

CIVIL ENGINEERING DEPARTMENT

Agreement No. CE 67/2001 (GE)
Landslide Mitigation Works against Natural Terrain Hazards
in Tung Wan and Shatin Heights
Design and Construction
(Tung Wan Landslide Mitigation Works)

PROJECT PROFILE

January 2003

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1 BASIC INFORMATION

Project Title

- 1.1 Agreement No. CE 67/2001 (GE) Landslide Mitigation Works against Natural Terrain Hazards in Tung Wan and Shatin Heights – Design and Construction, Tung Wan Landslide Mitigation Works.

Purpose and Nature of the Project

- 1.2 The objective of this Project is to design and supervise the construction of landslide hazard mitigation works at two sites, one at Tung Wan on Lantau Island, and the other at Shatin Heights in Shatin, where natural terrain landslides pose a major hazard to the occupants at the toe of the natural hillsides.
- 1.3 The proposed landslide mitigation works at Tung Wan fall within the Boundary of Lantau South Country Park (Figure 1.1), and as such should be regarded as a Designated Project (Section 1.8 refers). This report will therefore focus on the scope of environmental issues associated with proposed works at Tung Wan. Proposed works at Shatin Heights will not be addressed in this report.
- 1.4 For the Tung Wan Site, a natural terrain hazard study carried out by Geotechnical Engineering Office (GEO) of the Civil Engineering Department (CED) concluded that the natural hillside above Tung Wan Hostel and the Mok Law Shui Wah School is susceptible to landslides, which could threaten the Hostel and School. Mitigation measures are proposed under the Landslip Preventative Measures (LPM) Programme to protect the occupants at the School and Hostel.

Name of Project Proponent

- 1.5 The Project Proponent is the Planning Division of the Geotechnical Engineering Office, Civil Engineering Department, Government of the Hong Kong Special Administrative Region (HKSAR).

Location and Scale of Project and History of Site

- 1.6 Two natural terrain landslides (GEO incident numbers MW 1999/8/211 and MW 1999/9/3) occurred on government land above Tung Wan Hostel and Mok Law Shui Wah School, Tung Wan, Lantau in August 1999 (Figure 1.1). The first landslide was channelised and deposited debris in a drainage channel between the School and Hostel. The second was an open hillslope failure that deposited debris 6m from the crest of the cut slope behind the Hostel. Following a preliminary assessment carried out by GEO in January 2000, a detailed natural terrain hazard study was carried out in 2001, which concluded that the Hostel and the School are potentially at risk from natural terrain landslides and recommended that mitigation measures should be implemented in the interest of public safety. A subsequent review of

these reports carried out by the Consultant Maunsell Geotechnical Services Ltd. (MGSL) reached the same conclusion.

- 1.7 Proposed landslide mitigation measures would be carried out at two locations, to protect the existing developments at the toe of the hillside (Figures 1.2A & 1.2B). The proposed schemes can be summarised as follows:

Mitigation Works for the Natural Drainage Channel

- A 70° cut slope would be formed to create a platform at the toe of the hillside. Approximately 90 no. of soil nails would be used to stabilise the slope.
- A debris barrier consisting of a concrete check dam (approximately 6.5m high x 17m wide x 25m long) would be constructed on the platform.
- A 2.5m wide maintenance access path would be constructed from the existing road to the check dam. Path construction would necessitate cutting back small areas of the existing slope to a maximum of 40°. Along the access path, the cut slopes would be small, not exceeding 3m in height. Local cut slopes at the entrance of the maintenance access path would be slightly higher (over 3m in height).
- A photograph of an existing check dam with similar design is presented in Figure 1.3.

Mitigation Works for Open Hillside

- Approximately 230 no. of soil nails (32mm diameter steel bars in 100mm diameter drillholes) would be inserted at the open hillside catchment area in a 2m x 2m grid pattern to stabilise the hillside.
- A 4m high flexible boulder fence would be installed to trap loose debris falling down the hillside.
- Two drainage channels (225mm and 375mm wide) would be constructed at the toe of the hillside.
- A photograph of an existing boulder fence of similar design is presented in Figure 1.3.

Operation phase activities would be limited to routine maintenance of landslide mitigation measures only (e.g. periodic clearance of accumulated sediments in the check dam).

Number and Types of Designated Projects Covered by the Project Profile

- 1.8 In accordance with Category Q.1 (a) of Part 1, Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO), the proposed landslide mitigation works at Tung Wan fall within the Boundary of Lantau South Country Park, and as such should be regarded as a Designated Project. Therefore an Environmental Permit under the EIA Ordinance must be obtained prior to the commencement of the construction of landslide mitigation measures.

Name and Telephone Number of Contact Person(s)

- 1.9 All queries regarding the project can be addressed to the project proponent (Dr. K.C. Ng/GEO) or their consultants (Dr. G.P.R. Suraj De Silva/MGSL):

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2 OUTLINE OF PLANNING AND IMPLEMENTATION

Responsibilities of Parties

- 2.1 The Agreement was awarded by the Civil Engineering Department (CED) to Maunsell Geotechnical Services Ltd. (MGSL) as the engineering consultant in February 2002. MGSL is responsible for design and supervision of the landslide mitigation works. The proposed works will be implemented by Contractor(s) to be appointed by the Project Proponent at a subsequent stage.

Tentative Project Timetable

- 2.2 The contract for the landslide mitigation works is scheduled for tendering in March 2003 and is likely to commence in May 2003 with a duration of 14 months. The preliminary works timetable for the Project is summarised in Table 2.1 below.

Table 2.1 Preliminary schedule of works

Item	2003								2004					
	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Hoarding erection, site clearance & temporary access road formation	■	■												
Soil nail installation		■	■	■	■	■	■	■						
Check dam construction		■	■	■	■	■	■	■	■	■	■	■	■	
Access path formation												■	■	■

Interactions with Other Projects

- 2.3 There are no known interactions with other definitive projects on-going during the same period which need to be considered.

3 POSSIBLE IMPACT ON THE ENVIRONMENT

General

- 3.1 The potential environmental impacts of the landslide mitigation measures at Tung Wan are reviewed in this section.

Construction Phase

Air Quality

- 3.2 Potential construction phase air quality impacts pertinent to the Project would include dust nuisance and gaseous emissions from the construction plant and vehicles. Fugitive dust emissions arising from material handling, site excavation, drilling operation, truck movement and wind erosion would be the main sources of air pollution.
- 3.3 Given that the number of plant to be used on site would be limited and the work site area would be small, adverse dust impacts during construction at the identified Air Sensitive Receivers (ASRs: Table 4.2 and Figure 4.1 refer) would not be anticipated with the incorporation of mitigation measures stipulated in the Air Pollution Control (Construction Dust) Regulation. Vehicle and plant exhaust emissions from the site would not be considered to constitute a significant source of air pollution.

Noise

- 3.4 Noise impact arising from the construction phase of the Project would be associated with the use of powered mechanical equipment (PME) for construction works. The proposed PME to be used for various construction tasks are given in Appendix 3.1.
- 3.5 According to the construction programme for this Project, the construction is scheduled to commence in May 2003, and for completion in June 2004. The following construction tasks will be undertaken for the Project:
1. Hoarding Erection, Site Clearance & Temporary Access Road Formation;
 2. Soil Nail/Boulder Fence Installation;
 3. Check Dam Construction; and
 4. Access Path Formation.
- 3.6 Due to the close proximity of Noise Sensitive Receivers (NSRs Table 4.3 and Figure 4.2 refer) to the proposed work sites, adverse construction noise impacts would be anticipated if no mitigation measures are in place.
- 3.7 As broadly illustrated in the construction programme (Section 2 refers), some construction activities would be carried out concurrently during a particular period. Cumulative noise impacts arising from different construction activities on the representative NSRs were predicted in accordance with the assessment methodology as described in the Technical

Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM). The assessment results are presented in Appendix 3.2.

- 3.8 As indicated in Appendix 3.2, the cumulative noise levels at the representative NSRs were predicted to range from 80dB(A) to 94dB(A). The cumulative noise levels at all of the NSRs are predicted to exceed the noise criteria of 75 dB(A) for residential uses and 70 dB(A) for schools during normal hours throughout the construction period. Mitigation measures would therefore be required to alleviate the construction noise impacts, as presented in Section 5.

Water Quality

- 3.9 Water-bodies potentially affected by the proposed works include a small seasonal stream running through the works area (Figure 4.3), and coastal waters in Tung Wan Bay (Figure 1.1). During the construction phase, runoff and drainage from construction sites would be the main sources of potential water quality impacts to the nearby water bodies. Site runoff and drainage may contain increased loads of suspended solids and contaminants and may enter the adjacent coastal waters via associated drainage systems if uncontrolled. Sewage arising from the on-site construction workforce would also have the potential to cause water pollution if it is discharged directly into adjacent waters without any appropriate treatment.

Waste

- 3.10 Waste generated from the construction activities of the proposed works would mainly comprise excavated materials and construction materials. It is estimated that approximately 2500 m³ excavated materials and 1500 m³ construction materials would be generated. Provided that these wastes are handled, transported and disposed of using approved methods and that the recommended control measures in Section 5 are adhered to, no adverse environmental impacts and nuisance are expected.

Ecology

- 3.11 The proposed works would result in direct disturbance to small areas of grassland/shrubland mosaic, tall shrubland/plantation and seasonal stream course. Although the works area falls partly within the Lantau South Country Park Boundary, ecological surveys and assessment of the study area revealed that the affected habitats are of low ecological value. Furthermore, the proposed works would affect no flora/fauna of conservation interest (Sections 4.6-4.20 refer). Construction phase activities are therefore anticipated to result in minor and acceptable direct ecological impacts (Tables 3.1 and 3.2 refer).
- 3.12 Potential indirect impacts to the works area and adjacent habitats/wildlife would result from construction phase activities and increased human activity during the construction phase, such as trampling of habitats/vegetation, littering, human waste discharge and fires.
- 3.13 Such impacts would be temporary in nature and only affect low value ecological habitats and common and widespread species. Provided the mitigation measures presented in Section 5 are implemented, indirect ecological impacts are expected to be minimal.

Table 3.1 Overall Impact Evaluation to Grassland/Shrubland Mosaic and Tall Shrub/Plantation

Evaluation Criteria	Grassland/Shrubland Mosaic	Tall Shrub/Plantation
Habitat quality	The habitat quality is low.	The habitat quality is low.
Species	No rare or protected species would be impacted.	No rare or protected species would be impacted.
Size/Abundance	Approximately 0.4ha of habitat would be directly impacted by soil nail installation (0.3ha) and access path/check dam construction (0.1ha).	Approximately 0.1ha of habitat would be directly impacted by soil nail installation (0.03ha) and access path/check dam construction (0.07ha).
Duration	Loss of 0.1ha habitat through access path/check dam construction would be permanent. 0.3ha habitat expected to regenerate naturally after soil nail installation.	Loss of 0.07ha habitat through access path/Check dam construction would be permanent. 0.03ha habitat expected to regenerate naturally after soil nail installation.
Reversibility	Loss of habitat through access path/check dam construction would be permanent.	Loss of habitat through access path/check dam construction would be permanent.
Magnitude	The scale of the impacts is considered low.	The scale of the impacts is considered low.
Overall impact conclusion	Low.	Low.

Table 3.2 Overall Impact Evaluation to Seasonal Stream

Evaluation Criteria	Seasonal Stream
Habitat quality	The habitat quality is low.
Species	No rare or protected species would be impacted.
Size/Abundance	Approximately 34m of habitat would be directly impacted by check dam construction.
Duration	Loss of habitat through check dam construction would be permanent.
Reversibility	Loss of habitat through check dam construction would be permanent.
Magnitude	The scale of the impacts is considered low.
Overall impact conclusion	Low.

Cultural Heritage

- 3.14 The proposed landslide mitigation works area is situated on a steep hillside of low archeological potential. The Tung Wan Archaeological Site is located to the west of and outside the landslide mitigation works area. No direct or indirect impact to the Tung Wan Archaeological Site would be expected given the small scale of the landslide mitigation works, and provided that mitigation measures as presented in Section 5 are implemented.

Landscape and Visual Impact

Landscape Impact

- 3.15 The sources of construction phase landscape impacts would include:
- the construction works of the check dam and the access path;
 - the construction works of soil nails/boulder fence installation;
 - designation of temporary site areas for storage, plant cabins and associated site equipment;
 - temporary construction arrangements that affect access to adjacent areas; and
 - the construction works that affect the landscape quality of the adjacent natural slope.
- 3.16 The landscape impacts in the construction phase would include impacts upon landscape resources and landscape character. The impacts include:
- Negative impact upon the existing landscape character of the study area due to the construction of the check dam and the access path;
 - Negative impact upon the existing landscape character of the study area due to the construction and installation of soil nails;
 - Negative impact upon the existing landscape resources due to the loss of existing vegetation, although it is anticipated no mature trees would be felled as a result of the proposed works;
 - Negative impacts upon the existing landscape character of the country trail on Shek Mun Shan during the construction phase; and
 - Negative impacts upon the hill slope north of Mok Law Shui Wah School and Tung Wan Hostel, and Red Cross Shek Pik Youth Camp due to the construction phase activities within the study area.
- 3.17 Potential landscape impacts resulting from construction phase activities are summarised in Table 3.3.

Visual Impact

- 3.18 The potential visual impacts would be loss of views of the existing green slope within the study area. The primary sources of visual impacts during the construction phase would include the following:
- the construction works of the check dam and the access path;
 - the construction works of soil nail/boulder fence installation;
 - construction traffic; and
 - temporary site access areas, site cabins and heavy machinery.

- 3.19 Visual impacts during the construction phase are assessed and would include the following:
- views of the construction works of the check dam and installation works of soil nails;
 - loss of views to green backdrop from Visual Sensitive Receivers (VSRs: Table 3.4 and Figure 4.5 refer) located in the study area;
 - scaffolding and emergent structures; and
 - increased construction vehicular/pedestrian traffic in the vicinity of the study area.
- 3.20 It is considered that VSRs located close to the construction works will receive the most substantial negative visual impacts. On this basis, VSRs in the following developments would be most affected during the check dam and access path construction programme:
- Students and Staff of Mok Law Shui Wah School and Tung Wan Hostel;
 - Visitors and workers in the Red Cross Shek Pik Youth Camp; and
 - Visitors on the country trail at Shek Mun Shan.
- 3.21 Minor negative visual impact would be felt by VSRs located in the following locations:
- Passenger on ferries travelling to/from Chung Hau to Central;
 - Visitors on pleasure craft within Tai Long Wan and Tung Wan;
 - Workers and residents in Shek Pik Prison;
 - Workers and residents in Sha Tsui Detention Centre;
 - Visitors to Shek Pik Reservoir Commemorative Garden; and
 - Residents in Tai Long Wan Tsuen.
- 3.22 Potential visual impacts resulting from construction phase activities are summarised in Table 3.4.

Operation Phase

Air Quality

- 3.23 No adverse air quality impact would be expected during the operation phase.

Noise

- 3.24 There would be no adverse noise impact arising from the Project.

Water Quality

- 3.25 No adverse water quality impact is expected during the operation phase.

Waste

- 3.26 No adverse impact is expected during the operation phase.

Ecology

3.27 No adverse ecological impact is expected during the operation phase.

Cultural Heritage

3.28 No adverse cultural heritage impact is expected during the operation phase.

Landscape and Visual Impact

Landscape Impact

3.29 The sources of operation phase landscape impacts would be limited to the existence of the check dam, maintenance access path and boulder fence.

3.30 The landscape impacts in the operation phase would include impacts upon landscape resources and landscape character. The impacts include:

- Negative impact upon the existing landscape character of the study area due to the existence of the check dam, maintenance access path and boulder fence;
- Negative impact upon the existing landscape resources due to the loss of existing vegetation, although it is anticipated no mature trees would be felled as a result of the proposed works; and
- Negative impacts upon the existing landscape character of the country trail on Shek Mun Shan during the operation phase.

3.31 Provided mitigation measures proposed in Section 5 are implemented, landscape impacts resulting from the project are anticipated to be minor and acceptable.

3.32 Potential operation phase landscape impacts are summarised in Table 3.3.

Visual Impact

3.33 The potential visual impacts would be loss of views of the existing green slope within the study area. The primary sources of visual impacts during the operation phase would include the following:

- the existence of the check dam and the maintenance access path; and
- the existence of boulder fence.

3.34 Visual impacts during the operation phase are assessed and would include the following:

- views of the check dam, maintenance access path and boulder fence; and
- loss of views to green backdrop from Visual Sensitive Receivers (VSRs: Table 3.4 and Figure 4.5 refer) located in the study area;

- 3.35 Due to the nature and setting of the proposed project, visual impacts associated with the existence of the new check dam, maintenance access path and boulder fence would tend to be negative. However, there would only be limited glimpse views of the new check dam, boulder fence and maintenance access path for students and staff at the Tung Wan Hostel and Mok Law Shui Wah School; and for visitors and workers of Red Cross Shek Pik Youth Camp due to existing surrounding dense vegetation. Therefore, resulting negative visual impacts would be negligible to slight.
- 3.36 Due to the existing surrounding topography and distance from the proposed project, negligible to very slight negative impact would be felt by VSRs located in the following locations:
- Passenger on ferries travelling to/from Chung Hau to Central;
 - Visitors on pleasure craft within Tai Long Wan and Tung Wan;
 - Workers and residents in Shek Pik Prison;
 - Workers and residents in Sha Tsui Detention Centre;
 - Visitors to Shek Pik Reservoir Commemorative Garden; and
 - Residents in Tai Long Wan Tsuen.
- 3.37 Provided mitigation measures proposed in Section 5 are implemented, visual impacts resulting from the project are anticipated to be minor and acceptable.
- 3.38 Potential operation phase visual impacts are summarised in Table 3.4.

Table 3.3 Summary of Construction and Operation Phase Potential Landscape Impacts

Landscape Character Zone	Source of Impact	Magnitude of Change		Landscape Sensitivity	Impact Characteristic during Construction Phase after Implementation of Mitigation Measures	Impact Characteristic during Operation Phase after Implementation of Mitigation Measures
		Construction Phase	Operation Phase			
Red Cross Shek Pik Youth Camp in Tung Wan	Check dam and access path	Moderate	Low	Medium	Moderate Negative	Moderate to slight Negative
Country Trail on Shek Mun Shan	Check dam and access path	Moderate	Low	Medium	Moderate Negative	Moderate to slight Negative
Shek Pik Prison	Check dam and access path	Low	Low	Low	Slight to very Slight Negative	Slight to very Slight Negative
Hill slope north of Mok Law Shui Wah School and Tung Wan Hostel	Check dam and access path	High	Low	High	Very substantial to substantial negative	Moderate to Slight Negative

Table 3.4 Summary of Construction and Operation Phase Visual Impacts

Key Visually Sensitive Receivers (VSRs)	Distance between VSR and Study Area	Magnitude of Change	Receiver Sensitivity	Impact Characteristic during Construction Phase after Implementation of Mitigation Measures	Impact Characteristic during Operation Phase after Implementation of Mitigation Measures
Red Cross Shek Pik Youth Camp	170m	Medium- Low	High	High to Moderate Negative	Slight to Negligible Negative
Mok Law Shui Wah School and Tung Wan Hostel	20m	High-Medium	High	High to Moderate Negative	Slight to Negligible Negative
Country Trail at Shek Mun Shan	250m	High-Medium	High	High to Moderate Negative	Moderate to Negligible Negative
Ferry Passengers to/from Chung Hau	700m	Low- Negligible	Medium	Slight to Negligible	Negligible
Shek Pik Prison	800m	Low- Negligible	Medium	Slight to Negligible	Negligible
Sha Tsui Detention Centre	1000m	Low- Negligible	Medium	Slight to Negligible	Negligible
Shek Pik Reservoir Commemorative Garden	1500m	Low- Negligible	High	Slight to Negligible	Negligible
Tai Long Wan Tsuen	2000m	Low- Negligible	High	Slight to Negligible	Negligible

4 MAJOR ELEMENTS OF THE SURROUNDING ENVIRONMENT

Air Quality

- 4.1 There would be no major source of air pollution identified in the vicinity of the Tung Wan Landslide Mitigation Works area apart from the limited local traffic along Lantau Trail located to the west of the site. In the absence of in-situ monitoring data, the annual average concentrations of pollutants measured at EPD's nearest monitoring station (Tung Chung) would be used as a reference to provide information on the background air pollutant levels. Table 4.1 summarizes the annual average concentrations of the pollutants as reported in the "Air Quality in Hong Kong, 2000" published by EPD.

Table 4.1 Air Pollutant Levels Recorded at EPD's Air Quality Monitoring Stations (Tung Chung)

Pollutants	Annual Average Concentrations ($\mu\text{g}/\text{m}^3$)
TSP	71
NO ₂	45
RSP	45

- 4.2 In accordance with the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM), representative air sensitive receivers (ASRs) were identified close to the site, as presented in Table 4.2 (for locations, refer to Figure 4.1).

Table 4.2 Representative Air Sensitive Receivers (ASRs)

Sensitive Receiver	Description	Nearest Distance between ASR and site boundary (m)
A1	Tung Wan Hostel - Quarters	20
A2	Tung Wan Hostel - Quarters	27
A3	Tung Wan Hostel - Office	20
A4	Tung Wan Mok Law Shui Wah School – Classroom	10
A5	Hong Kong Red Cross Camp	170

Noise

- 4.3 The study area is generally rural in nature, and comprises mainly a school, its staff quarters and student hostel. No major noise emission source was found in the vicinity. The ambient noise level is expected to be low to moderate, and primarily affected by noise due to human activities.
- 4.4 Noise sensitive receivers (NSRs) were identified with reference to the EIAO-TM. Table 4.3 presents a brief description of the representative NSRs (for locations, refer to Figure 4.2).

Table 4.3 Description of Representative Noise Sensitive Receivers (NSRs)

Sensitive Receiver	Description	Nearest Distance between NSR and Site Boundary (m)	EIAO-TM Construction Noise Criteria, dB(A)
N1	Tung Wan Hostel – Quarters	20	75
N2	Tung Wan Hostel – Quarters	27	75
N3	Tung Wan Hostel – Office	20	75
N4	Tung Wan Mok Law Shui Wah School – Classroom	10	70 (normal period) 65 (examination period)
N5	Tung Wan Mok Law Shui Wah School – Classroom	10	70 (normal period) 65 (examination period)

Water Quality

- 4.5 The site is located at the toe of natural slopes near a small bay on Lantau Island. A small seasonal stream course characterized by a rocky substrate and steep gradient runs through the site (refer to Figure 4.3). The stream discharges into coastal waters around Tung Wan (refer to Figure 1.1).

Ecology

- 4.6 Ecological surveys of the proposed works area and adjacent areas (the Study Area) were conducted on 3rd April, 2nd July and 19th November 2002. The surveys consisted of the following aspects:

Habitat/Vegetation Surveys

- 4.7 Habitat types, along with dominant and notable plant species, relative abundance and growth forms of plants were recorded.

Avifaunal Surveys

- 4.8 Avifaunal surveys were conducted using a direct count method to record birds sighted or heard calling.

General Wildlife Surveys

- 4.9 General wildlife including herpetofauna, mammals and terrestrial insects (Odonates and Lepidoptera) was surveyed by direct sighting. Active searching in potential habitats of reptiles and amphibians was undertaken. Signs of terrestrial mammals (i.e., droppings, footprints and burrows) were searched for. A night survey was conducted on 19th November to search for nocturnal fauna, particularly bats.

Habitat/Vegetation

- 4.10 Part of the site falls within the boundary of Lantau South Country Park (CP). Natural areas of woodland exist within the CP, principally on the lower slopes of Lantau and Sunset Peaks (both areas were designated as "Special Areas" in January 1980). Extensive afforestation work has been carried out in many places and plantations have been established mainly in Chi Ma Wan and around the water catchment areas of Shek Pik Reservoir. Scrub and coarse grassland cover much of Lantau Island, the latter being predominant on the higher areas exposed to strong winds. On the more sheltered lower slopes, and in stream valleys, the surface lends itself more to scrub growth.
- 4.11 The habitats found in the Study Area are of low quality and consisted of a small seasonal stream, shrubland/grassland mosaic, and a mix of tall shrub and landscaped tree planting at the bottom of the slope. No mature or *Fung Shui* woodland was observed. A habitat map of the study area is given in Figure 4.3. Representative photographs of habitats are presented in Appendix 4.1
- 4.12 Aquatic habitats within the Study Area were limited to a seasonal stream course located within the channelised catchment area. The stream course was dry a few days after heavy rains and characterized by a rocky substrate and steep gradient. It is a temporary and fast flowing stream offering an extremely limited habitat for aquatic organisms. No aquatic flora and fauna was found in the stream during the study.
- 4.13 At the lower slope of the open hillside area immediately above the Tung Wan Hostel and Mok Law Shui Wah School, a series of shotcrete slopes planted with occasional trees was found. Above this is a band about 5m thick of tall shrub supporting common tree/shrub species *Rhodomlytrus tomentosa*, *Mallotus paniculatus* and *Pinus elliottii*.
- 4.14 The habitat of the upper slope is mainly grassland/low shrub mosaic of approximately 1m height dominated by the common *Dicranopteris linearis*, *Baeckea frutescens*, and *Rhus sp.* Part of the upper slope subjected to previous landslide has been shotcreted.
- 4.15 In total, 50 plant species were recorded in the Study Area (Appendix 4.2). No species of conservation interest were recorded, with most species being common and widespread in Hong Kong.

4.16 The ecological value of habitats in the Study Area is summarised in Tables 4.4 and 4.5 below:

Table 4.4 Ecological Value of Shrubland/Grassland Mosaic, and Tall Shrub /Plantation

Criteria	Shrubland/Grassland Mosaic	Tall Shrub/Plantation
Naturalness	Shrubland is maintained by frequent hillfires, and is therefore secondary in nature.	Many mature trees are exotic, planted species, therefore naturalness is low.
Size	Small.	Small.
Diversity	Low.	Low.
Rarity	No rare or protected species recorded.	No rare or protected species recorded.
Recreatability	Shrubland regenerates quickly and naturally, therefore recreatability is high.	Plantation is man-made, therefore recreatability is high.
Fragmentation	The habitats are not fragmented.	The habitats are not fragmented.
Ecological linkage	The habitat falls within the boundary of Lantau South Country Park.	The habitat is adjacent to the boundary of Lantau South Country Park.
Potential value	The potential value is low.	The potential value is low.
Nursery ground	No record of significant nursery or breeding ground was found in the survey.	No record of significant nursery or breeding grounds was found in the survey.
Age	The habitat is frequently disturbed, and therefore secondary in nature.	Mature trees in the plantation are probably 25-35yrs old.
Abundance/ Richness of Wildlife	Low.	Low.
Ecological value	Low.	Low.

Table 4.5 Ecological Value of Seasonal Stream

Criteria	Temporary Stream
Naturalness	The stream is largely natural.
Size	Small.
Diversity	Low. As the stream is temporary, it provides a poor habitat for aquatic species.
Rarity	No rare or protected species recorded.
Recreatability	Moderate.
Fragmentation	The habitat is not fragmented.
Ecological linkage	The habitat partially falls within the boundary of Lantau South Country Park.
Potential value	The potential value is low.
Nursery ground	No record of significant nursery or breeding ground was found in the survey.
Age	N/A.
Abundance/ Richness of Wildlife	Low.
Ecological value	Low.

Avifauna

4.17 Eleven species of bird were recorded in the Study Area (Appendix 4.3). All species recorded are common and widespread in Hong Kong.

Wildlife

- 4.18 Nine species of butterfly, and three species of odonate were recorded in the Study Area (Appendix 4.3). All the recorded terrestrial insects are common and widespread in Hong Kong.
- 4.19 Two species of amphibian (Ornate Pigmy Frog, *Microhyla ornata*, and Asian Common Toad, *Bufo melanostictus*) were observed during the survey. They are common and widespread in Hong Kong. Two common and widespread species of reptile were identified: Long Tailed Skink, *Mabuya longicaudata*; and Changeable Lizard, *Calotes versicolor*. One mammal, a single Japanese Pipistrelle (*Pipistrellus abramus*), was observed hawking insects close to the proposed works area. All mammals are protected under Hong Kong Law, although *P. abramus* is common and widespread in Hong Kong (refer to Appendix 4.3 for a summary of herpetofauna/mammals).
- 4.20 Aquatic communities were not encountered due to the absence of suitable habitats in the Study Area.

Cultural Heritage

- 4.21 Figure 4.4 shows the location of the Tung Wan Archaeological Sites to the west of the project area. Evidence of prehistoric occupation was found in the first excavation launched in 1937. The area was then occupied, on and off, for dredging related to Shek Pik Reservoir, construction of staff quarters and playground for over 30 years. Subsequent excavations conducted in late 1970s and 1980s, further discovered the presence of kiln remains, stone tools and clay debris dated from 2000-3000 B.C. (Middle Neolithic Period) to Tang Dynasty.

Landscape and Visual Impact

- 4.22 Landscape and visual sensitive receivers in the vicinity of the works area are summarised in Table 4.6 below.

Table 4.6 Landscape and Visual Impact Sensitive Receivers

Sensitive Receiver	Distance from Site Boundary
<i>Landscape</i>	
Red Cross Shek Pik Youth Camp in Tung Wan	170m
Country Trail on Shek Mun Shan	250m
Shek Pik Prison	800m
Hill slope north of Tung Wan Hostel and Mok Law Shui Wah School	0m
<i>Visual</i>	
Red Cross Shek Pik Youth Camp	170m
Mok Law Shui Wah School and Tung Wan Hostel	20m
Country Trail at Shek Mun Shan	250m
Ferry Passengers to/from Chung Hau	700m
Shek Pik Prison	800m
Sha Tsui Detention Centre	1000m
Shek Pik Reservoir Commemorative Garden	1500m
Tai Long Wan Tsuen	2000m

5 ENVIRONMENTAL PROTECTION MEASURES TO BE INCORPORATED IN THE DESIGN AND ANY FURTHER ENVIRONMENTAL IMPLICATIONS

Air Quality Impact

5.1 Dust mitigation measures stipulated in the Air Pollution Control (Construction Dust) Regulation will be implemented to control fugitive dust emission from the Site during construction phase. Relevant control measures are listed below:

- Use of regular watering to reduce dust emissions from exposed site surfaces and unpaved road, with complete coverage, particularly during dry weather;
- Use of frequent watering for particularly dusty static construction areas and areas close to air sensitive receivers;
- Tarpaulin covering of all dusty vehicle loads transported to, from and between site location;
- Establishment and use of vehicle wheel and body washing facilities at the exit points of the site; and
- Where feasible, routing of vehicles and positioning of construction plant should be at the maximum possible distance from air sensitive receivers.

5.2 With the above measures in place, the dust impacts arising from the construction of the Project would be minimized to an acceptable level.

Noise Impact

Good Site Practice

5.3 The following good site practices should be followed during construction:

- Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction program;
- Silencers or mufflers on construction equipment should be utilised and should be properly maintained during the construction program;
- Mobile plant, if any, should be sited as far away 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 utilised, wherever practicable, in screening noise from on-site construction activities.

Adoption of Quiet Powered Mechanical Equipment (PME)

5.4 In order to reduce the excessive noise impacts at the affected NSRs, quiet PME should be adopted, as detailed in Appendix 5.1 (or other type of quiet PMEs with the same total Sound Power Level (SWL)).

- 5.5 With the use of quiet PME, a noise reduction of up to 11dB(A) could be achieved. The cumulative construction noise levels arising from various construction activities at all of the NSRs would still exceed the noise criteria. Therefore, further noise mitigation measures would be required.

Restriction in Percentage On-time

- 5.6 In combination with the adoption of quiet PME, the total SWLs for various construction activities would be further reduced through restricting the PME percentage on-time. Since the PME would not be fully operated in practice, appropriate on-time percentages were recommended (Appendix 5.1 refers). The reduction in the PME percentage on-time would be considered feasible and practicable in completing the works within the schedule.

Use of Temporary Noise Barrier

- 5.7 In addition, a 3m high temporary noise barrier made of 18mm plywood is recommended to be erected along the southern work site boundary during the construction phase (Figure 4.2 refers). Taking into account the topography of the terrain of the Site, the line of sight of NSRs to most of the work sites, including Areas A, B and D for soil nail installation, sites for check dam construction and access path formation, would be fully blocked. It is anticipated that noise reduction of 10dB(A) could be achieved for cases where all items of PME to be used on the construction site are screened by the proposed barrier.

Residual Noise Impacts

- 5.8 By adopting the above mitigation measures, the cumulative construction noise levels predicted at all NSRs would meet their respective noise criteria, i.e. 75dB(A) for residential premises and offices, and 70dB(A) for schools during normal hours. As indicated in Appendix 5.2, construction noise levels predicted at NSRs N4 and N5 would, however, exceed the noise limit for schools by 4-5dB(A) while examinations are in progress in the months of June, July and December. The exceedances predicted at these two NSRs are mainly due to cumulative noise impact from the check dam construction and soil nail installation. Soil nail installation at Areas C and E would also result in construction noise levels exceeding the noise limit of 65dB(A) for examination hours. In order to minimize the potential noise impacts on the school during the course of examination, the following measures should be adopted wherever possible:

- (1) Construction activities to be undertaken simultaneously should be avoided; and
- (2) Soil nail installation works in Areas C and E should be avoided.

- 5.9 With the above measures adopted during examination hours, construction noise levels predicted at the school would be below 65dB(A). No adverse residual construction noise impacts on the schools would therefore be anticipated.

- 5.10 Monitoring of actual construction noise levels should be undertaken at representative NSRs.

Water Quality Impact

- 5.11 The Contractors should comply with the Water Pollution Control Ordinance (WPCO) and its subsidiary regulation. Relevant control measures are given below.
- 5.12 The Contractors should ensure that all runoffs arising from the work site are properly treated, e.g. by the use of sedimentation tanks or silt traps, and that the discharge standards as stipulated in WPCO are met. Any trade effluent or foul or contaminated or cooling or hot water should not be discharged into any public sewer, stormwater drain, channel, stream course or the sea. If site canteen or toilet facilities are erected, foul water effluent should be directed to a foul sewer or to a sewage treatment and disposal facility.
- 5.13 The Contractor should be responsible for the design, construction, operation and maintenance of all the mitigation measures and practices specified in the Professional Persons Environmental Consultative Committee Practice Note (ProPECC PN) 1/94 "Construction Site Drainage" issued by the Director of Environmental Protection.

Waste Management Implications

- 5.14 The Contractor should comply with the Waste Disposal (Chemical Waste) (General) Regulation, the Waste Disposal Ordinance and its subsidiary regulations and the Dumping at Sea Ordinance. Relevant control measures are given below.
- 5.15 The Contractor should not permit any sewage, waste water or effluent containing sand, cement, silt or any other suspended or dissolved material to flow from site onto any adjoining land or allow any waste matter which is not part of the final product from waste processing plants to be deposited anywhere within any site or onto any adjoining land.
- 5.16 The Contractor should prepare and implement a Waste Management Plan to reduce, re-use or recycle in order to keep waste arisings to a minimum and to ensure that waste is handled, transported and disposed of in a suitable manner.
- 5.17 The construction waste generated by the Contractor on site should be transported to the designated EPD outlying island transfer facilities in Mui Wo. The Contractor shall use a trip ticket system for the disposal of C&D materials to any designated public filling facility and/or landfill. Independent audits of the Contractor and resident site staff would be carried out to ensure that the correct procedures are being followed at all times.

Ecology

- 5.18 No ecologically significant habitats or species were recorded in the Study Area, and the Project is expected to have minimal ecological impact. Nevertheless, the following measures should be implemented to avoid, minimise and compensate for potential ecological impacts:
- Access road alignment and check dam location have been selected to avoid mature trees. No tree felling is anticipated to result from the proposed works.

- Newly created cut slopes and other disturbed areas would be hydroseeded. Additionally, an estimated 117 no. standard size trees would be planted along the access path and around the check dam (Figure 5.1). Native tree species would be used to attract wildlife.
- Placement of equipment or stockpile in the work areas and access routes should be selected on existing disturbed land where possible to minimise disturbance to vegetation.
- Construction activities should be restricted to work areas that should be clearly demarcated.
- Temporary work areas should be reinstated immediately after completion of the construction work.
- Open fires should be strictly prohibited on the works site.
- Waste generated from the site should be disposed of in a timely and proper manner.
- The Site Engineer should audit the proper implementation of the above mitigation measures.

Cultural Heritage

5.19 The following measures are recommended during the construction phase to avoid and minimise potential impacts on the Tung Wan Archaeological Site:

- Prohibit the access of site workers to the archaeological site.
- Prohibit the storage of construction equipment as well as building material in the archaeological site.
- Prohibit the dumping of waste in the archaeological site.

Landscape and Visual

Landscape Mitigation Measures

5.20 Construction phase landscape mitigation measures should include:

- Minimize contractor's construction access and working area as far as possible.
- Access road alignment and check dam location have been selected to avoid mature trees. No tree felling is anticipated to result from the proposed works.
- Advance planting.
- Conservation of top soil.

- Design of the temporary works areas so as to optimize eventual use and minimize unnecessary disturbance to existing woodland.

5.21 Operation phase landscape mitigation measures should include:

- Provide sensitive treatment and design to the external finish of the proposed built structures such as adopting the use of natural material to reduce the adverse impact on the character of the surround natural setting.
- Provide screen/buffer planting to blend in with the natural surroundings. The planting would include an estimated 117 no. standard size trees along the access path and around the check dam (Figure 5.1).

Visual Impact Mitigation Measures

5.22 Construction phase visual mitigation measures include:

- Sensitivity designed site hoarding to help screen views to the construction works of the access path and check dam; and
- Operation time restrictions to limit after-dark lighting and welding.

5.23 Operation stage visual mitigation measures include:

- Provision of screen/amenity planting alongside the access path and buffer planting to area surrounding the check dam to screen and blend in with the natural surroundings. The planting would include an estimated 117 no. standard size trees along the access path and around the check dam (Figure 5.1). Native tree species would be used to attract wildlife;
- Adopt natural materials and colours for the exterior finishing to blend in with the natural setting;
- Proposed soil nail heads shall be recessed type and covered with planting; and
- Pot-holes would be provided at the base of previous landslide scars. Climbers would be plated in the pot-holes to screen the existing shotcrete cover of the scars.

Severity, Distribution and Duration of Environmental Effects

5.24 No adverse residual environmental impacts are anticipated with the implementation of mitigation measures described in Table 5.1.

Further Implications

5.25 No further environmental implications are anticipated with the implementation of mitigation measures described in Table 5.1.

Table 5.1 Implementation Schedule of Environmental Mitigation Measures and Key EM&A Requirements

Mitigation Measure/EM&A Requirement	Location	Timing	Responsibility	Relevant Legislation and Guidelines
<i>Air Quality</i>				
Implementation of the Air Pollution Control (Construction Dust) Regulation and good site practices: <ul style="list-style-type: none"> • Use of regular watering to reduce dust emissions from exposed site surfaces and unpaved road, with complete coverage, particularly during dry weather; • Use of frequent watering for particularly dusty static construction areas and areas close to air sensitive receivers; • Tarpaulin covering of all dusty vehicle loads transported to, from and between site location; • Establishment and use of vehicle wheel and body washing facilities at the exit points of the site; • Routing of vehicles and positioning of construction plant should be at the maximum possible distance from ASRs. 	Whole site	All periods During Construction Phase	Contractor	Air Pollution Control (Construction Dust) Regulation
<i>Noise</i>				
Good Site Practice <ul style="list-style-type: none"> • Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction program; • Silencers or mufflers on construction equipment should be utilized and should be properly maintained during the construction program; • 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 	Whole site	All periods During Construction Phase	Contractor	EIAO-TM and Noise Control Ordinance

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Mitigation Measure/EM&A Requirement	Location	Timing	Responsibility	Relevant Legislation and Guidelines
<p>should, wherever possible, be orientated so that the noise is directed away from the nearby NSRs; and</p> <ul style="list-style-type: none"> Material stockpiles and other structures should be effectively utilised, wherever practicable, in screening noise from on-site construction activities. 				
Use of quiet PME	Whole site	All periods During Construction Phase	Contractor	EIAO-TM and Noise Control Ordinance
Restriction in PME percentage on-time	Whole site	All periods During Construction Phase	Contractor	EIAO-TM and Noise Control Ordinance
Erection of 3m high noise barrier made of 18mm thick plywood	Along the southern work site boundary (see Figure 4.2)	All periods During Construction Phase	Contractor	EIAO-TM and Noise Control Ordinance
Rescheduling of the soil nail installation at Areas C and E to avoid examination hours.	Areas C & E	When examinations are in progress	Contractor	EIAO-TM and Noise Control Ordinance
Rescheduling of construction activities to avoid simultaneous operation.	Whole site	When examinations are in progress	Contractor	EIAO-TM and Noise Control Ordinance
Monitoring of actual construction noise levels	Representative noise sensitive facade (NSR N4) at Mok Law Shui Wah School	Construction Phase	Contractor	EIAO-TM and Noise Control Ordinance

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Mitigation Measure/EM&A Requirement	Location	Timing	Responsibility	Relevant Legislation and Guidelines
<i>Water Quality</i>				
The Contractors should comply with the Water Pollution Control Ordinance and its subsidiary regulation.	Whole site	All periods During Construction Phase	Contractor	Water Pollution Control Ordinance and its subsidiary regulation.
During the proposed works, the Contractor should contain within the site all surface runoff generated from any works, dust control and vehicle washing etc. Any trade effluent or foul or contaminated or cooling or hot water should not be discharged into any public sewer, stormwater drain, channel, stream course or the sea. If site canteen or toilet facilities are erected, foul water effluent should be directed to a foul sewer or to a sewage treatment and disposal facility.	Whole site	All periods During Construction Phase	Contractor	-
The Contractor should be responsible for the design, construction, operation and maintenance of all the mitigation measures and practices specified in the Professional Persons Environmental Consultative Committee Practice Note (ProPECC PN) 1/94 "Construction Site Drainage" issued by the Director of Environmental Protection.	Whole site	All periods During Construction Phase	Contractor	Professional Persons Environmental Consultative Committee Practice Note (ProPECC PN) 1/94 "Construction Site Drainage"
<i>Waste Management</i>				
The Contractor should comply with the Waste Disposal (Chemical Waste) (General) Regulation, the Waste Disposal Ordinance and its subsidiary regulations and the Dumping at Sea Ordinance.	Whole site	All periods of construction /operation phase	Contractor/ Maintenance party	Waste Disposal (Chemical Waste) (General) Regulation, the Waste Disposal Ordinance and its subsidiary regulations and the Dumping at Sea Ordinance.
No sewage, waste water or effluent containing sand, cement, silt or any other suspended or dissolved material should flow from site onto any adjoining land. No waste matter which is not part of the final product from waste processing plants should be deposited anywhere within any site or onto any adjoining land.	Whole site and adjoining areas	All periods of construction /operation phase	Contractor/ Maintenance party	-

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Mitigation Measure/EM&A Requirement	Location	Timing	Responsibility	Relevant Legislation and Guidelines
A Waste Management Plan should be prepared and implemented to reduce, re-use or recycle in order to keep waste arisings to a minimum and to ensure that waste is handled, transported and disposed of in a suitable manner.	Whole site and adjoining areas	All periods of construction /operation phase	Contractor/ Maintenance party	-
The construction waste generated by the Contractor on site should be transported to the designated EPD outlying island transfer facilities in Mui Wo. The Contractor should use a trip ticket system for the disposal of C&D materials to any designated public filling facility and/or landfill. Independent audits of the Contractor and resident site staff from the consultant to ensure that the correct procedures are being followed at all times.	Whole site	All periods of construction	Independent Auditor/ Contractor	-
<i>Ecology</i>				
Planting of approximately 117no. standard size trees of native species along the access path/check dam.	Access path/ check dam	End of construction phase	Contractor	-
Newly created cut slope and disturbed areas shall be hydroseeded following the completion of the construction phase.	Whole site	End of construction phase	Contractor	-
Placement of equipment or stockpile in the work areas and access routes should be selected on existing disturbed land where possible to minimise disturbance to vegetation.	Whole site	Construction phase	Contractor	-
Construction activities should be restricted to the work areas that should be clearly demarcated.	Whole site	Construction phase	Contractor	-
Temporary work areas should be reinstated immediately after completion of the construction work.	Whole site	End of construction phase	Contractor	-
Open fires should be strictly prohibited on the works site.	Whole site	Construction phase	Contractor	-

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Project Profile for Tung Wan Landslide Mitigation Works

Mitigation Measure/EM&A Requirement	Location	Timing	Responsibility	Relevant Legislation and Guidelines
Waste generated from the site should be disposed of in a timely and proper manner.	Whole site	Construction phase	Contractor	-
The Site Engineer should audit the proper implementation of ecological mitigation measures.	Whole site	Construction phase	Site Engineer	-
<i>Cultural Heritage</i>				
Site workers shall be prohibited from entering the archaeological site.	Archeological site	Construction phase	Contractor	-
No construction equipment or building materials shall be stored in the archaeological site.	Archeological site	Construction phase	Contractor	-
No waste shall be stored or dumped in the archaeological site.	Archeological site	Construction phase	Contractor	-
<i>Landscape and Visual</i>				
Provision of sensitive treatment and design to the external finish of the proposed built structures such as adopting the use of natural material to reduce the adverse impact on the character of the surrounding natural setting.	Check dam and access path	Design phase	Design Consultant	-
Minimizing construction access and working area as far as possible to minimize disturbance to existing vegetation.	Whole site	All periods during construction phase	Contractor	-
Preservation of existing trees where possible.	Whole site	All periods during construction phase	Contractor	HK Government <i>A Guide to Tree Planting and Maintenance in Urban Hong Kong</i> Section 5 Core of Trees on Development Sites and the Country Parks Ordinance
Design of the temporary works areas so as to optimize eventual use and minimize unnecessary disturbance to existing woodland.	Whole site	All periods during construction phase	Contractor	-
Operational time restrictions to limit after-dark lighting and welding.	Whole site	All periods during construction phase	Contractor	-
Planting of approximately 117no. standard size trees of native species along the access path/check dam. Hydro-seeding of cut slopes/disturbed areas.	Whole site	End of construction phase	Contractor	-

6 USE OF PREVIOUSLY APPROVED EIA REPORTS

- 6.1 No previous EIA Reports have been submitted that cover the proposed works area.