Negligible	Negligible	Negligible	Negligible

Table 6.9 Assessment of Visual Impacts (without Landscape and Visual Mitigation Measures)

VSR	*Name (refer to Table 6.43 & 6.5 for detailed information on VSRs)*	*Sensitivity to Change and Visual Intrusion*	*Construction Phase*		*Operation Phase*	
			Magnitude of Visual Change	*Significance Threshold of Visual Impact*	*Magnitude of Visual Change*	*Significance Threshold of Visual Impact*
VSR 1	Pak Kok San Tsuen	Medium	Intermediate	Moderate/Adverse	Intermediate	Moderate/Adverse
VSR 2	Yung Shu Wan Pier/Sha Po New Village/Sha Po Old Village/Tai Yuen Village	Medium	Intermediate	Moderate/Adverse	Intermediate	Moderate/Adverse
VSR 3	Tai Wan To/Long Tsai Tsuen	Medium	Intermediate	Moderate/Adverse	Intermediate	Moderate/Adverse
VSR 4	Hiking Trail on Lamma Island (Pavilion)	Low	Intermediate	Slight-Moderate/Adverse	Intermediate	Slight-Moderate/Adverse
VSR 5	Hiking Trail on Lamma Island	Low	Intermediate	Slight-Moderate/Adverse	Intermediate	Slight-Moderate/Adverse
VSR 6	Repulse Bay	Medium	Small	Slight-Moderate/Adverse	Small	Slight-Moderate/Adverse
VSR 7	Pok Fu Lam Road	High	Intermediate	Moderate-Significant/Adverse	Intermediate	Moderate-Significant/Adverse
VSR 8	The Peak	Medium	Small	Slight-Moderate/Adverse	Small	Slight-Moderate/Adverse
VSR 9	Wah Fu	High	Intermediate	Moderate-Significant/Adverse	Intermediate	Moderate-Significant/Adverse
VSR 10	Cyberport	High	Intermediate	Moderate-Significant/Adverse	Intermediate	Moderate-Significant/Adverse
VSR 11	Ap Lei Chau	High	Intermediate	Moderate-Significant/Adverse	Intermediate	Moderate-Significant/Adverse

VSR	*Name (refer to Table 6.43 & 6.5 for detailed information on VSRs)*	*Sensitivity to Change and Visual Intrusion*	*Construction Phase*		*Operation Phase*	
			Magnitude of Visual Change	*Significance Threshold of Visual Impact*	*Magnitude of Visual Change*	*Significance Threshold of Visual Impact*
VSR 12	Mount Davis	Medium	Small	Slight-Moderate/Adverse	Small	Slight-Moderate/Adverse
VSR 13	Chung Hom Kok	Medium	Small	Slight-Moderate/Adverse	Small	Slight-Moderate/Adverse
VSR 14	Lamma East Channel	Low	Intermediate	Slight-Moderate/Adverse	Intermediate	Slight-Moderate/Adverse
VSR 15	Ocean Park	Medium	Intermediate	Moderate/Adverse	Intermediate	Moderate/Adverse
VSR 16	Tai Ling Pavilion/adjacent cable road	High	Large	Significant /Adverse	Large	Significant

Table 6.10 Summary of Residual Visual Impacts (with Landscape and Visual Mitigation Measures)

VSR Number	***WITHOUT Recommendation Mitigation Measures***		***Recommended Mitigation Measures (Refer to Section 6.7)***	***WITH Recommendation Mitigation Measures***		
	Significance Threshold of Visual Impact during Construction	*Significance Threshold of Visual Impact during Operation*		*Significance Threshold of Visual Impact during Construction*	*Significance Threshold of Visual Impact during Operation YEAR 1*	*YEAR 10*
VSR 1	Moderate/Adverse	Moderate/Adverse	MM3 and 5	Moderate/Adverse	Slight-Moderate/Adverse	Slight-Moderate/Adverse
VSR 2	Moderate/Adverse	Moderate/Adverse	MM3 and 5	Moderate/Adverse	Slight-Moderate/Adverse	Slight-Moderate/Adverse
VSR 3	Moderate/Adverse	Moderate/Adverse	MM3 and 5	Moderate/Adverse	Slight-Moderate/Adverse	Slight-Moderate/Adverse
VSR 4	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 5	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 6	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 7	Moderate-Significant/Adverse	Moderate-Significant/Adverse	MM3 and 5	Moderate-Significant/Adverse	Moderate/Adverse	Moderate/Adverse
VSR 8	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 9	Moderate-Significant/Adverse	Moderate-Significant/Adverse	MM3 and 5	Moderate-Significant/Adverse	Moderate/Adverse	Moderate/Adverse
VSR 10	Moderate-Significant/Adverse	Moderate-Significant/Adverse	MM3 and 5	Moderate-Significant/Adverse	Moderate/Adverse	Moderate/Adverse
VSR 11	Moderate-Significant/Adverse	Moderate-Significant/Adverse	MM3 and 5	Moderate-Significant/Adverse	Moderate/Adverse	Moderate/Adverse

VSR Number	***WITHOUT Recommendation Mitigation Measures***		***Recommended Mitigation Measures (Refer to Section 6.7)***	***WITH Recommendation Mitigation Measures***		
	Significance Threshold of Visual Impact during Construction	*Significance Threshold of Visual Impact during Operation*		*Significance Threshold of Visual Impact during Construction*	*Significance Threshold of Visual Impact during Operation YEAR 1*	*YEAR 10*
VSR 12	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 13	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 14	Slight-Moderate/Adverse	Slight-Moderate/Adverse	MM3 and 5	Slight-Moderate/Adverse	Slight/Adverse	Slight/Adverse
VSR 15	Moderate/Adverse	Moderate/Adverse	MM3 and 5	Moderate/Adverse	Slight-Moderate/Adverse	Slight-Moderate/Adverse
VSR 16	Significant /Adverse	Significant	MM1, 2, 3 and 5	Significant /Adverse	Significant	Significant

Table 6.11 Summary Landscape and Visual Mitigation Measures Programming, Funding, Implementation, Management and Maintenance Agents

MM Reference	Description of Landscape Mitigation Measures	Programme Stages			• Funding • Implementation Agent	1. Management Agency during operation 2. Maintenance Agency during operation
		D	C	O		
MM1	New cut and fill slopes and other land affected by construction works would be reinstated to natural land form and topography of the natural slope as far as practical. Grading of these slopes to resemble a natural, rolling landform similar to that of adjacent topography would be carried out. Approximately 1,400 sq.m. of disturbed areas would be reinstated.	✓	✓		• Project proponent • Contractor	Project proponent
MM2	Appropriate landscape planting including trees, shrubs and grasses (approx. 1,400 sq.m.) will be provided to soften the ground level appearance of the proposed wind turbine site.	✓	✓	✓	• Project proponent • Contractor	Project proponent
MM3	A light grey non-reflective colour scheme will be used to enable the proposed wind turbine to blend in well with natural surroundings and minimise the visual intrusion.	✓	✓	✓	• Project proponent • Contractor	Project proponent
MM4	Existing soil resources on site from the cut slope will be re-used for backfilling at site as far as practicable to minimize the need to import or export soils.	✓	✓		• Project proponent • Contractor	N/A
MM5	Selection of low rotating speed machine to minimize the visual disturbance.	✓	✓	✓	• Project proponent • Contractor	Project proponent

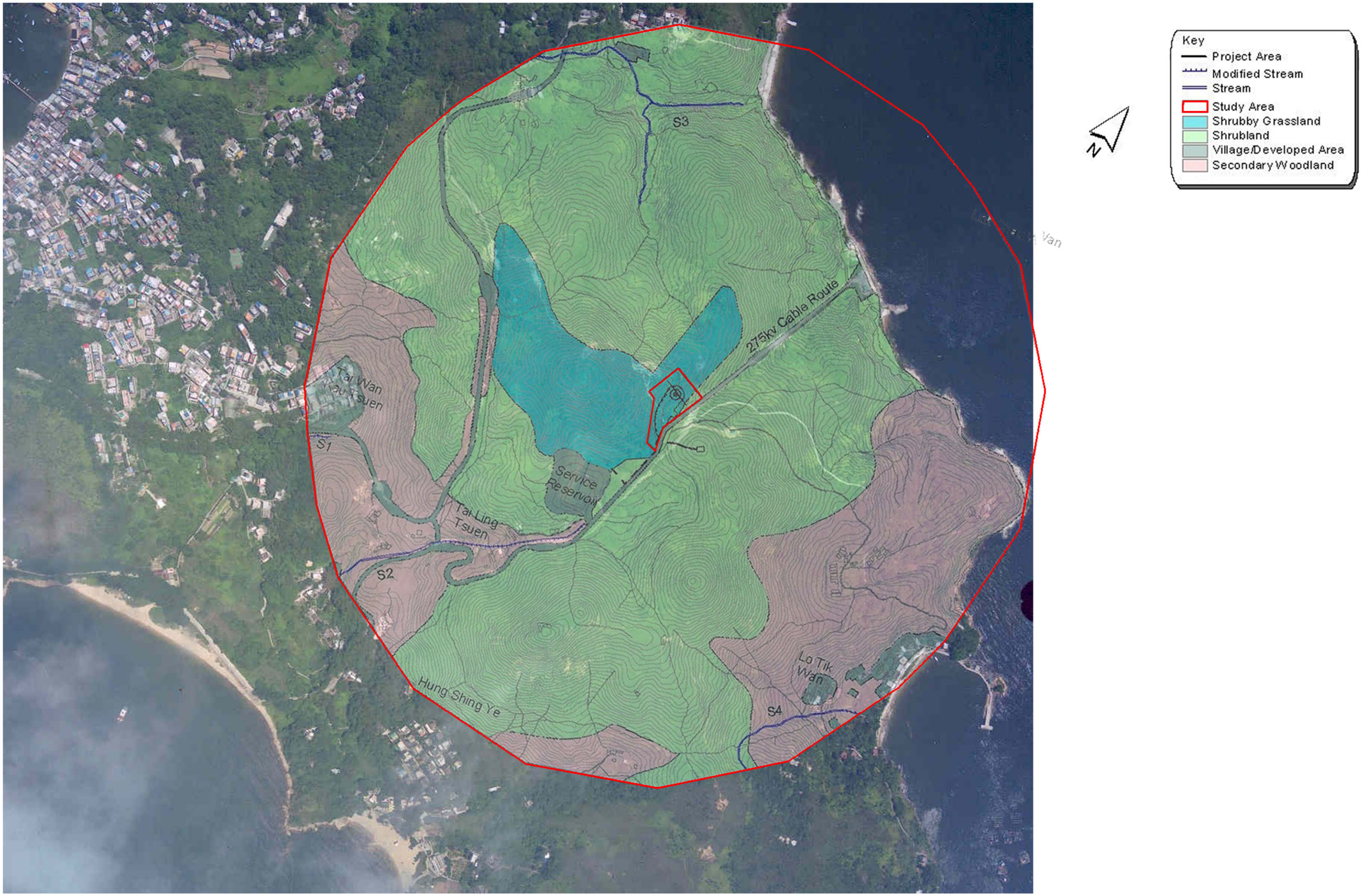

Figure 6.1 Existing Landscape Resources/Character Areas

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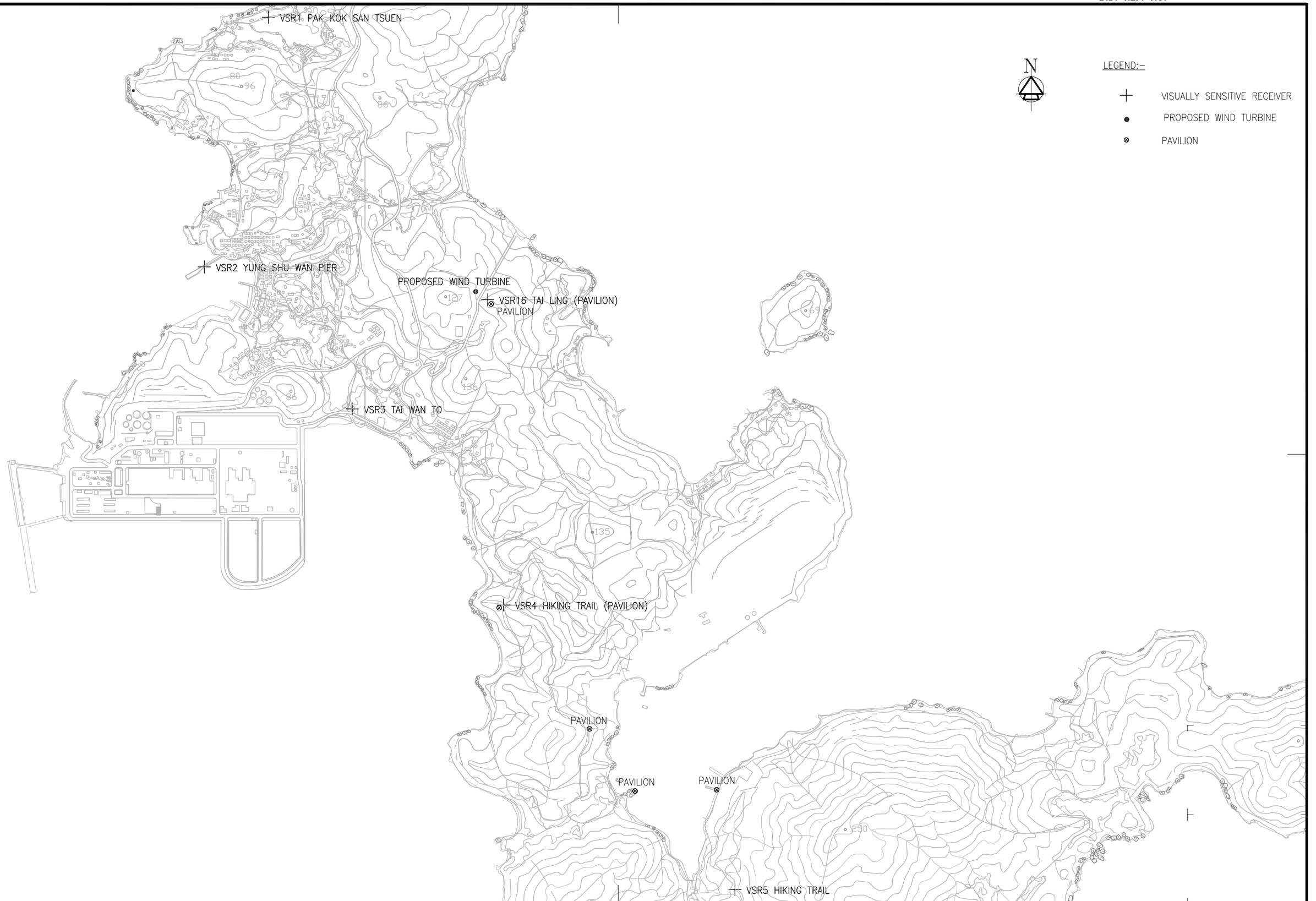

Issue	Date	By	Checked	Approved

Issue	Date	By	Checked	Approved

The Hongkong Electric Co Ltd
香港電燈有限公司
Projects Division
The Hongkong Electric Group

Project: **WIND TURBINE POWER GENERATION ON TAI LING, LAMMA ISLAND**

Drawing Title: **VISUAL ENEVLOPE AND VISUALLY SENSITIVE RECEIVERS AT LAMMA ISLAND**

Drawn	Checked	Approved
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Scale	Date
1:15000	14.06.2004

Drawing No.: **FIGURE 6.2**

Rev. No.:

B.D. REF. :

N

LEGEND:-

VISUAL ENEVLOPE

VISUALLY SENSITIVE RECEIVER

PROPOSED WIND TURBINE

VSR12 MOUNT DAVIS

VSR8 THE PEAK

VSR7 PO FU LAM ROAD

VSR10 CYBERPORT

VSR9 WAH FU

VSR11 AP LEI CHAU

VSR14 LAMMA EAST CHANNEL

VSR15 OCEAN PARK

VSR6 REPULSE BAY

PROPOSED WIND TURBINE

8km

VSR13 CHUNG HOM KOK

Issue	Date	By	Checked	Approved

Issue	Date	By	Checked	Approved

The Hongkong Electric Co Ltd
香港電燈有限公司
Projects Division
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Drawing No. **FIGURE 6.3** Rev. No.

Figure 6.4 - Topography of Existing Landscape Character Area

Figure 6.5 - Lo Tik Wan

Figure 6.6 - Village Development within LCA1

Figure 6.7.1 - Existing View

Figure 6.7.2 - Future View

Figure 6.7 - VSR1 View from Pak Kok San Tsuen (over 1km)

Figure 6.8.1 - Existing View

Figure 6.8.2 - Future View

Figure 6.8 - VSR2 View from Yung Shu Wan Pier/Sha Po New Village/
Sha Po Old Village/Tai Yuen Village (over 1km)

Figure 6.9.1 - Existing View

↓

Figure 6.9.2 - Future View

Figure 6.9 - VSR3 View from Tai Wan To (750m)

Figure 6.10.1 - Existing View

Figure 6.10.2 - Future View

Figure 6.10 - VSR4 View from Hiking Trail on Lamma Island (Pavilion) (over 1.5km)

Figure 6.11.1 - Existing View

Figure 6.11.2 - Future View

Figure 6.11 - VSR5 View from Hiking Route in Lamma Island(over 2.5km)

Figure 6.12.1 - Existing View

Figure 6.12.2 - Future View

Figure 6.12 - VSR6 View from Repulse Bay(over 8km)

Figure 6.13.1 - Existing View

Figure 6.13.2 - Future View

Figure 6.13 - VSR7 View from Pok Fu Lam Road(over 4km)

Figure 6.14.1 - Existing View

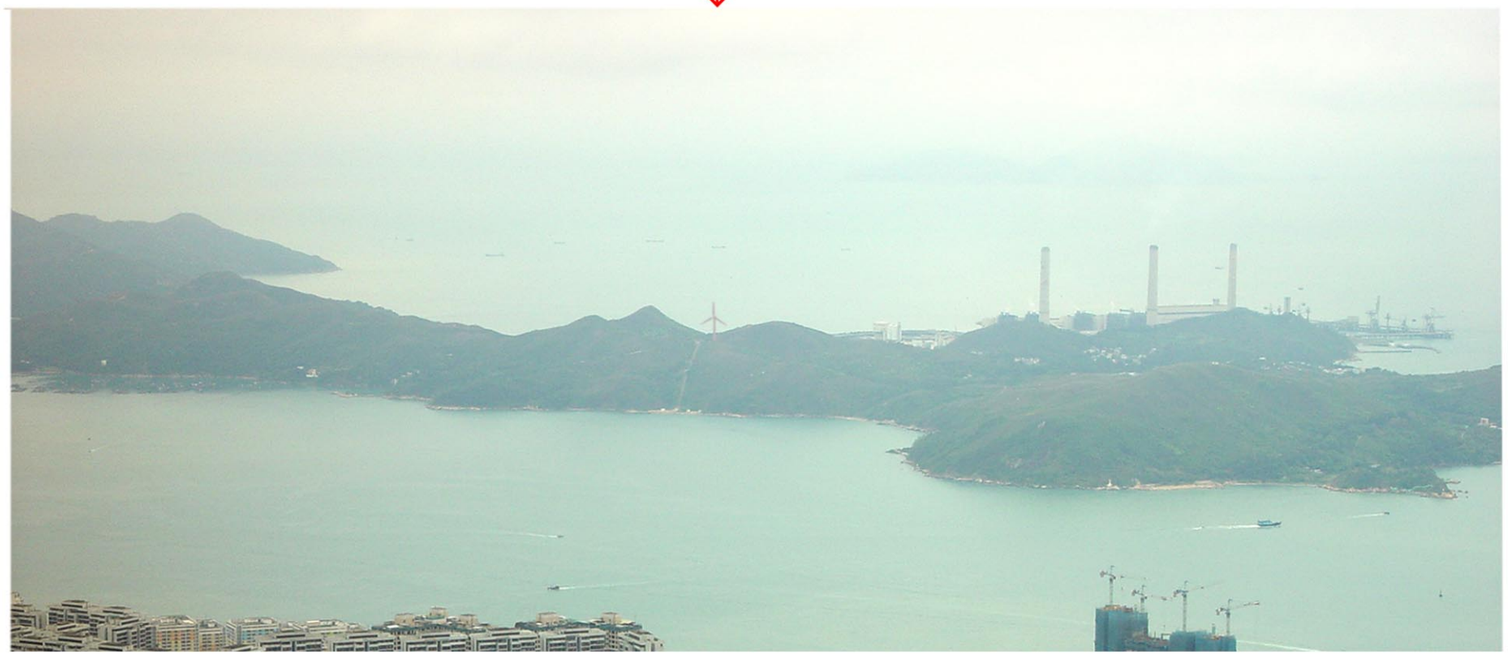

Figure 6.14.2 - Future View

Figure 6.14 - VSR8 View from The Peak (over 5km)

Figure 6.15.1 - Existing View

Figure 6.15.2 - Future View

Figure 6.15 - VSR9 View from Wah Fu (over 3km)

Figure 6.16.1 - Existing View

Figure 6.16.2 - Future View

Figure 6.16 - VSR10 View from Cyberport (over 3km)

Figure 6.17.1 - Existing View

Figure 6.17.2 - Future View

Figure 6.17 - VSR11 View from Ap Lei Chau (over 3km)

Figure 6.18.1 - Existing View

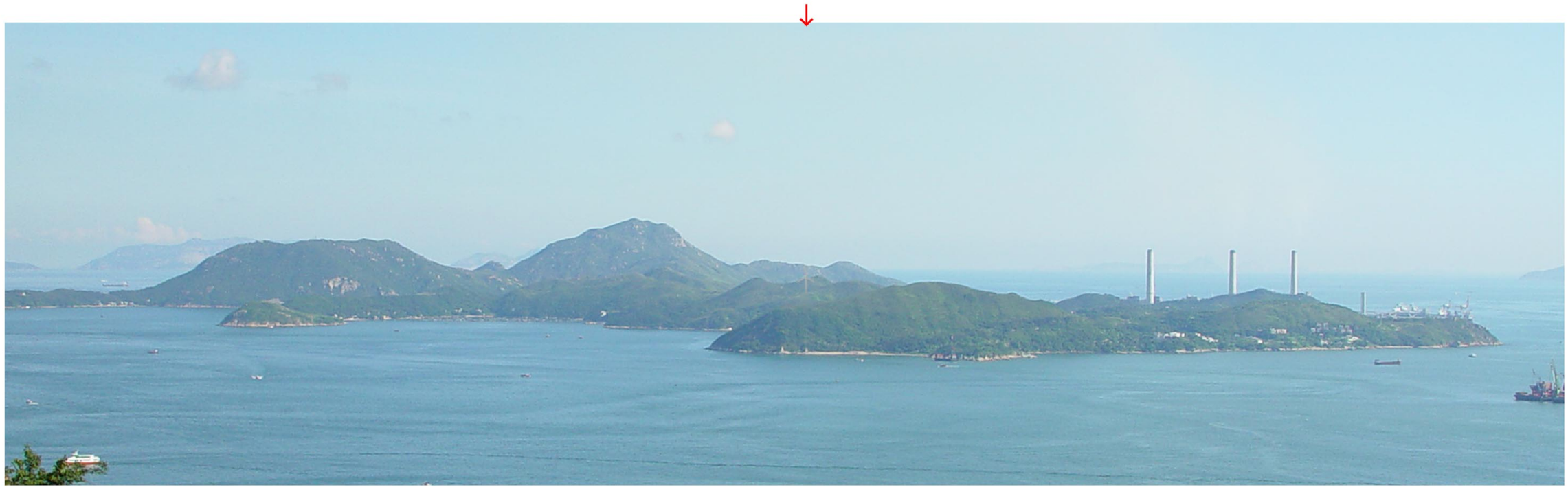

Figure 6.18.2 - Future View

Figure 6.18 - VSR12 View from Mount Davis (over 5km)

Figure 6.19.1 - Existing View

Figure 6.19.2 - Future View

Figure 6.19 - VSR13 View from Chung Hom Kok (over 8km)

Figure 6.20.1 - Existing View

Figure 6.20.2 - Future View

Figure 6.20 - VSR14 View from Lamma East Channel (over 1.5km)

Figure 6.21.1 - Existing View

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Figure 6.21 - VSR15 View from Ocean Park (over 3km)

Figure 6.22.1 - Wind Turbine in White Colour

Figure 6.22.2 - Wind Turbine in Light Grey Colour

Figure 6.22.3 - Wind Turbine in Light Green Colour

Figure 6.22.4 - Wind Turbine in Light Blue Colour

Figure 6.22 - Colour Selection

Figure 6.23.1 Existing View

Figure 6.23.2 Future View

Figure 6.23 - VSR16 View from Tai Ling (Pavilion)

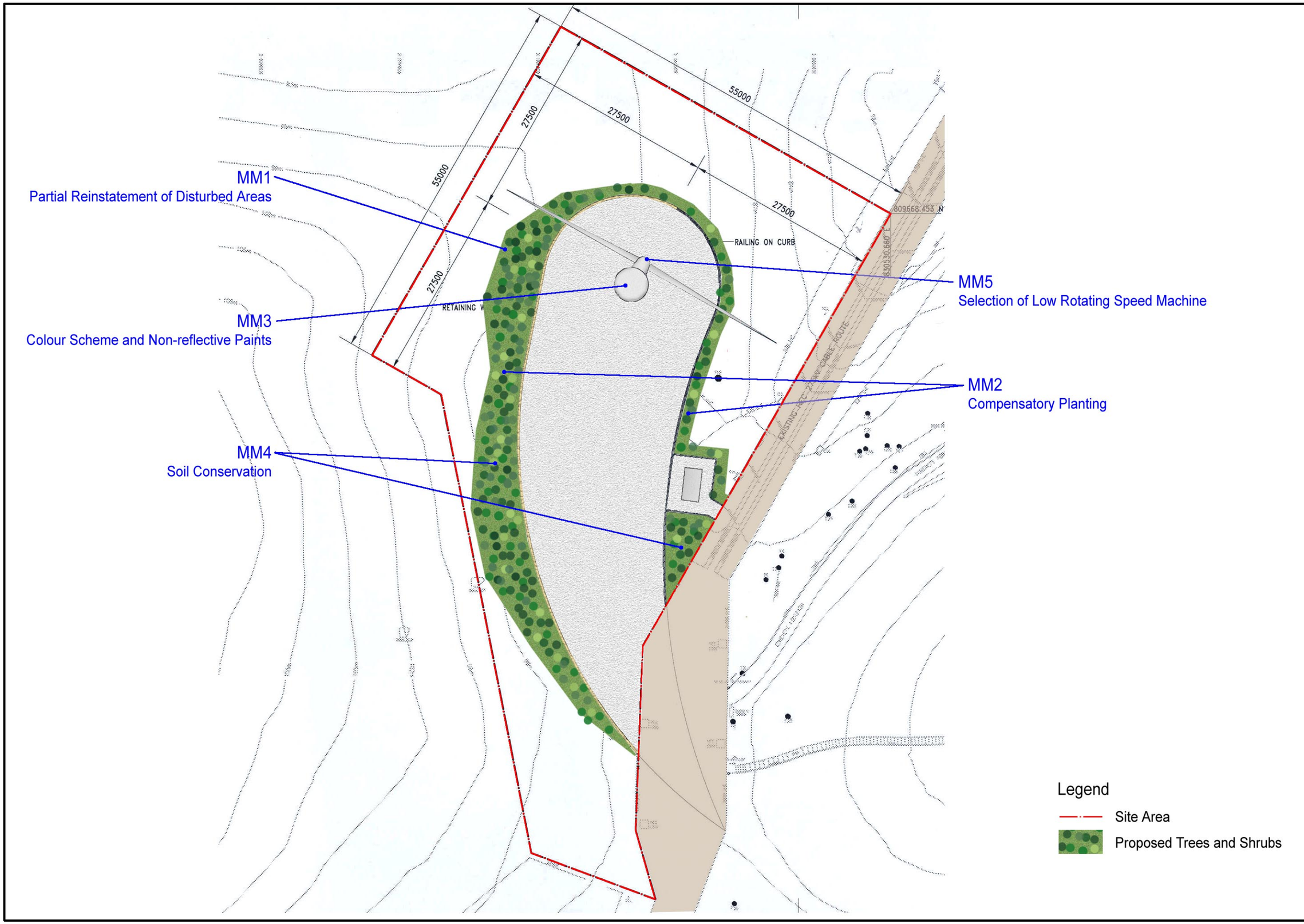

Figure 6.24 - Mitigation Measures (Layout Plan)

Existing

Proposed Wind Turbine Mitigated Year 1

Proposed Wind Turbine Unmitigated

Proposed Wind Turbine Mitigated Year 10

ICI colour code 1369
North Beach 50BG 72/011

Figure 6.25 - Mitigation Measures (Photomontage)

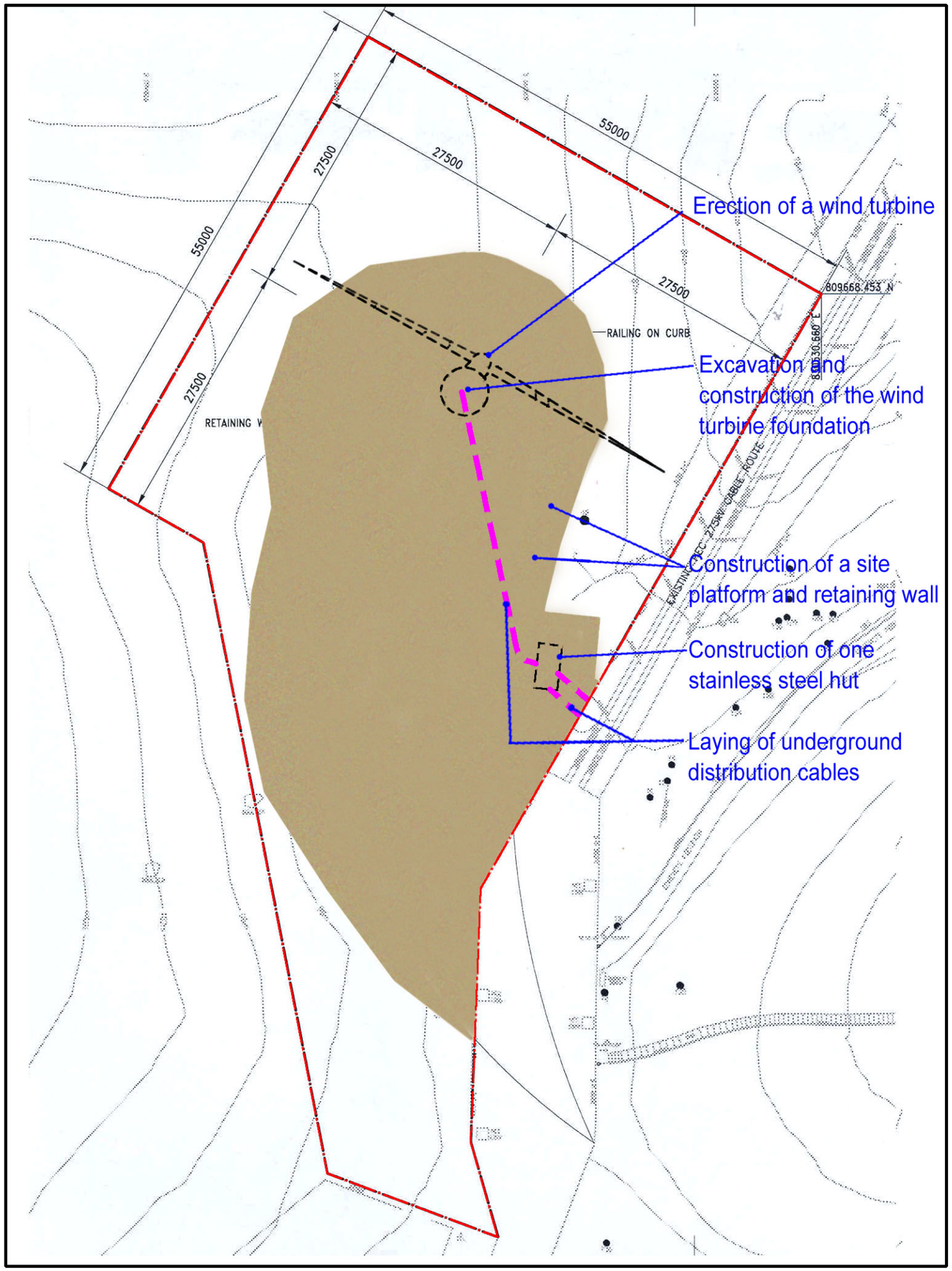

Figure 6.26.1 - Landscape Impacts during Construction

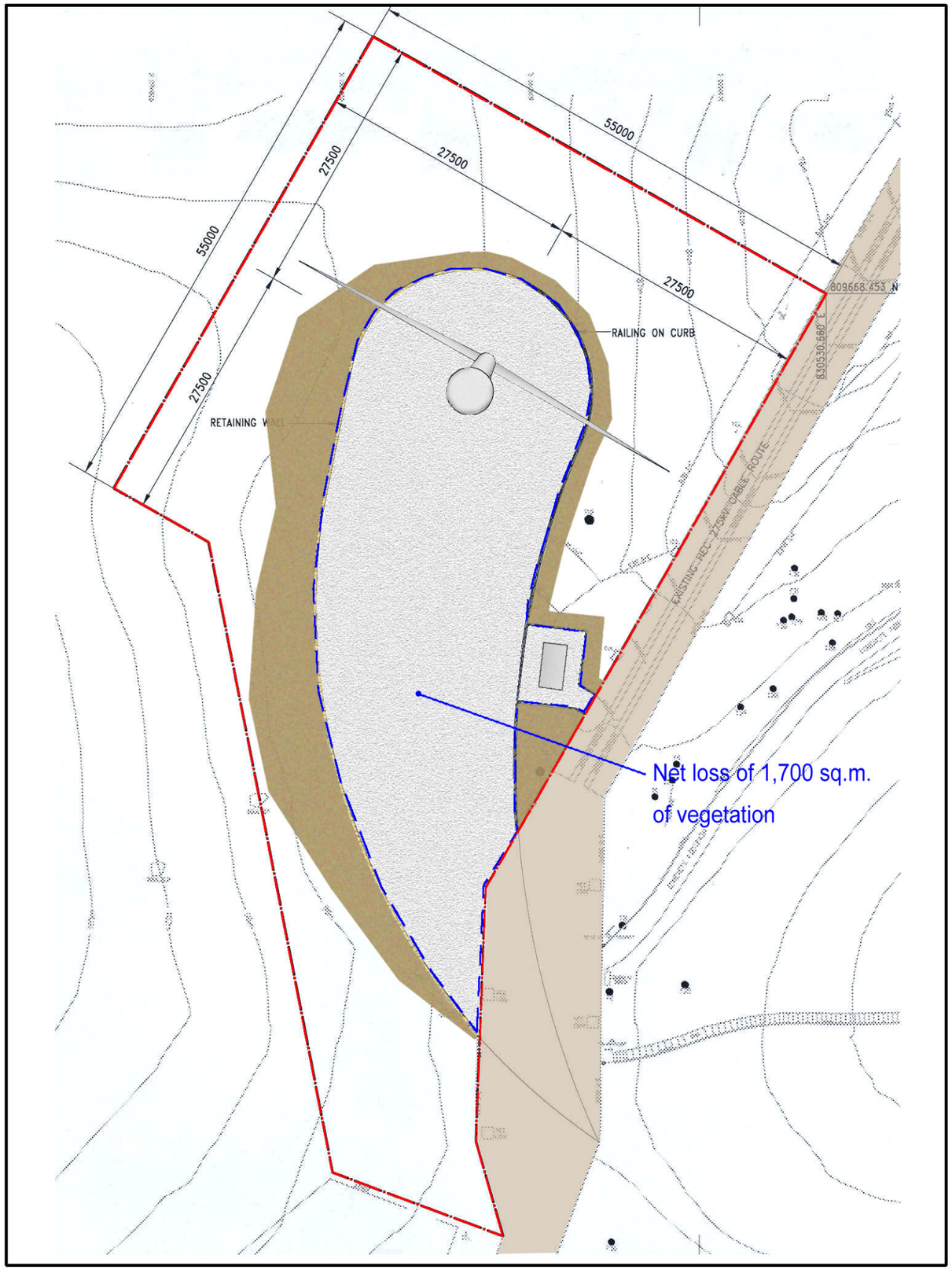

Figure 6.26.1 - Landscape Impacts during Operation

Figure 6.26 - Landscape Impacts during Construction and Operation

7 AIR QUALITY

7.1 INTRODUCTION

This section presents the potential air quality impacts during construction and operation of the wind turbine. Dust emission is the major concern of air pollution during construction. During operation, no air quality impact is expected as there is no pollutant generated from the wind turbine. It is noted that electricity generated from renewable energy source would substitute emissions from conventional forms of the equivalent amount of electricity production which is an environmental benefit.

7.2 LEGISLATIVE REQUIREMENTS AND RELEVANT CRITERIA

The principal legislation for the management of air quality in the HKSAR is the *Air Pollution Control Ordinance (APCO) (Cap 311).* The APCO lists a set of *Air Quality Objectives,* (AQOs) for seven air pollutants, stipulating statutory limits and permissible exceedances, as detailed in *Table 7.1.*

Table 7.1 Hong Kong Air Quality Objectives (μgm^{-3}) [(a)]

Air Pollutant	Averaging Time				
	1 Hour [(b)]	8Hour [(c)]	24 Hour [(c)]	3 Months [(d)]	1 Year [(d)]
Total Suspended Particulates (TSP)	-	-	260	-	80
Respirable Suspended Particulates (RSP) [(e)]	-	-	180	-	55
Sulphur Dioxide (SO_2)	800	-	350	-	80
Nitrogen Dioxide (NO_2)	300	-	150	-	80
Carbon Monoxide (CO)	30,000	10,000	-	-	-
Photochemical Oxidants (as ozone (O_3)) [(f)]	240	-	-	-	-
Lead (Pb)	-	-	-	1.5	-

Notes:

(a) Measured at 298K (25°C) and 101.325 kPa (one atmosphere)

(b) Not to be exceeded more than three times per year

(c) Not to be exceeded more than once per year

(d) Arithmetic means

(e) Suspended airborne particulates with a nominal aerodynamic diameter of 10 micrometres or smaller.

(f) Photochemical oxidants are determined by measurement of ozone only.

A maximum hourly level of TSP of 500 μgm^{-3} at ASRs is also stipulated in the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*) to control potential construction dust impacts.

The measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* should be followed to ensure that any dust impacts are minimised.

7.3 BASELINE CONDITIONS AND AIR SENSITIVE RECEIVERS

7.3.1 Baseline Conditions

The existing air quality within the vicinity of the Study Area is mainly affected by emissions from the existing HEC Lamma Power Station. The HEC does operate air quality monitoring stations (AQMSs) on Lamma Island to monitor the emissions of total suspended particulates (TSP), nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) from the power station. The nearest AQMS monitored TSP is located at Tai Yuen Tsuen whereas the nearest AQMS monitored NO_2 and SO_2 is located at Pak Kok Tsuen. The annual average air quality data monitored at the HEC AQMSs on Lamma Island for the year 2002 are summarized in *Table 7.2*.

Table 7.2 Annual Average Air Quality in 2002

Air Pollutant	Annual Average Concentration in μgm^{-3} [(a)]
HEC Pak Kok San Tsuen AQMS	
Sulphur Dioxide (SO_2)	11
Nitrogen Dioxide (NO_2)	25
HEC Tai Yuen Tsuen AQMS	
Total Suspended Particulates (TSP)	47

Notes:

(a) The annual average concentrations of air pollutants monitored at HEC AQMSs on Lamma Island in 2002 are provided by the HEC.

7.3.2 Air Sensitive Receivers

ASRs have been identified within 500 m from the Project Site in accordance with the EIA Study Brief (ESB-112/2004) and the criteria set out in *Annex 12* of the *EIAO-TM* and through site inspections and review of land use plan. Landuse type, height of buildings, their horizontal distance from the worksite boundary and approximate base elevation (in mPD) are summarised in *Table 7.3*. The locations of ASRs are shown in *Figure 7.1*.

Table 7.3 Air Sensitive Receivers

ASR	Location	Type	No. of Storeys	Distance from Nearest Worksite Boundary (m)	Approximate Base Elevation in mPD
A1	No.1 Tai Ling Tsuen	R	2	185	79
A2	No.2 Tai Ling Tsuen	R	1	240	69
A3	No.3 Tai Ling Tsuen	R	1	245	69
A4	Tai Wan Kau Tsuen	R	3	420	12
A5	Po Lo Villa, Long Tsai Tsuen	R	1	415	39
A6	Long Tsai Tsuen	R	1 – 3	470	35
A7	Lo Tik Wan Village	R	2 - 3	430	10
A8	Tai Peng	R	2-3	470	42

Note:

(a) The base elevation of the wind turbine is 92 mPD.

7.4 AIR QUALITY IMPACT ASSESSMENTS

7.4.1 Construction Phase

Dust in terms of Total Suspended Particulates (TSP) is expected to be the main air pollutant during the construction of the Project. The Project Area covers an area of about 4,400 m^2. The construction works will last for not more than ten months. Construction activities will include site formation through minor cutting of the hill slope and filling to form the site platform, foundation construction, cable laying, wind turbine erection and landscaping works. Approximately 1,300 m^3 of excavated materials will be generated and 95% of them will be temporarily stored on site for backfilling. The remaining portion will be transported by trucks to the HEC Power Station for offsite disposal. Therefore, the number of trucks is expected to be minimal. Wind erosion, materials handling and on-site stockpiling are therefore, the major dust generating activities for the Project.

Due to the very limited excavated materials generated and small size of the worksite (3,100 m^2), the dust emissions would be minor. In addition, the nearest ASR identified in Tai Ling Tsuen (A1) is located at 185 m away from the site. Hence, with the implementation of dust suppression measures in *Section 7.5.1*, the dust impact would be limited and no exceedance of dust level would be envisaged.

7.4.2 Operational Phase

During the operation of the wind turbine, no air emission is expected. However, the wind turbine will displace emissions of greenhouse gases and other emissions from conventional power generating plant. Assuming a 600 kW wind turbine producing electricity of 700 MWh/yr, the emission reduction of major air pollutants compared with that of the same capacity at the existing turbines is presented in *Table 7.4*.

Table 7.4 Air Pollutant Emission Reduction by Wind Turbine [(a) (b)]

Air Pollutants	Annual Emission Reduced (kg)
Sulphur dioxide (SO_2)	1941
Nitrogen oxides (NO_x)	1008
Particulates	100
Carbon dioxide (CO_2)	605.5 tonnes/yr (i.e., 605,500 kg/yr)

Note:

(a) Assuming 600 kW wind turbine produce electricity of 700 MWh/yr.

(b) Based on average emission generated from the existing coal-fired units including of 2.773 kg/MWhr of SO_2, 1.44 kg/MWhr of NO_x, 0.143 kg/MWhr of TSP and 865 kg/MWhr CO_2

It can be seen from above table that the operation of the wind turbine can bring about benefits through the reduction in emissions of air pollutants such as SO_2, NO_x, CO_2 and particulates.

7.5 MITIGATION OF ADVERSE AIR QUALITY IMPACTS

7.5.1 Construction Phase

In order to reduce the dust emissions during construction phase, the following dust suppression measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* will be incorporated into the Particular Specification and implemented by the Contractor.

- Covering entirely by impervious sheet or frequently watering of the on-site stockpile of excavated materials to keep wet always before backfilling;
- Frequent watering of exposed area or worksite of excavation to maintain surface wet, if necessary and practical;
- Provision of vehicle washing to remove any dusting materials from small village trucks' body and wheel at the exit of worksite;
- Well-maintained diesel-powered mechanical equipment to avoid black smoke emissions; and
- Shut-down of diesel-powered mechanical equipment or trucks inside the worksites when they are not in operation.

7.5.2 Operational Phase

No mitigation measures would be required as only reduction of air emissions is anticipated.

7.6 RESIDUAL AIR QUALITY IMPACTS

No residual construction and operational phase air quality impacts would be anticipated.

7.7 ENVIRONMENTAL MONITORING AND AUDIT

7.7.1 Construction Phase

During the construction phase, regular site auditing is recommended to ensure the recommended mitigation measures are properly implemented.

7.7.2 Operational Phase

No EM&A is required during the operational phase.

7.8 CONCLUSIONS

Dust nuisance is the only potential air quality impact during the construction of the Project. Site formation, foundation construction, cable laying, wind turbine erection and landscaping works are the main construction activities. Wind erosion, materials handling, on-site stockpiling and vehicles movements are the major dusty activities. Since the site area is small, the construction period is short with minimal construction activities and the distance from the ASRs is more than 185 m away, therefore, with the implementation of dust suppression measures in *Section 7.5.1*, the potential for causing dust impacts is very low. However, to protect the ASRs, regular site auditing is recommended to ensure the recommended mitigation measures are properly implemented.

No air quality impact would be envisaged during the operation of the wind turbine. The wind turbine will displace emissions of greenhouse gases and other emissions from conventional power generating plant. Estimates of the potential emission reductions have been presented.

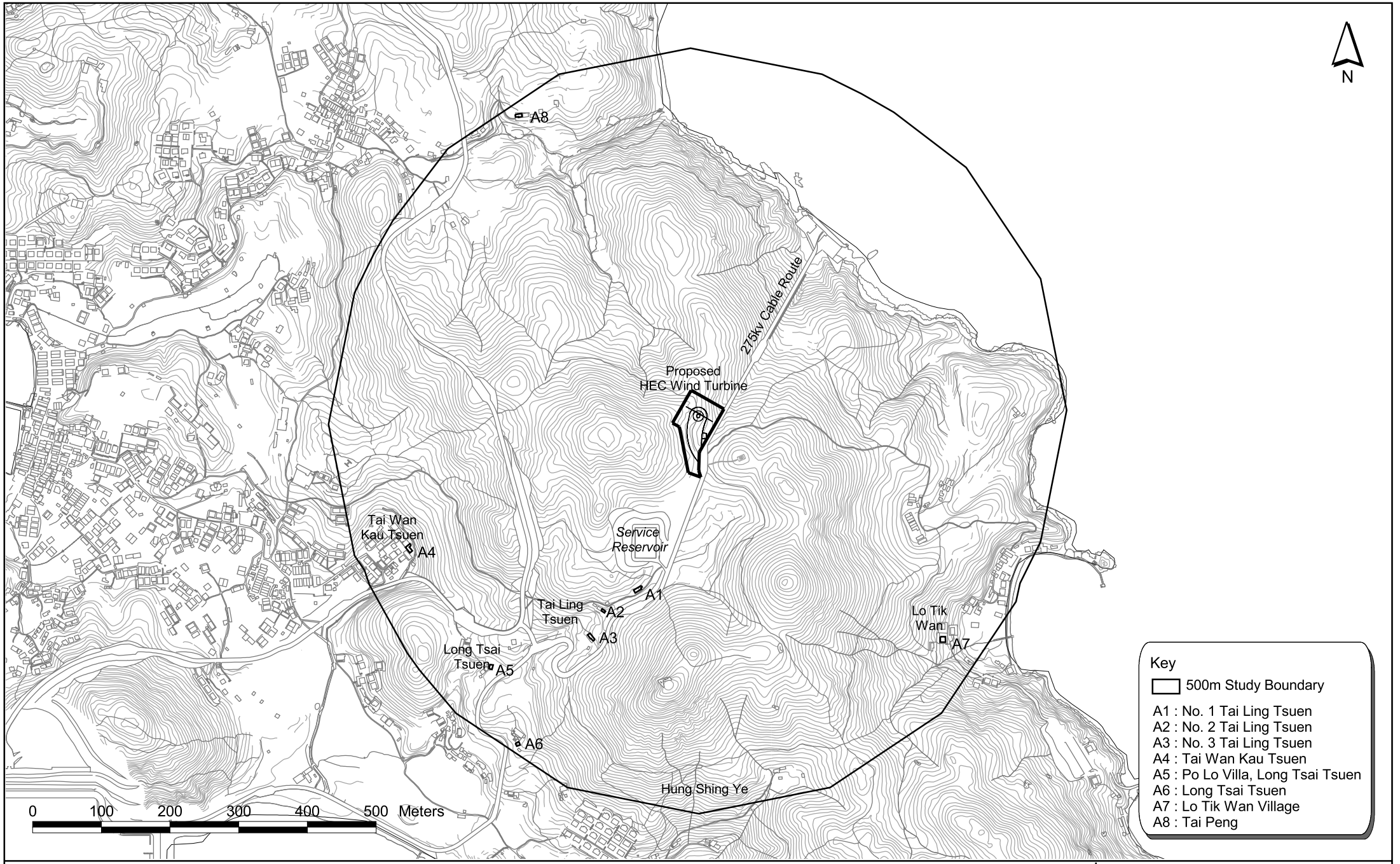

FIGURE 7.1

Location of Air Sensitive Receivers

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8 WATER QUALITY

8.1 INTRODUCTION

This Section describes the impacts on water quality associated with the construction and operation of a 600 – 850 kW wind turbine system supplying renewable energy to Lamma Island. The purpose of the assessment is to evaluate the acceptability of predicted impacts to water quality from the construction and operation of the wind turbine with reference to the relevant environmental legislation and standards. Although the Study Area for the Project covers a small portion of marine waters in the Southern WCZ, no discharge to marine waters as a result of construction and operation of the turbine will occur. Consequently, marine water quality impacts are not expected to occur and hence are not discussed further.

8.2 RELEVANT LEGISLATION AND GUIDELINES

The following relevant legislation and associated guidance are applicable to the evaluation of water quality impacts associated with the construction and operation of the Project.

- *Water Pollution Control Ordinance (WPCO);*
- *Technical Memorandum – Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*; and
- *Environmental Impact Assessment Ordinance (Cap. 499. S.16*), *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*), *Annexes 6 and 14*.

Apart from the above statutory requirements, the Practice Note for Professional Persons, *Construction Site Drainage* (ProPECC PN 1/94), issued by ProPECC in 1994, also provides useful guidelines on the management of construction site drainage and prevention of water pollution associated with construction activities.

8.2.1 *Water Pollution Control Ordinance*

The *WPCO* is the legislation for the control of water pollution and water quality in Hong Kong. Under the *WPCO*, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The WQOs set limits for different parameters that should be achieved in order to maintain the water quality within the WCZs. The Project is wholly located within the Southern WCZ. The WQOs for the Southern WCZ, which are presented in *Table 8.1*, are applicable as evaluation criteria for assessing compliance of any effects from the construction and operation of the Project.

Table 8.1 Water Quality Objectives for the Southern Water Control Zone

Water Quality Objectives	Part or parts of Zone
A. AESTHETIC APPEARANCE	
a) Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone
b) Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
c) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone
d) There should be no recognisable sewage-derived debris.	Whole zone
e) Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
f) Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B. DISSOLVED OXYGEN	
a) Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as the water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the year.	Marine waters excepting Fish Culture Subzones.
b) The dissolved oxygen level should not be less than 5 mg per litre for 90% of the sampling occasions during the year; values should be calculated as the water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed).	Fish Culture Subzones.
c) Waste discharges shall not cause the level of dissolved oxygen to be less than 4 mg per litre.	Inland waters of the Zone
C. pH	
a) The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters excepting Bathing Beach Subzones; Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) Subzones.
b) The pH of the water should be within the range of 6.0 - 9.0 units.	Mui Wo (D) and other inland waters.
c) The pH of the water should be within the range of 6.0 - 9.0 units for 95% of samples. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 units.	Bathing Beach Subzones.
D. TEMPERATURE	
Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 ^{o}C.	Whole zone

Water Quality Objectives	Part or parts of Zone
E. SALINITY	
Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone
F. SUSPENDED SOLIDS	
a) Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters.
b) Waste discharges shall not cause the annual median of suspended solids to exceed 20 mg per litre.	Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) Subzones.
c) Waste discharges shall not cause the annual median of suspended solids to exceed 25 mg per litre.	Mui Wo (D) Subzone and other inland waters.
G. AMMONIA	
The unionised ammonia nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone
H. NUTRIENTS	
a) Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine Waters
b) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.1 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed).	
I. 5-DAY BIOCHEMICAL OXYGEN DEMAND	
Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 mg per litre.	Inland waters of the Zone.
J. CHEMICAL OXYGEN DEMAND	
Waste discharges shall not cause the 5-day chemical oxygen demand to exceed 30 mg per litre.	Inland waters of the Zone.
K. TOXINS	
a) Waste discharges shall not cause the concentrations of dangerous substances in marine waters to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone
b) Waste discharges of dangerous substances shall not cause a risk to any beneficial uses of the aquatic environment.	Whole zone

8.2.2 Technical Memorandum for Effluent Discharges

All discharges during both the construction and the operational phases of the Project are required to comply with the *Technical Memorandum – Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM) issued under *Section 21* of the *WPCO*. The TM defines discharge

limits to different types of receiving waters. Under the TM, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for particular discharge volumes. Any new discharges within a WCZ are subject to licence conditions and the TM acts as a guideline for setting discharge standards for the licence.

8.2.3 EIAO-TM

Annexes 6 and *14* of the *EIAO-TM* provide general guidelines and criteria to be used in assessing water quality issues.

8.3 BASELINE CONDITIONS AND WATER QUALITY SENSITIVE RECEIVERS

In order to evaluate the water quality impacts resulting from the construction and operation of a 600-850 kW wind turbine on Lamma Island, the water sensitive receivers (WSR) have been identified in accordance with the Hong Kong Planning Standards and Guidelines, which provides criteria for identifying environmental factors influencing the proposed development.

8.3.1 Existing Water Bodies

The main inland water bodies within the Study Area (*Figure 8.1*) include:

- Service Reservoir (located north of Tai Ling Tsuen);
- A modified stream (Stream S1 passing through the northern part of Long Tsai Tsuen);
- A semi-natural stream (Stream S2 running from the service reservoir through Long Tsai Tsuen and terminated at Tai Wan To);
- A natural stream (Stream S3 locating north of the service reservoir); and
- A semi-natural stream (Stream S4 situated south of Lo Tik Wan).

8.3.2 Baseline Water Quality Conditions

During these construction activities the primary sources of water quality impacts will be from pollutants in site run-off. Pollutants, mainly suspended sediments, may also enter receiving waters if any pumped groundwater is not adequately controlled on-site.

The potential sources of impacts to water quality may be readily controlled by appropriate on-site measures to minimise potential impacts as described in *Section 8.6*. With the implementation of such measures adverse impacts to water quality are not expected to result from land based construction activities.

No EPD river water quality data are available for the identified streams within the Study Area. Site visits during the wet season revealed that the majority of the streams had low flow, particularly in the immediate vicinity of the works area. It is, therefore, expected that little or no water would be present in the dry season.

8.3.3 Identification of Sensitive Receivers

The turbine location is located reasonably far from the existing water bodies listed out in *Section 8.3.1*.

Table 8.2 Distance of the Wind Turbine from the Existing Water Bodies

Existing Water Bodies	Distance from the Wind Turbine
Service Reservoir	170 m
Modified stream S1	500 m
Semi-natural stream S2	230 m
Natural stream S3	270 m
Semi-natural stream S4	500 m

8.4 ASSESSMENT METHODOLOGY

8.4.1 Construction Phase

The assessment of the potential impact of land based construction activities on water quality has been undertaken in a qualitative manner. Consideration has been given to controlling potentially harmful impacts from the site works and to the use of 'best practice' measures to minimise the potential for discharges of pollutants to nearby receiving waters.

8.4.2 Operation Phase

The turbine and its operation will not create any waste waster emissions as it will be unmanned and hence there will be no adverse operational impacts to water quality.

8.5 IMPACT ASSESSMENT

Construction activities that may result in water quality impact directly or indirectly within and adjacent to the Study Area during the construction and operation of the proposed Project is described below.

The land-based construction activities that will be undertaken for the Project are listed as follows:

- Site excavation by cutting and filling for construction of a site platform (affected area approximately 3,100m^2);
- Construction of retaining wall around site perimeter;
- Site backfilling;
- Erection of wind turbine by one heavy duty mobile crane, one light duty mobile crane, and transformer pillars (hub height approximately 45 m and rotor blade diameter of approximately 52 m, overall height of the wind turbine approximately 71 m); and,

- Underground cable laying for connecting to the adjacent 275 kV Cable Route (approximately 50 m in length).

Stormwater runoff is considered to be the sole cause of impact to water quality through washing off sand/ suspended solids during excavation, backfilling and underground cable laying into any of the identified existing water bodies.

8.6 MITIGATION MEASURES

The Contractor shall implement the following on-site measures to minimise potential water quality impacts associated with land based construction.

8.6.1 Surface Run-off

- Surface run-off from the construction site should be directed into existing stream channel via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities.

- Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times.

- During excavation in the wet season, temporarily exposed soil surfaces should be covered, eg by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds. Intercepting channels should be provided (eg along the crest/edge of the excavation) to prevent storm runoff from washing across exposed soil surfaces. Arrangements should always be in place to ensure that adequate surface protection measures can be safely carried out well before the arrival of a rainstorm.

- Earthworks final surfaces should be well compacted and the subsequent permanent work or surface protection should be carried out as soon as practical after the final surface are formed to prevent erosion caused by rainstorms. Appropriate intercepting channels should be provided where necessary. Rainwater pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.

- Open stockpiles of construction materials (eg aggregates and sand) on site should be covered with tarpaulin similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

8.6.2 Wastewater from Site Facilities

- The use of chemical toilets will be necessary and these should be provided by a licensed contractor, who will be responsible for appropriate disposal and maintenance of these facilities.

8.7 RESIDUAL ENVIRONMENTAL IMPACT

8.7.1 Construction Phase

No residual water quality impacts were predicted to occur due to construction of the wind turbine provided the above described mitigation measures are implemented.

8.7.2 Operational Phase

No residual water quality impacts were predicted to occur in the Project.

8.8 ENVIRONMENTAL MONITORING AND AUDIT

No environmental monitoring and audit programme has been designed and specified as no adverse water quality impacts have been identified from either the construction or operation phases of the Project.

8.9 SUMMARY AND CONCLUSIONS

This Section has dealt with the assessment of the impacts on water quality of the construction and operation of the wind turbine on Lamma Island.

During the construction phase it was determined that minor impacts to water quality could arise directly from land-based construction works. These works relate to excavation and construction of the foundation for the wind turbine, and underground cable laying. No direct construction runoff is expected. However, stormwater runoff from the construction site could occur during rainstorms. Mitigation measures were described, which would provide a series of good site management options to minimise the impact of stormwater runoff.

No operational impacts to water quality are expected to occur. No mitigation measures are therefore necessary. Based on the impact assessment, no EM&A measures are required. The mitigation measures specified as well as good site management skills are considered sufficient to prevent impacts occurring.

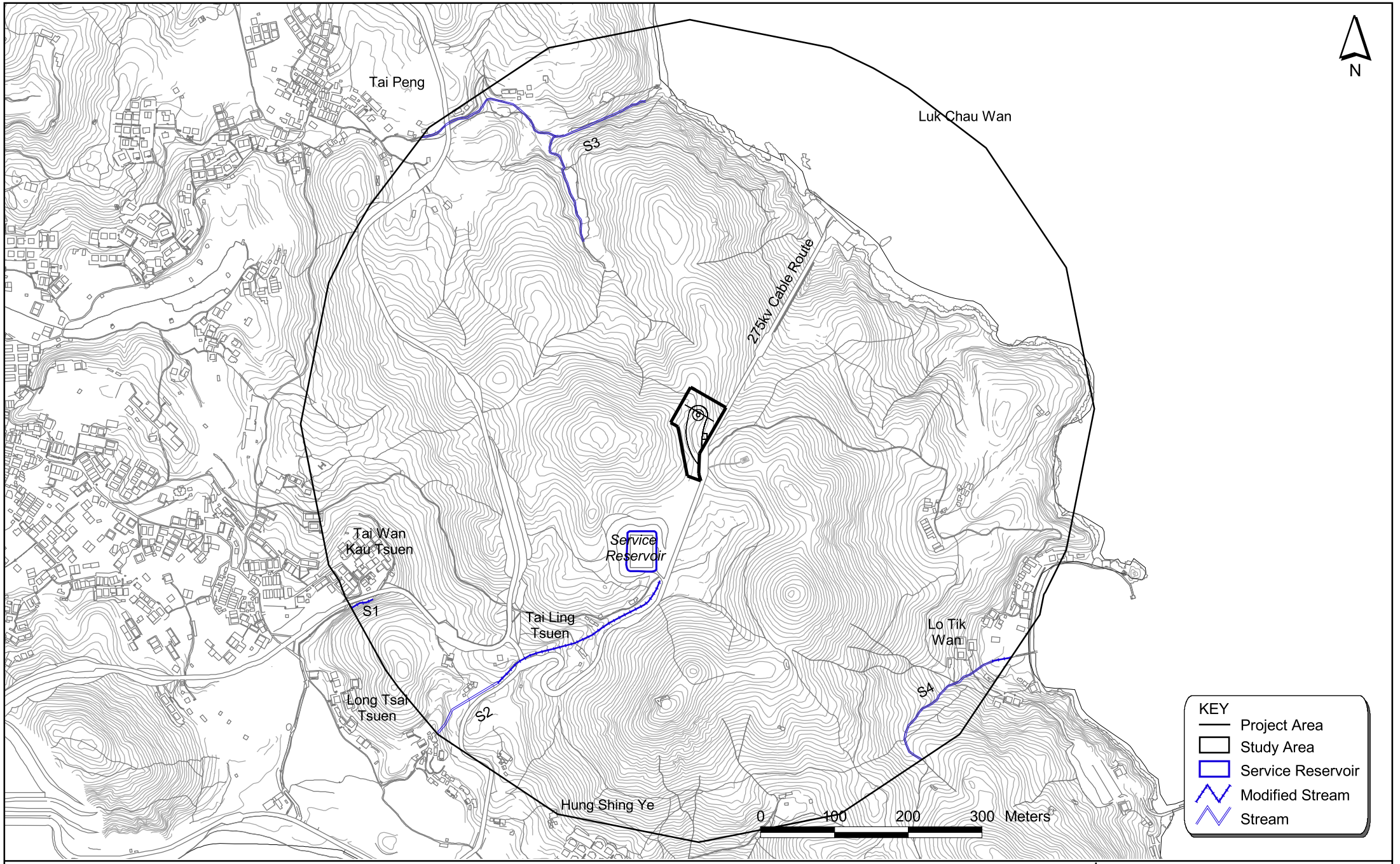

FIGURE 8.1

Water Bodies Recorded within the Study Area

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Date: 20/07/2004

Environmental Resources Management

ERM

9 ENVIRONMENTAL MONITORING AND AUDIT MEASURES

9.1 INTRODUCTION

This EIA Study has focused on the prediction and mitigation of the potential impacts associated with the construction and operation of the Project. One of the key outputs has been recommendations on the mitigation measures to be undertaken in order to ensure that residual impacts comply with regulatory requirements plus the requirements of the *EIAO TM*. The findings and recommendations of this EIA will form the basis on which HEC's environmental performance will be judged during the detailed design and construction of the Project. To ensure effective and timely implementation of the mitigation measures, it is considered necessary to develop Environmental Monitoring and Audit (EM&A) procedures and mechanisms by which the Implementation Schedule (*Annex D)* may be tracked and its effectiveness assessed.

9.1.1 *Implementation of EIA Findings and Recommendations*

Sections 4 to *8* have, where appropriate, identified and recommended the implementation of mitigation measures in order to minimise the potential construction and operational impacts of the Project. These findings and recommendations form the primary deliverable of the whole EIA process. Once endorsed by the EPD, they will form an agreement between HEC and the Government as to the measures and standards that are to be achieved. It is therefore, essential that mechanisms are put in place to ensure that the mitigation measures prescribed in the Implementation Schedule are fully and effectively implemented during construction.

The required format for the Implementation Schedule (*Annex D)* is specified in the EIA Study Brief. The format requires the specification of implementation agent(s), timing, duration and location for each of the recommended mitigation measures.

Apart from the mitigation measures defined in the EIA, there is also scope for other requirements to be included within the finalised Implementation Schedule. Prior to the issue of an Environmental Permit, there is an EIA Determination Period. During this period the EIA Report is reviewed and commented upon by both the public and professional bodies. Where recommendations are made and accepted by either the Advisory Council on the Environment (ACE) or its EIA subcommittee, these measures will be included within the Implementation Schedule, where appropriate.

9.1.2 *Statutory Requirements*

As the Project constitutes a Designated Project under the *EIAO* by virtue of Item D.1 of Part I of Schedule 2, an Environmental Permit must be obtained before construction or operation of the proposed wind turbine can commence.

Upon approval of the EIA Report, HEC can apply for an Environmental Permit. If the application is successful, the Environmental Permit will, in most circumstances, have conditions attached to it, which must be complied with. In addition, HEC and its appointed Contractors must also comply with all other controlling environmental legislation and guidelines, which are discussed within the specific technical chapters of this report. Failing to comply with these legislative requirements could lead to prosecution under the various *Pollution Control Ordinances*.

9.2 *ENVIRONMENTAL MANAGEMENT PLAN*

For construction of the Project, it is envisaged that the contractual documentation will require HEC's Contractors to define mechanisms for achieving the environmental requirements. This will most likely be achieved by requiring the Contractor to produce and implement an Environmental Management Plan (EMP).

EMP's are similar in nature to safety or quality plans and provide details of the means by which the Contractor (and all subcontractors working for the Contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined both in Hong Kong environmental legislation and in the Implementation Schedule. A primary reason for adopting the EMP approach is to make sure that the Contractor is fully aware of his environmental responsibilities and to ensure that his commitment to achieving the specified standards.

The EMP approach is grounded on the principle that the Contractor shall define the means by which the environmental requirements of the EIA process, and the contractual documentation shall be met. In the first instance, each Tenderer shall be required to produce a preliminary EMP for submission as part of the tendering process; the skeletal EMP will demonstrate the determination and commitment of the organisation and indicate how the environmental performance requirements laid out in the available EIA documentation will be met. It is recommended that this aspect be included as a specific criterion in the assessment of tender documents; this will act as a clear indication to all Tenderers of HEC's commitment to the minimisation and management of environmental impacts. Upon Contract Award, the successful Tenderer shall be required to submit a draft and final version of the EMP for the approval of HEC prior to the commencement of the works.

9.3 *EM&A MANUAL*

The EPD requires the submittal for approval of an EM&A Manual prior to the commencement of construction. The EM&A Manual has the purpose of defining the mechanisms for implementing the EM&A requirements specific to each phase of the work.

The EM&A Manual provides a description of the organisational arrangements and resources required for the EM&A programme based on the conclusions and recommendations of this EIA. The EM&A Manual stipulates details of the construction monitoring required, and actions that shall be taken in the event of exceedances of the environmental criteria. In effect, the EM&A Manual forms a handbook for the on-going environmental management during construction.

The EM&A Manual comprises descriptions of the key elements of the EM&A programme including:

- appropriate background information on the construction of the Project with reference to relevant technical reports;
- organisational arrangements, hierarchy and responsibilities with regard to the management of environmental performance functions during the construction phase to include the EM&A team, the Contractor's team and the Corporation's representatives;
- a broad construction programme indicating those activities for which specific mitigation is required, as recommended in the EIA, and providing a schedule for their timely implementation;
- descriptions of the parameters to be monitored and criteria through which performance will be assessed including: monitoring frequency and methodology, monitoring locations (in the first instance, the location of sensitive receivers as listed in the EIA), monitoring equipment lists, event contingency plans for exceedances of established criteria and schedule of mitigation and best practice methods for minimising adverse environmental impacts;
- procedures for undertaking on-site environmental performance audits as a means of ensuring compliance with environmental criteria; and
- reporting procedures.

The EM&A Manual will be a dynamic document which may undergo a series of revisions to accommodate the progression of the construction programme.

9.3.1 Objectives of EM&A

The objectives of carrying out EM&A for the Project include:

- to provide baseline information against which any short or long term environmental impacts of the projects can be determined;
- to provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- to monitor the performance of the Project and the effectiveness of mitigation measures;

- to verify the environmental impacts predicted in the EIA Study;
- to determine Project compliance with regulatory requirements, standards and government policies;
- to take remedial action if unexpected problems or unacceptable impacts arise; and
- to provide data to enable an environmental audit to be undertaken at regular intervals.

The following sections summarise the recommended EM&A requirements, further details are provided in the EM&A Manual.

9.4 NOISE

9.4.1 Construction Phase

Given the compliance with the stipulated noise criterion, noise monitoring is not required during the construction stage. Though site audit will be conducted to ensure that the plant inventory used on site are consistent with the assumptions used in the EIA report.

9.4.2 Operation Phase

During the operational phase, noise monitoring is recommended to ensure the compliance with the stipulated noise criterion at the nearby NSRs. A noise monitoring location is proposed at No. 1 Tai Ling Tsuen (N1). Details of the monitoring schedule and plan are presented in the separate EM&A Manual. To ensure the operational noise level complies with the noise standard, the supplier shall guarantee the wind turbine with allowable maximum noise level of 100 dB(A) and pure tone free, by providing certificate of measurement and verify the overall noise level during commissioning and testing in accordance to international standard procedures such as IEC 61400-11.

9.5 ECOLOGY

9.5.1 Construction

The implementation of the ecological mitigation measures stated in *Section 5.7* should be checked as part of the environmental monitoring and audit procedures during the construction period as presented in the separate EM&A Manual.

9.5.2 Operation

Monitoring for bird collision during operation is required. The purpose of the monitoring of wind turbines is to assess the impact (via collisions) of the wind farm on birds, with a particular focus on species of conservation interest (ie

Black Kite). During the operation of the wind turbine, monitoring will be undertaken at monthly intervals for a period of 12 months. An area of 50 m radius will be searched around the base of the turbine. After this 12-month period, the monitoring results will be reviewed. Should any bird mortality or injury be confirmed to be due to the wind turbine, relevant government departments (ie Environmental Protection Department (EPD) and Agriculture, Fisheries and Conservation Department (AFCD)) would be notified. If the bird collision event persists more than 3 times, HEC will discuss to propose for remedial action with government and implement any agreed actions to solve the event such as adjustment of wind turbine lighting and the colour of the wind turbine. The effectiveness of the proposed remedial action will be verified and evaluated with discussion with EPD/AFCD.

If, after the 12-months monitoring, insignificant number of bird collisions have been reported then monitoring will cease as it will have been demonstrated that the wind turbine is not having an adverse impact on bird species.

9.6 LANDSCAPE AND VISUAL

The implementation and operational maintenance of proposed landscape and visual mitigation measures should be checked as part of the environmental monitoring and audit procedures during the construction period as presented in the separate EM&A Manual. The detailed landscape designs shall be audited during the design stage. Construction and operational stage EM&A will comprise audit of the compensatory planting and planting establishment in the form of site inspection. Further details of the specific EM&A requirements are presented in the separate EM&A Manual.

9.7 AIR QUALITY

9.7.1 Construction Phase

During the construction phase, regular site auditing is recommended to ensure the recommended mitigation measures are properly implemented.

9.7.2 Operational Phase

As no adverse air quality impact is expected, air quality EM&A is not considered necessary.

9.8 WATER QUALITY

9.8.1 Construction Phase

During the construction phase, regular site auditing is recommended to ensure the recommended mitigation measures are properly implemented.

9.8.2 Operational Phase

As no water quality impact is expected, EM&A for water quality is not considered necessary.

9.9 WASTE MANAGEMENT

9.9.1 Construction Phase

During the construction phase, regular site auditing is recommended to ensure good construction practice as well as good waste management and disposal measures are properly implemented.

9.9.2 Operational Phase

No waste generation is expected since the turbine will be unmanned during operation.

10 CONCLUSIONS & ENVIRONMENTAL OUTCOMES

10.1 INTRODUCTION

This *Section* presents a summary of the key potential environmental outcomes associated with the construction and operation of the Project.

10.2 NOISE

Unmitigated construction activities associated with the Project will not cause adverse noise impact to the nearby NSRs as the predicted construction noise levels are in the range of 46 – 61 dB(A), which comply with the stipulated noise criterion. The mitigation measure of adopting good site practice is proposed to further minimise the construction noise impact to the environment. Regular site audits will be conducted during construction to ensure the plant inventory used on site is consistent with the assumptions in the EIA report.

With the adoption of a maximum sound power level of 100 dB(A) and a pure tone free wind turbine , the predicted facade noise levels will comply with the night-time noise criterion at all NSRs. It is proposed that the allowable maximum sound power level shall be included in the tender specification of wind turbine. Noise monitoring during the operational phase is recommended so as to ensure the compliance with the stipulated noise criterion at the nearby NSRs. To ensure the operational noise level complies with the noise standard, the supplier shall guarantee the wind turbine with allowable maximum noise level of 100 dB(A) and pure tone free, by providing certificate of measurement and verify the overall noise level during commissioning and testing in accordance with international standard procedures such as IEC 61400-11.

10.3 ECOLOGY

The ecological resources recorded within the Study Area included secondary woodland, shrubland, shrubby grassland, stream and village/ developed areas, as well as associated wildlife. Of these habitats, secondary woodland and the middle course of a stream near to Lo Tik Wan (Stream S4) have moderate to high and high ecological value respectively. The remaining habitats are of low or low to moderate ecological value. A total of 14 species of conservation interest were recorded within the Study Area, including five bird species (Black Kite, Greater Coucal, Lesser Coucal, Emerald Dove and White-bellied Sea Eagle), eight uncommon butterfly species (Red Lacewing, Bush Hopper, Common Duffer, White-edged Blue Baron, Tree Flitter, Yellow Orange Tip, Swallowtail and Small Cabbage White) and one amphibian (Romer's Tree Frog). Three calling male Romer's Tree Frog were recorded

within and adjacent to the Project Area during the surveys. A total of 17 bird species were observed during the vantage point surveys, with a total of 1,290 flight attempts in the Study Area. The flight attempts of most of the recorded species were generally flying < 10 m above the ground level near the Project Area. Only Black Kite (144 attempts, the maximum number of individuals recorded was 23 during the surveys), Barn Swallow (3 attempts) and Little Swift (2 attempts) were recorded flying over and crossing the location of the proposed wind turbine at a height > 10 m and <100 m above the ground level during the surveys.

In conclusion, the direct ecological impact due to the construction of the wind turbine is expected to be low, and will not contribute to any potential cumulative impact. In view of the generally poor vegetation cover and the dryness of the upland areas, it is believed that the Project Area and areas in the vicinity do not provide optimal habitats for the Romer's Tree Frog. The impacts on the Romer's Tree Frog are expected to be low given that pre-construction translocation of Romer's Tree Frogs (adult and tadpoles, if any) present at the site will be conducted.

Bird collisions are the main concern of the operational impacts of any wind turbine development. Barn Swallow, Little Swift and Black Kite, recorded as utilising the Project Area in this study, are the confirmed potential species that may be affected by the wind turbine during operation. Site selection is crucial to minimizing wind turbine bird collision. Since the wind turbine site is not considered to be either within important bird habitat or on the flight path of migratory birds, the impacts due to bird collision are of low magnitude and therefore not considered to be unacceptable.

No adverse residual impact is expected after the implementation of the recommended mitigation measures. One year bird monitoring will be undertaken to demonstrate that the wind turbine is having low magnitude of and not having an unacceptable impact on bird species.

10.4 LANDSCAPE AND VISUAL

The whole Study Area is considered to be covered under one single Landscape Character Area, LCA 1 - North Lamma Coastal Uplands. Landscape Resources found within the Study Area include LR1 - secondary woodland, LR2 - shrubland, LR3 - shrubby grassland, LR4 - streams and LR5 - village/developed area.

The following table gives the quantification, disturbance and net loss of these LCA and LRs.

Table 10.1 Summary of Net Loss to LCA1 and Various Landscape Resources

LCA/LR	Type of Landscape Resources Present in the LCA/LR	Quantification of Landscape Resources within the LCA/LR	Area in conflict with the proposed works	Net Loss in Area
LCA1	North Lamma Coastal Uplands	Approx. 79.4 ha	Approx. 3,100 m^2	Approx. 1,700 m^2
LR1	Secondary Woodland	20.5 ha	0m^2	0m^2
LR2	Shrubland	49.4 ha	0m^2	0m^2
LR3	Shrubby Grassland	5.7 ha	Approx. 3,100 m^2	Approx. 1,700 m^2
LR4	Stream	Total 1.1 km	0 km	0 km
LR5	Village/Developed Area	3.8 ha	0m^2	0m^2

Specific mitigation measures have been proposed to minimize identified impacts, including MM1 - reinstatement of disturbed areas (approx. 1,400 sq.m.), MM2- compensatory planting (approx. 1,400 sq.m.) and MM4 - soil conservation. The extent and location these mitigation measures are shown on *Figure 6.24.* All proposed MMs would be managed and maintained by the project proponent.

With the implementation of the mitigation measures proposed, the magnitude of change to LCA1 and LR3 are *small.* The residual impact significance threshold of LCA1 is *moderate/ adverse* for both years 1 & 10. Appropriate landscape planting including trees, shrubs and grasses will result in a net increase in the quantity of vegetation at the Project Site resulting in a significance threshold of the residual impact for LR3 to "*slight/adverse*" during Year 1 of operation and "*slight/beneficial*" during Year 10 of operation.

Visually, the proposed wind turbine can be seen from some parts of Lamma Island and Hong Kong Island South and a total of 16 VSRs are identified. These VSRs are classified into 3 main groups:

- Resident and people at work VSRs on Lamma Islands where the proposed wind turbine would be visible
- Resident and people at work VSRs on Hong Kong Island south and Ap Lei Chau
- Visitors and viewers in transit such as those on hiking tracks on Lamma Island and along the ferry routes as well as those in Ocean Park
- Visitors to the Tai Ling Pavilion and cable road adjacent to the Project Site

Specific mitigation measures have been proposed to minimize the visual impacts. These include MM1 - reinstatement of disturbed areas (approx. 1,400 sq.m.), MM2- compensatory planting (approx. 1,400 sq.m.), MM3 - colour scheme and MM5 - selection of low rotating speed machine. The extent and location these mitigation measures are shown on *Figure 6.24.* All proposed MMs would be managed and maintained by the project proponent.

With mitigation measures, the proposed wind turbine would result in *slight to moderate/ adverse* residual visual impact on views from the first 3 groups of viewers during operation.

At Tai Ling Pavilion and the cable route adjacent to the site, the visual significant threshold would be *significant* as the wind turbine and built structures would be dominating. However, whether it is an adverse or beneficial impact would very much depend on the viewers acceptance towards the use of this kind of renewable energy as a substitute to coal burning.

One of the objectives of this project is to educate the public and in particular students, for promotion of green awareness. With the gain in knowledge of the benefits of renewable energy such as the improvement of air quality, the likelihood of acceptance of the visual impact would be increased.

The overall residual impacts on landscape and visual aspects are considered to be acceptable with mitigation measures.

10.5 AIR QUALITY

Dust nuisance is the only potential air quality impacts during the construction of the Project. Site formation, foundation construction, cable laying, wind turbine erection and landscaping works are the main construction activities. Wind erosion, materials handling, on-site stockpiling and vehicles movements are the major dusty activities. Since the site area is small, construction period is short with minimal construction activities and the distance from the ASRs is more than 185 m away, therefore, with the implementation of dust suppression measures, the potential for causing dust impact is very low. However, to protect the ASRs, regular site auditing is recommended to ensure the recommended mitigation measures are properly implemented.

No air quality impact would be envisaged during the operation of the wind turbine. The wind turbine will displace emissions of greenhouse gases and other emissions from conventional power generating plant. Estimates of the potential emission reductions have been presented.

10.6 WATER QUALITY

The EIA has dealt with the assessment of impacts on water quality from the construction and operation of the wind turbine on Lamma Island.

During the construction phase it was determined that minor impacts to water quality could arise directly from land-based construction works. These works relate to excavation and construction of the foundation for the wind turbine, and underground cable laying. No direct construction runoff is expected. However, stormwater runoff from the construction site could occur during rainstorms. Mitigation measures were described, which would

provide a series of good site management options to minimise the impact of stormwater runoff.

No operational impacts to water quality are expected to occur. No mitigation measures are therefore necessary. Based on the impact assessment, no EM&A measures are required. The mitigation measures specified as well as good site management skills are considered sufficient to prevent impacts occurring.

10.7 WASTE MANAGEMENT

The construction works will involve some site formation which will necessitate the removal of small quantities of spoil. The quantity of waste materials arising from the construction phase (approximately 1,300 m^3 of excavated materials) is not expected to be high as most of the spoil (95% of the excavated materials) will be used as backfill, but practical measures will be taken to avoid, minimise and recycle wastes. The remaining portion will be transported by trucks to the HEC Power Station for offsite disposal. Good construction practices, including limiting activities within the site boundary and avoiding of filling and illegal dumping by site management and audit, are recommended to ensure that adverse environmental impacts are prevented.

10.8 ENVIRONMENTAL MONITORING AND AUDIT (EM&A)

During construction of the Project, environmental monitoring will be necessary to assess the effectiveness of measures implemented to mitigate potential noise and ecological impacts. Regular environmental auditing is also recommended to ensure that potential impacts from other sources are adequately addressed through the implementation of the mitigation measures defined in this EIA Report.

During operation of the Project, the monitoring work is focussed on ecology, specifically operation phase impacts to birds and to a noise sensitive receiver. Details are presented in the EM&A Manual.

10.9 ENVIRONMENTAL OUTCOME

No unacceptable residual impacts are predicted for the construction and operation of the Project. This section presents the environmental outcome of the Project.

10.9.1 Environmental Benefits

The wind turbine will be built in a grid connection scheme for supplying "green" electricity to HEC customers. The project will have the following environmental benefits:

- *Demonstration of utilizing wind energy for power generation:* The proposed wind turbine will be the first utility scale and grid-connected wind project in Hong Kong. Based on the wind potential on Lamma, the proposed wind turbine will harvest about 700 MWh of electricity per annum, helping to avoid the use of up to 240 tonnes of coal and reduce the associated emissions every year.

- *Education purpose*: Visitors' facilities such as display boards and guided tour will be provided at the wind turbine site to explain the principle of power generation by wind and the benefits of renewable energy. The wind turbine project will serve as educational use for promotion of green awareness among the public, in particular with students.

- *Wider application of renewable energy*: The project will provide invaluable local experience on the design, construction, operation and maintenance of wind turbines. Future utilization of wind energy in Hong Kong can be explored based on the information collected and experience gained, keeping pace with Government's policy, and the publics expectation of the promotion of renewable energy and improvement in air quality.

10.9.2 Environmental Friendly Designs

The wind turbine has been based on an environmentally friendly design which is beneficial to the environment as it helps to reduce air pollutant emissions and greenhouse gas emissions. Environmental impacts have been largely avoided through a detailed and careful site selection exercise for the wind turbine.

Desktop screening and site surveys conducted to identify potential sites for a wind turbine of suitable size on Lamma and Po Toi Island based on the criteria recommended in the guidelines for wind energy development issued by reputable international organizations of wind energy. The site search was confined to Lamma and Po Toi where reliable wind data are available.

Po Toi Island is an ecologically sensitive area which has been identified as a potential Country Park and is a known location of the endemic Romer's Tree Frog. As there is no vehicular access for sites of favourable wind potential on Po Toi the majority of the wind turbine equipment/materials would have to be delivered to site by helicopters. Construction of a new access road was not considered suitable due to the potential for adverse environmental impacts. Considering the limited payload of local helicopter services, the maximum capacity of a wind turbine on Po Toi would be restricted to about 50 kW. Any electricity generated on Po Toi would also be connected to the HEC grid. This could only be done through the use of submarine cables. Given that the marine waters between Po Toi, Hong Kong and Lamma Island are already quite congested with seabed utilities, finding an acceptable route for a cable may prove technically challenging. Although not expected to be unacceptable, the installation of a submarine cable would introduce additional environmental impacts.

In view of the accessibility considerations and absence of a power grid, Po Toi is considered neither technically feasible nor environmentally and economically attractive for a demonstration project with commercial scale wind turbine.

Once the above considerations had been accounted for, site selection was focussed on Lamma Island. The wind turbine site was then examined against engineering requirements and environmental concerns and further refined using the following site screening criteria:

- Wind potential;
- Site access;
- Height restriction;
- Electrical connection; and
- Area and land-use

Taking into account the above criteria, wind turbine location was identified with the application of constraint mapping techniques. The site is situated away from the ecological sensitive areas, including SSSI and the potential Country Park at South Lamma, and along the existing 275 kV Cable Routes which are the only vehicular roads on Lamma island.

10.10 OVERALL CONCLUSIONS

The EIA has critically assessed the overall acceptability of any environmental impacts likely to arise as a result of the construction and operation of the wind turbine on Lamma Island. Where necessary and practicable, the EIA has specified the conditions and requirements for the detailed design, construction and operation of the Project in order to mitigate environmental impacts to acceptable levels.

This EIA Study has predicted that the Project will comply with all environmental standards and legislation after the mitigation measures are implemented. The EIA has thus demonstrated the acceptability of any residual impacts from the Project and the protection of the population and environmentally sensitive resources. Where appropriate, EM&A mechanisms have been recommended before and during construction to verify the accuracy of the EIA predictions and the effectiveness of recommended mitigation measures. A post project monitoring exercise has been recommended to verify overall project performance.

The study concluded that there would be no adverse long term or cumulative effects/impacts on the environment.

In conclusion, it is considered that the EIA provides a suitable basis for the Director of Environmental Protection to consider granting the Environmental Permit to allow the construction and operation of the Project.

Annex A

Site Search Report

SITE SEARCH REPORT FOR THE

PROPOSED WIND TURBINE INSTALLATION

AT

LAMMA ISLAND

Projects Division

August 2004

Revision 2

The Hongkong Electric Co., Ltd.
香港電燈有限公司

1. INTRODUCTION

The Hongkong Electric Company Limited (HEC) proposes to install a wind turbine system for power generation on Lamma Island. The tentative capacity of the proposed wind turbine is in the range of 600kW to 1MW. The electricity produced by wind turbine will be fed into the existing main power grid for supplying of "green" power to local residents.

Lamma Island is an outlying island providing Hong Kong with valuable assets of non-urban lifestyle and refreshing scenery. HEC has sought to demonstrate the commitment of sustainable development through the application of renewable energy to meet the high environmental standard expected by the community. This Report presents the criteria and findings of the preliminary site search undertaken as part of the feasibility study for the proposed wind turbine installation at Lamma Island.

2. WIND MONITORING AND DATA ANALYSIS

HEC have commenced a feasibility study in April 1999 to collect wind data on Po Toi and Lamma Island to evaluate the wind potential in southern part of the Hong Kong territory. Two wind monitoring stations, one on Po Toi and another on Lamma Island, were set up in April and November 2001 respectively to record one-year wind profile (Fig. 1). Wind vanes and anemometers were installed at regular intervals up to 50m above ground to simulate typical hub height of modern wind turbines. The wind data were logged every second and integrated to a 10-minute average. The collected wind data were stored temporarily in a data logger and periodically downloaded for analysis.

Fig. 1 - Location of Wind Monitoring Stations

The 12-month wind power monitoring at Po Toi and Lamma had been completed in November 2002. The monthly and annual wind speed at Lamma Wind Monitoring Station is summarized in below:-

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Avg**
Wind Speed (m/s)	6.4	6.2	6.2	5.8	5.8	6.2	6.5	5.5	6.4	6.5	6.1	5.8	**6.11**

To calculate the variation of wind speed over the area of Lamma Island, the computer wind flow model WAsP and WindPro have been used. The inputs to the models include a digitized map of the topography, surface roughness of the terrain within the area of interest and primary wind data. The WAsP model predicts wind speed at a number of given points in the model domain, specified by Easting, Northing and height. The models are set to predict specific wind power density at intervals of 10m grids over the Lamma Island and at a height of 45m above ground level. This height represents the hub level of a typical modern 600kW wind turbine.

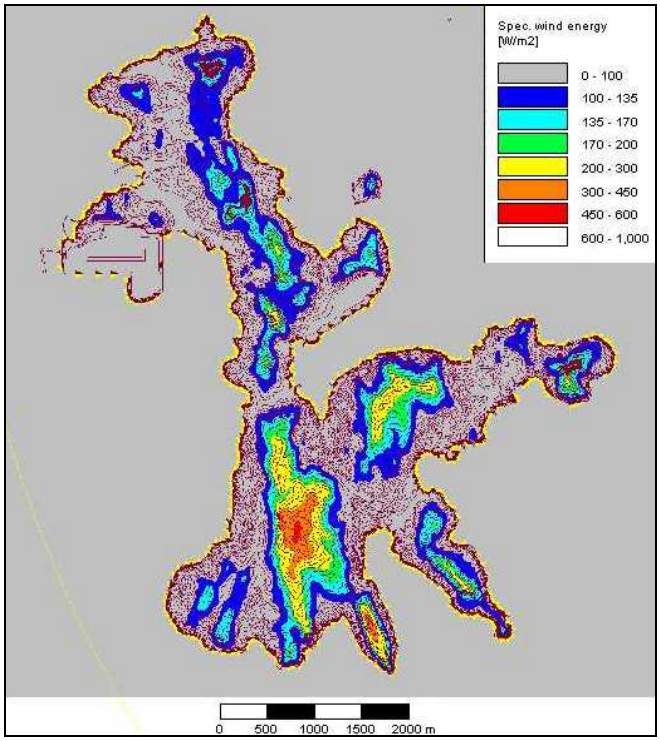

Fig. 2 - Wind Resource Map of Lamma Island

Areas of wind power density over 150W/m^2, equivalent to the average wind speed of about 5.5m/s, are considered suitable for wind energy utilization and warrant further evaluation [(1) (2) (3)]. Modern wind turbines have the cut-in wind speed of approximately 2.5 to 4 m/s and sites with annual wind speed below 5.5m/s are in general not considered economically viable due to low electricity output of the wind turbine. Fig. 2 shows the "isovent" map of Lamma Island, showing lines of equal power density in terms of energy per swept area of wind turbine blades. The areas of favourable potential are shown as blue, light blue, green, yellow and red colours. Areas of high wind potential are in general found at sites of high elevation such as hilltops and ridges of mountain.

3. Proposed Wind Turbine Plant

3.1 Wind Turbine Selection

Wind turbines come in size of 0.5m to over 100m in rotor diameter, in capacity of a few watts to 4 megawatts. Small wind turbines (say <30kW) are usually DC machines and are used to power individual households and remote industrial facilities. Utility scale wind turbines (>500kW) are used for the centralized generation of electricity near load centres. Wind turbines produce energy when the wind blows and for most application variable energy output is not acceptable without an energy buffer. Small wind turbine system uses batteries or diesel engines to supplement the wind power and large wind turbines are ideally suited for the grid-inertia systems.

Diversity of design concept and technical details is evident in present commercial wind turbines. Wind turbine is now becoming a matured technology and the cost is declining. The wind technology is becoming competitive with conventional forms of power generation in the sites of good wind potential. The industry is supported by the volume production worldwide. Until recently the market has been dominated by the concept of "horizontal axis, tubular tower, three bladed, stall or pitch regulated and variable or fixed speed" design for utility scale wind turbines.

The typical size of wind turbine has grown steadily in term of rotor diameter and rated power output over the past 20 years. Currently the most cost-effective wind turbine size range for grid connection use is 600 to 1500kW with rotor diameter of 45 to 75m. The average unit size of recently installed

(1) *Wind Energy – The Facts*, European Wind Energy Association, 2004

(2) *Wind Force 12*, European Wind Energy Association, May 2004

(3) *Assessing the World's Wind Resources, Dennis Elliott, IEEE Power Engineering Review, Vol. 22(9), Sept 2002 & NREL National Wind Technology Center Publications 2002*

wind turbines is found increasing all over the world. Capacity less than 600kW is being phrasing out of the production line due to economy of scale. Almost all major manufacturers in Europe, USA and Japan have started producing megawatt-scaled turbines, primarily for the European market where windy sites are found. HEC's wind project focuses on the wind turbines in the range of 600 kW to 1MW as a result of technology maturity, equipment sourcing and site constraints on height clearance.

3.2 Engineering Requirement

The construction and operational criteria upon which the planning of wind turbine system has been proceeded are summarized below.

Site Area

The layout of the wind turbine system will take into account the construction and operational requirements. The proposed wind turbine requires a minimum area of 30m x 20m as laydown area for construction and operation. The foundation, in size of 15m x 15m, will be either piling or footing design. The wind turbine will be ideally located on a piece of flat land to provide direct bearing foundation and to limit civil costs.

The transformer will be installed at the bottom of the wind turbine tower. Switchgear and power conditioning devices will be housed inside a high voltage distribution pillar (HVDP) made of stainless steel (4.6m L x 2.5m W x 2.8 m H). Power cables will be buried underground for connecting the wind turbine, HVDP and the nearby 11kV power grid on the 275kV cable route.

Height Clearance

The site will take into account the height limit imposed by the planning authority. Civil Aviation Department (CAD) has imposed height restriction for all permanent structures in accordance with the Hong Kong Airport Control of Obstructions Ordinance (Fig. 3). Most areas in north Lamma along the cable routes fall between the restricted heights of about 160 to 165m above the Hong Kong Principal Datum (PD).

Typically the 600kW and 1MW wind turbines have rotor diameters of about 45m and 60m respectively. The towers will normally have to cater for approximately half of a rotor diameter of clearance from the ground level. The site shall allow for a clearance of 68m and 90m from ground level to tip height for a 600kW and 1MW wind turbine respectively.

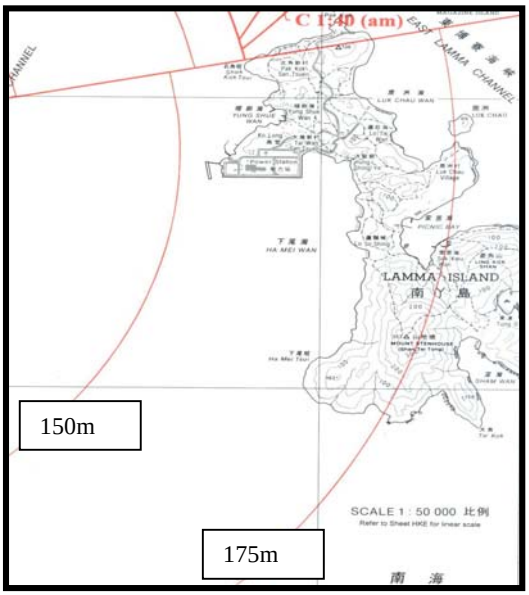

Fig. 3 - Height Restriction Map for Lamma Island

Access

The site will take into account the accessibility of vehicles and mobile equipment required for construction and maintenance of wind turbine system. The permanent road leading to the site shall be paved and have a minimum width of 5m and maximum inclination of not greater than 15% for the passage of heavy trucks and mobile cranes.

3.3 Conceptual Design

The system will consist of a wind turbine of capacity in the range of 600kW to 1MW, a transformer, a switchgear and associated power control devices required for integration to the utility grid.

The output from wind turbine is transmitted to the existing 11kV grid via a step up transformer and a switchgear. The synchronous generators of the grid system supply magnetizing current for the induction generator of wind turbine. The blades of wind turbine will start to move when wind speed is persistently exceeding the cut-in speed (~ 2.5 to 4m/s) of the wind turbine. The electricity generated will be fed to the utility grid if the power output is adequate to cope with the power loss on the transformer and cables. The output voltage of the wind turbine will be automatically adjusted to cater for voltage change across the distribution cables under various loading conditions. An auto-synchronous controller or soft starter will be required to control the operation of a synchronizing breaker with respect to the wind turbine output voltage and frequency (Fig. 4).

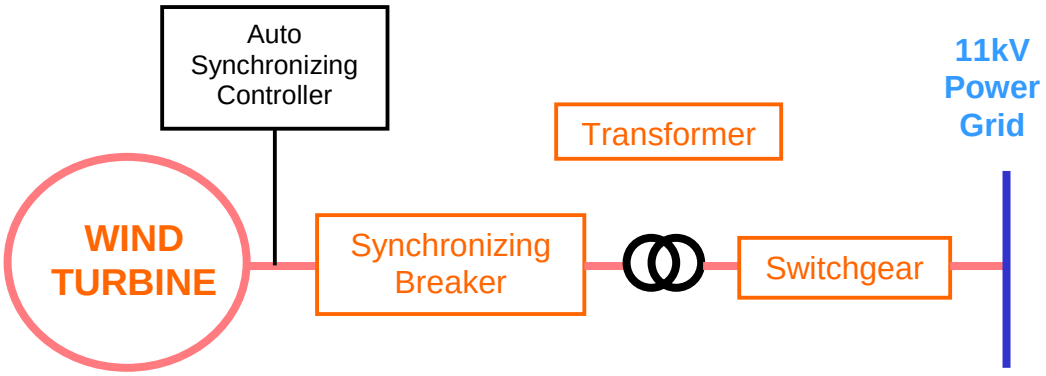

Fig. 4 - Schematic Diagram of the Proposed Wind Turbine Installation

4. Preliminary Site Search

4.1 Primary Screening Criteria

Primary screening is largely driven by the non-environmental criteria. In this section, broad environmental screening criteria have applied to focus on the identification of potential sites within the search envelope of Lamm Island. The possible sites resulting from application of both non-environmental and environmental screening criteria have formed the long list of potential sites.

The principal location requirements and evaluation criteria for the proposed development are to avoid ecologically sensitive areas on the Lamma Island. The proposed sites should not intrude into any of the following areas:-

- all potential sites for country parks and special area;
- all registered sites of special scientific interest (SSSI); and
- all developed areas.

For the purpose of the site search, the excluded areas shall be supplemented by the consideration of existing land-use and the identification of areas to be excluded due to insurmountable access constraints and height restriction. These consideration forms the basis for the preliminary screening criteria.

4.2 Constraint Mapping

4.2.1 Methodology

Constraint mapping techniques have long been used in site selection studies to bring together environmental and engineering considerations into an overall

assessment. This is achieved through the collection of layers of mapping information showing features, constraints and planning proposals, to produce a multi-layered constraints map that forms the basis for the identification of the unconstrained areas. Constraints mapping provides a means of taking into account of potentially damaging environmental effects in a structured and rigorous way.

4.2.2 Constraint Criteria

(a) *Country Parks*

Country Parks comprise areas designated under the Country Parks Ordinance for the purpose of providing informal outdoor recreation and conserving landscape, wildlife and historical features. No new development can be carried out within country parks without approval of the Country and Marine Parks Authority. No designated country parks on Lamma Island and the potential sites for country parks are shown in Figure 5.

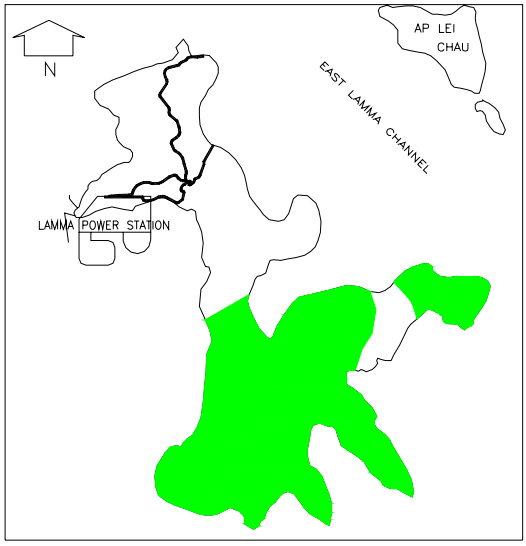

Fig. 5 - Potential Country Parks

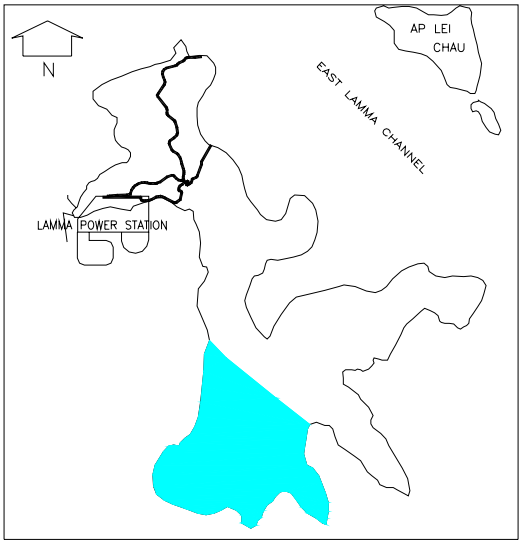

Fig. 6 - Site of Special Scientific Interest

(b) *Site of Special Scientific Interest (SSSI)*

The classification of a particular area as an SSSI carries significant weight amongst AFCD, EPD as well as conservation organizations and comes under the statutory protection of the Town Planning Ordinance. As a consequence, SSSI within the search envelope have been identified

and shown in Figure 6. The wind turbine installation should not be encroached up the SSSI.

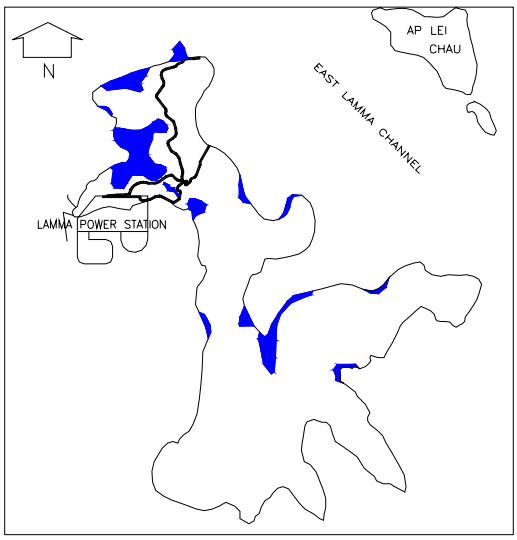

Fig. 7 - Developed Areas

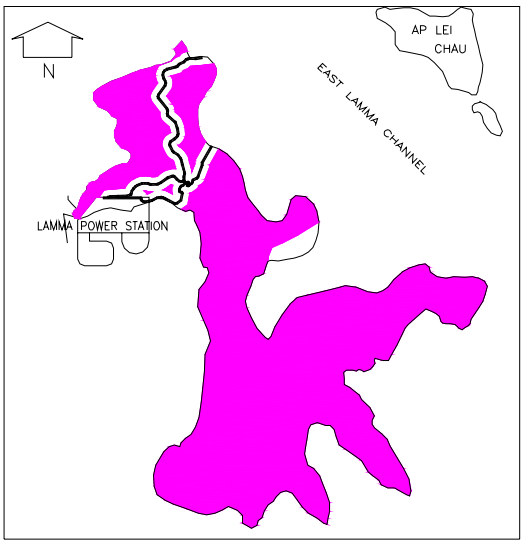

Fig. 8 - Areas without Proper Access

(c) *Developed Area*

Recent land use planning policy in Hong Kong has favoured the separation of industrial activities from the residential, commercial and retail mix of development areas. Developed areas of Lamma Island as shown in Figure 7 are therefore excluded from the area of search.

(d) *Access Constraints*

In view of the aesthetical impact and visual intrusion, any new permanent access leading to the site is not recommended. Most of the roads on Lamma Island are unable to fulfill the access requirements for erection and maintenance of a 600-850kW wind turbine. Areas accessible by heavy vehicles or marine vessels area limit to those along the existing 275kV Cable Routes and the coastal flatland closed to berthing facilities (Fig. 8).

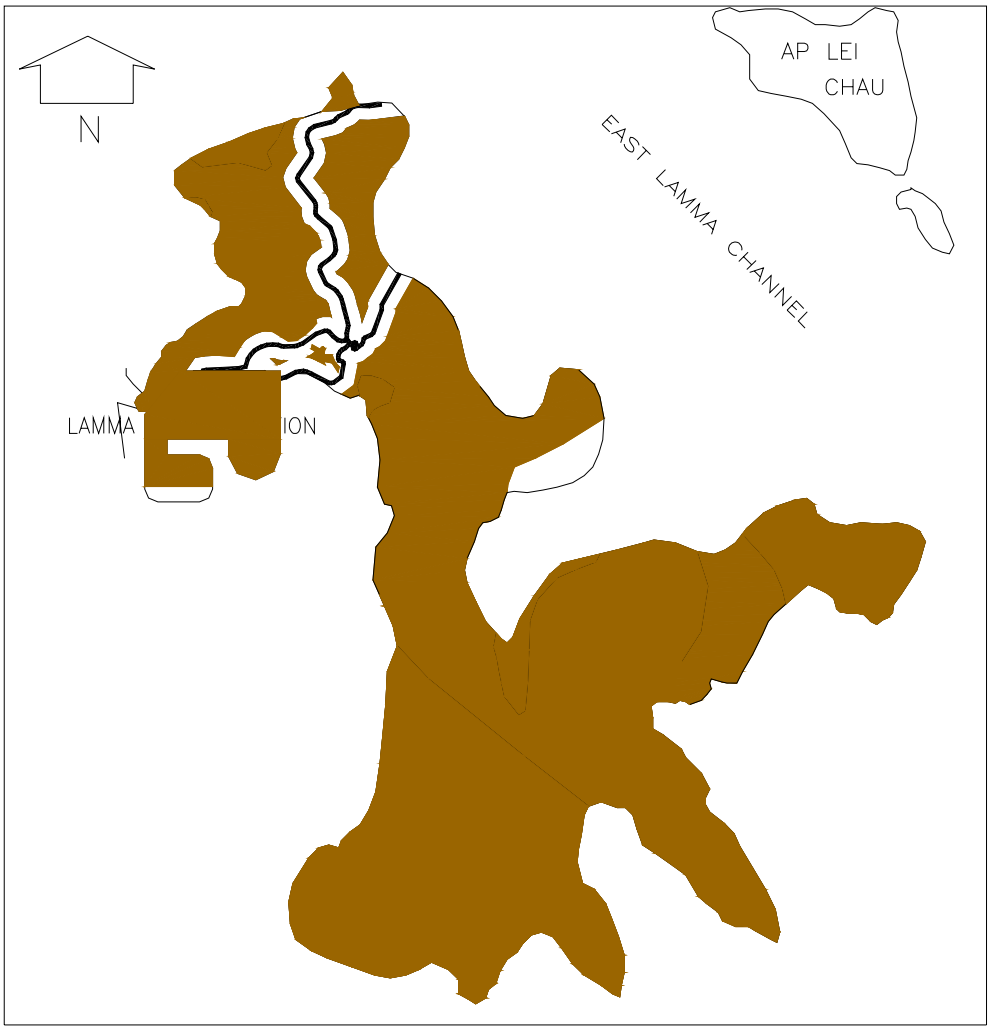

Fig. 9 - Composite Map of Constrained Area

4.3 Potential Sites

The constraints mapped, and described above, have been brought together to produce a composite map (see Figure 9) showing the unconstrained areas for the search of potential site. The unconstrained areas have been scrutinized to determine potential locations for the 600kW or 1MW class wind turbine depending on height restriction.

Six locations (Figure 10) are identified by applying broad engineering requirements to the unconstrained areas.

Site	Location	Allowable Wind Turbine Capacity
1	Lamma Extension	600kW to 1MW
2	Tai Ling	600kW to 850kW
3	Yung Shue Long	600kW to 850kW
4	Tai Peng	600kW to 1MW
5	Pak Kok Tsui	600kW to 1MW
6	Lamma Quarry	600kW to 1MW

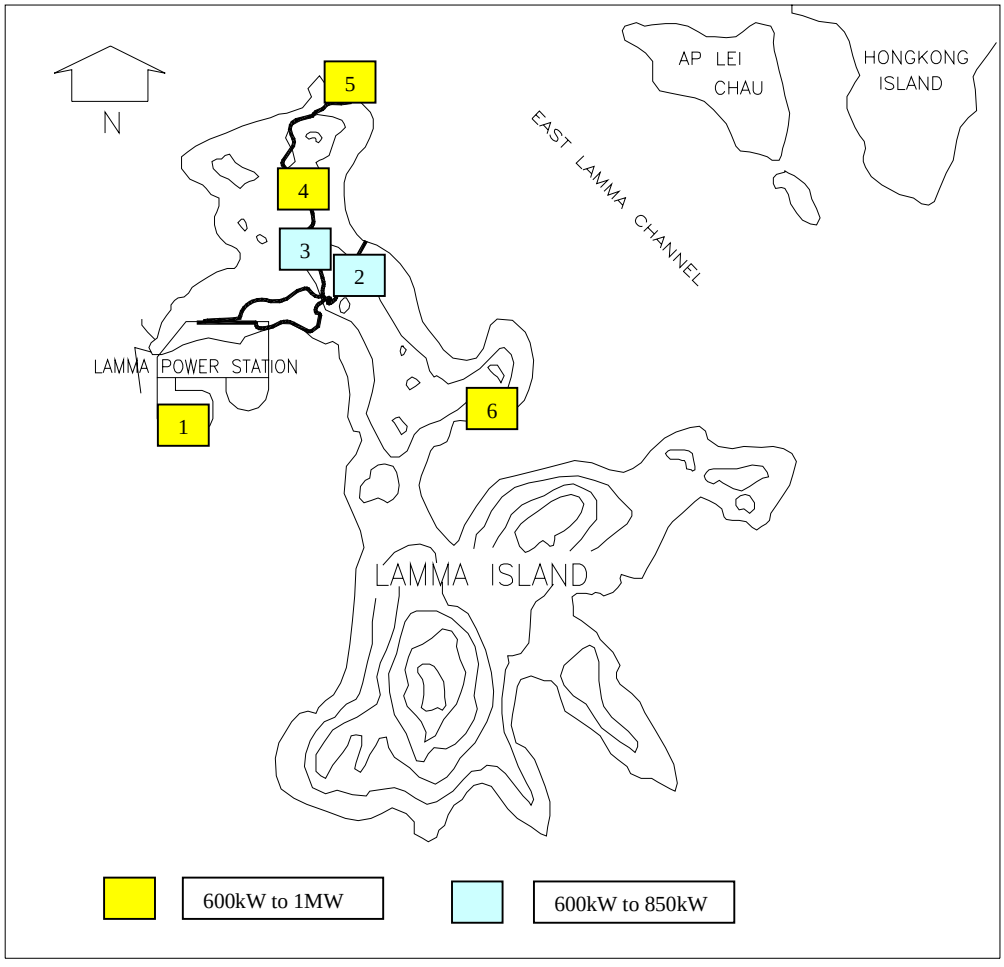

Fig. 10 - Potential Sites Identified for the Proposed Wind Turbine

5. Screening of the Potential Site

5.1 Intermediate Screening Criteria

Having identified sites that meet the broad environmental and technical criteria for a wind turbine installation, the intermediate screening exercise will establish a short list of feasible sites considered appropriate for further detailed investigation. The intermediate screening process includes site-specific engineering considerations in addition to appraisal of environmental and technical requirements. Each site is examined more closely to establish whether is to be retained for a detailed appraisal or excluded from further consideration because of a basic incompatibility with one or more of the highlighted issues.

The approach adopted is qualitative and sough to identify potential conflicts with the development of a wind turbine system. The criteria employed are as follows:-

(a) Engineering

- Wind Potential – favourable specific wind energy, reasonable energy output and utilization factor (average specific power more than 100W/m^2 or wind speed more than 5.0m/s)
- Geological Considerations – availability of adequate lay-down area, reasonable site platform
- Electrical Connection – proximity to existing 11kV power grid

(b) Environmental & Planning

- Noise – proximity to sensitive receivers
- Visual – proximity to dwellings and recreational areas/facilities
- Ecology – implication to site of conservation significance
- Land Use – potential confliction with area designated in the Outline Zoning Plan (OZP)
- Cultural & Historic Site – proximity to cemeteries, monastery ground and archaeological sites

Each of the long listed sites identified in Section 4.3 has been evaluated with respect to the intermediate screening criteria described above and the outcome is summarized below:

Long-listed Sites	**Conflicts of Long-listed Sites against Intermediate Screening Criteria**	
	Engineering	***Environmental & Planning***
Site 1 – Lamma Extension	Very low wind potential (~ 60W/m^2). ***Excluded on this ground.***	Encroach onto Lamma Extension site and limit future development of the power plant.
Site 2 – Tai Ling	No conflict identified.	Ground level 90mPD, maximum tip height of wind turbine limited to about 75m.
Site 3 – Yung Shue Long	Limited flat area and high back-slope, extensive excavation and slope reinforcement required. ***Excluded on this ground.***	Ground level 88mPD, maximum tip height of wind turbine limited to about 77m.
Site 4 – Tai Peng	A slope of about 3m between site and cable route.	No conflict identified.
Site 5 – Pak Kok Tsui	Unfavourable wind potential (< 100W/m^2).	Located on the landing point of 275kV cable linking up Lamma Power Station to HK Island. ***Excluded on this ground.***
Site 6 – Lamma Quarry	Very low wind potential (~ 60W/m^2). ***Excluded on this ground.***	Limit future restoration of Lamma Quarry. A visual intrusion to Sok Kwu Wan. ***Excluded on these grounds.***

5.2 Short-listed Sites

Of the 6 potential sites for wind turbine within the areas of least constraints established, four sites have been excluded due to principal engineering, environmental and planning conflicts summarized above, leaving the following two sties to be included in the comparative assessment (Figure 11) :-

(a) Site 2 – Tai Ling
(b) Site 4 – Tai Peng

Photos of Site 2 and Site 4 are attached in the Appendix 1.

6. Comparison of Short-listed Sites

The section provides an overall comparison and rankings of short-listed sites across all technical and environmental areas. At the end of this section, comparisons of each specialist area are then combined to provide the overall rankings of the short-listed sites. From the comparison assessment, the more preferred site is identified.

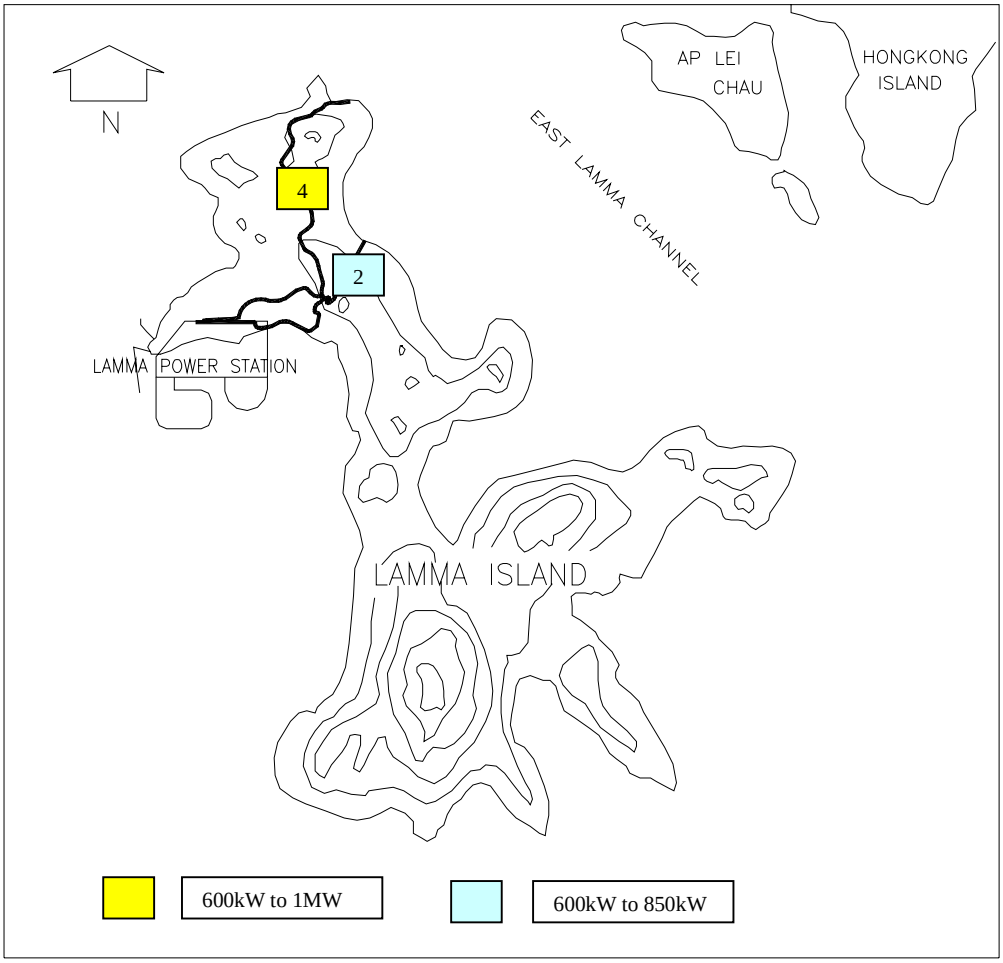

Fig. 11 – Short-listed Sites for the Proposed Wind Turbine

6.1 Wind Potential

Wind resource map (Fig. 2) reveals that both Site 2 – Tai Ling and Site 4 – Tai Peng have specific wind energy of about 150W/m^2. This wind potential is equivalent to an average wind speed of about 5.5m/s and suitable for utilization. Both sites have a clear exposure to the prevailing wind direction of easterly without topographic and man-made obstructions.

With a wind potential of 150W/m^2, the 600kW and 1MW wind turbines are able to generate about 700MWh and 1,150MWh electricity per annum respectively. These amount of electricity produced correspond to a utilization factor of 13%. Site 2 and Site 4 are considered to have same ranking in wind potential assessment.

Site / Rankings	Site 2 – Tai Ling	Site 4 – Tai Peng
Assessment for Wind Potential	1	1

6.2 Height Restriction

The ground level elevations of Site 2 – Tai Ling and Site 4 – Tai Peng are 90m and 72m PD respectively. The height allowance for wind turbine at Site 2 will be 75m which is suitable for a machine in the range of 600kW to 850kW depending on manufacturer's specification. Site 4, being lower in ground level, has a height clearance of 93m and is able to accommodate wind turbine up to 1MW. Site 4 is considered to have less restriction on height limitations and selection of wind turbine capacity.

Site / Rankings	Site 2 – Tai Ling	Site 4 – Tai Peng
Assessment for Height Restriction	2	1

6.3 Electrical Connection

The wind turbine will be connected to the existing power grid supplying electricity to Lamma residents. Lamma Island has an extensive network of 11kV cables allowing for integration of wind turbine to the grid. Both Site 2 and Site 4 are within a distance of 50m to the Cable Route where the 11kV transmission cables are laid. Site 2 and Site 4 are therefore considered to have identical ranking in electrical connection.

Site / Rankings	Site 2 – Tai Ling	Site 4 – Tai Peng
Assessment for Electrical Connection	1	1

6.4 Site Access

Site 2 – Tai Ling is located closed a Joint Bay on the Cable Route and can be accessed directly by mobile equipment required for construction and O&M of

wind turbine. Site 4 – Tai Peng is on a piece of elevated platform close to a Joint Bay. It is not directly accessible by vehicles and special provisions are necessary for equipment delivery. The construction materials and equipment are able to be lifted up to the site from the Joint Bay by a heavy-duty crane. The slope between cable route and proposed site will however require reinforcement. The slope has a size of 3m x 20m and the mitigations associated with the provisions are uncertain at this stage. Site 2 is considered to have a better ranking in assessment for site access.

Sites away from the existing Cable Route are not considered suitable due to technical and environmental constraints. As the new access road meeting the criteria of wind turbine construction and operation stated in above item 3.2 will require extensive excavation and slope reinforcement works, it is considered technically and environmental unattractive for a demonstration project for utilizing the renewable wind energy.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Assessment for Site Access	1	2 (-)

(-) denotes special provisions are required and a degree of uncertainty is associated with the provisions.

6.5 Land Use

Land use along the Lamma cable route is of mainly agricultural / farmland and green belt area. Both Site 2 - Tai Ling and Site 4 – Tai Peng are on the government land with abandoned farmland and village houses nearby. Consideration is given to the landowners involved in the development and their current and future options for land-use with reference to the latest Lamma Island Outline Zoning Plan. Both sites and their adjoining allotments are all found falling within the green belt areas zoned “Green Belt”. An application for change of land-use under Town Planning Ordinance will be required. Site 2 and Site 4 are considered to have same ranking in land use.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Assessment for Land Use	1	1

6.6 Ground Conditions

Site 2 – Tai Ling and Site 4 – Tai Peng have a similar site platform made of bare rocks and thin soil. Depending on the result of site investigation and availability of adequate rock beneath soil, it is expected that both sites are suitable for piling or footing type foundation. Site 4 however has the disadvantage of requiring reinforcement of a 3m height slope between the site and adjacent cable route. The extent of work is uncertain without a detailed site investigation for soil conditions. Site 4 is therefore considered inferior than Site 2 in term of ground conditions.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Assessment for Ground Conditions	1	2 (--)

(--) denotes site conditions unacceptable without mitigation and even with mitigation the impacts are likely to be of a major concern

6.7 Ecology

The proposed sites are typical low-shrub habitats with thin plant coverage. Vegetation at both sites is dominated by grasses, climbers and low trees. The species of natural habitat found at Site 2 and Site 4 are unknown but can be easily avoided if protected or rare species are identified. The construction period will be short and the site works will mainly involve building up of tower foundation and assembly of pre-fabricated components. Construction method will be carefully designed to minimize the potential impact to ground vegetation.

Documented evidences show that the impacts during operational phase will be confined to birds and bats. Overseas experiences of wild birds collision with wind turbines are site and species specific and associated with a dense array of wind turbines in wind farm. It is expected that wind turbine siting at both Site 2 – Tai Ling and Site 4 – Tai Peng with one single wind turbine will have insignificant impact to birds. Site 2 and Site 4 are considered to have similar ranking in ecological assessment.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Assessment for Ecology	1	1

6.8 Noise

Site 2 – Tai Ling and Site 4 – Tai Peng are approximately 270m and 100m away from the noise sensitive receivers (NSR) at Tai Ling Village and Tai Peng Village respectively. Most farmland and houses have been abandoned in Tai Ling Village and only few permanent households are found having human activities. Tai Peng Village, on the contrary, has over 50 village houses and is one of the major residential spot at North Lamma.

Limited powered mechanical equipment will be used during a short construction period. During operational phase, wind turbine produces low level noise when turbine blades pass through the air. Typically a 600kW wind turbine produces sound pressure level around 40dBA at a 300m distance from the machine.

Site 2 has the advantages of longer distance from NSR. The direct sight from Tai Ling Village to Site 2 is largely blocked by topography and landscape. Wind turbine at Site 2 is comparatively less prone to noise impact. Site 2 is therefore considered to have higher ranking than Site 4 on noise impact assessment.

Relocation of wind turbine at either Site 2 or 4 to increase setback between the machine and the NSR is an alternative way to reduce potential noise impact. As explained in above item 6.4, the access road will introduce additional environmental impacts and be not cost effective for a demonstration project.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Assessment for Noise Impact	1	2

6.9 Visual

The visually significant elements of the proposed wind turbine are a tower up to 60m and rotor swept area of about 2,550m^2. Key visual receiver groups within the zone of visual influence that are sensitive to the proposed development as identified as:-

(a) residential receivers sensitive on daily outlook and

(b) recreational users sensitive to visual intrusion of natural landscape.

The proposed wind turbine will have tip height up to about 160mPD and is unavoidably conspicuous and visible from part of the hiking paths and residential areas at Lamma and South District.

The visual intrusion on landscape from wind turbines is highly subjective. Many people see them as a welcome symbol of clean energy whereas as some find them unpleasant additions to the landscape. Objective prediction of appearance will be carried out during detailed design for a careful integration of development into the surrounding landscape.

As Site 4 would have a direct exposure to residential receivers at Tai Peng, it is therefore considered to have a lower ranking in visual impact assessment.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Assessment for Visual Impact	1	2

6.10 Overall Rankings

In the sub-sections presented above, the short-listed sites have been assessed and comparatively evaluated according to the potential impacts likely to arise as a consequence of construction and operation of a new wind turbine installation. Bring together the results of technical and environmental evaluation, the preferred site is identified. The categorization and ranking of the sites utilize the system described above are summarized as follows:

Site 2 – Tai Ling

The Tai Ling site is adjacent to a Joint Bay on the Cable Route. The site is directly accessible by vehicle and mobile equipment and has a reasonable laydown area for construction and O&M. The ground level is about 90mPD and can accommodate a 600-850kW wind turbine due to height restriction. The wind potential is about 150W/m^2 and annual energy production is estimated as 700MWh.

Site 2 has disadvantages of more stringent height restriction and in turn the selection for wind turbine capacity. Site 2 has however credited ranking in assessment for access, ground condition, noise and visual impact against Site 4.

Site 4 – Tai Peng

Site 4 – Tai Peng is on a piece of elevated site platform close to a Joint Bay and not directly accessible by vehicles. The construction materials and equipment would have to be lifted to the site from the Joint Bay by a heavy-duty crane. The ground level is about 72mPD and can accommodate a 1MW wind turbine. The wind potential is about 150W/m^2 and annual energy production is estimated as 1,1500MWh.

Site 4 has disadvantages of difficult access, uncertain ground conditions and shorter setback distance to the sensitive receivers of noise and visual impact. The ranking of assessment for electrical connection, land use and ecology for both sites are identical.

Site / Rankings	**Site 2 – Tai Ling**	**Site 4 – Tai Peng**
Wind Potential	1	1
Height Restriction	2	1
Electrical Connection	1	1
Site Access	1	2 (-)
Land Use	1	1
Ground Conditions	1	2 (--)
Ecology	1	1
Noise	1	2
Visual	1	2
Overall Ranking	**1**	**2**

Preferred Site

As a result of the above, Tai Ling is thus the preferred site overall. The proposed site layout is illustrated in Figure 12. The typical plant layout of a 600kW class wind turbine is shown in Figure 13.

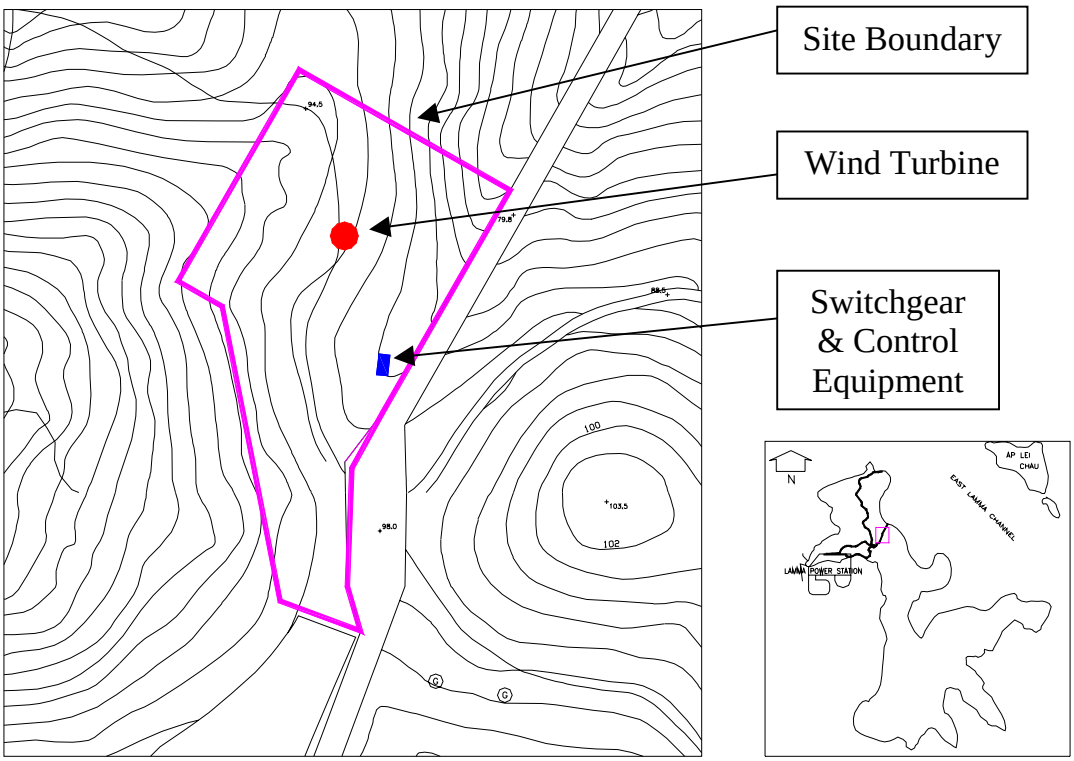

Fig. 12 - Proposed Site Layout at Tai Ling

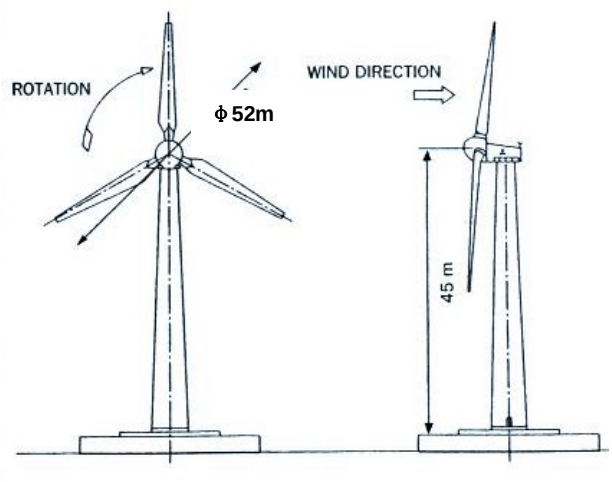

Fig. 13 – Typical Layout of a 600kW Class Wind Turbine

7. Program

Making reference to the similar project, a 9-month program for land application is required. The project will fall within the category of designated project under the EIAO due to power generation by a public utility and the environmental concerns identified in previous studies (e.g. visual and ecological impacts). Assuming the statutory EIA process and system design to proceed in parallel with the land application, the program of equipment manufacturing, delivery and site erection will require another 12 months. Adding up, the total lead-time for the wind turbine project will be about 18 months.

APPENDIX 1 – PHOTOS OF SITE 2 AND SITE 4

Site 2 – Tai Ling

Site 4 – Tai Peng

Annex B

Noise Assessment Information

Annex B1

Background Noise Measurement Report

B1 BACKGROUND NOISE MEASUREMENT REPORT

B1.1 INTRODUCTION

With reference to Clause 3.4.1.2(ii) of the EIA Study Brief for the above project, existing noise levels are required for determining the planning standards. In this regard, HEC has conducted a noise measurement in end May 2004. The details and results of the noise measurement are given below.

B1.2 MEASUREMENT DETAILS

B1.2.1 Measurement Period

Measurement was conducted continuously for 2 days from 25/05/2004 noon to 27/05/2004 noon.

B1.2.2 Measurement Location

Measurement was taken at a free field position 1.2 m above ground in the vicinity of No.1 Tai Ling Tsuen, i.e. the NSR nearest to the above project (see *Figure B1*).

B1.2.3 Instrumentation and Calibration

The measurement instrument used is "B&K 2238F sound level meter" which complies with IEC 60651 & 60804 Type 1 standard. Immediately prior to and after the noise measurement, the sound level meter was checked with "Rion NC-74 sound calibrator" which complies with IEC 60942 Class 1 standard. The calibration levels before and after the noise measurement agree to within 1.0dB.

B1.2.4 Noise Parameter

The noise measurement was made in terms of 96 consecutive 30-min L_{Aeq} values. Typical statistical data (L_{A10} and L_{A90}) for each 30-min interval were also obtained for reference.

B1.2.5 Weather Condition

The weather was generally fine and calm throughout the measurement period. The local wind speed near the microphone position was continuously monitored with an ultrasonic wind sensor and was found to be lower than 1 ms^{-1} most of the time although it was occasionally measured up to 4 ms^{-1}.

B1.3 MEASUREMENT REULTS

The measurement results are summarized in *Table B1.1* and details are given in *Table B1.2*.

Table B 1.1 Overall Measured Prevailing Noise Level

Period	$L_{Aeq, 30min}$		
	Minimum	Average	Maximum
0700 – 2300 hours	46.8	62.8	78.9
2300 – 0700 hours	44.6	57.8	79.5

Table B1.2 Measurement Results

Date	Start time	End time	L_{Aeq}	L_{A10}	L_{A90}
25-May-04	12:00	12:30	57.1	60.5	45.8
25-May-04	12:30	13:00	64.0	67.5	51.7
25-May-04	13:00	13:30	64.6	67.9	46.1
25-May-04	13:30	14:00	64.4	68.3	48.5
25-May-04	14:00	14:30	64.4	68.3	50.0
25-May-04	14:30	15:00	64.2	68.3	52.1
25-May-04	15:00	15:30	65.3	69.9	51.5
25-May-04	15:30	16:00	65.8	67.0	50.2
25-May-04	16:00	16:30	65.2	70.7	48.4
25-May-04	16:30	17:00	56.4	58.6	47.4
25-May-04	17:00	17:30	51.4	52.6	44.7
25-May-04	17:30	18:00	53.2	53.6	42.2
25-May-04	18:00	18:30	56.5	56.8	40.9
25-May-04	18:30	19:00	57.6	64.3	41.0
25-May-04	19:00	19:30	54.3	55.4	41.6
25-May-04	19:30	20:00	48.4	52.0	42.8
25-May-04	20:00	20:30	48.5	51.4	46.2
25-May-04	20:30	21:00	49.6	50.6	46.0
25-May-04	21:00	21:30	47.2	48.6	45.8
25-May-04	21:30	22:00	47.7	49.6	46.1
25-May-04	22:00	22:30	46.8	48.0	44.9
25-May-04	22:30	23:00	49.0	52.9	44.6
25-May-04	23:00	23:30	49.7	54.3	44.6
25-May-04	23:30	24:00	48.1	53.1	43.5
26-May-04	00:00	00:30	51.0	55.4	44.1
26-May-04	00:30	01:00	51.7	57.2	43.2
26-May-04	01:00	01:30	49.8	56.2	42.6
26-May-04	01:30	02:00	44.6	46.3	41.9
26-May-04	02:00	02:30	45.1	45.8	43.1
26-May-04	02:30	03:00	55.0	56.9	44.3
26-May-04	03:00	03:30	56.3	57.8	45.9
26-May-04	03:30	04:00	56.8	57.8	56.1

Date	Start time	End time	L_{Aeq}	L_{A10}	L_{A90}
26-May-04	04:00	04:30	56.5	57.0	56.0
26-May-04	04:30	05:00	56.8	57.7	56.1
26-May-04	05:00	05:30	61.9	62.6	56.1
26-May-04	05:30	06:00	71.2	74.1	63.3
26-May-04	06:00	06:30	75.2	77.8	70.7
26-May-04	06:30	07:00	78.2	80.0	75.7
26-May-04	07:00	07:30	78.4	80.3	76.0
26-May-04	07:30	08:00	77.3	79.5	74.9
26-May-04	08:00	08:30	76.7	78.7	74.2
26-May-04	08:30	09:00	74.5	76.9	70.9
26-May-04	09:00	09:30	72.5	75.8	66.7
26-May-04	09:30	10:00	74.4	77.7	63.0
26-May-04	10:00	10:30	63.8	68.1	44.1
26-May-04	10:30	11:00	68.9	71.6	45.2
26-May-04	11:00	11:30	70.0	74.0	51.1
26-May-04	11:30	12:00	69.0	74.1	46.4
26-May-04	12:00	12:30	53.0	55.8	41.9
26-May-04	12:30	13:00	69.9	75.4	46.9
26-May-04	13:00	13:30	67.6	71.9	47.7
26-May-04	13:30	14:00	68.7	72.2	55.5
26-May-04	14:00	14:30	63.1	66.3	44.1
26-May-04	14:30	15:00	64.7	70.3	45.6
26-May-04	15:00	15:30	66.7	71.0	54.4
26-May-04	15:30	16:00	69.4	69.1	46.6
26-May-04	16:00	16:30	67.9	70.1	54.2
26-May-04	16:30	17:00	57.3	59.0	45.6
26-May-04	17:00	17:30	65.5	59.1	45.5
26-May-04	17:30	18:00	55.8	51.8	44.1
26-May-04	18:00	18:30	64.0	65.1	43.6
26-May-04	18:30	19:00	65.6	67.4	43.7
26-May-04	19:00	19:30	55.8	54.7	43.2
26-May-04	19:30	20:00	53.8	55.5	47.0
26-May-04	20:00	20:30	52.5	54.9	48.1
26-May-04	20:30	21:00	52.4	55.4	48.2
26-May-04	21:00	21:30	52.8	55.6	48.2
26-May-04	21:30	22:00	51.0	55.2	47.2
26-May-04	22:00	22:30	47.7	48.6	46.3
26-May-04	22:30	23:00	48.3	48.8	46.3
26-May-04	23:00	23:30	48.7	48.9	46.1
26-May-04	23:30	24:00	52.3	55.4	46.1
27-May-04	00:00	00:30	52.7	54.9	46.2
27-May-04	00:30	01:00	53.7	54.8	53.0
27-May-04	01:00	01:30	53.0	54.0	47.3

Date	Start time	End time	L_{Aeq}	L_{A10}	L_{A90}
27-May-04	01:30	02:00	53.2	54.4	49.0
27-May-04	02:00	02:30	53.8	54.8	53.0
27-May-04	02:30	03:00	53.4	54.8	46.6
27-May-04	03:00	03:30	54.4	55.7	52.0
27-May-04	03:30	04:00	55.3	56.8	51.4
27-May-04	04:00	04:30	55.3	55.9	54.4
27-May-04	04:30	05:00	54.3	55.8	47.8
27-May-04	05:00	05:30	70.0	75.6	47.5
27-May-04	05:30	06:00	75.4	77.5	72.1
27-May-04	06:00	06:30	77.4	79.8	74.1
27-May-04	06:30	07:00	79.5	81.5	77.1
27-May-04	07:00	07:30	78.9	80.7	76.5
27-May-04	07:30	08:00	78.2	80.1	75.5
27-May-04	08:00	08:30	78.3	80.6	74.9
27-May-04	08:30	09:00	76.6	79.6	71.0
27-May-04	09:00	09:30	76.1	80.3	64.6
27-May-04	09:30	10:00	71.3	73.7	59.7
27-May-04	10:00	10:30	67.1	70.9	49.4
27-May-04	10:30	11:00	73.3	77.5	59.0
27-May-04	11:00	11:30	70.4	75.3	51.7
27-May-04	11:30	12:00	66.2	70.0	54.7

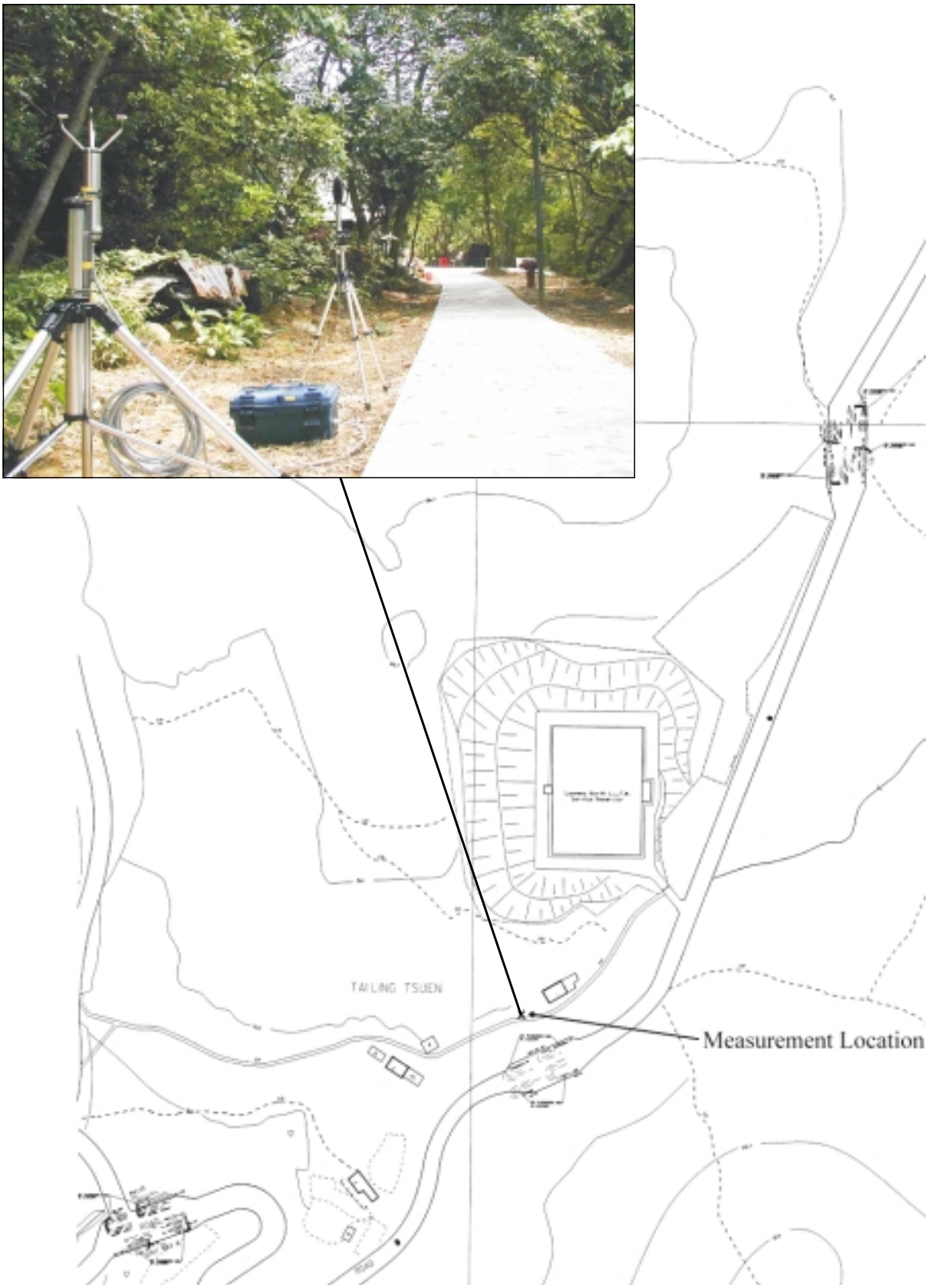

Figure B1

MEASUREMENT LOCATION

FILE: C2701f8
DATE: 19/07/04

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Annex B2

Construction Plant Inventory and Construction Noise Calculation

Construction Plant Inventory

Stage	Plant Team Ref.	Activities	Plant	CNP/BS5228 ref.	No. of PME	SWL
1	Civil Works	Site Formation	Crane Lorry	CNP 141	1	112
			Excavator	CNP 081	2	115
			Air Compressor <= 10m^3min^{-1}	CNP 001	2	103
			Breaker, hand-held >35kg	CNP 026	1	114
			Concrete Lorry Mixer	CNP 044	2	112
			Vibratory Poker	CNP 170	3	118
			Generator, standard	CNP 101	2	111
			Dump Truck	CNP 067	2	120
					Total SWL =	***124***
2	E&M Erection	Erection of Wind Turbine and Transformer Pillar	Heavy Duty Tracked Crane	CNP 048	1	112
			Mobile, Light Duty Crane	CNP 048	1	112
			Air Compressor <= 10m^3min^{-1}	CNP 001	1	100
			Generator, standard	CNP 101	1	108
			Lorry	CNP 141	1	112
					Total SWL =	***117***
3	Landscaping Works	Planting Trees and shrubs	Crane Lorry	CNP 141	1	112
					Total SWL =	***112***

Calculation of Construction Noise Impact at the NSRs

Stage 1

NSR	Location	Horizontal Distance	Vertical Distance	Slant Distance	Overall SWL	Correction Distance	Correction Barrier	Correction Façade	CNL
N1	1 Tai Ling Tsuen	260	18	261	124	-56	-10	3	61
N2	2 Tai Ling Tsuen	313	23	314	124	-58	-10	3	59
N3	3 Tai Ling Tsuen	357	29	358	124	-59	-10	3	58

Stage 2

NSR	Location	Horizontal Distance	Vertical Distance	Slant Distance	Overall SWL	Correction Distance	Correction Barrier	Correction Façade	CNL
N1	1 Tai Ling Tsuen	260	18	261	117	-56	-10	3	54
N2	2 Tai Ling Tsuen	313	23	314	117	-58	-10	3	52
N3	3 Tai Ling Tsuen	357	29	358	117	-59	-10	3	51

Stage 3

NSR	Location	Horizontal Distance	Vertical Distance	Slant Distance	Overall SWL	Correction Distance	Correction Barrier	Correction Façade	CNL
N1	1 Tai Ling Tsuen	260	18	261	112	-56	-10	3	49
N2	2 Tai Ling Tsuen	313	23	314	112	-58	-10	3	47
N3	3 Tai Ling Tsuen	357	29	358	112	-59	-10	3	46

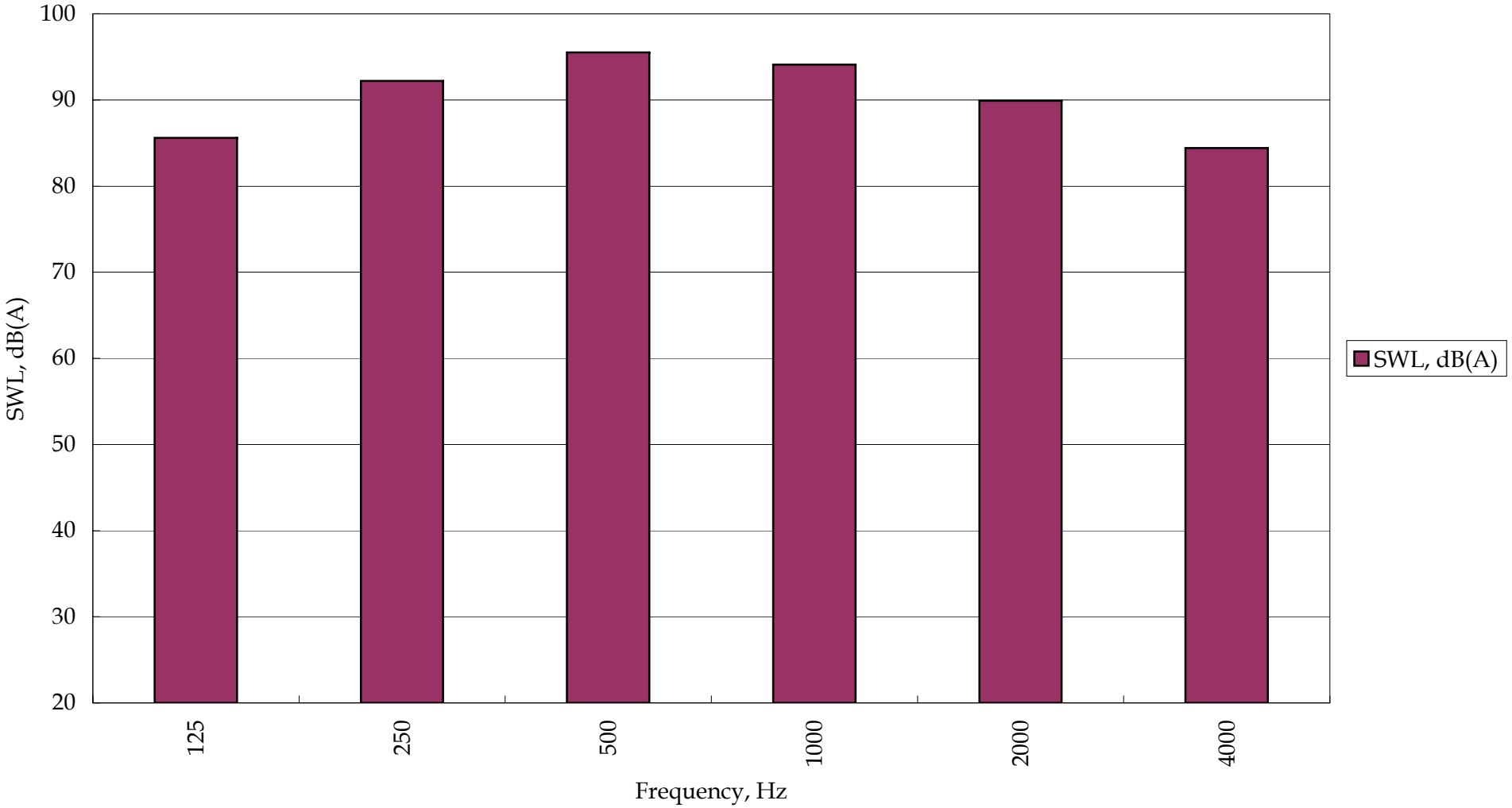
Identification Code	Description	SWL
CNP 001	Air compressor, air flow <= 10m^3/min	100
CNP 002	Air compressor, air flow > 10m^3/min and <=	102
CNP 003	Air compressor, air flow > 30m^3/min	104
CNP 004	Asphalt paver	109
CNP 021	Bar bender and cutter (electric)	90
CNP 022	Batching plant	108
CNP 023	Breaker, hand-held, mass <= 10kg	108
CNP 024	Breaker, hand-held, mass > 10kg and < 20kg	108
CNP 025	Breaker, hand-held, mass >= 20kg and <= 35kg	111
CNP 026	Breaker, hand-held, mass > 35kg	114
CNP 027	Breaker, excavator mounted (pneumatic)	122
CNP 028	Breaker, excavator mounted (hydraulic)	122
CNP 029	Ballast tamper, hand-held (electric)	105
CNP 030	Bulldozer	115
CNP 041	Conveyor belt	90
CNP 042	Concrete corer	117
CNP 043	Chipper, hand-held (pneumatic)	112
CNP 044	Concrete lorry mixer	109
CNP 045	Concrete mixer (electric)	96
CNP 046	Concrete mixer (petrol)	96
CNP 047	Concrete pump, stationary/lorry mounted	109
CNP 048	Crane, mobile/barge mounted (diesel)	112
CNP 049	Crane, tower (electric)	95
CNP 050	Compactor, vibratory	105
CNP 061	Derrick barge	104
CNP 062	Dredger, chain bucket	118
CNP 063	Dredger, grab	112
CNP 064	Drill, percussive, hand-held (electric)	103
CNP 065	Drill/grinder, hand-held (electric)	98
CNP 066	Dumper	106
CNP 067	Dump truck	117
CNP 081	Excavator/loader, wheeled/tracked	112
CNP 101	Generator, standard	108
CNP 102	Generator, silenced, 75 dB(A) at 7 m	100
CNP 103	Generator, super silenced, 70 dB(A) at 7 m	95
CNP 104	Grader	113
CNP 121	Hoist, passenger/material (pneumatic)	108
CNP 122	Hoist, passenger/material (electric)	95

CNP 123	Hoist, passenger/material (petrol)	104
CNP 141	Lorry	112
CNP 161	Paint line marker	90
CNP 162	Piling, diaphragm wall, bentonite filtering plant	105
CNP 163	Piling, diaphragm wall, hydraulic extractor	90
CNP 164	Piling, large diameter bored, grab and chisel	115
CNP 165	Piling, large diameter bored, oscillator	115
CNP 166	Piling, large diameter bored, reverse circulation	100
CNP 167	Piling, earth auger, auger	114
CNP 168	Power pack for hand-held items of PME	100
CNP 169	Power rammer (petrol)	108
CNP 170	Poker, vibratory, hand-held	113
CNP 171	Planer, wood, hand-held (electric)	117
CNP 181	Rock drill, crawler mounted (pneumatic)	128
CNP 182	Rock drill, crawler mounted (hydraulic)	123
CNP 183	Rock drill, hand-held (pneumatic)	116
CNP 184	Road planer or miller	111
CNP 185	Road roller	108
CNP 186	Roller, vibratory	108
CNP 201	Saw, circular, wood	108
CNP 202	Saw, chain, hand-held	114
CNP 203	Saw/groover, concrete (petrol)	115
CNP 204	Scraper	119
CNP 221	Tug boat	110
CNP 222	Tractor	118
CNP 241	Ventilation fan	108
CNP 261	Winch (pneumatic)	110
CNP 262	Winch (electric)	95
CNP 263	Winch (petrol)	102
CNP 281	Water pump (electric)	88
CNP 282	Water pump (petrol)	103
CNP 283	Water pump, submersible (electric)	85

Annex B3

Sound Power Level of Wind Turbine

Sound Power Levels of a Typical 600 - 850 kW Class Wind Turbine



Note: Reference has been made on the Type Approval report of a typical 600 - 850kW class wind turbine with adjustment to represent the worst case scenario of a maximum sound power level of 100dB(A)

Annex B4

Prediction of Operational Noise Impact

Calculation of Noise Level Due to Operation of Wind Turbine

NSR Location:	1 Tai Ling Tsuen	
Horizontal Distance=	260	m
Vertical Distance=	60	m
Slant Distance=	267	

Frequency, Hz	*125*	*250*	*500*	*1000*	*2000*	*4000*
SWL[1], dB(A)	85.6	92.2	95.5	94.1	89.9	84.4
Distance	267	267	267	267	267	267
Distance correction	-57	-57	-57	-57	-57	-57
Screening correction	0	0	0	0	0	0
Atmospheric Absorption[2]	-0.1	-0.3	-0.7	-1.3	-2.4	-6.1
Predicted Lp	29	35	38	36	31	22
A-Weighting, dB	0.0	0.0	0.0	0.0	0.0	0.0
Lp, dB(A)	29.0	35.4	38.2	36.2	31.0	21.8
A-Wt Sound Pr. Level =		42.2 dB(A)				

FACADE CORRECTION= 3 dB(A)

PREDICTED FACADE NOISE LEVEL AT NSR = 45 dB(A)

Note:

[1] Reference has been made on the Type Approval report of a typical 600 - 850kW class wind turbine with adjustment to represent the worst case scenario of a maximum sound power level of 100dB(A). The sound power levels of the *wind turbine are measured in accordance with* the Standard *"The Danish Ministry of Energy Order No. 304 of 14 May 1991* " and the guidelines from the Danish Environmental Agency's Laboratory. The report indicates that there are no audible tones in the noise.

[2] Basing on ISO 9613:Part 2 for Atmospheric Absorption at 20°C and Relative Humidity 70%, with reference made on the approved *EIA for Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, February 2000, ERM*

Calculation of Noise Level Due to Operation of Wind Turbine

NSR Location:	2 Tai Ling Tsuen	
Horizontal Distance=	313	m
Vertical Distance=	65	m
Slant Distance=	320	

Frequency, Hz	*125*	*250*	*500*	*1000*	*2000*	*4000*
SWL[1], dB(A)	85.6	92.2	95.5	94.1	89.9	84.4
Distance	320	320	320	320	320	320
Distance correction	-58	-58	-58	-58	-58	-58
Screening correction	-5	-5	-5	-5	-5	-5
Atmospheric Absorption[2]	-0.1	-0.4	-0.9	-1.6	-2.9	-7.3
Predicted Lp	22	29	32	29	24	14
Lp, dB(A)	22.4	28.8	31.5	29.4	23.9	14.0
A-Wt Sound Pr. Level =		35.4 dB(A)				

FACADE CORRECTION= 3 dB(A)

PREDICTED FACADE NOISE LEVEL AT NSR = 38 dB(A)

Note:

(1) Reference has been made on the Type Approval report of a typical 600 - 850kW class wind turbine with adjustment to represent the worst case scenario of a maximum sound power level of 100dB(A). The sound power levels of the *wind turbine are measured in accordance with* the Standard *"The Danish Ministry of Energy Order No. 304 of 14 May 1991* " and the guidelines from the Danish Environmental Agency's Laboratory. The report indicates that there are no audible tones in the noise.

(2) Basing on ISO 9613:Part 2 for Atmospheric Absorption at 20°C and Relative Humidity 70%, with reference made on the approved *EIA for Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, February 2000, ERM*

Calculation of Noise Level Due to Operation of Wind Turbine

NSR Location:	3 Tai Ling Tsuen	
Horizontal Distance=	357	m
Vertical Distance=	71	m
Slant Distance=	364	

Frequency, Hz	*125*	*250*	*500*	*1000*	*2000*	*4000*
SWL[1], dB(A)	85.6	92.2	95.5	94.1	89.9	84.4
Distance	364	364	364	364	364	364
Distance correction	-59	-59	-59	-59	-59	-59
Screening correction	-5	-5	-5	-5	-5	-5
Atmospheric Absorption[2]	-0.1	-0.4	-1.0	-1.8	-3.3	-8.3
Predicted Lp	21	28	30	28	22	12
Lp, dB(A)	21.3	27.6	30.3	28.1	22.4	11.8
A-Wt Sound Pr. Level =		34.1 dB(A)				

FACADE CORRECTION= 3 dB(A)

PREDICTED FACADE NOISE LEVEL AT NSR = 37 dB(A)

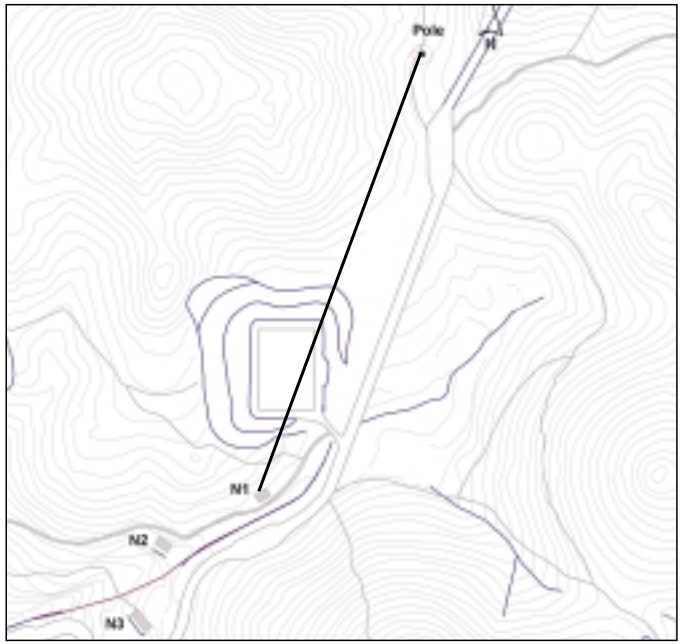
Note:

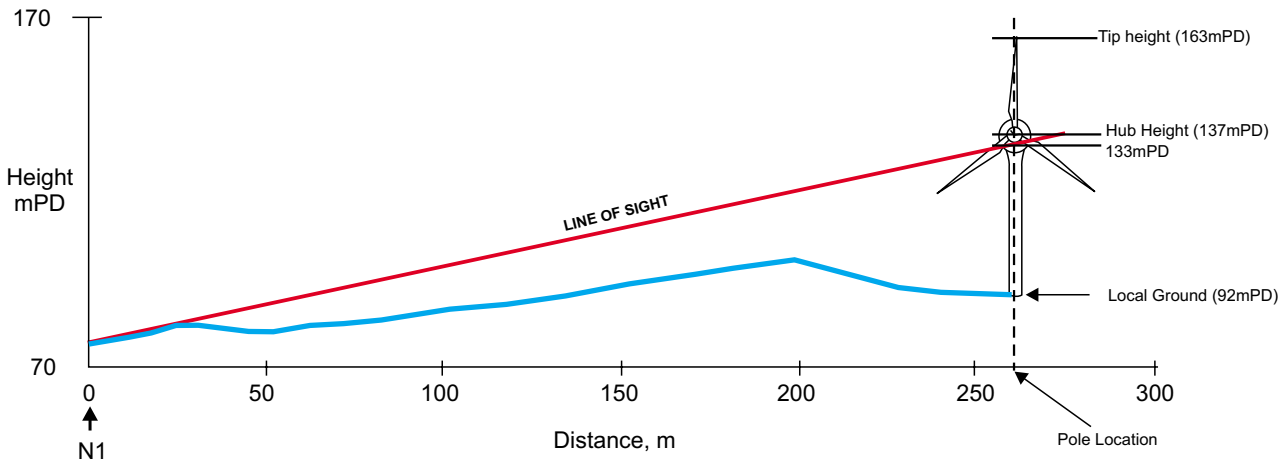
(1) Reference has been made on the Type Approval report of a typical 600 - 850kW class wind turbine with adjustment to represent the worst case scenario of a maximum sound power level of 100dB(A). The sound power levels of the *wind turbine are measured in accordance with* the Standard *"The Danish Ministry of Energy Order No. 304 of 14 May 1991* " and the guidelines from the Danish Environmental Agency's Laboratory. The report indicates that there are no audible tones in the noise.

(2) Basing on ISO 9613:Part 2 for Atmospheric Absorption at 20°C and Relative Humidity 70%, with reference made on the approved *EIA for Construction of an International Theme Park in Penny's Bay of North Lantau and its Essential Associated Infrastructures, February 2000, ERM*

Annex B5

Terrain Profile





Remark:
Shape of wind turbine is indicative only

Annex B5.1

Terrain Profile between N1 and Pole

FILE: C2701m
DATE: 04/08/04

Environmental Resources Management

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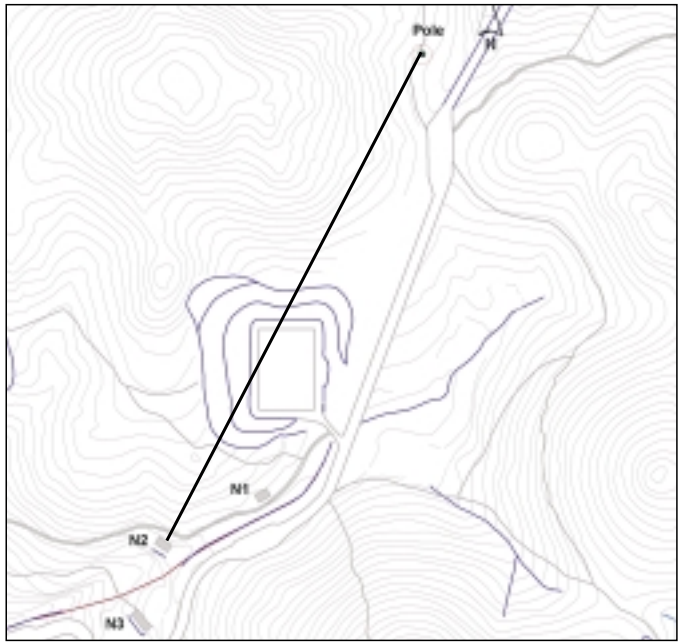
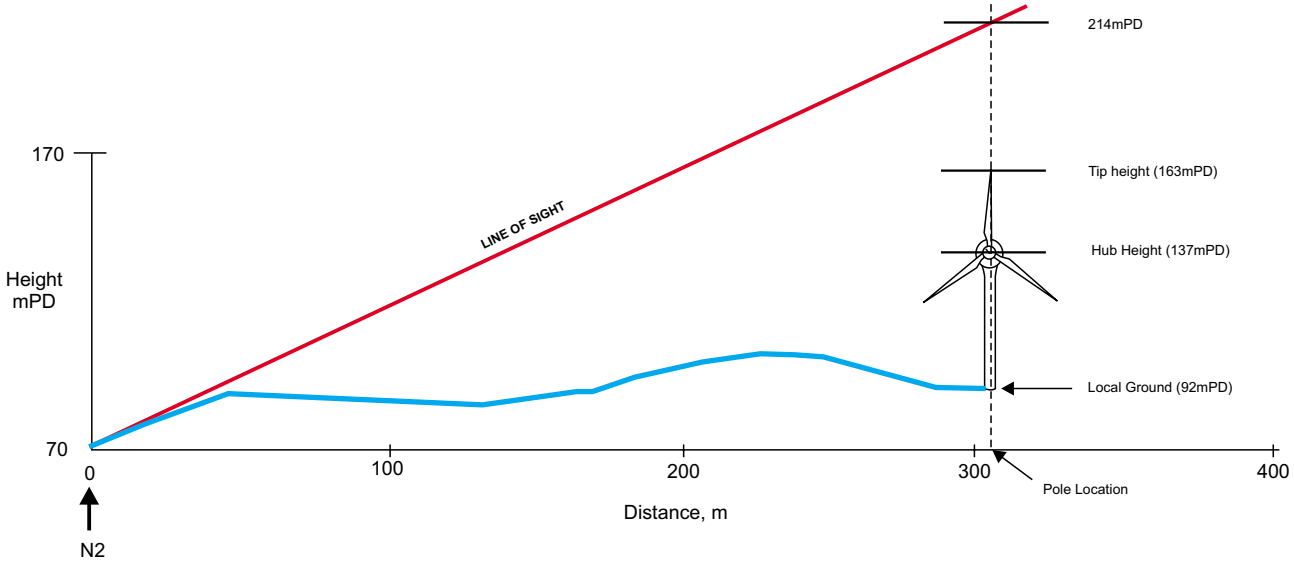




Remark:
Shape of wind turbine is indicative only

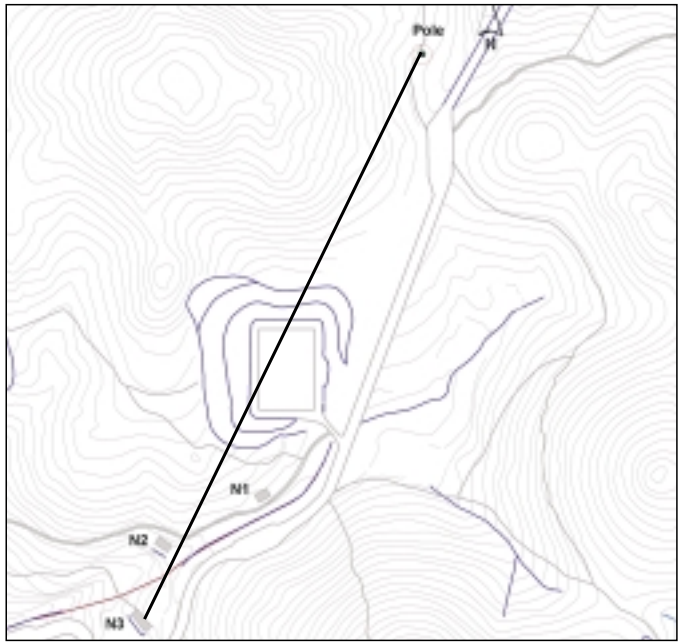
Annex B5.2

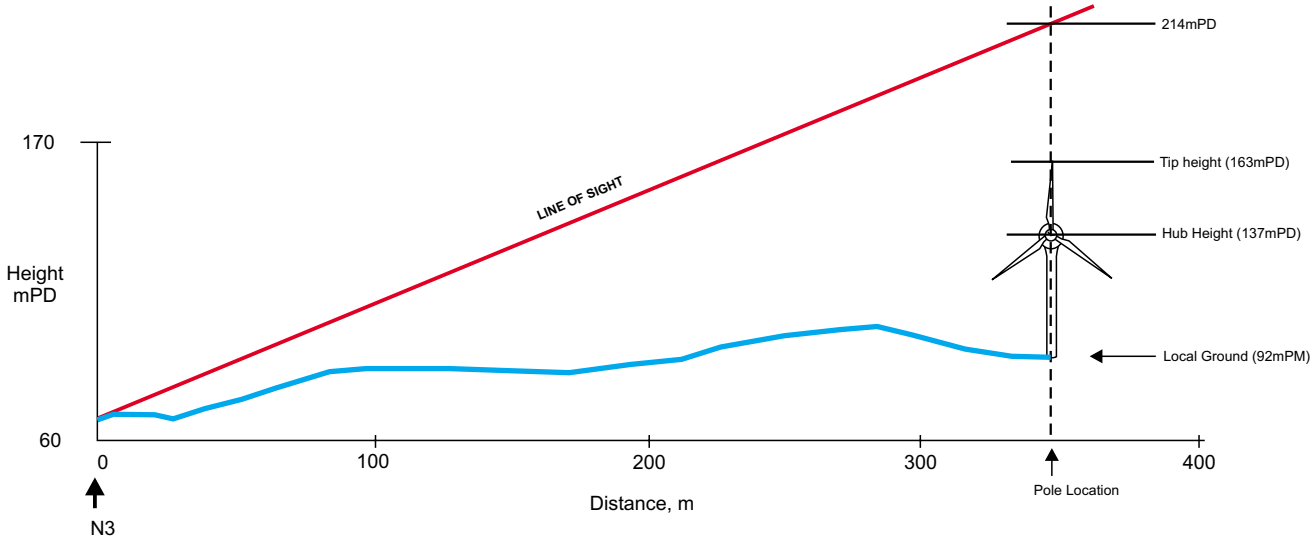
Terrain Profile between N2 and Pole

FILE: C2701m1
DATE: 04/08/04

Environmental
Resources
Management

ERM





Remark:
Shape of wind turbine is indicative only

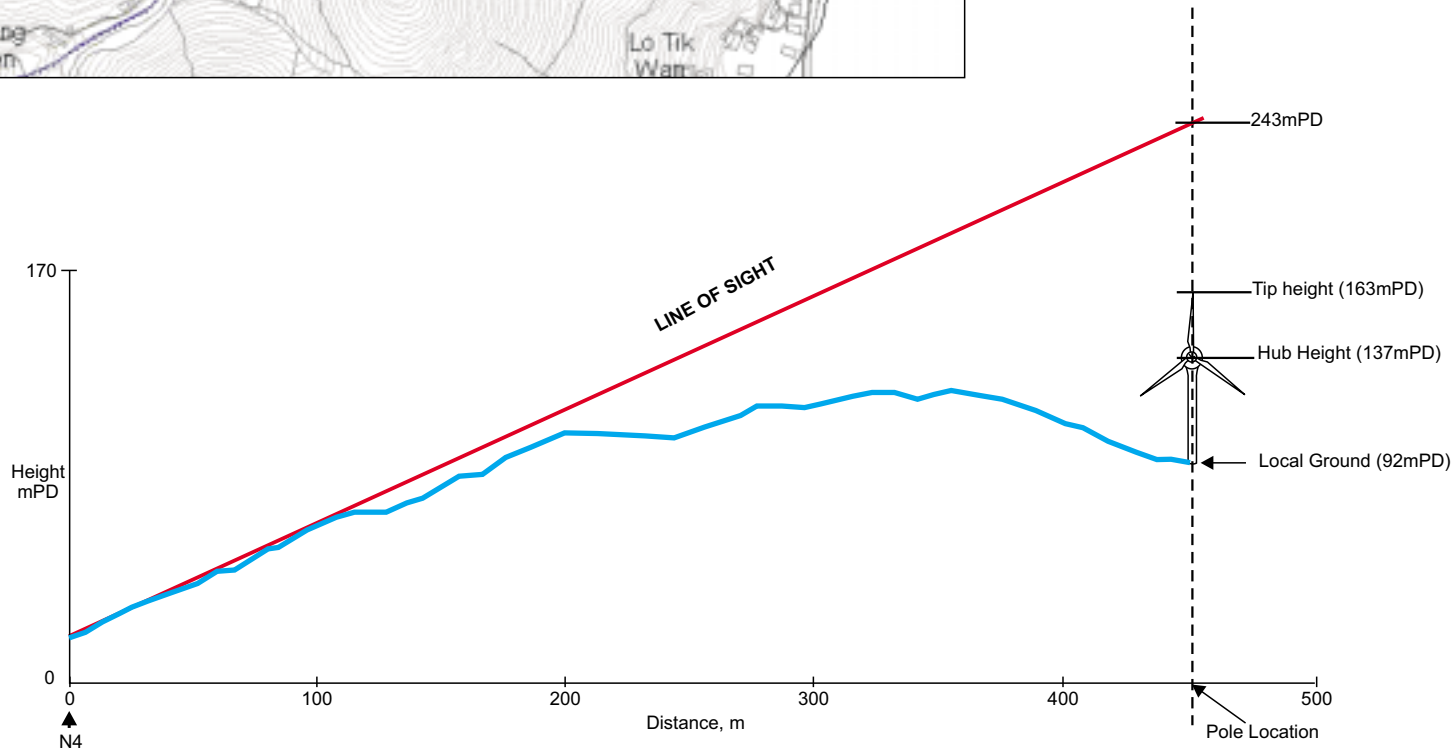
Annex B5.3

Terrain Profile between N3 and Pole

FILE: C2701m2
DATE: 04/08/04

Environmental
Resources
Management

ERM



Remark:
Shape of wind turbine is indicative only

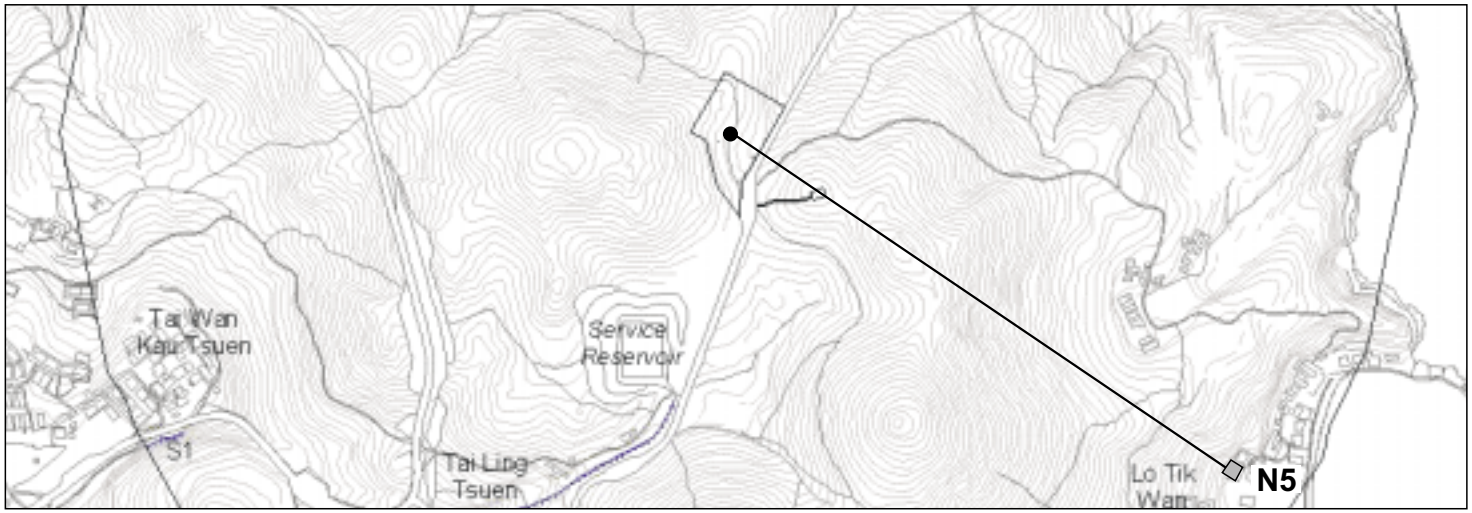
Annex B5.4

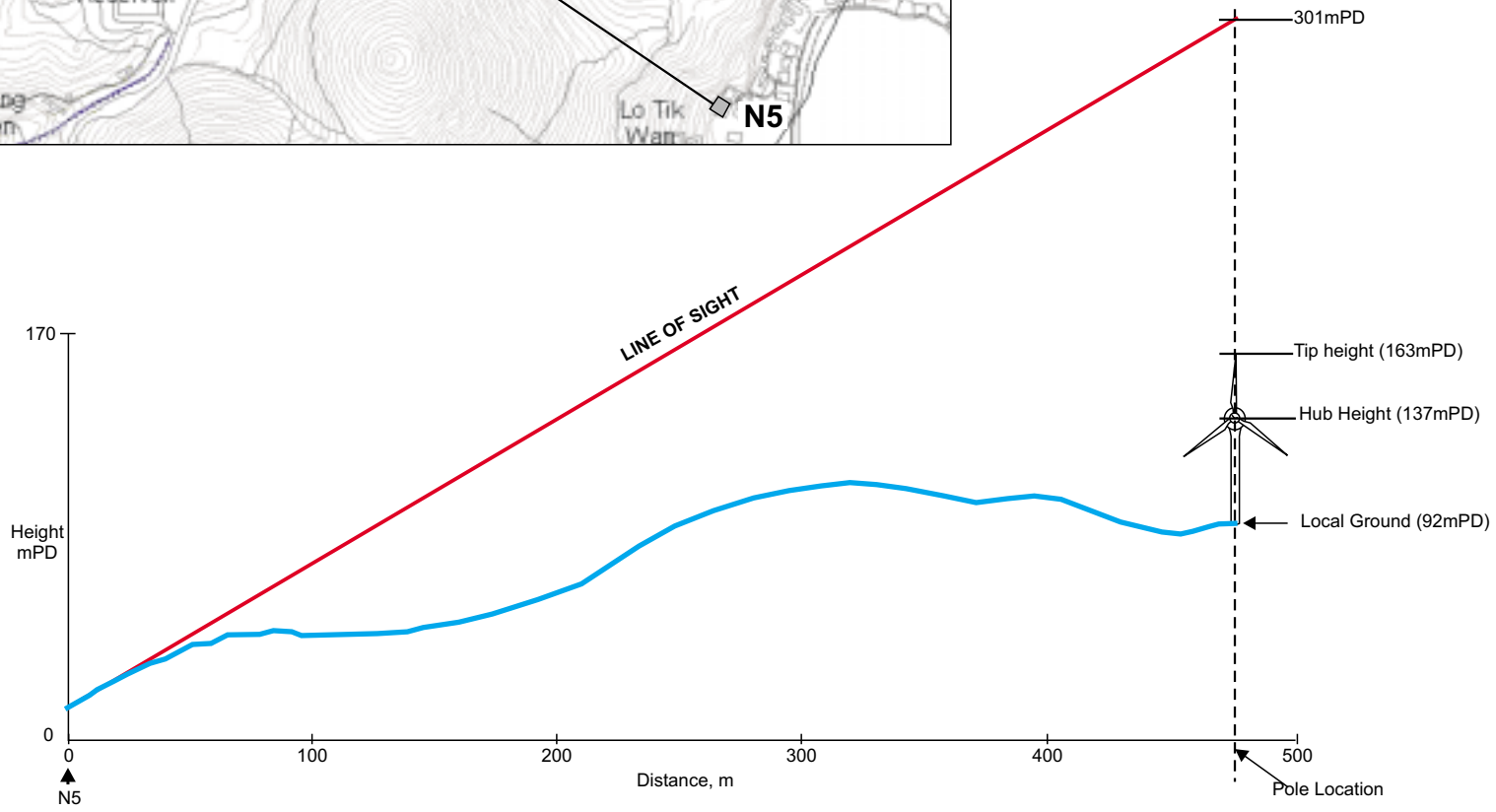
Terrain Profile between N4 and Pole

FILE: C2701o1
DATE: 04/08/04

Environmental
Resources
Management

ERM





Remark:
Shape of wind turbine is indicative only

Annex B5.5

Terrain Profile between N5 and Pole

FILE: C2701o
DATE: 04/08/04

Environmental
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Annex C

List of Floral and Faunal Species recorded within the Study Area

Annex C

Table 1 Representative Rare Plant Species (131 out of 151 Species) Recorded on Lamma Island (Extracted From Wong 1999)

Species	Family	Form	Rarity	Species	Family	Form	Rarity
Actinidia latifolia	Actinidiaceae	Liana	vr	*Glycosmis parvifolia*	Rutaceae	Shrub	vr
Alangium chinense	Alangiaceae	Tree	vr	*Meliosma rigida*	Sabiaceae	Tree	vr
Crinum asiaticum	Amaryllidaceae	Herb	vr	*Kadsura heteroclita*	Schisandraceae	Liana	vr
Ilex memecylifolia	Aquifoliaceae	Shrub	vr	*Picrasma quassioides*	Simaroubaceae	Tree	vr
Ilex viridis	Aquifoliaceae	Shrub	vr	*Turpinia montana*	Staphyleaceae	Tree	vr
Ilex kwangtungensis	Aquifoliaceae	Tree	vr	*Camellia hongkongensis*	Theaceae	Tree	vr
Ilex ficoidea	Aquifoliaceae	Tree	vr	*Ternstroemia luteoflora*	Theaceae	Tree	vr
Ilex rotunda	Aquifoliaceae	Tree	vr	*Tutcheria spectabilis*	Theaceae	Tree	vr
Arisaema penicillatum	Araceae	Herb	vr	*Tutcheria microcarpa*	Theaceae	Tree	vr
Arisaema erubescens	Araceae	Herb	vr	*Grewia biloba*	Tiliaceae	Shrub	vr
Asparagus lucidus	Asparagaceae	Vine	vr	*Celtis biondii*	Ulmaceae	Tree	vr
Balanophora harlandii	Balanophoraceae	Para	vr	*Acanthus ilicifolius*	Acanlhaceae	Shrub	r
Ehretia longiflora	Boraginaceae	Tree	vr	*Artabotrys hongkongensis*	Annonaceae	Liana	r
Cordia dichotoma	Boraginaceae	Tree	vr	*Tectaria subtriphylla*	Aspidiaceae	Herb	r
Buxus harlandii	Buxaceae	Shrub	vr	*Impatiens chinensis*	Balsaminaceae	Herb	r
Buxus sinica	Buxaceae	Shrub	vr	*Viburnum odoratissimum*	Caprifoliaceae	Tree	r
Caesalpinia bonduc	Caesalpiniaceae	Liana	vr	*Microtropis latifolia*	Celastraceae	Shrub	r
Capparis acutifolia	Capparaceae	Liana	vr	*Euonymus laxiflorus*	Celastraceae	Shrub	r
Lonicera macrantha	Caprifoliaceae	Liana	vr	*Sarcandra glabra*	Chloranthaceae	Shrub	r
Loeseneriella concinna	Celastraceae	Liana	vr	*Aster panduratus*	Compositae	Herb	r
Euonymus hederaceus	Celastraceae	Liana	vr	*Tridax procumbens*	Compositae	Herb	r
Euonymus longifolius	Celastraceae	Shrub	vr	*Gahnia tristis*	Cyperaceae	Herb	r
Gerbera piloselloides	Compositae	Herb	vr	*Diospyros eriantha*	Ebenaceae	Tree	r
Vernonia saligna	Compositae	Herb	vr	*Alchornea trewioides*	Euphorbiaceae	Shrub	r
Vernonia solanifolia	Compositae	Liana	vr	*Antidesma japonicum*	Euphorbiaceae	Tree	r
Aspidistra minutiflora	Convallariaceae	Herb	vr	*Mallotus apelta*	Euphorbiaceae	Tree	r
Merremia quinata	Convolvulaceae	Vine	vr	*Bridelia insulana*	Euphorbiaceae	Tree	r
Itea chinensis	Escalloniaceae	Tree	vr	*Bischofia javanica*	Euphorbiaceae	Tree	r

Species	Family	Form	Rarity	Species	Family	Form	Rarity
Euphorbia tirucalli	Euphorbiaceae	Shrub	vr	*Pseudopogonatherum contortum*	Gramineae	Herb	r
Antidesma paniculatum	Euphorbiaceae	Tree	vr	*Stauntonia obovata*	Lardizabalaceae	Liana	r
Mallotus hookerianus	Euphorbiaceae	Tree	vr	*Stauntonia chinensis*	Lardizabalaceae	Liana	r
Drypetes formosana	Euphorbiaceae	Tree	vr	*Litsea monopetala*	Lauraceae	Tree	r
Cyclobalanopsis myrsinifolia	Fagaceae	Tree	vr	*Lindera communis*	Lauraceae	Tree	r
Casearia glomerata	Flacourtiaceae	Tree	vr	*Neolitsea pulchella*	Lauraceae	Tree	r
Calophyllum membranaceum	Guttiferae	Shrub	vr	*Bowringia callicarpa*	Leguminosae	Liana	r
Altingia chinensis	Hamamelidaceae	Tree	vr	*Indigofera hirsuta*	Leguminosae	Shrub	r
Engelhardtia roxburgiana	Juglandaceae	Tree	vr	*Ormosia emarginata*	Leguminosae	Tree	r
Persea chinensis	Lauraceae	Tree	vr	*Lycopodium cernuum*	Lycopodiaceae	Herb	r
Litsea verticillata	Lauraceae	Tree	vr	*Tinospora sinensis*	Menispermaceae	Liana	r
Beilschmiedia fordii	Lauraceae	Tree	vr	*Maclura cochinchinensis*	Moraceae	Shrub	r
Cinnamomum parthenoxylon	Lauraceae	Tree	vr	*Ficus virens*	Moraceae	Tree	r
Albizia corniculata	Leguminosae	Liana	vr	*Embelia vestita*	Myrsinaceae	Liana	r
Abrus precatorius	Leguminosae	Liana	vr	*Maesa perlarius*	Myrsinaceae	Shrub	r
Millettia pulchra	Leguminosae	Shrub	vr	*Myrsine seguinii*	Myrsinaceae	Tree	r
Ormosia semicastrata	Leguminosae	Tree	vr	*Ludwigia adscendens*	Onagraceae	Herb	r
Gleditsia fera	Leguminosae	Tree	vr	*Ludwigia octovalvis*	Onagraceae	Herb	r
Thespesia populnea	Malvaceae	Tree	vr	*Eulophia flava*	Orchidaceae	Herb	r
Ficus sarmentosa	Moraceae	Liana	vr	*Pentaphylax euryoides*	Pentaphylacacea	Tree	r
Ficus pyriformis	Moraceae	Shrub	vr	*Pittosporum tobira*	Pittosporaceae	Shrub	r
Maclura tricuspidata	Moraceae	Shrub	vr	*Podocarpus neriifolia*	Podocarpaceae	Tree	r
Ardisia lindleyana	Myrsinaceae	Shrub	vr	*Clematis uncinata*	Ranunculaceae	Liana	r
Baeckea frutescens	Myrtaceae	Shrub	vr	*Morinda villosa*	Rubiaceae	Liana	r
Acmena acuminatissima	Myrtaceae	Tree	vr	*Antirhoea chinensis*	Rubiaceae	Shrub	r
Pholidota chinensis	Orchidaceae	Herb	vr	*Adina pilulifera*	Rubiaceae	Tree	r
Cymbidium ensifolium	Orchidaceae	Herb	vr	*Toddalia asiatica*	Rutaceae	Liana	r
Carallia brachiata	Rhizophoraceae	Tree	vr	*Striga lutea*	Scrophulariacea	Para	r
Rosa laveigata	Rosaceae	Liana	vr	*Lepidagathis incurva*	Scrophulariaceae	Herb	r
Prunus phaeosticta	Rosaceae	Tree	vr	*Pterospermum heterophyllum*	Sterculiaceae	Tree	r
Eriobotrya fragrans	Rosaceae	Tree	vr	*Symplocos lucida*	Symplocaceae	Tree	r
Ophiorrhiza pumila	Rubiaceae	Herb	vr	*Camellia caudata*	Theaceae	Tree	r

Species	Family	Form	Rarity	Species	Family	Form	Rarity
Mussaenda erosa	Rubiaceae	Liana	vr	*Callicarpa kochiana*	Verbenaceae	Shrub	r
Ixora chinensis	Rubiaceae	Shrub	vr	*Clerodendrum fortunatum*	Verbenaceae	Shrub	r
Lasianthus trichophlebus	Rubiaceae	Shrub	vr	*Gmelina chinensis*	Verbenaceae	Tree	r
Tarenna brevicymigera	Rubiaceae	Shrub	vr	*Callicarpa nudiflora*	Verbenaceae	Tree	r
Randia canthioides	Rubiaceae	Tree	vr	*Vitis balanseana*	Vitaceae	Liana	r
Tarenna mollissima	Rubiaceae	Tree	vr				

Rarity : r = rare; vr = very rare.

Table 2 Bird Species Previously Recorded in Lamma (from literature review)

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
Fregatidae	Frigate Bird (*Fregata* sp.)	1	1975 (Nov)	unclassifed	Foraging: open water		HKBWS 1976	**Secondary Species** The species is a vagrant
	Lesser Frigate Bird (*Fregata ariel*)	1	1990 (Jun)	OV	Foraging: open water	Seen flying over Hung Shing Ye Wan	HKBWS 1991	**Secondary Species** The species is a vagrant
Ardeidae	Pacific Reef Egret (*Egretta sacra*)	1-13	1972, 1993, 1994, 1995, 1996, 1997, 1998	R	Foraging: Rocky coastline Breeding: Rocky coastline	The highest count was 13 at Sok Kwu Wan in 1994	HKBWS 1973, 1992, 1994, 1995, 1998, 1999, 2002	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes coastal areas and is unlikely to fly over the study area.
	Purple Heron (*Ardea purpurea*)	1	1975 (Oct)	AM, P	Foraging: wetland Breeding: reedbed	Seen flying over the West Lamma Channel	HKBWS 1976	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species uses reedbed and wetland and is unlikely to fly over the study area.
	Striated Heron (*Butorides striatus*)	1	2004 (Apr)	SV	Foraging: wetland, stream	Seen foraging in a stream near Sok Kwu Wan	So, unpublished data	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes wetland and stream and is unlikely to fly over the study area
	Little Egret (*Egretta garzetta*)	Up to 6	1996-2004	P	Foraging: wetland and coastal area Breeding: woodland edge	Seen next to piers of both Yung Shue Wan and Sok Kwu Wan	So, unpublished data	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes wetland and coastal area and is unlikely to fly over the study area.
	Black-crowned Night Heron (*Nycticorax nycticorax*)	Up to 3	1996-2004	P	Foraging: wetland and coastal area Breeding: woodland edge	Seen next to piers of both Yung Shue Wan and Sok Kwu Wan	So, unpublished data	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes coastal area and is unlikely to fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
	Chinese Pond Heron (*Ardeola bacchus*)	Not specified	Not specified	P	Foraging: wetland Breeding: woodland edge		Maunsell 2003	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes wetland and is unlikely to fly over the study area.
	Cattle Egret (*Bubulcus ibis*)	Not specified	Not specified	P	Foraging: grassland and marshy area Breeding: woodland edge		Maunsell 2003	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes wetland and is unlikely to fly over the study area.
	Grey Heron (*Ardea cinerea)*	Not specified	Not specified	WV	Foraging: wetland		Maunsell 2003	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes wetland and is unlikely to fly over the study area.
	Yellow Bittern (*Ixobrychus sinensis*)	1	1999	PM, SV	Recorded in stream habitat		Maunsell 2003	**Primary Species** *Ciconiiformes* herons & storks are considered to be sensitive. Despite this the species utilizes wetland and stream and is unlikely to fly over the study area.
Rallidae	White-breasted Waterhen (*Amaurornis phoenicurus*)	Up to 2	2004 (Apr)	R	Foraging: wetland Breeding: wetland	Seen in marshy area of Pak Kok and during this study	So, unpublished data	**Secondary Species** The species utilizes wetland and usually will not fly high, and is unlikely to fly over the study area.
	Water Cock (*Gallicrex cinerea*)	Not specified	Not specified	PM	Foraging: marshy area		Maunsell 2003	**Secondary Species** The species utilizes wetland and is unlikely to fly over the study area.
Accipitridae	Black Kite (*Milvus lineatus*)	Up to 20	1998-1999, 2001-2002	WV, R	Foraging: open area Breeding: woodland edge		Walk 2001-2002; Maunsell 2003	**Primary Species** The species is the most frequently encountered bird in the study and utilizes the study area as foraging site.
	Common Buzzard (*Buteo buteo*)	Not specified	1990	WV	Foraging: wetland, stream		HKBWS 1991	**Primary Species** The species utilizes open area and the study area is a possible foraging site.
	Bonelli's Eagle (*Hieraetus fasciatus*)	1	1972 (Sep)	R	Foraging: open area Breeding: Mountainous area		HKBWS 1973	**Primary Species** The species utilizes open area and the study area is a possible foraging site.
	White-bellied Sea Eagle (*Haliaeetus leucogaster*)	Up to 4	1975, 2001, 2002	R	Foraging: open water Breeding: coastline	Seen in the West Lamma Channel, and Ngai Tau	HKBWS 1976, Walk 2001-2002	**Primary Species** The ordinary flight line may cross the study area

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
	Crested Goshawk (*Accipiter trivirgatus*)	Not specified	Not specified	R	Foraging: woodland and woodland edge Breeding: woodland		Maunsell 2003	**Primary Species** The species utilizes open area and the study area is a possible foraging site.
	Chinese Goshawk (*Accipiter soloensis*)	Not specified	Not specified	SM	Foraging: woodland and woodland edge		Maunsell 2003	**Primary Species** The species utilizes open area and the study area is a possible foraging site.
Falconidae	Kestrel (*Falco tinnunculus*)	Up to 2	1990 (Jan)	AM, WV	Foraging: open area		HKBWS 1991	**Primary Species** The species utilizes open area and the study area is a possible foraging site.
Charadriidae	Pacific Golden Plover (*Pluvialis fulva*)	1	1996 (Apr)	M, WV	Foraging: mudflat and wetland	Seen in East Lamma Channel	HKBWS 1998	**Primary Species** Charadriiformes waders are considered to be particularly, or potentially, sensitive to wind farm. Despite the species utilizes wetlands and is unlikely to fly over the study area, this species is still classified as primary species.
Scolopacidae	Ruddy Turnstone (*Arenaria interpres*)	2	1996 (Apr)	M	Foraging: mudflat and wetland	Seen in East Lamma Channel	HKBWS 1998	**Secondary Species** The species utilizes wetlands and is unlikely to fly over the study area.
	Common Sandpiper (*Actitis hypoleucos*)	Not specified	Not specified	M, WV	Foraging: wetland and coastal area		Maunsell 2003	**Secondary Species** The species utilizes wetlands and is unlikely to fly over the study area.
	Little Stint (*Calidris minuta*)	Not specified	Not specified	M	Foraging: wetland and marshy area		Maunsell 2003	**Secondary Species** The species utilizes wetlands and is unlikely to fly over the study area.
	Red-necked Phalarope (*Phalaropus lobatus*)	Not specified	Not specified	M	Foraging: open water		Maunsell 2003	**Secondary Species** The species utilizes wetlands and is unlikely to fly over the study area.
	Eurasian Woodcock (*Scolopax rusticola*)	Not specified	Not specified	WV	Foraging: woodland, woodland edge and along stream		Maunsell 2003	**Secondary Species** The species is a ground-dweller and is unlikely to fly over the study area.
	Curlew Sandpiper (*Calidris ferruginea*)	Not specified	Not specified	SM	Foraging: wetland		Maunsell 2003	**Secondary Species** The species utilizes wetlands and is unlikely to fly over the study area.
Laridae	Black-tailed Gull (*Larus crassirostris*)	4	1975 (Dec)	WV, M	Foraging: open water	Seen in the West Lamma Channel	HKBWS 1976	**Secondary Species** The species utilizes open water and is unlikely to fly over the study area.
	Black-headed Gull (*Larus ridibundus*)	6500	1975 (Jan)	WV	Foraging: open water	Seen roosting along the West Lamma Channel	HKBWS 1976	**Secondary Species** The species utilizes open water and is unlikely to fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
	Whiskered Tern (*Chlidonias hybridus*)	Up to 20	1983 (Aug), 1996 (Apr)	M	Foraging: open water Breeding: rocky island	Seen in water south of Lamma	HKBWS 1985, HKBWS 1998	**Secondary Species** The species utilizes open water and is unlikely to fly over the study area.
	White-winged Tern (*Chlidonias leucopterus*)	50-80	1975 (Sep), 1981	M	Foraging: open water Breeding: rocky island	Seen in West Lamma Channel	HKBWS 1976, Carey *et al.* 2001	**Secondary Species** The species utilizes open water and is unlikely to fly over the study area.
	Black-napped Tern (*Sterna sumatrana*)	1	1993 (Aug)	SV	Foraging: open water Breeding: rocky island		HKBWS 1994	**Primary Species** *Sternidae* terns are considered to be sensitive. The species utilizes open water and is unlikely to fly over the study area.
	Common Tern (*Sterna hirundo*)	Up to 130	1972 (Aug), 1983 (Sep), 1996 (Apr)	M	Foraging: open water Breeding: rocky island	Seen in water south of Lamma and West Lamma Channel	HKBWS 1973, HKBWS 1985, HKBWS 1993, HKBWS 1995, HKBWS 1998 Carey *et al*. 2001	**Primary Species** *Sternidae* terns are considered to be sensitive. The species utilizes open water and is unlikely to fly over the study area.
	Roseate Tern (*Sterna dougallii*)	16	1978	SV	Foraging: open water Breeding: rocky island	Seen in East Lamma Channel	Carey *et al*. 2001	**Primary Species** *Sternidae* terns are considered to be sensitive. The species utilizes open water and is unlikely to fly over the study area.
	Aleutian Tern (*Sterna aleutica*)	1-9	1993 (Aug), 1996 (Apr)	AM	Foraging: open water Breeding: rocky island	Seen in East Lamma Channel	HKBWS 1994, HKBWS 1998	**Primary Species** *Sternidae* terns are considered to be sensitive. The species utilizes open water and is unlikely to fly over the study area.
	Gull-billed Tern (*Gelochelidon nilotica*)	Up to 7	1980 (Apr), 1992 (Sep)	M	Foraging: open water	Seen in West Lamma Channel	HKBWS 1982, HKBWS 1993	**Secondary Species** The species utilizes open water and is unlikely to fly over the study area.
	Long-tailed Jaeger (*Stercorarius longicaudus*)	2	1996 (Apr)	SM	Foraging: open water	Seen in West Lamma Channel	HKBWS 1998	**Secondary Species** The species utilizes open water and is unlikely to fly over the study area.
Columbidae	Emerald Dove (*Chalcophaps indica*)	Not specified	1990 (Nov), 2004	R	Foraging: woodland Breeding: woodland	This species is also recorded in this study	HKBWS 1991	**Primary Species** The species utilizes woodland and is recorded in the study area.
	Spotted Dove (*Streptopelia chinensis*)	8	1998-1999	R	Foraging: open area, woodland edge Breeding: woodland edge		Maunsell 2003	**Primary Species** The species utilizes habitats similar to those in the study area and may fly over them

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
	Rock Dove (*Columba livia*)	Not specified	Not specified	R	Foraging: open area near human settlement		Maunsell 2003	**Secondary Species** There is only limited human settlement around the study area
Cuculidae	Common Koel (*Eudynamys scolopacea*)	Not specified	1998 (Nov-Dec)	SV, R	Foraging: woodland Breeding: woodland		HKBWS 2002	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Chestnut-winged Cuckoo (*Clamator coromandus*)	1	2004	SV	Foraging: woodland Breeding: woodland	Observer per. obs.		**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Black-winged Cuckoo (*Coracina melaschistos*)	3	1998	WV	Foraging: woodland Breeding: woodland		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Indian Cuckoo (*Cuculus micropterus*)	Not specified	Not specified	SV	Foraging: woodland Breeding: woodland		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Greater Coucal (*Centropus sinensis*)	2	1998-1999	R	Foraging: woodland edge and shrubland Breeding: woodland and shrubland		Maunsell 2003	**Primary Sepcies** The species utilizes habitat types provided by the study area.
	Lesser Coucal (*Centropus bengalensis*)	Not specified	Not specified	R	Foraging: woodland edge and shrubland Breeding: woodland and shrubland		Maunsell 2003	**Primary Sepcies** The species utilizes habitat types provided by the study area.
Alcedinidae	Common Kingfisher (*Alcedo atthis*)	Not specified	1972	AM, P	Foraging: Rocky coastline, wetland Breeding: edge of pond or stream		HKBWS 1973	**Secondary Species** The study area does not contain suitable habitat for the species.
	White-throated Kingfisher (*Halcyon symrnensis*)	Up to 4	1998-1998	AM, P	Foraging: wetland and woodland edge Breeding: rocky area		Maunsell 2003	**Primary Species** The proposed site for the wind turbine is a possible foraging site and breeding site for the species.
	Pied Kingfisher (*Ceryle rudis*)	Not specified	Not specified	R	Foraging: wetland Breeding: edge of pond or stream		Maunsell 2003	**Secondary Species** The study area does not contain suitable habitat for the species.
	Hoopoe (*Upupa epops*)	Not specified	Not specified	OV	Favours lawns and open grassland	Upupidae are unique ground-feeding birds	Maunsell 2003	**Secondary Species** This species is ground-feeding bird with curious flapping flight.
Coracidae	Dollarbird (*Eurystomus orientalis*)	1	1991 (Oct)	M	Foraging: woodland and open area		HKBWS 1992	**Primary Species** The species utilizes open area and may fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
Apodidae	Pacific Swift (*Apus pacificus*)	Up to 11	1992 (Jul), 1995 (Jul) 1999 (Mar)	SM, SV	Foraging: in the air		HKBWS 1993, HKBWS 1996, Maunsell 2003	**Primary Species** The species is an aerial-forager and may fly over the study area.
	Little Swift (*Apus affinis*)	Not specified	Not specified	R, SM	Foraging: in the air Breeding: cliff and roof of building		Maunsell 2003	**Primary Species** The species is an aerial-forager and may fly over the study area.
Hirundinidae	Barn Swallow (*Hirundo rustica*)	Up to 7	1999	SV, SM	Foraging: in the air Breeding: building		Maunsell 2003	**Primary Species** The species is an aerial-forager and may fly over the study area.
Passeridae	Tree Sparrow (*Passer montanus*)	37	1998-1999	R	Recorded in shrubland/grassland	This species is familiar of urban areas	Maunsell 2003	**Secondary Species** Ths species is low-flying bird.
Motacillidae	Yellow Wagtail (*Motacilla flava*)	Not specified	Not specified	M, WV	Foraging: wetland		Maunsell 2003	**Secondary Species** The study area does not contain suitable habitat for the species.
	White Wagtail (*Motacilla alba*)	6	1998 (Sept & Dec)	WV	Foraging: wetland	This species is recorded in coastlines (including rocky shore and mudflat exposed in low tide)	Maunsell 2003	**Secondary Species** The study area does not contain suitable habitat for the species.
	Grey Wagtail (*Motacilla cinerea*)	1	1999 (Mar)	WV	Foraging: wetland	This species is recorded in coastlines (including rocky shore and mudflat exposed in low tide)	Maunsell 2003	**Secondary Species** The study area does not contain suitable habitat for the species.
Campephagidae	Black-winged Cuckoo-shrike (*Coracina melaschistos*)	1	1998 (Sep)	AM, WV	Foraging: woodland	Seen at Sok Kwu Wan	HKBWS 2002	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
Laniidae	Brown Shrike (*Lanius cristatus*)	1	1990 (Oct), 1991 (Oct)	SM	Foraging: woodland edge, open area		HKBWS 1991, HKBWS 1992	**Primary Species** The study area has suitable foraging area for the species and it may fly over the study area.
	Long-tailed Shrike (*Lanius schach*)	1	1998	R	Foraging: open area Breeding: shrubland		Maunsell 2003	**Primary Species** The study area has suitable foraging area for the species and it may fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
Pycnonotidae	Red-whiskered Bulbul (*Pycnonotus jocosus*)	Up to 25	2004	R	Foraging: wide range of habitats Breeding: wide range of habitats		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.
	Chinese Bulbul (*Pycnonotus sinensis*)	Up to 17	2004	R	Foraging: wide range of habitats Breeding: wide range of habitats		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.
	Sooty-headed Bulbul (*Pycnonotus aurigaster*)	Not specified	Not specified	R	Foraging: woodland edge and shrubland Breeding: shrubland		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.
Turdidae	Grey Bushchat (*Saxicola ferrea*)	Not specified	Not specified	AM, WV	Foraging: woodland and shrubland		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.
	Siberian Rubythroat (*Luscinia calliope*)	Not specified	Not specified	WV	Foraging: woodland edge and shrubland		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.
	Blue Rock Thrush (*Monticola solitarius*)	Up to 3	1975 (Sep), 1991 (Apr)	WV, M	Foraging: rocky area		HKBWS 1976, HKBWS 1992	**Primary Species** The study area has suitable foraging area for the species and it may fly over the study area.
	Scaly Thrush (*Zoothera dauma*)	Not specified	1990 (Jan)	WV	Foraging: woodland		HKBWS 1991	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Grey-backed Thrush (*Turdus hortulorum*)	12	1998 (Dec)	WV	Foraging: woodland	Seen at Pak Kok	HKBWS 2002	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Pale Thrush (*Turdus pallidus*)	5	1998 (Dec)	WV, M	Foraging: woodland	Seen at Pak Kok	HKBWS 2002	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Blue Whistling Thrush (*Myiophoneus caeruleus*)	Not specified	Not specified	R	Foraging: woodland and along stream Breeding: woodland and along stream		Maunsell 2003	**Secondary Species** The study area does not have suitable habitat for this species.
	Daurian Redstart (*Phoenicurus auroreus)*	Not specified	Not specified	WV	Foraging: woodland, woodland edge and shrubland		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
	Oriental Magpie Robin (*Copsychus saularis)*	Up to 6	1998-1999	R	Foraging: woodland and woodland edge Breeding: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species utilizes woodland and woodland edge and is unlikely to fly over the study area.
Muscicapidae	Verditer Flycatcher (*Eumyias thalassina*)	1	1990 (Nov)	WV	Foraging: woodland	Male	HKBWS 1991	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Grey-streaked Flycatcher (*Muscicapa griseisticta*)	Not specified	Not specified	PM	Foraging: woodland		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Red-throated Flycatcher (*Ficedula albicilla*)	1	1974 (Feb), 1991	AM, WV	Foraging: Woodland		HKBWS 1975, HKBWS 1992	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Black-naped Monarch (*Hypothymis azurea*)	1	1995	WV, M	Foraging: woodland		HKBWS 1996	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
Paridae	Great Tit (*Parus major*)	1	1998 (Dec)	R	Foraging: woodland and woodland edge Breeding: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
Timaliidae	White-browed Laughing Thrush (*Garrulax sannio*)	Not specified	1990 (Sep)	R	Foraging: woodland and shrubland Breeding: woodland and woodland edge		HKBWS 1991	**Secondary Species** The species forages at the undergrowth and it unlikely to fly over the area.
	Masked Laughing Thrush (*Garrulax perspillatus*)	Not specified	Not specified	R	Foraging: woodland and shrubland Breeding: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species moves around in the undergrowth and is unlikely to fly over the study area.
	Hwamei (*Garrulax canorus*)	1	1999	R	Foraging: shrubland and woodland edge Breeding: shrubland and woodland edge		Maunsell 2003	**Secondary Species** The species moves around in the undergrowth and is unlikely to fly over the study area.
Sylviidae	Lanceolated Warbler (*Locustella lanceolata*)	1	1990 (Nov)	AM	Foraging: wetland	Found dead at Yung Shue Long Tsuen	HKBWS 1991	**Secondary Species** The species utilizes wetland and is unlikely to fly over the study area.
	Plain Prinia (*Prinia inornata*)	12	1991 (Dec)	R	Foraging: shrubland Breeding: shrubland		HKBWS 1992	**Secondary Species** The species moves around by flying short distance and low about ground, and is unlikely to fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
	Yellow-bellied Prinia (*Prinia flaviventris*)	Not specified	Not specified	R	Foraging: shrubland Breeding: shrubland		Maunsell 2003	**Secondary Species** The species moves around by flying short distance and low about ground, and is unlikely to fly over the study area.
	Artic Warbler (*Phylloscopus borealoides*)	Up to 6	1998 (Sep)	AM	Foraging: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Yellow-browed Warbler (*Phylloscopus inornatus*)	Up to 4	1998 (Dec), 1999 (Mar)	WV	Foraging: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Pallas's Leaf Warbler (*Phylloscopus proregulus*)	Not specified	1998	WV	Foraging: woodland		HKBWS 2002	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Pale-legged Leaf Warbler (*Phylloscopus tenellipes*)	1	1998 (Dec)	AM	Foraging: woodland	Seen at Pak Kok	HKBWS 2002	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Dusky Warbler (*Phylloscopus fuscatus*)	1	1998 (Dec)	WV	Foraging: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
	Common Tailorbird (*Orthotomus sutorius*)	4	1998	R	Foraging: woodland and shrubland Breeding: woodland and shrubland		Maunsell 2003	**Secondary Species** The species is not a strong flyer and is unlikely to fly over the study area.
Emberizidae	Crested Bunting (*Melophus lathami*)	1	1975, 1980 (May), 1992 (Dec)	R	Foraging: paddy field and grassland Breeding: rocky area		HKBWS 1976, HKBWS 1982, HKBWS 1993	**Secondary Species** Although there had been records of this species found on Lamma Island, it is rare and the surveys did not record it in the study area.
	Black-faced Bunting (*Emberiza spodocephala*)	Not specified	1996	M, WV	Foraging: open area and shrubland	Observer per. obs.		**Secondary Species** Although the species utilizes habitat similar to the study area, it usually forages close to the ground.
	Little Bunting (*Emberiza pusilla*)	Not specified	1996	WV	Foraging: open area	Observer per. obs.		**Secondary Species** Although the species utilizes habitat similar to the study area, it usually forages close to the ground.
Nectariniidae	Fork-tailed Sunbird (*Aethopyga christinae*)	1	1995 (Jan)	R	Foraging: woodland Breeding: woodland	Heard	HKBWS 1996	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.

Group	Species	Number of individuals	Year of Record	Principal Status	Habitats	Remarks	Reference	Category with Respect to Wind Turbine
Zosteropidae	Japanese White-eye (*Zosterops japonica*)	8	1998	R, W	Foraging: woodland and woodland edge Breeding: woodland		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
Estrildidae	Scaly-breasted Munia (*Lonchura punctulata*)	2	1998	R	Foraging: woodland edge and open area		Maunsell 2003	**Secondary Species** This species usually forages along lower growth of vegetation or on the ground.
Sturnidae	Black-collared Starling (*Sturnus nigricollis*)	28	1998-1999	R	Foraging: woodland edge and open area		Maunsell 2003	**Primary Species** The study area has suitable habitats for the species and it may fly over the study area.
	Crested Myna (*Acridotheres cristatellus*)	33	1998-1999	R	Foraging: shrubland and woodland edge		Maunsell 2003	**Primary Species** The study area has suitable habitats for the species and it may fly over the study area.
	Hill Myna (*Gracula religiosa*)	Not specified	Not specified	I	Foraging: woodland and woodland edge		Maunsell 2003	**Secondary Species** The species utilizes woodland and is unlikely to fly over the study area.
Dicruridae	Black Drongo (*Dicrurus macrocercus*)	1	1994	M, SV	Foraging: woodland edge and open area		HKBWS 2002	**Primary Species** The study area has suitable habitats for the species and it may fly over the study area.
Corvidae	Common Magpie (*Pica pica*)	4	1998-1999	R	Foraging: open area and woodland edge		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.
	Large-billed Crow (*Corvus macrorhynchus*)	Not specified	Not specified	R	Foraging: open area		Maunsell 2003	**Primary Species** The species utilizes habitats similar to the study area and may fly over the study area.

Principle Status: OV=Occasional Visitor P=Present all year, SM=Spring Migrant, AM=Autumn Migrant, M=Migrant, SV=Summer Visitor, WV=Winter Visitor, R=Resident and I=Introduced.
The Principle Status of the birds follow Carey *et al* (2001).

Table 3 ***Butterfly Species Recorded Previously in Lamma Island (From Literature Review)***

Common Name	Species Name	Abundance
Angled Castor	*Ariadne ariadne*	C
Baron	*Euthalia phemius*	UC
Birdwing	*Troides helena*	UC
Blue Glassy Tiger	*Ideopsis similes*	VC
Blue Pansy	*Junonia orithya*	UC
Blue Spotted Crow	*Euploea midamus*	VC
Chinese Peacock	*Papilio bianor*	C
Common Black Jezebel	*Delias pasithoe*	C
Common Faun	*Faunis eumeus*	C
Common Grass Yellow	*Eurema hecabe*	VC
Common Lascar	*Pantoporia hordonia*	C
Common Mormon	*Papilio polytes*	VC
Common White	*Artogeia canidia*	VC
Common White-banded Brown	*Lethe confusa*	C
Cornelian	*Deudorix epijarbas*	R
Dark Brand Bush Brown	*Mycalesis mineus*	VC
Dark Veined Tiger	*Danaus genutia*	VC
Fivebar Swordtail	*Graphium antiphates*	C
Golden Birdwing	*Troides aeacus*	R
Grass Demon	*Udaspes folus*	R
Great Eggfly	*Hypolimnas bolina*	C
Great Orange Tip	*Hebomoia glaucippe*	C
Grey Pansy	*Junonia atlites*	C
Hong Kong Cupid	*Everes lacturnus*	C
Hong Kong Fritillary	*Argyreus hyperbius*	VC
Hong Kong Lacewing	*Cethosia biblis*	UC
Lemon Pansy	*Junonia lemonias*	UC
Long-banded Silverline	*Spindasis lohita*	UC
Orange Awlet	*Bibasis oedipodea*	R
Painted Lady	*Vanessa cardui*	R
Paris Peacock	*Papilio paris*	VC
Punchinello	*Zemeros flegyas*	C
Red Admiral	*Vanessa indica*	UC
Red Helen	*Papilio helenus*	VC
Short-banded Sailor	*Phaedyma columella*	C
Small White	*Artogeia rapae*	R
Striped Blue Crow	*Euploea mulciber*	UC
Swallowtail	*Papilio xuthus*	UC
Tailed Green Jay	*Graphium agamemnon*	VC
Yellow Orange Tip	*Ixias pyrene*	UC

Abundance (Walthew 1997) : C = common, VC = very common, UN = uncommon, R = rare
Information Extracted from Maunsell 2003.

Table 4 ***Category (Primary or Secondary) of the Bird Species Recorded within Lamma Island (Records from the Literature)***

Family	Category	Criteria
Fregatidae	Secondary Species	The Frigate Birds are oceanic birds which are also long-distant migrants. There were 2 published records of Frigate Birds from Lamma, including one identified *Fregata ariel* flying over Hung Shing Yeh Wan (HKBWS 1976, 1991). Despite this the species is now classified as 'Occasional Visitor' to Hong Kong, the species is not regularly reported in Hong Kong waters. Therefore it is classified as secondary species in the study.
Ardeidae	Primary Species	The group includes the egrets, herons and bitterns. There are previous records of the group with a majority of records on Pacific Reef Egret (HKBWS 1973, 1992, 1994, 1995, 1998, 1999 and 2002). Purple Heron has also been recorded in the close vicinity of Lamma, which single bird was seen flying over the West Lamma Channel (HKBWS 1976). Although not formally published, Black-crowned Night Heron, Little Egret and Striated Heron were recorded in the study site (So, unpublished data). Chinese Pond Heron, Cattle Egret, Grey Heron and Yellow Bittern are also recorded by Maunsell (2003). *Ciconiiformes* herons & storks terns are considered to be particularly, or potentially, sensitive to wind farm. Despite the species utilizes habitat irrelevant to the Study Area and is unlikely to fly over the study area, this species is still classified as primary species.
Rallidae	Secondary Species	Up to two individuals of the White-breasted Waterhen (*Amaurornis phoenicurus*) was recorded in 2004, in Pak Kok (so, unpublished data). The species was also recorded in this study. The rare Hong Kong passage migrant Water Cock was also recorded. As these species utilizes wetland and usually will not fly high, and are unlikely to fly over the study area, therefore they are classified as secondary species.
Accipitridae	Primary Species	Six species were previous reported, which are Black-eared Kite, Common Buzzard, Crested Goshawk, Chinese Goshawk, Bonelli's Eagle and White-bellied Sea Eagle (HKBWS 1973, 1976 and 1991, Maunsell 2003). The residential bird White-bellied Sea Eagle was also recorded flying below 100m above the study area and the Black Kite is also recorded in this study. Accipitridae raptors are considered to be particularly, or potentially, sensitive to wind farm, and therefore they are all classified as primary species.
Falconidae	Primary Species	Up to two individuals were seen on Lamma Island (HKBWS 1991). As the species utilizes open area and the study area is a possible foraging habitat, it is classified as primary species.
Charadriidae	Primary Species	A single record of one Pacific Golden Plover being seen in East Lamma Channel (HKBWS 1998). Charadriiformes waders are considered to be particularly, or potentially, sensitive to wind farm. Despite the species utilizes wetlands and is unlikely to fly over the study area, this species is still classified as primary species.

Family	Category	Criteria
Scolopacidae	Secondary Species	A Ruddy Turnstone was seen in the East Lamma Channel (HKBWS 1998). The species utilizes wetlands and is unlikely to fly over the study area, therefore it is classified as secondary species. Other members from this family include the Common Sandpiper, Little Stint, Red-necked Phalarope, Curlew Sandpiper and Eurasian Woodcock. As the study area does not contain suitable habitat for these species, they are all classified as secondary species.
Laridae	Primary/ Secondary Species	This group includes gulls, terns and Jaeger. A total of 9 species were recorded in West and East Lamma Channels, and water south of Lamma Island. They are the Black-tailed Gull, Black-headed Gull, Whiskered Tern, White-winged Tern, Common Tern, Roseate Tern, Aleutian Tern, Gull-billed Tern and Long-tailed Jaeger (HKBWS 1973, 1976, 1985, 1992, 1993, 1994, 1995, 1998, Carey et al. 2001). There was also one record of Black-napped Tern from Lamma Island with unspecified location (HKBWS 1994). *Sternidae* terns are considered to be particularly, or potentially, sensitive to wind farm. Despite those species utilize open water and are unlikely to fly over the study area, those species are still classified as primary species. As the remaining species recorded in this group utilize open water and are unlikely to fly over the study area, they are all classified as secondary species.
Columbidae	Primary/ Secondary Species	There was record of Emerald Dove from Lamma Island (HKBWS 1991), which was also recorded in this study. The species utilizes woodland and had been recorded in the study area during this study, and therefore may fly over the study area. It is classified as primary species. Another species Spotted Dove had been recorded in Lamma Island (Maunsell 2003). This species utilizes habitats similar to those in the study area and may fly over them, it is classified as primary species. Rock Dove utilizes open area near human settlement. As there is only limited human settlement around the study area, it is classified as secondary species.
Alcedinidae	Primary/ Secondary Species	Four species from this group had been recorded on Lamma Island, including Common Kingfisher, the White-throated Kingfisher, the Pied Kingfisher and Hoopoe (HKBWS 1973 and 2002, Maunsell 2003). The White-throated Kingfisher utilizes habitat similar to the study area, and is also recorded in this study in the close vicinity of the proposed site of the construction of wind turbine. Therefore it is classified as primary species. The study area does not contain suitable habitat for the Common Kingfisher and the Pied Kingfisher, and therefore they are classified as secondary species. Hoopoe is a ground feeding bird on open lawn and grassland and is therefore classified as secondary species.
Coracidae	Primary Species	Dollarbirdr was recorded previous (HKBWS 1992). As the species also utilizes similar habitats as those in the study area, and therefore it is also classified as primary species.

Family	Category	Criteria
Cuculidae	Primary/ Secondary Species	This group consists of koel, cuckoos and coucals. The Common Koel (Eudynays scolopacea) was recorded on Lamma Island (HKBWS 2002), and was also recorded in this study. The Chestnut-winged Cuckoo (*Clamator coromandus*) was recorded in Sok Kwu Bay in 2004 (So, unpublished data). Indian Cuckoo was recorded in this study with up to 2 individuals and the Black-winged Cuckoo was also recorded. As all of these species utilize woodland habitat and are unlikely to fly over the study area, they are classified as secondary species. Greater Coucal and Lesser Coucal were recorded in this study. They utilize shrubland and woodland edge which also provided by the study area. The possibilities of these species flying over the study area lead to their primary species status.
Apodidae	Primary Species	Pacific Swift was recorded previously on Lamma Island (HKBWS 1992 and 1996), and was also recorded in this study. Little Swift was also recorded in this study. As both species are aerial-forager and may fly over the study area, they are classified as primary species.
Hirundinidae	Primary Species	Barn Swallow was recorded in this study. As the species is aerial-forager and may fly over the study area, it is classified as primary species.
Passeridae	Secondary Species	Tree Sparrow was recorded previously near Sok Kwu Wan (Maunsell 2003). Although the study area has suitable foraging habitat for this species, it is not a strong flyer and is unlikely to fly over the study area and is classified as secondary species.
Motacillidae	Secondary Species	This group contains the wagtails. Yellow Wagtail, White Wagtail and Grey Wagtail were recorded on the island (Maunsell 2003). As the study area does not contain suitable habitat for the species, it is therefore classified as secondary species.
Campephagidae	Secondary Species	Black-winged Cuckoo-shrike had been recorded at Sok Kwu Wan in 1998 (HKBWS 2002). The species utilizes woodland and is unlikely to fly over the study area, therefore it is classified as secondary species.
Laniidae	Primary Species	Brown Shrike was recorded in the study area in 1990 and 1991 (HKBWS 1991 and 1992). Long-tailed Shrike was recorded in this study. The study area has suitable foraging area for both species and they may fly over the study area, therefore they are classified as primary species.
Pycnonotidae	Primary Species	Three species from the group were recorded in this study, which are Red-whiskered Bulbul, Chinese Bulbul and Sooty-headed Bulbul. As these species utilize habitats similar to the study area and may fly over the proposed site for wind turbine, they are classified as primary species.

Family	Category	Criteria
Turdidae	Primary/ Secondary Species	This group includes bushchat, rubythroat, robins, redstart and thrushes. Blue Rock Thrush was recorded on Lamma Island with up to three individuals seen (HKBWS 1976 and 1992). The species forages in rocky area and the study area has suitable foraging area for the species, and it may fly over the study area. Therefore it is classified as primary species. Grey Bushchat, Siberian Rubythroat and Daurian Redstart were recorded previously on Lamma (Maunsell 2003). As they utilize habitats similar to the study area and may fly over the proposed wind turbine, they are classified as primary species. Other thrushes such as Scaly Thrush, Grey-backed Thrush, Pale Thrush and Blue Whistling Thrush were also recorded on the island (HKBWS 1991, 2002, Maunsell 2003). In addition the Oriental Magpie Robin was also recorded in this study. As these species utilize woodland and is unlikely to fly over the study area, therefore they are classified as secondary species.
Muscicapidae	Secondary Species	This group includes the flycathers and monarch. There were records of Verditer Flycatcher, Red-throated Flycatcher, Black-naped Monarch and Grey-streaked Flycatcher on Lamma Island (HKBWS 1975, 1991, 1992, 1996 and Maunsell 2003). Those species utilize woodland and are unlikely to fly over the study area, and therefore are classified as secondary species.
Paridae	Secondary Species	Great Tit was recorded in the Sok Kwu Wan (Maunsell 2003). As the species utilizes woodland and is unlikely to fly over the study area, it is classified as secondary species.
Timaliidae	Secondary Species	White-browed Laughing was recorded on Lamma Island (HKBWS 1991). In addition, Masked Laughing Thrush and Hwamei were recorded in this study. As these species forage at the undergrowth and it unlikely to fly over the area, therefore they are classified as secondary species.
Sylviidae	Secondary Species	Lanceolated Warbler, a rare autumn migrant, had been record on Lamma Island in 1990 (HKBWS 1991). Up to 12 Plain Prinia were recorded on the Island (HKBWS 1992) and it was recorded in this study. Although this species utilizes habitats similar to the study area, it usually moves around by flying short distance and low about ground, and is unlikely to fly over the study area. It is therefore classified as secondary species. Pallas's Leaf Warbler and Pale-legged Leaf Warbler were also recorded (HKBWS 2002). In addition, Common Tailorbird was recorded in this study. Artic Warbler, Yellow-bellied Prinia, Yellow-browed Warbler and Dusky Warbler were all reported in Sok Kwu Wan (Maunsell 2003). As these species forage in woodland area and are unlikely to fly over the study are, therefore they are all classified as secondary species.

Family	Category	Criteria
Emberizidae	Secondary Species	Both Black-faced Bunting and Little Bunting had been recorded in 1996 (So, unpublished data). Although the species utilizes habitat similar to the study area, it usually forages close to the ground and are classified as secondary species. There were previous records of Crested Bunting on the island which utilized habitats similar to the study area (HKBWS 1976, 1981 and 1993). However, the Crested Bunting has now become very rare due to the disappearance of paddy field in Hong Kong, and therefore it is classified as secondary species.
Nectariniidae	Secondary Species	There was a single record of Fork-tailed Sunbird in 1995 (HKBWS 1996). The species utilizes woodland and is unlikely to fly over the study area. It is classified as secondary species.
Zosteropidae	Secondary Species	The Japanese White-eye was recorded in this study. However, as the species utilizes woodland and is unlikely to fly over the study area, it is therefore classified as secondary species.
Estrildidae	Secondary Species	Scaly-breasted Munia was recorded previously (Maunsell 2003). As this species usually forage in the lower growth of vegetation, they are classified as secondary species.
Sturnidae	Primary/ Secondary Species	The introduced Hill Myna was recorded previously on the island (Maunsell 2003). As the species utilizes woodland and is unlikely to fly over the study area, it is classified as secondary species. Black-collared Starling and Crested Myna were also recorded in Lamma. These species utilize open area and woodland edge. The study area has suitable habitats for the species and they may fly over the proposed site for the wind turbine and therefore they are classified as primary species.
Dicruridae	Primary Species	Black Drongo had been recorded in 1994 (HKBWS 2002) as well as in this study. As the study area has suitable habitats for the species and it may fly over the proposed wind turbine, it is therefore classified as primary species.
Corvidae	Primary Species	Common Magpie and Large-billed Crow were recorded in this study. As both species may fly over the study area when foraging, therefore they are classified as primary species.

Table 5 Plant Species Recorded Within the Study Area

Species	Growth Form	Origin	Status	Local Abundance					
				Secondary Woodland	Shrubland	Shrubby Grassland	Village/Developed Area	Stream	Project Area
Acacia confusa	T	E	VC	A	O			F	
Ageratum conyzoides	H	N	VC		A				
Albizia lebbeck	T	N	C	F				F	
Alocasia macrorrhiza	H	N	VC	O			F		
Annona squamosa	S	E	C	F					
Antidesma bunius	S	N	C		O				
Aporusa dioica	S	N	VC	F	F	O		F	
Aquilaria sinensis	T	N	C	F				O	
Archidendron lucidum	S	N	VC		F			F	
Artocarpus heterophyllus	T	E	C				F		
Asparagus cochinchinensis	H	N	C	O					
Averrhoa carambola	S	N	C				F		
Bambusa spp.	T	N	C	O				S	
Breynia fruticosa	S	N	VC		F	O		F	
Bridelia tomentosa	S	N	VC	F	F		F		F
Callicarpa cathayana	S	N	C	F					
Carex chinensis	G	N	C		O			F	
Cassytha filiformis	C	N	VC		F	F			F
Casuarina equisetifolia	T	E	VC	O					
Celtis sinensis	T	N	C		O			O	
Centella asiatica	H	N	VC		O				
Cerbera manghas	T	E	C	S					
Chrysanthemum indicum	S	N	C		O				O
Cinnamomum camphora	T	N	C	F			O		
Cinnamomum parthenoxylon	T	N	C	O					
Citrus sinensis	S	E	C				F		

Species	Growth Form	Origin	Status	Local Abundance					
				Secondary Woodland	Shrubland	Shrubby Grassland	Village/Developed Area	Stream	Project Area
Clausena lansium	S	N	VC	O			F		
Clerodendrum fortunatum	S	N	VC	O	O				O
Clerodendrum inerme	S	N	C	O					
Cocculus orbiculatus	C	N	C	O	F				
Cratoxylumcochinchinensis	S	N	VC	O	F			F	
Cyperus rotundus	G	N	VC		O	F		F	
Dalbergia benthami	C	N	C	F	F			F	
Dalbergia millettii	C	N	VC	F	F			F	
Daphniphyllum calycinum	T	N	C		O				
Dianella ensifolia	H	N	VC		F	O			
Dicranopteris linearis	F	N	VC		O	O		O	O
Digitaria sanquinalis	G	N	C		O				
Dimocarpus longan	T	N	C	F	O		O		
Duranta repens	S	E	C	F					
Embelia laeta	C	N	VC		F	O		F	O
Embelia ribes	C	N	C		F			F	
Eriachne pallescens	G	N	C			A			
Erigeron floribundus	H	N	VC						O
Eurya nitida	S	N	VC		F	F		F	O
Ficus hirta	T	N	VC	O					
Ficus hispida	T	N	VC	F			F		
Ficus microcarpa	T	N	VC	O	F			O	
Ficus variegata	T	N	C	F					
Garcinia oblongifolia	T	N	C	F					
Glochidion lanceolatum	S	N	C	F					O
Gnetum montanum	C	N	C	F				O	
Gardenia jasminoides	S	N	C	F					
Gordonia axillaris	S	N	C	O	O			O	

Species	Growth Form	Origin	Status	Local Abundance					
				Secondary Woodland	Shrubland	Shrubby Grassland	Village/Developed Area	Stream	Project Area
Gymnema sylvestre	C	N	C		F	O		O	O
Hedyotis acutangula	H	N	VC		F				
Helicteres angustifolia	H	N	VC		F	F		O	F
Ilex asprella	S	N	VC	F	F	F		O	F
Inula cappa	H	N	VC		F	F		F	
Ipomoea cairica	C	N	VC		O				O
Ischaemum aristatum	G	N	VC		F	D		O	A
Lantana camara	S	E	VC	O	F			F	O
Leucaena leucocephala	S	N	VC	F					
Ligustrum sinensis	S	N	VC	F	F				
Litchi chinensis	T	N	C				O		
Litsea cubeba	T	N	C		F				
Litsea glutinosa	T	N	VC	F		O		O	F
Litsea rotundifolia	S	N	VC	O	F	O		O	F
Livistona chinensis	P	N	VC	O			O	S	
Lygodium dichotomum	C	N	VC	O	O	F			O
Macaranga tanarius	T	N	VC	F	O		F		O
Machilus velutina	T	N	C	O					
Macroptilium atropurpureum	S	E	C		F				
Mallotus paniculatus	T	N	C	F	F			S	
Mangifera indica	T	N	VC	O					
Melaleuca leucadendron	T	E	C	A					
Melastoma candidum	S	N	VC		F	F		F	F
Melodinus monogynus	C	N	C	F					
Michelia alba	T	E	C				F		
Microcos paniculata	S	N	C	F					
Mikania micrantha	C	E	VC		O		F		
Millettia reticulata	C	N	VC		F			F	

Species	Growth Form	Origin	Status	Local Abundance					
				Secondary Woodland	Shrubland	Shrubby Grassland	Village/Developed Area	Stream	Project Area
Miscanthus sinensis	G	N	VC					O	
Morus alba	S	N	C		O			O	
Musa paradisiaca	S	N	C	O			F		
Mussaenda pubescens	S	N	VC	O	F			F	
Nerium indicum	S	E	VC		O				
Neyraudia arundinacea	G	N	VC		O			O	O
Paederia scandens	C	N	C	F	O				
Pandanus tectorius	S	N	VC		S				
Panicum maximum	G	N	C	O	O				
Paspalum conjugatum	G	N	C		O				
*Pavetta hongkongensis**	S	N	P	S					
Pennisetum purpureum	G	N	C		O				
Phoenix hanceana	P	N	C		O				
Phyllanthus emblica	T	N	C		F			F	O
Phyllanthus cochinchinensis	S	N	VC	O		F			
Psychotria rubra	S	N	VC	F	F			F	
Pteroloma triquetrum	H	N	VC		F				
Punica granatum	S	N	C				F		
Rhaphiolepis indica	S	N	VC		F	F			
Rhodomyrtus tomentosa	S	N	VC		A	F			F
Rhus chinensis	S	N	VC					F	F
Rhus succedanea	S	N	VC	F	F			F	
Rhynchelytrum repens	G	N	VC			F			O
Saccharum officinarum	S	N	C				O		
Sapium discolor	S	N	C	O	O				
Sapium sebiferum	S	N	C		F				
Schefflera octophylla	S	N	VC	F	F			F	
Setaria glauca	G	N	C		O	F			

Species	Growth Form	Origin	Status	Local Abundance					
				Secondary Woodland	Shrubland	Shrubby Grassland	Village/Developed Area	Stream	Project Area
Stachytarpheta jamaicensis	H	N	VC		F	O			
Sterculia lanceolata	T	N	C	F					
Strobbilanthes alata	S	N	C		O				
Strophanthus divaricatus	C	N	VC	F		O			
Thevetia peruviana	S	E	VC		O				
Trema orientalis	S	N	VC		F			F	
Tricalysia dubia	S	N	VC	O			F		
Wedelia chinensis	C	N	VC		F				
Wikstroemia chinensis	S	N	VC	F	F				
Uvaria microcarpa	C	N	C	F	O				
Vitex negundo	S	N	C	O	F				
Zanthoxylum avicennae	S	N	VC	F					
Total no. of Species				**64**	**74**	**25**	**18**	**42**	**25**

Abundance: A=Abundant; F=Frequent; O=Occasional; S=Scarce
Status: C=Common; VC=Very Common; P=Protected
Plant Form: G=Grass; Climber; H=Herb; P=Palm; S=Shrub; T=Tree
Origin: N=Native; E=Exotic
* Indicated Species of Conservation Interest

Table 6 Bird Species Recorded during Point Count Surveys

Bird Species	Scientific Names	Status	Activities	Point Count Location								
				W1	W2	W3	S1	S2	S3	G1	G2	G3
Black Kite*	*Milvus migrans*	WV, R	Fl, Fr	O	O	O	O	O	O	O	O	O
White-bellied Sea Eagle*	*Haliaeetus leucogaster*	R	Fl									
Chinese Francolin	*Francolinus pintadeanus*	R	P, Br				O	O	O		O	O
White-breasted Waterhen	*Amaurornis phoenicurus*	R	Fr	O								
Spotted Dove	*Streptopelia chinensis*	R	P, Fr	O	O	O	O					
Oriental Turtel Dove	*Streptopelia orientalis*	WV	P	O								
Emerald Dove*	*Chalcophaps indica*	R	P		O	O						
Large Hawk Cuckoo	*Cuculus sparverioides*	SV	Br									
Indian Cuckoo	*Cuculus micropterus*	SV	Br, Fl	O	O	O					O	
Chestnut-winged Cuckoo	*Clamator coromandus*	SV	Br			O						
Common Koel	*Eudynamis scolopacea*	SV, R	Br	O	O	O						
Greater Coucal*	*Centropus sinensis*	R	P, Fr	O			O					
Lesser Coucal*	*Centropus bengalensis*	R	P, Fr	O	O	O	O	O			O	
Savanna Nightjar	*Caprimulgus affinis*	SV, WV	Fl								O	
Pacific Swift	*Apus pacificus*	SM, SV	Fl									
Little Swift	*Apus affinis*	R, SM	Fl				O					
Barn Swallow	*Hirundo rustica*	SM, SV	Fl	O		O	O			O	O	
Red-rumped Swallow	*Hirundo daurica*	M	Fl	O						O		
White-throated Kingfisher	*Halcyon smyrnensis*	AM, P	P, Fl			O	O					
Eurasian Tree Sparrow	*Passer monttanus*	R	P, Fr, Br	O								
Red-whiskered Bulbul	*Pycnonotus jocosus*	R	P, Fr, Br	O	O	O			O	O	O	O
Chinese Bulbul	*Pyconotus sinensis*	R	P, Fr, Br	O	O	O	O	O		O	O	O
Sooty-headed Bulbul	*Pyconotus aurigaster*	R	P, Fr			O	O	O	O	O	O	O
Oriental Magpie Robin	*Copsychus saularis*	R	P, Fr, Br	O	O	O			O	O		
Yellow-bellied Prinia	*Prinia flaviventris*	R	P				O		O			

Bird Species	Scientific Names	Status	Activities	Point Count Location								
				W1	W2	W3	S1	S2	S3	G1	G2	G3
Plain Prinia	*Prinia inornata*	R	P									
Common Tailorbird	*Orthotomus sutorius*	R	P, Fr	O	O	O						O
Masked Laughing Thrush	*Garrulax perspicillatus*	R	P, Fr		O	O			O			
Hwamei	*Garrulax canorus*	R	P, Br		O		O	O	O	O	O	O
Japanese White-eye	*Zosterops japonica*	R, WV	Fl	O	O							
Long-tailed Shrike	*Lanius schach*	R	P			O		O	O		O	O
Black Drongo	*Dicrurus macrocercus*	M, SV	P, Fl	O		O	O	O	O			
Common Magpie	*Pica pica*	R	P, Fl			O				O		
Large -billed Crow	*Corvus macrorhynchus*	R	Fl			O						
Black-collared Starling	*Sturnus nigricollis*	R	P, Fl	O	O	O		O	O	O		
White-shouldered Starling	*Sturnus sinensis*	M, WV, SV	P	O								
Crested Myna	*Acridotheres cristatellus*	R	P, Fl	O	O		O			O		O
White-rumped Munia	*Lonchura striata*	R	Fr, Br	O					O			

'O' sign indicates that the species was encountered at the particular sampled point during the surveys.
Principle Status: P=Present all year, SM=Spring Migrant, AM=Autumn Migrant, M=Migrant, SV=Summer Visitor, WV=Winter Visitor, R=Resident.
Activities P = perching/preening, Fr = foraging, Fl = Flying above, Br = Breeding activities.
* Indicates Species of Conservation Interest

Table 7a Details of Bird Survey Record in Woodland

		W1						W2						W3					
Bird Species	**Scientific Names**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Black Kite	*Milvus migrans*	6	4			1		7			6	1		2	4	6	1	8	
White-bellied Sea Eagle	*Haliaeetus leucogaster*																		
Chinese Francolin	*Francolinus pintadeanus*																		
White-breasted Waterhen	*Amaurornis phoenicurus*		1																
Spotted Dove	*Streptopelia chinensis*	2	2	1	1	1	1		1		1	2		1	1		2	2	
Oriental Turtel Dove	*Streptopelia orientalis*		1																
Emerald Dove	*Chalcophaps indica*							1	1	1		1						1	
Large Hawk Cuckoo	*Cuculus sparverioides*																		
Indian Cuckoo	*Cuculus micropterus*	1					1	1		1	1	1	1	1	1	1	1	1	
Chestnut-winged Cuckoo	*Clamator coromandus*															1			
Common Koel	*Eudynamis scolopacea*	1						1						1			1	1	
Greater Coucal	*Centropus sinensis*	1	1	1	2		1		1	2	1			1	1	1	1	2	
Lesser Coucal	*Centropus bengalensis*	1		2		1		1		1		1			1				
Savanna Nightjar	*Caprimulgus affinis*																		
Pacific Swift	*Apus pacificus*																		
Little Swift	*Apus affinis*																		
Barn Swallow	*Hirundo rustica*					4												2	
Red-rumped Swallow	*Hirundo daurica*					2													
White-throated Kingfisher	*Halcyon smyrnensis*																	1	
Eurasian Tree Sparrow	*Passer monttanus*		3		2	4	1												
Red-whiskered Bulbul	*Pycnonotus jocosus*	2	2		3	2	3	1	2	2	5	2		2	2		2	1	2
Chinese Bulbul	*Pyconotus sinensis*	2	2		2	2	2	4					3				1	2	1
Sooty-headed Bulbul	*Pyconotus aurigaster*																	2	
Oriental Magpie Robin	*Copsychus saularis*	1	2	1	2	1	2		1	1	2	3	1	1	1		1		
Yellow-bellied Prinia	*Prinia flaviventris*																		

		W1						W2						W3					
Bird Species	**Scientific Names**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Plain Prinia	*Prinia inornata*																		
Common Tailorbird	*Orthotomus sutorius*	2			1	1			1	2	1	1	1	1	2			1	
Masked Laughing Thrush	*Garrulax perspicillatus*										2				3				
Hwamei	*Garrulax canorus*								1			1	1						
Japanese White-eye	*Zosterops japonica*			1	3		3						2						
Long-tailed Shrike	*Lanius schach*																		1
Black Drongo	*Dicrurus macrocercus*	2		1	1									1	1				
Common Magpie	*Pica pica*													2	1			1	
Large -billed Crow	*Corvus macrorhynchus*													1					
Black-collared Starling	*Sturnus nigricollis*				2			1	1										
White-shouldered Starling	*Sturnus sinensis*				2														
Crested Myna	*Acridotheres cristatellus*	2			2	3	1	2											
White-rumped Munia	*Lonchura striata*		1	2	2														

Table 7b Details of Bird Survey Record in Shrubland

		S1						S2						S3					
Bird Species	**Scientific Names**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Black Kite	*Milvus migrans*	23	15	11	15			18	8	18						10			
White-bellied Sea Eagle	*Haliaeetus leucogaster*																		
Chinese Francolin	*Francolinus pintadeanus*		1	1			1	1	1	1	1	1				1		1	
White-breasted Waterhen	*Amaurornis phoenicurus*																		
Spotted Dove	*Streptopelia chinensis*					1													
Oriental Turtel Dove	*Streptopelia orientalis*																		
Emerald Dove	*Chalcophaps indica*																		
Large Hawk Cuckoo	*Cuculus sparverioides*																		
Indian Cuckoo	*Cuculus micropterus*																		
Chestnut-winged Cuckoo	*Clamator coromandus*																		
Common Koel	*Eudynamis scolopacea*																		
Greater Coucal	*Centropus sinensis*						2												
Lesser Coucal	*Centropus bengalensis*	1	1		3	1	1		1	1	1		1						
Savanna Nightjar	*Caprimulgus affinis*																		
Pacific Swift	*Apus pacificus*																		
Little Swift	*Apus affinis*									1									
Barn Swallow	*Hirundo rustica*						1												
Red-rumped Swallow	*Hirundo daurica*																		
White-throated Kingfisher	*Halcyon smyrnensis*			1															
Eurasian Tree Sparrow	*Passer monttanus*																		
Red-whiskered Bulbul	*Pycnonotus jocosus*			4												2	3		1
Chinese Bulbul	*Pyconotus sinensis*		2	3	4			4	3				2						
Sooty-headed Bulbul	*Pyconotus aurigaster*					3		2											1
Oriental Magpie Robin	*Copsychus saularis*																1		1
Yellow-bellied Prinia	*Prinia flaviventris*				1													1	

		S1						S2						S3					
Bird Species	**Scientific Names**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Plain Prinia	*Prinia inornata*																		
Common Tailorbird	*Orthotomus sutorius*																		
Masked Laughing Thrush	*Garrulax perspicillatus*																		4
Hwamei	*Garrulax canorus*			2	1		1		1	1	1	1	1				1		
Japanese White-eye	*Zosterops japonica*																		
Long-tailed Shrike	*Lanius schach*								1		1					1			
Black Drongo	*Dicrurus macrocercus*									1							1		1
Common Magpie	*Pica pica*																		
Large -billed Crow	*Corvus macrorhynchus*																		
Black-collared Starling	*Sturnus nigricollis*					1											2	2	2
White-shouldered Starling	*Sturnus sinensis*																		
Crested Myna	*Acridotheres cristatellus*		1				1												1
White-rumped Munia	*Lonchura striata*																	2	

Table 7c Details of Bird Survey Record in Shrubby Grassland

		G1						G2						G3					
Bird Species	**Scientific Names**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
Black Kite	*Milvus migrans*	2	2			2		2	4					1			1		
White-bellied Sea Eagle	*Haliaeetus leucogaster*																		
Chinese Francolin	*Francolinus pintadeanus*								1		1			1					
White-breasted Waterhen	*Amaurornis phoenicurus*																		
Spotted Dove	*Streptopelia chinensis*																		
Oriental Turtel Dove	*Streptopelia orientalis*																		
Emerald Dove	*Chalcophaps indica*																		
Large Hawk Cuckoo	*Cuculus sparverioides*																		
Indian Cuckoo	*Cuculus micropterus*								1										
Chestnut-winged Cuckoo	*Clamator coromandus*																		
Common Koel	*Eudynamis scolopacea*																		
Greater Coucal	*Centropus sinensis*																		
Lesser Coucal	*Centropus bengalensis*									1									
Savanna Nightjar	*Caprimulgus affinis*							1											
Pacific Swift	*Apus pacificus*																		
Little Swift	*Apus affinis*																		
Barn Swallow	*Hirundo rustica*		1										1						
Red-rumped Swallow	*Hirundo daurica*	2																	
White-throated Kingfisher	*Halcyon smyrnensis*																		
Eurasian Tree Sparrow	*Passer monttanus*																		
Red-whiskered Bulbul	*Pycnonotus jocosus*			2									2	3					2
Chinese Bulbul	*Pyconotus sinensis*	3										1			4		3		1
Sooty-headed Bulbul	*Pyconotus aurigaster*	3				3			3					2			3		3
Oriental Magpie Robin	*Copsychus saularis*					1													

Bird Species	Scientific Names	G1						G2						G3					
		Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Yellow-bellied Prinia	*Prinia flaviventris*																		
Plain Prinia	*Prinia inornata*																		
Common Tailorbird	*Orthotomus sutorius*													1		1		1	
Masked Laughing Thrush	*Garrulax perspicillatus*																		
Hwamei	*Garrulax canorus*	1											1						1
Japanese White-eye	*Zosterops japonica*																		
Long-tailed Shrike	*Lanius schach*											1					1		
Black Drongo	*Dicrurus macrocercus*				1	1													
Common Magpie	*Pica pica*			1								2					1		
Large -billed Crow	*Corvus macrorhynchus*																		
Black-collared Starling	*Sturnus nigricollis*			2							2								
White-shouldered Starling	*Sturnus sinensis*																		
Crested Myna	*Acridotheres cristatellus*	2						2						2				2	
White-rumped Munia	*Lonchura striata*																		

Table 8 Flight Attempts of All Primary Bird Species Recorded within Zone 5 (Total Number of Individuals was presented in Brackets). Observation time was 6 hours (360 minutes) per day. Each of the Flight Attempt has lasted for not more than 30 seconds.

		Mean Utilisation Rate (Birds/min)	**Day 1 (20th May 2004)**			**Day 2 (23rd May 2004)**			**Day 3 (26th May 2004)**			**Day 4 (29th May 2004)**			**Day 5 (30th May 2004)**			**Day 6 (6th June 2004)**		
Weather			**Overcast**			**Sunny**			**Sunny**			**Sunny**			**Rainy**			**Cloudy**		
Wind Direction			**45°**			**45°**			**45°**			**45°**			**45°**			**45°**		
Visibility			**>2km**			**>2km**			**>2km**			**>2km**			**>2km**			**>2km**		
Flight height		**Height above10 and below100m**	<10m	>10m <100m	>100m	<10m	>10m <100m	>100m	<10m	>10m <100m	>100m	<10m	>10m <100m	>100m	<10m	>10m <100m	>100m	<10m	>10m <100m	>100 m
Bird Species	**Behaviour recorded**																			
Black Kite *Milvus migrans*	Foraging and soaring	*0.0333*		14 (23)	4 (23)		19 (19)	10 (19)		13 (21)	7 (21)		19 (18)			72 (21)	2 (21)		7 (16)	
White-bellied Sea Eagle *Haliaeetus leucogaster*	Flying pass over the Study Area																1 (1)			
Spotted Dove *Streptopelia chinensis*	Flying pass over the Study Area		3 (3)									4 (4)						1 (1)		
Greater Coucal *Centropus sinensis*	Flying pass over the Study Area											1 (1)								
Little Swift *Apus affinis*	Foraing and Flying	*0.0004*																	2 (2)	
Barn Swallow *Hirundo rustica*	Foraing and Flying	*0.0007*			1 (1)														3 (3)	
White-throated Kingfisher *Halcyon smyrnensis*	Flying pass over the Study Area		1 (1)																	
Chinese Bulbul *Pyconotus sinensis*	Flying pass over the Study Area		4 (4)																	
Sooty-headed Bulbul *Pyconotus aurigaster*	Flying pass over the Study Area		18 (18)						2 (2)											
Common Magpie *Pica pica*	Flying pass over the Study Area		1 (1)												1 (1)					
Black-collared Starling *Sturnus nigricollis*	Flying pass over the Study Area		4 (4)									2 (2)								
Crested Myna *Acridotheres cristatellus*	Flying pass over the Study Area					3 (3)			4 (4)									**3 (3)**		

Table 9 Butterfly Species Recorded in the Study Area

Common Name	Species Name	Relative Abundance					Commonness
		Secondary Woodland	Shrubland	Shrubby Grassland	Village/ Developed Areas	Stream	
Plum Judy	*Abisara echerius*	A	A	A			VC
Common Hedge Blue	*Actyolepis puspa*	A	C				C
Bush Hopper*	*Ampittia dioscorides*	S					UC
Angled Castor	*Ariadne ariadne*	C					C
Common White	*Artogeia canidia*	C	O	O			VC
Colour Sergeant	*Athyma nefte*	C					C
Common Sergeant	*Athyma perius*	C					C
Lemon Emigrant	*Catopsilia pomona*	S	O				C
Mottled Emigrant	*Catopsilia pyranthe*	S	O				C
Common Gull	*Cepora nerissa*	C	S	S			C
Red Lacewing*	*Cethosia biblis*	S					UC
Lime Blue	*Chilades lajus*	O	O	O			VC
Common Mine	*Chilasa clytia*	A	O	O			C
Rustic	*Cupha erymanthis*	O					VC
Common Mapwing	*Cyrestis thyodamas*	S					C
Red-based Jezebel	*Delias pasithoe*	O	O				VC
Common Duffer*	*Discophora sondaica*	C					UC
Common Palmfly	*Elymnias hypermnestra*	S					C
Blue-spotted Crow	*Euploea midamus*	O					VC
Common Grass Yellow	*Eureman hecabe*	C	O	O			VC
White-edged Blue Baron*	*Euthalia phemius*	S					UC
Tailed Cupid	*Everes lacturnus*	C	O				C
Large Faun	*Faunis eumeus*	O	S				VC
Tailed Jay	*Graphium agamemnon*	O		O			VC
Common Jay	*Graphium doson*	S					C

Common Name	Species Name	Relative Abundance					Commonness
		Secondary Woodland	Shrubland	Shrubby Grassland	Village/ Developed Areas	Stream	
Common Blue bottle	*Graphium sarpedono*	A	O	S	S		VC
Great Orange Tip	*Hebomoia glaucippe*	O		O			C
Purple Sapphire	*Heliophorous epicles*	S					C
Red Ring Skirt	*Hestina assimilis*	O	S				C
Tree Flitter*	*Hyarotis adrastus*	O					UC
Great Egg-fly	*Hypolimnas bolina*	C					VC
Ceylon Blue Tiger	*Ideopsis similes*	C		O			VC
Yellow Orange Tip*	*Ixias pyrene*	O	O				UC
Dark Cerulean	*Jamides bochus*	S					C
Grey Pansy	*Junonia atlites*	A					C
Lemon Pansy	*Junonia lemonias*	C	O	O			C
Banded Tree Brown	*Lethe confusa*	C	S	O			VC
Common Evening Brown	*Melanitis leda*	C					C
Dark-band Bush Brown	*Mycalesis mineus*	O	O	O			VC
South Sullied Sailer	*Neptis clinia*	O					C
Common Sailer	*Neptis hylas*	O		O			VC
Chestnut Angle	*Odontoptilum augulatum*	S					C
Common Lascar	*Pantoporia hordonia*	S					C
Chinese Peacock	*Papilio bianor*	O		S			VC
Lime Butterfly	*Papilio demoleus*		C	C			C
Red Helen	*Papilio helenus*	O	S				VC
Great Mormon	*Papilio memnon*	O		S			VC
Paris Peacock	*Papilio paris*	O	O	S	S		VC
Common Mormon	*Papilio polytes*	A	C	O	S		VC
Spangle	*Papilio protentor*	O					VC
Swallowtail*	*Papilio xuthus*	S					UC
Glassy Tiger	*Parantica aglea*	O	O	O			VC

Common Name	Species Name	Relative Abundance					Commonness
		Secondary Woodland	Shrubland	Shrubby Grassland	Village/ Developed Areas	Stream	
Oriental Straight Swift	*Parnara bada*	O					C
Five-bar Swordtail	*Pathysa antiphates*	S					C
Little Banded Swift	*Pelopidas agna*	O					C
Indian Cabbage White	*Pieris canidia*	C		S			VC
Small Cabbage White*	*Pieris rapae*	C					UC
Pale Grass Blue	*Psedozizeeria maha*	A	C				VC
Common Jester	*Symbrenthia lilaea*	S					C
Water Snow Flat	*Tagiades litigiosus*	O					C
Blue Tiger	*Tirumala limniace*	C	O	O			C
Common Five-ring	*Ypthima baldus*		A	A			VC
Punchinello	*Zemeros flegyas*	O					C
Total Species		**61**	**26**	**23**	**3**		

Relative Abundance: A= Abundant; C = Common; O = Occasional; S = Scarce.
Commonness (Walthew 1997): UC = uncommon; C = common; VC = very common.
* Indicates Species of Conservation Interest

Table 10 Dragonfly Recorded in the Study Area

Common Names	Species Name	Relative Abundance					Commonness
		Secondary Woodland	Shrubland	Shrubby Grassland	Village/ Developed Area	Stream	
Orange-tailed Sprite	*Ceriagrion auranticum ryukyuanum*					S	Abundant
Common Blue Skimmer	*Orthetrum glaucum*		S		S	S	Abundant
Common Red Skimmer	*Orthetrum pruinosum neglectum*					S	Abundant
Wandering Glider	*Pantala flavescens*		O	O			Abundant

Relative Abundance: A= Abundant; C = Common; O = Occasional; S = Scarce.

Annex D

Implementation Schedule

D1 IMPLEMENTATION SCHEDULE

This *Annex* provides a consolidation of the mitigation measures recommended for the Project. The consolidation is presented in the form of an Implementation Schedule in accordance with the format specified in *Section 3.4.7.3* of the *EIA Study Brief No. ESB-112/2004*.

The Implementation Schedule has the following column headings:

EIA Ref

This denotes the section number or reference from the EIA Report Main text.

EM&A Log Ref

This denotes the sequential number of each of the recommended mitigation measures specified in the Implementation Schedule.

Environmental Protection Measures

This denotes the recommended mitigation measures, courses of action or subsequent deliverables that are to be adopted, undertaken or delivered to avoid, minimise or ameliorate predicted environmental impacts.

Objectives

This denotes the objectives of the recommended mitigation measures and main concerns to address.

Location/Duration of Measures/Timing of Completion of Measures

This indicates the spatial area in which the recommended mitigation measures are to be implemented together with details of the programming or timing of their implementation.

Implementation Agent

This denotes where the responsibility lies for the implementation of the recommended mitigation measures.

Implementation Stage

This denotes the stage at which the recommended mitigation measures are to be implemented either during the Design, Construction, Operation or Decommissioning.

Relevant Legislation

This section defines the controlling legislation that is required to be complied with.

Implementation Schedule

EIA* Ref.	EM&A Log Ref	Environmental Protection Measures	Objectives	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage**				Relevant Legislation & Guidelines
						Des	C	O	Dec	
		Noise - Construction Phase								
4.7.1	1	**Good Site Practices** • Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works; • Machines and plant that may be use intermittently, such as vibratory poker, should be shut down between work periods or should be throttled down to a minimum; • Plant known to emit noise strongly in one direction, should, where possible, be orientated to direct noise away from nearby NSRs; and • Mobile plant should be sited as far away from NSRs as possible.	To minimise potential noise nuisance arising from the works to nearby NSRs.	During Construction stage	Construction Contractor		✓			Noise Control Ordinance (NCO) and Annex 5 of the EIAO TM
		Noise - Operation Phase								
4.7.2	2	The allowable maximum sound power level of 100 dB(A) and pure tone free shall be included in the tender specification of wind turbine.	To minimise potential noise nuisance arising from operation of wind turbine	During detailed design stage	HEC	✓		✓		Noise Control Ordinance (NCO) and Annex 5 of the EIAO TM
		Ecology – Construction Phase								

5.11.2	3	**Measures for Romer's Tree Frog** • Undertake one day-time and one night-time survey for the Romer's Tree Frog within the Project Area just before the construction works commence. The surveyor(s) should actively search within the Project Area paying special attention to the water bodies (ie abandoned containers). All recorded Romer's Tree Frog (adults and tadpoles) must be caught by hand and translocated to the stream pools of middle course of Stream S4 near Lo Tik Wan, the critical natural habitat for the Romer's Tree Frog within the Study Area, immediately after the survey. The Romer's Tree Frog surveys and translocation works shall be undertaken by a qualified ecologist with at least five years of relevant experience in faunal translocation works.	To avoid impacts on the Romer's Tree Frog arising from the work	Prior to commence of construction	HEC/ Construction Contractor		✓			
5.11.2	4	**Measures for Construction Runoff** • Surface run-off from the construction site should be directed into existing stream channel via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities.	To minimise potential ecological impacts arising from the works	During construction	Construction Contractor		✓			

5.11.2	5	**Good Construction Practice** • Erect fences along the boundary of the works area before the commencement of works to prevent tipping, vehicle movements, and encroachment of personnel onto adjacent areas. • Avoid any damage and disturbance, particularly those caused by filling and illegal dumping, to the remaining and surrounding natural stream habitats. • Regularly check the work site boundaries to ensure that they are not breached and that no damage occurs to surrounding areas. • Prohibit and prevent open fires within the site boundary during construction and provide temporary fire fighting equipment in the Project Area. • Treat any damage that may have occurred to individual major trees in the adjacent area and along the 275 kV Cable Route (used to transport the construction materials) with surgery. • Reinstate temporary disturbed areas immediately after completion of the construction works, ie through on-site tree/shrub planting. Tree/shrub species used should make reference from those in the surrounding area and/or *Annex C* of EIA report.	To minimise potential ecological impacts arising from the works	During construction	Construction Contractor		✓			
		Ecology – Operation Phase								
5.11.3	6	No mitigation measures are required. See EM&A Manual for monitoring requirements.								

		Landscape and Visual – Construction Phase								
6.7	7	• Colour scheme and non-reflective paints will be made to enable the proposed wind turbine to blend in well with natural surroundings and minimise the visual intrusion. • Selection of low rotating speed machine to minimize the visual disturbance.	To minimum potential landscape and visual impacts arising from the works	Prior commence of construction	Construction Contractor	✓	✓			
6.7		• New cut and fill slopes and other land affected by construction works would be reinstated to natural land form and topography of the natural slope as far as practical. Grading of these slopes to resemble a natural, rolling landform similar to that of adjacent topography would be carried out. Approximately 1,400 sq.m. of disturbed areas would be reinstated. • Appropriate landscape planting including trees, shrubs and grasses (approx. 1,400 sq.m.) will be provided to soften the ground level appearance of the proposed wind turbine site. • Existing soil resources on site from the cut slope will be re-used for backfilling at site as far as practicable to minimize the need to import or export soils.	To minimum potential landscape and visual impacts arising from the works	During construction	HEC/ Construction Contractor	✓ ✓ ✓	✓ ✓ ✓	 ✓		
		Landscape and Visual - Operation Phase								
	8	No mitigation measures are required. See EM&A Manual for monitoring requirements.								

		Air Quality - Construction Phase								
7.5.1	9	• Covering entirely by impervious sheet or frequently watering of the on-site stockpile of excavated materials to keep wet always before backfilling; • Frequent watering of exposed area or worksite of excavation to maintain surface wet, if necessary and practical; • Provision of vehicle washing to remove any dusting materials from small village trucks' body and wheel at the exit of worksite; • Well-maintained diesel-powered mechanical equipment to avoid black smoke emissions; and • Shut-down of diesel-powered mechanical equipment or trucks inside the worksites when they are not in operation.	To minimise potential dust nuisance arising from the works	During construction	Construction Contractor		✓			Air Pollution Control (Construction Dust) Regulation
		Air Quality - Operation Phase								
7.5.2	10	N/A								
		WATER QUALITY - Construction Phase								
8.6.1	11	**Surface Run-off** • Surface run-off from the construction site should be directed into existing stream channel via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities.	To minimise potential water quality impacts arising from the works	During construction	Construction Contractor		✓			

		• Silt removal facilities should be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times. • During excavation in the wet season, temporarily exposed soil surfaces should be covered, eg by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as excavation proceeds. Intercepting channels should be provided (eg along the crest/edge of the excavation) to prevent storm runoff from washing across exposed soil surfaces. Arrangements should always be in place to ensure that adequate surface protection measures can be safely carried out well before the arrival of a rainstorm. • Earthworks final surfaces should be well compacted and the subsequent permanent work or surface protection should be carried out as soon as practical after the final surface are formed to prevent erosion caused by rainstorms. Appropriate intercepting channels should be provided where necessary. Rainwater pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities. • Open stockpiles of construction materials (eg aggregates and sand) on site should be covered with tarpaulin similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.								

8.6.2	12	**Wastewater from Site Facilities** • The use of chemical toilets will be necessary and these should be provided by a licensed contractor, who will be responsible for appropriate disposal and maintenance of these facilities.	To minimise potential water quality impacts arising from the works	During construction	Construction Contractor		✓			
		WATER QUALITY - Operation Phase								
8.7.2	13	No mitigation measures are required.								
		WASTE- Construction Phase								
3.5	14	• Excavated materials should be used as backfill as far as practicable; • Excavated materials should be segregated from other wastes; and • Works activities should be limited within the site boundary; and • Filling and illegal dumping should be inhibited through site management and audit.	To enhance reuse, recycling and, as appropriate, proper disposal of excavated materials To avoid contamination thereby ensuring acceptability at public filling areas and avoiding the need for landfill disposal To ensure that adverse environmental impacts are prevented	Project site/during construction	Construction Contractors		✓			ETWBTC No 34/2002; ETWBTC No 15/2003
		Waste - Operation Phase								
3.5	15	No mitigation measures are required.								