6 NOISE

6.1 INTRODUCTION

This Section presents an assessment of the potential noise impacts arising from the construction and operational phases of the Lamma Extension development, excluding noise impacts from construction of the transmission system between Lamma Extension and Hong Kong Island (which are reported in *Part C* of this Report).

The assessment contains a description of the existing noise environment in the vicinity of the proposed plant extension, relevant noise legislation and standards, methodologies used to predict construction and operational noise impacts, predicted noise impacts, recommended mitigation measures and a proposed noise monitoring and audit programme for construction and operational phases of the new development.

6.2 LEGISLATION AND STANDARDS

6.2.1 *Noise Control Ordinance*

The principal legislation on the control of plant construction and operation noise is the *Noise Control Ordinance (NCO) (Cap 400)*. The *Director of the Environmental Protection Department (DEP)* has been appointed as the *Noise Control Authority* under the *NCO*. Various *Technical Memoranda (TMs)*, which stipulate control approaches and criteria, have been issued under the *NCO*. The following *TMs* are applicable to the control of noise from construction activities and plant operation:

- *Technical Memorandum on Noise from Percussive Piling (PP-TM);*
- *Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM);*
- *Technical Memorandum on Noise from Construction Work in Designated Areas (DA-TM); and*
- *Technical Memorandum on the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites. (IND-TM).*

Noise assessment carried out during the planning phase under the EIAO does not constitute an exemption from the NCO requirements. The Authority will enforce the NCO based on future conditions such as the effect of prevailing influencing factors and the exact location of receivers and sources.

6.2.2 *Environmental Impact Assessment Ordinance*

For planning and early identification of potential environmental issues, the *Environmental Impact Assessment Ordinance (EIAO) (Cap. 499)* is the principal legislation. Relevant study methodology and assessment criteria for construction and operational noise are given in the following *TM*:

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

6.2.3 *Construction Noise Criteria*

Percussive Piling

Percussive piling is prohibited between 1900-0700 hours on any day not being a general holiday and at any time on a general holiday. A Construction Noise Permit (CNP) is required for such works between 0700-1900 hours on any day not being a general holiday.

When assessing a CNP application for percussive piling work, the *Environmental Protection Department (EPD)* is guided by the *PP-TM*. EPD will consider the difference between the Acceptable Noise Levels (ANLs), as promulgated in the *PP-TM*, and the Corrected Noise Levels (CNLs) that are associated with the proposed piling activities. Depending on when the percussive piling work is to be carried out, and on the projected noise levels at nearby Noise Sensitive Receivers (NSRs), EPD may allow between zero and 12 hours of daily piling time for percussive piling works using diesel hammer, pneumatic and/or steam hammer. Since the pile driving planned for the Lamma Extension project would not commence until after 1 October 1999, it would be subject to the most stringent (Stage 4) hours of work restrictions according to the *PP-TM* (see *Table 6.2a* below).

Table 6.2a ***Permitted Hours of Operation for Percussive Piling Involving the use of Diesel, Pneumatic and/or Steam Hammers (Non-Government Projects)***

Amount by which CNL exceeds ANL	Permitted hours of operation on any day not being a holiday
More than -10 dB(A)	Nil
Less than or equal to -10 dB(A)	0700 to 1900

For any educational institutions identified in this EIA Study, the ANLs should be adjusted by a -10 dB(A) correction factor in the subsequent noise assessment, taking account of the relative noise sensitivity of these uses.

General Construction Works

Noise arising from general construction works during normal working hours (ie 0700 to 1900 hours on any day not being a Sunday or public holiday) at the openable windows of buildings is assessed against criteria laid down in the *EIAO TM*. The recommended noise criteria are presented in *Table 6.2b*.

Table 6.2b ***EIAO TM Daytime Construction Noise Criteria ($L_{eq,\ 30\ min}$ dB(A))***

Uses	Noise Standards
Domestic Premises	75
Educational Institutions (normal periods)	70
Educational Institutions (during examination periods)	65

The *NCO* provides statutory controls on general construction works during the restricted hours (ie 1900-0700 hours Monday to Saturday and at any time on Sundays and public holidays). The use of Powered Mechanical Equipment (PME) for the carrying out of construction works during the restricted hours

would require a CNP. The EPD is guided by the *GW-TM* when assessing such an application.

When assessing an application for the use of PME, the EPD will compare the ANLs, as promulgated in the *GW-TM*, and the CNLs (after accounting for factors such as barrier effects and reflections) associated with the proposed PME operations. A CNP will be issued if the CNL is equal to or less than the ANL. The ANLs are related to the noise sensitivity of the area in question and different *Area Sensitivity Ratings (ASR)* have been drawn up to reflect the background noise characteristics of different areas. The relevant ANLs (in cases where construction work will last more than 14 days and where the NSRs will be affected by only one CNP) are shown in *Table 6.2c*.

Table 6.2c ***Acceptable Noise Levels (ANL, $L_{eq,\ 5\ min}$ dB(A))***

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

The ASR for NSRs in the vicinity of the Lamma Power Station is considered to be 'A'. Hence the most stringent criteria of 60/45dB(A) will be used.

6.2.4 *Operational Noise Criteria*

Planning Criteria

The *Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM)* specifies that noise from Fixed Sources under planning should be 5 dB(A) below the *Acceptable Noise Level (ANL)* listed in *Table 2* of the *TM* for the *Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites* (given below *in Table 6.2d*) or the prevailing background noise level. Therefore the potential noise impact due to the new 1,800MW power station shall be 5dB(A) less than the value given in Table 6.2d i.e 55/45 dB(A) during the day/at night, respectively, as *ASR* for Lamma Island is 'A'.

Table 6.2d ***Acceptable Noise Levels (ANL, $L_{eq,\ 30min}$ dB(A), Facade)***

Time Period	Area Sensitivity Rating		
	A	B	C
Daytime / evening (0700-2300 hours)	60	65	70
Night-time (2300-0700 hours)	50	55	60

The prevailing background noise levels at the critical location within the community has been established with due consideration of monitoring data at surrounding dwellings. A complete account is presented in *Section 6.3*.

Taking the prevailing background conditions into account (which represent more stringent criteria then the relevant TMs during the daytime), the combined operational noise criteria for day time would be 51.2 and 54.2 dB(A) for winter and summer respectively. While it would be 45 dB(A) for nighttime hours

throughout the year as this is the more stringent limit that would correspond to the relevant TM. Additional deliberations on the noise criteria and prevailing conditions are presented in *Section 6.3*.

Operation Criteria

Once the new power station is in operation, the noise impact will be subject to the control of the *Noise Control Ordinance*. The cumulative noise impact of the new power station and the existing coal-fired units shall be assessed against the ANLs given in Table 6.2d according to the *IND-TM*.

6.3 BASELINE CONDITIONS

6.3.1 *Existing Noise Environment on Lamma Island*

Lamma Island is a lightly populated area without a conventional road system. A limited number of small petrol or diesel-powered carts are used to transport materials but there is otherwise no vehicular traffic. As a result, ambient (baseline) noise levels are quite low and, at least over that portion of the island surrounding the present HEC plant, are dominated by noise from local village activities, natural sources (wind and waves) and the power plant.

6.3.2 *Noise Sensitive Receivers*

Settlement on the northern end of Lamma Island (mostly one to three storey residential buildings) is largely concentrated around the harbour at Yung Shue Wan and in the adjacent villages of Yung Shue Long, Sha Po, Ko Long, Wang Long and Tai Wan San Tsuen. These residences are shielded from plant noise to varying degrees by the intervening hill (Kam Lo Hom) which defines the plant's northern boundary. Northeast of the plant, the villages of Long Tsai Tsuen and Hung Shing Ye (beach area) lie outside the area shielded by the hill and hence are more directly exposed to noise from the plant.

Reference is made to the TMs in identifying NSRs. In particular, the *GW-TM* and *PP-TM* ask that "the *Noise Sensitive Receiver* (NSR) which will be most affected by noise from the construction work shall be identified". However, because of the complex terrain and the history of noise concerns expressed within the community, three representative residential locations have been identified as NSR's. These are NSR 1 in Long Tsai Tsuen/Hung Shing Ye, NSR 2 in Ko Long and NSR 3 on the north slope above Yung Shue Wan harbour. In addition a fourth location (NSR 4) has been identified at a school within the Village of Tai Wan San Tsuen. The locations of these four NSR's are shown in *Figure 6.3a*.

The Government has indicated its interest in providing for more settlement on Lamma Island so that, within the 12 year time frame of the construction work (from late 1999 to early 2012), there may be a significant increase in the numbers of residents exposed to noise from plant construction. However, barring the unlikely construction of new homes on top of Kam Lo Hom hill, it is not possible for NSR's to be located significantly closer to the construction site than at present, so that projected noise exposures do not have to be adjusted.

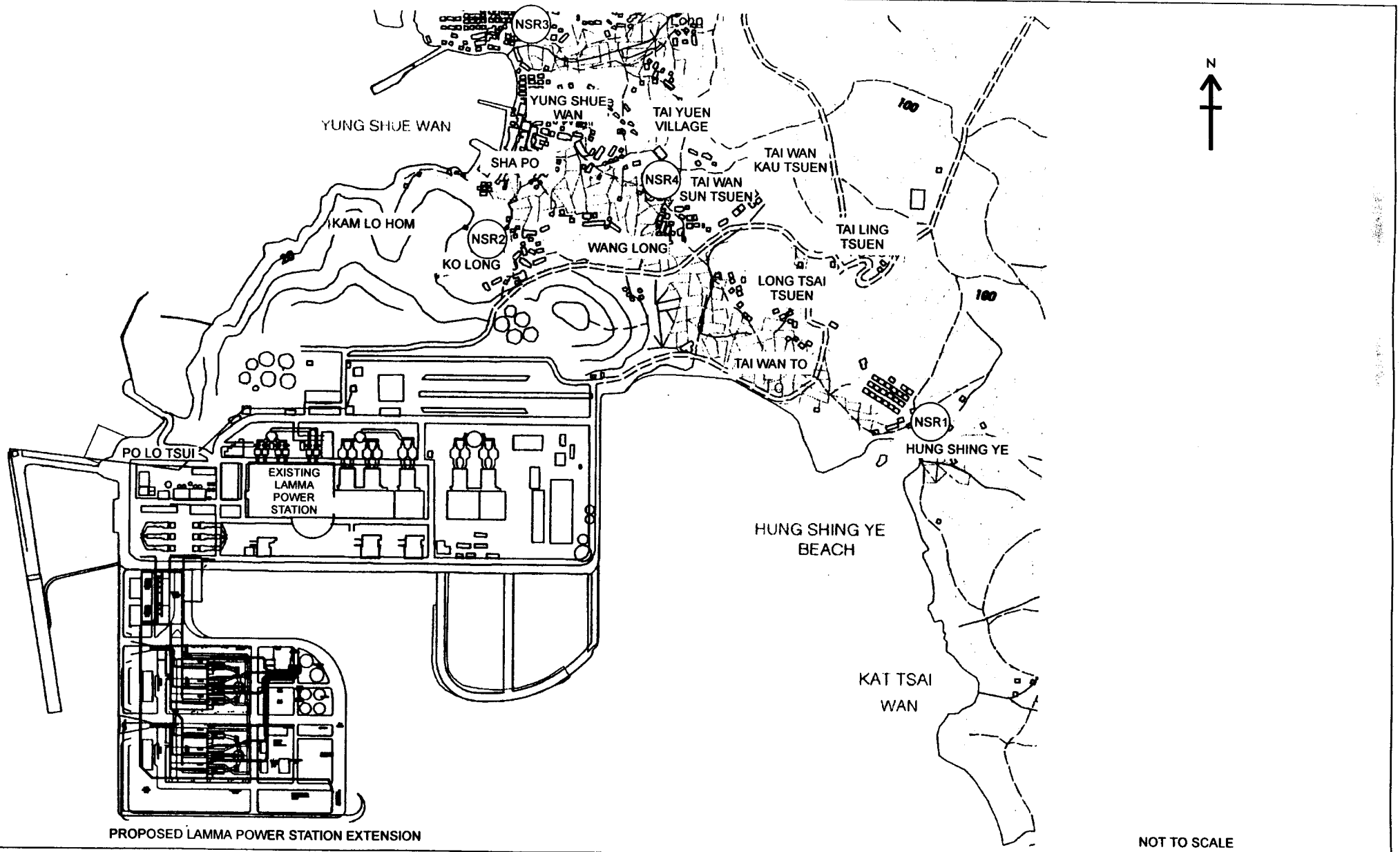

FIGURE 6.3a

LOCATIONS OF SELECTED NOISE SENSITIVE RECEIVERS (NSRs) USED IN CONSTRUCTION NOISE IMPACT ASSESSMENT

FILE: C1830/C1830Z18
DATE: 29/10/98

Environmental Resources Management

ERM

6.3.3 *Baseline Community Noise Monitoring*

Two sources of information were made available for this EIA Study by the *Hongkong Electric Co. Ltd. (HEC)*. They were monitored at locations close to existing dwellings with similar landuse and orientation from the Lamma Power Station. The principal difference between the data obtained is due to the method of monitoring.

Hung Shing Ye Permanent Monitoring Station - 1997 Data

HEC has for many years had a permanent noise monitoring station established near the police station at Hung Shing Ye. This site was selected to be representative of those residences to the east and northeast of the existing power plant which have been and will remain directly exposed to existing plant operation noise and will be directly exposed (with no terrain shielding) to operational noise from the proposed plant extension (*Figure 6.3a*). This monitoring site is located on a seaside cliff top with a clear view towards the plant. The site is quite well removed from many of the sources of day-to-day community noise but is still routinely exposed to non-plant noise from natural (wind, waves, insects, birds) and some man-made (boats, aircraft, powered carts) sources.

The ambient noise level data collected by HEC's permanent noise monitoring station at Hung Shing Ye has been summarized in Table 6.3a. The data has been presented in terms of monthly and annual averages of the maximum, average and minimum values of L_{A90} and L_{Aeq} during both the daytime/evening (0700 to 2300) and nighttime (2300 to 0700). These noise levels then represent the combined contributions of all plant and non-plant sources.

Tai Wan To Manned Noise Monitoring Data - 1997 Data

Regular manned monitoring of noise levels at Tai Wan To was conducted throughout 1997 by Hong Kong Productivity Council under Contract 96/9387 at the closest NSR from the existing Lamma Power Station. This data is summarized, in terms of daytime and nighttime monthly and annual average noise levels, in Table 6.3b below.

A primary aim of this manned noise monitoring was to estimate the contribution of the existing power plant to the ambient community noise levels eliminating, where possible, the effects of sporadic extraneous noise sources on the measured levels. To this end, the sound level metre was manually paused when powered carts, aircraft, people etc. were judged to be influencing the measured levels. However, the effects of more continuous natural noise sources such as insects (which can be significant) cannot be removed in this way. Data judged to be significantly affected by insects, barking dogs and other persistent, extraneous (non-plant) sources were therefore not included in the averaged noise levels presented in Table 6.3b. The total averaged levels are still, however, the product of over 70 separate 90-minute measurements, which are considered to primarily represent the noise emissions of the power plant. It should be realized, however, that these levels will unavoidably still include elements of background noise from largely natural sources (insects, wind and waves).

Table 6.3a ***Hung Shing Ye Permanent Noise Monitoring Data (1997)***

Daytime	LA90			LAeq		
Month	Max.	Ave.	Min.	Max.	Ave.	Min.
Jan	59.0	53.9	51.5	65.3	55.1	51.9
Feb	57.8	53.0	51.4	62.8	54.4	51.8
Mar	70.4	53.4	51.2	71.9	54.9	51.6
Apr	63.7	51.6	43.2	65.5	53.4	45.6
May	77.0	52.2	43.7	79.8	55.6	46.2
Jun	72.4	53.7	46.3	76.2	58.0	48.0
Jul	59.9	52.2	44.6	63.1	54.8	47.1
Aug	66.8	53.9	48.1	68.0	57.0	49.3
Sep	59.9	49.4	42.8	62.9	51.8	44.2
Oct	56.0	48.4	42.3	62.7	50.9	44.0
Nov	57.6	51.0	45.0	60.7	53.4	48.0
Dec	56.9	50.9	46.4	66.6	53.3	47.8
Average		52.0	46.4		54.4	48.0
Nighttime	LA90			LAeq		
Month	Max.	Ave.	Min.	Max.	Ave.	Min.
Jan	55.2	52.9	51.3	57.3	53.7	52
Feb	58.8	52.4	51.4	62.9	53.5	51.7
Mar	59.0	52.0	51.0	65.1	52.7	51.3
Apr	57.5	50.4	44.1	60.9	51.5	45.0
May	75.3	49.7	44.6	77.4	52.1	46.6
Jun	72.3	52.3	45.9	76.8	55.4	46.9
Jul	61.2	51.7	45.6	65.6	54.0	47.5
Aug	61.8	53.2	47.7	64.1	55.8	49.8
Sep	58.5	48.5	44.1	62.7	50.5	45.4
Oct	53.0	47.7	43.5	59.5	49.6	45.1
Nov	56.9	50.1	45.2	58.4	51.8	46.2
Dec	54.3	49.8	46.1	58.7	51.6	47.6
Average		50.9	46.7		52.7	47.9

Table 6.3b ***Tai Wan To Manned Noise Monitoring Data (near Hung Shing Ye) (HKPC 1997 data, $L_{eq, 30\ min}$)***

Month	Nighttime	Daytime.
Jan	41.6	48.5
Feb	49.1	49.4
Mar	43.7	48.6
Apr	46.0	49.5
May	46.2	48.9
Jun	50.7	52.5
Jul	52.2	54.4
Aug	48.9	53.3
Sep	48.8	49.3
Oct	45.1	47.5
Nov	46.1	47.8
Dec	45.1	49.7
Average	46.8	49.7

6.3.4 *Evaluation of Baseline Monitoring Data*

Both sets of data monitored at Hung Shing Ye (HSY) and Tai Wan To (TWT) were summarise in *Table 6.3c*. It was observed from *Table 6.3a* and *6.3b* that the 2 sets of data exhibit seasonal characteristics which could be attributed in part to changes in extraneous sources in the background and in part to the seasonal load pattern of the power station. In order to characterise the effects of seasonal variations, data in *Table 6.3c* are grouped into summer and winter months.

Table 6.3c ***Seasonal Background Noise at HSY and TWT ($L_{eq, 30\ min}$)***

Location	Daytime			Nighttime		
	Summer	Winter	Difference	Summer	Winter	Difference
HSY	55.4	53.6	1.8	53.6	52.1	1.5
TWT	51.7	48.7	3.0	49.4	45.2	4.2
Difference	3.7	4.9		4.2	6.9	

In summer, which is defined as between May and September, the loads of the Lamma Power Station are generally higher than the loads in winter months (October - April). The minimum loads occur during winter months when typically only 3 to 4 units operate at night whereas during the maximum load period on summer days, typically 4 to 7 units are in operation. The number of units in operation at night are normally 1-2 units less than during the day.

Extraneous Noises

In view of the similarity in the landuse and orientation to the Lamma Power Station, the noise environment at HSY and TWT should be very similar. The difference between the two datasets would hence indicate the effect of sporadic extraneous sources present typically in the environment.

From the last row of *Table 6.3c*, it can be concluded that the extraneous noise sources are actually the dominant component at the surrounding receptors, particularly at night during winter months when the night-time background is the lowest.

Seasonal Variations

From the 4th and 7th columns of *Table 6.3c*, it can be seen that variations due to seasonal changes is smaller than the effects due to extraneous sources (last row). The net effect due to power station load is even less than that given in the columns as part of the change was due to a general increase in background noise of a steady character from either human or natural sources during summer.

Existing Background Noise

Of the 2 datasets, the TWT data are considered to be a more stringent representation of the background because the data were manually screened to eliminate certain particular extraneous noise sources present in the environment. Thus they are adopted for use as the background. From *Table 6.3c*, the background is estimated to be 51.7/49.4 dB(A) during daytime/nighttime, respectively, for summer. The corresponding figures are 48.7/45.2 dB(A) for winter.

6.3.5 *Noise from Existing Lamma Power Station*

As the TWT data were manually edited to eliminate apparent sporadic noise events, they tend to approximate the net contribution from the existing Lamma Power Station better than the HSY data. However it should be noted that despite all efforts in screening the sporadic extraneous noise sources, the measurements were not exempt from the influences of other noise sources present in the natural environment. The use of TWT data should therefore be conservative.

Under the greenhouse gas assessment in *Section 4.7*, HEC has committed the use of the 1,800MW gas-fired Combined Cycle Gas Turbines (CCGT) units for base load operation. Should additional loads be required, priority will be given to the most efficient coal-fired units that are fitted with Flue Gas Desulphurisation (FGD) plant and Low NOx Burners (LNB) in the existing Lamma Power Station. Under the worst case scenario in 2012, when the system operates at peak load, it is expected that the night-time demand would reach below half of the day time peak of 3,916MW as shown in *Part A Table 2.2a*. Therefore at most 3 units will need to operate and 2 units will be in operation for most of the time during night-time.

Hence the maximum potential noise impact of the existing plant can conservatively be estimated by the monitored data in December 1997 from *Table 6.3b* when at least 3 units (covering L6, L7 and L8) were in operation during the measurements.

Following this conservative approach, the December 1997 monitored nighttime level of 45.1 dB(A) would be used to calculate the future scenario (new plant plus existing plant). The 45.1 dB(A) would be the worst case (existing) situation as no more than three units (L6, L7 and L8) will operate.

From *Table 6.3b*, it can be concluded that, given the forecast load of 3,916MW in 2012, the night-time noise level due to operational of the existing Lamma Power Station in 2012 can conservatively be estimated as 45.1dB(A) at surrounding NSRs. For daytime noise impact assessment, the summer average of 51.7 dB(A) would be the worst case estimate.

6.4 CONSTRUCTION PHASE IMPACTS

6.4.1 *Methodology for Assessment of Construction Noise Impacts*

Construction Schedule

According to the project schedule supplied by HEC, the construction programme would span about 12 years, beginning in November 1999 with dredging and site formation work and ending in March 2012 with completion of the installation of the sixth combined-cycle unit. Throughout this period, many phases of construction will be carried out simultaneously so that their noise emissions would be additive. The schedule has then been reviewed to identify all concurrent activities so that total noise emissions for each unique time period could be calculated. *Table 6.4a* lists the various major phases of the construction programme and indicates their projected start and finish dates.

Inventory of Construction Equipment (PMEs)

An inventory of the construction equipment (Powered Mechanical Equipment, or PMEs) expected to be used during the various work phases has been provided by the HEC and is summarised in *Tables 6.4b* to *6.4d*. Also shown for each type of PME is its Sound Power Level, or SWL (obtained from either the *GW-TM* or the British Construction Noise Standard BS 5228), the number of similar units expected to be employed, as well as an appropriate Usage Factor (the proportion of time that the PME can reasonably be expected to operate at or near full power). Together this information permits the calculation of the total SWL emissions from the construction site during each phase of the work.

Construction Noise Prediction Procedure

The procedures used in assessing general construction noise and noise from percussive piling have been based on the *GW-TM* and *PP-TM* respectively. These procedures are outlined below (sample calculations are provided in *Annex B6-1*) :

- locate NSR's which will be most directly affected by project noise;
- calculate the total sound power level to be produced in each major construction phase using the PME lists and the individual SWLs provided for each PME;

Table 6.4a *Schedule of Major Construction Activities*

Phase	Major Construction Activity	Hours/Day	Start	Finish
Dredging and Site Formation				
L9-L14	Dredging	24	12/1999	07/2000
	Filling for Foundation and Seawall	16	03/2000	10/2000
	Placing Vertical Seawall Block	16	07/2000	10/2000
	Filling for Platform	16	08/2000	07/2001
Piling and Civil works				
L9	Piling	12	11/2000	09/2001
	Foundation & Substructure	12	11/2000	12/2002
	Superstructure	12	04/2001	12/2002
L10	Piling	12	07/2002	03/2003
	Foundation & Substructure	12	01/2003	12/2004
	Superstructure	12	04/2003	12/2004
L11	Piling	12	07/2004	03/2005
	Foundation & Substructure	12	01/2005	12/2006
	Superstructure	12	04/2005	12/2006
L12	Piling	12	07/2007	03/2008
	Foundation & Substructure	12	01/2008	12/2009
	Superstructure	12	04/2008	12/2009
L13 & L14	Piling	12	07/2009	03/2010
	Foundation & Substructure	12	01/2010	12/2011
	Superstructure	12	04/2010	12/2011
Structural Steelwork and E&M Erection				
L9	Erect Steelwork & install Electrical & Mechanical Equipment	12	08/2001	06/2003
L10	" " "	12	04/2003	03/2005
L11	" " "	12	04/2005	03/2007
L12	" " "	12	04/2008	03/2010
L13 & L14	" " "	12	04/2010	03/2012

- for percussive piling, the distances between the piling zones and the NSRs will be used instead;

- calculate the attenuation of noise levels with distance from the "Notional Source Location" on the construction site, the effects of barriers (hills) and of reflections (from building facades); and

- for each construction phase, predict construction noise levels at each NSR in the absence of mitigation measures.

Table 6.4b ***Inventory of Powered Mechanical Equipment (PMEs) to be Employed during the Dredging and Site Formation Phase***

Major Activity: Dredging & Site Formation (L9 - L14)	Equipment Type (PME)	Reference	SWL (dBA)	No. of Units	Variation during restricted hours
Dredging	Grab Dredger	CNP 063	112	2	0
	Trailer Suction Hopper Dredger	ERM	111	1	-1*
	Tug Boat	CNP 221	110	2	-1*
Filling for Foundation and Seawall	Tug Boat	CNP 221	110	2	0
	Grab Dredger	CNP 063	112	2	0
	Derrick Barge	CNP 061	104	2	0
Placing Vertical Seawall Block	Derrick Barge	CNP 061	104	3	0
Filling for Platform	Trailer Suction Hopper Dredger	ERM	111	1	0
	Cutter Suction Dredger	Estimate	115	2	0
	Vibro Compact'n Probes	BS5228 (No. 118)	108	10	0
	Scraper	CNP 204	119	2	-1#

Notes: * During night time only (2300 - 0700 hours)
During day time only (0700-1900 hours) on public holidays including Sundays

Table 6.4c ***Inventory of Powered Mechanical Equipment to be Employed during the Piling, Foundation and Substructure, and Superstructure Phases of L9***

Major Construction Activity	Equipment Type (PME)	Reference	SWL (dBA)	No. of Units	Variation during Restricted Hours
Piling Driving (Percussive) (L9)	Mobile Crane	CNP 048	112	8	-8%
	Diesel Hammer (steel piles)	PP-TM (Table 2)	132	8	-8%
Foundation and Substructure (L9)	Excavator	CNP 081	112	6	-3#
	Air Compressor	CNP 001	100	10	0
	Breaker, hand held >35 kg	CNP 026	114	2	0
	Concrete Mixer	CNP 046	96	1	0

Major Construction Activity	Equipment Type (PME)	Reference	SWL (dBA)	No. of Units	Variation during Restricted Hours
	Concrete Lorry Mixer	CNP 044	109	4	0
	Vibratory Poker	CNP 170	113	6	-3#
	Concrete Pump (lorry-mounted)	CNP 047	109	1	0
	Crane Lorry	BS5228 (Table C.6, Ref No.39)	116	4	-2#
	Submersible water pump	CNP 283	85	4	0
	Scraper	CNP 204	119	2	-1#)
	Roller (vibratory)	CNP 186	108	2	0
Superstructure (L9)	Material Hoist (electric)	CNP 122	95	8	0
	Tower Crane (electric)	CNP 049	95	4	0
	Mobile Crane	CNP 048	112	4	0
	Air Compressor	CNP 001	100	10	0
	Breaker, hand held >35 kg	CNP 026	114	2	0
	Concrete Mixer	CNP 046	96	1	0
	Concrete Lorry Mixer	CNP 044	109	6	0
	Vibratory Poker	CNP170	113	6	0
	Concrete Pump (lorry-mounted)	CNP 047	109	2	0
	Crane Lorry	BS 5228 (Table C.6, Ref No.39)	116	4	0
	Generator (standard)	CNP 101	108	8	0
	Dump truck	CNP 067	117	4	0
	Grout Pump	BS 5228 (Table C.5, Ref No. 13)	108	2	0

Notes: # During day time only (0700 - 1900 hours) on public holidays including Sundays
*During all day time on public holidays including Sundays

Table 6.4d ***Inventory of Powered Mechanical Equipment to be Employed during the Piling, Foundation and Substructure, and Superstructure Phases of L10 to L14***

Major Construction Activity	Equipment Type (PME)	Reference	SWL (dBA)	No. of Units	Variation during Restricted Hours
Pile Driving (Percussive) (L10 to L14)	Mobile Crane	CNP 048	112	4	-4*
	Diesel Hammer (steel piles)	PP-TM (Table 2)	132	4	-4*
Foundation and Substructure (L10 to L14)	Excavator	CNP 081	112	3	0
	Air Compressor	CNP 001	100	5	0
	Breaker, hand held > 35 kg	CNP 026	114	1	0
	Concrete Mixer	CNP 046	96	1	0
	Concrete Lorry Mixer	CNP 044	109	4	0
	Vibratory Poker	CNP170	113	6	0
	Concrete Pump (lorry-mounted)	CNP 047	109	1	0
	Crane Lorry	BS 5228 (Table C.6, Ref No.39)	116	2	0
	Submersible Water Pump	CNP 283	85	2	0
	Scraper	CNP 204	119	1	0
	Roller (vibratory)	CNP 186	108	1	0
Superstructure (L10 to Ll4)	Concrete Hoist (electric)	CNP 122	95	4	0
	Tower Crane (electric)	CNP 049	95	2	0
	Mobile Crane	CNP 048	112	2	0
	Air Compressor	CNP 001	100	5	0
	Breaker, hand held > 35 kg	CNP 026	114	1	0
	Concrete Mixer	CNP 046	96	1	0
	Concrete Lorry Mixer	CNP 044	109	4	0
	Vibratory Poker	CNP170	113	6	0
	Concrete Pump (lorry-mounted)	CNP 047	109	1	0
	Crane Lorry	BS 5228 (Table C.6, Ref No.39)	116	2	0
	Generator (standard)	CNP 101	108	4	0
	Dump truck	CNP 067	117	2	0
	Grout Pump	BS 5228 (Table C.5, Ref No.13)	108	2	0

Major Construction Activity	Equipment Type (PME)	Reference	SWL (dBA)	No. of Units	Variation during Restricted Hours
Structural Steelwork and E & M Erection (L9 -L14)	Heavy Duty Tracked Crane	BS 5228 (Table C.7)	110	2	0
	Mobile, Light Duty Crane	BS 5228 (Table C.7)	107	2	0
	Air Compressor	CNP 001	100	2	0
	Generator (standard)	CNP 101	108	1	0
	Truck (general lorry)	CNP 141	112	4	0

Note: * During all day time on public holidays including Sundays

6.4.2 *Predicted Construction Noise Impacts*

The noise impacts due to the proposed works programme and the equipment lists are predicted in this section. The objective is to assess the project feasibility during this planning stage and to identify if there is any potential constraint on the works programme or the use of construction equipment. It should be noted that when the project reaches the construction phase, an application for a *Construction Noise Permit* will be required prior to commencement of the works. Compliance with the ANLs will be further assessed based on future situations during the application.

Setback Distances From Construction Site to NSRs

Because of the large size (about 500 m by 400 m) of the construction site, the effective noise source location, or "Notional Source Position" is taken, as prescribed in the *GW-TM*, to be at a distance of 50 m inside the closest site boundary to the NSR in question. On this basis the source-to-NSR distances were found to range from 950 m to NSR 2 at Ko Long to 1500 m at NSR 3 on north slope of Yung Shue Wan Harbour. In addition, the intervening hill will provide significant noise shielding for all NSRs except that at Hung Shing Ye.

Percussive Piling

Under the *NCO*, percussive piling works is prohibited during evening and nighttime hours (1900 to 0700). The *PP-TM* specifies allowable hours of operation for daytime percussive piling based on when the work will be carried out (more stringent limitations have been in the process of being phased since 31 March 1998 and will reach the final "Stage 4" limits by 1 October 1999) and how the Corrected Noise Levels (corrected for barrier and reflection effects) at the NSRs compare with the Acceptable Noise Levels (ANLs). For residences with windows but no central air conditioning, the ANL is 85 dB(A), expressed in terms of the A-weighted equivalent continuous sound pressure level. For educational institutions, the ANL is 10 dB(A) lower, or 75 dB(A). For percussive piling work involving the use of diesel hammers, pneumatic and/or steam hammers carried out after 1 October 1999, the permitted hours of operation are determined as follows:

- **0700 to 1900** - if CNL is 10 dB(A) or more below the ANL; or
- **Nil** - if the CNL is not 10 dB(A) or more below the ANL.

It is expected that piling will be carried out at the following areas as shown in *Figure 4.4d*:

- Station Buildings & Control Buildings, and Gas Turbine Units;
- Switching Station;
- Chimney; and
- LGO Tank and Raw Water Tanks.

The following *Table 6.4e* lists the four NSRs, their setback distances from the appropriate piling zones and the ranges of CNLs predicted for percussive piling work during the various stages of construction. It also indicates how these CNLs compare to the relevant ANLs. It is seen that the CNL's are substantially (from 20 to 34 dBA) below the ANL's so that percussive pile driving during regular daytime hours will be clearly acceptable.

Table 6.4e ***Predicted Percussive Pile Driving Noise Levels at NSRs on Lamma Island***

Noise Sensitive Receivers (NSRs)		Distance to Piling Zone (m)	CNL (dBA)	CNL less ANL (dBA)
No.	Location			
NSR 1	Long Tsai Tsuen/Hung Shing Ye	1250 to 1850	60 to 67	-25 to -18
NSR 2	Ko Long	950 to 1250	54 to 59	-31 to -26
NSR 3	North Slope above Yung Shue Wan Harbour	1400 to 1700	53 to 55	-32 to -30
NSR 4	School in Tai Wan San Tsuen	1300 to 1600	54 to 57	-21 to -18

The above assessment results show that the proposed piling schedule is feasible, without causing any potential constraint on the construction works programme. Before percussive piling can commence at site, the *Noise Control Authority* would assess the application for a CNP based on contemporary situations. Compliance with the PP-TM limits will need to be further assessed with updated details on the piling method, locations and schedule, as guided by the *PP-TM*.

General Construction Work

The Corrected Noise Levels, or CNLs, predicted to be created at each NSR by general construction works over the 12 year duration of the project are summarized in *Table 6.4f*. The CNL's expected at residential NSRs range from a high of 60dB(A) at NSR 1 during a 3 month period in the second quarter of 2001 to a low of 35 dB(A) at NSR 4 during a 8 month period. The highest noise level expected at the school (NSR 4) is 52dB(A) from late 1999 to mid 2000. Therefore, at no time will noise levels from general construction work approach the criteria prescribed in the *EIAO-TM* for daytime hours of 75 and 70 dB(A) at residences and schools respectively.

Table 6.4f General Construction Noise Levels at NSRs on Lamma Island (LAeq)

Construction Period	Corrected Construction Noise Levels (CNLs)											
	Day (0700- 1900 Hours) (Restricted Hours during Public Holidays Only)				Evening (1900-2300 Hours) (Restricted Hours)				Night (2300-0700 Hours) (Restricted Hours)			
	NSR1	NSR2	NSR3	NSR4	NSR1	NSR2	NSR3	NSR4	NSR1	NSR2	NSR3	NSR4
12/1999 - 02/2000	* 47 (47)	41 (41)	36 (36)	37 (37)	47	41	36	37	45	39	34	35
03/2000 - 07/2000	50 (50)	44 (44)	39 (39)	40 (40)	50	44	39	40	45	39	34	35
08/2000 - 09/2000	55 (54)	48 (47)	43 (42)	45 (44)	55	48	43	45	-	-	-	-
10/2000	55 (54)	48 (47)	43 (42)	45 (44)	55	48	43	45	-	-	-	-
11/2000 - 03/2001	59 (57)	53 (50)	48 (45)	49 (47)	54	47	42	44	-	-	-	-
04/2001 - 07/2001	62 (60)	55 (54)	50 (49)	52 (50)	54	47	42	44	-	-	-	-
08/2001 - 09/2001	61 (60)	55 (53)	50 (48)	51 (50)	-	-	-	-	-	-	-	-
10/2001 - 06/2002	61 (60)	54 (53)	49 (48)	51 (50)	-	-	-	-	-	-	-	-
07/2002 - 12/2002	61 (60)	54 (53)	49 (48)	51 (50)	-	-	-	-	-	-	-	-
01/2003 - 03/2003	57 (56)	50 (50)	45 (45)	47 (46)	-	-	-	-	-	-	-	-
04/2003 - 06/2004	59 (59)	52 (52)	47 (47)	49 (49)	-	-	-	-	-	-	-	-
07/2004 - 12/2004	59 (59)	53 (52)	48 (47)	49 (49)	-	-	-	-	-	-	-	-
01/2005 - 03/2005	57 (56)	50 (50)	45 (45)	47 (46)	-	-	-	-	-	-	-	-
04/2005 - 12/2006	59 (59)	52 (52)	47 (47)	49 (49)	-	-	-	-	-	-	-	-
01/2007 - 03/2007	49 (49)	43 (43)	38 (38)	39 (39)	-	-	-	-	-	-	-	-
04/2007 - 06/2007	-	-	-	-	-	-	-	-	-	-	-	-
07/2007 - 12/2007	47 (-)	41 (-)	36 (-)	37 (-)	-	-	-	-	-	-	-	-
01/2008 - 03/2008	56 (55)	49 (49)	44 (44)	46 (45)	-	-	-	-	-	-	-	-
04/2008 - 06/2009	59 (59)	52 (52)	47 (47)	49 (49)	-	-	-	-	-	-	-	-
07/2009 - 12/2009	59 (59)	53 (52)	48 (47)	49 (49)	-	-	-	-	-	-	-	-
01/2010 - 03/2010	57 (56)	50 (50)	45 (45)	47 (46)	-	-	-	-	-	-	-	-
04/2010 - 12/2011	59 (59)	52 (52)	47 (47)	49 (49)	-	-	-	-	-	-	-	-
01/2012 - 03/2012	49 (49)	43 (43)	38 (38)	39 (39)	-	-	-	-	-	-	-	-

** The numbers in brackets denote the day time predicted noise levels during public holidays including Sundays, which are regulated under the NCO as restricted hours. A Construction Noise Permit (CNP) is required prior to the commencement of works during public holidays.*

In applying for a Construction Noise Permit (CNP) to work during restricted hours, the noise limit prescribed by the *GM-TM* between 1900 and 2300 hours Monday to Saturday and between 0700 and 2300 on Sundays and public holidays is 60 dB(A). Given the equipment schedule shown in Table 6.3b, 6.4c, 6.4d the ANLs can be met with only slight variations in equipment schedule during restricted hours. When general construction work is to be carried out on a 7 day per week basis, as is scheduled between 12/1999 and 12/2002, then, during the busiest portions of the schedule, daytime noise levels can be met by reducing the number of plant in operation during day time of public holiday by the amount shown in Tables 6.4b and 6.4c.

Conclusions

On the basis of the above assessment, noise emissions during the 12 year construction program are not expected to result in unacceptable impacts on the surrounding community, however the limited application of reduction in plant operation, will assure that the noise criteria for the more sensitive time periods (nighttime and Sundays/holidays) are not exceeded.

6.5 OPERATIONAL PHASE IMPACTS

6.5.1 *Methodology for Assessment of Operational Noise Impacts*

Operational Noise Sources

There are a large number of significant noise sources associated with the proposed plant extension. The primary sources are expected to include:

- gas turbines (including accessories), turbine intakes and turbine exhaust systems;
- steam turbines;
- electricity generators;
- heat recovery steam generators (HRSGs);
- transformers;
- pumps, air compressors, electric motors, blowers and ventilation fans;
- fire pumps;
- control valves and associated pipework; and
- steam discharges.

However, most of the major noise sources in continuous operation are expected to be located within two fully-enclosed turbine buildings and a number of the sources will also then be housed in individual acoustic enclosures to limit the noise exposure of personnel on site. Further, the use of seawater cooling for the steam condenser eliminates a significant source of noise (the cooler fans) associated with air-cooled condensers. As a result, the primary continuously-operating noise sources affecting noise levels externally and hence in the community are expected to be:

- gas turbine intakes, located at high level above roofs of turbine halls;
- gas turbine exhaust systems;
- HRSGs, located east of the turbine building;
- transformers, located west of the building;
- cooling water pumps and motors;
- control valves and associated pipework; and
- steam discharges.

Small pumps associated with the effluent treatment systems and tank areas are not expected to contribute significantly to plant or community noise levels.

Plant noise levels must meet both environmental and occupational noise requirements. Consequently, specific noise requirements for the above equipment may be dictated by the need to meet either the environmental noise limits or on-plant (occupational) noise limits.

Prediction Methodology

It is standard practice during the design of such plants to specify individual noise limits for all significant equipment on the plant. Initially, a general equipment noise limit of 85 dB(A) at 1 m was assumed. Because of its large size, a more stringent limit (80 dB(A) at 1m) was required for the HRSG. These limits are considered practically achievable for the majority of the noise sources, particularly those located externally. Specific limits for individual equipment may later be revised as part of the detailed design work.

These noise limits would normally be "free field" (ie. limits to be met by the equipment operating on hard ground, in the open, with no reflective surfaces nearby and no significant influence from other sources). Noise levels will always be higher within a room (e.g turbine house) and with other sources contributing.

Sound power levels (SWLs) in octave bands were estimated for each of the external sources, based on the 80 or 85 dB(A) limit, a sound pressure to sound power conversion factor (based on the estimated size of the unit) and a representative spectrum for each type of source.

In deriving the sound power level due to noise breakout through the walls/roof of the turbine building, an overall average internal noise level within the turbine hall of 90 dB(A) was assumed, based on detailed calculations carried out on a previous project and measurements on similar plants elsewhere. A (conservative) estimate was made of the transmission loss of the external cladding, assumed to be profiled steel with an internal, acoustically-absorptive lining system.

A computer model of the plant was then developed to handle the large number of calculations involved in predicting noise levels due to many sources at a number of receiver locations, particularly in a situation where barrier attenuation, due to both the existing power plant buildings and the terrain to the north of the plant can also be a significant factor.

Calculations were performed in accordance with *EEMUA Specification 140 (EEMUA stands for the Engineering Equipment & Materials Users Association)*. This describes in detail methods for calculation of sound power level, sound propagation with distance under free field conditions, and summation of noise sources. Calculations are performed in octave bands from 31 Hz to 8 kHz, and include the effects of source dimensions, distance and atmospheric attenuation. Since there is primarily water between the plant and Hung Shing Ye and most of the noise sources are elevated, no ground attenuation has been assumed. Barrier attenuation is calculated (in accordance with Maekawa) for sources screened from the receivers by features within the proposed plant site, the existing plant site, or the terrain.

Further details of the calculation procedure are given in *Annex B6-2*.

The dominant individual noise source SWLs, as well as the total SWL, derived in this manner for the new plant are summarised in Octave Bands in *Table 6.5a below.*

Table 6.5a ***Plant Sound Power Levels (dB re. 10^{-12} W)***

Equipment	Octave Band Centre Frequency (Hz)								SWL
Description	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**dB(A)**
Turbine Hall Breakout	114.7	102.7	99.4	98.9	89.4	81.5	78.5	76.5	98.7
GT Intake	94.0	94.0	96.0	98.0	101.0	101.0	102.0	101.0	107.9
HRSG	118.4	119.4	113.4	109.4	104.4	100.4	96.4	93.4	111.6
Transformer	103.7	110.7	105.7	102.7	93.7	84.7	77.7	70.7	103.0
Exhaust	108.2	106.2	102.2	101.2	86.2	91.2	86.2	81.2	101.0
Cooling Water Pump	97.0	104.0	102.0	99.0	100.0	85.0	73.9	64.0	102.3
Total Plant	127	127.9	122.3	118.8	115.0	111.7	110.9	109.5	121.7

Note: Total Plant PWL is based on 2 turbine halls, 6 GT Intakes, 6 HRSGs, 6 Transformers, 2 Exhausts and 6 Cooling Water Pump

6.5.2 *Predicted Operational Phase Noise Impact*

Normal Operation

Predicted free-field noise levels in areas surrounding the site due to the operation of the plant extension are presented as noise contours in *Figure 6.5a* .

The predicted noise level at the nearest NSRs (in the vicinity of Hung Shing Ye, and up to Tai Wan To), upon applying a 2.5 dB(A) facade correction, is then 45.1 dB(A), just on the identified design noise limit. Because of the large distance between the source and receivers, there is no significant difference in the noise level calculated at different building elevations.

The predicted noise levels at Hung Shing Ye/Tai Wan To due to the new and combined (new plus existing) plants are then as given in *Table 6.5.b* below.

Table 6.5b ***Predicted Noise Levels - Hung Shing Ye/Tai Wan To ($L_{eq, 30min}$ dB(A)) - Facade Corrected***

	New Plant	Existing Plant*	New + Existing
Daytime	45.1	summer 54.2	54.7
		winter 51.2	52.2
Nighttime	45.1	summer 47.6	49.5
		winter 47.6	49.5

Note: * Based on the conservative estimates in Section 6.3.5, with a 2.5 dB façade correction added. Note, these levels are conservative estimates of the existing plant operation as they will inevitably contain some contributions from natural noise sources such as insects, wind, waves, etc..

At these locations the new plant will generally give rise to levels below those of the existing plant. Therefore, under the quietest operational states of the existing plant, cumulative plant noise levels may be increased slightly due to new plant operation, but at the higher operational loads, the new plant will not create any significant increases in overall plant noise exposures at the NSRs.

At locations to the north of the existing plant (eg Wang Long, Ko Long), the existing buildings and the terrain act as barriers, significantly reducing noise levels due to the new plant, to 30 dB(A) and below.

At these locations, noise levels will be dominated by noise from the existing plant so any change is likely to be downwards for the reasons noted above.

Emergency Conditions

Noise levels may exceed the 85 dB(A) equipment specification and may exceed the baseline noise levels in the local community during high pressure steam venting or when certain emergency equipment (eg fire pumps) is operating.

These sources may be audible in the local community under these conditions. However, assuming treatment as discussed in the following sections and given

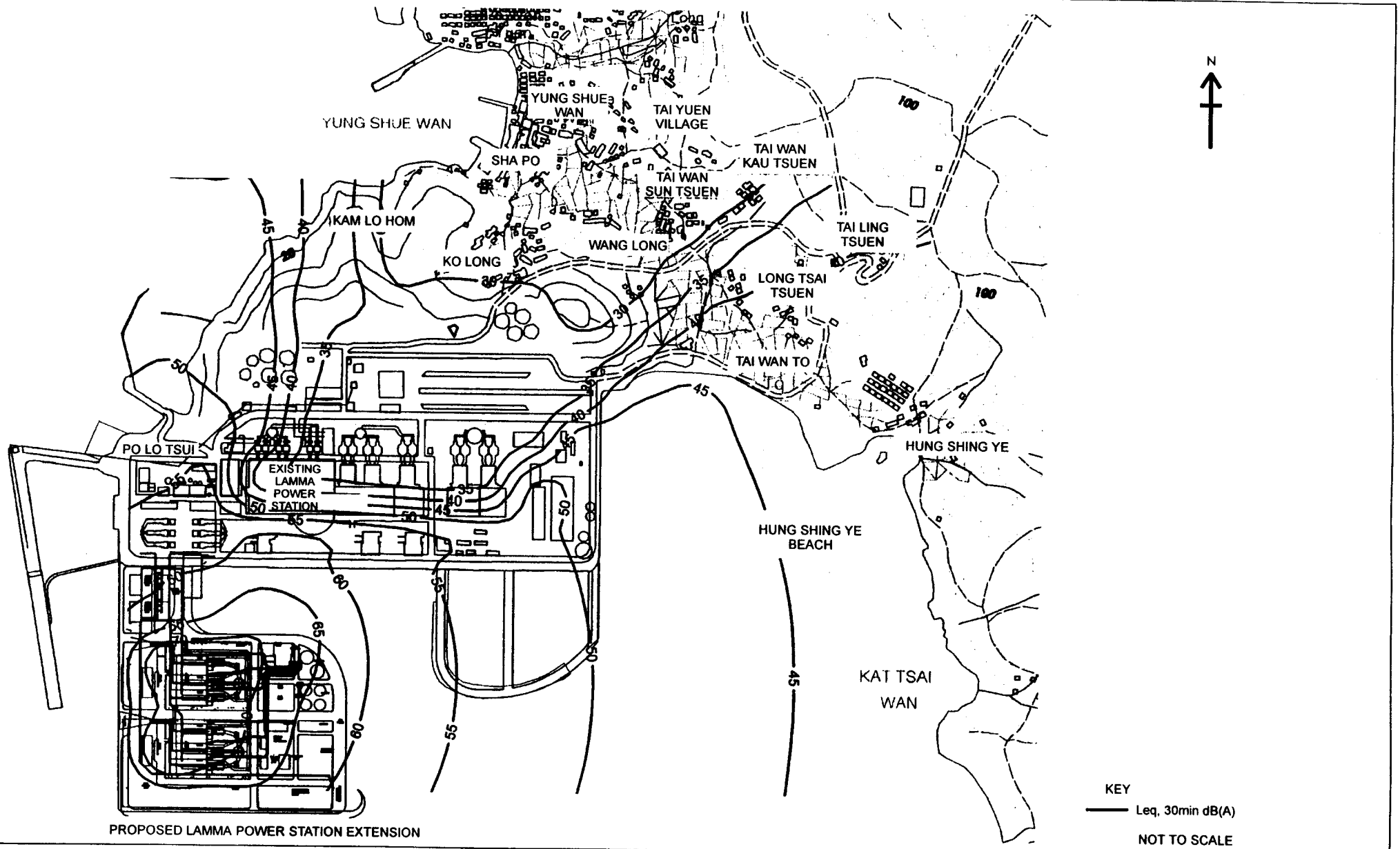

FIGURE 6.5a

PREDICTED FREE-FIELD OPERATION NOISE LEVELS FROM NEW PLANT EXTENSION ONLY (W/O FACADE - CORRECTION)

FILE: C1830/C1830Z13
DATE: 29/10/98

Environmental Resources Management

ERM

the rare occurrence of such events, this is unlikely to give rise to significant noise impacts.

Conclusions

On the basis of the assessment above, plant noise during normal operation is not expected to give rise unacceptable environmental impacts, assuming the general utilisation of commercially-available low noise equipment, which is discussed in the following *Section 6.6*.

6.6 SUMMARY OF MITIGATION MEASURES

6.6.1 *Construction Noise Mitigation Measures*

Percussive Piling

Percussive piling is prohibited during the evening and nighttime (1900 to 0700 hours) while this assessment has shown that, during the daytime, the projected percussive piling noise levels will be far below the 85 and 75 dB(A) limits specified for residences and schools in the *PP-TM*. Therefore, there is no need to consider mitigation measures in the normal sense.

General Construction Work

No mitigation measures need to be considered in order to carry out general construction works during unrestricted hours, provided the slight reduction in plant operation is adopted during day time on any public holidays or night time during the initial phase of dredging. Similarly, the noise levels projected to result from general construction work scheduled for evening hours, while closer to the relevant limit, will not require mitigation. If, however, work is to be carried out on Sundays and public holidays during the most active construction phases, noise levels could reach up to the 60 dBA limit. While in theory mitigation would not be indicated, it would be advisable to consider those forms of mitigation which could be implemented relatively easily should a construction noise monitoring programme indicate that the limit is at times being exceeded. These might include the application of source controls on, or the substitution of "quiet plant" for, some key PMEs or alternatively, and the rescheduling of some PMEs to less sensitive time periods.

A similar approach is recommended for the potential mitigation of the noise from general construction work at night (ie, dredging). If construction noise monitoring indicates that the 45 dB(A) nighttime limit is indeed being exceeded, then this most likely marginal situation could be corrected through a directed programme of source noise controls on key pieces of dredging equipment.

6.6.2 *Operational Noise Mitigation Measures*

General Approach

It is clearly important to limit the noise emission of all major noise sources on the new plant for both environmental and occupational reasons. The specific noise limit to be placed on an individual item of equipment may be dictated by either the on-plant requirements or by the target levels in surrounding community, depending on the source size, location and elevation. More stringent noise limits than the general 85 dB(A) specification may be required in some cases.

It is important therefore to ensure that appropriate noise limits are specified within the equipment tender documents and that guarantees are obtained for all major equipment. A detailed noise control study should be carried out as part of the detailed design of the plant to ensure that appropriate limits and noise control measures are incorporated.

Providing the majority of the equipment complies with the 85 dB(A) equipment noise specification, noise levels would then be expected to meet the environmental requirements. Mitigation measures expected to be required to meet the equipment noise specification, or a more stringent specification, are discussed below:

Gas Turbine Intakes

These sources are located at high level so will be essentially unscreened from most of the nearest community locations to the east. Gas turbine intake noise is very high frequency and as such tends to be quite directional. Ideally then, the GT intakes should be oriented to the west, away from the residential communities to the east and north.

However, the primary mitigation measure is the incorporation of high performance attenuators (typically, rectangular splitter silencers) in the turbine intake duct upstream of the turbine. It is not expected that this would pose any major problems. The acoustic performance of the attenuators would be determined during the detailed design. Because intake noise is high frequency, it is relatively easily attenuated.

Any external sections of intake ducting between the turbine and the silencers should be acoustically insulated to minimise noise breakout through he ducting.

Typically insulation would comprise mineral wool of thickness 50 to 100 mm with 0.7 to 1.0 mm steel cladding.

Gas Turbine Exhaust / HRSG

Gas turbine exhaust noise is primarily low frequency in character and is therefore not as readily attenuated as the high frequency intake noise. It is also not particularly directional in nature.

Based on the current design, three gas turbines will discharge via a common exhaust stack at high elevation. There will be no noise screening between the exhaust stack and Hung Shing Ye.

Again, high performance cylindrical or rectangular splitter exhaust silencers are expected to be required although HRSG units have also been found to give significant inherent attenuation. The acoustic performance of the silencers would be determined in detailed design, taking this attenuation into account.

There may also be a need for acoustic insulation of the HRSG and exhaust ducting between the turbine and HRSG and HRSG and silencer to minimise noise breakout throughout the ducting. Insulation may need to be 150 mm thick or feature high density barrier layers to increase the low frequency performance.

Because of its large size and location, it will be particularly important that noise levels due to the HRSG meet the project requirements.

Cooling Water Pumps

Noise levels due to electric-driven pumps can vary significantly for units of a similar rating. A wide range of low noise or silenced designs of motors are available. Noise reduction measures may include use of special fans, use of acoustic fan covers, air intake/discharge attenuators, or increasing the frame size.

The cooling water pumps on the existing Lamma power station were noted to be particularly quiet for the size of the units (about 83 dB(A) at 1 m) so no particular problems are envisaged for this equipment.

As an additional noise control measure the units could be located in a pump house thereby eliminating their contribution to community noise levels.

Gas & Steam Turbines / Generators

It is expected that a number of the major sources located within the turbine hall would be housed in acoustic enclosures to meet the occupational noise limits. Noise levels in such situations within the turbine hall would be expected to be 90 to 95 dB(A). The small proportion of this noise which would escape into the environment is included in the calculations of *Annex B6-2* the as "turbine breakout noise".

Miscellaneous Pumps /Motors

Most of the other major pumps and motors (eg vacuum pumps, condensate pumps) are expected to be located within the turbine building. As such they are not expected to be a problem with respect to environmental noise. Low noise motors should still be selected, however, to meet the occupational noise limits. Pump cladding and pipe insulation may be required for certain units.

Blower Fans

Externally located blower fans, if required, should feature inlet/discharge attenuators (as appropriate) and may need to be acoustically-clad or enclosed.

Ventilation Fans

Ventilation fans may require external (and possibly internal) attenuators. Ideally they should again be located on the west ends of the turbine halls so as not to contribute significantly to overall plant noise levels in the community.

Control Valves and Associated Pipework

Control valves can generate very high noise levels, depending principally on their flow rate and pressure drop. High noise levels may be expected from any valve operating with a pressure drop that is close to or exceeds the critical pressure ratio of the gas or vapour. Noise is generated at the valve, but radiated by the downstream and, to a lesser extent, upstream piping.

Control valves may contribute significantly to noise levels on site both outside and inside turbine halls and hence will need to be addressed from the occupational noise exposure standpoint . However, due to their relatively small size and predominantly high frequency content, their noise is not generally significant at large setback distances, such as those between the new plant site and the surrounding community.

The primary means of reducing valve noise is to use low noise valve trims which achieve the reduction in noise level by dropping pressure in stages rather than in a single stage. If low noise trims cannot be used for a given duty, downstream piping may require acoustic insulation (mineral wool insulation with steel cladding).

Steam Bypass, Steam Discharges and Leaks

Steam bypass lines and high pressure steam venting, discharges and leaks can also give rise to very high noise levels. Again however, there predominantly high frequency content tend to diminish their significance at large distances.

Steam vent silencers will be required for various duties and certain external piping may require acoustic insulation as discussed above.

Transformers

While transformers can generate quite high noise levels, the units at the new plant site are expected to be located to the west of the turbine buildings where they will be effectively screened from the critical community locations to the east. On this basis they are not expected to require treatment to meet the environmental limits.

Turbine Hall Cladding System

It is expected that a conventional cladding system similar to the specification of the cladding on the existing Lamma turbine halls would be used (profiled steel). Its acoustic performance can be enhanced by the addition of an acoustically-absorptive layer, faced with perforated steel sheet, for the inner face of the building.

The specification of the acoustic performance of the cladding system (in terms of both transmission loss and absorption) will be an important factor in meeting the environmental (and occupational) noise limits. It would be expected to be considered in detail during the design process.

The acoustic requirements are most critical for the east wall, for which a more stringent specification may be required. Translucent panelling (to provide natural lighting) should preferably be along the west wall of the turbine hall. Any openings in the building structure should be made as small as possible.

6.7 EM&A REQUIREMENTS

6.7.1 *Construction Phase*

Daytime construction noise levels (both from percussive piling and general work) have been found to well within the criteria indicated in the *EIAO TM*. However, it is desirable to carry out a limited amount of daytime noise monitoring, at least within the initial 18 months of the construction schedule, to observe the first of the projected maximum general construction noise output periods as well as the first several months of percussive pile driving. Given the large margins between the projected daytime levels and their criteria, noise monitoring for 30 to 60 active minutes on a weekly or bi-weekly basis should be sufficient. The preferred location for noise monitoring within the community would be at Hung Shing Ye, with the Police Station site currently used by HEC being a conservative choice, suitable for daytime and perhaps evening monitoring.

Projected evening noise levels from general construction are also comfortably below the applicable limit but much less so than the daytime levels. Therefore, monitoring should be conducted on a semi-weekly basis (30 to 60 minutes), particularly during the period between 10/2000 and 03/2001 when the levels of construction activity during the evening are scheduled to be near their peak. This should be continued until a sustained pattern of compliance has been established. A similar approach should be taken to noise monitoring if , as indicated, construction work is to be carried out on Sundays or public holidays. Here, it would be reasonable to conduct 30 to 60 minutes of monitoring on every Sunday and holiday worked.

The need to monitor nighttime construction noise levels during the first eight months of the schedule will be most critical. However, it will not generally be possible to confidently measure construction noise levels in the vicinity of 45 dB(A) within the community due to the presence of both existing plant operation noise and other local ambient noise. Therefore, it will likely be necessary to conduct such monitoring much closer to the site, at a location where construction noise clearly dominates the noise from existing plant operations and all other sources. Construction noise levels within the community (eg, at Hung Shing Ye) could then be obtained by applying the anticipated noise reduction between the two locations. This latter could either be estimated from basic acoustic principals or measured directly under more favourable "signal to noise" conditions.

Given the need to carry out construction noise monitoring over a period of years, it may be most efficient to establish a permanent monitoring station dedicated to the task from which data could be selected as needed to fulfill the above requirements as well as any others which may arise during construction or operation.

6.7.2 *Operational Phase*

Equipment Compliance Monitoring

Noise compliance tests should be conducted at the vendor works or, failing this, at the site for all major items of rotating equipment in order to ensure vendor compliance with project noise requirements.

Plant / Community Noise Survey

A comprehensive on-plant and community noise survey should be conducted on completion of commissioning of the new plant at a period of peak demand. Further surveys should be conducted following any significant changes in plant design or operational procedures.

Monitoring Locations / Parameters

Monitoring should be carried out at the two nearest NSRs. However, in practice, it is expected to generally be difficult to monitor new plant operational noise levels at the NSRs discussed earlier due to noise from the existing plant and from other sources in the community. Under such circumstances it would be appropriate to monitor noise levels at a point closer to the site (eg on the east boundary) and extrapolate the results so obtained to the NSR's.

Monitoring Procedure

Prior to any monitoring programme being undertaken, all monitoring equipment should be serviced, calibrated and certified by an accredited laboratory. Equipment should be operated in accordance with the manufacturer's instructions and all tests and checks recommended by the manufacturer should be carried out. During monitoring activities, wind direction, wind speed and ambient humidity and temperature should be measured and recorded.

Monitoring Audit Reporting

Monitoring results from the designated monitoring stations can be compared with the operational noise limits given in *Section 6.3.3*. If monitoring results indicate exceedance of the limits, the individual nominated for environmental responsibility within the management structure, will be responsible for further monitoring, checking operational procedures, equipment and mitigation measures and instigating any additional remedial action.

6.8 *Summary and Conclusions*

6.8.1 *Construction Phase*

Due to a combination of the relatively large setback distances between the construction site and the surrounding community, the presence of substantial building (plant) and terrain shielding to the north of the site and the work schedule proposed by HEC, construction noise levels to be experienced within the community have been found to be well below the relevant criteria prescribed by the *EIAO TM* except for two cases where only marginal compliance were predicted. The two cases are the nighttime dredging work, which is to be carried

out within the first eight months of the schedule, and the "Foundation and Substructure for L9" work which is scheduled for seven days per week for the first two years and would hence occur (mostly during the daytime) on Sundays and public holidays. In both cases the worst-case projected noise levels are within one or zero dB(A) of the limits-in the nighttime case, just within the limit of 45 dB(A), and in the Sunday/holiday case, 1dB(A) under the limit of 60 dB(A).

It is therefore concluded that, while no substantive construction noise mitigation programme will be required, the proponent should identify opportune means of minimising noise output (through source controls on key PMEs, or minor reallocation of PME's) during these two sensitive periods so as to maintain a comfortable margin of safety.

In addition it will be necessary to carry out construction noise monitoring, particularly during the first 18 to 24 months of the programme. This would be intended to ensure compliance with nighttime and Sunday/holiday limits throughout the duration of the planned nighttime work as well as through a representative period of "maximal" construction activity on the site.

6.8.2 *Operational Phase*

Noise levels during normal operation of the plant extension are expected to meet (within limits of predictive accuracy) the most stringent derived noise limit of 45 dB(A) (nighttime) at all identified sensitive community locations, assuming compliance with the recommended 80/85 dB(A) equipment noise limits. These limits are considered to be practicably achievable assuming the general utilisation of commercially-available low noise equipment and a high performance turbine hall cladding system

On this basis, plant noise during normal operation is not expected to give rise to a major environmental impact.

Noise levels may exceed the equipment noise specifications during certain emergency situations (eg steam discharge or bypass, fire pump operation). However, given the intermittent nature of such events, this is unlikely to give rise to significant noise impacts.

It is clearly important to limit the noise emission of all major noise sources on the plant (for both environmental and occupational reasons) by the specification of appropriate noise limits within the equipment tender documents and by obtaining guarantees for all major plant.

It is recommended that a further noise control study is carried out during the detailed design of the plant to ensure that appropriate equipment noise limits are specified and that practicable noise control measures are fully incorporated into the design of the plant.

Noise compliance tests should be conducted at vendor works or, failing this, at the site for major items of rotating equipment in order to ensure vendor compliance with project noise requirements.

A comprehensive on-plant and community noise survey should be conducted on completion of commissioning of the plant at a period of peak demand. Further surveys should be conducted following any significant changes in plant design or operational procedures.