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Agreement No. CE 18/2002 (EP)
Environmental Impact Assessment Study for
Construction of Helipads at
Peng Chau and Lamma Island - Investigation

EIA Study for Helipad at Yung Shue Wan, Lamma Island

Final EIA Study Report

BMT Asia Pacific Limited in Association With:

Hyder Consulting Limited
Asiatic Marine Limited
Archaeo-Environments Limited
Cosine Limited

BMT Asia Pacific Limited

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1 INTRODUCTION

1.1 General

1.1.1 In August 2002 BMT Asia Pacific Limited (BMT) was awarded the contract for Agreement No. CE 18/2002: *Environmental Impact Assessment Study for Construction of Helipads at Peng Chau and Lamma Island / Investigation* by the Civil Engineering Office, Civil Engineering and Development Department (CEDD).

1.1.2 The Agreement requires the completion of Environmental Impact Assessment (EIA) studies for two proposed helipads: one at Peng Chau and one at Yung Shue Wan, Lamma Island.

1.1.3 This Report presents the approach to and findings of the EIA study for the proposed *Yung Shue Wan* helipad, and follows the requirements of Environmental Impact Assessment Study Brief No. *ESB-089/2001*.

1.2 Project Background

1.2.1 The Project involves the construction and operation of a permanent helipad at Yung Shue Wan, Lamma Island, and is a 'designated project' under Item B.2, Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO) by virtue of being: "*A helipad within 300m of existing or planned residential development*". Accordingly, an Environmental Permit is required for the Project.

1.2.2 The Project has been planned and managed in-house by the Land Works Division of CEDD on behalf of the Home Affairs Department (HAD). Construction works are to be completed by contractors under CEDD's supervision. CEDD will hand over the helipad to the management department (yet to be determined) upon its commissioning.

1.2.3 The helipad is solely required for transporting residents in areas of North Lamma to urban areas for medical treatment in emergency situations, and is not for commercial use. The previous Yung Shue Wan helipad – located on a soccer pitch outside the North Lamma Clinic – ceased operation in May 1998 when the Government Flying Service (GFS) classified the Site to a Category 1 Landing Site.[*]

1.2.4 Since this time there has been no permanent, dedicated helipad serving the local community. The community was until recently using the helipad at The Hongkong Electric Co. (HEC) Ltd's Lamma Power Station – a distance of 2.75 km and a typical trip time of around 20 minutes by mini-ambulance from the North Lamma Clinic.[†] As a more acceptable interim measure, HAD commissioned the development of a temporary helipad that has been in operation at Yung Shue Wan since October 2003 pending the construction of a permanent helipad to serve the local community [para. 2.2.34 refers].

1.2.5 A full description of the Project is presented in *Section 2* of this Report.

[*] Landing Site Categorization: Category 1 – "Sites that tend to be located in an urban or congested area and which have no clear approach and departure paths. A helicopter landing at these sites places both 3rd parties on the ground and the helicopter and its occupants at risk, if the helicopter were to suffer a major mechanical or engine failure during the approach or departure phase of flight."

[†] Travel time provided by Department of Health official in telecon on 13th January 2003.

1.3 Purpose and Approach of the EIA Study

1.3.1 The purpose of this EIA Study is to provide information on the nature and extent of environmental impacts arising from the Project and other concurrent works. This information will contribute to decisions by the Director of the Environmental Protection Department (EPD) on:

(i) The overall acceptability of any adverse environmental consequences that are likely to arise as a result of the proposed Project;

(ii) The conditions and requirements for the detailed design, construction and operation of the proposed Project to mitigate against adverse environmental consequences wherever practicable; and

(iii) The acceptability of residual impacts after implementation of proposed mitigation measures.

1.3.2 Satisfying the aims of the EIA Study has been managed by achieving a number of more specific objectives as listed in the EIA Study Brief. The objectives of the EIA study are to:

(i) Describe the proposed Project and associated works together with the requirements for carrying out the proposed Project;

(ii) Consider alternative design and construction method(s) for the proposed Project and to compare the environmental benefits and disadvantages of each of the method(s) and design in selecting a preferred one;

(iii) Identify and describe elements of community and environment likely to be affected by the proposed Project and/or likely to cause adverse impacts to the proposed Project, including natural and man-made environment;

(iv) Identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

(v) Identify and quantify potential losses or damage to aquatic organism and natural habitats and to propose measures to mitigate these impacts;

(vi) Identify and quantify potential losses or damage to flora, fauna and natural habitats and to propose measures to mitigate these impacts;

(vii) Propose the provision of mitigation measures so as to minimise pollution, environmental disturbance and nuisance during construction and operation of the proposed Project;

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

(ix) Identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the proposed Project which are necessary to mitigate these environmental impacts and reducing them to acceptable levels;

(x) Investigate the extent of the secondary environmental impacts that may arise from the proposed mitigation measures, and to identify the constraints associated with the mitigation measures recommended in the EIA study as well as the provision of any necessary modification;

(xi) Design and specify environmental monitoring and audit requirements, if required, to ensure the implementation and the effectiveness of the environmental protection and pollution control measures adopted.

1.4 Structure of this EIA Study Report

1.4.1 The EIA Report is divided into a total of 9 sections. Following this *Section 1*, Introduction, the Report is organised as follows:

- Section 2 – Project Description
- Section 3 – Air Quality Impact Assessment
- Section 4 – Noise Impact Assessment
- Section 5 – Waste Management Assessment
- Section 6 – Water Quality Impact Assessment
- Section 7 – Ecology
- Section 8 – Cultural Heritage Impact Assessment
- Section 9 – Implementation Schedule of Recommended Mitigation Measures
- Section 10 – Summary Conclusion & Recommendations

1.4.2 The respective assessments for each technical discipline follow the appropriate requirements as set out in the *Technical Memorandum on Environmental Impact Assessment Process (EIA-TM)*.

1.4.3 For each section, all Figures are at the back of the section for ease of reference, while all Appendices are together at the back of the EIA Report.

2 PROJECT DESCRIPTION

2.1 Key Project Requirements

2.1.1 The fundamental Project requirements are the construction of an easily accessible and permanent helipad and an associated Emergency Vehicle Access (EVA) link with sufficient width to allow free movement of a mini-ambulance. The Fire Services Department has agreed to a 3.5 metres wide EVA for the Yung Shue Wan helipad. The GFS has also confirmed that a round helipad of 25 metres diameter is sufficient for helicopter operations.

2.1.2 The helipad is solely intended for emergency use and associated *essential* 'casevac' training flights, and will not be used for commercial operations. As such, helipad use will be intermittent, with no fixed flight schedule. The primary considerations for helipad development are flight operation safety and its accessibility by ground emergency vehicles from the Lamma Clinic in emergency situations. The helipad must also be operable and accessible at all times.

2.1.3 According to GFS Helipad Specification Guidelines, the guiding factors for siting a 'surface-level helipad' are as follows:

a) The design and the location should be such that downwind operations are avoided and crosswind operations are kept to minimum to maximise helicopter manoeuvrability and operational safety. It should have two approach surfaces, separated by at least 150 degrees (i.e., a minimum *flight path angle* of 150 degrees).

b) The site should be conveniently situated as regards ground transport access mainly for emergency service (e.g. ambulance, fire engines) and adequate vehicle parking facilities.

c) The ambient noise level should be considered near noise sensitive receivers, and especially in relation to areas below the helicopter approach / departure path(s). This means that the helicopter flight path should be situated away from residential areas as far as is practicable, and for this reason the flight path for the proposed Yung Shue Wan Helipad will approach and depart from the proposed helipad across the sea.

d) Ground conditions beneath the take-off climb and approach surfaces should permit safe landings in the event of engine failure or forced landings during which injury to persons on the ground and damage to property is minimised.

e) Consider, and assess with flight tests if necessary, the potential for and effects of eddies and turbulence that may be caused by any large structures close to the proposed helipad.

f) Consider the presence of high terrain or other obstacles, especially power lines, in the vicinity of the proposed site that may pose a potential hazard.

2.1.4 As information on the usage frequency of the proposed Yung Shue Wan Helipad is critical for accurate operational phase impact assessment, relevant flight data from GFS for the 2000 – 2004 period has been reviewed (Table 4.12 refers). Data for the year 2002 represents the greatest number of casevac flights in recent years, and so has been used as a basis for the impact assessment.

2.1.5 Information on possible future changes in the size of the resident population is also important, and the Notes of the draft Lamma Island OZP No. S/I-LI/6 (dated 1st April 2005) indicates a planned population of about 12,000 persons compared with the population of around 5,500 persons estimated from the 2001 Census. However, it is not anticipated that any such future population growth will significantly increase the population exposed to residual helicopter noise, given that the land closest to the proposed helipad has already been developed.

2.1.6 There is no specific data available on tourist visits to Lamma Island and there are no particular new tourist attractions to be developed, suggesting that tourism numbers are not anticipated to change significantly in the future.

2.2 Project History and Site Selection

Identification of Options / Alternatives

2.2.1 With reference to *Clause 3.3* of the EIA Study Brief, a number of construction and operational scenarios have been considered for the Project, with the preferred option selected accordingly. Consideration has been given to alternatives for:

(i) Helipad location and EVA link alignment;

(ii) Project design and construction methods; and

(iii) Helicopter approach and departure paths.

2.2.2 As regards potential helipad siting options, three potential options identified through a site selection exercise initiated by the then District Planning Office (DPO) for Sai Kung & Islands (now DPO for Lantau & Islands) were taken forward for consideration: Option A, Option B (Alternative B1) and Option C.

2.2.3 A further four options / alternatives were identified under this Study for investigation: Option B (Alternative B2), Option D and Option E (Alternatives E1 and E2).

2.2.4 The characteristics of these seven options / alternatives that were taken forward for more detailed consideration are summarised below. *Figure 2.1* shows the locations of the seven sites.

Option A: Yung Shue Wan North

2.2.5 The proposed '*Option A*' site is located at the northern end of Yung Shue Wan, near the existing shoreline and adjacent to a public library. It is close to a number of residences that are located on the slope and foot of a hill.

Option B: Alternative B1 - Kam Lo Hom North

2.2.6 The proposed '*Option B, Alternative B1*' site is situated at the edge of reclaimed land in the vicinity of Kam Lo Hom.

2.2.7 This option has the benefit of being adjacent to an existing EVA, but would require the development of the helipad platform in coastal waters and a short EVA link from the reclaimed land to the helipad.

Option B: Alternative B2 - Kam Lo Hom North (EVA Extension)

2.2.8 The proposed '*Option B, Alternative B2*' site would involve extending the '*Alternative B1*' EVA to locate the helipad beyond the helicopter noise 'impact zone' [*Sub-section 4.6* refers].

Option C: Kam Lo Hom (South)

2.2.9 The proposed '*Option C*' site is situated immediately southwest of and adjacent to the '*Alternative B1*' helipad on a piece of recently reclaimed land.

2.2.10 The '*Option C*' site is well located in terms of proximity to the North Lamma Clinic and distance from the built area, but most of the reclaimed land is already proposed for development of the Yung Shue

Wan Sewage Treatment Works (STW) by the Drainage Services Department (DSD).

Option D: Ferry Pier

2.2.11 The proposed '*Option D*' site is located at the roof of the existing Ferry Pier at Yung Shue Wan. The site would be accessible using the existing pier as an EVA. It is also in the vicinity of a number of residences and other Noise Sensitive Receivers.

Option E: Alternative E1 - Kam Lo Hom West (Marine EVA)

2.2.12 The proposed '*Option E, Alternative E1*' site is located at the southwest of Kam Lo Hom, approximately 150 metres from the 'Alternative B1' helipad, to locate the helipad beyond the helicopter noise 'impact zone' [*Sub-section 4.6* refers].

2.2.13 The '*Alternative E1*' helipad would be accessed by way of a marine EVA to be constructed parallel to the existing sloping boulder seawall.

Option E: Alternative E2 - Kam Lo Hom West (Land EVA)

2.2.14 The proposed '*Option E, Alternative E2*' helipad site is also located at the southwest of Kam Lo Hom, and would have the same footprint as the '*Alternative E1*' helipad. However, the '*Alternative E2*' EVA would be land-based, being constructed around the back of the reclaimed land and the future STW.

Construction Methods

2.2.15 Three construction methods for forming the helipad platform and the EVA link have been considered and these are briefly summarised as follows:[*]

- Reclamation would require dredging of marine sediment to a suitable depth to allow construction of a stable foundation, followed by deposition of filling materials up to the required platform level.
- Small diameter pre-bored piling method involves sinking a casing through the substrate and removing the material within. Concrete is then poured into the casing to form the pile. A platform structure is then constructed on top of the piles.
- Percussive piling involves driving steel piles into the bedrock. As the piles are driven through to the bedrock, sediments are laterally displaced without the need for dredging or excavation. A platform is constructed similarly as for the pre-bored piling method.

Community Consultation

2.2.16 Under the broader remit of the Assignment, the Consultants established a framework based on the basic principles of the EIA process that collectively aim to protect the environment through prevention.[†]

2.2.17 The evaluation framework comprised an initial assessment, mainly on environmental issues, through which environmental impacts were predicted through joint consideration of helipad location and construction method / programme. This was followed by a Value Management (VM) exercise that

[*] The development of a Floating Pontoon was investigated but was not considered feasible for 'casevac' operations due to operability and accessibility concerns during adverse weather conditions (i.e., pontoon movement by wind and wave action) that may prevent safe helicopter landing.

[†] EPD (2000). EIAO Guidance Note No. 1/2002: Basic Principles of the EIA Process. January 2002.

involved consultation with, and direct participation of, the local community and other stakeholders at the early stage of the Project and before detailed technical assessment had been undertaken.

2.2.18 The VM exercise involved a forum with residents and community group members at a Yung Shue Wan Area Committee meeting in February 2003. Nominees from this meeting attended a formal VM workshop in March 2003 whereat various evaluation criteria, including time frame, engineering feasibility, project cost, site availability, land ownership and community / social impacts were taken discussed and prioritised by participants.

2.2.19 The key community concerns raised through the VM exercise are listed below (in order of importance):

a. *Operational safety* – the safety of the helicopter crew, passengers and the nearby community during helicopter activity was the main concern.

b. *Time frame* – site availability and the speed of construction were raised as important factors due to the fact that the helipad is for emergency casualty evacuation.

c. *Direct ground access* – given the inconvenience of the existing helipad, proximity to and availability of direct and uninterrupted access to the North Lamma Clinic is another issue of key concern.

2.2.20 ETWB Technical Circular (Works) No. 13/2003 on "Guidelines and Procedures for Environmental Impact Assessment of Government Projects and Proposals" (September 2003) promotes Continuous Public Involvement. Accordingly, ongoing consultation has been conducted during the course of the study to present an update on progress, discuss key issues and to obtain stakeholder feedback.

2.2.21 At the most recent meeting with the Island District Council in February 2005, Council members reiterated their support for the proposed helipad and requested that the works commence as early as possible at the currently proposed site. Community support for the project at the studied location was also reiterated at the North Lamma Rural Committee meeting in April 2005, and the Lamma Area Committee consultation in May 2005.

Evaluation of Options / Alternatives

2.2.22 A summary of the helicopter site option evaluation in relation to environmental benefits, dis-benefits and other key non-environmental considerations (e.g., access and safety issues) is presented in *Table 2.1*. Elaboration on the factors affecting site selection is provided in the following paragraphs.

2.2.23 As the '*Option A*' site is in close proximity to the built-up area of Yung Shue Wan and the helicopter approach and departure paths are partially obstructed by natural topography, this option is considered unsuitable by the GFS on flight safety grounds. Besides this, the proximity of this option location to the built-up area means that the residual helicopter noise levels from helicopter approach / departure to and from the helipad and from helicopter manoeuvring at the helipad would likely be unacceptably high. Moreover, ambulance travel would be necessary along the narrow and sometimes busy Yung Shue Wan Main Street before it can reach the helipad from the Lamma North Clinic [*Figure 2.1* refers]. This may cause undue delay in transporting patient to the helipad.

2.2.24 Most of the reclaimed land at Kam Lo Hom (South) has been scheduled for the development of the Yung Shue Wan STW [*Sub-section 2.4* refers]. As such, sufficient land is not available for further development of the '*Option C'* site into a helipad.

2.2.25 A helipad at the '*Option D*' location was also considered unsuitable by the GFS on flight safety grounds due to the proximity of marine vessels, including public ferries and fishing boats, that are moored in the area which may infringe upon safe helicopter access / egress. The '*Option D*' site also suffers similar drawbacks to '*Option A'* in terms of accessibility and its close proximity to residences.

Helicopter flight path noise and manoeuvring noise is also a key concern for this option due to the central location of this site in Yung Shue Wan and the absence of shielding / noise exposure of surrounding buildings.

2.2.26 The development of a helipad was considered at '*Option E*' location at southwest Kam Lo Hom. Two alternatives for EVA construction were reviewed: *Alternative E1* by way of marine EVA, and *Alternative E2* by way of a land-based EVA [*Figure 2.1* refers]. The *Alternative E1* EVA would pass in front of the proposed Yung Shue Wan STW and DSD has raised that this alignment is not acceptable as it would exclude access to the STW and prevent construction and maintenance of the proposed sewage outfall [*Figure 2.1* refers]. As regards *Alternative E2*, this EVA route would encroach on undisturbed woodland at the foot of Kam Lo Hom and would require tree felling and land clearance and AFCD has stated that this alternative is undesirable in terms of nature conservation. For *Alternative E1* there may also be potential impacts on hard corals found along the sloping boulder seawall due to construction and operation of the marine EVA [*Figure 2.1* refers].

2.2.27 As regards the *Option B* alternatives, a helicopter noise level of up to 87 dB(A) has been predicted at the '*Alternative B1*' location when the 'Eurocopter EC 155B1' type helicopter is in use (compared with the helicopter noise standard of 85dB(A)). The helicopter noise level may reach 90 dB(A) when the preferred 'Eurocopter EC 155B1' type helicopter is not available for use, and the heavier / noisier 'Eurocopter Super Puma AS332 L2' type helicopter is in operation. Accordingly, consideration was also given to extending the EVA to locate the helipad further away from the built environment and beyond the helicopter noise impact zone: '*Alternative B2*'.

2.2.28 It was found that in order to locate the helipad beyond the helicopter noise impact zone that the '*Alternative B2'* EVA would need to be extended by approximately 270 metres from the '*Alternative B1*' helipad location [*Figure 2.1* refers]. Ultimately, as advised by the Marine Department, such a scenario was not preferred because the extension would reduce the area of navigable water between the *Alternative B2* and the existing ferry pier. This would have the effect of increasing the proximity of marine traffic in those waters, and hence increase the risk of vessel collision. Furthermore, Marine Department is of the view that in order to minimise the marine traffic risk the proposed helipad location should not extend any further offshore (i.e., from the proposed '*Alternative B1*' location) [para. 4.6.24 and *Figure 4.4c* refer].

2.2.29 As regards the predicted helicopter noise level of 87dB(A) at '*Alternative B1*' under 'normal' operating conditions (i.e., use of the 'Eurocopter EC 155B1'), based on actual 'casevac' and flight data for the year 2002 the impact duration is predicted to last no longer than 5-10 seconds. The impact frequency (i.e., helipad use) is predicted to be once approximately every 3 days. If the 'Super Puma AS332 L2' type helicopter were in operation then, while the noise level would increase to 90 dB(A), the impact duration would be 5-10 seconds and the impact frequency would be once approximately every 24 days [*Sub-section 4.6* refers].

2.2.30 Consideration was given to implementing direct and indirect mitigation measures to satisfy the 85dB(A) helicopter noise standard. As referred above with respect to '*Option E*' and '*Alternative B2*', there are various physical constraints that precluded these options / alternatives from development, including adverse landscape impacts, increased waste handling and habitat loss.

2.2.31 As the helipad is intended mainly for emergency use there is no fixed flight schedule. As such, the use of indirect mitigation measures, such as improved window glazing and installation of air conditioners, was not considered feasible due to the short impact duration (<10 seconds) and unpredictable timing of helicopter operations at the proposed helipad [*Sub-section 4.6* refers].

Table 2.1 Summary Matrix for Evaluation of Helipad Site Options & Alternatives

Option / Alternative	Location [1]	Key Environmental Benefit(s)	Key Environmental Dis-benefit(s)	Other Key Considerations (e.g., safety & access)	Conclusion
A	Yung Shue Wan North	• No key environmental benefits.	• Residual helicopter noise impacts from approach / departure to and from the helipad (i.e., *flight path* noise).[2] • Residual helicopter noise impacts from helicopter *manoeuvring* at the helipad.[3] • Construction noise impact.	• Helicopter flight safety concerns due to proximity to built-up area in Yung Shue Wan. • Potential limitations on land accessibility from Clinic due to the narrow and sometimes busy Yung Shue Wan Main Street.	Unacceptable in terms of flight safety, accessibility and noise impacts.
B1	Kam Lo Hom North	• No significant construction phase impacts.[4] • No helicopter *flight path* noise impact.[5]	• Helicopter *manoeuvring* noise impact.[6]	• Joint-closest to the Clinic (i.e., highly accessible).	Residual helicopter *manoeuvring* noise impact, but no construction or access concerns.
B2	Kam Lo Hom North (EVA Extension)	• No helicopter *flight path* or *manoeuvring* noise impacts.	• Potentially significant visual impact from 270m long marine EVA.	• Easy access from Clinic. • Marine safety risk (vessel collision) concerns due to EVA length.	Residual helicopter noise impacts unlikely to be significant, but unacceptable marine risk concerns.
C	Kam Lo Hom (South)	• No significant construction phase impacts (land already formed). • Helicopter flight path or manoeuvring noise impacts unlikely to be significant.[7]	• No key environmental dis-benefits.	• Joint-closest to the Clinic (i.e., highly accessible). • Land required for proposed Sewage Treatment Works (STW).	Residual helicopter noise impacts unlikely to be significant, but site required for proposed STW development.
D	Ferry Pier	• No key environmental benefits.	• Helicopter *flight path* and *manoeuvring* noise impacts. • Construction noise impact.	• Marine vessels by the ferry pier may infringe upon safe helicopter access / egress. • Potential limitations on land accessibility from Clinic due to the narrow and sometimes busy Yung Shue Wan Main Street.	Unacceptable in terms of flight safety, accessibility and residual helicopter noise impacts.

Option / Alternative	Location [1]	Key Environmental Benefit(s)	Key Environmental Dis-benefit(s)	Other Key Considerations (e.g., safety & access)	Conclusion
E1	Kam Lo Hom West (Marine EVA)	• Helicopter flight path or manoeuvring noise impacts unlikely to be significant.[7]	• Potential impacts on hard coral found along the sloping boulder seawall due to construction and operation of the marine EVA.	• Easy access from Clinic. • Prevents marine access to proposed STW; interferes with sewage outfall construction & maintenance.	Residual helicopter noise impacts unlikely to be significant, but unacceptable in terms of access to proposed STW and sewage outfall.
E2	Kam Lo Hom West (Land EVA)	• Helicopter flight path or manoeuvring noise impacts unlikely to be significant.[7]	• Ecology impact from secondary woodland clearance.	• Easy access from Clinic.	Residual helicopter noise impacts unlikely to be significant, but likely adverse ecological and landscape impacts.

1. *Figure 2.1* refers.
2. Flight Path noise is the noise from the helicopter while in flight approaching to or departing from the helipad [Section 4.6.1 refers].
3. Manoeuvring noise is the noise from the helicopter while manoeuvring on or directly over the helipad [Section 4.6.1 refers].
4. A detailed Construction Noise Impact Assessment has been conducted and is presented in sub-section 4.5 of this EIA Report.
5. A detailed Operational (Helicopter) Noise Impact Assessment has been conducted and is presented in sub-section 4.6 of this EIA Report [specifically, Tables 4.14 & 4.15 refer].
6. A detailed Operational (Helicopter) Noise Impact Assessment has been conducted and is presented in sub-section 4.6 of this EIA Report [specifically, Table 4.13 refers].
7. Based on the detailed Noise Impact Assessment in Section 4, these helipad locations are located sufficiently far from the built environment so as to avoid adverse noise impacts.

2.2.32 Overall, with the consideration of the residual helicopter noise impact on the local community, development of the '*Option B, Alternative B1*' helipad location is preferred. Reasons for preference of this option were its easy access from the North Lamma Clinic, avoidance of travel through the built-up and sometimes congested areas of Yung Shue Wan and, in particular, due to the relatively short time frame required for project development and availability for community use. It is also noted that the proposed location provides a significant improvement in terms of helicopter noise levels than the soccer pitch in front of the Yung Shue Wan Clinic that was used as a landing site by GFS up to May 1998.

2.2.33 Evaluation of the construction options concluded that '*Option B, Alternative B1*' could preferably be constructed by small diameter pre-bored piling. This offers a range of environmental benefits when compared to the dredge and reclaim method, and particularly with respect to waste management (*Section 5*), water quality (*Section 6*) and marine ecology (*Section 7*). The main benefits of small diameter pre-bored piling relate to absence of marine dredging that minimises waste handling / management requirements. There will be minimal disturbance to the seabed from pile installation, and hence only highly localised water quality impacts and no marine ecology impacts are anticipated.

2.2.34 As the proposed helipad is urgently required, a temporary helipad was developed as an interim measure at the '*Option C'* site location to meet the immediate need of the public and commenced operations in October 2003. This was possible as construction of the Yung Shue Wan STW is tentatively scheduled to commence in August 2007. The cessation date of the operation of the temporary helipad stipulated in the condition of the Environmental Permit has recently been extended to 31 October 2006.

Design Refinements to the Preferred Option

2.2.35 Consideration has been given to means by which the design could be refined to minimise the scale and duration of the works and optimise the position of the helipad, and hence avoid or reduce the environmental impact potential. This approach of proactive avoidance and minimisation through design takes precedence over impact mitigation.

2.2.36 During the course of the Study, the following measures have been taken to refine the project design with a view to avoiding potential impacts:

- The elevation of the helipad and EVA have been lowered as far as practicable in order to minimise their footprint, and hence the disturbance to the affected coastal waters.
- The construction sequence shall be optimised to avoid cumulative construction noise effects with works for the proposed construction works of the Yung Shue Wan Sewage Treatment Works.
- The construction method by small diameter pre-bored piling, as opposed to dredging and reclamation, was proposed. The benefits of the chosen construction method are summarised in para. 2.2.33.
- The width of the EVA link has been reduced from the standard 4.5m to 3.5m, with the effect that material requirements for the project will be reduced as well as the footprint of the EVA on the seabed.

2.2.37 In addition, during the detailed design stage, effort shall be made to reduce the elevation of the proposed helipad platform as far as practicable while satisfying the engineering requirements to minimise visual impact. Futhermore, the position of the helipad shall be refined as far as practicable in order to optimise the shielding effect by natural topography on the helipad.

Operational Considerations

2.2.38 Helicopter noise is the main environmental concern during operation of the helipad. It is predicted that there would be residual noise impact of up to 5 dB(A) at the nearby noise sensitive receivers (NSRs) under the worst-case scenario. Based on worst-case GFS data for 'casevac' operations at Yung Shue Wan, the predicted frequency of the residual impact is approximately once every 3 days. The impact duration would last for not more than 5-10 seconds per event. A number of issues were considered in this regard, and are discussed in greater detail in *Sub-section 4.6*. They include:

Helipad distance from the built environment:

2.2.39 There are severe constraints on land availability in Yung Shue Wan due to the need to satisfy the flight safety requirements [*Section 2.1* refers]. In particular, there are restrictions on flight paths and helicopter manoeuvrability imposed by existing buildings, overhead power lines and high terrain.

2.2.40 It is required to minimise the noise impacts during helicopter operations as far as practicable. Based on the results of helicopter noise assessment, it was found that the helipad has to be at a minimum distance of 276m from the nearest Noise Sensitive Receiver in order to control the noise level to below 85dB(A) under normal operating conditions [para. *4.6.18* refers].[*] On the other hand, there is need to minimise the travelling time from the Clinic to the helipad, bearing in mind it takes one minute for the mini-ambulance to travel approximately 200 metres.[†] A suitable balance must be struck between these conflicting requirements.

2.2.41 Having considered various factors of all the Options/Alternatives, 'Option B, Alternative B1' offers the best location as it is relatively close to the Clinic. Assessment results indicated that the helicopter noise impact due to flight path would comply with the noise criterion albeit the manoeuvring noise impact would exceed the criterion by up to 5 dB(A).

Helicopter Type

2.2.42 Consideration has been given to the use of helicopter types generating lower noise levels for casualty evacuation operations. However, the GFS has confirmed that at present only the two helicopter types that have been assessed in this EIA Report (i.e., the 'EC155 B1' and 'Super Puma AS332 L2') are available for such operations.

2.2.43 For operational considerations, the GFS would not be able to exclude the use of the 'Super Puma AS332 L2', the noisier of the two helicopter types, from using the helipad although the GFS has agreed to give priority to the quieter 'EC155 B1' type helicopter for 'casevac' operations wherever practicable. This approach also follows the trend of current usage of the two helicopter types at Yung Shue Wan. As only one helicopter is able to operate at the helipad at any one time, no cumulative helicopter noise effects will be generated. During the years 2003 and 2004, GFS has only used the smaller and quieter EC155 B1 type helicopter for night-time casevac operations and GFS has advised that this usage trend is expected to continue.

Helicopter Flight Path

2.2.44 The flight path is necessarily constrained by the flight safety requirements of GFS. The GFS guideline states that a surface level helipad should have two approach surfaces extending from the helipad. In plan view, the centreline of the two flight paths should ideally be separated by at least 150 degrees so that should wind conditions impose constraints on flight safety (para 2.1.3a) refers) there is always one other option for safe helicopter approach / departure.

2.2.45 It was determined that a flight path separation angle of 150 degrees would adversely affect all residences at the residential area. With the agreement of GFS, the angle of separation between the two flight paths for the *'Option B, Alternative B1'* site has been reduced to 80 degrees for use of 'EC155 B1' type helicopter and to 70 degrees for use of the 'Super Puma' [*Figure 4.3* refers]. The re-aligned

[*] Based on predicted 'manoeuvring' mode noise levels from the 'EC155 B1' helicopter type – the normal operating scenario.

[†] Assumption based on information from Department of Health [Section 1.2 refers].

helicopter flight path will increase the distance between the noise source (helicopter) and the noise sensitive receiver (residential area) so that helicopter approach noise generated by both types helicopters can be reduced to within the 85dB(A) guideline at all noise sensitive receivers.

2.3 Project Characteristics and Site Location

2.3.1 The Project involves the construction of a helipad by small diameter pre-bored piling in coastal waters at Kam Lo Hom (North), Yung Shue Wan – '*Option B, Alternative B1*'. No dredging or reclamation works are required for the construction. Minimal excavation of slurry from within the pile casing will be required. However, this process will be an entirely contained activity, separated from the adjacent water column.

2.3.2 The project location was selected after detailed consideration of the operational requirements and environmental impact potential of developing the Project at each of seven site locations. With reference to the current statutory Lamma Island Outline Zoning Plan (No. S/I-LI/6), the proposed site is within a "Government, Institution or Community" ("G/IC") zone and has been identified as a possible helipad. According to the Notes of the OZP, "Helicopter Landing Pad" is a Column 2 use that may be permitted with or without conditions on application to the Town Planning Board.

2.3.3 The helipad deck will be located approximately 25 metres from existing formed land, and an EVA link will be constructed to connect the proposed helipad with the existing EVA. *Figure 2.2* shows the site location.

2.3.4 As referred under Clause 3.4.7 of the EIA Study Brief, visual illustration materials have been prepared to present the as-built appearance of the Helipad and EVA. These materials are presented in *Appendix 2.1*, and specifically include a site layout plan, diagrammatic section, elevation and photomontages of the Helipad and EVA from 3 locations at Yung Shue Wan that are representative of the views that residents and visitors to Yung Shue Wan may encounter. The perspective drawings referred to in the EIA Study Brief are considered not necessary as the 3 photomontages adequately illustrate the project appearance.

2.3.5 The site location was selected after due consideration of the operational requirements and environmental impact potential of constructing and operating the Yung Shue Wan helipad at each of four site locations. Specific Project details are as follows:

- A total of approximately twenty-six numbers of small diameter pre-bored piles of about 610mm in diameter will be required for the construction of the helipad and EVA link.
- The EVA link will be about 25 metres long and 3.5 metres wide, and will incline slightly from the existing formed land at 4.9 mPD to the helipad deck.
- The helipad will have a diameter of 25 metres.
- The helipad surface will be constructed to a height of about 7.85 mPD.
- Railings will be installed along the EVA link, and wave deflectors will be installed around the helipad to enhance operational safety.
- An off-site works area (including site office) to be located on the existing vacant land east of the Refuse Transfer Station will be required for approximately 2.3 years, from April 2006.*

2.3.6 The construction programme can be broadly summarised as presented by *Table 2.2*.

* Based on information from the Planning Department, part of the vacant land may be required for other uses, including a Police station, activity room, refuse collection point, liquefied petroleum gas (LPG) cylinder store and sand depot. As such, the needs of other stakeholders will be determined before use of this land area can be confirmed.

Table 2.2 Summary of Yung Shue Wan Helipad Construction Programme

Construction Activity	Construction Period
Site Clearance	16-May-2006 to 22-Jul-2006
Mobilisation	24-May-2006 to 16-Aug-2006
Pile Installation	17-Aug-2006 to 27-Jan-2007
Helipad Construction	29-Jan-2007 to 22-Jun-2007
E&M Works	30-May-2007 to 5-Jul-2007
Demobilisation	6-Jul-2007 to 30-Jul-2007

2.3.7 Further details of the construction works are presented in *Section 4*, while the full construction programme is presented in *Appendix 2.2*.

2.4 Nearby Projects

2.4.1 Other projects identified in the vicinity that require consideration for the purposes of identifying and assessing as necessary the potential for cumulative effects.

Yung Shue Wan Development: Engineering Works, Phase 2

2.4.2 According to the tentative construction programme obtained from the Civil Engineering and Development Department, the Yung Shue Wan Development Engineering Works Phase 2 will not commence until Year 2008. Therefore, there will be no potential cumulative effects.

Yung Shue Wan Sewage Treatment Works

2.4.3 The tentative schedule for the Drainage Services Department (DSD) to commence construction of the Yung Shue Wan STW is in August 2007, and works would last for about 3 years. Therefore, the STW would not be constructed in parallel with the Helipad project. However, if the proposed helipad is still being constructed at the time that the STW construction commences, the existing temporary helipad will need to be relocated back to the Lamma Power Station, and this will cause a delay in casevac service. As such, CEDD and DSD have agreed to avoid overlapping these two projects. Even under the unlikely scenario that there are concurrent construction activities for the two projects, assessment results indicate that no adverse cumulative construction noise impacts are anticipated.

HEC's Lamma Power Station Navigation Channel Improvement

2.4.4 Siltation in the main navigation channel leading to the HEC Lamma Power Station requires that maintenance dredging be conducted to ensure safe passage of coal delivery vessels. HEC has advised that the works were completed in early 2004, and as such there will be no cumulative effects.

HEC's Lamma Power Station Extension Works

2.4.5 The marine works for the Power Station Extension were completed in 2003 before the proposed navigation channel dredging period, and therefore there will be no cumulative effects.

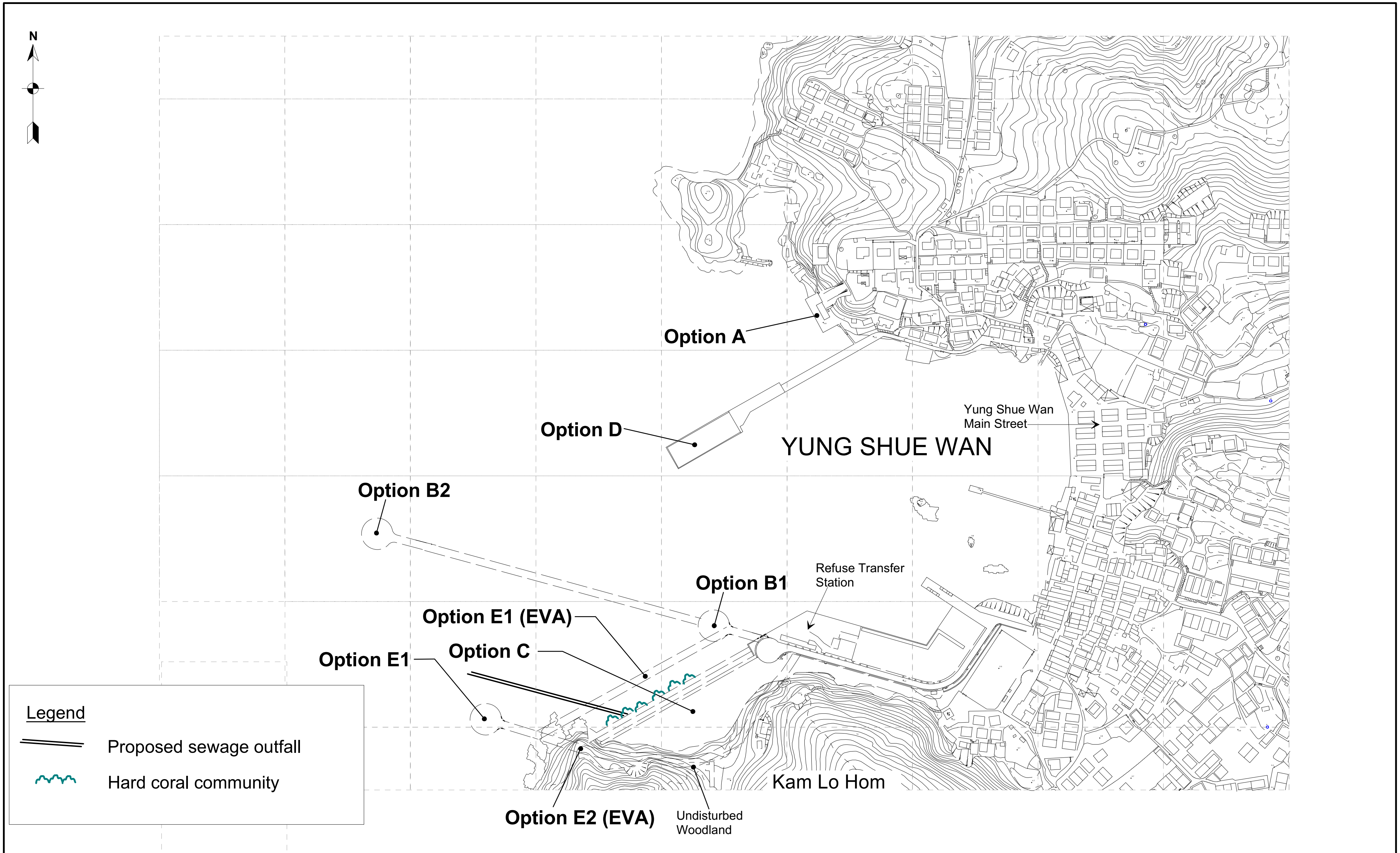
2.5 Likely Future Environmental Conditions Without the Project

2.5.1 As the Helipad previously used by the community is located at the HEC Lamma Power Station – a distance of 2.75 km from Yung Shue Wan – there are presently no local environmental concerns that the Project will resolve / improve.

2.5.2 Without the Project the predicted operational helicopter noise impact would be avoided. However, should the helipad not be developed, and upon the commencement of development of the Yung Shue Wan STW by DSD, the local community will be required to continue using the HEC helipad that requires ~20 minutes of travel time from the clinic [Para. 1.2.4 refers]. This would be an undesirable situation as the travel time to reach emergency services is unnecessarily prolonged.

2.5.3 Although there is an existing temporary helipad that has been in use since October 2003 that does not pose significant adverse environmental concerns, it is located at the proposed STW site and will need to close before STW construction can commence. Based on consultations, this situation would not be acceptable to the local community unless the permanent helipad is in place.

2.5.4 Given the project nature and anticipated intermittence of helicopter use, with or without the project the ambient noise environment at Yung Shue Wan will remain rural in character.



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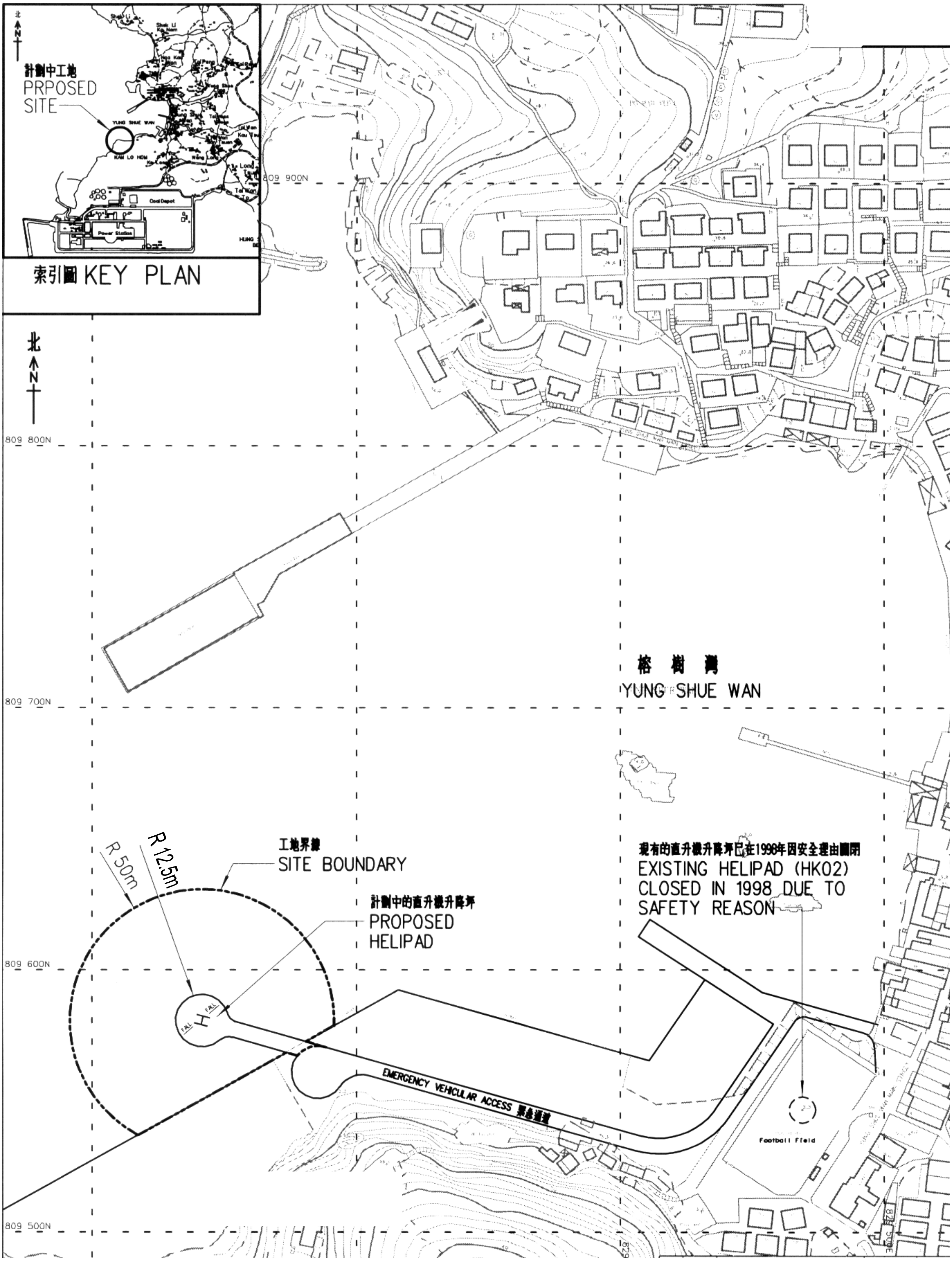
EIA Study for Helipad at Yung Shue Wan, Lamma Island

YUNG SHUE WAN HELIPAD SITING OPTIONS

Figure 2.1

Drawn	FEW	Checked	RBR
Scale	1 : 4000	Date	November 2005



EIA Study for Helipad at Yung Shue Wan, Lamma Island

YUNG SHUE WAN HELIPAD – SITE LOCATION

Figure 2.2

Drawn	MAT	Checked	RBR
Scale	NTS	Date	November 2005

3 AIR QUALITY IMPACT ASSESSMENT

3.1 Introduction

3.1.1 With reference to *Clause 3.4.3* of the EIA Study Brief, the Applicant shall follow the requirements stipulated under the Air Pollution Control (Construction Dust) Regulation and propose any other remedies or mitigation measures in dust control to ensure that construction dust impacts are controlled within the relevant standards as stipulated in Section 1 of Annex 4 of the EIA-TM.*

3.1.2 No operational Air Quality Impacts Assessment is required under the EIA Study Brief as the use of the proposed helipad will be limited, and there will be no other emissions associated with helipad operation. No potential operational phase air quality impacts are anticipated.

3.2 Relevant Guidelines, Standards & Legislation

Air Pollution Control Ordinance (Cap. 311)

3.2.1 The Air Pollution Control Ordinance (APCO) provides the statutory authority for controlling air pollutants from a variety of stationary and mobile sources, including fugitive dust emissions from construction sites. It encompasses Air Quality Objectives (AQOs) for 7 common air pollutants. The AQOs are given in *Table 3.1*.

Table 3.1 Hong Kong Air Quality Objectives

Pollutant	Concentration ($\mu g/m^3$)(1) Averaging Time				
	1 Hour(2)	8 Hour(3)	24 Hours(3)	3 Months(4)	1 Year(4)
Sulphur Dioxide SO_2	800	–	350	–	80
Total Suspended Particulates (TSP)	–	–	260	–	80
Respirable Suspended Particulates (RSP)(5)	–	–	180	–	55
Nitrogen Dioxide NO_2	300	–	150	–	80
Carbon Monoxide CO	30000	10000	–	–	–
Photochemical Oxidants (as ozone(6))	240	–	–	–	–
Lead	–	–	–	1.5	–

Notes:
(1) Measured at 298 K and 101.325 kPa (one atmosphere).
(2) Not to be exceeded more than three times per year.
(3) Not to be exceeded more than once per year.
(4) Arithmetic means.
(5) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometers or less.
(6) Photochemical oxidants are determined by measurement of ozone only.

3.2.2 Section 1, Annex 4 of EIA-TM stipulates the hourly average Total Suspended Particulate (TSP) concentration of 500 $\mu g/m^3$ measured at 298 K (25°C) and 101.325 kPa (1 atmosphere) for construction dust impacts. Mitigation measures for construction sites specified in the Air Pollution Control (Construction Dust) Regulation should be followed.

* Technical Memorandum on Environmental Impact Assessment Process (EIA-TM)

3.2.3 The APCO subsidiary regulation Air Pollution Control (Construction Dust) Regulation defines notifiable and regulatory works activities that are subject to construction dust control.

Notifiable Works:

(a) Site formation;
(b) Reclamation;
(c) Demolition of a building;
(d) Work carried out in any part of a tunnel that is within 100 m of any exit to the open air;
(e) Construction of the foundation of a building;
(f) Construction of the superstructure of a building; or
(g) Road construction work.

Regulatory Works:

(a) Renovation carried out on the outer surface of the external wall or the upper surface of the roof of a building;
(b) Road opening or resurfacing work;
(c) Slope stabilisation work; or
(d) Any work involving any of the following activities-
- Stockpiling of dusty materials;
- Loading, unloading or transfer of dusty materials;
- Transfer of dusty materials using a belt conveyor system;
- Use of vehicles;
- Pneumatic or power-driven drilling, cutting and polishing;
- Debris handling;
- Excavation or earth moving;
- Concrete production;
- Site clearance; or
- Blasting.

3.2.4 Notifiable works require that advance notice of activities be given to EPD. The Regulation also requires the works contractor to ensure that both notifiable works and regulatory works will be conducted in accordance with the Schedule of the Regulation, which provides dust control and suppression measures.

3.3 Baseline Conditions and Air Sensitive Receivers

Existing Environment

3.3.1 The existing air quality within the Yung Shue Wan area is generally rural. It is currently affected by the emissions from the Hongkong Electric Co. Ltd's Lamma Power Station, which is approximately 800 m due southwest to Yung Shue Wan. There are no major road networks within Lamma Island and therefore there are no vehicular emissions related air quality impacts.

3.3.2 Environmental Protection Department (EPD) operates a network of Air Quality Monitoring Stations in Hong Kong, but none of these monitoring stations is located within or near Yung Shue Wan. As such, air quality data collected at the Tap Mun monitoring station in Sai Kung District – which resembles a rural area type setting similar to the environs of Yung Shue Wan – has been selected as being broadly representative of the existing ambient air quality conditions at Yung Shue Wan. These data are summarised in *Table 3.2*[*].

Table 3.2 Annual Average Pollution Concentrations Recorded in Tap Mun (Year 2002)

Pollutants Monitored	Annual Average in micrograms per cubic metre
Respirable Suspended Particulates (RSP)	39
Sulphur Dioxide (SO_2)	11
Nitrogen Dioxide (NO_2)	13
Carbon Monoxide (CO)	688
Ozone (O_3)	63

Notes:
1. *All concentrations are measured at 298K (25°C) and 101.325KPa (one atmosphere)*
2. *Data of the Tap Mun Monitoring Station are extracted from "Air Quality in Hong Kong 2002", published by EPD*

3.3.3 The Hongkong Electric Co. Ltd. has operated an air quality monitoring station at Pak Kok San Tsuen on Lamma Island for a number of years. The monitored SO_2 and NO_2 annual average concentrations in year 2002 are 11 $\mu g/m^3$ and 25 $\mu g/m^3$, respectively. These results are comparable to the Tap Mun data.

Future Conditions

3.3.4 The Yung Shue Wan Phase 2 Reclamation will likely be a potential fugitive dust-polluting source during its works phase. However, this will only be a short-term change in the ambient condition and will not alter the nature of the air quality condition of Yung Shue Wan once the works are completed. Also it will commence after the completion of the helipad construction and therefore will not affect the background air quality condition during the helipad construction. A small sand depot has been planned to locate in the Yung Shue Wan Phase 1 Reclamation area.

3.3.5 Based on the helicopter flight paths advised by GFS, helicopters will not over-fly the Phase 1 Reclamation area and the distance of the sand depot from the helipad would be too far for any dust (wind-blown sand) impacts to be generated. As such, no adverse air quality (dust) impacts are anticipated from Project operation. There are no distributor roads or other major infrastructure development planned in Yung Shue Wan and therefore, the air quality conditions are not expected to have any significant change in the future.

Air Sensitive Uses

3.3.6 Currently there are no occupied domestic premises in the immediate environs of the helipad site. The potential air sensitive uses nearest to the helipad are an existing football field and the cluster of buildings near the football field, including low-rise (maximum 3-storey high) village houses, North Lamma Clinic, and a Tin Hau Temple. These are generally located over 200 metres from the helipad site and over 50 metres from the off-site works area (adjacent to the refuse transfer station). Village houses located along the coast of the Yung Shue Wan bay are also air sensitive uses [*Figure 3.1* refers].

[*] Environmental Protection Department, Air Service Group: Air Quality in Hong Kong 2002, (2002), Tables C3 & C4.

3.4 Construction Dust Impact Assessment

Identification of Impacts

3.4.1 If uncontrolled, construction activities may result in construction dust impacts. Construction of the helipad using a small diameter pre-bored piling method will include dust generation activities, some of which are notifiable / regulatory works. They are described below.

3.4.2 The construction will begin with site clearance, including breaking a short section (approximately 15 metres length) of a landscape planter at the top of the seawall. This will be a regulatory works procedure that requires appropriate dust suppression measures under the Regulation to adequately control dust to within an acceptable level.

3.4.3 Erection of site office, hoarding and fencing at the works area (approximately 50m x 25m) at the area adjacent to the refuse transfer station may involve very minor excavation that is regulatory work. Dusty material stockpiling and handling will be done in the works area as well as at the site, for which dust control measures will be implemented. Therefore dust will be controlled within acceptable level.

3.4.4 Pile installation for the EVA and helipad will be conducted through the water column, and therefore no dust impacts will arise.

3.4.5 The construction of the helipad deck and EVA may result in minor wind blown dust impacts. However, this activity is a regulatory works procedure and requires proper suppression measures to control dust to within an acceptable level.

3.4.6 There may be use of trucks for material transport from the works area to the site via the short section of the existing concrete paved EVA. Use of vehicles is a regulatory work procedure and the required dust control measures shall ensure dust levels are controlled to an acceptable level.

Cumulative Impacts

3.4.7 The construction of DSD's Yung Shue Wan STW and Outfall is tentatively scheduled to commence in August 2007 for approximately 3 years. The Helipad and STW developments have been scheduled to avoid concurrent works and cumulative air quality impacts.

Evaluation of Potential Impacts

3.4.8 The small diameter pre-bored piling works will be carried out entirely in coastal waters and no dust impacts are anticipated. There will also be some minor works carried out at the off-site works area on existing ground adjacent to the refuse transfer station.

3.4.9 In view of small scale of the works, construction dust impacts can be controlled with appropriate implementation of dust suppression measures. Moreover, dust control and suppression measures are statutory requirements under the Air Pollution Control (Construction Dust) Regulation. As such, fugitive dust impacts during the construction can be adequately controlled and no significant impacts are anticipated.

3.5 Mitigation Measures

3.5.1 All the dust control measures as recommended in the Air Pollution Control (Construction Dust) Regulation, where applicable, should be implemented. Typical dust control measures include:

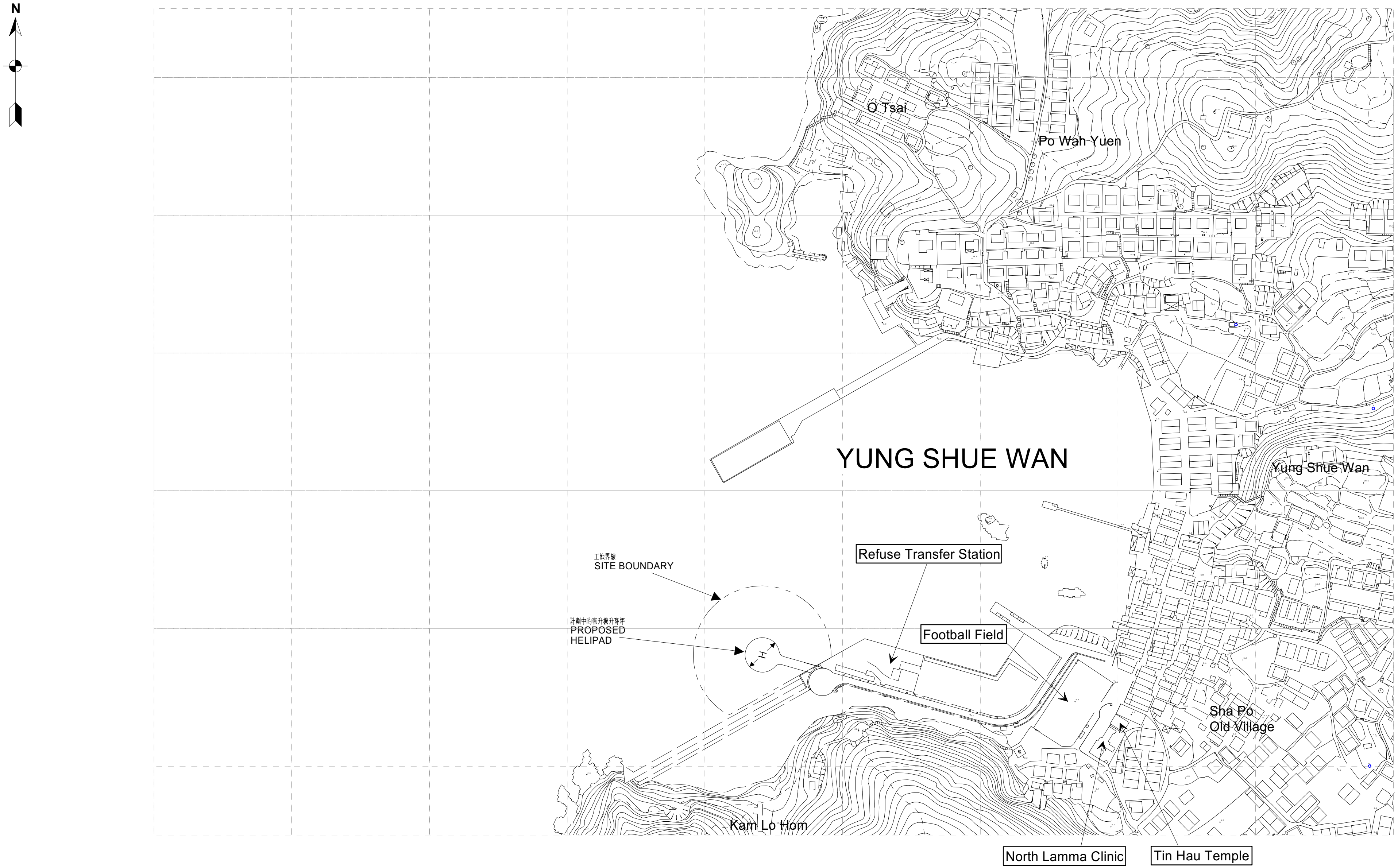
- The working area for site clearance shall be sprayed with water or a dust suppression chemicals immediately before, during and after the operation so as to maintain the entire surface wet.
- Restricting heights from which materials are dropped, as far as practicable to minimise the fugitive dust arising from unloading/loading.
- Immediately before leaving a construction site every vehicle shall be washed to remove any dusty materials from its body and wheels.
- All spraying of materials and surfaces should avoid excessive water usage.
- Where a vehicle leaving a construction site is carrying a load of dusty materials, the load shall be covered entirely by clean impervious sheeting to ensure that the dusty materials do not leak from the vehicle.
- Travelling speeds should be controlled to reduce traffic induced dust dispersion and re-suspension within the site from the operating haul trucks.
- Erection of hoarding of not less than 2.4 m high from ground level along the site boundary.
- Any stockpile of dusty materials shall be either:
  a) Covered entirely by impervious sheeting;
  b) Placed in an area sheltered on the top and the 3 sides; or
  c) Sprayed with water or a dust suppression chemical so as to maintain the entire surface wet.
- All dusty materials shall be sprayed with water or a dust suppression chemical immediately prior to any loading, unloading or transfer operation so as to maintain the dusty materials wet.

3.6 Environmental Monitoring and Audit Requirements

3.6.1 It is necessary to ensure proper implementation of the dust control measures as required under the Air Pollution Control (Construction Dust) Regulation. No specific construction dust monitoring is necessary, although environmental audits will be carried out to ensure proper implementation of air quality control measures.

3.7 Conclusions and Recommendations

3.7.1 Through proper implementation of dust control measures as required under the Air Pollution Control (Construction Dust) Regulation, construction dust can be controlled to acceptable level and no significant impacts are anticipated.



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EIA Study for Helipad at Yung Shue Wan, Lamma Island

PROPOSED HEILPAD LOCATION AND THE ENVIRONS

Figure 3.1

Drawn	DEH	Checked	RBR
Scale	1 : 4000	Date	November 2005

4 NOISE IMPACT ASSESSMENT

4.1 Introduction

4.1.1 This Section provides an evaluation of the potential noise impacts associated with the construction and operational phases of the proposed development of a helipad at Yung Shue Wan, Lamma Island.

4.1.2 During the construction phase of the helipad, power mechanical equipment (PME) used for the helipad construction will be the primary noise sources. The key noise generating activities include:

- Site clearance for the erection of site office, hoarding and fencing;
- Temporary staging construction and demolition;
- Pile installation; and
- Construction of helipad and EVA.

4.1.3 The helipad will solely be used for emergency use and associated essential 'casevac' training flights, and will not be used for commercial operations. The sole noise source during the operational phase of the Project will be from helicopter activities, as follows:

- Helicopter 'approaching' the helipad while it is descending at an angle to the helipad surface;
- Helicopter manoeuvring on and directly over the helipad; and
- Helicopter 'taking-off' from the helipad while it is climbing up at an angle to the helipad surface during departure.

4.1.4 Noise sensitive receivers (NSRs) have been identified in accordance with Annex 13 of the EIA-TM. As required under *Clause 3.4.2.2 (iii) (b)* of the EIA Study Brief, the selection of representative NSRs has been presented to and agreed by the Authority prior to commencement of this noise impact assessment.

4.1.5 Where appropriate, practicable mitigation measures are recommended to alleviate any potential noise impacts identified during both the construction and operational phases of the helipad so that the applicable noise guidelines and regulations can be achieved.

4.2 Relevant Guidelines, Standards & Legislation

Construction Noise During Non-restricted Hours

4.2.1 Noise arising from construction for designated projects during the non-restricted periods, i.e., between 07:00-19:00 hours of any days not being a Sunday or general holiday, is assessed with reference to the noise criteria listed in Table 1B, Annex 5 of the EIA-TM, which are summarised in *Table 4.1*. These criteria shall be met as far as practicable according to Annex 5 of the EIA-TM.

Table 4.1 Recommended Construction Noise Levels (Non-restricted Hours)

Noise Sensitive Receiver Uses	Noise Levels $L_{eq(30\ min)}$ dB(A)
All domestic premises including temporary housing accommodation, hotels and hostels	75
Schools	70 (normal school hours) 65 (during examination periods)

4.2.2 Subsidiary regulations of the Noise Control Ordinance (NCO) include *the Noise Control (Hand Held Percussive Breakers)* and *Noise Control (Air Compressors) Regulations*. These require compliance with relevant noise emission standards and the fixing of noise emission labels to hand-held percussive breakers and air compressor. Whilst these requirements are not directly relevant to the construction noise impact assessment, contractors must comply with these regulations during the construction phase.

Construction Noise During Restricted Hours

4.2.3 Construction noise is controlled during restricted hours, i.e., between 19:00-07:00 hours and on Sundays and public holidays (anytime for percussive piling), under the NCO and Technical Memoranda (TMs): *Noise from Percussive Piling* (PP-TM), *Noise from Construction Work Other Than Percussive Piling* (GW-TM) and *Noise from Construction Work in Designated Areas* (DA-TM).

4.2.4 A Construction Noise Permit (CNP) is required under the NCO for works involving the use of Power Mechanical Equipment (PME) during restricted hours. The noise criteria for the use of PME during restricted hours are determined upon the Area Sensitivity Rating (ASR), which 'ranks' the background noise conditions of the area in which the NSR is located. *Table 4.2* shows the ASR selection criteria as stated in GW-TM.

Table 4.2 Area Sensitivity Rating Criteria

Type of area containing the NSR	Degree to which NSR is affected by IF(4)		
	Not Affected(1)	Indirectly Affected(2)	Directly Affected(3)
(i) Rural area, including country parks or village type developments	A	B	B
(ii) Low density residential area consisting of low rise or isolated high-rise developments	A	B	C
(iii) Urban area	B	C	C
(iv) Area other than those above	B	B	C

Notes:
(1) Not Affected means that the NSR is at such a location that the noise generated by the influencing factors(4) (IFs) is not noticeable at the NSR.
(2) Indirectly Affected means that the NSR is at such a location that the noise generated by the IF, whilst noticeable at the NSR, is not a dominant feature of the noise climate of the NSR.
(3) Directly Affected means that the NSR is in such a location that the noise generated by the IF is readily noticeable at the NSR and is a dominant feature of the noise climate of the NSR.
(4) IFs are defined as industrial areas, major roads or the area within the boundary of Hong Kong International Airport.

4.2.5 The noise criteria for construction noise during restricted hours for each ASR are given in *Table 4.3*.

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

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

4.2.6 Percussive piling is only permitted when the Noise Control Authority has granted a CNP. PP-TM sets out the permitted hours of operation of percussive piling and Acceptable Noise Level (ANL) requirements, which are dependent on the architectural characteristics of the NSR. The ANL criteria for percussive piling are reproduced in *Table 4.4*. ANLs for hospitals, schools, clinics, courts of law and other particularly sensitive receivers are 10 dB(A) below the figures quoted in *Table 4.4*.

Table 4.4 Acceptable Noise Levels for Percussive Piling

Architectural Characteristics of NSR	ANL, dB(A)
No windows or other openings	100
With central air conditioning system	95
With windows or other openings but without central air conditioning system	85

4.2.7 Regardless of any description or assessment made in the following paragraphs, in assessing a filed application for a CNP the Noise Control Authority will be guided by the relevant Technical Memoranda. The Authority will consider all the factors affecting their decision taking contemporary situations / conditions into account. Nothing in this Report shall bind the Authority in making their decision, and there is no guarantee that a CNP will be issued. If a CNP is to be issued, the Authority shall include any conditions they consider appropriate, and such conditions are to be followed while the works covered by the CNP are being carried out. Failing to do so may lead to cancellation of the permit and prosecution action under the NCO.

4.2.8 There are some factors affecting the assessment results of a CNP application, such as the assigning of Area Sensitivity Rating, Acceptable Noise Levels etc. The Noise Control Authority would decide these at the time of assessment of such an application based on the contemporary situations/conditions. It should be noted that the situations / conditions around the sites may change from time to time.

Helicopter Noise

4.2.9 Table 1A, Annex 5 of the EIA-TM stipulates the noise standards of the helicopter noise (between 07:00 and 19:00 hours) for planning purposes. These are summarised in *Table 4.5*.

Table 4.5 Helicopter Noise Standards for Planning Purposes

Uses	Helicopter Noise L_{max} dB(A) 07:00 to 19:00 hours
- All domestic premises including temporary housing accommodation; - Hotels and hostels - Educational institutions including kindergartens, nurseries and all others where unaided voice communication is required - Place of public worship and courts of law - Hospitals, clinics, convalescences and home for the aged, diagnostic rooms, wards	85
Offices	90

Notes
(1) The above standards apply to uses that rely on opened windows for ventilation.
(2) The above standards shall be viewed as the maximum permissible noise levels assessed at 1 m from the external façade.

4.2.10 There are no specified evening/night-time noise guidelines for the HKSAR, and accordingly a document review of international practice was undertaken to determine international practice. The review included the US Federal Aviation Agency (US FAA), the International Civil Aviation Organization, the US-based National Organization to Insure a Sound-controlled Environment (NOISE), and various individual airport / heliport web-sites.

4.2.11 From this review it was identified that most literature on aircraft noise concerns relates to *commercial* airplane and helicopter noise. However, during the public consultation exercise for the 'US FAA [public] Hearings on [non-military] Helicopter Noise', there was a wide consensus among parties consulted that noise from *emergency medical services* was a tolerable necessity.[*] This situation also applies to existing casevac operations for Yung Shue Wan, which both GFS and CAD confirm have never received a noise complaint from the local community during day-time or night-time casevac operations. With reference to the above consideration, the local environment and other EIA reports on helicopter noise, it is expected that the 85dB(A) L_{max} could be one of the parameter to guage the possible noise impact on the residents during the evening period. The current approach adopted in Hong Kong is to curfew the general commercial helicopter activities during night-time.

4.2.12 Recognising the tolerable necessity of emergency helicopter flights it was suggested during the FAA hearings that consideration be given to imposing some regulation on these operations to reduce noise impacts to NSRs. Such consideration has been given during the course of this EIA Study in determining both the proposed helipad location and the proposed helicopter flight-path, and such details are provided in *Sub-section 4.6*.

4.3 Noise Sensitive Receivers

4.3.1 Noise sensitive receivers (NSRs) have been identified in accordance with the criteria set out in Annex 13 of the EIA-TM. The spatial scope of the noise impact assessment shall include all areas within 300 metres from the Project boundary in accordance with the EIA Study Brief.

4.3.2 Site visits have been conducted to ensure the selection of existing representative NSRs. A review of the latest Outline Zoning Plan (Lamma Island OZP No. S/I-LI/6), Outline Development Plan (Lamma Island ODP No. D/I-LI/2), and consultation with the Planning Department was conducted to identify the most likely location for future / potential future NSRs.

4.3.3 As required under *Clause 3.4.2.2 (iii) (b)* of the EIA Study Brief, the selection of representative NSRs has been presented to and agreed by the Authority prior to commencement of this noise impact assessment. A brief description of existing and planned NSRs is provided below, while *Figure 4.1* displays their locations.

Existing Noise Sensitive Uses

4.3.4 The majority of the developments along the coast of Yung Shue Wan are residential village houses, varying from single to 3 storeys high. Some of these buildings are used for commercial purpose on the ground floor, e.g., grocery store and restaurant. There are isolated and dilapidated village houses located at the north of Kam Lo Hom (currently a "Green Belt" zone) that are not occupied, and hence are not noise sensitive.[†]

[*] In the year 2000 the US FAA was requested to report to the US Congress on the effects of nonmilitary helicopter noise in densely populated areas in the U.S. and ways of reducing that noise. Verbal feedback on the unpublished report of the public consultation was provided in a telecon with Mr Sandy Liu of the US FAA (Noise Division) on 24th August 2005.

[†] According to DO's memo ref. (45) in IS 80/8/02 dated 17.12.1997 and a site visit by BMT in June 2003.

4.3.5 The first tier buildings (i.e., those with a direct line of sight to the proposed helipad) will be the most affected by helicopter noise, but in turn they will provide some noise shielding to the second tier buildings (i.e., those buildings situated behind them). The natural topography of Kam Lo Hom also provides noise shielding to the buildings located south of the existing football pitch that are laterally the closest to the helipad site [*Figure 4.1* refers].

4.3.6 The closest noise sensitive building with a direct line of sight to the helipad footprint is No. 105 Yung Shue Wan Main Street (NSR4), which is a residential village house about 220m southeast of the helipad site. This NSR is considered as the worst-case as it is not shielded and will thus be directly affected by helicopter noise generated at the helipad. At about 250m from the site, the North Lamma Clinic (NSR3) is the closest non-residential type NSR within direct line of sight of the helipad.

4.3.7 The cluster of buildings near the ferry pier also has direct line of sight to the helipad, of which the North Lamma Public Library (NSR2) is the closest to the helipad footprint at about 260m. The North Lamma Public Library is also closest to the possible helicopter flight path to / from the helipad. In addition, a village house at O Tsai (NSR1) has been selected as a representative residential type NSR.

Planned Noise Sensitive Uses

4.3.8 The main purpose of selecting planned NSRs is for the assessment of future noise impacts due to the operation of the helipad. The current Lamma Island OZP has designated a “Comprehensive Development Area (1)” (‘CDA(1)’) zone for the land already reclaimed at the south of Yung Shue Wan and for the proposed reclamation under the Yung Shue Wan Phase 2 Reclamation project west of the bay. Based on the latest information from the Planning Department [*Appendix 4.1* refers], the scale of the Phase 2 Reclamation has been reduced and the Reclamation will not be developed to the extent outlined on the current approved OZP.

4.3.9 Planning Department has advised that the land use review on the reduced reclamation at Yung Shue Wan has been completed and amendment to the OZP would be made to reflect the land use changes. Accordingly, the closest potential future NSRs would be near the existing football field and / or near the ferry pier (NSR5 and NSR6, respectively). Planned NSRs will likely be residential type village houses (maximum building height of 3 storeys) to be constructed on available land lots in the existing “Village Type Development” (‘V’) zone.

4.3.10 The characteristics of NSRs in the vicinity of the proposed Yung Shue Wan Helipad are summarised in *Table 4.6*. *Figure 4.1* illustrates their locations.

Table 4.6 Location of NSR Assessment Points in Yung Shue Wan

NSR Assessment Point	NSR Location	Number of storeys	Ground Level (mPD)	Land Use
NSR1	Village House at O Tsai	3	20.0	Residential
NSR2	North Lamma Public Library	1	4.0	Library
NSR3	North Lamma Clinic	1	3.3	Clinic
NSR4	No. 105 Yung Shue Wan Main Street	3	3.2	Residential
NSR5*	Future Development in “Village Type Development” Zone (near existing football pitch)	3#	3.1	Residential
NSR6*	Future Development in “Village Type Development” Zone (near existing ferry pier)	3#	15.5	Residential

Notes:

* *Future NSR.*

\# *Assume a 3-storey high (8.23 m) residential building, based upon the most updated Lamma Island OZP No.S/I-LI/6 available (gazetted on 1.4.2005), excluding the proposed Yung Shue Wan Phase 2 Development.*

4.4 Noise Environment at Yung Shue Wan

Existing Noise Environment at NSRs

4.4.1 Lamma Island is an outlying island with limited road network and has no major road traffic related noise sources. However, it is observed from site visits that there are motorised carts travelling on access routes within the Yung Shue Wan area that may create noise disturbance. Yung Shue Wan is a popular tourist destination and the noise environment is dominated by human activities, with most activities during the daytime, and particularly at weekends and public holidays.

Future Trend

4.4.2 Based on the latest planning information, the Yung Shue Wan Phase 2 development work and Drainage Services Department's (DSD's) Yung Shue Wan Sewage Treatment Works (STW) will be potential noise sources. During the Phase 2 development works and construction of the STW, NSRs close to the works site will be subject to construction noise, although upon completion of the works no significant change in the noise environment at Yung Shue Wan is anticipated.

4.5 Construction Noise Impact Assessment

Assessment Methodology

4.5.1 This construction noise impact assessment has been conducted based on the construction schedule and equipment inventory as presented in *Appendix 2.2* and *Appendix 4.2*, respectively. The construction schedule provided by CEDD is based upon all works to be undertaken during non-restricted hours only. Construction noise impacts at representative NSRs were assessed in accordance with Annex 13 of the EIA-TM. The noise level at the most affected floor (i.e., 1/F) has been assessed and corrections such as façade correction and barrier correction have been applied as appropriate.

4.5.2 Based on the construction schedule, the noise assessment has been divided into 24 'assessment periods' throughout the 18-month construction programme in accordance with the worst-case sound power level that may arise from the Site. Each 'assessment period' represents a distinct construction task in the overall programme that can be used as a basis for construction noise impact assessment.

Identification of Potential Construction Noise Impacts

4.5.3 It is anticipated that the use of Powered Mechanical Equipment (PME) during the construction phase will generate potential noise impact upon the existing NSRs in the vicinity of the helipad site. Based on a practicable equipment inventory provided by the Project Proponent, *Table 4.7* presents the likely PME that shall be used to construct the Project according to schedule and the corresponding sound power levels.

Table 4.7 Powered Mechanical Equipment to be used for Construction of Helipad

Identification Code	Description	Sound Power Level, dB(A)
CNP 021	Bar bender (electric)	90
CNP 044	Concrete lorry mixer	109
CNP 047	Concrete pump, stationary/ lorry mounted	109
CNP 048	Crane, barge mounted (diesel)	112
CNP 061	Flat top barge	104
CNP 081	Excavator/ Backhoe	112
CNP 102	Generator, Silenced	100
CNP 068	Mini-truck	105
CNP 172	Vibrator	115
CNP 166	Piling, large diameter bored, reverse circulation drill	100
CNP 167	Auger	114
CNP 170	Poker, vibratory, hand-held	113
CNP 221	Tug boat	110

Source: GW-TM and Sound power levels of other commonly used PME issued by EPD.

4.5.4 The entire construction sequence can be separated into four activities according to the construction schedule given in *Appendix 2.2* and as summarised in *Table 4.8*. The geographical centres of each activity for determining equipment locations (i.e., notional source position*) to calculate construction noise levels are presented in *Figure 4.2*.

Table 4.8 Construction Activities

Construction Activities	Details of Works
Site Clearance	• Erection of office, hoarding and fencing
Mobilisation	• Plant set up; • Construction of working platform; • Mobilising and assembling of drilling machine; and • Ground investigation.
Pile Installation	• Pre-drilling; • Drilling and installing casing; • Install H-pile; • Concreting; and • Preliminary/main pile test.
Helipad Construction	• Construction of beams and slabs for helipad/EVA; • Construction of wave return walls for helipad/EVA; and • Road and drainage works.
E&M Works	• E&M installation; and • E&M testing and commissioning.
Demobilisation	• Demobilise the working platform and plant.

* Notional source position - the location of all the PME to be grouped at the position mid-way between the approximate geographical centre of the construction activity and its boundary nearest to the NSR.

Prediction and Evaluation of Construction Noise Impacts

4.5.5 Based on the construction schedule and equipment inventory, the predicted unmitigated construction noise levels for each assessment period is summarised in Table 4.9. Detailed calculations are presented in *Appendix 4.3*.

Table 4.9 Predicted Construction Noise Levels $L_{eq(30\ min)}$ dB(A) - Unmitigated

Assessment Period †	NSR1	NSR2	NSR3	NSR4	NSR5	NSR6
1	59	60	69	71	69	60
2	66	68	71	73	71	67
3	65	67	71	73	71	66
4	65	67	71	73	71	66
5	68	69	72	74	72	68
6	64	66	67	69	67	65
7	64	66	67	69	67	65
8	60	61	63	64	62	60
9	60	61	63	64	62	60
10	63	64	66	67	65	63
11	67	68	70	71	69	67
12	66	67	69	70	68	66
13	68	69	71	72	70	68
14	67	68	70	71	69	67
15	66	67	69	70	68	66
16	65	66	68	69	67	65
17	60	61	63	64	62	60
18	68	69	71	72	71	68
19	68	69	71	72	71	68
20	68	69	71	72	71	69
21	68	69	71	72	71	69
22	59	60	62	63	62	59
23	52	53	55	56	54	52
24	63	64	66	67	65	63

Notes: † 'Assessment Period' refers to distinct construction tasks in the works programme [Appendix 2.2 refers].

4.5.6 The highest unmitigated construction noise level at the closest NSR (i.e., NSR4) is predicted to be 74 dB(A). This level complies with the noise standard stipulated in Table 1B, Annex 5 of the EIA-TM.

Mitigation of Adverse Construction Noise Impacts

4.5.7 The predicted construction noise levels at representative NSRs comply with the noise standard. Therefore, no mitigation measures are required. Nevertheless, it is recommended that the Contractor should adopt good working practices in order to minimise construction noise as far as possible:

a) Noisy equipment and noisy activities should be located as far away from the NSRs as is practical;
b) Unused equipment should be turned off;
c) Powered mechanical equipment should be kept to a minimum and the parallel use of noisy equipment / machinery should be avoided;
d) Regular maintenance of all plant and equipment; and
e) The Contractor shall observe and comply with the statutory requirements and guidelines.

Cumulative Noise Impacts

4.5.8 As mentioned in *Section 2*, it is identified that the Yung Shue Wan Phase 2 Development Engineering Works will commence in Year 2008. Therefore, there will be no cumulative impacts from the development works. However, the completed Phase 1 reclamation immediately south of the proposed helipad is reserved for development of DSD's Sewage Treatment Works (STW). According to the preliminary STW construction programme, the 3-year construction period may commence in August 2007. Therefore, both sites would not be constructed in parallel.

4.5.9 Furthermore, there is a temporary helipad currently operated by GFS at the STW site. The permanent helipad will replace the temporary helipad for emergency casevac. However, if the permanent helipad construction is not completed before STW construction commences, the temporary helipad will need to move back to the Lamma Power Station. So as not to affect emergency helicopter services, CEDD and DSD have agreed to avoid any overlap in the development of these two projects. As such, cumulative construction noise impacts are not anticipated.

4.6 Operational Noise Impact Assessment

Assessment Methodology

4.6.1 Noise associated with the proposed helipad at Yung Shue Wan will be generated during helicopter manoeuvring over the helipad and during lateral (approach / departure) flight. The different operational modes that may generate noise are summarised as follows:

Without Lateral Movements

Helicopter manoeuvring above the helipad within the Final Approach and Take-off Areas (FATO)* includes several modes:

- 'Hovering' – helicopter turns on the spot over the helipad to achieve the desirable orientation for touchdown / lift-off;
- 'Touchdown' – helicopter descends on to the helipad surface;
- 'Idling' – helicopter remains on the helipad surface with its rotary blades kept running; and
- 'Lift-off' – helicopter ascends vertically from the helipad surface to achieve a hover before departure.

With Lateral Movements

a) Helicopter 'approaching' the helipad while it is descending at an angle to the helipad surface; and
b) Helicopter 'taking-off' from the helipad while it is climbing up at an angle to the helipad surface.

4.6.2 According to Table 1A, Annex 5 of the EIA-TM, helicopter noise impacts shall be assessed in terms of the L_{max} level, which is the maximum instantaneous sound pressure level at the noise sensitive receiver. Since all the identified NSRs are located at considerable distances (over 150 m) from the helipad, helicopter noise can be considered as a 'point' source. Therefore, the sound pressure level at NSRs can be evaluated based on standard acoustic principle of a 'point' source, i.e., the sound pressure level in any direction (in the open) will decrease at a rate of 6 dB per doubling of distance away from the source. The difference in noise levels at two different distances, r_1 and r_2, can be calculated using the following formula:

$$\text{Noise Level Difference (dB)} = 20 \log_{10}\left(\frac{r_2}{r_1}\right)$$

* With reference to the GFS Helipad Specification Guidelines, a 'FATO' is an area over which a helicopter completes the approach manoeuvre to a hover or landing, or commences into forward flight during take-off. All final approaches shall terminate at the FATO and all take-off movements shall start there.

4.6.3 Noise source terms (i.e., the L_{max} at a given distance) of each helicopter operation mode has been provided by the Government Flying Service (GFS). On site noise measurements have also been conducted to supplement the noise source terms data.

4.6.4 The International Civil Aviation Organization (ICAO) has stipulated noise standard for helicopters for different flying modes, including 'approach', 'take-off' and 'flyover' (i.e., the maximum noise level [in EPNdB] used as the noise certification standards adopted by the Council of ICAO). The noise standards for the two types of GFS' helicopter used for 'casevac' operations are summarised in *Table 4.10*, with test noise measurement points for each flying mode illustrated in *Appendix 4.4*. *Table 4.10* also presents the Demonstrated Noise Level data for the GFS helicopters as tested by the helicopter manufacturer (i.e., the noise level for that helicopter type measured by the manufacturer in accordance with standard technical procedures in the ICAO noise certification).

Table 4.10 Helicopter Noise Data – Airborne Helicopter with Lateral Movements

Reference Measurement Configurations	Super Puma AS332 L2		EC155 B1	
	ICAO Max. Noise Level EPNdB	Demonstrated Noise Level EPNdB	ICAO Max. Noise Level EPNdB	Demonstrated Noise Level EPNdB
Approach	100.7 (87.7)	96.1 (83.1)	97.9 (84.9)	95.7 (82.7)
Take-off	99.7 (86.7)	94.6 (81.6)	96.9 (83.9)	92.2 (79.2)
Flyover	98.7 (85.7)	93.5 (80.5)	95.9 (82.9)	88.9 (75.9)

Notes:
Figures in brackets are the L_{max} values.
L_{max} = EPNdB – 13, with reference to the 'Transportation Noise Reference Book' (Nelson, 1987).

4.6.5 Based on the given noise data in *Table 4.10*, the 'approach' mode generates the highest noise level when the helicopter is airborne with lateral movements. Accordingly, the helicopter noise assessment makes reference to the ICAO standard for the approach mode that represents the worst-case scenario. By assessing the worst-case scenario any uncertainty in the quantitative prediction has been taken into consideration.

4.6.6 According to GFS Helipad Specification Guidelines, the helicopter approach and departure trajectory will be projected at an 8% slope within 245 metres from the edge of the helipad. Beyond 245 metres the slope increases to 12.5%. GFS has advised that the approach and departure angle is generally within the sector of 250-330 degrees from the centre of the helipad for the EC155 B1 type helicopter, and 250-320 degrees for the Super Puma AS332 L2 type helicopter [*Figure 4.3* refers]. Accordingly, the closest distance between the airborne helicopter and the identified NSR (on the top floor) can be measured and used for evaluating the worst-case noise level.

4.6.7 The ICAO standards do not include standards for helicopter manoeuvring on and over the helipad, i.e., hovering, touchdown, idling and lift-off. As such, on-site noise surveys on GFS's helicopters were conducted at GFS helipad at Chek Lap Kok on 24th June 2003 to generate supplementary noise data. The noise survey involved measuring the L_{max} noise level generated by the GFS helicopters simulating manoeuvring on and over a helipad. The measurements were taken at the far-field region such that the formula quoted below paragraph 4.6.2 can be applied. The L_{max} noise level measured has been used for assessing the worst-case scenario when the helicopter is at the helipad. Details of the helicopter noise survey are provided in *Appendix 4.5*.

4.6.8 It was found that the L_{max} noise level is less when the helicopter is idling (with rotors on) on the ground than the L_{max} noise level occurs when the helicopter is in the air without lateral movements (either during hovering or lift-off mode). *Table 4.11* displays the measured L_{max} noise levels.

Table 4.11 Measured L_{max} Noise Level of GFS Helicopters – Without Lateral Movements

Measurement Configurations (Reference distance: 150m)	Super Puma AS332 L2	EC155 B1
Helicopter on ground, Idling	82.0	80.0
Helicopter in the air *	90.6	87.7

Notes:
Lmax noise levels in dB(A).
** For 'Super Puma AS332 L2', the L_{max} noise level was measured during the hovering mode.*
For 'EC155 B1', the L_{max} noise level was measured during the lift-off mode.

Identification of Potential Noise Impacts

4.6.9 Assessment of helicopter noise has been conducted for each of the operational modes as introduced in paragraph 4.6.1.

4.6.10 The GFS will use the proposed helipad for 'casevac' operations. GFS helicopter fleet comprises two helicopter types: the 'Super Puma AS332 L2' and the 'EC155 B1'. The 'Super Puma AS332 L2' has a higher maximum operational weight than the 'EC155 B1', and hence operates at a higher power output and generates a higher noise level. However, GFS has agreed to deploy the 'EC 155 B1' type helicopter whenever possible for 'casevac' operations, and only under very special circumstances shall the 'Super Puma AS332 L2' be deployed.

4.6.11 The Super Puma was introduced into the GFS helicopter fleet in November 2001, while the EC155 B1 was introduced into the GFS fleet in November 2002. Prior to this time the GFS relied on Sikorsky S76 / Sikorsky S70 type helicopters for casevac operations, and these were phased out during 2003. *Table 4.12* summarises actual GFS helicopter usage data for 'casevac' operations from 2000 through 2004.

Table 4.12 Helicopter Use for Yung Shue Wan 'Casevac' Operations during years 2000 – 2004

Year	Total No. of Casevac from 0700 to 2200 hours[1]	Total No. of Casevac from 2200 – 0700 hours[2]	No. of Casevac Training Flights[3]
2000	51 (1)	30	3
2001	69 (7)	39	4
2002	104 (13)	37	6
2003	92 (7)	34	5
2004	66 (1)	29	4

Notes:
1. *The figures in brackets ( ) are the number of casevac flights carried out by Super Puma (or Sikorsky prior to 2004).*
2. *Since 2003, all night-time casevac has been undertaken using the EC155 B1 type helicopter only, although for the purpose of this noise impact assessment it cannot be discounted that the Super Puma may be required for night-time casevac in future years.*
3. *Five casevac-training flights were conducted to the Yung Shue Wan helipad in 2003 (i.e., an additional 4% of the total casevac flights). As no such data is available for other years, the number of casevac training flights for 2000-2002 and 2004 have been calculated using the same % contribution. It should be noted that GFS does not anticipate any increase in training flights in the short to medium term as the helicopter fleet was upgraded in 2001/02 and there are no plans to add additional types of helicopters.'*

4.6.12 Using the flight data for the year 2002 as a worst-case scenario, it has been assumed that there may be a total of 147 flights in a single year. Of this total it has been assumed that the 'Super Puma' would be operated for up to 13 casevac flights a year. In the absence of a specific data breakdown, it has also been assumed that two of the six training flights would be using the Super Puma. Overall, as a worst-case scenario it is assumed that the Super Puma would be used on no more than 15 occasions in a year: equivalent to one flight every 24.3 days.

4.6.13 Using the same calculation method, and including all nigh-time flights, it has been assumed that the EC155 B1 type helicopter would be used for casevac at Yung Shue Wan on no more than 132 occasions in a year: equivalent to one flight every 2.8 days.

Cumulative Helicopter Noise Impacts

4.6.14 Upon commencement of operations at the proposed Yung Shue Wan helipad, use of the currently temporary landing site on the future STW will cease. The HEC helipad located approximately 800 metres southwest of the proposed helipad is infrequently used. In addition, GFS also confirmed that only one helicopter will use the helipad at one time and therefore no cumulative noise impacts are anticipated.

4.6.15 There is no other significant noise source in the area that may contribute to a cumulative operational noise effect.

Prediction and Evaluation of Noise Impacts

Without Lateral Movements

4.6.16 The assessment of helicopter noise generated at the helipad is based on the L_{max} noise levels of the helicopter manoeuvring over the helipad and the horizontal separation between the helipad and identified NSRs. *Table 4.13* summarises the calculated L_{max} noise levels at the identified NSRs. Details of the calculation are provided in *Appendix 4.6*.

Table 4.13 Worst-case Helicopter Noise Levels at NSRs during Helicopter Manoeuvring

NSR ID	Horizontal separation to centre of the Helipad (metres)	L_{max} @ NSR dB(A) [1]		Façade Correction dB(A)	Corrected L_{max} @ NSR dB(A)	
		Super Puma AS332 L2	EC155 B1		Super Puma AS332 L2	EC155 B1
NSR1	301	85 (76)	82 (74)	3	**88** (79)	85 (77)
NSR2	257	**86** (77)	83 (75)	3	**89** (80)	**86** (78)
NSR3	246	**86** (78)	83 (76)	3	**89** (81)	**86** (79)
NSR4	221	**87** (79)	84 (77)	3	**90** (82)	**87** (80)
NSR5*	263	**86** (77)	83 (75)	3	**89** (80)	**86** (78)
NSR6*	292	85 (76)	82 (74)	3	**88** (79)	85 (77)

Notes:
[1] Calculated with reference to measured L_{max} noise level at reference distance of 150m.
** Future NSR.*
Figures in brackets are the L_{max} during the idling mode.
Bold figures indicate exceedance of the L_{max} 85 dB(A) limit.

4.6.17 The evaluation results in *Table 4.13* show that the worst-case L_{max} noise level during helicopter manoeuvre above the helipad will be 90 dB(A) at NSR4 when a 'Super Puma AS332 L2' helicopter is in hovering mode, and 87 dB(A) when an 'EC155 B1' helicopter is lifting off (i.e., ascending vertically) from the helipad. With both helicopter types the worst-case L_{max} exceeds the 85 dB(A) limit. The worst-case L_{max} noise level during the idling mode is less than the 85 dB(A) limit for both helicopter types.

4.6.18 It has been calculated that during helicopter manoeuvring, the minimum distance separation between the helipad and an NSR to comply with the 85 dB(A) helicopter noise limit is 386m for the 'Super Puma AS332 L2' in hovering mode, and 276m for the 'EC155 B1' in lift-off mode [*Figure 4.4a* refers].

With Lateral Movements

4.6.19 Regarding the helicopter approach mode, the projected worst-case trajectory of the approach path (i.e., closest to the NSR), is at the line with a bearing of 330 degrees to the centre of the helipad for 'EC155 B1' helicopters and 320 degrees for 'Super Puma AS332 L2' helicopters. NSR1, NSR2 and NSR6 are closest to the approach path and will therefore be the most affected by helicopter noise during approach.

4.6.20 *Table 4.14* and *Table 4.15* display the worst-case L_{max} noise levels based upon the closest slant distance between the helicopter and the top floor of the NSRs. Calculations are based on the ICAO maximum noise level. Calculation details are provided in *Appendix 4.6*.

Table 4.14 Worst-case Helicopter Approach / Departure Noise Levels at NSRs from the Super Puma AS332 L2 Type Helicopter

NSR ID	Slant distance between helicopter & NSR (metres)	L_{max} @ NSR dB(A) [1]	Façade Correction dB(A)	Corrected L_{max} @ NSR dB(A)
NSR1	253	81	3	84
NSR2	226	82	3	85
NSR3	246	82	3	85
NSR4	221	82	3	85
NSR5*	263	81	3	84
NSR6*	281	80	3	83

Notes:
[1] Calculated with reference to ICAO maximum noise level (i.e., noise standard) at reference distance of 120m.
** Future NSR.*

Table 4.15 Worst-case Helicopter Approach / Departure Noise Levels at NSRs from the EC155 B1 Type Helicopter

NSR ID	Slant distance between helicopter & NSR (metres)	L_{max} @ NSR dB(A) [1]	Façade Correction dB(A)	Corrected L_{max} @ NSR dB(A)
NSR1	220	80	3	83
NSR2	201	80	3	83
NSR3	246	79	3	82
NSR4	221	80	3	83
NSR5*	263	78	3	81
NSR6*	261	78	3	81

Notes:
[1] Calculated with reference to ICAO maximum noise level (i.e., noise standard) at reference distance of 120m.
** Future NSR.*

4.6.21 With reference to *Table 4.14* and *Table 4.15*, the worst-case L_{max} noise level for the helicopter approach mode complies with the 85 dB(A) limit for both 'EC 155 B1' and 'Super Puma AS332 L2' helicopters. Note that while compliance with the 85 dB(A) daytime standard is anticipated, helicopter noise nuisance may still be experienced.

Mitigation of Adverse Noise Impacts

4.6.22 Noise levels from helicopter manoeuvring over the helipad will likely exceed the L_{max} 85 dB(A) limit at some NSRs for both helicopter types. Accordingly, the feasibility of adopting various direct mitigation measures has been investigated with reference to Annex 13 of the EIA-TM. These measures are discussed below. As the predominant user of the proposed helipad, GFS has been consulted on the various measures and has advised on the practicality of mitigation measures in terms of helicopter operations, as appropriate.

<u>Alternative land use arrangement and siting:</u>

4.6.23 With reference to the current statutory Lamma Island Outline Zoning Plan OZP No. S/I-LI/6, the selected helipad site is located within a "Government, Institution or Community" ("G/IC") zone. According to the Notes of the OZP, Helicopter Landing Pad is a column 2 use that may be permitted with or without conditions on application to the Town Planning Board. This site is considered to be optimally located in terms of operational safety, accessibility from the North Lamma Clinic and environmental implications.

4.6.24 In order to completely contain the helicopter noise (i.e., manoeuvring noise) to within the 85dB(A) standard, relocating the helipad approximately 80 metres further westwards from the proposed *'Option B, Alternative B1'* site was considered: *'Option B, Alternative B2'*. A total EVA extension of 270 metres would be required to eliminate manoeuvring noise from the 'Super Puma' type helicopter due to its higher noise level (i.e., the helipad would have to be located ≥386m from the nearest NSR within direct line of sight).* However, the marine traffic risk related to an EVA extension of 270m is not preferred by the Marine Department as it would reduce the area of navigable water between the '*Option B, Alternative B2*' and the existing ferry pier, thereby increasing the proximity of marine traffic and the risk of vessel collision. Furthermore, Marine Department is of the view that in order to minimise the marine traffic risk the proposed helipad location should not be extended any further offshore from the proposed '*Option B, Alternative B1*' location [*Figure 2.1* refers].

4.6.25 Considering the potential increase of marine traffic risk and delay of helipad, further offshore extension of the EVA from the proposed '*Option B, Alternative B1*' is infeasible.

4.6.26 In order to completely contain the helicopter noise to within the 85dB(A) standard, relocating the helipad approximately 150 metres further to the southwest from the proposed '*Alternative B1*' site was considered (i.e., '*Option E*'). However, such relocation via a marine EVA (i.e., '*Alternative E1*') would place the EVA directly in front of the proposed Yung Shue Wan STW, and across the proposed marine outfall from the STW. Such an arrangement is not supported by Drainage Services Department as it would impede construction and maintenance of the marine outfall, and would prevent marine access to the proposed STW. The land-based EVA (i.e., '*Alternative E2*'; *Figure 2.1* refers) would encroach on undisturbed woodland at the foot of Kam Lo Hom requiring tree felling and land clearance, and AFCD has stated that this alternative is undesirable in terms of ecology / nature conservation.

<u>Screening by Noise Tolerant Buildings</u>

4.6.27 The nearby Refuse Transfer Station (RTS) could be a noise tolerant building approximately 6 metres high, but it is not a solid structure that can form an effective noise screen to NSRs 3-5. The land area around the proposed helipad Site is limited, and there are no options to construct any noise tolerant buildings in the vicinity in the future due to the lack of land. Moreover, development of any buildings in the vicinity of the proposed helipad may also introduce constraints on flight safety.

* The calculated EVA extension distances of 80 metres (EC155 B1) and 270 metres (Super Puma) represent the intersection point of two lines at which the helicopter noise is able to comply with the 85 dB(A) limit. These lines are drawn: (i) from the nearest NSR; and (ii) along the alignment of the current proposed EVA [*Figure 4.4c* refers].

Setback

4.6.28 The proposed helipad does not involve any building development, so *building* setback is not relevant.

4.6.29 A smaller re-positioning of the proposed *Option B, Alternative B1* location from the “G/IC” zone gazetted for the helipad on the latest OZP was also investigated. The objective was to further refine the proposed location to optimise shielding of NSRs by the natural topography of the Kam Lo Hom headland. However, a minimum shift of 25m further west would be required to reduce residual noise impacts on approximately eight NSRs. Ultimately, such as shift would require amendment of the OZP under Section 12A of Town Planning (Amendment) Ordinance 2004, and would delay project implementation and may infringe marine access to the proposed STW.

Decking Over

4.6.30 This measure relates to road traffic noise control and is not applicable to helicopter noise control.

Extended Podium

4.6.31 The proposed helipad does not involve any building development. This option is not applicable.

Building Orientation

4.6.32 The proposed helipad does not involve any building development, so this measure is not applicable.

Treatment of Source

4.6.33 GFS has agreed to give priority to deploying the quieter ‘EC155 B1’ type helicopter for ‘casevac’ and emergency operations at Yung Shue Wan wherever practicable [*Table 4.12* refers]. However, it is not possible to exclude the ‘Super Puma’ from using the helipad in serious emergency situations when a larger capacity helicopter type is required. As the ‘Super Puma’ and ‘EC155 B1’ type helicopters were only introduced into GFS fleet late in 2001 and 2002 respectively, there are no plans at this time to replace the existing helicopter fleet.

Alternative Alignment

4.6.34 GFS has already agreed to reduce the angle of the helicopter flight path from the standard 150 degrees to 80 degrees for the ‘EC155 B1’ and to 70 degrees for the ‘Super Puma AS332 L2’ helicopter. This re-alignment had the effect of increasing the distance between the noise source (helicopter) and the noise sensitive receiver (residential area) so that helicopter approach / departure noise was reduced to within the 85 dB(A) standard [*Figure 4.4(a)* refers]. Thus, this measure has effectively eliminated the residual helicopter flight path noise impacts on approximately 420 noise sensitive dwellings during approach / departure of the ‘EC155 B1’ type helicopter and on approximately 300 noise sensitive dwellings during approach / departure of the ‘Super Puma’ type helicopter [*Figure 4.4(b)* refers].

4.6.35 A further reduction in the flight path angle cannot eliminate the residual helicopter *manoeuvring* noise that is generated by the helicopter on or over the helipad surface. The only way manoeuvring noise can be reduced / eliminated is to locate the helipad further from noise sensitive buildings [paras. 4.6.23 – 4.6.27 refer].

Noise Barrier / Enclosure

4.6.36 In the case of the Yung Shue Wan helipad, physical structures such as noise barriers / enclosures cannot be constructed to provide effective noise shielding of the helicopter noise. This is because the noise is airborne (at an elevation of approximately 17 mPD) and will be emitted when the helicopter is at a linear distance of approximately 30 metres from the helipad.

Special Building Design

4.6.37 The proposed helipad does not involve any building development, and therefore this measure is not applicable.

Architectural Features / Balcony

4.6.38 The proposed helipad does not involve any building development, and therefore this measure is not applicable.

Open-textured Road Surfacing

4.6.39 This measure is not applicable to helicopter noise control.

Indirect Mitigation Measures

4.6.40 The application of indirect mitigation measures would require installation of acoustic insulation into all NSRs at which the predicted L_{max} exceeds 85 dB(A). Effective indirect mitigation requires that NSR occupants comply with a 'closed-window' living environment during helicopter manoeuvring.

4.6.41 It is considered that such measures would not be effective, as residents would receive no prior notice of an impending helicopter arrival. In addition, the short impact duration (5 – 10 seconds) means that the impact event would be over by the time a response could be made. Accordingly, mitigation measures would not be a practicable means of noise mitigation and they are not recommended.

Evaluation of Residual Impacts

4.6.42 Adverse helicopter noise impact is not anticipated due to the short impact duration of 5 – 10 seconds. The significance of the residual helicopter noise impact has been considered in accordance with appropriate factors referred to under section 4.3.3 of the TM on the EIA Process, as set out below.

Effects on public health and Risk to life

4.6.43 In terms of effect on public health, the proposed helipad location and flight path will reduce the ambient noise level on the exposed community compared with the currently tolerated situation. As regards the duration of the residual impact, it is known that the sense of hearing becomes less acute when the ear is exposed to intense loud noise for a period of time (Ward *et al*, 1959). Furthermore, the Factories and Industrial Undertakings (Noise at Work) Regulation (CAP 59T) established a daily personal exposure (L_{epd}) noise level of 85 dB(A), meaning that a person exposed to noise level of 85dB(A) for 8 hours may require hearing protection.[*] As a basis for comparison only, the anticipated duration of the residual helicopter noise impact will be no more than 10 seconds, equivalent to a L_{epd} of 51 - 55 dB(A). As such the effect of the residual helicopter noise on public health will be insignificant.

4.6.44 As regards risk to life, the proposed helipad is not a hazardous source and there shall be no storage of fuels or other dangerous goods at the site. There is also no risk to life associated with the construction of the helipad. However, it is considered that the improved access to urban areas for medical treatment in emergency situations that the proposed helipad offers when compared with the previous reliance on HEC Ltd's Lamma Power Station may potentially decrease the risk to life.

[*] www.legislation.gov.hk/blis_export.nsf/CurAllEngDocAgent?OpenAgent&Chapter=59 [Section 2 & Schedule refer]

Magnitude, duration and frequency of Impact

4.6.45 After taking into account all the practicable direct mitigation measures, the worst-case L_{max} noise levels are predicted to be 90 dB(A) [residual noise is 5 dB(A)] resulting from hovering of a 'Super Puma AS332 L2' type helicopter and 87 dB(A) [residual noise is 2 dB(A)] due to lift-off by a 'EC155 B1' type helicopter at NSR4. The noise impact duration will last 5-10 seconds according to GFS. No adverse helicopter idling noise impact is predicted.

4.6.46 It should be noted that GFS primarily uses the EC155 B1 type helicopter for casevac operations at Yung Shue Wan. With reference to the casevac data from GFS for the period 2000-2004, the flight frequency of the Super Puma and EC155 B1 type helicopter is equivalent to one flight every 24.3 days and 2.8 days, incurring a maximum 5 dB(A) and 2 dB(A) exceedance of the 85 dB(A) limit, respectively. The duration of the residual impact would be 5-10 seconds per event.

4.6.47 GFS has been directly consulted throughout the preparation of this EIA study report, and being fully aware of the residual helicopter noise issue, has expressed a willingness to avoid use of the Super Puma whenever practicable (i.e., provided the 'EC155 B1' is available). Based on actual GFS casevac data for 2003 and 2004, only the 'EC155 B1' has been used for night-time casevac. However, it cannot be discounted that under special circumstances (e.g., large-scale emergency) the use of the 'Super Puma' may be required for night-time casevac.

Geographic extent and likely size of community that may be affected

4.6.48 The first tier buildings with facades directly facing the Yung Shue Wan bay area would likely be subject to the residual helicopter noise impact. Approximately 75 dwellings within 276 metres of the helipad, and with a direct line of sight, would be affected during lift-off of the 'EC155 B1' type helicopter. Similarly, approximately 360 dwellings located at or within 386 metres, and with a direct line of sight, of the helipad would be affected by the 'Super Puma AS332 L2' type helicopter during hovering. *Figure 4.4(a)* displays the locations of these noise sensitive buildings.

4.6.49 With reference to the Notes of the draft Lamma Island OZP No. S/I-LI/6 (dated 1st April 2005), it indicates the planned population for Lamma Island of about 12,000 persons compared with the population of around 5,500 persons. However, it is not anticipated that any such future population growth will significantly increase the population exposed to residual helicopter noise, given that the land closest to the proposed helipad has already been developed.

4.6.50 The predicted residual helicopter noise impacts associated with the proposed helipad operation will only occur locally, i.e., at Yung Shue Wan and within an affected zone. There will be no spread of such noise impacts elsewhere.

Reversibility of Impact

4.6.51 The operational helicopter noise impact shall be reversible. The impact will occur on a less than daily basis, and each residual impact event shall be of short duration.

Other Considerations

4.6.52 Consideration had been given to eliminating this residual noise impact altogether, such as relocating the proposed helipad further north or west. However, such proposals are not acceptable due to environmental, risk and accessibility concerns.

4.6.53 Consideration has been given to constructing physical structures such as noise barriers / enclosures to provide effective noise shielding of the helicopter noise (para. 4.6.36), although the erection of such structures is not practicable. Taking into account the various other mitigation measures that have been considered / adopted as outlined in para. 4.6.22 to 4.6.41, it would appear that there would still be a residual noise impact of up to 5 dB(A). Considering that this residual noise impact is of short duration, lasting < 10 seconds per event, as well as occurring only once about every 2.8 days for EC155 B1 and 24.3 days for Super Puma, this will not cause long term noise nuisance to the nearby affected residents.

4.6.54 As residual noise may be audible during night-time from 7pm to 7am, research was undertaken to identify a suitable local or international guideline to govern helicopter noise at night. The proposed use of the helipad is for emergency use. Research into the public consultation exercise for the United States of America Federal Aviation Agency Hearings on [Non-military] Helicopter Noise has indicated that noise from emergency medical helicopter services was exempted from the list of 'Recommended Noise Reduction Approaches'. There was a wide consensus among stakeholders that emergency helicopter service is a tolerable necessity, although consideration may also be given to imposing some regulation on operations to reduce noise impacts to NSRs. One example would be to require helicopters to use flight routes that take them as a matter of regulation over the least densely populated areas (para *4.2.11* refers).

4.6.55 Locally there is no standard for helicopter noise at night-time. In accordance with the Civil Aviation (Aircraft Noise) Ordinance (Cap 312), which is the legislative means in Hong Kong to control the helicopter noise arising from the operation of the helipad, administrative means can be used to reduce the noise impact of the helipad operations on the NSRs. However restrictions such as limiting the number of helicopter flights at night time or restrictions on the operating hours of the helipad are not practical as the use concerned is for emergency service, which will be on an as needed basis that cannot be controlled.

4.6.56 Regarding the control of helicopter flightpath, the proposed route displayed *Figure 4.3* represents the best arrangement to satisfy operational requirements. As the helipad is for emergency purposes, and considering that this is a tolerable necessity, it is proposed that construction of the helipad at the proposed location is acceptable. This view is supported not only by the findings of the technical assessment, but also from community feedback from the Value Management exercise [*Sub-section 2.2* refers] and the fact that the pre-1998 landing site outside the North Lamma Clinic did not lead to any recorded noise complaints.

4.6.57 The only environmental impact arising from the proposed helipad is the residual noise impact. To totally remove the residual noise impact will involve further relocating the proposed site westwards which will not be acceptable as outlined above. Also, since the residual noise impact has been identified as being of short duration and infrequent occurrence, it will not lead to any long-term serious environmental implications.

4.6.58 In August 2005, with the assistance of GFS, noise measurements of the 'EC155 B1' and 'Super Puma AS332 L2' type helicopters were conducted at representative NSRs as the helicopters simulated manoevring activities on and adjacent to the temporary and proposed permanent helipads. Noise measurements were made at the four NSRs displayed by *Figure 4.5*, with two of the NSRs having been used in the impact assessment (i.e., M1 (NSR2) and M4 (NSR4)). The measured noise results are presented in *Table 4.16* for reference.

Table 4.16 Measured L_{max} Levels

Measurement location		Measured L_{max}, dB(A)		Predicted Noise Level, dB(A)
		Lift-off	Hovering	
EC155 B1				
M1 (NSR2)	1st	71	'NM'	**86**
	2nd	76	82	
M2	1st	73	84	NIL
	2nd	78	83	
M3	1st	68	73	NIL
	2nd	71	74	
M4(NSR4)	1st	65	69	**87**
	2nd	65	69	
Super Puma AS332 L2				
M1(NSR2)	1st	75	86	**89**
	2nd	80	87	
M2	1st	82	87	NIL
	2nd	85	86	
M3	1st	79	79	NIL
	2nd	81	76	
M4 (NSR4)	1st	61	71	**90**
	2nd	64	71	

Note:

1. 'NM' = Not Measured.
2. *During the noise survey, both helicopter types lifted-off over the existing temporary helipad and manoeuvred near the location of the proposed permanent helipad (i.e. over the sea) in turn. There was no lift-off operation of the helicopters near the location of the proposed permanent helipad.*
3. *Some measurement locations would be subject to a degree of shielding by topographic features / structures between the noise source and receiver (e.g., the Refuse Transfer Station and the topographic features/structures in the vicinity of the measurement location provide shielding to M4). The corresponding noise levels obtained at ground levels at such locations would thus be lower than unshielded upper floors where higher noise levels can be anticipated.*
4. *The predicted noise levels shown in the last column of the table are for indication only and no direct comparison of these noise levels with the measured levels shall be made.*
5. *"1st" and "2nd" shown in the second column of the table refer to 1st and 2nd set of noise data measured.*

4.6.59 The survey was conducted on a single day based on simulated operational events at a few selected locations only. The survey was subject to the actual simulation and would have been affected by specific site/environmental conditions during noise measurements. It would therefore be premature to draw any conclusion about the actual helicopter noise impacts on the NSRs. According to *Table 4.16*, the measured L_{max} at the worst affected measurement location is 87 dB(A).

4.7 Environmental Monitoring and Audit Requirements

Construction Phase

4.7.1 No construction phase noise exceedance is anticipated. However, regular construction noise impact monitoring and audit is recommended during the construction period in order to ensure the construction noise impacts at NSRs are in an acceptable limit. As there is no anticipated construction phase noise impact, there is no requirement for real-time reporting of monitoring data as raised under *Clause 4.2* of the EIA Study Brief.

4.7.2 The Environmental Monitoring and Audit (EM&A) requirements are detailed in the stand-alone Project EM&A Manual.

Operational Phase

4.7.3 The study has considered all practicable means to minimise the potential operational helicopter noise impacts, including realignment of helicopter flight paths to avoid helicopter approach noise impacts without compromising flight safety. In accordance with the GFS guidelines and current practice, the quieter 'EC155 B1' type helicopter shall be deployed whenever practicable.

4.7.4 Accordingly, due to the small magnitude and short duration of impacts, and the exhaustion of all practicable means to mitigate residual helicopter noise impacts, operational phase noise monitoring, including real-time reporting, is not recommended.

4.7.5 Should the need arise, the local community may lodge noise complaints with the Islands District Office by the following means:

- Fax: 2815 2291
- Email: dois@had.gov.hk
- Address: Islands District Office, Harbour Building, 20th Floor, 38 Pier road, Central.

4.8 Conclusions and Recommendations

Construction Phase

4.8.1 The potential noise levels arising from daytime construction activities of the helipad during the period from May 2006 to October 2007 at the nearby NSRs have been evaluated. Based on the construction schedule and plant inventory given, unmitigated construction noise levels at all NSRs will comply with the daytime noise standards stated in Table 1B, Annex 5 of EIA-TM. Therefore, no specific mitigation measures are required.

4.8.2 The cumulative noise impacts from the construction of helipad and the Yung Shue Wan STW upon common NSRs has also been considered, and no adverse cumulative noise impacts are anticipated.

Operational Phase

4.8.3 In accordance with Table 1A, Annex 5 of the EIA-TM, and with reference to noise data provided by GFS and obtained through on-site measurements, helicopter noise impacts have been assessed based on the maximum instantaneous sound pressure level at a specified NSR – i.e., the L_{max} level. The L_{max} was calculated for two types of helicopter used for 'casevac' operations by GFS during helipad approach / departure (i.e., with lateral movements) and during a series of manoeuvring modes on and immediately over the helipad (i.e., without lateral movements).

4.8.4 An initial assessment of helicopter noise levels from lateral movements predicted that the L_{max} for both helicopter types would exceed the limit of 85 dB(A). Accordingly, the flight path angle was reduced with the agreement of GFS to eliminate the impact, with a subsequent L_{max} of 85 dB(A) from the 'Super Puma AS332 L2' and 83 dB(A) from the 'EC155 B1'.

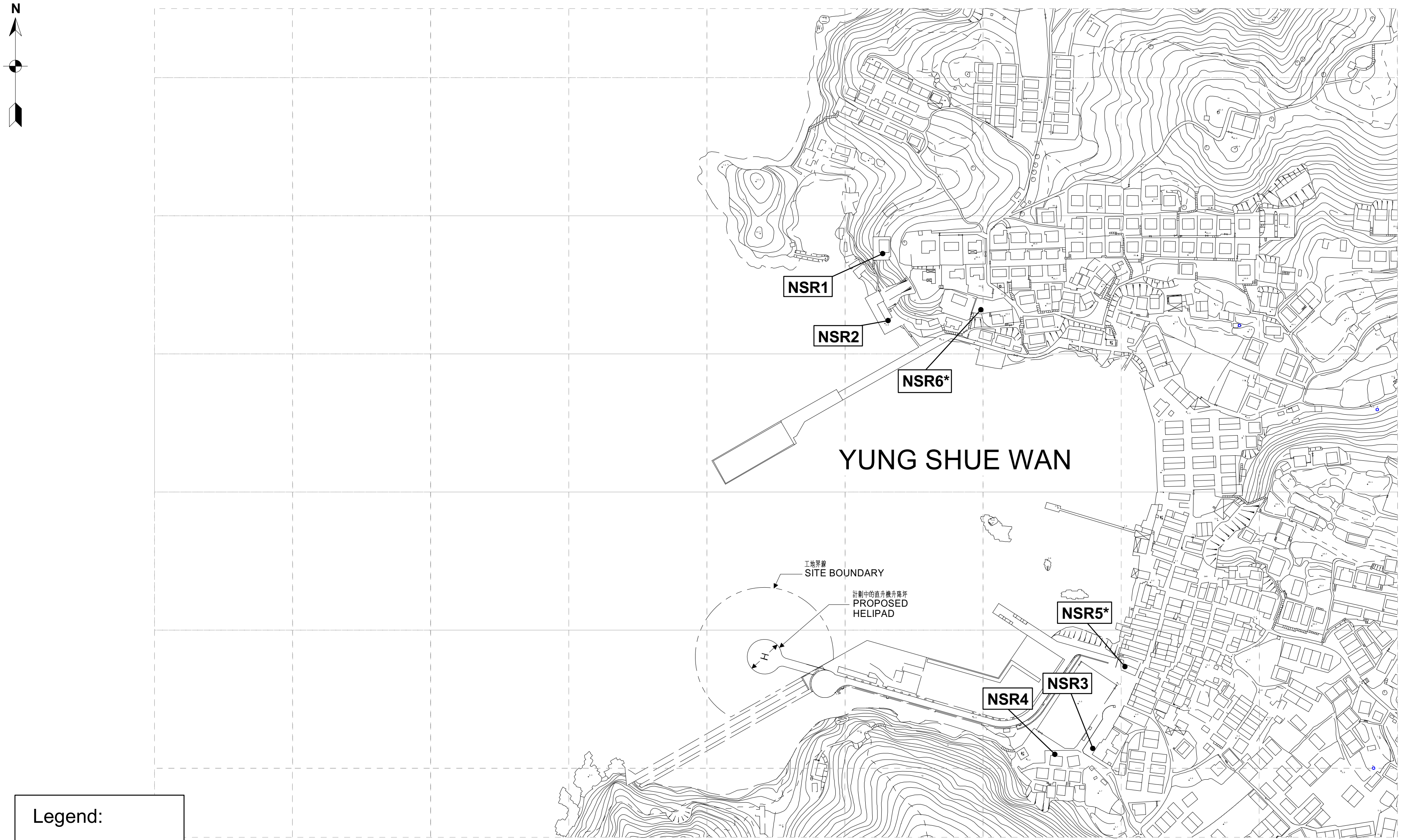
4.8.5 The worst-case L_{max} noise level during helicopter manoeuvring over the helipad is predicted to be 90 dB(A) at NSR4 when a 'Super Puma AS332 L2' helicopter is in hovering mode, and 87 dB(A) from an 'EC155 B1' helicopter in lift-off mode. Accordingly, mitigation options have been investigated in accordance with Annex 13 of the EIA-TM. Of the applicable helicopter noise mitigation options, consideration was given to helipad relocation further from the built environment, although physical constraints to each of the options / alternatives precluded any relocation. Installation of a noise barrier around part of the helipad was considered, but this option was not feasible on flight safety grounds.

4.8.6 After exhaustion of direct mitigation measures, the application of indirect mitigation measures was considered. Ultimately indirect mitigation measures were not recommended due to the impracticability of providing prior notice of an impending helicopter arrival and the very short impact duration (i.e., 5-10 seconds).

4.8.7 In summary, based on actual GFS flight data for Yung Shue Wan, the residual helicopter noise impact from operation of the 'EC155 B1' type helicopter would involve a 1-2 dB(A) exceedance of the 85 dB(A) limit approximately every 2.8 days, and would affect approximately 75 dwellings . The residual impact from the 'Super Puma AS332 L2' type helicopter would involve a 3-5 dB(A) exceedance of the 85 dB(A) limit approximately every 24.3 days, affecting approximately 360 dwellings [*Figure 4.4(a)* refers]. The impact duration would last for less than 10 seconds per event, and the predicted magnitude, frequency and duration of residual impacts would not give rise to any serious long-term environmental implications.

4.9 References

- Nelson, P. M. (1987), *Transportation Noise Reference Book*, Butterworths.
- Ward, W.D., Glorig, A. & Sklar, D.L. (1959). *Temporary threshold shift produced by intermittent exposure to noise*. Journal of the Acoustic Society of America 31, pp791 –794.



Legend:

* Future NSR

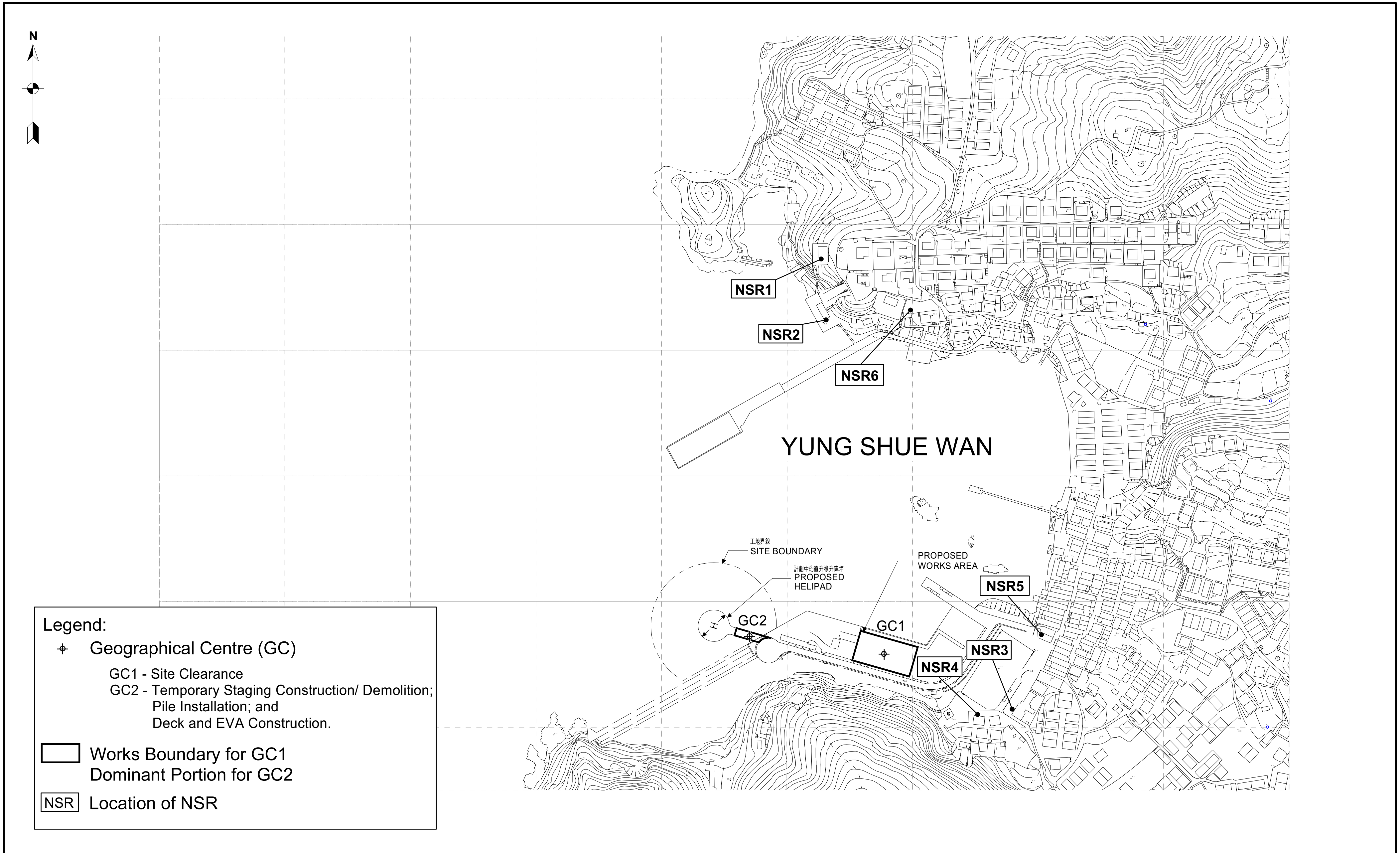
BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

REPRESENTATIVE NOISE SENSITIVE RECEIVER LOCATIONS

Figure 4.1

Drawn: DEH	Checked: RBR
Scale: 1 : 4000	Date: November 2005



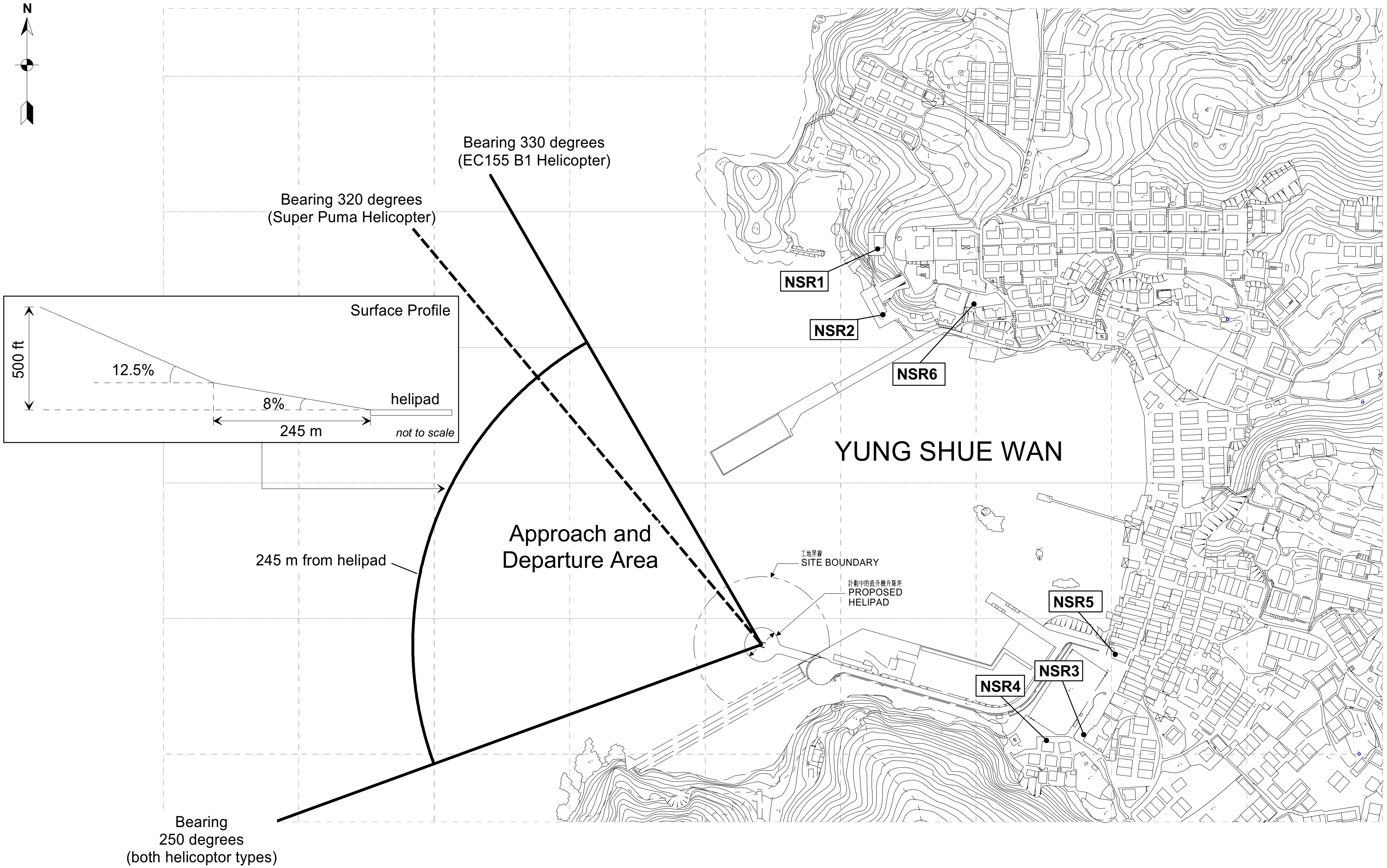
BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

GEOGRAPHICAL CENTRES OF CONSTRUCTION ACTIVITIES

Figure 4.2

Drawn	DEH	Checked	RBR
Scale	1 : 4000	Date	November 2005

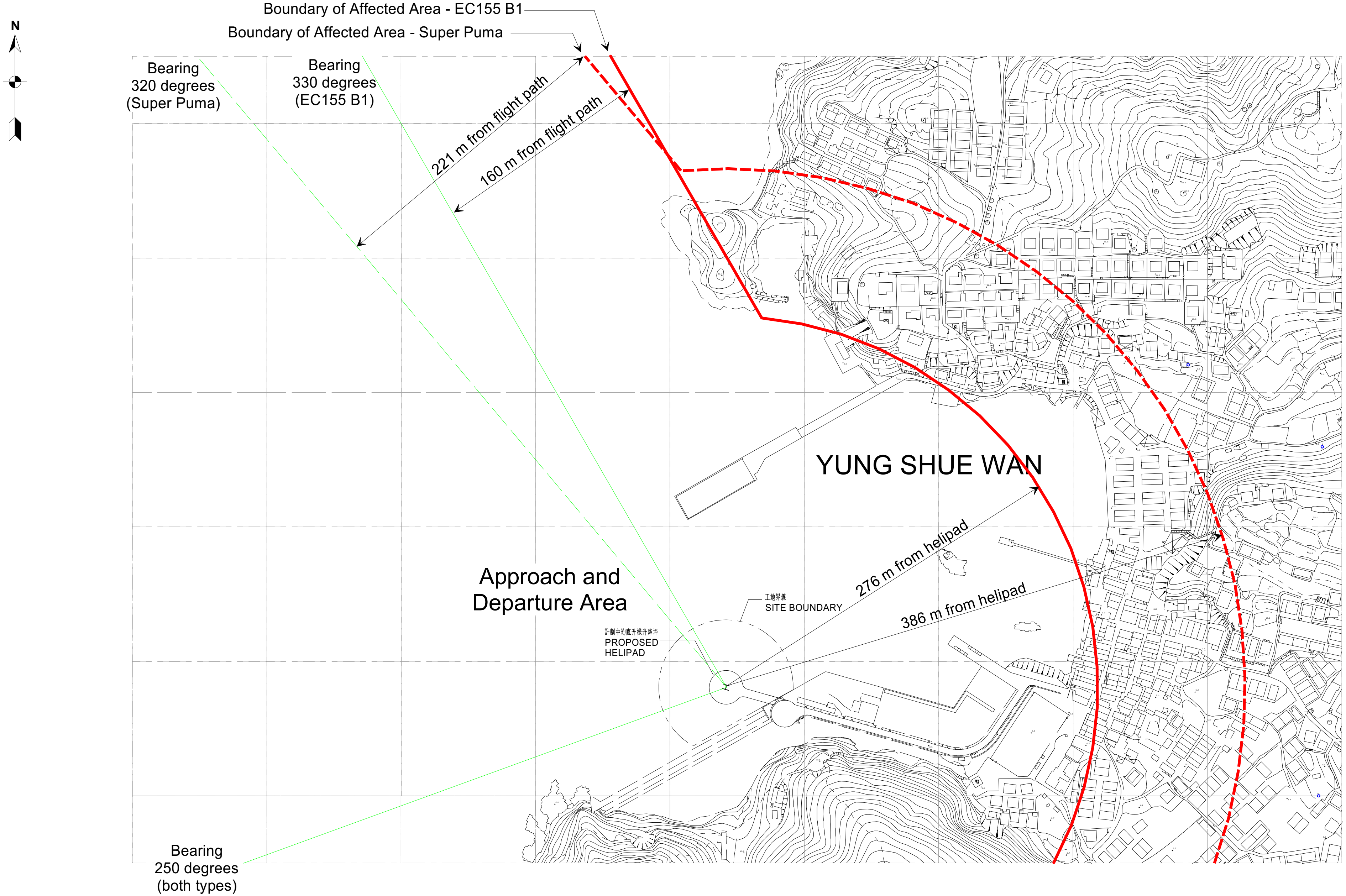


EIA Study for Helipad at Yung Shue Wan, Lamma Island

APPROACH AND DEPARTURE AREA AND SURFACE PROFILE

Figure 4.3

Drawn	DEH	Checked	RBR
Scale	1 : 4000	Date	November 2005



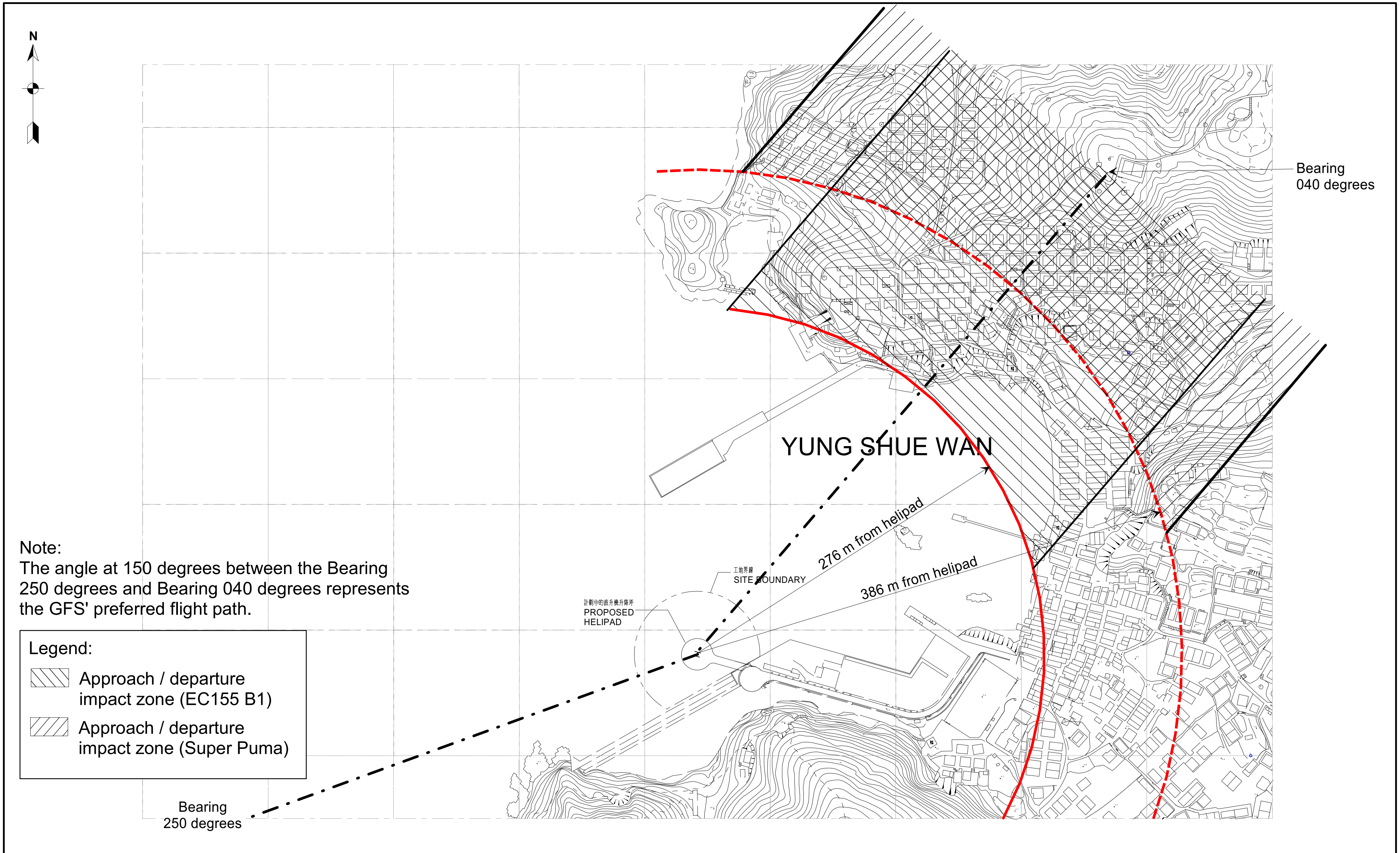
BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

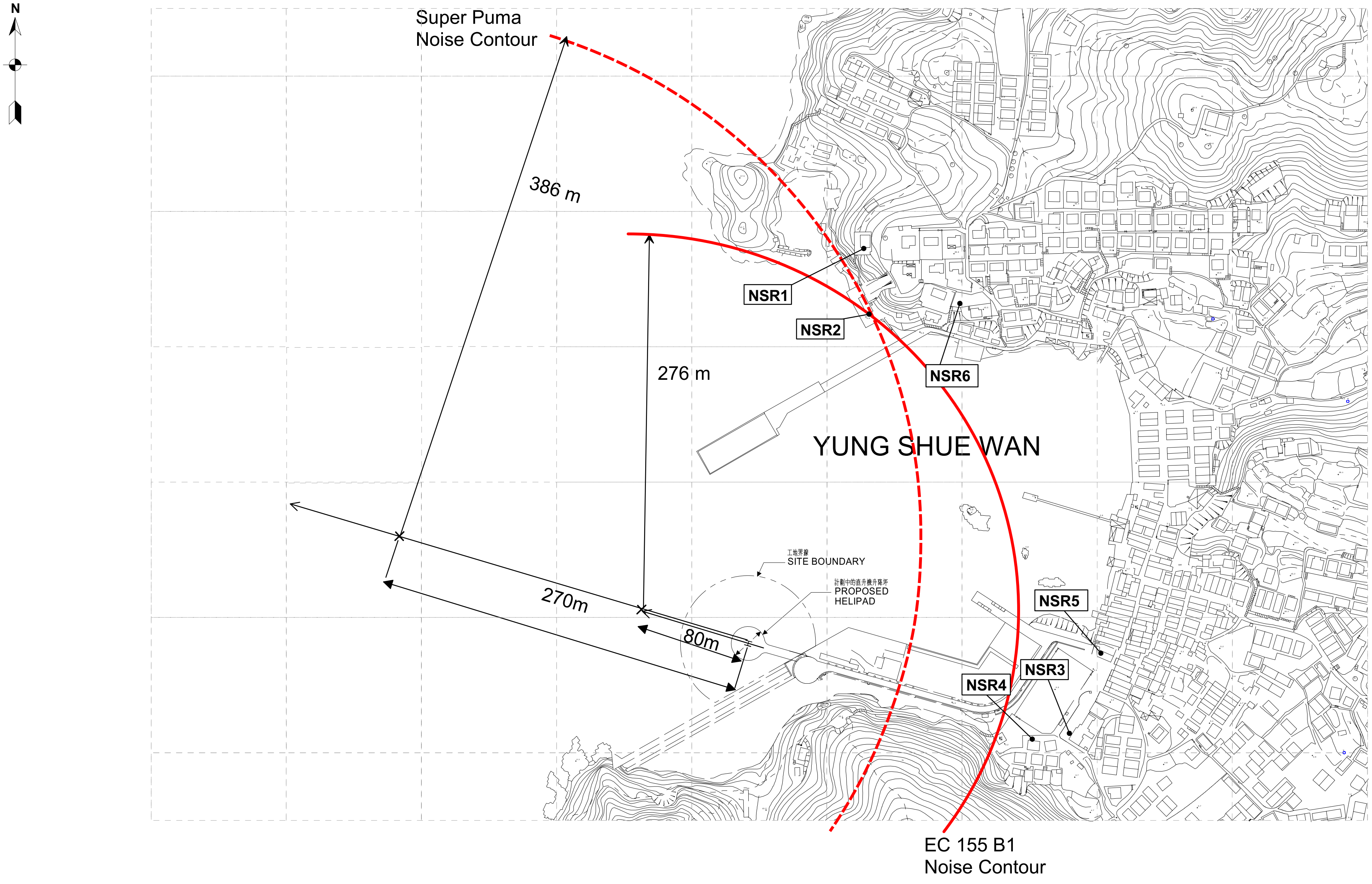
ILLUSTRATION OF AREA AFFECTED BY HELICOPTER MANOEUVRING NOISE

Figure 4.4a

Drawn	DEH	Checked	RBR
Scale	1 : 4000	Date	November 2005



BMT	EIA Study for Helipad at Yung Shue Wan, Lamma Island	Figure 4.4b
	ILLUSTRATION OF AREA PROTECTED FROM HELICOPTER APPROACH / DEPARTURE NOISE	Drawn: FEW; Checked: RBR
		Scale: 1 : 4000; Date: November 2005

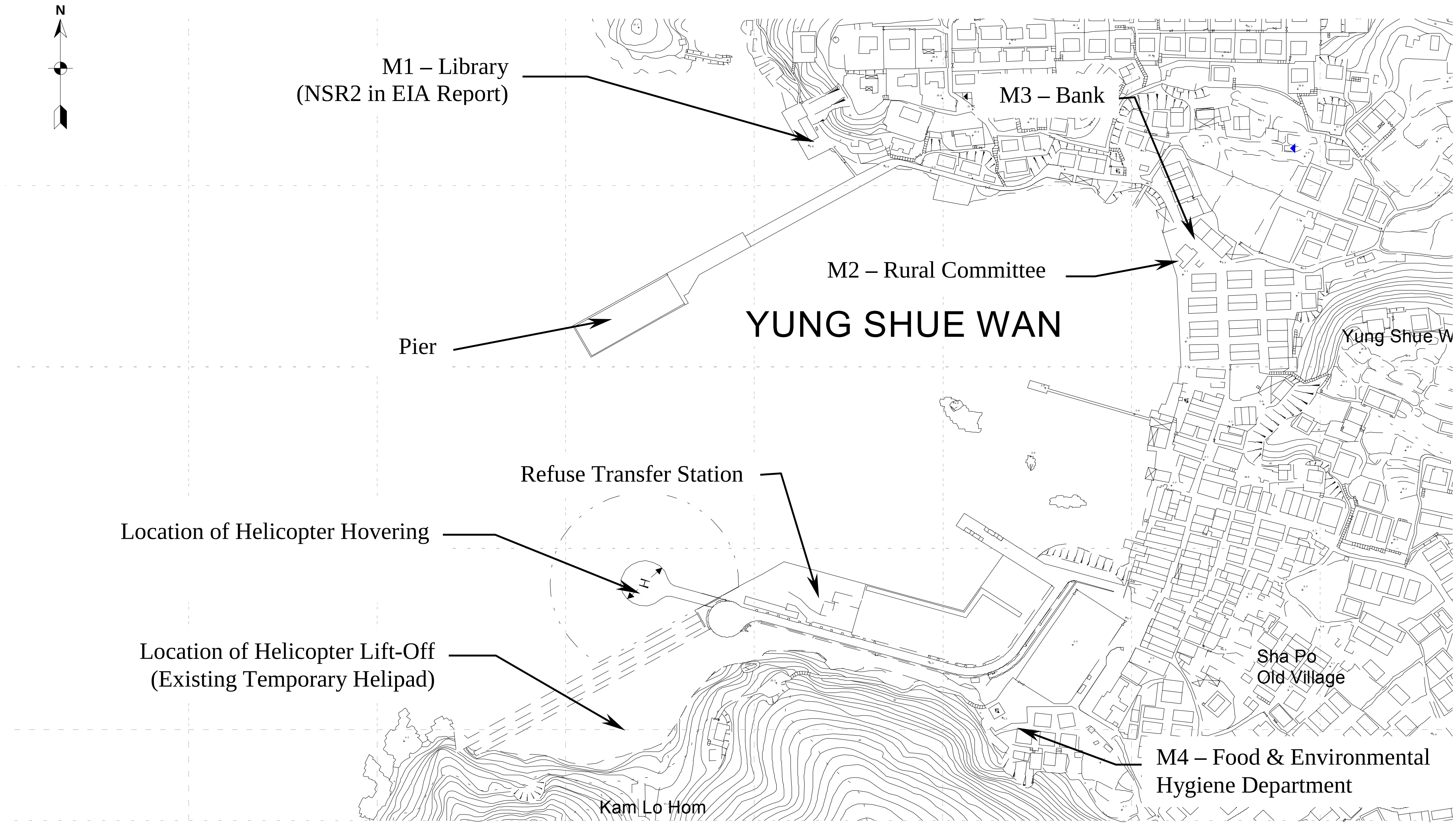


EIA Study for Helipad at Yung Shue Wan, Lamma Island

HELIPAD RELOCATION DISTANCE REQUIREMENTS TO ELIMINATE RESIDUAL HELICOPTER MANOEUVRING NOISE

Figure 4.4(c)

Drawn FEW	Checked RBR
Scale 1 : 4000	Date November 2005



BMT	EIA Study for Helipad at Yung Shue Wan, Lamma Island HELICOPTER NOISE - MEASUREMENT LOCATIONS	Figure 4.5	
		Drawn ANW	Checked RBR
		Scale NTS	Date November 2005

5 WASTE MANAGEMENT ASSESSMENT

5.1 Introduction

5.1.1 This section presents the approach to and the findings of the waste management assessment. The aim of this assessment is to analyse the type of activities associated with the construction of the helipad and the likely types of waste to be generated in order to outline measures to minimise impacts to the surrounding environment and where possible to minimise generation in the first place.

5.2 Legislation & Standards

5.2.1 In carrying out the assessment, reference has been made to Hong Kong legislation governing waste management and disposal. Directly relevant legislation include:

- The *Waste Disposal Ordinance* (Cap. 354) and subsidiary legislation such as the *Waste Disposal (Chemical Waste) (General) Regulation* sets out requirements for the storage, handling and transportation of all types of wastes.
- The *Dumping at Sea Ordinance* (Cap. 466) provides for the control on marine dumping, extends control on marine pollution, and gives legal effect to the Marine Dumping Action Plan.
- Land (Miscellaneous Provisions) Ordinance (Cap 28).
- Public Health and Municipal Services Ordinance (Cap 132) – Public Cleansing and Prevention of Nuisance Regulation – control of disposal of general refuse.
- EIAO and EIA-TM (Annexes 7 and 15).

5.2.2 Other relevant documents and guidelines are also applicable to waste management and disposal in Hong Kong:

- Environmental, Transport and Works Bureau Technical Circular (Works) No. 22/2003, Additional Measures to Improve Site Cleanliness and Control Mosquito Breeding on Construction Sites;
- Environmental, Transport and Works Bureau Technical Circular (Works) No. 15/2003, Waste Management on Construction Sites;
- Buildings Department, Practice Note for Authorised Person and Registered Structured Engineers 252, Management Framework for Disposal of Dredged/Excavated Sediments;
- Environment, Transport and Works Bureau Technical Circular (Works) No. 33/2002, Management of Construction and Demolition Material Including Rock;
- Environmental, Transport and Works Bureau (Works) Technical Circular No. 34/2002, Management of Dredged/Excavated Sediment;
- Environmental, Transport and Works Bureau Technical Circular (Works) No. 31/2004 Trip-ticket System for Disposal of Construction and Demolition Materials;
- Works Bureau Technical Circular No. 6/2002, Enhanced Specification for Site Cleanliness and Tidiness;
- Environment, Transport and Works Bureau Technical Circular (Works) No. 6/2002A, Enhanced Specification for Site Cleanliness and Tidiness;
- Works Bureau Technical Circular No. 12/2000, Fill Management;
- Environmental Guidelines for Planning in Hong Kong (1990), Hong Kong Planning and Standards Guidelines, Hong Kong Government;
- New Disposal Arrangements for Construction Waste (1992), Environmental Protection Department and Civil Engineering Department; and

- Waste Disposal Plan for Hong Kong (December 1989), Planning Environment and Lands Branch, Hong Kong Government Secretariat.

5.3 Baseline Conditions & Sensitive Receivers

5.3.1 The closest sensitive receiver building with a direct line of sight to the helipad footprint is No. 105 Yung Shue Wan Main Street, which is a residential village house and about 220 metres southeast of helipad site [*(NSR4) in Section 4, Figure 4.2* refers].

5.3.2 All waste generated on Lamma Island is currently collected and transported to the refuse transfer station (for landfill disposal) which is located immediately south east of the proposed helipad Project site boundary.

Site Conditions

5.3.3 Sediment quality along the shoreline of Yung Shue Wan was previously investigated in 2001 under the *Engineering Works for the Yung Shue Wan Development Phase II* (Mouchel Asia Ltd, 2001).

5.3.4 A total of five locations were sampled, the closest one of which is located approximately 220m east of the proposed helipad. At this location, the top 2 metres of sediment was classified as Category H, but contained less than 10x the LCEL. Below this depth, the sediments were graded Category L. A flow chart illustrating the categorisation of sediments in accordance with Environmental, Transport and Works Bureau Technical Circular (Works) (ETWB TCW) No. 34/2002, Management of Dredged/Excavated Sediment is presented in *Appendix 5.1*.

5.3.5 In 2002, sampling and analysis of sediments less than 100m west of the proposed helipad location was performed under the *Outlying Islands Sewage Stage I, Phase I Works Package C* (Mouchel Asia Ltd, 2002).

5.3.6 Five locations, equidistant and extending in a straight line NW from the shore, were sampled. Only the 0.9 – 1.9m interval in the sample collected closest to shore containing any parameter that exceeded Category L (according to the ETWB 34/2002). The sample contained 1.3 mg/kg of Mercury (above the EPD's UCEL) and therefore the sample was classified as Category H. However, the Mercury concentration was within 10x the LCEL, therefore careful dredging and disposal at East Sha Chau was recommended. The remaining sediments were passed for open sea disposal.

5.3.7 A plan indicating the historical sampling locations is presented in *Appendix 5.2*.

5.4 Assessment Methodology

5.4.1 In addition to Annexes 7 and 15 of the EIA-TM, the waste management assessment has also been carried out in accordance with the requirements of Clause 3.4.4 of the EIA Study Brief. This stipulates the assessment of waste management implications shall also cover analyses of works activities and waste generation and propose options / measures for managing waste.

5.4.2 The waste management hierarchy has been adopted in carrying out the assessment and in developing mitigation measures for waste. The hierarchy is comprised of the following key elements in order of their priority:

- Avoidance;
- Reduce;
- Reuse/Recycle;
- Bulk Waste Reduction; and

- Dispose.

5.4.3 Opportunities for reducing waste generation have been evaluated in the process of the assessment and have been based on the following factors:

- Avoiding or minimising the generation of waste where possible during the design stage (i.e. use of prefabricated elements);
- Adopting better site management practices in material control and promoting on site sorting of Construction and Demolition (C&D) material;
- Exploring the potential for reuse/recycling of materials (i.e. reuse of inert C&D material); and
- Diverting C&D material to Public Fill Areas, Fill Banks or other construction sites (if it cannot be reused on site).

5.4.4 The types and quantities of waste have been estimated and disposal options for each category of waste identified in this assessment, having taken into account the existing or future spare capacities of the waste disposal facilities and the environmental implications of the handling, collection and disposal of waste material.

5.5 Waste Types

5.5.1 Use of the small diameter pre-bored piling option has been proposed as the preferred construction method. This construction method requires significantly less removal of marine sediments and import of fill materials than would construction dredging and reclamation. It is estimated that approximately $100m^3$ per month of slurry will be excavated from within the pile casing during the 5½ months of piling works, although this activity will be entirely contained and separate from the adjacent water column. Approximately $80m^3$ of C&D material will also be generated over the entire construction period.

5.5.2 In addition, the following types of waste are also anticipated to be generated during the construction activities although estimated to be in much smaller quantities:

(i) General construction waste (e.g. wood, scrap metal, concrete);

(ii) Chemical wastes generated by general site practices (e.g. vehicle and plant maintenance/ servicing); and

(iii) Municipal wastes generated by site workers.

5.6 Impact Assessment and Evaluation

Background

5.6.1 The generation of waste will primarily arise from the construction of the helipad whilst during its operation, waste generation is predicted to be minimal. The following sections present the assessment conducted to evaluate the source and potential volumes of waste to be generated during each of these two phases.

5.6.2 All waste materials shall be disposed of to designated waste disposal facilities (i.e., landfills, Public Fill Banks, Public Filling Areas, etc.) whose operations are covered under an approved EIA report or environmental permit (issued under the EIAO) except where the materials may be reused or recycled.

Construction Phase

5.6.3 Pre-bored H piles will be sunk to form the supporting frame for the reinforced concrete structure of the helipad. This construction method is similar to the small diameter pre-bored piling method that requires installation of a hollow casing and excavation of the sediment within. Once the sediment is removed, the steel H-piles will be inserted and cement grout poured into the casing to form the final pile structure.

5.6.4 As sediment will be removed during the piling process and given the uncertainty of the characteristic of sediments below the helipad footprint, a Sediment Testing Proposal was prepared under this study to carry out additional sediment sampling and analysis to more accurately categorise the sediments.

Sediment Testing

5.6.5 A Sediment Testing Proposal was prepared under this study and approved by the relevant Authority, including EPD, to carry out sediment sampling to assess the quality of sediments within the footprint of the proposed helipad. Three locations were marked within the footprint for sampling – conducted by vibrocore to allow a continuous sediment core to be retrieved with minimal sample disturbance.

5.6.6 A plan illustrating the co-ordinates of the sampling locations (H1/H1A, H2A and H3A) and the ETWB 34/2002 sediment classification guidelines are presented in *Appendix 5.3*. The reference sample was collected from EPD's routine marine mud monitoring location within Port Shelter.

5.6.7 The chemical analytical suite and methods adopted by the HOKLAS accredited laboratory for the analysis of these samples is presented in *Table 5.1*.

5.6.8 *Table 5.2* presents the sediment quality criteria (as adopted from ETWB 34/2002) against which the analytical data were assessed.

5.6.9 A total of 14 sub-samples were collected, however sub-samples H1/E, H1/F and H3A/E were held from chemical analyses pending the results of those sub-samples collected at shallower depths at the respective locations. Moreover, under instruction from CEDD, sub-sample H2A/C was divided into two sub-samples, H2A/C and H2A/D. Both sub-samples were analysed and a summary of the chemical test results for the other 12 sub-samples collected (4 from each sampling location) are presented in *Appendix 5.3*.

5.6.10 All samples from H1/H1A, H2A and H3A locations had metal concentrations below the respective LCELs while no samples were found to contain PAH or PCB concentrations that exceeded the detection limit of the respective analytical tests.

5.6.11 The results of the chemical screening indicate that sediment at the proposed site is graded Category L and thus can be considered as having little or no contamination and can be disposed to open sea.

Table 5.1 Analytical Suite and Analytical Methods

Parameters	Sample Preparation Method (US EPA Method)	Analytical Method (US EPA Method)	Reporting Limits
Metals (mg/kg dry wt.)			
Cadmium	3050B	6020A or 7000A or 7131A	0.2
Chromium	3050B	6010C or 7000A or 7190	8
Copper	3050B	6010C or 7000A or 7210	7
Mercury	7471A	7471A	0.05
Nickel	3050B	6010C or 7000A or 7520	4
Lead	3050B	6010C or 7000A or 7420	8
Silver	3050B	6020A or 7000A or 7761	0.1
Zinc	3050B	6010C or 7000A or 7950	20
Arsenic	3050B	6020A or 7000A or 7061A	1
Organic PAHs (µg/kg dry wt.)			
Low Molecular Weight PAHs	3550B or 3540C or 3630C	8260B or 8270C	55
High Molecular Weight PAHs	3550B or 3540C or 3630C	8260B or 8270C	170
Organic non-PAHs (µg/kg dry wt.)			
Total PCB	3550B or 3540C or 3665A	8082	3

Table 5.2 Sediment Quality Criteria

Parameters	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metals (mg/kg dry wt.)		
Cadmium	1.5	4
Chromium	80	160
Copper	65	110
Mercury	0.5	1
Nickel	40	40
Lead	75	110
Silver	1	2
Zinc	200	270
Arsenic	12	42
Organic PAHs (µg/kg dry wt.)		
Low Molecular Weight PAHs	550	3160
High Molecular Weight PAHs	1700	9600
Organic non-PAHs (µg/kg dry wt.)		
Total PCB	23	180

Piling Works

5.6.12 Spoil generation will be limited to the material displaced by piling and will be a function of the size (diameter and length) and the number of piles to be installed. The grabbed material from inside the casing will be a muddy slurry/spoil and if dumped onto the ground will result in runoff into the coastal waters and result in water quality impacts. The spoil will therefore need to be properly handled to minimise contamination to the marine water and any exposed ground areas due to leakage or improper storage (i.e. onto bare ground instead of into tanks).

5.6.13 Although the volume of slurry generated is estimated to be small (~200m^3 total), the Contractor will still need to obtain approval from the Marine Fill Committee (MFC) for off-site disposal and allocation of disposal space. As at the issuing of this report, the Director of the Environmental Protection (DEP) has indicated that it is acceptable to dispose of the sediments at the South Cheung Chau Spoil Disposal Area. However, the Contractor is required to reconfirm this once the final dredging volumes are confirmed and apply for a dumping permit from EPD.

5.6.14 It is estimated that the number of barge movements required for the off-site disposal of the marine sediments will be 2 to 3 barges over the course of the piling works (August 2006 to January 2007) to remove the small volume of spoil anticipated to be generated. Given the nature of the works and the duration at which it is conducted (07:00-19:00), this frequency is not considered to cause any significant increase in marine traffic or impacts to nearby sensitive receivers.

5.6.15 Alternatively, the Contractor may consider passing the slurry through mud separators / de-silting tanks to remove or settle out soil particles and/or other solid materials from the wastewater. This inert material should be regularly collected and delivered to a Public Fill Area and/or Public Fill Bank. If the inert material is delivered to other construction sites, this will require the consent of the receiving site and prior written approval from EPD.

5.6.16 Any direct discharge of wastewater arising from the construction activities / surface run-off within the site boundary to the coral habitat shall be avoided by the Contractor. The Contractor will also need to obtain a discharge licence issued under the Water Pollution Control Ordinance (WPCO) and ensure that the effluent meets the statutory water quality standards set out in the permit prior to discharge out to the open marine waters.

Imported Fill

5.6.17 According to information provided by CEDD, it is estimated that the total volume of concrete required will be 1,500m^3 throughout the entire construction period [*Table 5.3* refers].

Table 5.3 Material Import Requirements

Imported Material Type	**Quantity (m^3)**		
	Recycled Material	**Virgin Material**	**Total**
Rock fill	-	-	-
Sand fill	-	-	-
Sandy foreshore	-	-	-
Hardcore	-	-	-
General fill	-	-	-
Rock armour	-	-	-
Concrete	-	1,500	1,500
Total	**-**	**1,500**	**1,500**

5.6.18 The concrete material requirements consist of cement grout (500m^3) and ready-mix concrete (1,000m^3). The former will be used for the formation of piles whilst the latter will be used to construct the helipad deck and EVA link.

5.6.19 While the cement grout will be packaged, any stockpiling of the grout should be adequately protected to prevent unnecessary wastage (from exposure to rain). Any storage is expected to be for a maximum duration of 5 to 5½ months. Upon completion of the piles, the use of cement grout will no longer be necessary and as such strict material control and storage should be adopted to avoid over ordering supplies and any unnecessary wastage of the raw material.

5.6.20 There will be no need to store the pre-mixed concrete on site as concrete will be used shortly after arrival delivery at the site. However, the delivery and handling of this material will need to be properly managed to prevent any spillage from the transporting vessels into the marine waters or being spilled out onto the works platform.

Construction Waste

5.6.21 Based on the engineering design of the helipad, the construction of the EVA extension and the landing pad itself will likely generate various types of construction waste material including the following:

- Site clearance waste (vegetation, rocks);
- Waste metal (off cuts) from *in-situ* concrete casting work;
- Spent concrete (from helipad and EVA link decking); and
- Material and equipment wrappings (from packaging of cement grout).

5.6.22 It is estimated that site clearance activities will result in the generation of 5m^3 of C&D waste, while another 30 - 40m^3 of slurry will be generated monthly over a 6 month period and 80m^3 of C&D materials over the entire duration of the construction period. This will include such wastes as formwork cut-offs, excess spent concrete, etc. All C&D materials generated on site should be sorted into inert (public fill) and non-inert (C&D wastes) material. Where possible, reuse of these materials on site should be identified and implemented as far as practicable to minimise material volumes requiring landfill disposal. Alternatively, outlets such as Public Fill Banks should be identified for the inert material if no on-site reuse opportunities exist.

5.6.23 Given the nature and the irregularity (in size) of the waste material, reuse will not be likely. However, the Contractor should identify likely arising quantities for recyclable materials and the possible recycling options (i.e. waste metal, plastic film wrap, etc.) prior to considering landfill disposal. Sufficient space and manpower should be allocated to the storage, collection and disposal of such wastes.

Chemical Waste

5.6.24 Plant and vehicle maintenance will likely be the primary source of chemical wastes during the construction period. The majority of chemical waste produced is therefore expected to consist of waste oils and solvents. Typical wastes may include the following:

- Solid wastes (empty fuel/lubricant drums, used oil/air filters, scrap batteries, brake clutch linings which may contain asbestos); and
- Liquid wastes (waste oils/grease, spent solvents/detergents, which may be halogenated, and possibly spent acid/alkali from battery maintenance).

5.6.25 The volume of chemical waste will depend upon the total number of plant / vehicles and how much maintenance is actually carried out on site. However based on the proposed plant list as provided by CEDD [*Section 4, Table 4.7* refers] it is unlikely that volumes of chemical waste will exceed 480 litres / month. These wastes may pose environmental and safety hazards if not properly handled, stored and disposed of. Given the small quantities anticipated, provided the waste is properly handled, stored and disposed of, no impacts are predicted to arise.

General Refuse

5.6.26 The construction workforce will generate general refuse such as waste paper (e.g., newspaper and office paper), plastic packaging and possibly food waste. Such refuse will generally be collected on site and brought to the nearby refuse transfer station for disposal to landfill.

5.6.27 It is expected that no canteen will be established for site workers given the close proximity of the site works area to the commercial areas of Yung Shue Wan. However, as a worst case, it is estimated that a factor of 1.06 kg/person/day of municipal waste will be generated (EPD, 2000). The total quantity of waste generated will thus be dependent on the number on site workers that the contractor proposes to use. For estimation purposes, we have assumed that the size of the work force will be a maximum of 20 site workers. Based on these assumptions, the volume of MSW likely to be generated on site will be 127 kg/week.

5.6.28 These wastes have the potential to cause adverse impacts (environmental, health and nuisance) if not properly handled, stored and disposed of. If the waste is not regularly removed (for disposal), odour issues may arise. Given that the site is located along the shoreline and in direct line of site of the ferry pier, any windblown debris will cause water quality impacts if the debris lands in the water and result in visual impacts. Moreover, if the storage area of these wastes are not regularly cleaned and maintained, there is potential to attract vermin and pests to the site. Sufficient covered waste bins should be placed on site in convenient locations for site workers to dispose of their waste. With proper on-site handling and storage as well as regular disposal of these wastes to the nearby refuse transfer station facility, no adverse impacts are predicted.

Sewage

5.6.29 The construction work force will generate sewage on a daily basis and which will require proper disposal. It is anticipated that chemical toilets shall be provided by the Contractor for the workforce, in which case night-soil will need to be collected by an approved contractor for disposal on a regular basis to avoid odour issues. Alternatively, the use of a septic tank system may be acceptable provided that appropriate connection is made to sewerage or sewage is treated prior to disposal.

Operational Phase

5.6.30 Upon completion, the helipad will only be used for emergency purposes. No equipment will be placed on the landing pad or along the EVA. Helicopters will not be parked at the landing pad and all repair and maintenance works (on the helicopters) will be conducted off site. As such the only source of waste generation during the operation of the helipad is anticipated to be from the long-term maintenance of the pad.

5.6.31 During the operational phase of the helipad, storage of maintenance materials will not be permitted at any time either along the EVA or on the helipad itself. It is envisaged that little or no waste will be generated during regular maintenance of the helipad and thus is considered to have no adverse impact to the environment.

5.7 Summary of Waste Materials Generated

5.7.1 The generation of waste will primarily result from the construction phase of the helipad and EVA whilst negligible volumes will be generated once the helipad becomes operational.

5.7.2 Based on the assessment above, estimates for the amount of generated waste have been assigned for each waste type and are presented in Table 5.4. In general, the inert portion of C&D materials should be disposed of to Public Fill Banks or other Public Filling Areas while the non-inert portion should be sent to landfill for disposal. Any potential for reuse of materials on site should be explored prior to disposal.

Table 5.4 Summary of Construction Phase Waste Generation

Activity	Material Type	Likely time of arising	Estimated total volumes generated	Disposal / Treatment Site
Ground preparation	Site clearance	Pre-construction	5 m^3*	Landfill (via Outlying Islands Transfer Facility located adjacent to the Project site).
Piling	Slurry	August 2006 – January 2007	~40 m^3 / month	South Cheung Chau Spoil Disposal Area ^
General works	Construction waste	Throughout construction period	80 m^3**	Public Fill Bank #
	Chemical waste	Throughout construction period	480 litres / month**	Chemical Waste Treatment Centre
	General refuse (generated by site staff)	Throughout construction period	127kg / week (assuming max. 20 staff & 6 day week)	Landfill (via Outlying Islands Transfer Facility located adjacent to the Project site).

*Notes: * Volume estimates will be based upon vegetation height and density of cover.*
*** Provisional estimate.*
^ Disposal of slurry to South Cheung Chau Spoil Disposal Area has been approved by DEP (fax ref.: (19) in EP60/G1/12-398). However, this should be re-visited once generation volumes are confirmed.
 # Tseung Kwan O Area 137 or Tuen Mun Area 38.

5.8 Impact Mitigation & Residual Impact Assessment

5.8.1 Significant impacts due to the generation of waste on site are not predicted. However, given the potential for environmental impacts to arise (dust, noise, water quality and visual impacts) mitigation measures are required to ensure that proper handling, storage, transportation and disposal of materials is implemented at the outset and throughout the construction phase of the helipad. In line with Government's position on waste minimisation, the practice of avoiding and minimising waste generation and waste recycling should be adopted as far as practicable.

5.8.2 Recommended mitigation measures to be implemented through the course of the construction of the helipad include:

i) An on-site environmental co-ordinator should be identified at the outset of the works. The co-ordinator shall prepare a Waste Management Plan (WMP) in accordance with the requirements as set out in the ETWB TCW No. 15/2003, Waste Management on Construction Sites. The WMP shall include monthly and yearly Waste Flow Tables (WFT) that indicate the amounts of waste generated, recycled and disposed of (including final disposal site), and which should be regularly updated;

ii) Spoil generated from the piling activities will need to be properly handled to minimise contamination to the marine water and any exposed ground areas due to leakage or improper storage (i.e. onto bare ground instead of into tanks). Any dredged sediments generated from the site works shall be handled in accordance with the ETWB TCW No. 34/2002;

iii) The reuse/recycling of all materials on site shall be investigated prior to treatment/disposal off site;

iv) Good site practices shall be adopted from the commencement of works to avoid the generation of waste, reduce cross contamination of waste and to promote waste minimisation;

v) All waste materials shall be sorted on site into inert and non-inert C&D materials, and where the materials will be recycled or reused, these shall be further segregated. Inert material, or public fill, is comprised of stone, rock, masonry, brick, concrete and soil which is suitable for land reclamation and site formation whilst non-inert material includes all other waste generated from the construction process including items such as plastic packaging and vegetation (from site clearance). The Contractor shall be responsible for identifying which materials can be recycled/reused, whether on site or off site. In the event of the latter, the Contractor shall make arrangements for the collection of the recyclable materials. Any remaining non-inert waste shall be collected and disposed of to the refuse transfer station whilst any inert C&D material shall be re-used on site as far as possible. Alternatively, if no use of the inert material can be found on site, the material can be delivered to a Public Fill Area or Public Fill Bank after obtaining the appropriate licence;

vi) With reference to ETWBTC (W) No.31/2004, Trip-ticket System for Disposal of Construction and Demolition Material, a trip ticket system should be established at the outset of the construction of the helipad to monitor the disposal of C&D and solid wastes from the site to public filling facilities and landfills;

vii) Under the Waste Disposal (Chemical Waste) (General) Regulation, the Contractor shall register as a Chemical Waste Producer if chemical wastes such as spent lubricants and paints are generated on site. Only licensed chemical waste collectors shall be employed to collect any chemical waste generated at site. The handling, storage, transportation and disposal of chemical wastes shall be conducted in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* and *A Guide to the Chemical Waste Control Scheme* both published by EPD;

viii) A sufficient number of covered bins shall be provided on site for the containment of general refuse to prevent visual impacts and nuisance to sensitive receivers. These bins shall be cleared daily and the collected waste disposed of to the refuse transfer station. Further to the issue of ETWB TCW No. 6/2002A, Enhanced Specification for Site Cleanliness and Tidiness, the Contractor is required to maintain a clean and hygienic site throughout the Project works; and

ix) All chemical toilets shall be regularly cleaned and the night-soil collected and transported by a licensed contractor to a Government Sewage Treatment Works facility for disposal; and

x) Tool-box talks should be provided to workers about the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling.

5.8.3 The Contractor shall comply with all relevant statutory requirements and guidelines and their updated versions that may be issued during the course of Project construction.

5.9 Environmental Monitoring and Audit Requirements

5.9.1 The assessment has concluded that under proper handling, storage, collection, transportation and disposal of waste materials generated during construction of the helipad will not give rise to any significant impacts to nearby sensitive receivers. While no specific EM&A requirements have been identified, it is recommended that during the construction phase, site inspections and supervisions of waste management procedures and auditing of the effectiveness of implemented mitigation measures be undertaken on a regular basis (weekly as a minimum). These tasks shall be scheduled in the WMP to be prepared by the Contractor, and a summary of the site audits shall be presented in the EM&A reports as required by the EM&A Manual.

5.9.2 Given the nature of use of the helipad, there are no EM&A requirements for the project operational phase.

5.10 Conclusions and Recommendations

5.10.1 The proposed construction activities associated with the proposed works will generate a number of waste materials. These include:

- Vegetation and demolition wastes from site clearance;
- Excavated materials;
- Construction waste;
- Chemical waste;
- Marine sediments; and
- Municipal waste.

5.10.2 Organic (vegetation) waste is anticipated to be the only form of waste generated due to the operation of the helipad (from intermittent maintenance works). However, given that volume of such waste is expected to be negligible, no adverse environmental impacts are anticipated during the operational phase of the helipad.

5.10.3 In view of the HKSAR policy towards the promotion recycling schemes and due to the clear environmental benefits this will provide, recycling and waste reduction by site staff/contractors (construction phase) and operators (operational phase) alike should be encouraged.

5.10.4 While an estimate has been made on the likely volumes and types of waste to be generated from the construction of the helipad, the Contractor should regularly update and submit the details of their WMP, including monthly and yearly WFT, to the Project Proponent. These WFT tables should provide a more accurate estimate on volumes of waste generation on site.

5.10.5 The potential impacts of wastes arising from the construction and operational phases of the Project have been assessed. Provided that the mitigation measures outlined above [*Section 5.8* refers] are put in place and incorporated into the site specific EM&A Manual, potential impacts to the environment associated with waste generated by the construction and operational phases of the Project will be controlled.

5.10.6 With the recommended procedures/measures in place, the construction and operational wastes generated / disposed as part of this Project, will not lead to any significant adverse environmental impacts.

5.11 References

- EPD (2000). *Monitoring of Municipal Solid Waste 1999*. Environmental Protection Department.
- Mouchel Asia Ltd. (2001). CE 33/2000: Yung Shue Wan Development, Engineering Works, Phase 2. Preliminary Sediment Quality Report & Biological Testing Proposal. July 2001. Civil Engineering Department.
- Mouchel Asia Ltd. (2002). Outlying Islands Sewerage Stage 1, Phase 1 Package C – Yung Shue Wan Sewage Treatment Works and Outfall. Sediment Quality Report. May 2002. Drainage Services Department.

6 WATER QUALITY IMPACT ASSESSMENT

6.1 Introduction

6.1.1 This section presents the approach to and the findings of the water quality impact assessment, the aim of which is to identify and examine all beneficial uses and sensitive receivers within the assessment area in order to protect, maintain or rehabilitate the natural environment.

6.1.2 The water quality assessment area is a 1-km radius around the Project site.

6.2 Assessment Approach

6.2.1 The water quality impact assessment has been carried out in accordance with Annexes 6 and 14 of the EIA-TM under the EIAO, and the requirements set out in *Clause 3.4.1* of the EIA Study Brief as follows:

(i) Collect and review relevant background information on the existing and planned water system;

(ii) Characterise water and sediment quality based on existing information collected during the last 5 years or the more recent information collected from appropriate site surveys/tests;

(iii) Identify and analyse existing, planned/committed activities and beneficial uses related to the water system and identify all water sensitive receivers;

(iv) Evaluate the possible impacts arising from the construction, including any possible dredging, filling and/or piling works;

(v) Identify any alteration(s) / change(s) to bathymetry or flow regimes;

(vi) Identify and analyse all existing, future and other project(s) related water and sediment pollution sources; and analyse these in relation to the provision and adequacy of future facilities to reduce such pollution in terms of capacity and levels of treatment;

(vii) Calculate the impacts on the affected water system and the sensitive receivers due to those alterations and changes identified in (v) above and the pollution sources identified in (vi) above;

(viii) Predicting the cumulative impacts due to other construction activities within a radius of 2 km around the Project area (e.g., Yung Shue Wan Sewage Treatment Works);

(ix) Propose water pollution prevention and mitigation measures to be implemented during the construction and operational stages so as to minimise the water / sediment quality impacts;

(x) Evaluate and quantify residual impacts on the water system and sensitive receivers with regard to the appropriate water quality criteria, standards or guidelines; and

(xi) If necessary, identify and quantify all dredging, fill extraction, filling, mud/sediment transportation and disposal activities and requirements as stipulated under Clause 3.4.1.3 (x) (a) – (c) of the EIA Study Brief.

6.3 Regulations, Standards and Guidelines

Water Pollution Control Ordinance (Cap. 358)

6.3.1 The *Water Pollution Control Ordinance* (WPCO) is the principal legislation for the control of water quality in the HKSAR. Under the Ordinance, HKSAR waters are divided into 10 Water Control Zones (WCZs) – each with specific Water Quality Objectives (WQOs).

6.3.2 The water quality study area for the Yung Shue Wan helipad falls entirely within the Southern WCZ. The coastal waters around Yung Shue Wan are designated as a secondary contact recreation sub-zone within Group 4a Southern WCZ under the WPCO. The WQOs for this WCZ are presented in *Table 6.1*.

Table 6.1 Relevant Water Quality Objectives for Southern WCZ

Parameters	WQOs
Dissolved Oxygen (depth average, 90% of sampling occasions during the year)	4 mg/L
Dissolved Oxygen (within 2m of seabed, 90% of sampling occasions during the year)	2 mg/L
Unionized Ammonia (annual average)	0.021 mg/L
Total Inorganic Nitrogen (annual depth average)	0.1 mg/L
E. coli	<610 cfu/100ml *
Suspended Solids	<30% increase over the ambient level

Note: * Annual geometric mean

Technical Memorandum on Environmental Impact Assessment Process

6.3.3 Annexes 6 and 14 of the Technical Memorandum sets out the criteria and guidelines for evaluating and assessing water pollution.

Environmental Transport and Works Branch Technical Circular (Works) No. 34/2002: Management of Dredged/Excavated Sediment

6.3.4 This Technical Circular provides guidelines and procedures for obtaining an approval to dredge / excavate sediment and the management framework for marine disposal of such sediment.

6.4 Baseline Conditions

Water Sensitive Receivers

6.4.1 Beneficial uses sensitive to water pollution with a radius of 1km from the Project site have been identified in accordance with Annex 14 of the EIA-TM.

6.4.2 The coastal waters around Yung Shue Wan are designated as a secondary contact recreation sub-zone for recreation uses, although no water sports or leisure boating activities were been observed in the vicinity of the Project area during this Study. The Project site is within the Southern WCZ – also a Water Sensitive Receiver (WSR).

6.4.3 The coral site at Shek Kok Tsui is approximately 1 km to the northwest, while the Ecological Baseline Survey for this Project also recorded that a hard coral community has become established on the sloping seawall constructed under the Yung Shue Wan Phase 1 Reclamation [*Section 7* refers]. The locations of the WSRs are displayed on *Figure 7.1*.

6.4.4 There are no bathing beaches or seawater abstraction / cooling water intakes in the assessment area.

6.4.5 The closest Fish Culture Zone (FCZ) to the project area is the Lo Tik Wan FCZ on the eastern side of Lamma Island – some 4km from the proposed helipad. This distance separation, together with the nature of the construction works and the Contractor's compliance with the WPCO, means that the FCZ is not a WSR of concern for this assessment.

Ecology

6.4.6 Live hard coral communities have been identified around the north of Yung Shue Wan and Shek Kok Tsui [*Figure 7.1* refers]. These coral communities are water sensitive receivers and have been subject to impact assessment. The impact evaluation is presented in *Section 7*. There are no other sites of ecological conservation importance within the assessment area.

Water Quality

6.4.7 Yung Shue Wan has a semi-enclosed bay with low tidal currents. It is relatively well protected from severe wave action with respect to the main offshore storm wave directions, while locally generated wind waves that may affect the bay have a very short fetch.

6.4.8 At present, diffuse polluted discharges including domestic effluent and discharges from the numerous seafront restaurants are having an impact on local water quality. Based upon the Sewerage Master Plan for the Yung Shue Wan area, it was recommended that the village areas be sewered and that a small treatment plant be constructed on the Phase 1 reclamation for primary treatment prior to effluent discharge via a dedicated marine outfall outside the bay. The interception of these discharges and the proposed wastewater treatment facilities should result in an overall improvement of the water quality in Yung Shue Wan. The operational helipad Project would not generate any discharges.

6.4.9 Yung Shue Wan is located within the Southern WCZ, for which the EPD collect routine water quality monitoring data. No specific field data is available for Yung Shue Wan, although there are monitoring stations located within the general water body west of Lamma Island. The three closest stations to Yung Shue Wan are SM5, SM6 and SM7.

6.4.10 From EPD data collected in the year 2003, data from each of these stations were within the WQOs for Dissolved Oxygen and Unionised Ammonia (NH3-N). However, all three stations failed the WQOs for Total Inorganic Nitrogen (TIN).

6.4.11 Conditions within Yung Shue Wan bay are expected to be less favourable than that measured at stations SM5, SM6 and SM7 due to low water exchange rates and the diffuse discharges from septic tank overflows and from restaurants into the bay.

6.4.12 The monitoring station closest to the proposed Project site is 'SM5' located approximately 2.5km south of the Project site (co-ordinate: 22^{o}12.141'N, 114^{o}6.728'E). The water quality of SM5 for the past 5 years as extracted from Marine Water Quality in Hong Kong (1999-2003) is summarised in *Table 6.2*.

Table 6.2 Summary of Water Quality at 'SM5' between 1999 and 2003

Parameter	1999	2000	2001	2002	2003
DO mg/L	6.4 (3.5-8.4)	7.0 (4.5-11.2)	6.4 (3.9-9.2)	7.3 (4.8 – 12)	6.3 (4.5 – 8.6)
DO mg/L (bottom)	6.0 (3.5-7.9)	6.9 (5.0-9.8)	5.8 (4.0-7.9)	6.9 (5.3 – 9.1)	6.2 (5.1 – 7.9)
DO % Saturation	91 (51-123)	99 (67-168)	89 (66-118)	103 (72 – 176)	90 (69 – 129)
DO % Saturation (bottom)	85 (51-100)	98 (73-143)	82 (60-112)	98 (79 – 135)	88 (69 – 118)
Suspended Solids (mg/L)	5.6 (1.9-16.0)	4.7 (0.5-16.0)	7.8 (3.3-17.3)	7.4 (1.8 – 30.0)	6.6 (1.5 – 17.0)
E. coli (cfu/100ml)	9.2 (1 – 68)	10 (1 – 110)	5.7 (1 – 18)	37 (1 – 420)	3.3 (1 – 16)
Unionised Ammonia (mg/L)	0.002 (0.001-0.004)	0.002 (0.001-0.007)	0.002 (0.001-0.007)	0.001 (0.001-0.008)	0.002 (0.001-0.009)
Total Inorganic Nitrogen (mg/L)	0.18 (0.03-0.61)	0.15 (0.02-0.47)	0.18 (0.04-0.61)	0.17 (0.04-0.73)	0.09 (0.01-0.34)

Notes:
1. *Unless otherwise specified, data presented are depth-average (A) values calculated by taking the means of three depths: Surface (S), Mid-depth (M) and Bottom (B).*
2. *Data in brackets indicate the ranges.*

Sediment Quality

6.4.13 The closest EPD monitoring station for sediment quality is station 'SS4', which is located some 2.5km west of the Project site (co-ordinate: 22°11.500'N, 114°4.743'E). The sediment quality of SS4 for the past 5 years as extracted from Marine Water Quality in Hong Kong (1999 – 2003) is summarised in *Appendix 6.1*. It can be seen that the sediment belongs to Category L (i.e., sediment contamination levels do not exceed the Lower Chemical Exceedance Level (LCEL)).

6.4.14 A Sediment Testing Proposal was prepared specifically for this Study, and approved by EPD. Accordingly, sediment sampling was conducted within the proposed helipad footprint. Through chemical analysis it was determined that the sediment had concentrations of all tested metals below the respective LCELs, while levels of PAH's or PCB's were below the limit of detection [*Section 5* refers].

Water Quality Criteria

6.4.15 The EPD sediment quality data shows that the marine sediment around the Project site belongs to Category L (i.e., the contaminant level not exceeding the Lower Exceedance Level). Therefore, suspended solid (SS) is the only parameter concerned in this water quality impact assessment.

6.4.16 Elevated SS levels may affect WSRs through the formation and transport of sediment plume formation should dredging works be required, and may potentially affect WSRs as described above. The level of elevation will determine whether the impact is acceptable. The WQOs in terms of SS for the Southern WCZs are defined as being an allowable maximum elevation of 30% above the background level. The 90th percentile of the SS level over the last 5 years (1999 – 2003) is 13.6 mg/l, which was used as the background level. A 30% increase above the background level is an elevation of ~4.1 mg/l, giving a total SS limit of 17.7 mg/l.

6.4.17 Silt and clay, also called cohesive sediment, will form large particles by the process of flocculation after being released into the water column, which will then settle back to the seabed, resulting in a smothering effect. This smothering effect can be detrimental to the corals. A limit on the sedimentation rate of 0.1 $kg/m^2/day$ was applied to the Project, following the study for Sand Dredging at the West Po Toi Marine Borrow Area (ERM, 2001).

6.5 Impact Assessment & Evaluation

6.5.1 As presented in *Section 2*, the construction of the helipad will not require dredging or back-filling, as it will be a reinforced concrete deck supported on piles.

6.5.2 A temporary platform will be required for the construction of the helipad and associated EVA. This working platform will be constructed by installing steel piles into the seabed to the required depth and then welding steel planks on top. As permanent casing will be used for the bored piles, bentonite slurry will not be necessary.

6.5.3 During drilling for the permanent casing, marine sediments shall be airlifted under pressure through the top of the casing and channelled into a sedimentaion tank located on the working platform. After settlement of solids, the effluent may be discharged into the foul sewer or into marine waters. A disposal license under the WPCO may be required for the respective discharge methods and the license conditions complied with prior to discharge. It is proposed that the settled uncontaminated marine sediment be disposed at the South Cheung Chau spoil disposal area. After installation of the permanent casing, grout shall be pumped into the bottom of the casing to displace muddy seawater into the same sedimentation tank with the effluent and sediment to be disposed as outlined above.

6.5.4 During pile installation and extraction, marine sediment shall be disturbed and will cause a highly localised water quality impact. A silt curtain shall be installed around the works area to contain mobilised sediment and ensure no potential adverse impacts on the hard coral community at the sloping boulder seawall [*Section 7* refers]. The silt curtain shall not impinge on the hard coral community at the sloping boulder seawall. The silt curtain shall be removed after pile extraction once the sediment has settled. The location of the temporary working platform is indicated in *Figure 6.1*. After completion of all works the temporary works platform / piles shall be removed by a barge-mounted crane.

6.5.5 During operation the water flow through the piled structure will generally be maintained as at present, although there may be localised effects due to the physical resistance of the piles. However, no significant impact on the flow regime or water quality will arise during operation.

6.6 Cumulative Impacts

6.6.1 As regards potential for marine ecology impacts, Phase 2 of the Yung Shue Wan Development Engineering Works will commence in Year 2008, by which time all construction works for the Yung Shue Wan Helipad will be complete.

6.6.2 The construction of DSD's Yung Shue Wan STW and Outfall is tentatively scheduled to commence in August 2007 for approximately 3 years. The Helipad and STW developments have been scheduled to avoid concurrent works and cumulative water quality impacts.

* The mixing zone is the region of a water body where initial dilution of pollution input takes place and where water quality criteria can be exceeded (EIA-TM, Annex 6).

6.7 Impact Mitigation & Residual Impact Assessment

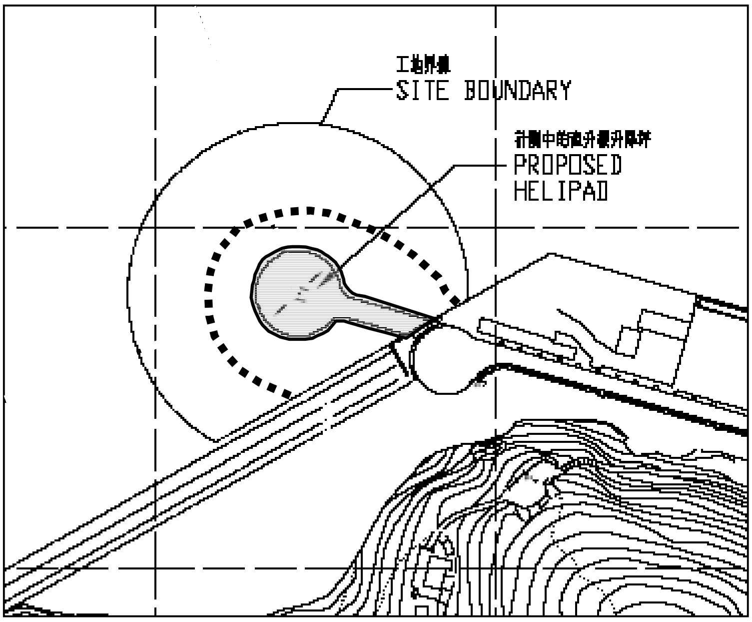
6.7.1 In view of the construction method, no significant adverse water quality impacts are predicted.

6.7.2 As a precautionary good practice measure to ensure no adverse direct or induced impact on the hard coral community on the sloping boulder seawall or upon adjacent marine waters, it is recommendedthat a silt curtain be installed surrounding the whole of the site as indicated in *Figure 6.1*.

6.7.3 The following good site practices are also recommended to further minimise the potential water quality impact in addition to the procedures outlined under Section 6.5.3 to comply with ProPECC PN 1/94:

- The holding tank should be fitted with a tight fitting seal to prevent sediment leakage; and
- The holding tank should not be filled to a level which will cause overflow of sediment during loading and transportation.

Figure 6.1 Indicative Silt Curtain Alignment during Marine Construction Works



Legend

Indicative location of the temporary working platform

Silt curtain surrounding the site.

6.8 Environmental Monitoring & Audit (EM&A)

6.8.1 Given the nature of the construction method, and given that a silt curtain shall be installed surrounding the whole works site, no water quality impacts are anticipated. However, a licence under the WPCO may be necessary for the various discharges and the license conditions should be complied with prior to discharge.

6.9 Conclusions and Recommendations

6.9.1 It can be concluded that the assessed construction method will not generate adverse water quality impacts. There may be some minor spillage during the transfer of excavated sediment, although such a volume would be negligible and restricted to the waters immediately around the pile location. As such, no adverse significant water quality impacts are anticipated.

6.9.2 Hydrodynamic effects of the constructed Project will be negligible, while there will be no operational discharges that could potentially translate into impacts on the marine environment.

6.9.3 No specific mitigation measures are considered to be necessary, although the use of a silt curtain is recommended as a good working practice for marine piling works.

6.10 References

- EPD (2000). Hong Kong Marine Water Quality.
- EPD (2001). Hong Kong Marine Water Quality.
- EPD (2002). Hong Kong Marine Water Quality.
- EPD (2003). Hong Kong Marine Water Quality.
- ERM (2001). *Focused Cumulative Water Quality Impact Assessment of Sand Dredging at the West Po Toi Marine Borrow Area*. Final report submitted to Civil Engineering Department, HKSAR Government.

7 ECOLOGY

7.1 Introduction

7.1.1 This section presents the approach to and the findings of the ecological impact assessment. The aim of the ecological impact assessment is to examine all marine ecosystem components (including sub-tidal and inter-tidal habitats) within the assessment area in order to protect, maintain or rehabilitate the natural environment.

7.1.2 For the purpose of the marine ecological assessment the 'assessment area' is the same as that for the water quality impact assessment, i.e., a 1 km radius around the Project site.

7.1.3 There is no requirement in the Study Brief for a terrestrial ecological impact assessment. However, a broad assessment has been conducted to support presentation of a complete ecological baseline for the area. Given the scale, nature and location of the works, the terrestrial ecology assessment area has been defined as an area of 100 metres radius from the proposed helipad to take account of wildlife disturbance during the operational phase. Any direct impacts during the construction phase of the Project would be within this area.

7.1.4 *Figure 7.1* illustrates the boundaries of the marine and terrestrial ecology assessment areas.

7.2 Assessment Approach

7.2.1 The ecological assessment has been undertaken in accordance with the criteria and guidelines in Annexes 8 and 16 respectively of the EIA-TM, and with reference to the requirements of Clause 3.4.6 of the EIA Study Brief as follows:

(i) Review the findings of relevant studies and collate all the available information regarding the ecological characters of the assessment area;

(ii) Evaluate the information collected and identify any information gap relating to the assessment of potential ecological impacts to the aquatic environment;

(iii) Carry out necessary ecological field surveys of at least four months duration and investigations to verify the information collected and fill the information gaps identified;

(iv) Establish the general ecological profile of the assessment area and describe the characteristics of each habitat found;

(v) Using suitable methodology, and considering cumulative effects, identify and quantify as far as possible any direct, indirect, on-site, off-site, primary, secondary and cumulative ecological impacts;

(vi) Determine that the ecological impacts are avoided by design to the maximum practicable extent;

(vii) Evaluate the significance and acceptability of the ecological impacts identified using well-defined criteria;

(viii) Recommend all possible alternatives and practicable mitigation measures to avoid, minimise and/or compensate for the adverse ecological impacts identified;

(ix) Evaluate the feasibility and effectiveness of the recommended mitigation measures and define the scope, type, location, implementation arrangement, subsequent management and maintenance of such measures;

(x) Determine and quantify as far as possible the residual ecological impacts after implementation of the proposed mitigation measures;

(xi) Evaluate the severity and acceptability of the residual ecological impacts using well-defined criteria; and

(xii) Review the need for and recommend any ecological monitoring programme required.

7.3 Regulations, Standards and Guidelines

7.3.1 In order to evaluate the significance of any potential impact upon the ecological components within the assessment area, it is necessary to understand which components are of 'conservation importance'. This is defined as any species and / or habitat regularly occurring in the Study Area that is globally, regionally threatened / important, protected in the HKSAR, and /or locally or regionally endemic, rare or restricted.

7.3.2 In addition to the requirements of the EIAO (Cap. 499), those regulations, standards and guidelines applicable to the ecological evaluation are summarised as follows:

Town Planning Ordinance (Cap. 131)

7.3.3 In accordance with Section 4(1)(g) of the Town Planning Ordinance (the Ordinance), draft plans prepared under Section 3(1)(a) of the Ordinance for the lay-out of any such area may show or make provision for country parks, coastal protection areas, Sites of Special Scientific Interest, green belts or other specified uses that promote conservation or protection of the environment.

7.3.4 Under Chapter 10 of the Hong Kong Planning Standards & Guidelines there are guidelines for the identification and protection of Natural Landscapes and Habitats.

Forests and Countryside Ordinance (Cap. 96) and Forestry Regulations

7.3.5 This Ordinance protects both natural and planted forests, and the Forestry Regulations under this Ordinance provide for the protection of specified local wild plant species.

Wild Animals Protection Ordinance (Cap. 170)

7.3.6 The Wild Animals Protection Ordinance provides for the protection of species listed in 'Schedule 2' of the Ordinance by prohibiting the disturbance, taking or removal of such animals, their nests and eggs.

7.3.7 This Ordinance excludes fish and marine invertebrates, but does allow for the protection of all marine mammals found in Hong Kong waters.

Animals & Plants Ordinance (Protection of Endangered Species) (Cap. 187)

7.3.8 This Ordinance controls the local possession of any endangered species of animals and plants listed in its schedules. These include various types of coral, including Stony (hard) corals (order Scleractinia) and Black corals (order Antipatharia). Soft coral is not protected under this Ordinance.

Fisheries Protection Ordinance and Regulations (Cap. 171)

7.3.9 Through the regulation of fishing practices and the prevention of activities detrimental to the fishing industry, this Ordinance aims to protect fishes and other marine biota in HKSAR waters.

Regionally / Internationally protected species

7.3.10 Chinese White Dolphin and Finless Porpoise are listed as "Insufficiently Known" in the International Union for Conservation of Nature and Natural Resources (IUCN) Red Data Book, and both species are listed in Appendix I (i.e., highest protection) of the Convention on International Trade in Endangered Species (CITES) [of Wild Flora and Fauna].

7.3.11 In the Mainland PRC, the Chinese White Dolphin is listed as a Grade I National Key Protected Species, whilst the Finless Porpoise is listed as a Grade II protected species.

7.3.12 Both CITES and the international *Convention on Biological Diversity* both include provisions for the protection of corals.

7.4 Ecological Baseline

7.4.1 Clause 3.4.6.4 (iv) (a) – (e) of the EIA Study Brief provides guidelines for establishing a general ecological profile of the study area. To this end, the characteristics of the general area and the key habitats are described under the sub-sections below.

7.4.2 Where appropriate, sensitive receivers referred to under the literature review and identified through the field survey are displayed on *Figure 7.1* and / or *Figure 7.2*.

Literature Review

<u>*General*</u>

7.4.3 A literature review has been undertaken to collate relevant data and information regarding ecological resources within the assessment area – including the locations of recognised sites of conservation importance and other ecologically sensitive areas.

7.4.4 Literature reviewed is from both public and private sector studies, and includes the following:

- Consultancy Study on Marine Benthic Communities in Hong Kong (CityU Professional Services Limited, 2002).
- EIA Study for Lamma Power Station Navigation Channel Improvement (Hyder, 2003).
- EIA Study for Yung Shue Wan Development, Engineering Works, Phase 2 (Mouchel, 2002).
- EIA Study for Lamma Power Station Extension (ERM, 1999).
- EIA Study for Yung Shue Wan Sewage Treatment Works and Outfall (CES, 1997).
- SEA for 'Landfill Extension Study' – North Lamma option (Scott Wilson / BMT, 2002).

Sub-tidal Ecology

7.4.5 Sub-tidal benthic survey was conducted adjacent to the proposed helipad site in October 1996 for the *EIA Study for Yung Shue Wan Sewage Treatment Works and Outfall* (CES, 1997). This survey, conducted prior to reclamation works, recorded the sediment to be comprised of fine mud and silt mixed with occasional shell fragments. The most abundant benthic infauna taxa were of the Order Polychaeta. Polychaete worms favour muds for burrowing, and particularly abundant were species of the Family Capitellidae that are indicators of low oxygen environments. No coral was identified in the immediate vicinity of the proposed site from this past ecological survey, although there are scattered coral communities in the broader area.

7.4.6 A comprehensive survey of the HKSAR's marine benthic community was undertaken on behalf of AFCD throughout 2001, and included a sampling station located in Ha Mei Wan approximately 1 km to the south of the HEC Lamma Power Station – the closest such sampling location to the Project area. The survey station is slightly outside the marine ecology assessment area, although the survey results were that the marine benthic community in Ha Mei Wan is broadly characteristic of most of the sampling stations in western and southern HKSAR waters and represents a typical soft-bottom infauna.

7.4.7 The community was characterised by a number of polychaetes and other species that were represented in at least half of the 120 sampling stations across the HKSAR (CityU, 2002). *Table 7.1* below summarises these representative species and shows their presence / absence in the seabed community at Ha Mei Wan from summer and winter surveys.

Table 7.1 Representative Species in the Ha Mei Wan Marine Benthic Community *(CityU, 2002)*

Family	Species	Summer Survey	Winter Survey
Polychaete	*Mediomastus spp.*	√	√
	Sigambra hanaokai	√	-
	Agalaophamus dibranchis	√	√
	Cossurella dimorpha	√	-
	Ophiodromus angustifrons	√	-
	Paraprionospio pinnata	√	√
	Prinospio malmgreni	-	√
	Prinospio ehlersi	-	√
	Otopsis sp.	-	√
Crustaceae	*Callianassa japonica*	√	-
	Neoxenophthalamus obscuris	√	√
Echinoderm	*Amphiodia obtecta*	-	√
Sipunculan	*Apionsoma trichocephalus*	√	√
	Total Species Richness (0.5 m^2)	39	34
	Total Individuals (m^2)	284	142
	Total Wet Weight (g/m^2)	54.70	81.20

7.4.8 To appreciate the ecological significance of the marine benthic community at Ha Mei Wan a comparison was made of the univariate indices (*d*, *H'* and *J*) at this location with the mean values for other stations in western and southern (W & S) HKSAR waters [*Table 7.2*refers].

***Table 7.2 Univariate Statistics for Ha Mei Wan & Similar HKSAR Survey Areas** (CityU, 2002)*

Index	Summer		Winter	
	Ha Mei Wan	W & S HKSAR	Ha Mai Wan	W & S HKSAR
Species Richness index (*d*)	7.67	7.26	7.74	4.90
Species Diversity index (*H'*)	3.02	2.87	3.24	2.32
Species Evenness index (*J*)	0.83	0.82	0.93	0.73

7.4.9 *Table 7.2* shows that there is no significant difference (p>0.05) between the summer and winter indices for species richness (*d*), diversity (*H'*) or evenness (*J*) at Ha Mei Wan. Compared to other survey stations with similar characteristics (mainly in western and southern waters) the Ha Mei Wan community generally has higher species richness, diversity and evenness – particularly in the winter period – indicating it is broadly of above average ecological value. Despite this, no marine benthic species of particular note were found in the Ha Mei Wan area, nor would be expected at Yung Shue Wan where the sediment is more disturbed and the water quality poorer.

7.4.10 As regards corals, *Figure 7.1* illustrates the location of the closest coral community to the proposed helipad site. This is a west-facing rocky headland at the north of Yung Shue Wan, approximately 400 metres north of the proposed helipad site (Mouchel, 2002).

7.4.11 From a qualitative dive survey around this headland small and scattered colonies comprising four species of encrusting hard coral were observed: *Montipora peltiformis*; *Favites abdita*; *Favia speciosa*, and *Plesiastrea verispora*. These species are commonly found in HKSAR waters. Around the southern part of the headland, upon entering Yung Shue Wan, there was reportedly a fairly sudden change in the benthic community composition, with the oyster *Saccostrea cucullata* becoming dominant (*ibid*.).

7.4.12 Hard corals have previously also been recorded from the coastline of Shek Kok Tsui, some 800m north of the proposed helipad, where the encrusting hard coral *Psammocora superficialis* and small colonies of Faviidae species were observed. The coral density at this site was reported as <2% and was not considered to be of any particular conservation importance (ERM, 1999).

7.4.13 A more diverse coral community, including soft corals and gorgonians, exists at Pak Kok, northeast Lamma. Here the cover of the coral community is in the order of 13%, and the site has conservation value (Binnie, 1995).

7.4.14 An incidental observation of the Green Turtle *Chelonia mydas* – one of 4 species of sea turtle found in Hong Kong – has also been observed in waters around Pak Kok (Scott Wilson / BMT, 2002). The Green Turtle is the only turtle species known to breed locally, with nesting only reported thus far at the sandy beach at Sham Wan, south Lamma, approximately 9 km from the Project area. The Green Turtle is protected under the Wild Animals Protection Ordinance, Cap.170 and is listed under Appendix I of CITES. The beach at Sham Wan and the nearby shallow waters were designated a SSSI in June 1999, whilst (since 1999) approximately 0.5ha of the nesting area including the beach is a 'Restricted Area' from 1st June to 31st October each year.

7.4.15 Given that the Project is now to be developed by small diameter pre-bored piling structures, the water quality impact will be negligible and highly localised around the piles. As such, the Pak Kok area, at 2.5 km distance, will not be affected by the Project. Likewise, the Green Turtle nesting beach and nearby shallow waters at Sham Wan will not be affected by the Project.

7.4.16 Based on records accumulated by AFCD between October 1995 and April 2003, there is only one 'official' record of the Chinese White Dolphin *Sousa chinensis* in the general area, and that close to the Power Station – some 1.5 km from the proposed Yung Shue Wan helipad site (AFCD, 2003a).

7.4.17 The scenario is similar for the Finless Porpoise *Neophocaena phocaenoides*. From records accumulated by AFCD between February 1996 and April 2003 there is one official record – again, in waters just off the Power Station (AFCD, 2003b). However, an undated casual observation of a group of some 10 porpoises was made to the *north* of the Yung Shue Wan ferry pier, as reported in Mouchel (2002). Despite this observation, it was concluded that the waters in the vicinity of Yung Shue Wan are not of particular importance to the Finless Porpoise.

7.4.18 Porpoises move into the waters of West Lamma, around Ha Mei Wan, in December and reach their peak abundance around southwest Lamma between March and May (*ibid*.). This core area for the Finless Porpoise is approximately 5 km from Yung Shue Wan (Scott Wilson / BMT, 2002).

7.4.19 Fisheries resources of potential ecological significance in the broader area are present around the south of Lamma Island where there are important spawning and nursery grounds for a range of fish and crustacean species (ERM, 1998). These waters also support the squid *Loligo* sp., the lion-head fish *Collichthys lucida* and the tiger-tooth croaker *Otolithes argenteus* that comprise the most common and numerically important prey species of the Finless Porpoise (Jefferson, 2001).

7.4.20 The results of Port Survey 2001/2002 (AFCD, 2003c) provide adult fish catch data (kg / hectare) throughout HKSAR waters for the top ten families, and also provides data for specific areas. Accordingly, catch data for the top ten HKSAR families in waters to the northwest and southwest of Yung Shue Wan provides an indication of fish / crustacean family abundance in the area. The adult catch data for these two Yung Shue Wan areas has been combined and ranked against the HKSAR average, as presented in *Table 7.3*.

Table 7.3 Top Ten Ranked Adult Fish / Crustacean Families *(from AFCD, 2003)*

Family	Rank	
	HKSAR	**Yung Shue Wan**
Rabbitfish (SIGANIDAE)	1	2
Sardine (CLUPEIDAE)	2	9
Croaker (SCIAENIDAE)	3	2
Scad (CARANGIDAE),	4	5
Squid	5	5
Shrimp	6	1
Anchovy (ENGRAULIDAE)	7	10
Crab	8	7
Seabream (SPARIDAE)	9	2
Threadfin bream (NEMIPTERIDAE)	10	7

Note: The top ranking category, "Mixed Species", has been excluded from Table 7.3 *as it comprises* juvenile *fishes.*

7.4.21 Fisheries data from the Port Survey 1996/97 (AFCD, 1998) are more detailed in terms of indicative species abundance (from catch data) at two defined fishing zones in waters adjacent to Yung Shue Wan: Pak Kok and Po Lo Tsui. Together these zones cover a sea area of over 1 km to the north, west and south of Yung Shue Wan. On a unit area basis the Po Lo Tsui zone is the most productive for both adult and fry fish, ranking 43rd of 210 zones and 29th of 89 zones respectively (*ibid*.). The top ten adult species caught (by weight) in each of these zones is as presented in *Table 7.4*.

***Table 7.4 Top Ten Adult Fish Species Caught off Yung Shue Wan** (from AFCD, 1998)*

Species	Common Name	Zone / Rank	
		Pak Kok	***Po Law Tsui***
Mixed Species	N/A (various)	1	1
Siganus oramin	Rabbitfish	2	6
Caranx spp.	Scad / Crevalle	6	2
Pseudosciaena crocea	Yellow Croaker	4	5
Sebasticus marmoratus	Rockfish	5	4
Eleutheronema tetradactlyus	Threadfin	3	-
Sardinella jussieu	Sardine	-	3
Clupanodon punctatus	Gizzard Shad	7	-
Stolephorus spp.	Anchovy	-	7
Leiognathus brevirostris	Pony Fish	8	-
Argyrosomus spp.	Croaker	-	8
Trachurus japonicus	Scad	9	-
Sparid spp.	Sea Bream	-	9
Mixed Crabs	N/A (various)	10	-
Ambassis gymnocephalus	N/A	-	10

7.4.22 From the above 'Port Survey 1996/97' data it is of note that 5 of the top 6 species were caught in both fishing zones. Due to differences in raw data presentation, a direct comparison cannot be made between data from the two Port Surveys. However, the two tables above provide an idea of abundant fish / crustacean taxa in the Yung Shue Wan area.

Inter-tidal / Terrestrial Habitat

7.4.23 From a review of work conducted by CES (1997), prior to reclamation for the proposed Yung Shue Wan STW site the inter-tidal zone was surveyed by line transect. The transect closest to the proposed Yung Shue Wan helipad site was comprised of granite boulders and sand, and the predominant species recorded were common gastropods, crabs and algae.

7.4.24 More recent inter-tidal survey work at the north of Yung Shue Wan conducted by Mouchel (2002) gathered data from three hard shore and three soft shore locations mainly around the north / northeast of the bay.

7.4.25 The soft shore areas comprised sandy beach and soft muds, with shell fragments present. Of the three areas investigated, benthic fauna were only recorded from the location beside a culvert at the northeast of the bay. The community was similar for both wet and dry season survey, being dominated by Capitellid polychaetes, with Nephytid and Cossurid polychaetes also present.

7.4.26 The hard shore communities were more diverse, comprising 4 – 9 species in the dry season and 4 – 10 species in the wet season. The lowest species richness and abundance in both wet and dry seasons was from the hard shore adjacent to the culvert at the northeast of the bay – a probable response to chronic water pollution at this area and the data for the soft shore area would suggest. It was noted that the two hard shore locations at the fringes of Yung Shue Wan displayed relatively high species diversity and abundance (*ibid*.). A characteristic seasonal decline in abundance was recorded from the dry to the wet season, although there was an increase in species diversity.

7.4.27 The type, zonation and seasonality of representative benthic fauna species at the two hard shore areas north and northwest of Yung Shue Wan (i.e., remote from the polluted culvert discharge) is summarised in *Table 7.5*.[*] None of the species recorded are of particular conservation importance.

[*] 'Representative' species are those in the dataset represented by a mean of >1 individuals at any shore zone.

Table 7.5 Hard Shore Benthic Fauna, Yung Shue Wan – Year 2001 Data *(from Mouchel, 2002)*

Species	North YSW		Northwest YSW	
	January	***June***	***January***	***June***
Monodonta australis	H, M, L	H	/	/
Nodolittorina trochoides	H	/	H	H
Nodolittorina radiata	H	H	H, M	H
Thais clavigera	M	M, L	L	H
Liolophura japonica	M	/	M, L	H, M
Nerita albicilla	/	/	L	/
Cellana toreuma	M, L	H	M, L	H, M
Patelloida pygmaea	/	/	L	/
Patelloida saccharina	M	H	M, L	H, M
Saccostrea cucullata	M, L	M	/	/
Teraclita squamosa	M, L	H, M	M, L	M
Pollicepes mitella	/	H	M	H
Septifer bilocularis	/	/	M	/
Ornithichiton hirasei	/	H, M	/	/

Note: Shore zones where species present: H = High; M = Mid; L = Low; / = absent from all zones

7.4.28 Given that reclamation works in the immediate vicinity of the Yung Shue Wan helipad site are only recently complete, there is no natural (or planted) inter-tidal vegetation community present. However, behind the area reclaimed for the Yung Shue Wan STW the natural coastal scrub / secondary woodland community has been largely retained. Species in this coastal community include the grass *Pennisetum* sp., the ubiquitous exotic shrub *Lantana camara* and the very common trees *Macaranga tanarius* and *Ficus hispida* (CES, 1997). A few small banana (*Musa paradisiaca*) groves in this community are characteristic of abandoned cultivation, and are not of conservation importance (*ibid*.).

7.4.29 No records of terrestrial fauna in the immediate area were presented in past study reports. However, there are records for the broader environs of Yung Shue Wan as presented by Mouchel (2002). Given their mobility, observations of birds are potentially of most significance to the proposed helipad site, with one record (2 specimens) of the Reef Egret *Egretta sacra* and two records (4 specimens) of the Night Heron *Nycticorax nycticorax* recorded from within Yung Shue Wan on 9th January 2001 and 20th June 2001, respectively. Both species are local but not uncommon.

Field Survey Methodologies

7.4.30 The Ecological Baseline Survey was conducted in March and April 2003. Details of the mapping and survey methodologies and findings are presented under the following headings.

Habitat Mapping

7.4.31 A Habitat Map of the immediate area around the proposed helipad was developed with reference to land use maps and aerial photographs of the assessment area taken and supplied by GFS. This was supported by 'ground truthing' conducted on 25th March 2003, which involves systematically surveying the assessment area to verify the accuracy of the initial interpretation of maps and photographs.

Sub-tidal Habitat

7.4.32 Recently completed survey work by Mouchel (2002) has generated an updated sub-tidal ecology profile for much of the Yung Shue Wan area, although the survey area did not specifically include the area around the helipad. Accordingly, a dive survey was conducted under this Assignment on 27th April 2003 to verify the assumed status of the seabed benthic community and the site of the proposed helipad footprint, and to inspect the boulder seawall that has previously not been surveyed.

7.4.33 A series of spot-check reconnaissance dives were initially conducted from a ‘P4’ boat by two qualified marine biologists. The objective of the reconnaissance dives was to gain familiarity with the underwater terrain, following which a decision was made as to where best to conduct qualitative survey transects.

7.4.34 There was nothing of particular note in the immediate vicinity of the proposed helipad footprint, although there were signs of a potentially interesting benthic community on the boulder seawall. Accordingly a dive transect was surveyed along 400m of coastline starting at the vertical seawall by the Refuse Transfer Station (RTS) and covering the length of the sloping boulder seawall (130m) and part of the natural rocky shoreline [*Figure 7.2* refers].

7.4.35 The transect depth was close to the surface, at approximately -0.5m CD. A second transect was followed back to the RTS, at approximately -5.0m CD, and hence a total transect distance of approximately 800 metres was surveyed. Visibility on the day of survey was greater than 4m and so observations from the two transects were able to cover the entire sub-tidal area of the seawall (i.e., approximately 4.5m length [down from the water surface level] by 130m wide).

7.4.36 This method was employed to assess the substrate for the presence of coral communities and to update any existing desktop studies and previous site surveys. The following detailed information was categorised: Location, depth, visibility, substrate type, distance surveyed, % hard coral and soft coral cover, coral species and other biota present. Representative video footage and digital images were taken on mini digital-video format, using a 3CCD camera system.

Inter-tidal / Terrestrial Habitat

7.4.37 To complete an ecological profile for the area, a qualitative survey of vegetation, birds and butterflies present in terrestrial habitat behind the reclamation was completed on 25th March 2003. Survey involved walking a line-transect along the base of and up the foot-slope behind the reclamation [*Figure 7.2* refers]. Weather on the day was dry and warm, 22 degrees Celsius – conditions that are generally conducive to wildlife activity.

7.4.38 A qualitative survey of benthic species found on the sloping boulder seawall adjacent to the proposed helipad location was also conducted on the same day. This element of the survey was conducted by walking along the lower part of the sloping seawall that forms the front of the proposed STW reclamation (there being no biota at the middle or upper seawall area) [*Figure 7.2* refers]. Observations were also made for biota colonising the vertical seawall adjoining the sloping seawall to the north (i.e., fronting the RTS).

Field Survey Results

Habitat Mapping

7.4.39 From the Habitat Mapping exercise, a total of five discreet habitat types were identified in the assessment area. *Table 7.6* summarises their respective areas.

7.4.40 *Figure 7.2* presents the delineation of the five habitats in the assessment area. For completeness, the figure also shows the delineation of a small area of cultivated land to the east (outside) of the assessment area, although this land is not subject to impact assessment – being too remote from the Project to be affected.

Table 7.6 Habitat Types in the Assessment Area

Habitat Type	Approximate Area (hectares)
Sub-tidal	~ 150 ^
Granite Boulder Seawall	0.1
Rocky Shore	~ 0.5 ^
Developed / Disturbed Area	0.8
Mixed Scrub / Secondary Woodland	0.8

Note: ^ Area of Sub-tidal habitat and Rocky Shore calculated within the 1 km marine ecology assessment area.

7.4.41 A brief summary of the five habitat categories in the assessment area is provided below, with further details provided under "*Evaluation of Ecological Value*". Representative colour photographs of the habitats are presented as *Figure 7.3*.

1. *Sub-tidal* [The seabed around Kam Lo Hom is predominantly of silty muds, with erratic boulders to around 10 metres from the foot of the sloping seawall. No benthic fauna was observed on the silty seabed, although several fish species were observed].

2. *Granite Boulder Seawall* [present as a uniform sloping seawall across the inter-tidal zone, with more irregularity in shallow sub-tidal waters by the seawall].

3. *Rocky Shore* [natural granite shoreline slab adjoining the boulder seawall to the south / southeast of the proposed works area].

4. *Developed / Disturbed Area* [This category includes reclaimed land that has been set aside for the development of the proposed Yung Shue Wan sewage treatment works, and a length of vertical concrete seawall around the existing Refuse Transfer Station that extends into and around much of the main bay of Yung Shue Wan].

5. *Mixed Scrub / Secondary Woodland* [Behind and around the reclaimed platform is vegetated land, characterised by mixed scrub and secondary woodland].

<u>*Sub-tidal Ecology*</u>

7.4.42 Three major habitat types were studied during the dive survey: granite boulder habitat (inter-tidal and sub-tidal), granite rocky shore (inter-tidal and sub-tidal) and silty marine muds (sub-tidal only).

7.4.43 The spatial extent of the sloping boulder seawall was to a maximum depth of -4.0m CD, whilst in deeper waters (-4.0 to -6.0m CD) scattered boulders and fine silt were predominant. It was also noted that boulders in deeper waters were smothered with silt. Below –6.0m CD silty muds were dominant and visibility was poor due to natural sediment re-suspension from wave action. No benthic taxa were recorded from the seabed areas inspected.

7.4.44 The recorded benthic community was entirely confined to the hard boulder and rocky shore habitat types only, with typical hard community taxa such as bryozoans, encrusting sponges, mussels and barnacles present. These taxa were, however, far more abundant on the shallow sub-tidal face of the sloping seawall than the flatter and smother rocky shore habitat, and were particularly found in the -0.5 to -3.0m CD depth band. A high % cover of turf and calcareous algae was also widespread in the same depth range on the sloping seawall.

7.4.45 Of particular note, the dive survey also recorded a total of 15 species from four families of hard coral found on the sloping granite seawall and the rocky headland at the southwest end of the seawall [*Table 7.7* refers]. All hard coral species in the community are common in the HKSAR, with the dominant family being the Faviidae.

Table 7.7 Hard coral species, Yung Shue Wan (BMT, 27th April 2003)

Family	Scientific Name
Faviidae	*Favites pentagona*
	Favites chinensis
	Favites flexuosa
	Favites abdita
	Goniastrea aspera
	Favia rotumana
	Oulastrea crispata
	Cyphastrea serailia
	Platygyra carnosus
	Plesiastrea versipora
Siderasteriidae	*Psammocora haimeana*
	Psammocora profundacella
	Psammocora superficialis
Dendrophyllia	*Turbinaria peltata*
Poritidae	*Porites* cf *lutea / lobata*

7.4.46 The corals were present in numerous isolated sub-massive and encrusting colonies, with several colonies > 0.5m diameter. Within the confines of the baseline survey it was not possible to allocate a particular percentage cover to each coral species due to the tightly integrated character of the colonies.

7.4.47 Most of the corals were found on the upper surface of large boulders (i.e., boulders typically with a surface area > $1.0m^2$), with the corals generally being confined to a depth range of -1.5m to -2.0m CD. The distribution of hard corals was scattered but generally uniform along the length of the survey transects.

7.4.48 In summary, the live coral cover on the sloping boulder seawall and adjacent rocky headland was 6 – 10% of the surveyed area (i.e., an area cover in the range of 35.1 – $58.5m^2$ [of a total *sub-tidal* boulder seawall surface area of $585m^2$]).

7.4.49 During the dive survey, a checklist of fish seen around the sloping boulder seawall and over the adjacent seabed was recorded. Species recorded include: Waspfish (*Paracentropogon longispinus*), Hong Kong butterfly fish (*Cheatodon wiebeli*), Silver sweeper (*Pempheris oualensis*), Cardinalfish (*Apogon* spp.), Wrasse (*Labridae* spp.) and Pearl-spot chromis (*Chromis notata*).

7.4.50 All these fish species are common and are generally found in boulder / silt habitats.

Inter-tidal / Terrestrial habitat

7.4.51 Despite the loss of the natural inter-tidal shoreline some common and versatile species were recorded colonising the sloping rock-armour seawall adjacent to the proposed Helipad site. The sloping seawall is approximately 200 metres long and an epifauna community was present only at the lower part, within the tidal range. The limpet *Cellana toreuma* and the top shell *Monodonta australis* dominate the community. Other species widespread on the lower wall, but less abundant, were the amphipod *Ligia exotica* and the acorn barnacle *Teraclita squamosa*. The pockets between the boulders of the sloping seawall were barren and no vegetation had become established.

7.4.52 No epifauna or vegetation was recorded from the vertical seawall off which the EVA link is to be constructed.

7.4.53 Along the top of the sloping and vertical seawall (as far as the RTS) a landscaped planting area has been developed. This supported only ornamental species, with most of these being exotic (e.g., *Bougainvillia* sp. and *Lantana* sp.). None of the ornamental species are of ecological conservation value.

7.4.54 In the mixed scrub / secondary woodland community at the back of the reclaimed land there was a diverse community of grasses, herbs, shrubs and trees. The most abundant species immediately behind the reclaimed land included the grasses *Eleusine indica*, *Paspalum* sp., *Chloris barbata*, *Miscanthus floridulus*, *Rhynchelytrum repens* and *Pennisetum* sp., and a number of common herbs and climbers (e.g., *Ageratum conyzoides*, *Bidens pilosa*, *Hedyotis* sp., and *Ipomoea cairica*).

7.4.55 Further upslope, where the land levels out somewhat and the soil is deeper, there is a diverse tree community – part of a continuous habitat up the north-facing slope. There are some abandoned village houses in this area and evidence of past cultivation, with several exotic ornamental plants (e.g., *Bougainvillia* spp. and *Thevetia peruviana*) and stands of the banana *Musa paradisiaca* growing wild. However, most species are native, and include *Ficus microcarpa*, *F. virens*, *F. variagata*, *Sterculia lanceolata* and *Schefflera octophylla*. There are also a number of sizable bamboo stands in this habitat.

7.4.56 Due to its naturalness and size, the mixed scrub / secondary woodland community also supports a range of butterflies and birds. The most abundant butterfly species observed included the Large Faun *Faunis eumeus*, Common Tiger *Danaus genutia*, Glassy Tiger *Parantica aglea*, Lime Blue *Chilades lajus*, Red Helen *Papilo helenus*, Paris Peacock *P. paris*, and the Common Mormon *P. polytes*. All butterflies observed are common and widespread species.

7.4.57 Bird species in the mixed scrub / secondary woodland habitat included the Crested Bulbul (*Pycnonotus jocosus*), Chinese Bulbul (*P. sinensis*), Red-vented Bulbul (*P. aurigaster*), Magpie (*Pica pica*), Rufous backed shrike (*Lanius schach*), Large hawk-cuckoo (*Cuculus sparverioides*) and the Greater coucal (*Centropus sinensis*). All bird species observed around the fringes of the vegetated area, closest to the coastal works area, are locally common and widespread species.

7.4.58 The foot of the vegetated slope is approximately 30 metres from the edge of the EVA link works area, and will not be physically disturbed by the Project.

7.4.59 Observations were made of birds around the south of the Yung Shue Wan coastal area, in the vicinity of the proposed helipad works area. A total of four bird species were noted within an approximate radius of 200 metres from the proposed helipad. Most notably, there were 14 Little Egrets (*Egretta garzetta*) recorded – most of these resting on small boats and exposed rocks within the bay. The other species were 2 individuals of Black Kite (*Milvus migrans*) flying overhead, a solitary Cattle Egret (*Bubulcus ibis*) also resting on a floating pontoon in the bay, and a number of crested mynahs (*Acridotheres cristatellus*) flying through the area.

Recognised Sites of Conservation Importance

7.4.60 With reference to Appendix A (Note 1) of Annex 16 of the EIA-TM, there are no recognised sites of conservation importance at or in the vicinity of the Project site.

Habitat Evaluation

7.4.61 Based on the data / information for the assessment area as presented in the literature review and field surveys results, an ecological evaluation of each habitat type within the assessment area has been conducted in accordance with the criteria listed in Annex 8 of the EIA-TM, as follows.

<u>*Sub-tidal (Pelagic and Benthic) Habitat*</u>

7.4.62 The evaluation of the ecological value of the sub-tidal habitat is presented in *Table 7.8* below.

Table 7.8 Ecological Evaluation of the Sub-tidal habitat

Criteria	Evaluation
Naturalness	Largely natural, but influenced by local and regional human activities, including discharges from Yung Shue Wan and sediment contamination.
Size	Approximately 0.50 hectares of marine benthic habitat in the Project area. Contiguous with surrounding seabed.
Diversity	Pelagic – Moderate diversity due to linkage with coastal / marine waters. Benthic – Very low diversity; dominated by polychaete worms in the Yung Shue Wan bay area.
Rarity	No rare species encountered in the assessment area.
Re-creatability	Pelagic habitat cannot be re-created, but potential for recreation of benthic habitat.
Fragmentation	N/A
Linkage	Potential linkage with adjacent hard shore, and contiguous with surrounding coastal waters.
Potential Value	Mainly limited by very high turbidity / natural seabed re-suspension (and possibly effluent discharge).
Nursery / Breeding Ground	Not of any particular value.
Age	N/A
Wildlife Abundance / Richness	Reported abundance from the general Yung Shue Wan bay area is high, but with a very low species richness as is typical of low oxygen / polluted waters.
Ecological Value	*Low value* due to continual re-suspension of seabed silt and poor water quality that controls the current ecological value and future potential.

Granite Boulder Seawall

7.4.63 The ecological evaluation of the sloping boulder seawall is presented in *Table 7.9* below.

Table 7.9 Ecological Evaluation of the Granite Boulder Seawall

Criteria	Evaluation
Naturalness	Entirely artificial habitat, but naturally colonised.
Size	The wall has a length of 130 metres, and is approximately 8 metres 'high' (~4.5m sub-tidal 'height' at high water).
Diversity	The seawall coral community was moderately diverse, although other benthic species diversity was low.
Rarity	None of the species encountered were rare, although the coral assemblage is of some significance.
Re-creatability	The habitat can be easily recreated.
Fragmentation	N/A.
Linkage	Contiguous with rocky shore habitat to the southwest. Various common gastropods recorded.
Potential Value	The presence of hard corals would indicate that the habitat, although artificial, has good habitat value potential provided the water quality in the area does not deteriorate.
Nursery / Breeding Ground	Of local significance to hard corals and possibly fish fry, but otherwise not of any particular note.
Age	< 5 years.
Wildlife Abundance / Richness	Abundant coral growth, and fair species richness (n=15). Otherwise, moderate / high abundance and low richness of gastropods.
Ecological Value	*Moderate value* due to relatively high coral richness[*] and good potential value.

[*] Oceanway (2001) & Denise McCorry, pers. comm. (2003).

Rocky Shore

7.4.64 The ecological evaluation of the rocky shore is presented in *Table 7.10* below.

Table 7.10 Ecological Evaluation of the Hard Shore habitat

Criteria	Evaluation
Naturalness	The remaining rocky hard shore in the assessment area is natural and physically intact, although its naturalness has been partly affected by past reclamation at both ends.
Size	Hard shore in the marine ecology assessment area covers approximately 0.5 hectares, with a total length of approximately 1.8 km.
Diversity	Low diversity epifauna community, supporting a range of common species – mainly gastropods.
Rarity	The hard shore habitat is not rare and there were no rare species present.
Re-creatability	Can be recreated using boulder seawall as a proxy.
Fragmentation	Fragmented by reclamation at Yung Shue Wan and typhoon shelter to the southwest.
Linkage	The length of rocky shore in the assessment area is contiguous with similar habitat that continues along the coastline to the southwest as far as to HEC power station.
Potential Value	Potential value limited by factors including narrow shore depth and exposure to wind / waves that limit species richness and community diversity.
Nursery / Breeding Ground	Of local significance to hard shore organisms, but no special value.
Age	N/A
Wildlife Abundance / Richness	High abundance of gastropods, but low species richness.
Ecological Value	*Low / Moderate value* by virtue of the total area / length of habitat and general naturalness (i.e., isolation and hence lack of disturbance).

Developed / Disturbed Area

7.4.65 The ecological evaluation of the developed / disturbed area is presented in *Table 7.11* below.

Table 7.11 Ecological Evaluation of the Developed / Disturbed Area

Criteria	Evaluation
Naturalness	Completely artificial habitat.
Size	The developed / disturbed area in the assessment area covers approximately 0.8 hectares.
Diversity	Very low – few weed and ornamental flora species and common birds / butterfly species present. Vertical reclamation seawall all but devoid of biota.
Rarity	Habitat is artificial. No rare species.
Re-creatability	N/A
Fragmentation	N/A
Linkage	N/A
Potential Value	Some potential for enhancement through revegetation, particularly with native vegetation,
Nursery / Breeding Ground	None identified.
Age	N/A
Wildlife Abundance / Richness	Minimal. Restricted to exotic / common species.
Ecological Value	*Very Low* value as an artificial and continuously disturbed area.

Mixed Scrub / Secondary Woodland

7.4.66 The ecological evaluation of the mixed scrub / secondary woodland habitat is presented in *Table 7.12* below.

Table 7.12 Ecological Evaluation of the Mixed Scrub / Secondary Woodland habitat

Criteria	Evaluation
Naturalness	Largely natural and is physically intact, although would have been subject to localised part disturbance (e.g., as evident from derelict housing and remnants of ornamental / orchard species). No evidence of fire damage.
Size	The habitat area within the 'assessment area' is approximately 0.8 hectares.
Diversity	Supports a range of grasses, ferns, shrubs and tree species.
Rarity	A locally uncommon habitat, although fairly well represented across the HKSAR.
Re-creatability	Not easily recreated given the age and stratification of the habitat.
Fragmentation	Not fragmented, but bound by the coastline and existing development. Very little human activity / disturbance potential in the vicinity.
Linkage	Part of a contiguous area of similar habitat, but generally confined by the natural coastline and existing developed land.
Potential Value	Potential that if left undeveloped and undisturbed, through ecological succession much of the area will continue to develop into native woodland.
Nursery / Breeding Ground	No breeding grounds were noted during survey, but this habitat will support such a role for various insects, reptiles and likely resident birds.
Age	Most vegetation is tall shrubs / semi-mature trees, although there are a number of mature trees spread through the habitat. Estimated to be around 20 – 30 years, with more mature trees likely to be 50+ years old.
Wildlife Abundance / Richness	The community offers a range of flowering and fruiting plant species that are particularly attractive to birds and butterflies.
Ecological Value	*Moderate / High value* due to naturalness, size, diversity, lack of disturbance, age and potential ecological value.

7.5 Ecological Impact Assessment & Evaluation

Methodology

7.5.1 The assessment of ecological impacts has been conducted with reference to Annex 16 of the EIA-TM, and is based on the scale and duration of the Project, and the ecological significance (importance) of habitats and / or species that may be affected.

Construction Phase

Sub-tidal Ecology

7.5.2 As the Project is of a small scale and is to be constructed by small diameter pre-bored piling, it will not result in any significant sub-tidal habitat loss. The area of habitat permanently lost will be limited to the cumulative footprint area of the piles that support the EVA link and the helipad – approximately 16m^2 (i.e., 26 no's. of 0.610m diameter piles).

7.5.3 As determined through the water quality impact assessment, there will be localised seabed disturbance during the installation of the small diameter pre-bored piles in the immediate vicinity of the works. However, given the construction method and the weak tidal circulation around Yung Shue Wan, seabed sediment will be confined to the bottom of the water column and will re-settle quickly.

7.5.4 The construction will require excavation of marine sediment from within pile casing. While there may potentially be some minor sediment leakage during excavation, this would be restricted to within the pile casing and no water quality impacts would arise. There is some potential for leakage into the receiving waters during the transfer of the excavated sediment to the holding tank, although this can be avoided by using a tightly sealed grab. In addition, a silt curtain shall be installed during the marine construction works. As such, no significant water quality-induced ecological impacts are anticipated.

7.5.5 Given the small scale of the project, the localised nature of the impacts and that the piling installation works would only be conducted off the existing seawall, there would not be any direct loss of hard coral communities as identified along the artificial boulder seawall. The contractor would be expected to maintain a tidy works area at this working location closest to the sloping seawall to ensure there are no water quality-induced impacts in the vicinity of the hard coral community. The good site practices are summarized in paragraph 7.6.2.

Inter-tidal / Terrestrial Ecology

7.5.6 The Project is to be constructed in coastal waters by small diameter pre-bored piling. The vertical seawall off which the Project will be developed does not support any marine biota and will not be affected by the works, while there is no terrestrial habitat in the vicinity that will be physically impacted. As such, the Project will not result in any direct loss of inter-tidal or terrestrial habitat.

7.5.7 There would be the need to remove a small length of the landscaped planter. The species in the planter are exotic and of no ecological value. However, demolition of the planter must be carefully conducted so that demolition material does not enter the adjacent waters.

7.5.8 As the Project will be constructed off the existing vertical seawall, the closest pile location to the sloping seawall where there is a basic inter-tidal community is approximately 10 metres. Given the works method, there will be no water quality-induced effects on inter-tidal habitat. In any event, a silt curtain will be used during the works as a good practice measure and to ensure no adverse effect on the coral community. The silt curtain would also ensure that sediment does not affect the inter-tidal community.

Operation Phase

Sub-tidal Ecology

7.5.9 Given the nature of the Project, there will be no waste / materials generated during the operational phase, and therefore no water quality impacts are anticipated that could potentially translate into impacts on the marine environment.

7.5.10 As concluded in the water quality impact assessment, the absence of any significant constraint to water flow in the Project area means that no hydrodynamic and / or associated water quality impacts are anticipated during the operational phase of the Project.

Inter-tidal / Terrestrial Ecology

7.5.11 Regarding inter-tidal ecology, as with sub-tidal ecology there will be no waste / materials generated and no water quality impacts are anticipated that could affect adjacent inter-tidal areas. Similarly, there will be no hydrodynamic and / or associated water quality impacts are anticipated during the operational phase of the Project.

7.5.12 Regarding terrestrial ecology, while the operational helipad will be a source of noise when in use that has the potential to disturb birds, and potentially affect butterflies through air turbulence, the helipad will be located approximately 50 metres from the closest part of the vegetated habitat where most observations of birds and butterflies were made. Furthermore, the absence of suitable shoreline in the vicinity of the Project area means that bird activity is very limited. There were no observations of birds on the artificial sloping seawall or on the rocky shore to the west of the Project, while those birds observed around Yung Shue Wan to the east and southeast would be able to freely move inshore (within the bay) if disturbed by helicopter noise. As such, no significant ecological impacts are anticipated during the operational phase of the Project.

Cumulative Impacts

7.5.13 As regards potential for marine ecology impacts, Phase 2 of the Yung Shue Wan Development Engineering Works will commence in Year 2008, by which time all construction works for the Yung Shue Wan Helipad will be complete.

7.5.14 Construction of the Yung Shue Wan Sewage Treatment Works (STW) is tentatively scheduled to commence in August 2007 for approximately 3 years. The Helipad and STW developments have been scheduled to avoid concurrent works. No cumulative water quality-induced effects will be generated.

7.6 Impact Mitigation & Residual Impact Assessment

Sub-tidal Ecology

7.6.1 While the water quality assessment does do not predict any adverse impact on the live coral community on the sloping boulder seawall, a silt curtain shall be installed surrounding the whole of the site as indicated in *Figure 6.1* to ensure no adverse water quality-induced ecological impacts.

7.6.2 The following good site practices are also recommended to further minimise the potential water quality-induced ecological impacts:

- Particular care should be taken when demolishing the existing concrete planter to ensure no waste enters the water column;
- Particular care should be taken when decommissioning the silt curtain to avoid sudden dispersion of muddy water that may cause adverse impact to the nearby marine life.
- Materials storage areas should be located well away from the seawall, and any such areas should be covered during the works;
- The holding tank for sediment excavated from within the pile casing should be fitted with a tight fitting seal to prevent leakage;
- The contractor should ensure that excavator grab seal is tightly closed and the hoist speed is suitably low;
- The holding tank should not be filled to a level which will cause overflow of sediment during loading and transportation; and
- Large objects should be removed from the excavator grab to avoid sediment spills.

7.7 Environmental Monitoring & Audit Requirements

7.7.1 Given the nature of the construction method and the Project scale, no significant adverse ecological impacts have been identified and as such no ecological monitoring is considered necessary. In particular, the water quality impact assessment has confirmed that no significant adverse impacts will arise from Project development that could potentially induce adverse impacts on the marine ecosystem, including corals.

7.8 Conclusions & Recommendations

7.8.1 As the Project is of a small scale and is to be constructed by small diameter pre-bored piling, it will not result in any significant sub-tidal habitat loss, while there is not anticipated to be any impact on the hard coral community from pile installation so long as good working practices are followed. No specific mitigation measures are considered to be necessary, although the use of a silt curtain has been recommended. Accordingly, there is no ecological monitoring requirement.

7.8.2 Similarly, the vertical seawall off which the Project will be developed does not support any marine biota and will not be affected by the works, while there is no terrestrial habitat in the vicinity that will be physically impacted. As such, no inter-tidal or terrestrial ecology impacts are anticipated given the construction method and distance to sensitive receivers. Likewise, there is no ecological monitoring requirement.

7.8.3 Hydrodynamic effects of the constructed Project will be negligible, while there will be no operational discharges that could potentially translate into impacts on the marine environment.

7.9 References

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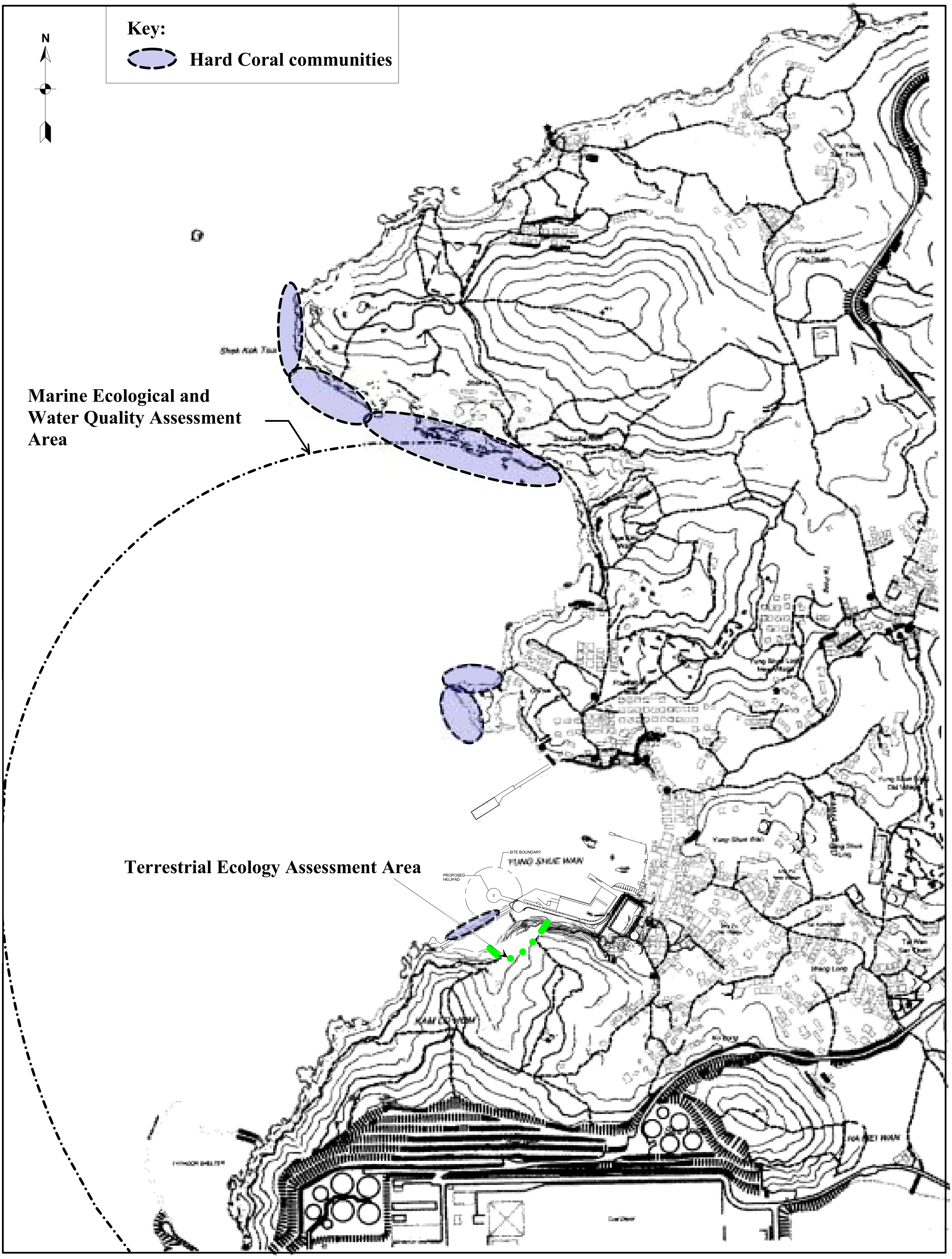

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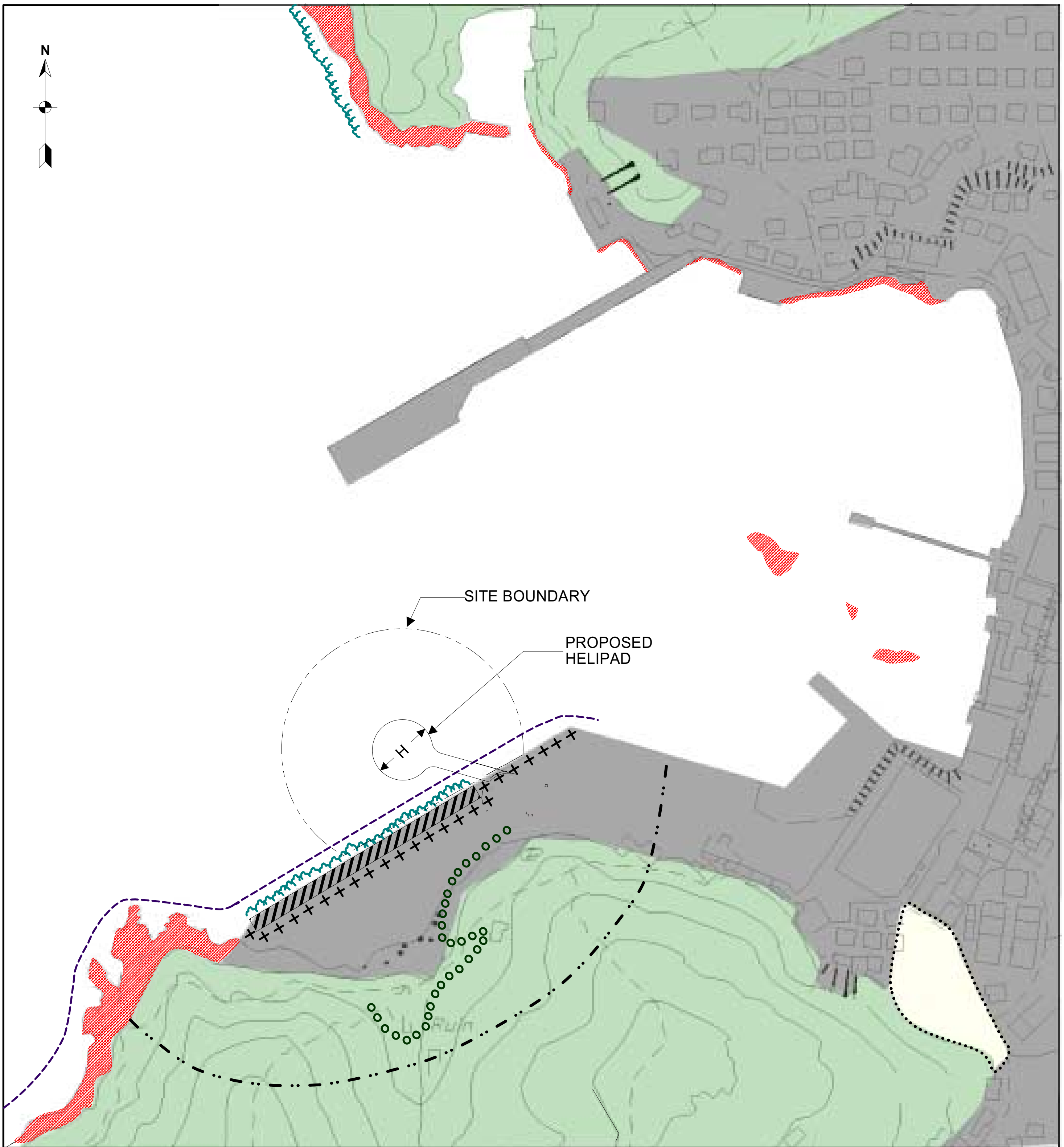
EIA Study for Helipad at Yung Shue Wan, Lamma Island

ECOLOGY & WATER QUALITY ASSESSMENT AREA AND SENSITIVE RECEIVERS

Figure 7.1	
Drawn ANW	Checked RBR
Scale 1:10000	Date November 2005



Legend:

Sub-tidal	Mixed scrub / Secondary woodland
Granite boulder seawall	Cultivation
Rocky shore	Hard coral community
Developed / disturbed area	
Dive survey transect	Inter-tidal survey transect
Vegetation and wildlife survey transect	Terrestrial assessment area

BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

HABITAT MAP OF THE YUNG SHUE WAN STUDY AREA

Figure 7.2

Drawn	FEW	Checked	RBR
Scale	1:2500	Date	November 2005

Coastal Waters of Yung Shue Wan

Granite Boulder Seawall (& Ornamental Planted area)

Mixed Scrub / Secondary Woodland

Developed / Disturbed Area

Sub-tidal – Encrusting Hard Coral on Boulder Seawall

Rocky Shore

BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

HABITAT PHOTOGRAPHS

Figure 7.3	
Drawn FEW	Checked RBR
Scale N/A	Date November 2005

8 CULTURAL HERITAGE IMPACT ASSESSMENT

8.1 Introduction

8.1.1 This section presents the approach to and the findings of the cultural heritage impact assessment; the aim of which is to identify and examine the nature and extent of potential impacts of the helipad development at Yung Shue Wan on cultural heritage and terrestrial and marine archaeology.

8.1.2 For the purpose of the marine archaeology assessment the ‘assessment area’ occupies a semi-circular area with a 50m radius that extends from the seawall at the far southern end of the Yung Shue Wan foreshore. The assessment area for the marine archaeological investigation is provided on *Figure 8.1*.

8.1.3 For terrestrial archaeology and cultural heritage assessment, Clause 3.4.5.2 of the EIA Study Brief states that the assessment area should be “at or close to the proposed Project”. As such, given the nature and scale of the Project, and the absence of any sites of archaeological or cultural heritage value in the vicinity, a nominal radius of 100m was used as the assessment area.

8.2 Assessment Approach

8.2.1 The cultural heritage impact assessment has been carried out in accordance with Annex 10 and 19 of the EIA-TM which pertain to criteria for evaluating the impacts on sites of cultural heritage and guidelines for impact assessment, respectively; and the requirements referred under Clause 3.4.5 and presented in Appendix A of the EIA Study Brief, as follows:

- The cultural heritage study shall assess both direct and indirect impacts on the marine archaeology, as well as identifying other unknown items of archaeological and historical interests at or close to the proposed Project, and propose appropriate mitigation measures.
- Assessment requirements for the Marine Archaeological Investigation (MAI) are detailed in *Sub-section 8.4* below.

8.3 Regulations, Standards and Guidelines

8.3.1 The legislation directly relevant to the protection and preservation of the local cultural heritage is the Antiquities and Monuments Ordinance (Cap. 53). This Ordinance, enacted in January 1976, provides for the preservation of any “site of cultural heritage”. This refers to the following:

- *Historical buildings and structures*, i.e. currently pre-1950 buildings and structures that possess definite heritage value.
- Archaeological sites and structures.
- *Palaeontological sites*, i.e. pre-Holocene geological beds of sedimentary rocks containing fossil remains and their impressions.
- *Other cultural features*, e.g. in the assessment area these may include amongst others, stone engravings, foundation and boundary stones, graves and track ways.

8.3.2 The Ordinance provides for two main areas of heritage protection:

- The statutory declaration of sites of cultural heritage of exceptional qualities and significance in the Government Gazette as Monuments, Historical Buildings, Archaeological Sites, etc., under the Antiquities and Monuments (Declaration of Historical Building) Notice.

- Relics, (defined under the Ordinance as fossils and objects/artefacts created, modified, etc. by human agency before 1800 AD) discovered after 1976 are, by law, properties of the Hong Kong SAR Government. Search and excavation for relics should comply with the Ordinance. All discoveries of antiquities or supposed antiquities must also be reported.

8.3.3 Annexes 10(2) and 19(2) of EIA-TM present guidelines for the evaluation and assessment of impacts on cultural heritage, respectively. In addition, Guidance Notes on *Assessment of Impact on Sites of Cultural Heritage in Environmental Impact Assessment Studies* under the Environmental Impact Assessment Ordinance (Cap. 499) are applicable.

8.3.4 Other legislation that supplements the work of heritage preservation includes the Lord Wilson Heritage Trust Ordinance (Cap. 425) that came into operation in 1992.

8.4 Assessment Methodology

Marine Archaeology

8.4.1 As detailed in Appendix A of the EIA Study Brief, marine archaeology assessment involves four stages, as follows:

<u>*Baseline Study*</u>

8.4.2 A review was undertaken to identify the potential for archaeological resources and, if identified, their likely character, extent, quality and value. This includes:

- Historical land use and settlement data as well as archive records such as seabed survey data collected from previous geological research (GEO).
- Marine Department, Hydrographic Office - the Department holds a substantial archive of hydrographic data and charts; and
- Royal Naval Hydrographic Department in the UK.

8.4.3 The above data sources – including dredging history - will provide historical records and more detailed geological analysis of submarine features which may have been subsequently masked by more recent sediment deposits and accumulated debris.

8.4.4 Throughout the course of the assessment meetings and discussions were held with representatives of the Antiquities and Monuments Office (AMO).

<u>*Geophysical Survey*</u>

8.4.5 In accordance with marine archaeological investigation (MAI) guidelines a marine geophysical survey was carried out in the assessment area in November 2002 with the following aims:

(a) Providing exact definition of greatest archaeological potential;
(b) Assessment of the depth and nature of the seabed sediments to define which areas consist of suitable material to bury and preserve archaeological material; and
(c) Detailed examination of the geophysical records to map anomalies on the seabed that may be archaeological material.

8.4.6 The geophysical survey involved the use of side scan sonar and a seismic boomer. Echo sounding was conducted in conjunction with the seismic survey to be able to get reasonably detailed coverage (side scan sonar survey lines are more widely separated). Further details of the geophysical survey and equipment involved are presented in *Sub-section 8.6*.

8.4.7 Prior to the geophysical survey a tide gauge was installed and checked for correct operation at the southeast corner of Cheung Chau typhoon shelter. The tide gauge data was required to calibrate the distance range between the survey vessel / equipment and the seabed, and to refer all data acquired to the Hong Kong Principal Datum (HKPD). Position fixing was carried out by differential GPS (DGPS) system. The system was checked for correct calibration at a known co-ordinated point onshore prior to installation on the survey vessel. A professional geophysicist has interpreted the data to identify potential areas of archaeological interest.

Establishing Archaeological Potential

8.4.8 The data examined during the desktop review and geophysical survey will be analysed to provide an indication of the likely character and extent of archaeological resources within the assessment area. This would facilitate formulation of a strategy for investigation.

Remote Operated Vehicle (ROV) / Visual Diver Survey / Watching Brief

8.4.9 Subject to the outcome of the above tasks, a field evaluation programme may be planned to acquire more detailed data on areas identified as having archaeological potential. Either ROV or divers could be employed to conduct inspection given that the marine traffic in the vicinity of the proposed helipad at Yung Shue Wan is not heavy. Alternatively, an archaeological watching brief can be used to monitor dredging operations should any area of high potential be identified through previous survey.

Cultural Heritage

Desktop Study

8.4.10 The aim of the desktop study is to identify archaeological and cultural heritage resources in the assessment area from previous studies / investigations relevant to terrestrial archaeology. The assessment initially involves compiling details of geology and geomorphology through reference to geological maps; available bore hole data, early maps of the area and aerial photographs.

8.4.11 Any unpublished papers, records, archives and historical documents or archaeological investigation and excavation reports kept by the AMO were also reviewed where appropriate and possible. For information on historic buildings and other structures, reference was made to the list of declared monuments (via the AMO's Internet pages). The list of deemed (but not declared) monuments and the list of sites of cultural heritage identified by the AMO were also reviewed.

Field Evaluation

8.4.12 Verification of historical buildings and structures as well as existing and potential archaeological sites has been carried out in and around the assessment area.

8.5 Baseline Conditions

Geological and Topographical Setting

8.5.1 The geology of the area is medium grained granite with debris flow in and around the lower slopes of the valley at Yung Shue Wan.

Land use history: Historic background

8.5.2 Lamma Island lies 2 nautical miles south west of Hong Kong. The village of Yung Shue Wan occupies an alluvial plain behind a former raised sand bar. Yung Shue Wan has a long history as a fishing harbour.

8.5.3 Due to its proximity to major shipping channels (East Lamma Channel) and access to Hong Kong and Canton, Lamma Island has been recorded in nautical surveys as early as 1806-19 (James Horsburgh, East India Company) and 1816 (Sayer, 1975). The earliest recorded settlement on Lamma Island occurred in the 17^{th}-18^{th} Century with relocation of the Chow clan and later the Tsang clan from Aberdeen to Sha Po Tsuen. Yung Shue Wan was settled first by the Sum and Fong clans engaged primarily in farming and fishing.

8.5.4 During World War II the area around Lamma was heavily mined and the British ship *HMS Indomitable* launched attacks on Japanese suicide bombers in the bays around Lamma (Melson, 1997).

Land use history: Prehistoric background

8.5.5 Lamma Island and Yung Shue Wan in particular has a long tradition of archaeological study dating to early 1920's. The primary archaeological sites in and around Yung Shue Wan include:

- *Sha Po Tsuen* – A rich site producing middle and late Neolithic artefacts, Bronze Age, Han, Six Dynasties and Tang dynasty pottery and artefacts.
- *North Lamma Public School* – Neolithic and Bronze Age pottery artefact.
- *Wang Long* – Neolithic pottery and artefacts.

8.5.6 Nearby sites of significance include Tai Wan – located approximately 1.5 km from the beach at Yung Shue Wan – which was the site of the first prehistoric findings on Lamma, in 1932. This site has produced bronze artefacts and other important remains.

Historical Building and Structures

8.5.7 A comprehensive historic buildings / structures survey conducted for the EIA Study for the Yung Shue Wan Development Phase 2 project recorded and documented twenty houses, temples, shrines and banyan trees were recorded and documented (Mouchel, 2002). However, none of these buildings / structures are within the cultural heritage assessment area for the helipad Project, and there will be no impacts on historic buildings / structures or cultural heritage.

8.5.8 The closest such building to the Project area is the North Lamma Medical Clinic, situated approximately 200 metres to the southeast. The Clinic was built in 1957 and is of local heritage value.

8.6 Impact Assessment and Evaluation

Marine Archaeology

8.6.1 The geophysical survey recorded shallow water depths (1 - 5 metres deep) adjacent to the existing seawall. Useful seismic data were diminished or precluded in this area due to the presence of the seawall and the apron of broken rock armour. Small areas of locally elevated seabed can be attributed to isolated rocks / boulders as the rock-head does not rise to the sea floor within the area of the site.

8.6.2 Reduced seabed levels vary within the range -2.7 to -5.0 mPD, and the thickness of sediment varies between 3.6 and 15.9 metres (Cosine Ltd., 2003). The sea floor sediments are unconsolidated materials transported, deposited and accumulated on the seabed as products of erosion. Typically they can comprise muds, silts, sands, sandy silts and larger cobbles.

8.6.3 From an archaeological perspective, finer sediments including muds and silts are deposited in relatively calm or sheltered waters and therefore tend to offer better conditions for burial and preservation of artefacts. In contrast, turbulent water conditions would be physically detrimental to archaeological preservation, keeping silts and muds in suspension and selectively depositing coarse sands and cobbles.

8.6.4 From the geophysical survey it was observed that fine-layered sea floor sediments are confined to the outer part of the proposed helipad and they thin toward the coastline, wedging out completely at the dredged channel. Those sediments are seismically characteristic of fine sands or silty sands, indicating that the sediment is of a suitable thickness and nature to bury and preserve archaeological material. However, no discrete objects were seismically defined. Beneath that wedge of fine material, the sediments are coarse and probably less suitable for the preservation of archaeological materials. Small individual items within these coarse deposits generally would not be seismically recognisable.

8.6.5 The seismic and echo sounder data indicate a sharply defined channel, 1 to 2 metres deep and at least 20 metres wide, crossing the proposed helipad site in an East - West direction. The sea floor appears to have been dredged and the edges of the channel are distinct and abrupt, suggesting moderate cohesion in the material. Piles of dredged sediments may have been deposited on the margins of the channel in some places, evident as a local ‘lip’. The probability of archaeological items remaining intact in this presumed dredged area would seem to be lower than elsewhere in the site.

8.6.6 The focus of the evaluation was therefore placed on those areas with the greatest marine archaeological potential. An evaluation of these areas is summarised in the following paragraphs.

8.6.7 Side-scan sonar data identified three items in the assessment area. These ‘items’, labelled A, B and C, are displayed by *Figure 8.1*, and the evaluation of these items is as follows:

- Item A is approximately 20 metres long and is considered most likely to be a drag mark associated with the dredged channel into which it extends. In other words, Item A overlies the dredged channel, and so was developed more recently (i.e., in the last few years).

- Item B is situated in the seawall dredge zone to the west of the proposed helipad footprint. This item is most likely to be either sediment deposits or a local depression from past dredging, and / or boulders.

- Item C is situated in the seawall dredge zone to the east of the proposed helipad footprint. Similar to Item B, Item C is most likely to be either sediment deposits or a local depression from past dredging, and / or boulders.

8.6.8 Prior to the construction of the sea wall, part of the seabed was dredged. With reference to the dredging plans for the seawall, it was concluded that the dredged zone extended outwards from the rock rubble / armour in front of the seawall. As such, the potential for submerged cultural remains in the vicinity of this dredged area is minimal.

8.6.9 To summarise, no objects or items of potential marine archaeological value were identified in the assessment area. As such, no further field investigation through ROV / visual diver survey or implementation of a watching brief is necessary.

Historical Buildings and Structures

8.6.10 The nearest terrestrial archaeological site to the proposed helipad is some 200m away and separated by substantial recent seawall and harbour development. In addition the new seawall and harbour at Yung Shue Wan from which the proposed helipad will extend is at least 200m from the nearest building of historic interest.

8.6.11 Accordingly, the Project has no potential to impact upon terrestrial archaeological sites, historical buildings or structures.

8.7 Impact Mitigation & Residual Impact Assessment

8.7.1 No potential impacts on resources of cultural heritage or archaeological value will arise from the proposed Project. As such, there is no mitigation requirement.

8.8 Environmental Monitoring & Audit

8.8.1 There are no archaeological / cultural heritage monitoring and audit requirements for the Project.

8.9 Conclusions & Recommendations

8.9.1 Three items / objects were recorded by the marine geophysical survey. Based on the geophysical survey data interpretation, and given the recent history of the area adjacent to the seawall, it was concluded that none of these are of archaeological value.

8.9.2 Desktop review and brief field evaluation in and around the proposed helipad at Yung Shue Wan revealed no existing or potential archaeological sites, historic buildings or structures within 200m of the assessment area.

8.10 References

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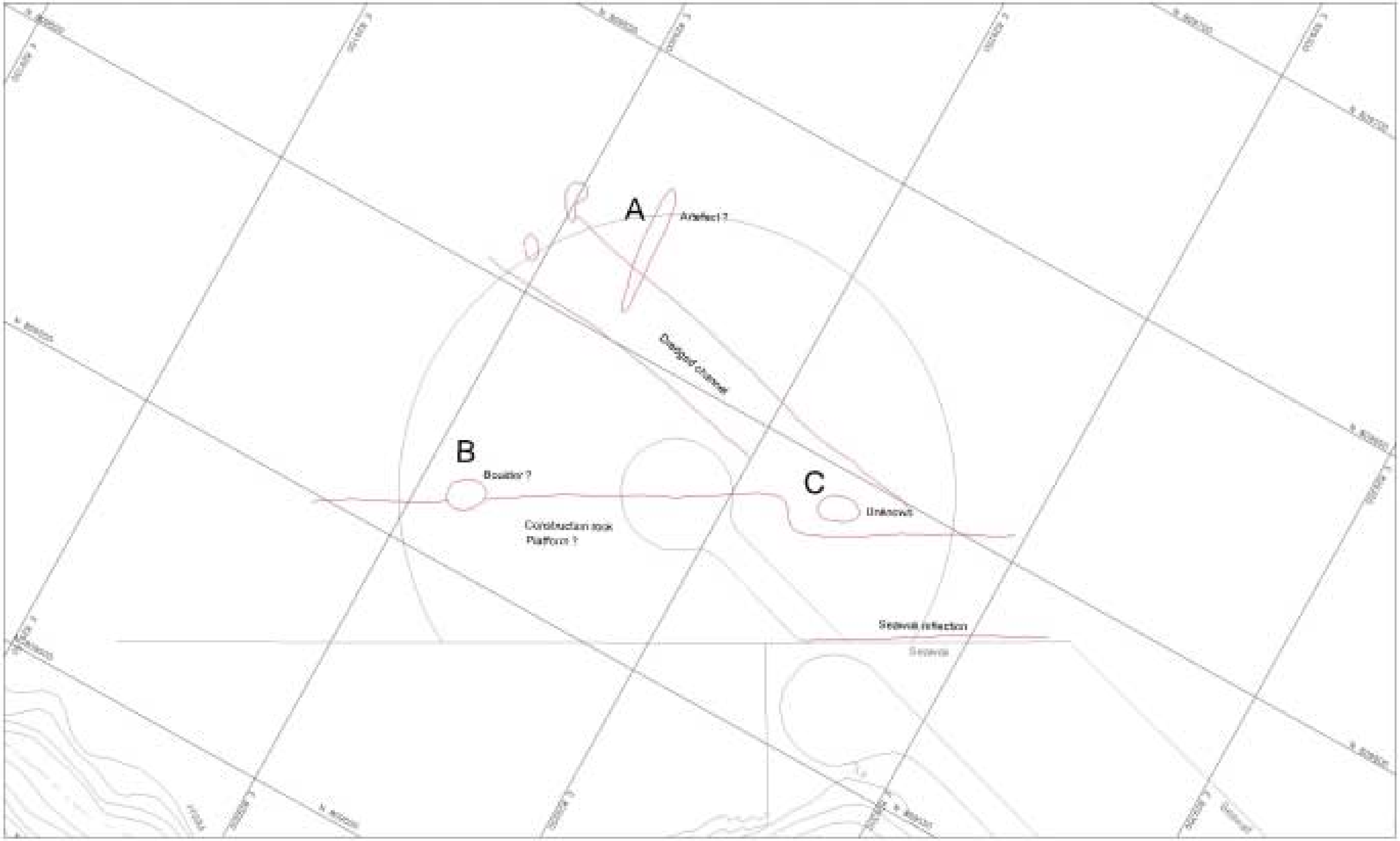

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EIA Study for Helipad at Yung Shue Wan, Lamma Island

MARINE ARCHAEOLOGY ASSESSMENT AREA AND FEATURES OF NOTE FROM GEOPHYSICAL SURVEY

Figure 8.1	
Drawn WWY	Checked FC
Scale NTS	Date November 2005

9 IMPLEMENTATION SCHEDULE OF RECOMMENDED MITIGATION MEASURES

9.1 Introduction

9.1.1 The implementation schedules of the recommended mitigation measures for each environmental aspect assessed in this EIA are given in the following Table 9.1 – Table 9.5, as appropriate.

Table 9.1 Air Quality – Implementation Schedule of Recommended Mitigation Measures

EIA Ref.	EM&A Ref.	Recommended Environmental Protection Measures / Mitigation Measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.3.6.1	S.4.2.3	All the dust control measures as recommended in the Air Pollution Control (Construction Dust) Regulation, where applicable, should be implemented.	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	Typical dust control measures include: • Restricting heights from which materials are dropped, as far as practicable to minimise the fugitive dust arising from unloading / loading;	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• All stockpiles of excavated materials or spoil of more than 50 m^3 should be enclosed, covered or dampened during dry or windy conditions;	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• Effective water sprays should be used to control potential dust emission sources such as unpaved haul roads and active construction areas;	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• All spraying of materials and surfaces should avoid excessive water usage;	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• Vehicles that have the potential to create dust while transporting materials should be covered, with the cover properly secured and extended over the edges of the side and tail boards;	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation

EIA Ref.	EM&A Ref.	Recommended Environmental Protection Measures / Mitigation Measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.3.6.1	S.4.2.2	• Materials should be dampened, if necessary, before transportation;	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• Travelling speeds should be controlled to reduce traffic induced dust dispersion and re-suspension from the operating haul trucks; and	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• Vehicle washing facilities will be provided to minimise the quantity of material deposited on public roads.	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation
S.3.6.1	S.4.2.2	• Erection of hoarding not less than 2.4m high from ground level along the site boundary.	Air Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	EIA-TM, Air Pollution Control (Construction Dust) Regulation

Table 9.2 Noise – Implementation Schedule of Recommended Mitigation Measures

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
-	S.5.9.2	Use of silenced plant, or plant equipped with mufflers or dampers in substitute of ordinary plant.	Noise During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period.	Annex 5 of EIA-TM
-	S.5.9.2	Movable noise barriers positioned as close as possible to PMEs such that none of the PMEs will be visible when viewed from any noise sensitive façades.	Noise During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period.	Annex 5 of EIA-TM
S.4.5.7	S.5.9.2	Adopt good working practices in order to minimise construction noise as far as possible: • Noisy equipment and noisy activities should be located as far away from the NSRs as is practical;	Noise control during construction	Contractors	At all construction work sites, throughout the whole duration of the construction period.	Annex 5 of EIA-TM
S.4.5.7	S.5.9.2	• Unused equipment should be turned off;	Noise control during construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Annex 5 of EIA-TM
S.4.5.7	S.5.9.2	• Number of powered mechanical equipment (PME) should be kept to minimum and the parallel use of noisy equipment / machinery should be avoided;	Noise control during construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Annex 5 of EIA-TM
S.4.5.7	S.5.9.2	• Regular maintenance of all plant and equipment; and;	Noise control during construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Annex 5 of EIA-TM
S.4.5.7	S.5.9.2	• Observe and comply with the statutory requirements and guidelines.	Noise control during construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Annex 5 of EIA-TM

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.4.6.33	-	• Use of quieter helicopter type EC155 B1 in priority.	Noise control during operation	GFS	At all time during operations	-
S.4.6.34	-	• Reduce the angle of the helicopter flight path from the standard 150 degrees to 80 degrees for the 'EC155 B1' and to 70 degrees for the 'Super Puma AS332 L2' helicopter	Noise control during operation	GFS	At all time during operations	-
S.1.2.3	-	• The helipad will be solely for emergency use.	Noise control during operation	GFS/HAD	At all time during operations	-

Table 9.3 Waste Management – Implementation Schedule of Recommended Mitigation Measures

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.5.8.1	S.6.1.2	Ensure that proper handling, storage, transportation and disposal of materials is implemented at the outset and throughout the construction phase of the helipad.	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period.	Annex 7 of EIA-TM
S.5.8.1	S.6.2.2	In line with Government's position on waste minimisation, the practice of avoiding and minimising waste generation and waste recycling should be adopted as far as practicable.	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period.	Annex 7 of EIA-TM
S.5.8.2	-	Recommended mitigation measures to be implemented include: • An on-site environmental co-ordinator should be identified at the outset of the works. The co-ordinator shall prepare a Waste Management Plan	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Environmental, Transport and Works Bureau Technical Circular (ETWBTC) No. 15/2003

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.5.8.2	S.6.2.2	• Spoil generated from the piling activities will need to be properly handled to minimise contamination to the marine water and any exposed ground areas due to leakage or improper storage (i.e. onto bare ground instead of into tanks).	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Environment, Transport and Works Bureau Technical Circular (Works) (ETWBTCW) No. 34/2002
S.5.8.2	S.6.2.2	• The reuse/recycling of all materials on site shall be investigated prior to treatment/disposal off site;	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	ETWBTCW No. 33/2002, ETWBTC No. 15/2003
S.5.8.2	S.6.2.2	• Good site practices shall be adopted from the commencement of works to avoid the generation of waste and to promote waste minimisation practices;	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	ETWBTCW No. 33/2002
S.5.8.2	S.6.2.2	• All waste materials shall be sorted on site into inert and non-inert C&D materials, and where the materials will be recycled or reused, these shall be further segregated. The Contractor shall be responsible for identifying which materials can be recycled/reused, whether on site or off site. In the event of the latter, the Contractor shall make arrangements for the collection of the recyclable materials. Any remaining non-inert waste shall be collected and disposed of to the refuse transfer station whilst any non-inert C&D material shall be re-used on site as far as possible. Alternatively, if no use of the material can be found on site, the inert C&D material can be delivered to a public filling area, public barging point or public stockpile area after obtaining the appropriate licence;	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	ETWBTCW No. 33/2002, ETWBTCW No. 34/2002
S.5.8.2	S.6.2.2	• A trip ticket system should be established at	Monitor the disposal of	Contractors	At the outset of the	ETWB TC(W) 31/2004

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
		the outset of the construction of the helipad to monitor the disposal of C&D and solid wastes from the site to public filling facilities and landfills;	C&D and solid wastes from the site		construction of the helipad, throughout the whole duration of the construction period	
S.5.8.2	S.6.2.2	• The Contractor shall register with EPD as a Chemical Waste Producer if there is any use of chemicals on site including lubricants, paints, diesel fuel, etc. Only licensed chemical waste collectors shall be employed to collect any chemical waste generated at site. The handling, storage, transportation and disposal of chemical wastes shall be conducted in accordance with the relevant guidelines as published by Government.	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Waste Disposal (Chemical Waste) (General) Regulation, Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes, Guide to the Chemical Waste Control Scheme
S.5.8.2	S.6.2.2	• A sufficient number of covered bins shall be provided on site for the containment of general refuse to prevent visual impacts and nuisance to sensitive receivers. These bins shall be cleared daily and the collected waste disposed of to the refuse transfer station. Further to the issue of Environment, Transport and Works Bureau Technical Circular (Works) No. 6/2002A, Enhanced Specification for Site Cleanliness and Tidiness, the Contractor is required to maintain a clean and hygienic site throughout the Project works.	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	ETWBTCW No. 6/2002A, ETWBTC No. 15/2003
S.5.8.2	S.6.2.2	• All chemical toilets shall be regularly cleaned and the night-soil collected and transported by a licensed contractor to a Government Sewage Treatment Works facility for disposal.	Waste Management During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	ETWBTCW No. 6/2002A, ETWBTC No. 15/2003

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.5.8.2	S.6.2.2	• Tool box talks shall be provided to workers about the concepts of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling.	Waste Management During Construction	Contractors	Throughout construction period	ETWBTCW No. 15/2003
S.5.8.3	S.6.2.3	Contractor shall comply with all relevant statutory requirements and guidelines and their updated versions.	Waste Management During Construction	Contractors	At all construction work sites, throughout construction period	EIAO - TM
S.2.2.33	-	The helipad shall be constructed by using small diameter pre-bored piling instead of dredging and reclamation.	Construction method	Contractors	At all construction work sites, throughout construction period	-
S.5.6.30	-	The helipad will only be used for emergency purposes. No equipment will be placed on the landing pad or along the EVA. Helicopters will not be parked at the landing pad and all repair and maintenance works (on the helicopters) will be conducted off site. As such the only source of waste generation during the operation of the helipad is anticipated to be from the long-term maintenance of the pad.	Operation	GFS/HAD	At all time during operations	-

Table 9.4 Water Quality – Implementation Schedule of Recommended Mitigation Measures

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.6.7.2	S.7.2.3	Silt curtain to be installed surrounding the whole of the site.	Water Quality During Construction	Contractors	Around the whole works area prior to commencement of the piling works.	Water Pollution Control Ordinance (Cap. 358), Water Quality Objectives for Southern WCZ if direct discharge to sea is adopted.
S.6.7.3	S.7.2.4	The following good site practices are recommended: • The holding tank should be fitted with a tight fitting seal to prevent sediment leakage;	Water Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period.	Not applicable (good practice only)
S.6.7.3	S.7.2.4	• Ensure that excavator grab seal is tightly closed and the hoist speed is suitably low;	Water Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Not applicable (good practice only)
S.6.7.3	S.7.2.4	• The holding tank should not be filled to a level which will cause overflow of sediment during loading and transportation;	Water Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Not applicable (good practice only)
S.6.7.3	S.7.2.4	• Large objects should be removed from the excavator grab to avoid sediment spills.	Water Quality During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	Not applicable (good practice only)
S.2.2.33	-	• The helipad shall be constructed by using small diameter pre-bored piling instead of dredging and reclamation.	Construction method	Contractors	At all construction work sites, throughout construction period	-

Table 9.5 Ecology – Implementation Schedule of Recommended Mitigation Measures

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.7.6.1	S.8.2.3	Silt curtain to be installed surrounding the whole of the site.	Ecology During Construction	Contractors	Around the whole works area prior to commencement of the piling works.	Animals & Plants Ordinance (Protection of Endangered Species) (Cap. 187)
S.7.6.2	S.8.2.4	Good practice measures to control water quality-induced ecological impacts: • Particular care should be taken when demolishing the existing concrete planter to ensure no waste enters the water column;	Ecology During Construction	Contractors	At the existing concrete planter, throughout the whole duration of the construction period.	Not applicable (good practice only)
S.7.6.2	S.8.2.4	• Particular care should be taken when decommissioning the silt curtain to avoid sudden dispersion of muddy water which may cause adverse impact to the nearby marine life;	Ecology During Construction	Contractors	Along the western side of the Project boundary, on the completion of piling.	Not applicable (good practice only)
S.7.6.2	S.8.2.4	• Materials storage areas should be located well away from the seawall, and any such areas should be covered during the works;	Ecology During Construction	Contractors	At all construction work sites, throughout the whole duration of the construction period	ProPECC Note PN 1/94 on *Construction Site Drainage*
S.7.6.2	S.7.2.4	• The holding tank for sediment excavated from within the pile casing should be fitted with a tight fitting seal to prevent leakage;	Ecology During Construction	Contractors	At the piling areas, throughout the whole duration of the piling period	Not applicable (good practice only)
S.7.6.2	S.7.2.4	• Ensure that excavator seal is tightly closed and the hoist speed is suitably low;	Ecology During Construction	Contractors	At the marine areas, throughout the whole duration of the construction period	Not applicable (good practice only)

EIA Ref.	EM&A Ref.	Recommended mitigation measures	Objectives of the recommended measures & main concerns to address	Who to implement the measures?	Location / Timing of implementation of Measures	What requirements or standards for the measures to achieve?
S.7.6.2	S.7.2.4	• The holding tank should not be filled to a level which will cause overflow of sediment during loading and transportation;	Ecology During Construction	Contractors	At the marine areas, throughout the whole duration of the construction period	Not applicable (good practice only)
S.7.6.2	S.7.2.4	• Large objects should be removed from the excavator grab to avoid sediment spills.	Ecology During Construction	Contractors	At all construction work areas, throughout the whole duration of the construction period	Not applicable (good practice only)
S.2.2.33	-	• The helipad shall be constructed by using small diameter pre-bored piling instead of dredging and reclamation.	Construction method	Contractors	At all construction work sites, throughout construction period	-

10 SUMMARY CONCLUSION & RECOMMENDATIONS

10.1 Summary Conclusion of Technical Assessments

10.1.1 The Project will involve the construction of a permanent helipad at Kam Lo Hom (North), Yung Shue Wan to serve the local community in the absence of an existing permanent facility. The helipad is required mainly for emergency use. The Kam Lo Hom (North) site selected for the Project is the optimal as of all sites considered it is the most remote from the built environment, but is also easily accessible from the Lamma Clinic.

10.1.2 The Helipad will be constructed by small diameter pre-bored piling that offers environmental advantages compared to the dredge and reclaim construction method. In particular, there will be minimal waste handling / management requirements and minimal disturbance to the seabed from pile installation, and hence only highly localised water quality impacts and no marine ecology impacts. Similarly, no construction dust impacts nor marine archaeology / cultural heritage impacts are anticipated.

10.1.3 Based on the construction schedule and plant inventory given, the unmitigated construction noise levels at all Noise Sensitive Receivers (NSRs) comply with the daytime noise standards stated in Table 1B, Annex 5 of EIA-TM. No cumulative noise impacts are predicted with the construction of the Yung Shue Wan Sewage Treatment Works. Accordingly, there are no specific mitigation measures or monitoring requirements.

10.1.4 Helicopter noise is the key issue of the Project. Through liaison with the Government Flying Service the helicopter flight path approach angle has been adjusted to eliminate noise impacts during helicopter approach, while not compromising flight safety. During helicopter manoeuvring at and over the helipad a worst-case scenario impact of up to 5 dB(A) is predicted when the ‘Super Puma AS L2’ type helicopter is used. However, the frequency of such an occurrence would be approximately once every 24.3 days, and the impact duration would be in the order of 5-10 seconds.

10.1.5 Under normal operating conditions the quieter type ‘EC155 B1’ helicopter will be used and will generate a residual impact of up to 2dB(A) during lift-off from the helipad surface. The residual impact duration under normal operations would be approximately 5-10 seconds, while the impact frequency would be approximately once every 2.8 days. This level of impact is not considered significant given the nature of the Project and the overall convenience of the proposed site to the local community.

10.1.6 Consideration was given to helicopter noise mitigation. However it was found that there are no options for direct mitigation of helicopter noise, while indirect measures, such as use of increased window glazing and installation of air conditioners, was considered impracticable due to the intermittent / unpredictable helicopter use and the short impact duration.

10.2 Key Recommendations

10.2.1 Although no construction phase noise exceedance is predicted, noise impact monitoring and audit is recommended during throughout the construction period to ensure noise levels at NSRs are kept within an acceptable limit. The Environmental Monitoring and Audit (EM&A) requirements are detailed in the stand-alone Project EM&A Manual. As regards helicopter noise, all practicable measures have been taken to avoid / minimise impacts, and as such EM&A is not recommended. However, should the need arise, the local community may lodge noise complaints with the Islands District Office.

10.2.2 No waste management impacts are predicted, and EM&A is not recommended. However, good site practise measures have been proposed to ensure the proper handling, storage, transportation and disposal of materials throughout the works. Although not predicted, these waste management control measures, and additional good practice measures proposed in *Section 3*, will ensure there are no construction dust impacts.

10.2.3 Likewise, although no water quality or marine ecology impacts are predicted, precautionary good site practice measures are recommended to further minimise the potential for water quality / marine ecology impacts. In particular, placement of a silt curtain surrounding the whole of the site is recommended to ensure no adverse effects on the hard coral community that was identified growing on and along the bottom of the boulder seawall.

10.3 Summary of Environmental Outcomes

10.3.1 The key environmental outcomes of the Project may be summarised as follows:

10.3.2 *Population and environmentally sensitive area protected*: An optimum Project site has been selected that that is relatively distant from the built environs of Yung Shue Wan but which is also readily accessible from the Lamma Clinic. The chosen helipad site offers the local community a time saving of approximately 20 minutes compared with the travel time to the previous helipad at the HEC Lamma Power Station. Furthermore, due to the availability of existing access road, the helipad can be developed relatively quickly for available to / use by the local community.

10.3.3 The realignment of the helicopter flight path to avoid flight over residential areas at north Yung Shue Wan has had a 'net impact avoidance' of adverse helicopter flight noise impacts on approximately 420 dwellings from operation of the 'EC155 B1' type helicopter.[*] For the 'Super Puma' type helicopter, flight path realignment is predicted to result in net impact avoidance on approximately 300 dwellings [*Figure 4.4(b)* refers].

10.3.4 *Environmentally friendly designs recommended*: The design makes the best use of the existing infrastructure in Yung Shue Wan by locating the helipad at the edge of the built environment. This minimises the amount of construction phase disturbance that is necessary. The helipad location has been selected to avoid encroachment on secondary woodland habitat or the hard coral community.

10.3.5 Project construction will be by small diameter pre-bored piling that represents the environmentally preferred method in terms of practically eliminating concerns over potential waste management, water quality and marine ecology impacts. The precautionary use of silt curtains will ensure there are no adverse water quality-induced impacts on the ecologically sensitive hard corals. The EVA width has been reduced from the standard 4.5m to 3.5m, with the effect that construction material requirements for the Project will be minimised.

10.3.6 *Key environmental problems avoided*: As referred above, the nature of the project and the construction method will minimise the potential for waste management, water quality and both direct and water quality-induced marine ecology impacts. The site location avoids the secondary woodland at the foot of the Kam Lo Hom slope, and hence avoids potential ecology and landscape concerns. Realignment of the helicopter flight path has allowed the avoidance of residual helicopter noise impacts on approximately 420 dwellings from operation of the 'EC155 B1' type helicopter that will mainly be used [*Figure 4.4(b)* refers].

[*] "Net impact avoidance" refers to the number of noise sensitive dwellings that flight path realignment is able to protect from adverse residual helicopter noise impacts, taking into account those dwellings that are still adversely affected by residual helicopter manoeuvring noise. For example, before flight path realignment there would be approximately 495 dwellings adversely affected by residual helicopter noise from operation of the 'EC155 B1' type helicopter. Flight path realignment is able to protect approximately 420 of these, leaving some 75 dwellings affected only by residual manoeuvring noise.

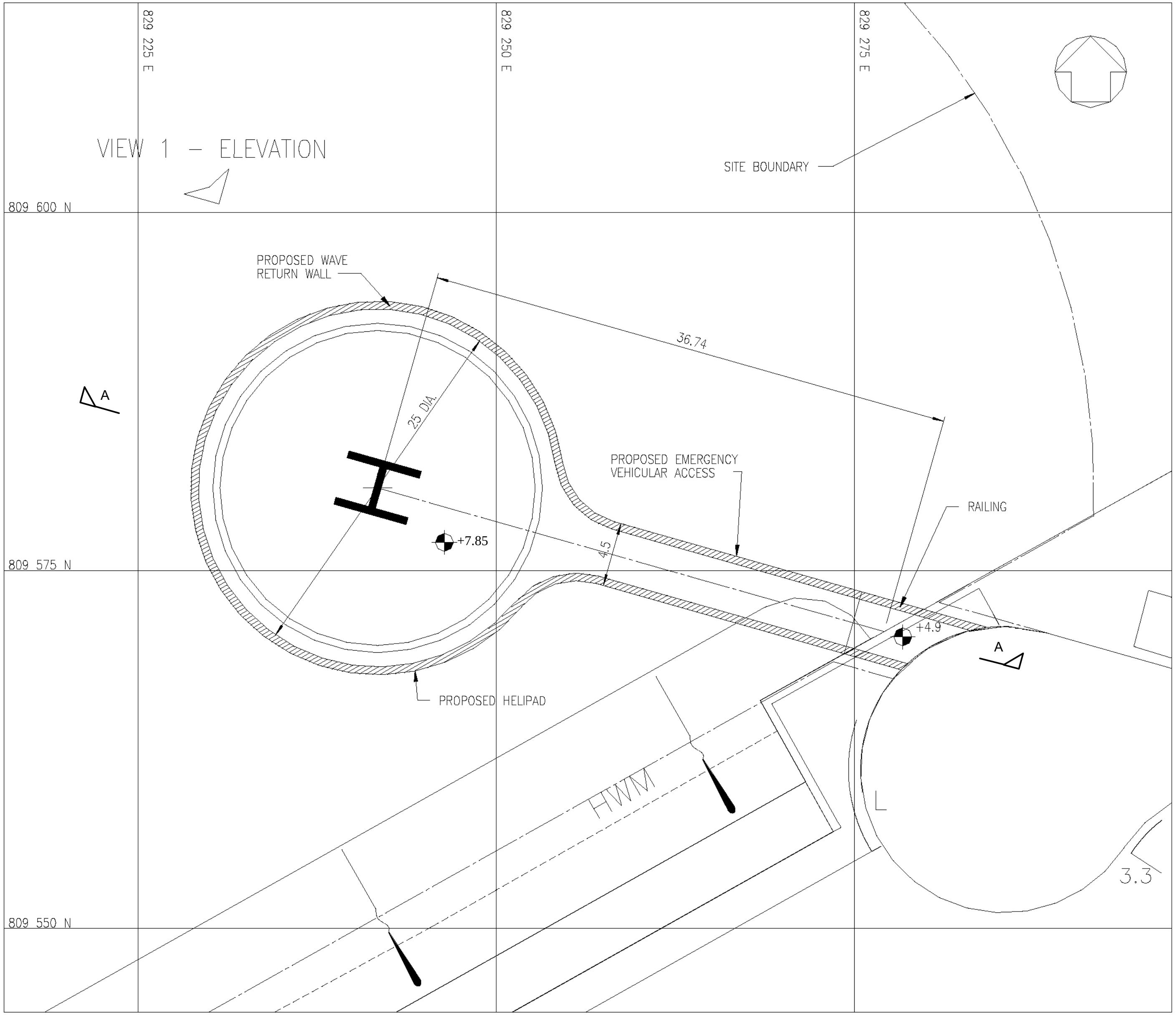
10.3.7 *Compensation areas included*: There is no significant habitat loss as a consequence of the Project, and there are no specific compensation areas. However, it can be expected that the helipad and EVA structure will bring about some benefit to inshore fisheries and marine ecology in terms of providing new hard habitat for colonisation by marine benthic organisms and by providing shelter for fry and juvenile fish.

10.3.8 *Environmental benefits of environmental protection measures recommended*: Initial residual helicopter noise impacts associated with helicopter approach / departure have been effectively eliminated through realignment of the helicopter flight path. Without helicopter flight path realignment, noise levels at approximately 420 *additional* noise sensitive dwellings at north Yung Shue Wan would exceed the helicopter noise guideline of L_{max} 85 dB(A) under the normal operating scenario (i.e., use of the 'EC155 B1' type helicopter).

10.3.9 There will be a residual helicopter manoeuvring noise impact under normal operating conditions of up to 2 dB(A) associated with helicopter lift-off. The impact duration would be 5-10 seconds and, based on actual helicopter use data for Yung Shue Wan in the year 2003, the impact frequency is predicted to occur approximately every 2.8 days. GFS will make use of the quieter 'EC155 B1' type helicopter (rather than the noisier 'Super Puma AS L2' type helicopter) wherever possible.

Appendix 2.1

VISUAL ILLUSTRATIONS

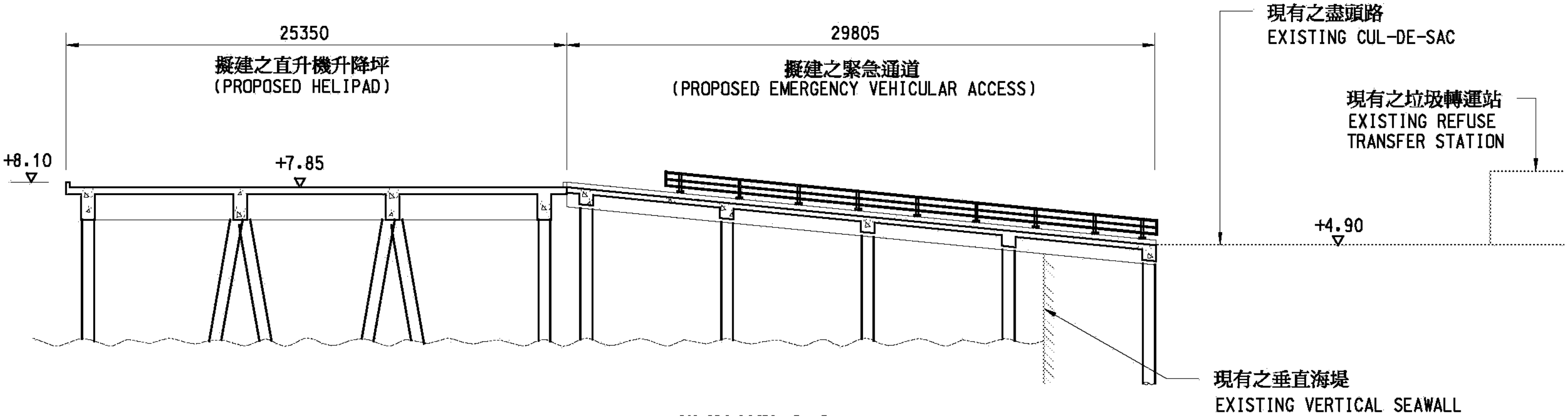


EIA Study for Helipad at Yung Shue Wan, Lamma Island

SITE LAYOUT PLAN

Figure A2.1a

Drawn	DEH	Checked	RBR
Scale	NTS	Date	November 2005



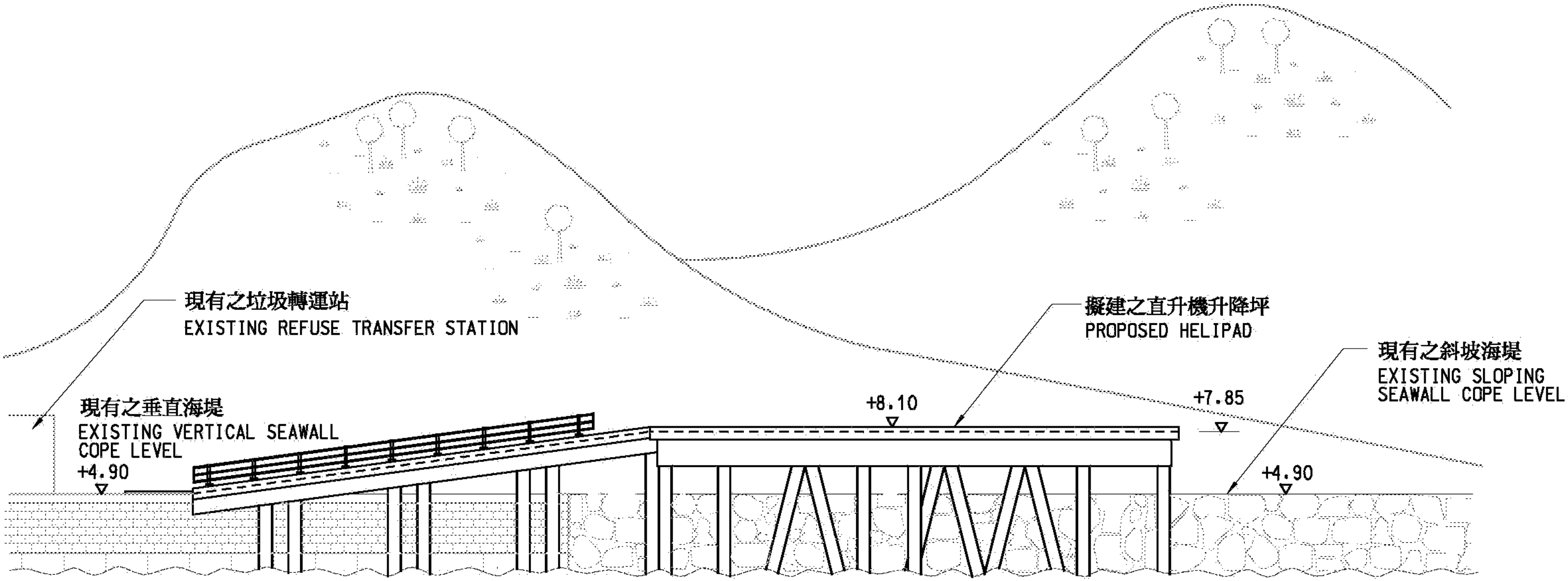
SECTION A-A

EIA Study for Helipad at Yung Shue Wan, Lamma Island

DIAGRAMATIC SECTION

Figure A2.1b

Drawn	DEH	Checked	RBR
Scale	NTS	Date	November 2005



BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

ELEVATION

Figure A2.1c

Drawn	DEH	Checked	RBR
Scale	NTS	Date	November 2005

BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

PHOTOMONTAGE INDEX

Figure A2.1d

Drawn FEW	Checked RBR
Scale 1 : 4000	Date November 2005

EIA Study for Helipad at Yung Shue Wan, Lamma Island

VISUAL ILLUSTRATION

View A2.1a

Drawn	DEH	Checked	RBR
Scale	NTS	Date	November 2005

BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

VISUAL ILLUSTRATION

View A2.1b	
Drawn DEH	Checked RBR
Scale NTS	Date November 2005

BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

VISUAL ILLUSTRATION

View A2.1c	
Drawn DEH	Checked RBR
Scale NTS	Date November 2005

Appendix 2.2

CONSTRUCTION SCHEDULE

APPENDIX 2.2 - Construction Schedule

No.	Activity Description	Duration (days)	Start Date	Finish Date	Period 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					###### - 23-May-06	###### - 9-Jun-06	###### - 27-Jun-06	###### - 18-Jul-06	19-Jul-06 - 22-Jul-06	23-Jul-06 - 23-Jul-06	24-Jul-06 - 16-Aug-06	###### - 19-Aug-06	###### - 23-Aug-06	###### - 26-Aug-06	###### - 30-Aug-06	###### - 2-Oct-06	3-Oct-06 - 14-Nov-06	###### - 17-Nov-06	###### - 21-Nov-06	###### - 23-Dec-06	###### - 27-Jan-07	###### - 28-Feb-07	1-Mar-07 - 29-May-07	###### - 6-Jun-07	7-Jun-07 - 22-Jun-07	###### - 3-Jul-07	4-Jul-07 - 5-Jul-07	6-Jul-07 30-Jul-07
					8d	17d	18d	21d	4d	1d	24d	3d	4d	3d	4d	33d	43d	3d	4d	32d	35d	32d	90d	8d	16d	11d	2d	25d
1	**Site Clearance**																											
a	Site Clearance	08 days	16-May-06	23-May-06	######																							
b	Erection of Office/Hoarding/Fencing	60 days	24-May-06	22-Jul-06		######	######	######	######																			
2	**Mobilization**																											
a	Plant set up	03 days	24-May-06	26-May-06		######																						
b	Construction of working platform	56 days	28-May-06	22-Jul-06		######	######	######	######																			
c	Mobilizing & Assembling of drilling machine/Ground Investigation	29 days	19-Jul-06	16-Aug-06					######	######	######																	
3	**Pile installation**																											
	Preliminary pile installation (1 nr)																											
a	Pre-drilling	03 days	17-Aug-06	19-Aug-06								######																
b	Drilling and installing casing	03 days	21-Aug-06	23-Aug-06									######															
c	Installing H-pile	03 days	24-Aug-06	26-Aug-06										######														
d	Grouting	03 days	28-Aug-06	30-Aug-06											######													
e	Preliminary pile test (1 nr)	33 days	31-Aug-06	2-Oct-06												######												
	Pile installation (23 nr)																											
f	Pre-drilling	83 days	24-Aug-06	14-Nov-06										######	######	######	######											
g	Drilling and installing casing	82 days	28-Aug-06	17-Nov-06											######	######	######	######										
h	Installing H-pile	83 days	31-Aug-06	21-Nov-06												######	######	######	######									
I	Grouting	82 days	3-Oct-06	23-Dec-06													######	######	######	######								
j	Main pile test (2 nr - tension and compression)	33 days	26-Dec-06	27-Jan-07																	######							
4	**Helipad construction**																											
a	Construction of beams and slabs (Helipad)/(EVA)	121 days	29-Jan-07	29-May-07																		######	######					
b	Construction wave return walls (Helipad)/(EVA)/Road & Drainage Works	24 days	30-May-07	22-Jun-07																				######	######			
5	**E&M Works**																											
a	E&M Installation	35 days	30-May-07	3-Jul-07																				######	######	######		
b	E&M Testing & commissioning	02 days	4-Jul-07	5-Jul-07																							######	
6	**Demobilization**																											
a	Demobilization of working platform and plants	25 days	6-Jul-07	30-Jul-07																								######

Construction activity will be carried out during the assessment period

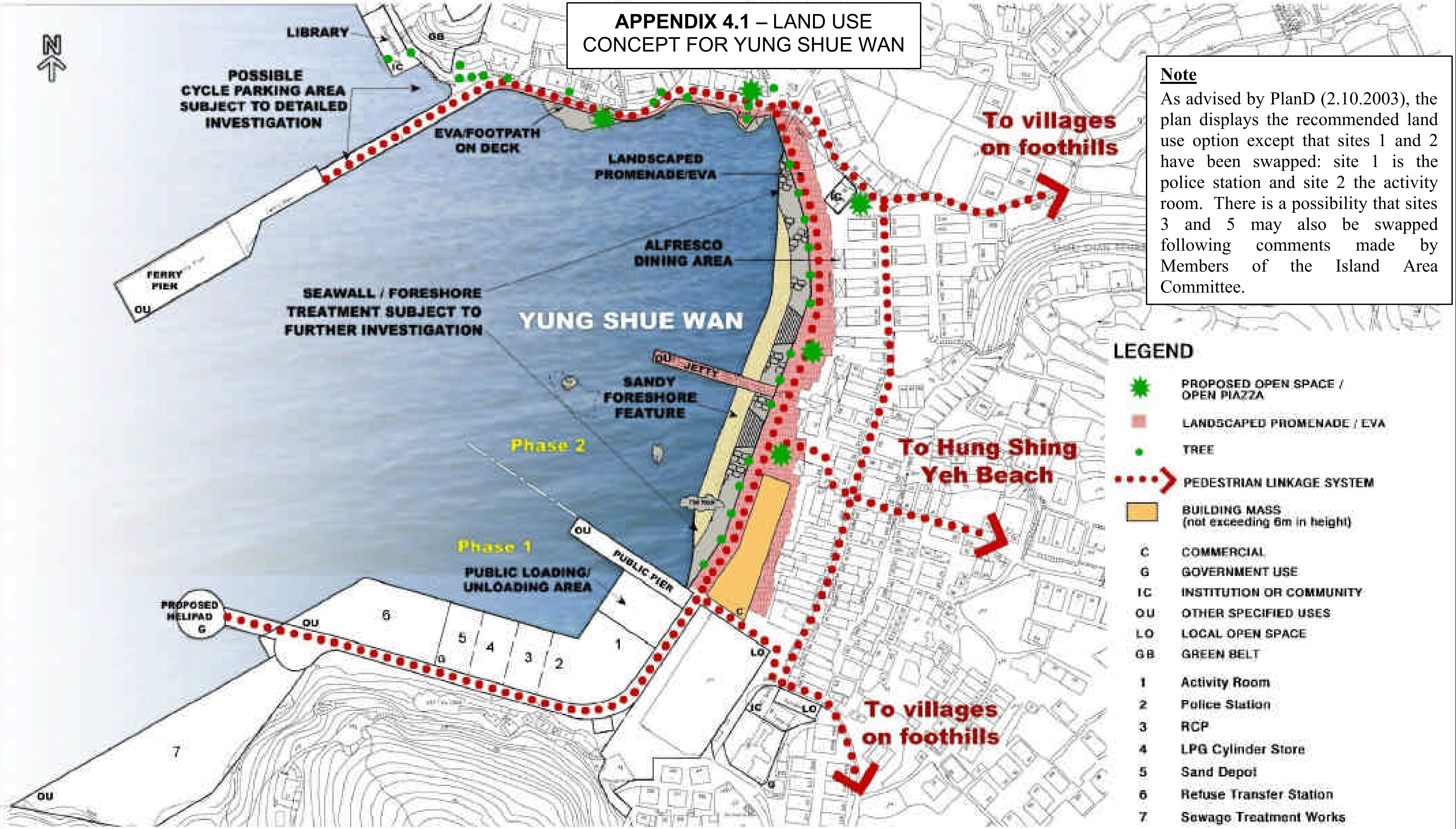
Appendix 4.1

INDICATIVE LAND USE CONCEPT FOR YUNG SHUE WAN

APPENDIX 4.1 – LAND USE CONCEPT FOR YUNG SHUE WAN

Note

As advised by PlanD (2.10.2003), the plan displays the recommended land use option except that sites 1 and 2 have been swapped: site 1 is the police station and site 2 the activity room. There is a possibility that sites 3 and 5 may also be swapped following comments made by Members of the Island Area Committee.



INDICATIVE PURPOSE ONLY
SUBJECT TO FURTHER INVESTIGATION
PLAN PREPARED ON 9.6.03

LAND USE CONCEPT FOR YUNG SHUE WAN
RECOMMENDED LAND USE OPTION - REDUCED RECLAMATION
(SUBJECT TO CHANGE)

規劃署 大嶼山及離島規劃處
LANTAU AND ISLANDS
DISTRICT PLANNING OFFICE
PLANNING DEPARTMENT

M/LI 03/13B | PLAN 3

Appendix 4.2

CONSTRUCTION EQUIPMENT INVENTORY

APPENDIX 4.2 - Equipment Inventory

No.	Activity Description	Duration (days)	Start Date	Finish Date	Tug Boat	Crane, barge mounted	Vibrator	Flat Top Barge	Auger	Bored Piling	Backhoe	Mini-Truck	Concrete Pump	Vibratory Poker	Concrete Lorry Mixer	Generator	Bar Bender (Electric)	Total SWL (Standard)
				CNP ID Code	221	048	172	061	167	166	081	068	047	170	044	102	021	
					Sound Power Level, dB(A)													
				Sound Power Level in NCO-TM/other commonly used PME	110	112	115	104	114	100	112	105	109	113	109	100	90	
					No. of plant to be operating													
1	**Site Clearance**																	
a	Site Clearance	08 days	16-May-06	23-May-06							1	2						113.5
b	Erection of Office/Hoarding/Fencing	60 days	24-May-06	22-Jul-06							1	1				1		113.0
2	**Mobilization**																	
a	Plant set up	03 days	24-May-06	26-May-06	1	1												114.1
b	Construction of working platform	56 days	28-May-06	22-Jul-06	1	1	1									1		117.7
c	Mobilizing & Assembling of drilling machine/Ground Investigation	29 days	19-Jul-06	16-Aug-06	1	1			2			1				1		119.0
3	**Pile installation**																	
	Preliminary pile installation (1 nr)																	
a	Pre-drilling	03 days	17-Aug-06	19-Aug-06	1	1				1						1		114.4
b	Drilling and installing casing	03 days	21-Aug-06	23-Aug-06	1	1				1						1		114.4
c	Installing H-pile	03 days	24-Aug-06	26-Aug-06	1	1										1	1	114.3
d	Grouting	03 days	28-Aug-06	30-Aug-06	1	1		1					1		6	1		119.3
e	Preliminary pile test (1 nr)	33 days	31-Aug-06	2-Oct-06	1	1										1		114.3
	Pile installation (23 nr)																	
f	Pre-drilling	83 days	24-Aug-06	14-Nov-06	1	1				1						1		114.4
g	Drilling and installing casing	82 days	28-Aug-06	17-Nov-06	1	1				1						1		114.4
h	Installing H-pile	83 days	31-Aug-06	21-Nov-06	1	1										1	1	114.3
I	Grouting	82 days	3-Oct-06	23-Dec-06	1	1		1					1		6	1		119.3
j	Main pile test (2 nr - tension and compression)	33 days	26-Dec-06	27-Jan-07	1	1										1		114.3
4	**Helipad construction**																	
a	Construction of beams and slabs (Helipad)/(EVA)	121 days	29-Jan-07	29-May-07	1	1		1					1	5	6	1	1	122.7
b	Construction wave return walls (Helipad)/(EVA)/Road & Drainage Works	24 days	30-May-07	22-Jun-07				1				1	1	5	6	1	1	122.1
5	**E&M Works**																	
a	E&M Installation	35 days	30-May-07	3-Jul-07							1	2				1		113.6
b	E&M Testing & commissioning	02 days	4-Jul-07	5-Jul-07								1				1		106.2
6	**Demobilization**																	
a	Demobilization of working platform and plants	25 days	6-Jul-07	30-Jul-07	1	1					1	3				1		117.2

Appendix 4.3

CONSTRUCTION NOISE CALCULATION – UNMITIGATED

APPENDIX 4.3 - Construction Noise Calculation – Unmitigated

1 Site Clearance — Predicted Noise Level, dB(A)

NSR	Description	Distance, m: NSR to NSP1	Corrections, dB(A): Distance Att.	Barrier Corr.	Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					Lw	113.5	113.0	113.0	113.0	113.0																			
1	Village House at O Tsai	312	57.9	0	PNL	58.6	58.1	58.1	58.1	58.1																			
2	North Lamma Public Library	263	56.4	0	PNL	60.1	59.6	59.6	59.6	59.6																			
3	North Lamma Clinic	98	47.8	0	PNL	68.7	68.2	68.2	68.2	68.2																			
4	No. 105 Yung Shue Wan Main Street	74	45.3	0	PNL	71.1	70.7	70.7	70.7	70.7																			
5	Village House (Potential Future)	98	47.8	0	PNL	68.7	68.2	68.2	68.2	68.2																			
6	Village House (Potential Future)	267	56.5	0	PNL	59.9	59.5	59.5	59.5	59.5																			

2 Mobilization — Predicted Noise Level, dB(A)

NSR	Description	NSR to NSP2	Distance Att.	Barrier Corr.	Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					Lw		120.2	118.9	118.9	122.0	119.0	119.0																	
1	Village House at O Tsai	303	57.6	0	PNL		65.5	64.3	64.3	67.4	64.4	64.4																	
2	North Lamma Public Library	257	56.2	0	PNL		67.0	65.7	65.7	68.8	65.8	65.8																	
3	North Lamma Clinic	214	54.6	0	PNL		68.6	67.3	67.3	70.4	67.4	67.4																	
4	No. 105 Yung Shue Wan Main Street	189	53.5	0	PNL		69.7	68.4	68.4	71.5	68.5	68.5																	
5	Village House (Potential Future)	227	55.1	0	PNL		68.1	66.8	66.8	69.9	66.9	66.9																	
6	Village House (Potential Future)	288	57.2	0	PNL		66.0	64.8	64.8	67.8	64.9	64.9																	

3 Pile installation — Predicted Noise Level, dB(A)

NSR	Description	NSR to NSP2	Distance Att.	Barrier Corr.	Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					Lw								114.4	114.4	117.4	121.5	120.4	122.2	121.5	120.5	119.3	114.3							
1	Village House at O Tsai	303	57.6	0	PNL								59.8	59.8	62.8	66.8	65.8	67.6	66.8	65.9	64.7	59.7							
2	North Lamma Public Library	257	56.2	0	PNL								61.2	61.2	64.2	68.3	67.2	69.0	68.2	67.3	66.1	61.1							
3	North Lamma Clinic	214	54.6	0	PNL								62.8	62.8	65.8	69.9	68.8	70.6	69.8	68.9	67.7	62.7							
4	No. 105 Yung Shue Wan Main Street	189	53.5	0	PNL								63.9	63.9	66.9	71.0	69.9	71.7	70.9	70.0	68.8	63.8							
5	Village House (Potential Future)	227	55.1	0	PNL								62.3	62.3	65.3	69.4	68.3	70.1	69.3	68.4	67.2	62.2							
6	Village House (Potential Future)	288	57.2	0	PNL								60.3	60.3	63.2	67.3	66.2	68.1	67.3	66.3	65.1	60.1							

4 Helipad construction — Predicted Noise Level, dB(A)

NSR	Description	NSR to NSP2	Distance Att.	Barrier Corr.	Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					Lw																		122.7	122.7	122.1	122.1			
1	Village House at O Tsai	303	57.6	0	PNL																		68.0	68.0	67.5	67.5			
2	North Lamma Public Library	257	56.2	0	PNL																		69.5	69.5	68.9	68.9			
3	North Lamma Clinic	214	54.6	0	PNL																		71.1	71.1	70.5	70.5			
4	No. 105 Yung Shue Wan Main Street	189	53.5	0	PNL																		72.2	72.2	71.6	71.6			
5	Village House (Potential Future)	227	55.1	0	PNL																		70.5	70.5	70.0	70.0			
6	Village House (Potential Future)	288	57.2	0	PNL																		68.5	68.5	67.9	67.9			

5 E&M Works — Predicted Noise Level, dB(A)

NSR	Description	NSR to NSP2	Distance Att.	Barrier Corr.	Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					Lw																				113.6	113.6	113.6	106.2	
1	Village House at O Tsai	303	57.6	0	PNL																				59.0	59.0	59.0	51.6	
2	North Lamma Public Library	257	56.2	0	PNL																				60.4	60.4	60.4	53.0	
3	North Lamma Clinic	214	54.6	0	PNL																				62.0	62.0	62.0	54.6	
4	No. 105 Yung Shue Wan Main Street	189	53.5	0	PNL																				63.1	63.1	63.1	55.7	
5	Village House (Potential Future)	227	55.1	0	PNL																				61.5	61.5	61.5	54.1	
6	Village House (Potential Future)	288	57.2	0	PNL																				59.5	59.5	59.5	52.0	

6 Demobilization — Predicted Noise Level, dB(A)

NSR	Description	NSR to NSP2	Distance Att.	Barrier Corr.	Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
					Lw																								117.2
1	Village House at O Tsai	298	57.5	0	PNL																								62.7
2	North Lamma Public Library	252	56.0	0	PNL																								64.1
3	North Lamma Clinic	206	54.3	0	PNL																								65.9
4	No. 105 Yung Shue Wan Main Street	179	53.1	0	PNL																								67.1
5	Village House (Potential Future)	221	54.9	0	PNL																								65.3
6	Village House (Potential Future)	283	57.0	0	PNL																								63.1

Total — Predicted Noise Level, dB(A)

NSR	Description					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	Village House at O Tsai				PNL	59	66	65	65	68	64	64	60	60	63	67	66	68	67	66	65	60	68	68	68	68	59	52	63
2	North Lamma Public Library				PNL	60	68	67	67	69	66	66	61	61	64	68	67	69	68	67	66	61	69	69	69	69	60	53	64
3	North Lamma Clinic				PNL	69	71	71	71	72	67	67	63	63	66	70	69	71	70	69	68	63	71	71	71	71	62	55	66
4	No. 105 Yung Shue Wan Main Street				PNL	71	73	73	73	74	69	69	64	64	67	71	70	72	71	70	69	64	72	72	72	72	63	56	67
5	Village House (Potential Future)				PNL	69	71	71	71	72	67	67	62	62	65	69	68	70	69	68	67	62	71	71	71	71	62	54	65
6	Village House (Potential Future)				PNL	60	67	66	66	68	65	65	60	60	63	67	66	68	67	66	65	60	68	68	69	69	59	52	63

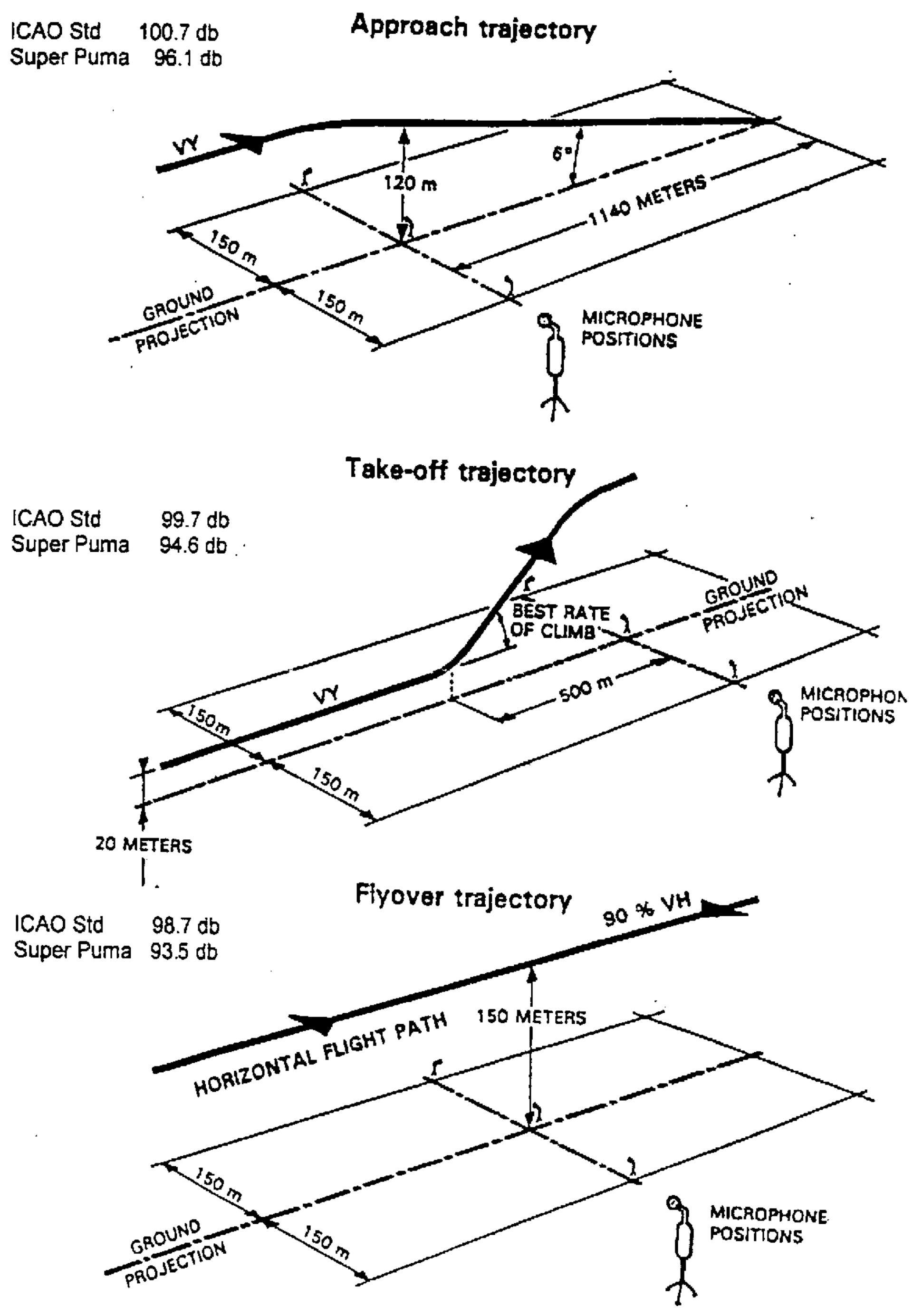
NSP - Notion Source Position for each NSR

Lw - Total Sound Power Level during the assessment Period
PNL - Predicted Noise Level

Appendix 4.4

HELICOPTER NOISE MEASUREMENT POINTS AND NOISE LEVELS

APPENDIX 4.4 Helicopter Test Noise Measurement Points and Noise Level



Eurocopter EC155 B1

	ICAO Limit for 4850kg helicopter	EC155 B1 Measured Noise Level (EPN dB)
Approach	**97.9**	**95.7**
Take-off	**96.9**	**92.2**
Flyover	**95.9**	**88.9**

Appendix 4.5

HELICOPTER NOISE SURVEY REPORT

APPENDIX 4.5 Helicopter Noise Survey

1 INTRODUCTION

1.1 Background

1.1.1 To supplement the helicopter noise data, on-site field survey has been conducted to determine the operational noise levels of the Government Flying Service's (GFS) 'EC155 B1' and 'Super Puma AS332 L2' helicopter model when manoeuvring on and over the helipad without lateral movement.

1.2 Site Information and Survey Date

1.2.1 This noise survey was undertaken at the GFS helipad at No. 18, South Perimeter Road, Chek Lap Kok. The GFS helipad is generally flat concrete, with no substantial obstacles in the vicinity. The South Runway of the Hong Kong International Airport was in active use during the survey period.

1.2.2 *Figure 1* displays the locations of helipad, measurement locations and its surrounds. The survey was conducted between 10:00 and 16:00 hours on 24th June 2003.

1.3 Weather Conditions

1.3.1 The day of the survey was hot and sunny with light breeze. An isolated shower at around 13:00 hours lasted for about 10 minutes.

1.4 Instrumentation

1.4.1 The following instruments were used:

Table 1 Equipment List

Item	Manufacturer and Model	Description
Precision Sound Level Analysers	Bruel and Kjaer Type 2238	IEC 651-1979 Type 1 / IEC 804-1985 Type 1
Acoustical Calibrator	Bruel and Kjaer Type 4231	IEC 942-1988 Class 1
GPS Device	MLR Electronique	-
Anemometer	Kestrel 1000 Pocket Wind Meter	-

2 NOISE MEASUREMENT PROCEDURE

2.1.1 Measurements of the maximum noise levels (L_{max}) emitted during each of four helicopter manoeuvring modes on and over the helipad: (i) hovering over the helipad; (ii) touchdown on the helipad; (iii) idling on the ground (with rotors on); and (iv) lift-off from the helipad surface to achieve a hover. Far-field measurements were taken at three locations that were each over 100 metres from the centre of the helipad, such that helicopter noise can be considered as a point source. The three measurement locations (M1, M2 and M3) and the helipad location are detailed in *Table 2*.

Table 2 Noise Measurement Location Details

Location	Latitude	Longitude	Distance from centre of helipad (m)
Centre of Helipad	22 N 17.784	113 E 54.341	N/A
Measurement location M1	22 N 17.745	113 E 54.428	166
Measurement location M2	22 N 17.736	113 E 54.391	124
Measurement location M3	22 N 17.783	113 E 54.443	175

2.1.2 All three sound level meters were calibrated and 5-minute background noise measurements were conducted prior to and after the noise survey. The L_{max} for each helicopter mode was recorded.

2.1.3 Other noise events such as aircraft activities and vehicle pass-by were also recorded so that any affected readings can be edited.

3 MEASUREMENT RESULTS

3.1.1 The sound level meters were calibrated prior to and after the noise survey. The calibration noise levels obtained before and after the measurement were both 94.0 dB(A). The data obtained in this survey is therefore considered to be acceptable.

3.1.2 The measured background noise levels and instant wind speeds are summarized in *Table 3*.

Table 3 Measured Background Noise Levels ($L_{eq(5\text{-}minute)}$) in dB(A)

Location	Prior to Noise Survey		After Noise Survey	
	$L_{eq\ (5\text{-}min)}$	Wind Speed (m/s)	$L_{eq\ (5\text{-}min)}$	Wind Speed (m/s)
M1	45.8	1.5	46.6	1
M2	42.3	1	42.6	1
M3	46.9	4.6	47.9	1.3

3.1.3 The measured L_{max} of helicopter manoeuvring on the ground and over the helipad are tabulated in *Table 4* and *Table 5*, respectively. The normalised L_{max} at 150m were calculated based on standard acoustic principle, using the formula:

$$L_{max} \text{ at } r_1 = L_{max} \text{ at } r_2 + 20\log_{10}\left(\frac{r_2}{r_1}\right)$$ where r_1 and r_2 are the distances from the centre of helipad.

Table 4 Measured L_{max} when Helicopter is "On the Ground"

Helicopter No.	Operation	M1 @ 166m	M2 @ 124m	M3 @ 175m	Normalised at 150m			
					M1	M2	M3	Maximum
"EC155 B1" Model								
Helicopter 1	Idling	x	x	73.5	x	x	74.8	74.8
Helicopter 2	Idling	x	x	76.3	x	x	77.6	77.6
Helicopter 5	Idling	74.7	77.6	78.7	75.6	75.9	80.0	**80.0***
"Super Puma AS332 L2" Model								
Helicopter 10	Idling	79.3	82.4	80.7	80.2	80.7	82.0	**82.0***

Note: "x" indicates data not available at that location.
** Lmax use for helicopter noise calculation in EIA*

Table 5 Measured L_{max} when Helicopter is "In the Air"

Helicopter No.	Operation	M1 @ 166m	M2 @ 124m	M3 @ 175m	Normalised at 150m			
					M1	M2	M3	Maximum
"EC155 B1" Model								
Helicopter 1	Hovering	x	x	78.7	x	x	80.0	80.0
Helicopter 2	Hovering	x	x	75.3	x	x	76.6	76.6
Helicopter 3	Touch-down	79.3	77.7	73.0	80.2	76.0	74.3	80.2
Helicopter 4	Lift-Off	86.8	86.7	84.3	87.7	85.0	85.6	**87.7***
Helicopter 5	Hovering	79.7	82.0	85.0	80.6	80.3	86.3	86.3
Helicopter 5	Touch-down	75.5	74.6	70.6	76.4	72.9	71.9	76.4
"Super Puma AS332 L2" Model								
Helicopter 10	Lift-Off	88.1	85.9	83.6	89.0	84.2	84.9	89.0
Helicopter 10	Hovering	89.7	91.6	86.3	90.6	89.9	87.6	**90.6***
Helicopter 10	Hovering	81.8	83.5	82.9	82.7	81.8	84.2	84.2
Helicopter 10	Lift-Off	85.6	85.7	80.7	86.5	84.0	82.0	86.5

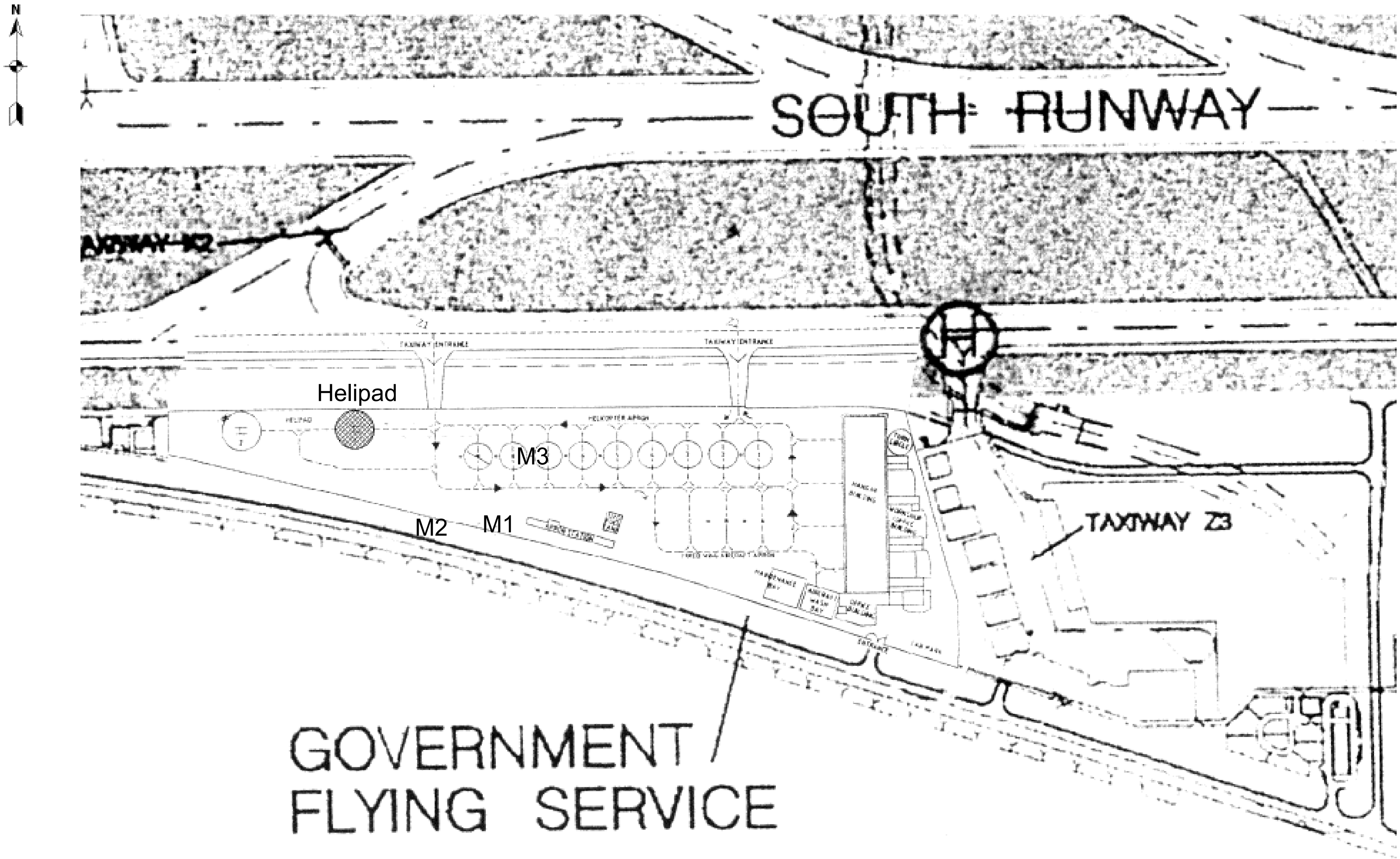
Note: "x" indicates data not available at that location.
** Lmax use for helicopter noise calculation in EIA*

4 SUMMARY

4.1.1 The measured background noise levels were around 45 dB(A). The difference between the background noise level and the measured results for all modes exceeded 10 dB(A). Therefore, no correction needs to be applied to the measured results.

4.1.2 Measurement results that were affected by aircraft noise and pass-by vehicles at the airport were discarded.

4.1.3 The worst-case L_{max} levels of "EC155 B1" helicopter idling and above the helipad were measured to be 80.0 dB(A) and 87.7 dB(A) at 150 metres, respectively. For the 'Super Puma AS332 L2' model, L_{max} levels of helicopter 'idling' and above the helipad were measured to be 82.0 dB(A) and 90.6 dB(A) at 150 metres, respectively.



EIA Study for Helipad at Yung Shue Wan, Lamma Island

HELICOPTER NOISE MEASUREMENT LOCATIONS

Appendix 4.5 - Figure 1

Drawn	DEH	Checked	RBR
Scale	NTS	Date	March 2004

Appendix 4.6

HELICOPTER NOISE CALCULATIONS

APPENDIX 4.6 - Helicopter Noise Calculation

Without Lateral Movements - Idling

Super Puma AS332 L2 - Idling

Location	Horizontal Distance (m)	Line of Sight	Lmax @ 150m, dB(A)	Lmax @ NSR, dB(A)	Topo. Corr., dB(A)	Façade Corr., dB(A)	Corrected Lmax, dB(A)	Exceedance, dB(A)
NSR1	301.0	Direct line of sight	82.0	76.0	0	3	79.0	nil
NSR2	256.6	Direct line of sight	82.0	77.3	0	3	80.3	nil
NSR3	246.4	Direct line of sight	82.0	77.7	0	3	80.7	nil
NSR4	220.7	Direct line of sight	82.0	78.6	0	3	81.6	nil
NSR5	263.3	Direct line of sight	82.0	77.1	0	3	80.1	nil
NSR6	292.1	Direct line of sight	82.0	76.2	0	3	79.2	nil

EC155 B1 - Idling

Location	Horizontal Distance (m)	Line of Sight	Lmax @ 150m, dB(A)	Lmax @ NSR, dB(A)	Topo. Corr., dB(A)	Façade Corr., dB(A)	Corrected Lmax, dB(A)	Exceedance, dB(A)
NSR1	301.0	Direct line of sight	80.0	74.0	0	3	77.0	nil
NSR2	256.6	Direct line of sight	80.0	75.3	0	3	78.3	nil
NSR3	246.4	Direct line of sight	80.0	75.7	0	3	78.7	nil
NSR4	220.7	Direct line of sight	80.0	76.6	0	3	79.6	nil
NSR5	263.3	Direct line of sight	80.0	75.1	0	3	78.1	nil
NSR6	292.1	Direct line of sight	80.0	74.2	0	3	77.2	nil

Without Lateral Movements - Manoeuvring

Super Puma AS332 L2 - Hovering

Location	Horizontal Distance (m)	Line of Sight	Lmax @ 150m, dB(A)	Lmax @ NSR, dB(A)	Topo. Corr., dB(A)	Façade Corr., dB(A)	Corrected Lmax, dB(A)	Exceedance, dB(A)
NSR1	301.0	Direct line of sight	90.6	84.6	0	3	87.6	2.2
NSR2	256.6	Direct line of sight	90.6	85.9	0	3	88.9	3.5
NSR3	246.4	Direct line of sight	90.6	86.3	0	3	89.3	3.9
NSR4	220.7	Direct line of sight	90.6	87.2	0	3	90.2	4.8
NSR5	263.3	Direct line of sight	90.6	85.7	0	3	88.7	3.3
NSR6	292.1	Direct line of sight	90.6	84.8	0	3	87.8	2.4

EC155 B1 - Lift-Off

Location	Horizontal Distance (m)	Line of Sight	Lmax @ 150m, dB(A)	Lmax @ NSR, dB(A)	Topo. Corr., dB(A)	Façade Corr., dB(A)	Corrected Lmax, dB(A)	Exceedance, dB(A)
NSR1	301.0	Direct line of sight	87.7	81.7	0	3	84.7	nil
NSR2	256.6	Direct line of sight	87.7	83.0	0	3	86.0	0.6
NSR3	246.4	Direct line of sight	87.7	83.4	0	3	86.4	1.0
NSR4	220.7	Direct line of sight	87.7	84.3	0	3	87.3	1.9
NSR5	263.3	Direct line of sight	87.7	82.8	0	3	85.8	0.4
NSR6	292.1	Direct line of sight	87.7	81.9	0	3	84.9	nil

With Lateral Movements - Approaching [Calculation based on ICAO maximum noise level]

Super Puma AS332 L2 - Approaching (250 - 320 degrees bearing)

Location	Slant Distance (m)	Line of Sight	Lmax @ 120m, dB(A)	Lmax @ NSR, dB(A)	Topo. Corr., dB(A)	Façade Corr., dB(A)	Corrected Lmax, dB(A)	Exceedance, dB(A)
NSR1	253.1	Direct line of sight	87.7	81.2	0	3	84.2	nil
NSR2	226.3	Direct line of sight	87.7	82.2	0	3	85.2	nil
NSR3	246.4	Direct line of sight	87.7	81.5	0	3	84.5	nil
NSR4	220.7	Direct line of sight	87.7	82.4	0	3	85.4	nil
NSR5	263.3	Direct line of sight	87.7	80.9	0	3	83.9	nil
NSR6	281.1	Direct line of sight	87.7	80.3	0	3	83.3	nil

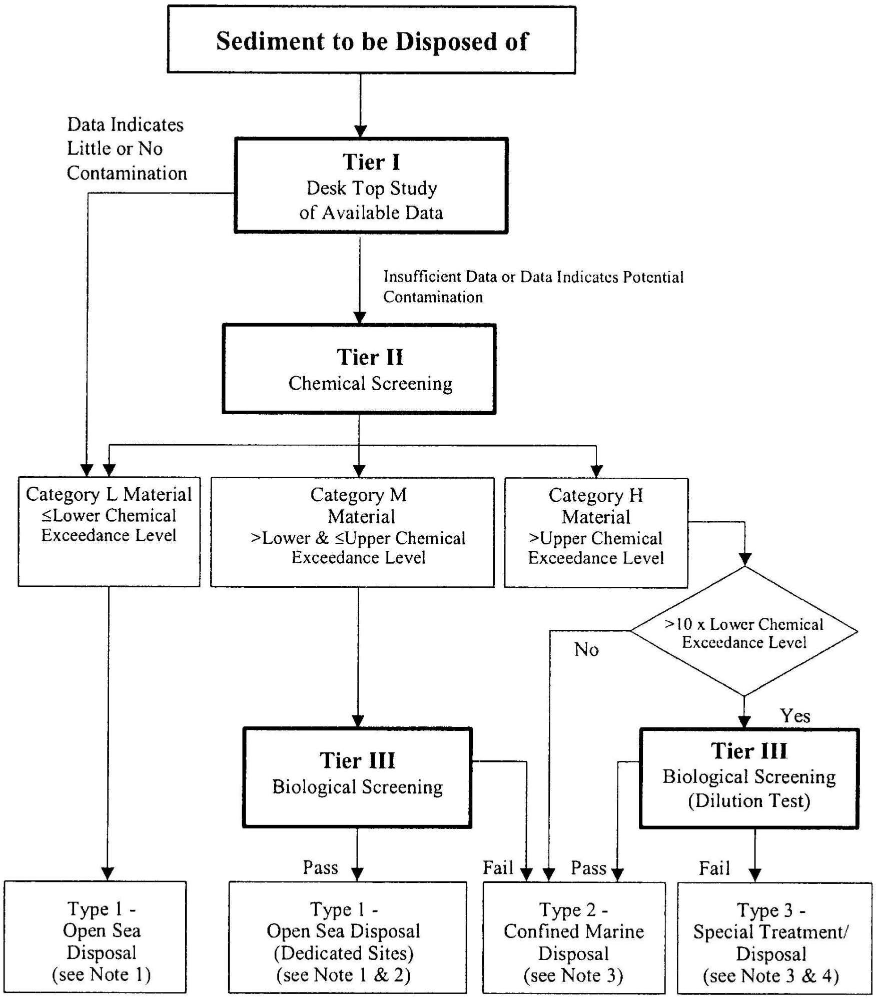
EC155 B1 - Approaching (250 - 330 degrees bearing)

Location	Slant Distance (m)	Line of Sight	Lmax @ 120m, dB(A)	Lmax @ NSR, dB(A)	Topo. Corr., dB(A)	Façade Corr., dB(A)	Corrected Lmax, dB(A)	Exceedance, dB(A)
NSR1	220.0	Direct line of sight	84.9	79.6	0	3	82.6	nil
NSR2	200.6	Direct line of sight	84.9	80.4	0	3	83.4	nil
NSR3	246.4	Direct line of sight	84.9	78.7	0	3	81.7	nil
NSR4	220.7	Direct line of sight	84.9	79.6	0	3	82.6	nil
NSR5	263.3	Direct line of sight	84.9	78.1	0	3	81.1	nil
NSR6	261.0	Direct line of sight	84.9	78.2	0	3	81.2	nil

Appendix 5.1

SEDIMENT CLASSIFICATION FLOW CHART

Management Framework for Dredged/Excavated Sediment



Notes

(1) Most open sea disposal sites are multi-user facilities and as a consequence their management involves a flexibility to accommodate varying and unpredictable circumstances. Contract documents should include provisions to allow the same degree of flexibility should it be necessary to divert from one disposal site to another during the construction period of a contract.

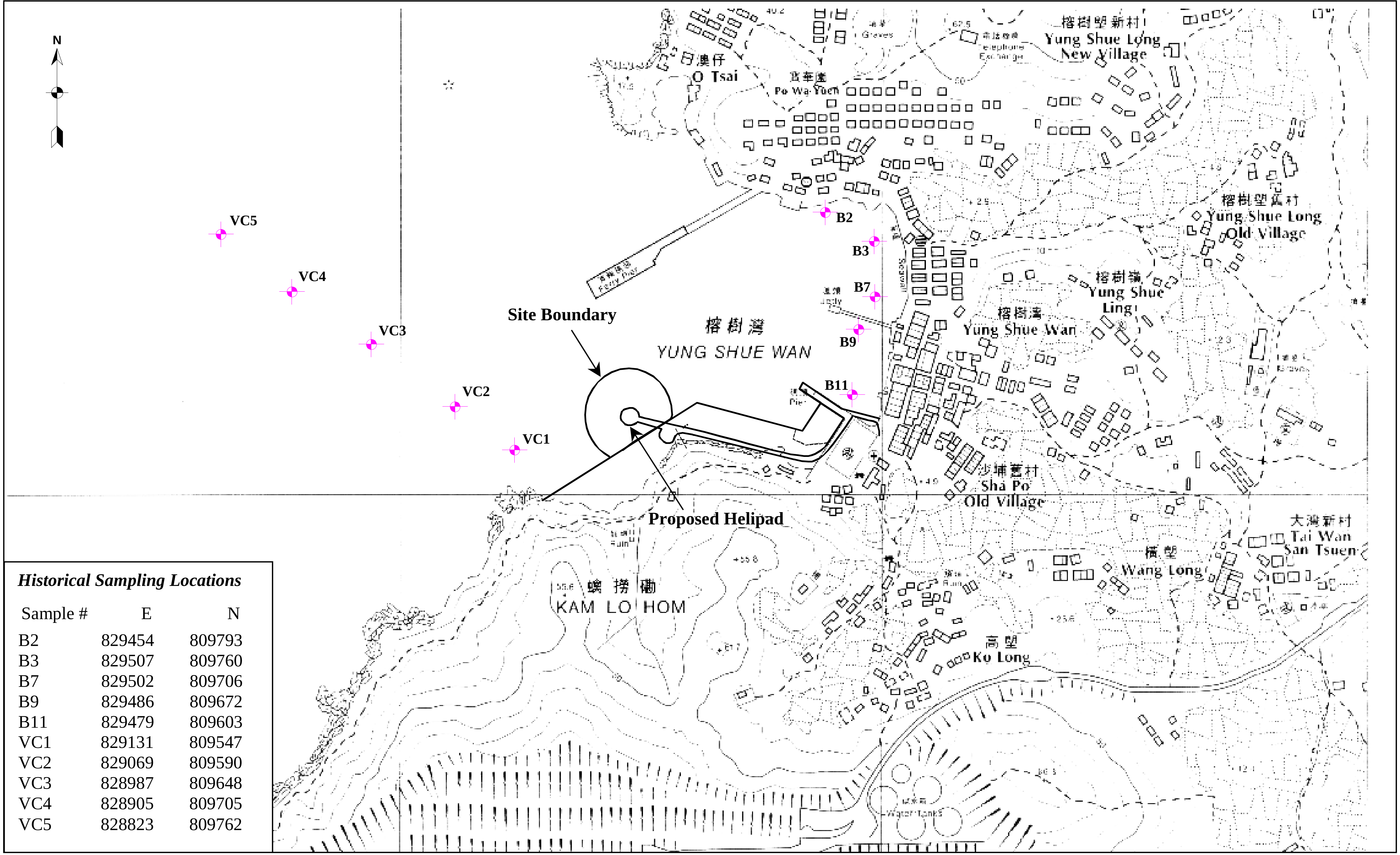
(2) Dedicated Sites will be monitored to confirm that there is no adverse impact.

(Source: Environment, Transport and Works Bureau Technical Circular (Works) No. 34/2002 Management of Dredged/Excavated Sediment, Appendix C)

BMT	EIA Study for Helipad at Yung Shue Wan, Lamma Island	Appendix 5.1 - Figure 1		
	SEDIMENT CLASSIFICATION FLOW CHART	Drawn LYI	Checked RBR	
		Scale NTS	Date November 2005	

Appendix 5.2

HISTORICAL MARINE SEDIMENT SAMPLING LOCATIONS AT YUNG SHUE WAN



Historical Sampling Locations

Sample #	E	N
B2	829454	809793
B3	829507	809760
B7	829502	809706
B9	829486	809672
B11	829479	809603
VC1	829131	809547
VC2	829069	809590
VC3	828987	809648
VC4	828905	809705
VC5	828823	809762

EIA Study for Helipad at Yung Shue Wan, Lamma Island

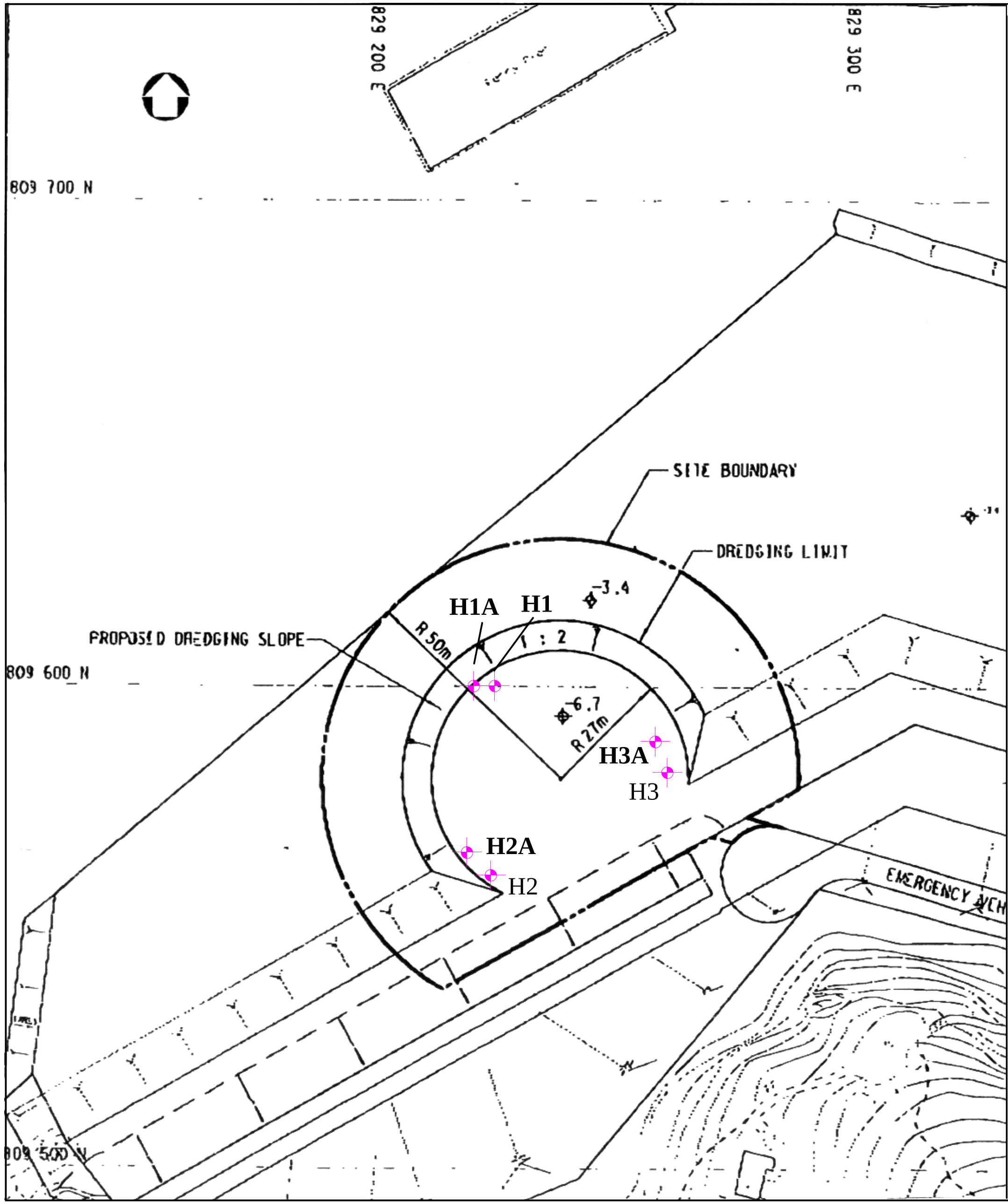
HISTORICAL SAMPLING LOCATIONS

Appendix 5.2 – Figure 1

Drawn	MAT	Checked	LYI
Scale	NTS	Date	November 2005

Appendix 5.3

SEDIMENT SAMPLING PROGRAMME & CHEMICAL SCREENING DATA AT YUNG SHUE WAN



ETWB TCW No.34/2002 Guidelines

	Metals (mg/kg)									Organic PAHs (µg/kg dry wt.)		Organic non- PAHs (µg/kg dry wt.)
	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag	L.M.W PAHs	H.M.W PAHs	Total PCBs
LCEL	1.5	80	65	40	75	200	0.5	12	1	550	1700	23
UCEL	4	160	110	40	110	270	1	42	2	3160	9600	180

Chemical Screening Data

			Metals (mg/kg)									Organic PAHs (µg/kg dry wt.)		Organic non- PAHs (µg/kg dry wt.)	
Sampling Location	Sub-sample	Depth Interval (- mPD)	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag	L.M.W PAHs	H.M.W PAHs	Total PCBs	Sediment Classification
H1/H1A	H1A	4.98 - 5.81	<0.1	19	12	12	25	44	0.1	3.7	0.1	<55	<170	<2	L
	H1B	5.81 - 6.81	<0.1	6	2.6	5	25	18	0.09	1.7	<0.1	<55	<170	<2	L
	H1C	6.81 - 7.81	<0.1	10	3.4	7	13	21	0.07	2.1	<0.1	<55	<170	<2	L
	H1D	7.81 - 8.81	<0.1	6.2	2.6	3.7	15	20	0.1	2.3	0.2	<55	<170	<2	L

			Metals (mg/kg)									Organic PAHs (µg/kg dry wt.)		Organic non- PAHs (µg/kg dry wt.)	
Sampling Location	Sub-sample	Depth Interval (- mPD)	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag	L.M.W PAHs	H.M.W PAHs	Total PCBs	Sediment Classification
H2A*	H2A	4.73 - 5.63	<0.1	5.1	1.9	2.8	12	16	0.05	1.7	<0.1	<55	<170	<2	L
	H2B	5.63 - 6.63	<0.1	3.2	1.3	1.9	8.5	<10	0.07	<1.0	<0.1	<55	<170	<2	L
	H2C	6.63 - 7.63	<0.1	4.2	1.7	2.8	10	12	<0.05	2.7	<0.1	<55	<170	<2	L
	H2D	7.63 - 8.13	<0.1	2.4	<1	1.5	17	10	<0.05	<1.0	<0.1	<55	<170	<2	L

			Metals (mg/kg)									Organic PAHs (µg/kg dry wt.)		Organic non- PAHs (µg/kg dry wt.)	
Sampling Location	Sub-sample	Depth Interval (- mPD)	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag	L.M.W PAHs	H.M.W PAHs	Total PCBs	Sediment Classification
H3A*	H3A/A	4.18 - 4.98	<0.1	3.5	1.7	2.1	8.4	12	0.2	<1.0	0.7	<55	<170	<2	L
	H3A/B	4.98 - 5.98	<0.1	3.6	1.5	2	14	12	0.1	1	0.2	<55	<170	<2	L
	H3A/C	5.98 - 6.98	<0.1	5	1.8	2.9	11	14	0.07	2	<0.1	<55	<170	<2	L
	H3A/D	6.98 - 7.98	<0.1	2.6	<1.0	1.2	6	<10	<0.05	<1.0	<0.1	<55	<170	<2	L

			Metals (mg/kg)									Organic PAHs (µg/kg dry wt.)		Organic non- PAHs (µg/kg dry wt.)	
Sampling Location	Sub-sample	Depth Interval (- mPD)	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag	L.M.W PAHs	H.M.W PAHs	Total PCBs	Sediment Classification
Reference Sediment	R1		<0.1	25	12	18	31	60	0.3	4.8	0.9	<55	<170	<2	L

NOTE:

UCEL	Upper Chemical Exceedence Level
LCEL	Lower Chemical Exceedence Level
L.M.W	Low Molecular Weight
H.M.W	High Molecular Weight
H1/H1A	Two Vibrocores combined to make composite sub-samples at this location
*	Samples successfully collected on second vibrocore attempt therefore samples labelled H2A & 3A rather than H2 & H3. First vibrocore refused on seabed.

Proposed Sampling Locations (from STP)

	E	N
H1	829232.11	809600.14
H2	829226.72	809564.58
H3	829265.33	809585.44

Actual Sampling Locations

	E	N
H1	829232.11	809600.14
H1A	829231.38	809599.29
H2A	829224.00	809567.59
H3A	829261.80	809589.28

BMT

EIA Study for Helipad at Yung Shue Wan, Lamma Island

SAMPLING PROGRAMME AND CHEMICAL SCREENING DATA

Appendix 5.3 – Figure 1

Drawn MAT	Checked LYI
Scale 1:4700	Date November 2005

Appendix 6.1

SUMMARY OF SEDIMENT QUALITY AT MONITORING STATION ‘SS4’ (1999 – 2003)

APPENDIX 6.1 Summary of Sediment Quality for Routine Marine Sediment Quality Monitoring Station 'SS4' (1999 – 2003)

	Lower Chemical Exceedance Level (LCEL)	Higher Chemical Exceedance Level (UCEL)	1999 - 2003
Particle Size Fractionation (%ww)	---	---	87 (68-96)
Electrochemical Potential (mV)	---	---	-148 (-208 to -81)
Specific Gravity	---	---	---
Total Volatile Solids (%w/w)	---	---	7.4 (7.0-7.9)
Total Solids (%w/w)	---	---	45 (42-51)
Dry Wet Ratio (w/w)	---	---	0.4 (0.4-0.5)
Chemical Oxygen Demand (mg/kg)	---	---	15500 (14000-18000)
Total Carbon (%w/w)	---	---	0.6 (0.5-0.7)
Ammonical Nitrogen (mg/kg)	---	---	5.1 (0.35-9.6)
Total Kjeldahl Nitrogen (mg/kg)	---	---	356 (240-420)
Total Phosphorus (mg/kg)	---	---	192 (160-240)
Total Sulphide (mg/kg)	---	---	48 (15-140)
Total Cyanide (mg/kg)	---	---	<0.1 (<0.1-0.1)
Aluminium (mg/kg)	---	---	34000 (22000-41000)
Arsenic (mg/kg)	12	42	10.1 (8.7-11.0)
Boron (mg/kg)	---	---	30 (20-36)
Cadmium (mg/kg)	1.5	4	<0.1 (<0.1-<0.1)
Chromium (mg/kg)	80	160	38 (26-44)
Copper (mg/kg)	65	110	38 (20-48)

	Lower Chemical Exceedance Level (LCEL)	**Higher Chemical Exceedance Level (UCEL)**	**1999 - 2003**
Iron (mg/kg)	---	---	31700 (21000-36000)
Lead (mg/kg)	75	110	44 (25-50)
Manganese (mg/kg)	---	---	585 (370-670)
Mercury (mg/kg)	0.5	1	0.14 (0.08-0.21)
Nickel (mg/kg) (7)	40	40	22 (16-27)
Silver (mg/kg)	1	2	<1.0 (<1.0-1.0)
Zinc (mg/kg)	200	270	112 (75-130)
Total Polychlorinated Biphenyls (PCBs)	23	180	<5 (<5-23)
Low Molecular Weight Polyaromatic Hydrocarbons (PAHs) (µg/kg) (3) (5)	550	3160	13 (N.D.-18)
High Molecular Weight Polyaromatic Hydrocarbons (PAHs) (µg/kg) (4) (5)	1700	9600	120 (28-186)
Polycyclic Aromatic Hydrocarbons (µg/kg)	---	---	---
Polychlorinated Biphenyls (µg/kg)	---	---	---

Notes:

1. Data presented are arithmetic means- data in brackets indicate ranges.
2. All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.
3. Low molecular weight polyaromatic hydrocarbons (PAHs) include congeners of molecular weight below 200, namely Acenaphthylene, Acenaphthene, Flourene, Phenathrene and Anthracene.
4. High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners with molecular weight above 200, namely Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluorathene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(ghi)perylene and Indeno(1,2,3-cd)pyrene.
5. PCBs results are based on sediment samples collected in 1998-2001 only.
6. N.D. Not detected – all congeners are below the detection limit.
7. When the LCEL and UCEL for a contaminant are the same, the contaminant level is considered to have exceeded UCEL if it is greater than the value shown.