4 NOISE IMPACT ASSESSMENT

4.1 Introduction

A noise impact assessment has been undertaken to define the nature and scale of potential environmental impacts associated with the Project specifically in terms of the effects in the vicinity of sensitive receivers. Both construction and operational phase impacts have been assessed and mitigation measures have been identified to determine whether any residual impacts can be reduced to acceptable levels.

4.2 Legislation, Standards, Guidelines and Criteria

Construction Noise

The principal legislation for the control of construction noise is the *Noise Control Ordinance (NCO) (Cap 400)*. Various Technical Memoranda (TMs), which stipulate control approaches and criteria, have been issued under the NCO and EIAO. For this project, the following TMs are relevant to the assessment of the construction noise impacts:-

- 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 Environmental Impact Assessment Process (TMEIA).

General Construction Works

Noise impacts arise from general construction works during normal working hours (i.e. 0700 to 1900 hours on any day not being a Sunday or public holiday) at the openable windows of noise sensitive buildings are to be assessed as per the guidelines contained in the TMEIA. The recommended noise standards are 75dB(A) for domestic premises, 70dB(A) for educational institutions, 65dB(A) during examinations.

The NCO provides statutory controls on general construction works during the restricted hours (i.e. 1900-0700 hours Monday to Saturday and at any time on Sundays and public holidays). The use of powered mechanical equipment (PME) for carrying out 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 characteristics of different areas. The relevant ANLs are shown in **Table 4.1** below.

Table 4.1 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

Regardless of any description or assessment made in this EIA Report on construction noise aspects, there is no guarantee that a CNP will be issued for construction of the project. The Noise Control Authority will consider a well-justified CNP application, once filed, for construction works within restricted hours as guided by the relevant Technical Memoranda issued under the Noise Control Ordinance. The Noise Control Authority will take into account contemporary conditions / situations of adjoining land uses and any previous complaints against construction activities at the site before making his decision in granting a CNP. Nothing in this EIA Report shall bind the Noise Control Authority in making his decision. If a CNP is to be issued, the Noise Control Authority shall include in it any condition he thinks fit. Failure to comply with any such conditions will lead to cancellation of the CNP and prosecution action under the NCO.

At this moment, only construction works during non-restricted hours are assumed and the feasibility of carrying out works during restricted hours has not been assessed.

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

SPME :
- Hand-held breaker
- Bulldozer
- Concrete lorry mixer
- Dump truck
- Hand-held vibratory poker

PCW :
- Erection or dismantling of formwork or scaffolding
- Loading, unloading or handling or rubble, wooden boards, steel bars, wood or scaffolding material
- Hammering

In an attempt to provide environmental additional protection carrying out of PCW is generally banned inside a DA. As for the use of SPME, it would be necessary to comply with DA-TM noise level requirements that are 15 dB(A) more stringent than those listed in

the GW-TM before a CNP would be issued. As some works areas of the project will be within DA, the requirements stated in the DA-TM apply to this study.

Groundborne Noise

Noise arising from general construction works during normal working hours is governed by the TM-EIAO under the EIAO as shown in **Table 4.1**. TM for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (PL-TM) under the NCO stipulates that noise transmitted primarily through the structural elements of building, or buildings, shall be 10 dB(A) less than the relevant ANLs.

Based on the principle for groundborne noise criteria (i.e. taking account of the minus 10dB(A) requirement under the NCO PL-TM), groundborne construction noise levels inside domestic premises and schools relying on open window for ventilation will be limited to 65dB(A) and 60dB(A) respectively, with reference to the daytime airborne noise criterion of 75dB(A) and 70 dB(A) in accordance with TMEIA. In the evening (1900 – 2300hrs) and during nighttime (2300 – 0700hrs), groundborne noise level will be limited to 10dB(A) below the respective ANLs for the Area Sensitivity Rating category of "A, B and C" at the NSRs along the proposed project. A summary of these criteria is given in **Table 4.2** below.

Table 4.2 Groundborne Noise Criteria (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)	50	55	60
All days during the night-time (2300-0700 hours)	35	40	45

Area Sensitive Ratings (ASRs)

Determination of the Area Sensitivity Ratings for the NSRs in this study has been made with reference to relevant TMs. The study area comprises three intake and one outfall structures. Each of which is defined by different ASRs based on the type of area containing the NSR and effect of influencing factors. For the NSRs at Intake 1 and outfall 1, an Area Sensitivity Rating of "C" is assigned as the area is classified as the 'urban area' and directly influenced by road traffic noise from major roads (i.e. Cheung Pei Shan Road and Tuen Mun Road). For the NSRs at Intakes 2 and 3, an Area Sensitivity Rating of "A" is assigned as the area is classified as 'low density area' and not influenced by road traffic noise from main roads.

4.3 Assessment Methodology

A methodology for assessing construction noise other than percussive piling has followed the guidelines set out in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (GW-TM). The methodology is as follows:

- identify the likely type, sequence and duration of principal noisy construction activities required for the implementation of the proposed project;
- identify a list of plant inventory likely to be required for each construction activity;
- calculate the maximum total sound power level (SWL) for each construction activity using the plant list and SWL data given for each plant in the technical memorandum.
- representative NSRs as defined by the EIA-TM have been identified, based on existing and committed landuses in the study area that may be affected by the worksite. For the purposes of this study, NSRs have been identified up to a distance of 300m from the alignment. However, the distance may be reduced, subject to the first layer of NSRs providing adequate acoustic shielding;
- calculate the distance attenuation and barrier corrections to NSRs from worksite notional noise source point; and
- predict construction noise levels at NSRs in the absence of any mitigation measures.

If the noise assessment criteria are exceeded at NSRs, mitigation measures must be considered. A re-evaluation of the total SWL for each construction activity will be made assuming the use of practical mitigation measure such as "quiet" equipment and movable noise barriers. If the criteria were still exceeded, further mitigation measures such as reduction in noisy plant working simultaneously would be considered.

Noise and Vibration Due to TBM Tunnelling

For machines working in rock a preliminary estimate of vibration and ground borne noise can be made applying Miller and Bowers equations (ref.10)

Vibration

$V = 180x^{-1.3}$

Where V = upper bound PPV resultant (mm/s)

x = Distance between TBM source and receptor (m)

Ground Borne Noise

Introduction

The method used to predict construction groundborne noise is based on the U.S. Department of Transportation "High-Speed Ground Transportation Noise and Vibration Impact Assessment", 1998 (ref.11). The vibration level $L_{v,rms}$ at a distance R from the source is related to the vibration source level at a reference distance R_o. The conversion from vibration levels to groundborne noise levels is determined by the following factors:

C_{dist}: Distance attenuation
$C_{damping}$: Soil damping loss across the geological media
$C_{building}$: Coupling loss into building foundation
C_{floor}: Coupling loss per floor
C_{noise}: Conversion factor from floor vibration levels to noise levels

The predicted groundborne noise level L_p inside the noise sensitive rooms is given by the following equation.

$$L_p = L_{v,rms} + C_{dist} + C_{damping} + C_{building} + C_{floor} + C_{noise}$$

Reference Vibration Sources

The vibration velocities of TBM were determined by measurements and some of these in Peak Particle Velocity (PPV). In such cases, a crest factor of four was applied to establish the rms level in accordance with the FTA Guidance Manual (ref.12).

The vibration measurements for the TBM were extracted from the in-situ measurements during the bored tunnelling of Kwai Tsing Tunnel of the West Rail project. The geology consists of mainly granite, which is considered similar to the geology along Tsuen Wan Drainage. The measurements records are considered the most appropriate available information for the purpose of assessing TBM groundborne noise.

Soil Damping Loss

The geological profiles along Tsuen Wan are mainly hardrock. No soil damping loss is assumed.

Coupling Loss into Building Structures

This represents the change in the incident ground-surface vibration due to the presence of the piled building foundation. The empirical values based on the guidance set out in the Transportation Noise Reference Book (ref.13) are given in following Table.

Loss factor for coupling into building foundation

Loss factor for coupling into building foundation, dB	**Octave Band Frequencies, Hz**					
	16	**31.5**	**63**	**125**	**250**	**500**
Large building on Piles	-7	-10	-12	-15	-17	-14
Single residences	-5	-6	-6	-5	-4	-3

Coupling Loss Per Floor

This represents the floor-to-floor vibration transmission attenuation. In multi-storey buildings, a common value for the attenuation of vibration from floor-to-floor is approximately 1dB attenuation in the upper floor regions at low frequencies and greater than 3dB attenuation at lower floors at high frequencies. Coupling loss of –1 dB reduction per floor is assumed for a conservative assessment.

Conversion from Floor Vibration to Noise Levels

Conversion from floor vibration levels to indoor reverberant noise levels is based on standard acoustic principles. The conversion factor is dependent on the surface area *S* of the room in m^2, the radiation efficiency σ, the volume of the room V in m^3 and the room reverberation time RT in seconds. Analyses were carried out for residential units, school and temple. Results are summarised in following Table.

Conversion factors from floor vibration levels to indoor reverberant noise levels

NSR Description	Conversion C_{noise} (dB re $1x10^{-6}$ mm/s)
Residential Unit	–27
Temple	–27
School	–24

4.4 Baseline Conditions/ Sensitive Receivers

4.4.1 Baseline Conditions

The construction noise resulting from the proposed project will be present at the three intake structures, I-1, I-2 and I-3 and outlet structure. The existing ambient noise within Study Area is generally urban with road traffic with the exception of Intake I-3 which is located within the area proposed in future to be an ecological park (although no plans have been put in place yet).

- Intake I-1 is within 60m of Cheung Pei Shan Road; and a number of smaller roads including Wo Yi Hop Road (20m), Shing Mun Road (adjoining) and Wo Yi Hop Lane (20m).
- Intake I-2 adjoins Lo Wai Road, within 100m of Hill Top Road and other smaller roads.
- Intake I-3 is located 150m from at Route Twisk.
- Outlet O-1 adjoins Castle Peak Road (Ting Kau), Tau Lai Road (160m) and Tuen Mun Road (100m) and other smaller roads

4.4.2 Sensitive Receivers

Representative Noise Sensitive Receivers (NSRs) within 300m of the Project limit have been identified according to the criteria set out in the TMEIA and through site inspections and a review of land use plans. NSRs and their horizontal distance to the nearest emission source have been identified and are summarized in **Table 4.3.** Locations of the NSRs are shown in **Figure 4.1** (Intake I-1), **Figure 4.2** (Intake I-2), **Figure 4.3** (Intake I-3) and **Figure 4.4** (Outfall O-1).

Table 4.3 Noise Sensitive Receivers

ID No.	NSR No.	Locat.	Description	Noise Criteria	Distance to the nearest Emission Source (m)	No. of floors
1	NSR1*	**I1**	Sik Sik Yuen Ho Fung College	70	60	6
2	NSR2*		Kwai Shue House	75	90	25
3			Chuk Shue House	75	120	N.A
4			Sheng Kung Hui Li Ping Secondary School	70	130	N.A
5			Lei Muk Shui Estate (Block 6)	75	140	N.A

ID No.	NSR No.	Locat.	Description	Noise Criteria	Distance to the nearest Emission Source (m)	No. of floors
6			Lei Muk Shui Estate Chung Shue House	75	140	N.A
7			Leu Muk Shui Estate (Block 5)	75	190	N.A
8			Ho Shun Primary School	70	210	N.A
9			Chu Oi Primary School	70	260	N.A
10	NSR3*	**I2**	Hong Hoi Chee Hong Temple	75	24(1)	1
11	NSR4*		Yuen Yuen Care and Attention Home for the Aged	75	55	6
12	NSR5*		Western Monastery	75	70	1
13			Yuen Yuen Home for the Aged	75	70	N.A
14			Yuen Yuen Institute (Sam Dip Tam Temple)	75	100	N.A
15	NSR6*	**I3**	Squatters	75	50	1
16	NSR7*		Route Twisk Villa (Block 7-8)	75	160	6
17	NSR8*	**O1**	Beach Tower (Long Beach Gardens)	75	70	30
18	NSR9*		Greenview Terrace (Block 1)	75	60	30
19			Marina Tower (Long Beach Gardens)	75	130	N.A
20			Fung Chik Sen Villa	75	95	N.A
21			Grandview Villa (Block 10)	75	120	N.A
22			Blossom Terrace (Block 10)	75	130	N.A

Note: * Noise Sensitive Receivers are representative and will be used in prediction calculations. Noise Criteria/ Standards are based on Noise resulting from Daytime Construction Activities listed in the TMEIA.

(1) Distance to the notional source position

N.A. Not Applicable

4.5 Impact Assessment

4.5.1 Construction

Identification of Potential Impacts

Potential impacts that could arise from this Project include noise generated from site clearance and site preparation, machinery operation (site foundation and excavation, concreting and formwork and reinforcement); and vehicle movements. Tunnelling works are expected to be undertaken over a 24 hour period. The depth of the tunnel ranges from 7m to 200m below ground level. With regard to 24-hour working, a Construction Noise Permit (CNP) will be necessary for the construction during restricted period as the main tunnel will be driven by TBM (Working 24 hours). For the sake of provision for optimal programming and use of resources 24-hour working for tunnel construction is assumed to be normal practice. The allowance in the programme for the TBM drive is 22 months. Assuming a practical driven rate of 20m/day for 24 hrs working, the tunnelling works could be completed in 8 to 9 months for the 5.13km tunnel. This leaves plenty of float in the programme for the tunnelling works to be undertaken.

During restricted hours the construction activities will be contained within the tunnel. All material excavated during restricted hours will be stockpiled within the tunnel or at the tunnel portal and will be removed only during normal working hours (7am to 7pm). These measures will significantly reduce noise generated from tunnel construction during nighttime.

Various construction methods have been reviewed in the Options Selection Report from which it was concluded that TBM or drill and blast would be applicable to the deep tunnel option to be constructed below bedrock level (Grade III rock or better). For the construction method of the intake shafts, drill and blast at I-2 and I-3 is more feasible for the relatively short lengths and varying diameters based on the current proposed differing shaft diameters. The proposed shaft diameters for I-2 and I-3 are 7.8m and 5.25m respectively.

The noise assessment has used the premise that the most noisy construction task (e.g. Site Formation and Excavation) is representative of the worst case situation. No percussive piling is required for this construction. The plant inventory list has been established and the details are contained in **Table 4.4**.

Table 4.4 Plant Inventory (for Tunnel Construction and for Intakes 1, 2, 3 and Outfall 1) (No Mitigation Measures)

	Activities	**PME**	**TM ID Code**	**Unit**	**SWL dB(A)**
Powered Mechanical Equipment Used for Tunnel Construction					
A	General	Loader	CNP 081	1	112
		Backhoe / Muck Car	CNP 081	1	112
		Concrete Lorry Mixer	CNP 044	1	109
		Mobile Crane	CNP 048	1	112
		Dump Truck	CNP 067	1	117
		Concrete Pump	CNP 047	1	109
		Mobile Generator	CNP 101	1	108
		Compressor	CNP 002	1	102
		Water Pump	CNP 281	1	88
		Ventilation Fan	CNP 241	1	108
			Total SWL		**121**
B	Site Formation	Rock Drill (Hydraulic)	CNP 182	1	123
		Shotcrete Vehicle	CNP 047	1	109
		Explosive Delivery Vehicle	CNP 141	1	112
		Total SWL			**123**
C	TBM Tunnel Construction	Tunnel Boring Machine	-	1	88
		Conveyor Belt System (thorough the tunnel and at the Outfall for spoil disposal)	CNP 041	1	90
			Total SWL		**92**
D	Concreting Works	Concrete Delivery Truck	CNP 141	1	112
		Pumping Plant	CNP 047	1	109
			Total SWL		**114**
Powered Mechanical Equipment Used for Construction of I-1					
A	General	Mobile Crane	CNP 048	1	112
		Dump Truck	CNP 067	2	112
		Mobile Generator	CNP 101	2	108
		Compressor	CNP 002	2	102
		Water Pump	CNP 281	2	88

	Activities	PME	TM ID Code	Unit	SWL dB(A)
				Total SWL	**118**
B	Site Formation and Excavation	Excavator	CNP 081	2	112
		Dump Truck	CNP 067	1	117
				Total SWL	**119**
C	Concreting	Crane, mobile	CNP 048	1	112
		Concrete Lorry Mixer	CNP 044	1	109
		Compactor, vibratory	CNP 050	1	105
				Total SWL	**114**
D	Piling	Piling, large diameter bored, oscillator	CNP 165	1	115
		Piling, large diameter bored, reverse circulation drill	CNP 166	1	100
				Total SWL	**116**
E	Slope work	Drill, percussive, hand-held (electric)	CNP 064	2	103
		Excavator	CNP 081	2	112
		Roller, vibratory	CNP 186	1	108
				Total SWL	**116**
F	Formwork and Reinforcement	Bar bender and cutter (electric)	CNP 021	2	90
		Generator, standard	CNP 101	1	108
		Crane, mobile	CNP 048	1	112
		Saw, circular, wood	CNP 201	1	108
		Lorry	CNP 141	1	112
				Total SWL	**116**
Powered Mechanical Equipment Used for Construction of I-2					
A	General	Mobile Crane	CNP 048	1	112
		Dump Trucks	CNP 067	2	117
		Mobile generator	CNP 101	2	108
		Compressor	CNP 002	2	102
		Water Pump	CNP 281	2	88
				Total SWL	**121**
B	Site Formation and Excavation	Excavator	CNP 081	2	112
		Dump Trucks	CNP 067	1	117
				Total SWL	**119**
C	Concreting	Crane, mobile	CNP 048	1	112
		Concrete Lorry Mixer	CNP 044	1	109
		Compactor, vibratory	CNP 050	1	105
				Total SWL	**114**
D	Hand Digging for Intake Shaft (for the first 8m below ground)	Breaker, hand-held, mass>35kg	CNP026	1	114
		Excavator/loader, wheeled/tracked	CNP081	1	112
				Total SWL	**116**
E	Drill & Blast for Intake Shaft	Rock Drill (Hydraulic)	CNP 182	1	123
		Shotcrete Vehicle	CNP 047	1	109
		Explosive Delivery Vehicle	CNP 141	1	112
				Total SWL	**123**

	Activities	PME	TM ID Code	Unit	SWL dB(A)
F	Diaphragm walling	Piling, diaphragm wall, bentonite filtering plant	CNP 162	1	105
		Piling, diaphragm wall, hydraulic extractor	CNP 163	1	90
				Total SWL	**105**
G	Formwork and Reinforcement	Bar bender and cutter (electric)	CNP 021	2	90
		Generator, standard	CNP 101	1	108
		Crane, mobile	CNP 048	1	112
		Saw, circular, wood	CNP 201	1	108
		Lorry	CNP 141	1	112
				Total SWL	**116**
Powered Mechanical Equipment Used for Construction of I-3					
A	General	Mobile Crane	CNP 048	1	112
		Dump Trucks	CNP 067	2	117
		Mobile Generator	CNP 101	2	108
		Compressor	CNP 002	2	102
		Water Pump	CNP 281	2	88
				Total SWL	**121**
B	Site Formation and Excavation	Excavator	CNP 081	2	112
		Dump Trucks	CNP 067	1	117
				Total SWL	**119**
C	Concreting	Crane, mobile	CNP 048	1	112
		Concrete Lorry Mixer	CNP 044	1	109
		Compactor, vibratory	CNP 050	1	105
				Total SWL	**114**
D	Drill & Blast for Intake Shaft	Rock Drill (Hydraulic)	CNP 182	1	123
		Shotcrete Vehicle	CNP 047	1	109
		Explosive Delivery Vehicle	CNP 141	1	112
				Total SWL	**123**
E	Diaphragm walling	Piling, diaphragm wall, bentonite filtering plant	CNP 162	1	105
		Piling, diaphragm wall, hydraulic extractor	CNP 163	1	90
				Total SWL	**105**
F	Slope work	Drill, percussive, hand-held (electric)	CNP 064	2	103
		Excavator	CNP 081	2	112
		Roller, vibratory	CNP 186	1	108
				Total SWL	**116**
G	Formwork and Reinforcement	Bar bender and cutter (electric)	CNP 021	2	90
		Generator, standard	CNP 101	1	108
		Crane, mobile	CNP 048	1	112
		Saw, circular, wood	CNP 201	1	108
		Lorry	CNP 141	1	112
				Total SWL	**116**
Powered Mechanical Equipment Used for Construction of O-1					
A	General	Mobile Crane	CNP 048	1	112
		Dump Trucks	CNP 067	2	117
		Mobile Generator	CNP 101	2	108

	Activities	PME	TM ID Code	Unit	SWL dB(A)
		Compressor	CNP 002	2	102
		Water Pump	CNP 281	2	88
				Total SWL	**121**
B	Site Formation and Excavation	Excavator	CNP 081	2	112
		Dump Truck	CNP 067	1	117
				Total SWL	**119**
C	Concreting	Crane, mobile	CNP 048	1	112
		Concrete Lorry Mixer	CNP 044	1	109
		Compactor, vibratory	CNP 050	1	105
		Explosive Delivery Vehicle	CNP 141	1	112
				Total SWL	**116**
D	Piling	Piling, large diameter bored, oscillator	CNP 165	2	115
		Piling, large diameter bored, reverse circulation drill	CNP 166	1	100
				Total SWL	**118**
E	Slope work	Drill, percussive, hand-held (electric)	CNP 064	2	103
		Excavator	CNP 081	2	112
		Roller, vibratory	CNP 186	1	108
				Total SWL	**116**
F	Formwork and Reinforcement	Bar bender and cutter (electric)	CNP 021	2	90
		Generator, standard	CNP 101	1	108
		Crane, mobile	CNP 048	1	112
		Saw, circular, wood	CNP 201	1	108
		Lorry	CNP 141	1	112
				Total SWL	**116**
G	Rap-rip	Derrick barge	CNP 061	1	104
		Dump Truck	CNP 067	1	117
				Total SWL	**117**

Prediction of Impacts

The predicted noise impacts are shown in **Table 4.5** (no mitigation measures), **Table 4.6** (mitigation measures - quiet plant), and **Table 4.7** (mitigation measures - noise barrier), the detailed calculations are shown in **Appendix D** which gives the construction activities involved at each intake and outfall location. Typically, the activities required for the construction of I-2 and I-3 included drill and blast shaft construction, hand dug method (for I-2 only), site formation and excavation, slope work and concreting. For I-1 and O-1, all aforesaid construction activities are required except hand digging and drill and blast shaft construction. Based on the construction programme of Tsuen Wan Drainage Tunnel given as Appendix A, there is a potential interfacing project named the Construction and Improvement of Tuen Mun Road. In order to predict the noise level in worse case scenario, the cumulative effect of construction activities at outfall location of Tsuen Wan Drainage Tunnel and at Yau Kom Tau section of Tuen Mun Road are assumed to be undertaken concurrently and shown in **Table 4.5** below.

Table 4.5 Cumulative Noise Impacts (No mitigation Measures) - ($L_{eq,\ 30min}$ dB(A))

NSR No.	Location	Description	Noise Criteria	Noise Impacts from the Project /dB(A)[(1)]
NSR1	**Intake 1**	Sik Sik Yuen Ho Fung College	70	**79**
NSR2		Kwai Shue House	75	75
NSR3	**Intake 2**	Hong Hoi Chee Hong Temple	75	**91**
NSR4		Yuen Yuen Care and Attention Home for the Aged	75	**84**
NSR5		Western Monastery	75	**82**
NSR6	**Intake 3**	Squatters	75	**85**
NSR7		Route Twisk Villa	75	74
NSR8	**Outfall 1**	Beach Tower (Long Beach Gardens)	75	**82**
NSR9		Greenview Terrace (Block 1)	75	**84**

Notes: Bold figures indicates that the noise criteria is exceeded.
The noise assessment is based on the construction stage with the highest total SWL.

Evaluation of Impacts

Table 4.5 shows that the cumulative construction noise impact of unmitigated construction activities associated with construction of tunnel, intakes and outfall together with the potential interfacing project would cause exceedence of daytime construction noise criterion at majority of the NSRs, up to 91dB(A) at NSR3, Hong Hoi Chee Hong Temple located close to the proposed intake I-2 location. Mitigation measures are therefore required for these NSRs in order to alleviate the noise impacts generated from the construction works.

1st Level of Mitigation Measures

Table 4.6 Cumulative Noise Impacts (Mitigation Measures – Quiet Plant)

NSR No.	Location	Description	Noise Criteria	Noise Impacts from the Project /dB(A)[(1)]
NSR1	**Intake 1**	Sik Sik Yuen Ho Fung College	70	75
NSR2		Kwai Shue House	75	72
NSR3	**Intake 2**	Hong Hoi Chee Hong Temple	75	**91**
NSR4		Yuen Yuen Care and Attention Home for the Aged	75	**83**
NSR5		Western Monastery	75	**81**
NSR6	**Intake 3**	Squatters	75	**84**
NSR7		Route Twisk Villa	75	74
NSR8	**Outfall 1**	Beach Tower (Long Beach Gardens)	75	**81**
NSR9		Greenview Terrace (Block 1)	75	**83**

Notes: Bold figures indicates that the noise criteria is exceeded.
The noise assessment is based on the construction stage with the highest total SWL.

With the use of quiet plant, the cumulative noise impact would still exceed the daytime noise criterion (i.e. 75dB(A) for residential use and 70dB(A) for institutional use) by up to 16dB(A) and 5dB(A) respectively as shown in **Table 4.6**. Due to the close proximity to the construction works, the Hong Hoi Tsz Chee Hong Temple (NSR3) would be adversely affected and the predicted noise levels would exceed the daytime noise criterion (i.e. 75dB(A) for residential) by 16dB(A) and the Sik Sik Yuen Ho Fung College (NSR1) would exceed the criterion (i.e. 70dB(A) for schools) by 5dB(A). Details of the calculation are provided in **Table D-3** and **D-4** of **Appendix D**. Additional mitigation measures are therefore required to further reduce noise to acceptable levels.

2nd Level of Mitigation Measures

Table 4.7 Cumulative Noise Impacts (Mitigation Measures – Noise Barrier)

NSR No.	Location	Description	Noise Criteria	Noise Impacts from the Project /dB(A)(1)
NSR1	**Intake 1**	Sik Sik Yuen Ho Fung College	70	70
NSR2		Kwai Shue House	75	66
NSR3	**Intake 2**	Hong Hoi Chee Hong Temple	75	75
NSR4		Yuen Yuen Care and Attention Home for the Aged	75	68
NSR5		Western Monastery	75	66
NSR6	**Intake 3**	Squatters	75	74
NSR7		Route Twisk Villa	75	74
NSR8	**Outfall 1**	Beach Tower (Long Beach Gardens)	75	74
NSR9		Greenview Terrace (Block 1)	75	75

Notes: Bold figures indicates that the noise criteria is exceeded.
The noise assessment is based on the construction stage with the highest total SWL.

In addition to the above mitigation measures, a temporary vertical barrier[1] which would provide sufficient screening effect ranged from 5 to 10 dB(A) reduction is proposed to be erected at the tunnel portal area (i.e. Outfall 1) and intake locations (i.e. intakes 1, 2 and 3) in order to alleviate the construction noise impact by blocking the line of view from the nearby receivers. Indicative locations and details of the barrier are demonstrated on **Figure 4.6**. Especially for the construction of vertical shaft at Intake I-2, as the first 8m of the shaft will be carried out by hand dug method, using vertical noise barrier will be able to reduce the noise level to within acceptable level. When the shaft excavation reaches 8m below ground, rock drilling will be required. However, the shielding effect offered by the shaft above could achieve further 5 to 10 dB(A) reduction. A total of 15 dB(A) noise reduction for Rock Drill could be achieved. In addition, all the equipment operating in the intake shafts at I-2 and I-3 will be screened by a movable cover on top of the shaft during construction.

[1] Noise barriers should be located as close as possible to either the noise source or receiver. Gaps and openings at joints in the barrier material should be avoided where possible. Barrier material of surface mass in excess of 7 kg/m^2 is desirable to achieve the maximum screening effect. The length of a barrier should generally be at least five times greater than its height and the minimum height of a barrier should be such that no part of the noise source will be visible from the noise sensitive receiver being protected.

Table 4.7 demonstrated that with incorporation of quiet plant and the use of movable barrier, the cumulative noise impact at all NSRs would comply with the daytime construction noise criterion. Details of the calculation are provided in **Table D-5** and **D-6** of **Appendix D**.

Ground-borne Noise and Vibration

Both TBM and Drill and Blast activities will be used to excavate rock. The interaction between the operation of equipment and the rock will induce ground borne noise and vibration (to varying extent depending on the geological conditions and equipment used). A preliminary assessment was carried out and presented in the following paragraphs.

Preliminary Blasting Assessment

As explained in Section 4.5.1, drill and blast (D&B) techniques are considered more feasible and thus envisaged for the rock excavations for the shaft constructions of Intakes I-2, and I-3. A separate Blasting Assessment Report will be produced in accordance with Practice Note for Authorized Persons (PNAP) 178 and submitted to Building Department in early 2005 for approval (not part of the EIA submission). **Figure 4.5** is produced to highlight the locations of the proposed blasting, the nearest noise sensitive receivers, and the anticipated dominant vibration constraints. Discussions on each intake shafts are provided below.

Intake I-2

The noise sensitive receiver identified in the proximity is the Hong Hoi Chee Hong Temple 5m from the shaft. Preliminary assessment indicates the use of explosives could be constrained by the temple itself as well as the CLP electric cable running along the Lo Wai Road. Blasting would be carried out above 100mPD or 8m below ground. The maximum charge weight is expected to be less than 0.4 kg/delay.

Intake I-3

The noise sensitive receiver identified in the proximity is the squatters 50m south. Preliminary assessment indicates the use of explosives could be constrained by an existing registered feature (cut slope) immediate east of the shaft and the above mentioned squatters. The maximum charge weight is expected to be less than 0.4 kg/delay.

For the Yau Kom Tau water treatment work, the preliminary assessment indicates that the vibration level at this receiver would be 1.5mm/s which will below the PPV limit of water retaining structure (i.e. 13mm/s).

Duration of Blasting Works

As mentioned earlier, blasting is only required at intake structure I2 and I3 during daytime and the realistic duration for blasting is around 4 months for each intake. Apart from the short duration of blasting with a frequency of only once a day, the time for blasting will be scheduled during non sensitive hours. The opening of the shaft will also be covered up during the operation on site to further mitigate the noise level to adjacent SRs. The findings indicate that the impact would be minimal.

Preliminary TBM Assessment

As TBM would be used for tunnel excavation, the preliminary noise assessment due to the operation of TBM was conducted and the discussions on each intakes are provided below. Similar to the drill and blast, the contract will require the D & C contractor to carry out a detailed assessment to ascertain the possible noise impact on properties adjacent to the rock sections of tunnelling.

Intake I-1 and Outfall

The noise sensitive receivers identified in the proximity at Intake I-1 and Outfall are Ho Fung College and Greenview Terrace respectively. Preliminary assessment indicates that the noise level at those receivers would be ranged from 24 dB(A) to 36 dB(A) which complied with the noise criteria during non-restricted period (i.e. 1900 to 0700). The detailed calculation is shown in Appendix D.

Intake I-2 and I-3

The noise sensitive receiver identified in the proximity at Intake I-2 and I-3 are Hong Hoi Chee Hong Temple and Squatters respectively. Preliminary assessment indicates that the noise level at this receiver would be approximately 42 dB(A) and 45 dB(A) which exceeded the noise criteria by 7 dB(A) and 10 dB(A) during restricted period (i.e. 2300 to 0700). Hence, it is recommended to restrict the TBM operation in non-restricted period (i.e. 0700 to 1900) for tunnel section from chainage 1295m to 1449m near the temple and for tunnel section from chainage 3143m to 3308m near the squatters. The detailed calculation is shown in Appendix D

Duration of TBM Works

The assessment as shown in this section previously carried out only indicates marginal/non-compliance with the night-time criteria at 2300 – 0700 so it is suggested that at these locations the TBM would only operate between 7 a.m. and 7 p.m. and this could still achieve the overall project completion programme.

Referring to the foregoing section, the impacts due to ground borne noise and vibration were assessed throughout the tunnelling operation. The results revealed that the levels were well below normal human perception levels. To conclude, the transmission of structure borne noise due to the TBM and Drill and Blast operation is unlikely to cause impacts to the nearby residents or worshippers at the temple.

4.5.2 Operation

Identification of Potential Impacts

Maintenance may include the use of vehicles to remove debris from inside the tunnel and general maintenance surrounding the intake and outlet structures such as ensuring access is not encroached by vegetation, desilting of boulder/sand traps at intakes and outfall and repairing concrete surface. Details of the plant inventory for maintenance are listed as follows:

Activity	Plant
General	Lorry
	Ventilation fan
	Loader
Desilting	Excavator
	Grab
	Water Jet
Concrete repairing	Concrete chipper
	Concrete pump
	Compactor/vibratory

The main noise will come from the cascade at the outfall structure. The tunnel will only be in operation when rainfall intensities exceed 30m/hr. Under such conditions, the noise of the rainfall itself in the vicinity of the noise sensitive receiver is expected to exceed those from the cascade. However, as mentioned, the event would only occur in very short duration under rare occasion.

Also, the outfall structure is in the form of cascade at which the level difference between tunnel portal and sea level is divided by 18 steps. The level drop at each stop is only about 1.8m. It implied that the noise level due to outfall structure in the form of cascade would be lowered due to the energy dissipation being spread out. The noise level at receiver would be further masked by the noise from major road traffic in the vicinity such as Tuen Mun Road and Castle Peak Road i.e. 60 to 70 dB(A).

Consequently, outfall noise is belonging to the categories of ‘white noise’, which is a combination of all of the different frequencies of sound, that aids sleeping, relaxation and provides sound masking for distracting unwanted noise.

Hence, based on the above-mentioned points, it can be concluded that the noise impact from outfall would be insignificant.

Evaluation of Impacts

Noise levels during maintenance activities are anticipated to be acceptable as the impacts are likely to be very short in duration (two times per year), will be conducted during normal working hours and will not require the simultaneous use of a number of PME.

4.6 Mitigation of Impacts

4.6.1 During Construction

Appropriate mitigation measures such as the use of quiet equipment and movable barriers will be developed to ensure that noise can be reduced to acceptable levels without causing programme delays.

Good Site Practice

Good site practice and noise management can significantly reduce the impact of construction site activities on nearby NSRs. The following package of measures should be followed during construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works;
- machines and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- plant known to emit noise strongly in one direction, should, where possible, be orientated to direct noise away from the NSRs;
- mobile plant should be sited as far away from NSRs as possible; and
- material stockpiles and other structures should be effectively utilised, where practicable, to screen noise from on-site construction activities.

For Drill and Blast Works

- Charge mass per delay should be decreased by minimising the number of blastholes firing on each delay.
- Smaller blasthole patterns and longer delays should be used between dependent charges
- Times of blasting should be established to suit the situation and firing blasts when neighbours are busy with their daily tasks (and at a regular time such as lunch time).

For TBM Tunnelling

- For the tunnel excavation, it is anticipated that beyond the initial length (say within 30m), excavation will be carried out well within the tunnel and door should be provided to further minimize the noise nuisance to the nearby receivers.

4.6.2 During Operation

Good site practice and noise management can significantly reduce the impact of maintenance activities on nearby NSRs. The following package of measures should be followed during construction:

- only well-maintained plant should be operated on-site;
- machines and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum; and
- plant known to emit noise strongly in one direction, should, where possible, be orientated to direct noise away from the NSRs.

4.7 Residual Impacts

No residual impacts are predicted for the construction or operation of the Project.

4.8 Environmental Monitoring and Audit

Full compliance with the noise criteria will be achieved at all NSRs with the implementation of mitigation measures. Environmental monitoring and audit is recommended to ensure that the noise levels do not exceed the criteria during the construction phase as discussed in the EM&A Manual.

4.9 Conclusion

The construction of the Project may lead to noise generation if noise mitigation measures are not undertaken. It is predicted that various construction activities associated with the earthworks, excavation and construction may cause temporary impacts without mitigation. "Best practice measures", Quiet plant and mobile noise barriers are recommended to suppress noise emissions from construction activities where noise exceedance is anticipated.

4.10 References

1) Noise Control Ordinance.

2) Professional Persons Environmental Consultative Committee (ProPECC) (1993) Practice Note 2/93 *Noise from Construction Activities – Non-statutory Controls.*

3) Planning Department (2003) Hong Kong Planning Standards and Guidelines.

4) Environmental Protection Department (Updated 2003) Guidelines On Design of Noise Barriers.

5) http://www.epd.gov.hk/epd/textonly/english/environmentinhk/noise/guide_ref/design_barriers_content1.html

6) Technical Memorandum on Environmental Impact Assessment Process.

7) Technical Memorandum on Noise from Construction Work other than Percussive Piling.

8) U.K. Li, S.Y. Ng, Prediction of blast vibration and current Practice of measurement in Hong Kong. Geotechnical Engineering Office, Hong Kong Government

9) Australian Standards Association, Australian Standard AS2187.2 Part 2, 1993

10) Hiller, D.M. & Bowers K.H. Groundborne vibration from mechanized tunnelling works. Transport Research Laboratory, Berkshire, United Kingdom.

11) U.S. Department of Transportation "High-Speed Ground Transportation Noise and Vibration Impact Assessment", 1998

12) U.S. Department of Transportation, "Transit Noise and Vibration Impact Assessment", 1995

13) Transportation Noise Reference Book