

5 NOISE IMPACT

5.1 Introduction

5.1.1 Potential noise impacts during the construction and operational phases of the Project have been evaluated and mitigation measures have been recommended where necessary and appropriate in this section.

5.2 Description of the Environment

5.2.1 The land use in the Study Area is mainly residential, with existing low-rise villages such as Lung Wo Tsuen and Tan Shan Tsuen and planned housing developments within the Anderson Road Quarry Main Site. The existing noise climate is dominated by road traffic noise from Clear Water Bay Road.

5.3 Construction Programme

5.3.1 The construction works for cavern are expected to commence in early 2018 and be completed by early 2020 for operation.

5.4 Noise Sensitive Receivers

5.4.1 A mixture of existing residential buildings, future residential buildings, schools, commercial and industrial premises are located within the Study Area, namely the area that extends a distance of 300m from the works boundary of the Project. Representative noise sensitive receivers (NSRs) located in the Study Area have been identified.

5.4.2 With reference to the latest Outline Zoning Plans (OZP), Tseng Lan Shue Outline Zoning Plan (No. S/SK-TLS/8) dated March 2006 and Kwun Tong North OZP (Plan No. S/K14N/13) dated September 2010, existing and planned NSRs including domestic premises and educational institutions within the Study Area are identified following the requirement of Annex 13 to the EIAO-TM.

5.4.3 For the purpose of the noise assessment, a number of representative assessment points are selected which are considered to be potentially worst-affected NSRs. The NSRs for noise assessments are summarised in **Table 5.1** and their locations are illustrated in **Figure 5.1**. Photographs of all the identified existing NSRs are provided in **Appendix 5.1**.

Table 5.1 Representative NSRs for Noise Impact Assessment within the Study Area

Noise Sensitive Receivers (NSR)	Existing / Planned Land Use	Description	Approx. Setback Distance (m)
<i>Construction Phase</i> ^[1]			
NLWT-01 ^[2]	Existing Residential	Lung Wo Tsuen	>200
CYCS-01 ^[2]	Existing Residential	Chi Yum Ching She	>200
TSV-01 ^[2]	Existing Residential	Tan Shan Tsuen	>250
<i>Operational Phase</i> ^[2]			
R2-1-R006 ^[1]	Planned Residential	Private Housing, ARQ Site R2-1	80
R2-2-R013 ^[1]	Planned Residential	Private Housing, ARQ Site R2-2	195

Notes:

[1] Based on the approved Schedule 3 EIA Report for Development of Anderson Road Quarry (and subsequent review exercise), the intake year for NSRs ARQ R2-1 and R2-2 would be in the time frame of Year 2026, whereas the construction of rock cavern would be completed by 2020. There is no overlap between the occupation of NSRs ARQ R2-1 and R2-2 and the construction works.

[2] For the operational fixed plant noise assessment, the selected assessment points are ARQ Private Housing Sites (ID: R2-1-R006 and R2-2-R013). These two NSRs would be closest to the rock cavern development for the

operational phase assessment. Other existing NSRs (ID: NLWT-01, CYCS-01 and TSV-01) are much further away and completely shielded by the hill in between. NSR ID: R2-1-R006 and R2-2-R013 at Private Housing Site would experience the worst impacts from the fixed noise sources, and therefore the recommended noise mitigation measures for fixed noise sources should be formulated (by backward calculation) based on these selected assessment points at ARQ Private Housing Site.

5.5 Potential Sources of Impact

Construction Phase

Construction Noise during Non-restricted Hours

- 5.5.1 The potential sources of noise impacts during the construction phase of the Project would mainly be the use of Powered Mechanical Equipment (PME) for various construction activities. Major construction works would include site clearance, portal slopes excavation and stabilisation works, cavern excavation and temporary installation, permanent cavern (and adits) lining construction. The construction programme is shown in **Table 5.2**.

Table 5.2 Construction Programme for Cavern Development

Works Activity for Museum Cavern Development	Anticipated Start	Anticipated End
Mobilization and Site Clearance	Jan-2018	Mar-2018
Slopes Excavation and Stabilisation	Apr-2018	Jul-2018
Cavern Excavation	Aug-2018	May-2019
Permanent Cavern and Adits Lining Works	Jun-2019	Oct-2019
Landscaping & Finishing Works	Nov-2019	Jan-2020

Construction Noise during Restricted Hours

- 5.5.2 Based on the currently envisaged construction programme, no construction works during restricted hours will be required under normal circumstances.

Cumulative Construction Noise Impacts from Other Concurrent Projects

- 5.5.3 Some concurrent construction works/projects within the Study Area may have an interface with the Project. These are listed below and their locations are illustrated in **Appendix 5.2**:
- Site Formation and Engineering Infrastructure Works at Main Site of Anderson Road Quarry Main Site - Phase 2 area (Worksites S11a, S11b, S12a, S12b, S12c, S13a, S13b & S13c);
 - Construction of Drainage Retention Tank (Worksite S21b);
 - Construction of Viewing Platform (Worksite S26c); and
 - Foundation and Superstructure Works of Service Reservoirs and Pumping Station (Worksites S31a & S31b).
- 5.5.4 As the worksite of the road improvement works at the junction of Clear Water Bay Road and On Sau Road (Item 5 of the road improvement works described in Section 2.3.2) is located outside the Study Area of the Project, it is not included as a concurrent noise source for the construction phase assessment.

Operational Phase

- 5.5.5 The potential operational noise impact is associated with the fixed plant noise sources such as the ventilation shaft proposed at the cavern museum development.

5.6 Environmental Legislation, Standards and Guidelines

General

- 5.6.1 Noise impacts were assessed in accordance with the relevant criteria stipulated in the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM).

Construction Phase

- 5.6.2 As indicated in Section 5.5.2, no construction works will be required during restricted hours. On this basis, the criteria stipulated in Table 1B of Annex 5 to the EIAO-TM, namely $L_{eq(30 \text{ minutes})}$ 75 dB(A) at the façades of dwellings and 70 dB(A) at the façades of schools (65 dB(A) during examinations), are applicable to the assessment of construction noise impacts.

Operational Phase - Fixed Plant Noise

- 5.6.3 The criterion for fixed plant noise is stipulated in Table 1A of Annex 5 to the EIAO-TM, which in turn makes reference to Table 3 of the Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places or Construction Sites (IND-TM) issued under the NCO. The applicable noise criterion for a particular NSR, which varies with respect to the Area Sensitive Rating (ASR) of that NSR and the time of the day, is 5 dB(A) below the Acceptable Noise Level (ANL - 5 dB(A)), as presented in **Table 5.3**, or the prevailing background noise level, whichever is lower. For the assessment of impacts from fixed noise sources in this EIA, the ASR is determined based on the best available information at this stage of the Project. Nothing in this assessment would bind the Noise Control Authority in the context of law enforcement against any fixed sources being assessed.

Table 5.3 Fixed Plant Noise Criteria/ Design Target

Time Period	Fixed Plant Noise for Different Area Sensitivity Rating, (Leq 30 min, dB(A))					
	ANL, dB(A)			ANL-5, dB(A) [see Note]		
	ASR A	ASR B	ASR C	ASR A	ASR B	ASR C
Day (0700 to 1900 hrs)	60	65	70	55	60	65
Evening (1900 to 2300 hrs)	60	65	70	55	60	65
Night (2300 to 0700 hrs)	50	55	60	45	50	55

Note:

The ultimate noise criterion should be 5dB(A) below the Acceptable Noise Level (ANL-5dB(A)) or the prevailing background noise level, whichever is lower.

5.7 Identification of Environmental Impacts

Construction Phase

- 5.7.1 The primary source of potential noise impact from the construction works is the use of powered mechanical equipment on site. The construction activities would involve excavation and associated works which have the potential to pose adverse noise impacts to the surrounding NSRs.
- 5.7.2 As the major construction activity would be mechanical excavation, it would not cause adverse structure-borne noise. The nearest NSRs at ARQ Site R2-1 and Site R2-2 are also located at more than 200m from the cavern site on the other side of the hill and adverse structure-borne impacts are considered extremely unlikely with such a large setback distance.

Operational Phase

- 5.7.3 Fixed plant noise from the ventilation shafts of the cavern would be the major source of noise impacts, if any, during the operational phase.

5.8 Assessment Methodologies

Construction Phase

- 5.8.1 A construction plant inventory is first developed based on the engineering design and construction programme. Construction noise impacts on the representative NSRs within the Study Area are assessed in accordance with the methodology stipulated in Annex 13 to the EIAO-TM.
- 5.8.2 The procedures for the construction noise assessment are summarized as follows:
- Locate the NSRs which would most likely be affected by noise from the construction work;
 - Determine the items of PME for each discrete construction activity, based on available information or agreed plant inventories;
 - Assign sound power levels (SWLs) to the proposed PME ;
 - Calculate distance attenuation to NSRs from notional noise source;
 - Apply corrections in the calculations such as potential screening effects and acoustic reflection, if any;
 - Predict construction noise levels at NSRs in the absence of any mitigation measures;
 - Consider cumulative impact from other concurrent works/projects, if any, within the Study Area; and
 - Compare the cumulative noise level against the noise criterion and propose suitable mitigation measures.
- 5.8.3 For the SWLs of PME, reference is made to Table 3 of the Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM). Groups of PME have been assigned for the various activities anticipated for the construction of the Project. The proposed plant inventory for the construction of the Project has been provided by the Preliminary Design Consultants of the Project Proponent. According to Section 4.2 in the EIAO Guidance Note No. 9/2010 "*Preparation of Construction Noise Impact Assessment Under the EIAO*" (GN 9/2010), reduction of percentage on-time is not a viable mitigation measures for PME and it should never be considered as a direct way to mitigate construction noise impacts after the assessment found exceedance in the unmitigated construction noise levels. Nonetheless, the application of percentage on-time is still considered reasonable to reflect the actual situation for some PME which only stays on for a short period in 30 minutes, for example, concrete lorry mixer in the case of concreting and dump truck in the case of disposal of excavated materials from roadside, and therefore has been used as the basic assumption for those specific types of PME in the assessment. The feasibility, practicability and reasonableness for the proposed plant inventory and associated plant utilisation rates adopted for the assessment have been confirmed by the Project Engineer responsible for the design and supervision of construction works of the Project.

Operational Phase - Fixed Plant Noise

- 5.8.4 Representative NSRs within the Study Area are identified for the assessment. For this assessment, standard acoustic principles are applied.
- 5.8.5 As noise specifications of the proposed fixed plant in this Project are not available for the EIA Study, the maximum permissible sound power levels of fixed plant (Max. SWLs) are determined for future detailed engineering design to ensure compliance with the relevant noise criteria. Cumulative impacts from potential concurrent fixed noise sources such as the

pumping station located within the Study Area are considered with reference to the approved EIA report for Development of Anderson Road Quarry (EIAO Register No.: AEIAR-183/2014).

5.8.6 The following formula is used for calculating the Max. SWL:

$$\text{SPL} = \text{Max. SWL} - \text{DC} + \text{FC} + \text{TC}^1 - \text{BC}$$

where

SPL	Sound Pressure Level, in dB(A)
Max. SWL	Maximum Permissible Sound Power Level, in dB(A)
DC	Distance Attenuation, in dB(A) (i.e. $20 \log D + 8$ [where D is the distance in metres])
FC	Facade Correction, in dB(A) (i.e. 3 dB(A))
TC	Tonal Correction, in dB(A)
BC	Barrier Correction, in dB(A)

5.8.7 It is assumed that all the fixed plant noise sources would be operated at the same time with no noise barrier screening correction for a conservative assessment of the worst-case scenario.

5.8.8 The fixed noise sources associated with the Project should be free of the characteristics of tonality, impulsiveness and intermittency. If any tonality, intermittency or impulsiveness characteristics are identified during the detailed design or the commissioning of the plant, the Max SWL should be reduced in accordance with the applicable correction factors, in the range of 3 to 6 dB(A), as prescribed in Section 3.3 of the IND-TM.

5.9 Prediction and Evaluation of Environmental Impacts

Construction Phase

5.9.1 The plant inventory and associated utilisation rates in **Appendix 5.2**, which have been reviewed and confirmed by the Project Engineer responsible for the design and supervision of construction works of the Project, are adopted for the construction noise assessment. The following key features have been considered during the design of the Project to alleviate the construction noise impacts as far as practicable:

- Minimisation of the number of PME to be deployed; and
- Grouping of PME adopted for the same construction activities, where practicable, in order to reduce the construction noise emission due to concurrent use of PME.

5.9.2 The unmitigated noise levels at representative NSRs are predicted and presented in **Table 5.4** based on the construction programme and plant inventory in **Appendix 5.2**. Locations of notional sources and distance to NSRs are also shown in **Appendix 5.2**. The percentage on-time for the PME has been reviewed and confirmed by the Project Engineer responsible for the design and supervision of construction works of the Project to be reasonable.

¹ In determination of maximum permissible sound power levels, same approach for tonal correction is adopted from Appendix 5.13 of the approved Schedule 3 EIA Report for Development of Anderson Road Quarry (EIAO Register No.: AEIAR-183/2014).

Table 5.4 Cumulative Unmitigated Construction Noise Levels (Non-restricted Hour)

NSR ID	Description	Predicted Unmitigated Construction Noise Levels, dB(A)	EIAO-TM Noise Criteria, dB(A)	Exceedance of EIAO-TM Noise Criteria? (Y/N)
TSV-01	Tan Shan Tsuen	61 – 70	75	N
NLWT-01	Lung Wo Tsuen	62 – 71	75	N
CYCS-01	Chi Yum Ching She	63 – 72	75	N

5.9.3 The predicted noise levels at the representative NSRs range from 61 to 72 dB(A). No exceedances are predicted at the NSRs and no specific construction noise mitigation measures will be required. Nonetheless, to minimize noise impacts on the surrounding environment, the future contractors are recommended to follow the noise control requirements set out under the "Recommended Pollution Control Clauses for Construction Contracts" published by the Environmental Protection Department (EPD).

Operational Phase – Fixed Plant Noise

5.9.4 The location of fixed plant noise sources and NSRs are shown in **Appendix 5.3**. The worst-affected NSRs are identified to be planned private housings at Site R2-1 and Site R2-2 at the Anderson Road Quarry Main Site. Representative assessment points at Site R2-1 (NSR ID R2-1-R006) and Site R2-2 (NSR ID R2-2-R013), which are about 80m and 195m respectively from the Project works boundary, are selected and depicted in **Appendix 5.3**.

5.9.5 As the fixed plant noise criteria at the selected assessment points depend on the prevailing noise level, prevailing noise measurement results in the approved EIA report for Development of Anderson Road Quarry (EIAO Register No.: AEIAR-183/2014) are adopted in the determination of the noise criteria as detailed in **Appendix 5.3**. The Max. SWLs for the ventilation shaft, derived based on the methodology described in Section 5.8, for Day/Evening time (0700 to 2300 hours) and Night time (2300 to 0700 hours) are presented in **Table 5.5**.

Table 5.5 Fixed Plant Noise Design Criteria for Ventilation shaft

Time Period	Maximum Permissible Sound Power Level ($L_{eq, 30min}$, dB(A)) ^[a] ^[b] ^[c]
	Exhaust at the Ventilation Shaft
Day and Evening (0700 to 2300 hours)	93
Night (2300 to 0700 hours)	86

Notes:

[a] The maximum permissible SWLs were obtained based on an assumed tonal correction factor of 3dB(A). The tonal correction factor to be adopted for the actual equipment should be determined according to Section 5.8.8 and 5.9.6.

[b] If any tonality, intermittency or impulsiveness characteristics are identified for the fixed plant during its detailed design or commissioning, the noise design limit should be reduced to cater for these corrections in accordance with the IND-TM.

[c] Maximum Allowable SWL (Day and Evening / Night) of Ventilation Shaft of Proposed Rock Cavern at +200mPD be subject to change pending confirmation of exact location of the Ventilation Shaft in the detailed engineering design.

5.9.6 In addition, the equipment should be free of the characteristics of tonality, impulsiveness and intermittency. If any tonality, impulsiveness and intermittency characteristics are identified for the equipment during the detailed design or the commissioning, the Max SWL should be reduced to cater for the relevant correction factors as prescribed in Section 3.3 of IND-TM.

- 5.9.7 If there is any change in engineering design information during the detailed design stage or the fitting-out stage, the fixed plant noise design should also be reviewed by engineer/contractor to ensure that both the relevant noise criteria can still be met at the NSRs.

5.10 Recommended Mitigation Measures

Construction Phase

- 5.10.1 The construction noise assessment indicates that there would be no exceedance of the construction noise criteria at the representative NSRs even without any mitigation measures. Notwithstanding the above, the future contractors should follow the requirements set out in the "Recommended Environmental Pollution Control Clauses" published by EPD and adopt good site practice outlined below to minimise construction noise impacts on the surrounding environment.

Good Site Practice

- 5.10.2 Good site practices are easy to implement and do not impact upon the works schedule. The site practices listed below should be followed during the construction of the Project:
- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction phase;
 - Silencers or mufflers on construction equipment should be utilized and should be properly maintained during the construction phase;
 - Mobile plant, if any, should be sited as far from NSRs as possible;
 - Machines and plant (such as trucks) 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, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and
 - Material stockpiles and other structures should be effectively utilized, wherever practicable, in screening noise from on-site construction activities.

Operational Phase – Fixed Plant Noise

- 5.10.3 With the fixed plant properly designed to meet the maximum permissible SWL in **Table 5.5**, no operational phase noise impacts are anticipated. The following noise reduction measures are recommended to be considered as far as practicable during the detailed design and procurement stages:
- Choose quieter plant;
 - Include noise levels specification when ordering new electro-mechanical equipment for the ventilation system;
 - Locate fixed plant/louvres away from any NSRs as far as practicable;
 - Locate fixed plant in walled plant rooms or in specially designed enclosures;
 - Locate noisy machines in a basement or a completely separate building;
 - Install direct noise mitigation measures including silencers, acoustic louvres and acoustic enclosure where necessary; and
 - Develop and implement a regularly scheduled plant maintenance programme so that equipment is properly operated and serviced in order to maintain controlled level of noise. The programme should be implemented by properly trained personnel.

5.11 Evaluation of Residual Environmental Impacts

- 5.11.1 The assessment has not found any excessive residual noise impacts for both the construction and operational phases of the Project.

5.12 EM&A Requirements

Construction Phase

- 5.12.1 As the Project would not result in any adverse construction noise impacts, construction phase noise monitoring is considered not necessary.

Operational Phase

- 5.12.2 Prior to the operational phase of the Project, a commissioning test for ventilation shaft should be conducted to ensure compliance with the relevant noise criteria.

5.13 Conclusion

Construction Phase

- 5.13.1 Noise impacts arising from the construction activities of the Project have been assessed for NSRs in the Study Area. Cumulative unmitigated construction noise levels at the representative NSRs are predicted to be in the range of 61 to 72 dB(A), which comply with the construction noise criterion of 75 dB(A). No adverse construction noise impact is therefore anticipated.
- 5.13.2 To minimise noise impacts on the surrounding environment, the future contractors are recommended to follow the noise control requirements set out under the "Recommended Pollution Control Clauses for Construction Contracts" published by EPD.

Operational Phase

- 5.13.3 The maximum permissible SWLs for the ventilation shaft of the cavern have been derived as noise design target. With the selection of suitable plant equipment and adoption of appropriate acoustic treatment in accordance with the design target SWL, the NSRs would not be adversely affected by the noise generated from the operation of the ventilation shaft.
- 5.13.4 If there is any change in engineering design information during detailed design stage or fitting-out stage, the fixed plant design should be reviewed by engineer/contractor to ensure that the noise criteria should still be met at the NSRs.