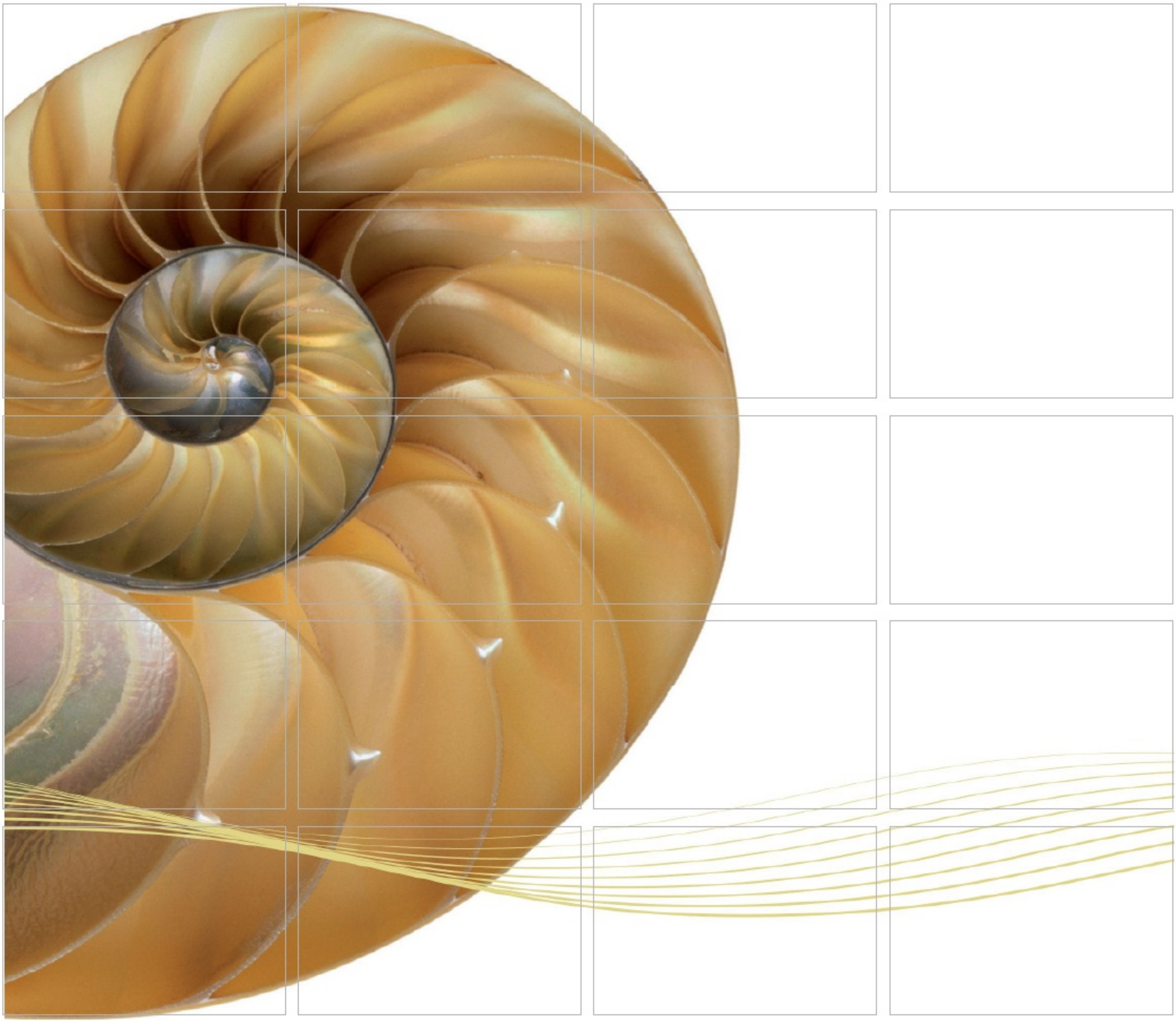

Environmental Consultancy Service for Operation of the Existing Tai Lam Explosives Magazine at Tai Shu Ha, Yuen Long for Liantang/Heung Yuen Wai Boundary Control Point Project

EIA Report

September 2015

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EIA Report

ERM Document Code: 0272671

Client: Dragage Hong Kong Limited		Project No: ***0272671***			
Summary: EIA Report in accordance to requirements of EIA Study Brief ESB-280/2014 and the *Technical Memorandum on Environmental Impact Assessment Process* (*TM-EIAO*).		Date: 18 September 2015 Approved by: *Terence Fong* *Partner*			
0	EIA Report for formal review	FZ	TF	TF	18/09/2015
Revision	Description	By	Checked	Approved	Date

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CONTENTS

ANNEXES

1 *INTRODUCTION*

1.1 *BACKGROUND OF THE PROJECT*

The existing Tai Lam Explosives Magazine (Tai Shu Ha, Yuen Long District, New Territories, Land Allocation GLA-TYL 1288, forthwith known as 'TLEM') has been licensed and is currently in use by the MTR Corporation Limited (MTRC) for the construction of the Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) until end of 2015 (Environmental Permit No. EP-349/2009/L), being used by the MTR XRL 824 Contractor.

This Project is for the continued operation of the existing TLEM at Tai Shu Ha, Yuen Long for the Liantang/Heung Yuen Wai Boundary Control Point (BCP) project (hereafter 'HKLTH') tunnel construction works. The TLEM will be available for use from late 2015 or early 2016 (expected January 2016) to December 2017 and Dragages Hong Kong Limited (DHK), contracted by Civil Engineering and Development Department (CEDD), intends to continue using it for HKLTH.

1.2 *PURPOSE OF THE EIA*

The Project is classified as a Designated Project under Schedule 2, Part I, item K.10 of the *Environmental Impact Assessment ordinance (EIAO)* as "an explosives depot or explosives manufacturing plant in a stand-alone, purpose built building", and art II, Item 11 of the *EIAO* as "decommissioning of an explosives depot".

MTRC will use the TLEM up to end 2015. DHK intends to then continue using it for HKLTH therefore an application for an Environmental Impact Assessment (EIA) Study Brief under *section 5*(1)(a) of the Environmental Impact Assessment Ordinance (EIAO) was submitted on 11 September 2014 with a project profile (No. PP-516/2014) (the Project Profile), to enable the continued operation of TLEM.

This EIA Report presents the results of the EIA study as detailed in the EIA Study Brief ESB-280/2014 and provides information on the nature and extent of any environmental impacts arising from the operation and decommissioning of the Project and any related activities that take place concurrently.

1.3 *SCOPE OF THE EIA*

The EIA study covers the Project and associated works proposed in PP-516/2014 and addresses any likely key issues. This covers:

- the use of the existing TLEM from late 2015 or early 2016 (expected January 2016) to December 2017 with the same operation as current users;

- Explosives transport from the existing TLEM to the three worksites by DHK, using trucks approved by Civil Engineering and Development Department (CEDD)'s Mines Division (Mines); and
- Decommissioning of the existing TLEM after operation.

The approved Hong Kong Section of *Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA Report* (No. AEIAR-143/2009) (hereafter 'XRL EIA') has been reviewed specifically for the environmental impacts arising from operation of the Tai Lam Explosive Magazine (TLEM). The scope of the XRL EIA was far broader than just the TLEM and after review it is considered that as well as the Hazard to Life assessment the various environmental media relevant to the TLEM are Ecology, Airborne Noise, Air Quality and Waste Management and these are elaborated upon further in the remainder of this EIA report. Other media covered in the XRL EIA but considered either of minor importance or not relevant to the current Project, are generally discussed in one collective chapter which includes Water Quality, Landscape and Visual, Cultural Heritage, Fisheries, Ground-borne Noise, Land Contamination, Landfill Gas Hazard and Impacts on the Restored Ngau Tam Mei Landfill.

This EIA study also covers the potential Hazard to Life caused by explosive storage and transport during operation of the Project.

Finally the EIA study also considers cumulative impacts of the Project, through interaction or in combination with other existing, committed and planned projects in the vicinity of the Project.

1.4 REPORT STRUCTURE

The structure of this EIA Report is as follows:

- ***Chapter 1*** presents the introduction to the EIA Study;
- ***Chapter 2*** presents the description of the Project including the alternatives that have been considered for the Project;
- ***Chapter 3*** presents potential ecological impacts arising from the Project;
- ***Chapter 4*** presents potential airborne noise impacts arising from the Project;
- ***Chapter 5*** presents potential air quality impacts arising from the Project;
- ***Chapter 6*** presents potential waste management impacts arising from the Project;
- ***Chapter 7*** discusses other potential environmental impacts arising from the Project such as water quality and landscape and visual resources and justifies why other environmental media considered in the XRL EIA are not necessary for this EIA;

- ***Chapters 8*** presents the findings of the hazard to life study.
- ***Chapters 9*** lists all the environmental monitoring and audit requirements of the Project.
- ***Chapters 10*** summarises the overall outcomes of the EIA report and provides the conclusion.

In addition a number of Annexes provide information supporting the main EIA Report, as detailed in the Table of Contents.

An Executive Summary of the EIA report is also provided separately.

2 PROJECT DESCRIPTION

This chapter of the EIA report presents information on the Project and its alternatives in sufficient detail in order to describe, at a level that can be understood by a lay person, the proposed features and activities of the Project; and facilitate a comprehensive identification of the potential impacts on resources and receptors that could result from Project activities.

There are no known existing, committed and/or planned projects in the vicinity of the Project that could potentially cause cumulative environmental impacts through their interaction with the Project.

2.1 PROJECT ALTERNATIVES

2.1.1 Alternative Site Locations

To enable a timely delivery of explosives to worksites and in order to meet the proposed construction work programme, an Explosives Storage Magazine (Magazine) is required for the Liantang / Heung Yuen Wai Boundary Control Point (BCP) Work which connects the new BCP with Fanling Highway. The purpose of the magazine is to maintain progress rate for construction activities, i.e. to meet multiple blasts per day and also act as a buffer in case of delivery interruptions by Mines from the Geotechnical Engineering Office (GEO), CEDD.

For the XRL EIA, a long list of potential locations for explosives magazine sites were identified, reviewed and short-listed for further detailed study and discussion with Mines. Factors considered included:

- External separation distance - the distance from the explosive stores to inhabited areas and sensitive receivers. The required minimum internal and external separation distances from the magazines should follow the requirements stated in UK *Explosives Regulations 2014* published by the UK Health & Safety Executive, a document as specified by the Hong Kong Commissioner of Mines (CoM). In addition, it is preferable to limit the transportation distances as far as practicable when considering the possible location of magazine. This is particularly pertinent given explosives are not permitted within road tunnels, and there would be a considerable distance of about 40 km to 50 km for explosives transported from northern New Territories to Kowloon via above ground or at grade roads, and vice versa;
- Access for Mines Division explosive delivery vehicles;
- Site constraints such as existing conditions;
- Land availability; and
- Potential environmental and heritage impacts.

The magazine site selection process for the XRL project is documented in *Working Paper No. 13A –Explosives Magazine Site Selection* and two explosives magazine sites were selected as being necessary to store the explosives for the XRL project, one being the TLEM site (and the other at So Kwun Wat).

This TLEM site has been selected for the current Project given: it is already constructed so there are no construction impacts or land conversion issues; it is being used for exactly the required purpose now under EP-349/2009/L which would imply any operational and decommissioning impacts associated with the current Project will be acceptable; it is potentially available from end 2015 which suits the HKLTH project tunnelling schedule; and its location is suitable for the HKLTH project as elaborated upon below. In addition, since there is no requirement to build a new magazine site, the timeline for the tunnel Project may be expedited as well as there being no requirement to build a new magazine site which may cause more significant environmental impacts elsewhere.

Further details of the magazine requirement and selection are presented in *Section 9.4.2* of *Annex 8A*.

2.1.2 *Proposed Explosive Transport Routes Options*

Three possible transport routes that do not pass through tunnels have been identified for this Project, i.e. the proposed explosive transport route options R1, R2 and R3, from the magazine site to the three worksites (i.e. Mid-Ventilation Adit, North Portal and South Portal). *Figure 2.1*, *Figure 2.2* and *Figure 2.3* show plans of the proposed explosive transport route options R1, R2 and R3 respectively and more details of these routes from Tai Lam Explosives Magazine site to the three worksites are provided in *Annex 8A*, *Table 2.9*.

In Route Options R1 and R3, the explosives delivery truck will pass through Pok Oi Interchange and Shap Pat Heung Interchange. During the Fourth Meeting of Traffic and Transport Committee under Yuen Long District Council on 24 July 2014 (Thursday), members expressed concerns on the traffic conditions of Pok Oi Interchange. Currently there is road improvement work which leads to serious traffic jams, thus temporary road diversion and traffic control measures are enforced. The road improvement work is expected to be completed in 2015 but may be delayed due to the flyover foundation. Therefore, members generally did not prefer the use of Pok Oi Interchange by the explosives delivery truck during the road improvement work, and recommended to use Tong Yan San Tsuen Interchange and Yuen Long Road, which is Route Option R2 (see *Annex 10RtC* which provides relevant minutes of the July 2014 District Council Meeting).

The explosives delivery routes will be:

- At early stage of this project, during road improvement work at Pok Oi Interchange (expected to be completed in 2015 but may be delayed), Route Option R2 will be used. Route Options R1 and R3 are not feasible since they both route via Pok Oi Interchange.
- After road improvement work at Pok Oi Interchange is completed, all three routes will be available for use. The Route Option with minimum transport risk will be used.

Figure 2.1 Proposed Explosive Transport Route Option R1

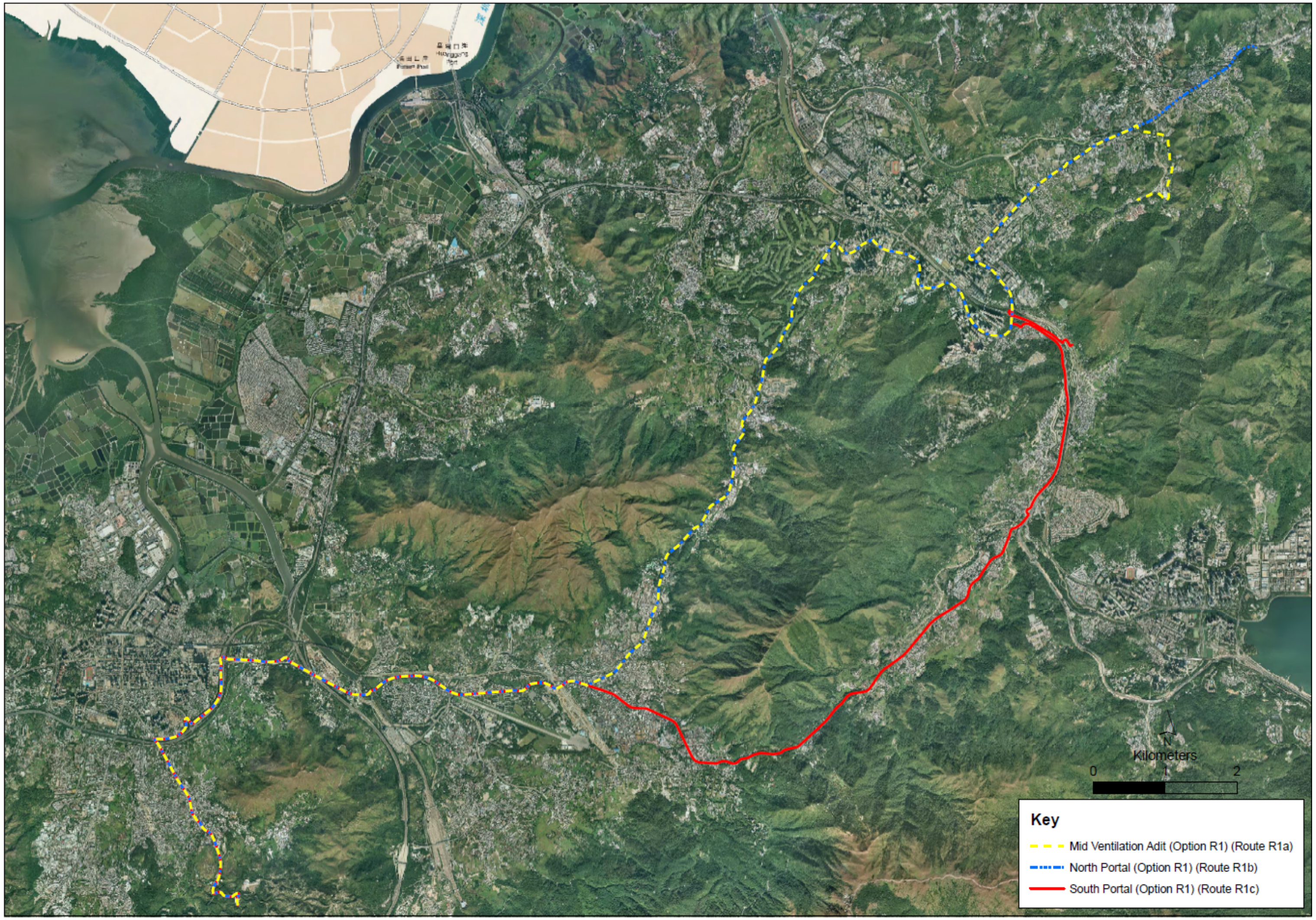


Figure 2.2 Proposed Explosive Transport Route Option R2

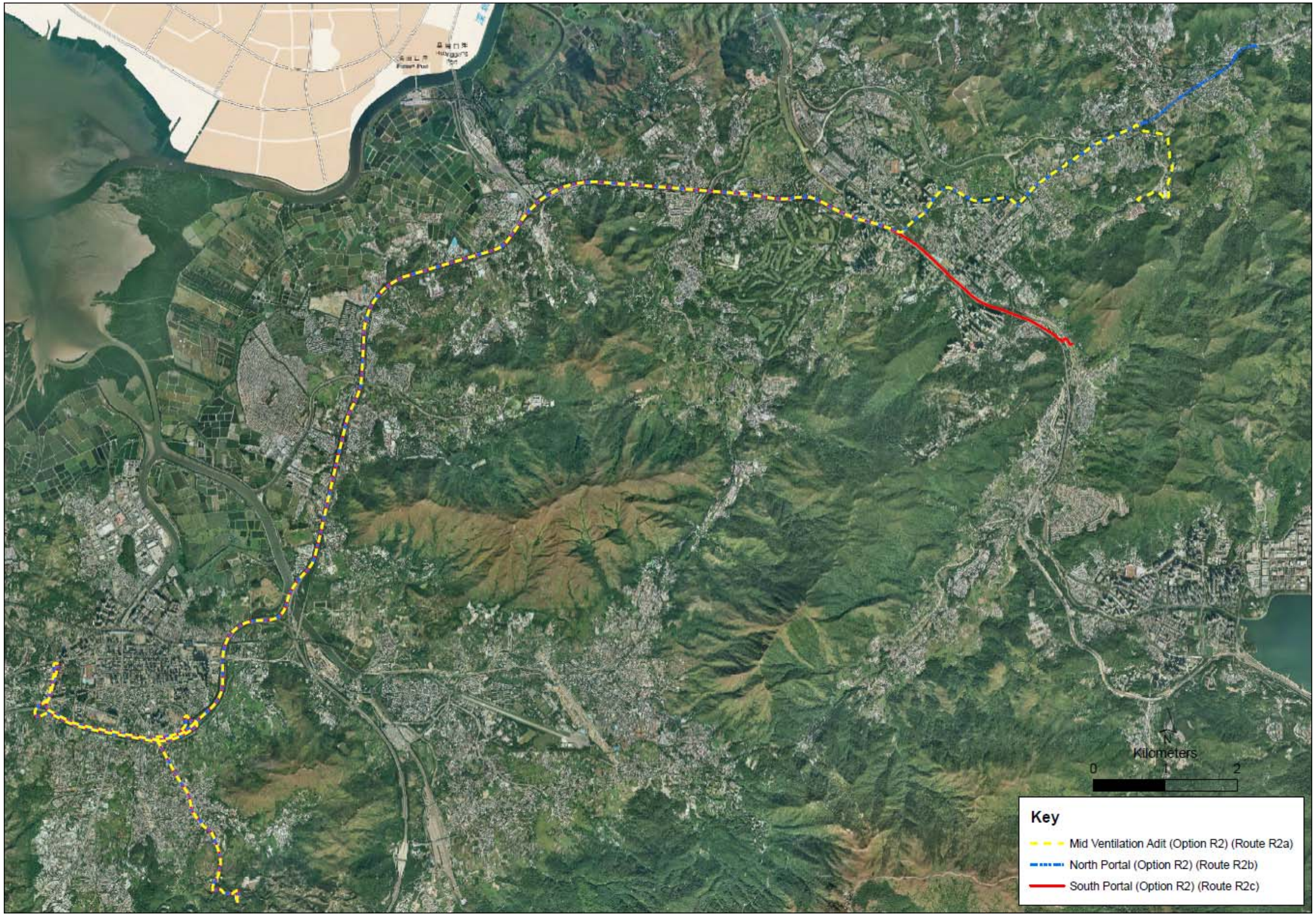


Figure 2.3 Proposed Explosive Transport Route Option R3

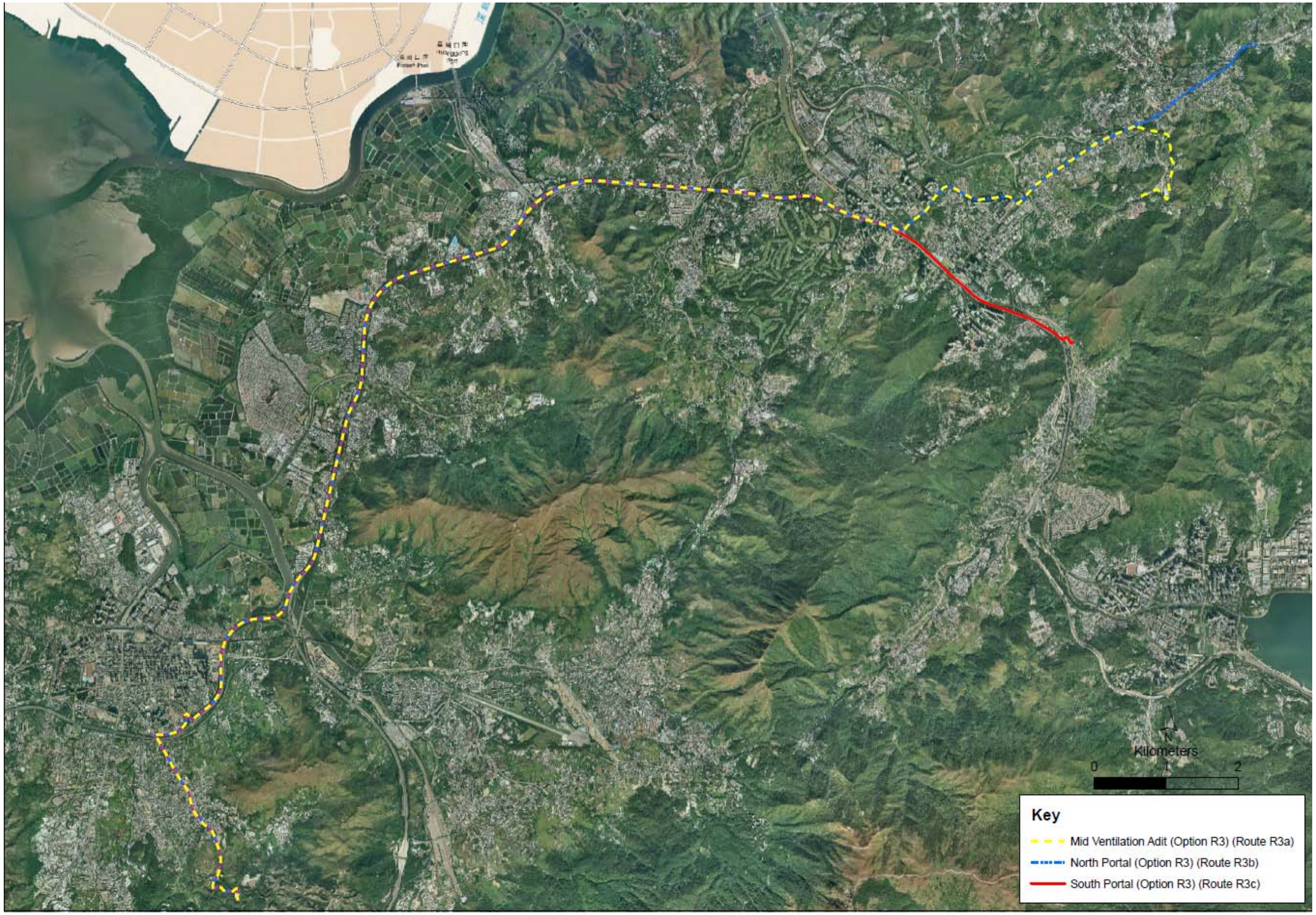


Table 2.1 provides a comparison of transport distances to each worksite between the three proposed explosive transport route options.

Table 2.1 Transport Distance to each worksite via different Route Options

Worksite	Transport Distance (km)		
	Route Option R1	**Route Option R2**	**Route Option R3**
Mid-Ventilation Adit	27.7	30.9	24.7
North Portal	27.6	30.8	24.6
South Portal	23.2	27.8	21.6

Figure 2.4, Figure 2.5 and *Figure 2.6* below show the overall Potential Life Loss (PLL) and Fatality N and frequency f (FN curves) for all three proposed explosive transport route options and full details are presented in the EIA Report's *Annex 8A, Section 8*.

Figure 2.4 F-N Curve for Storage and Transport of Explosives (Route Option R1)

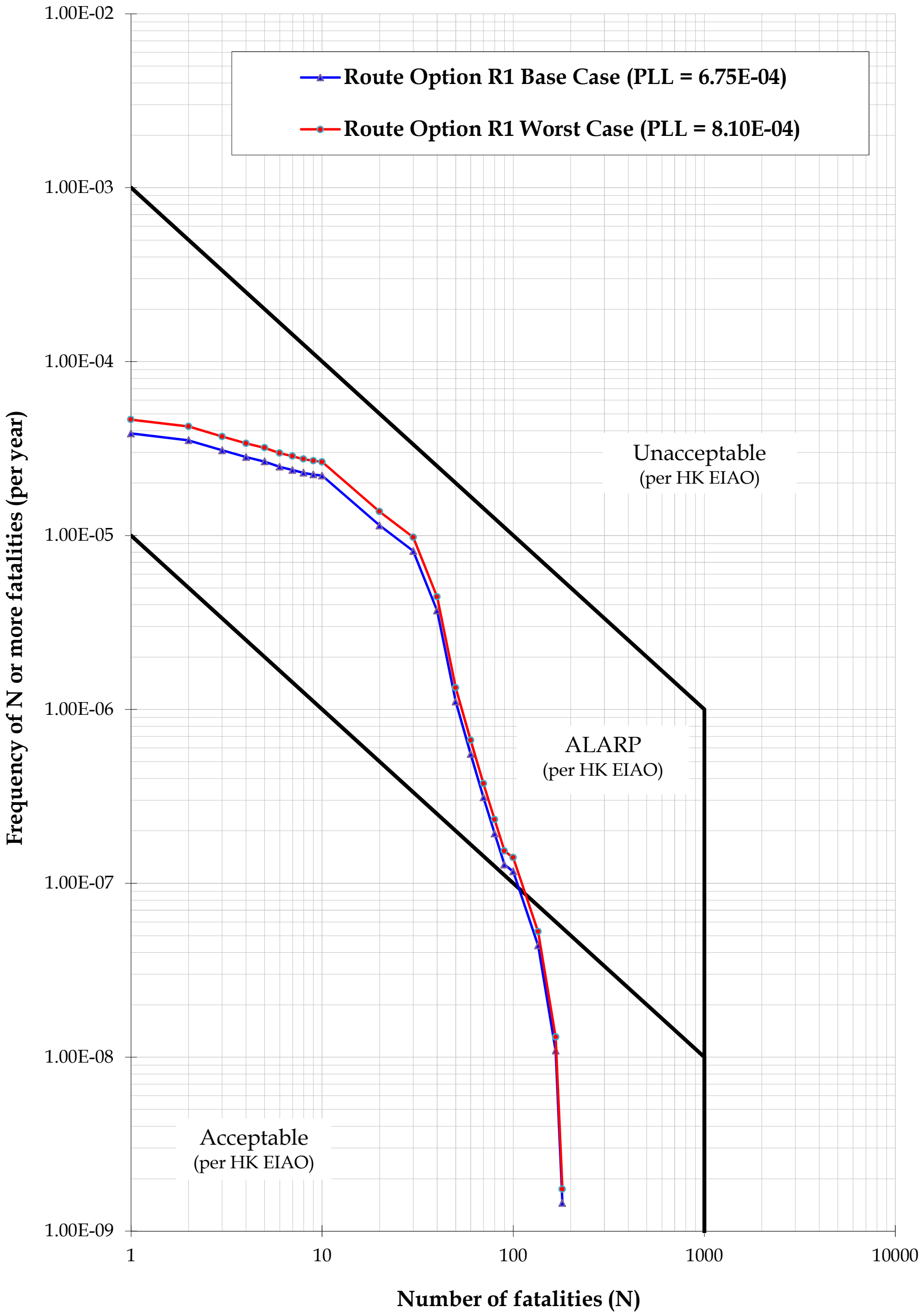


Figure 2.5 F-N Curve for Storage and Transport of Explosives (Route Option R2)

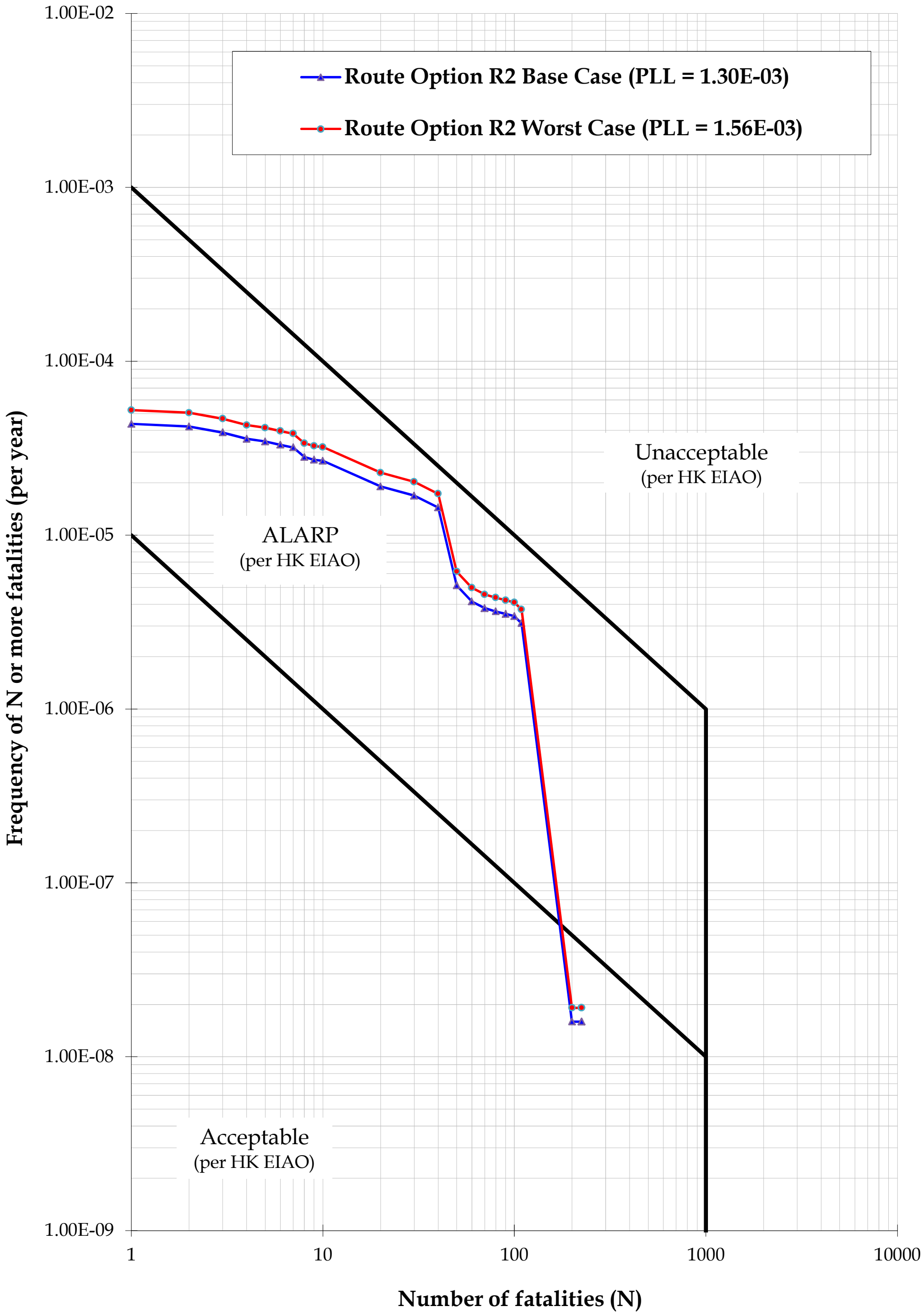
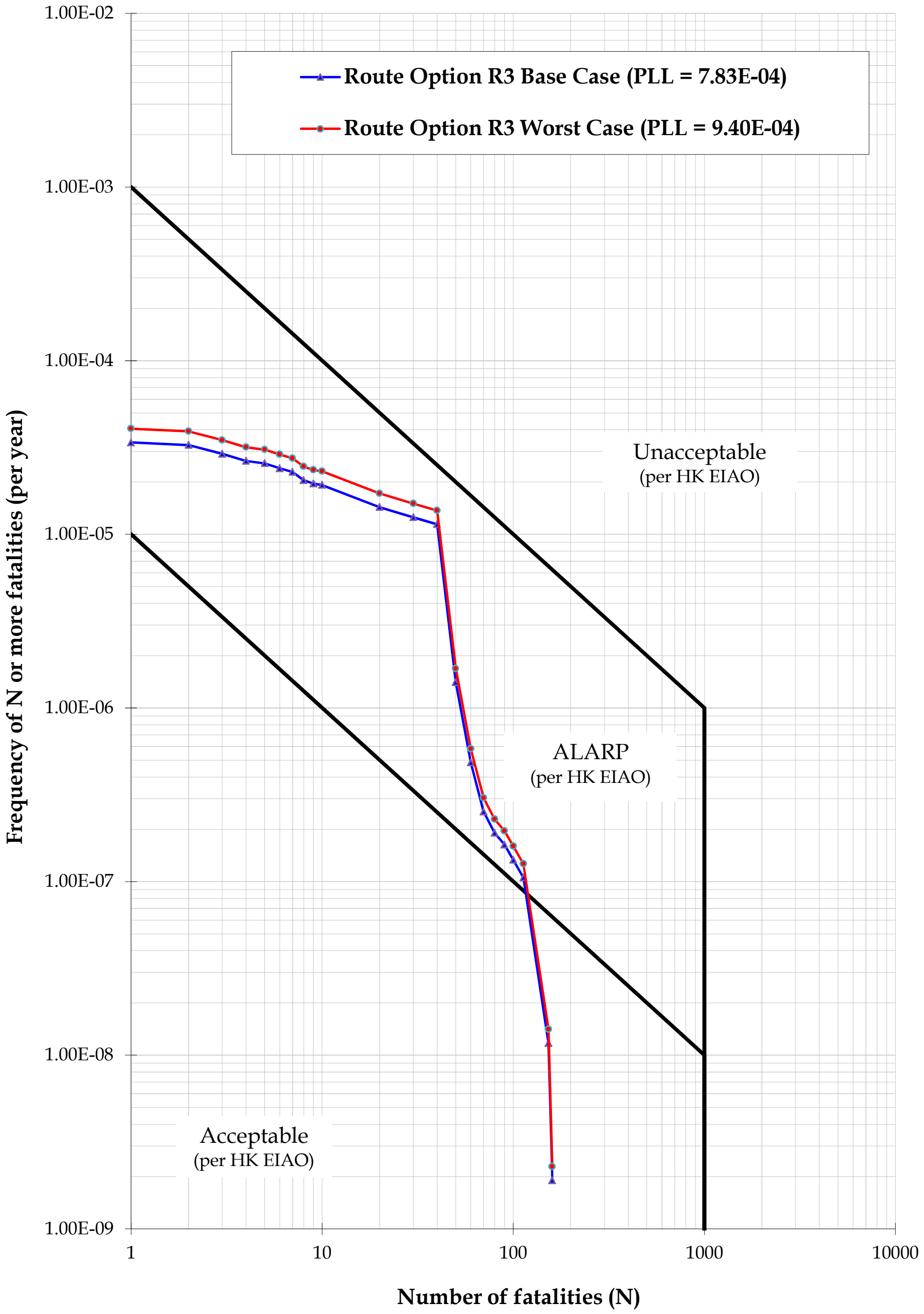


Figure 2.6 F-N Curve for Storage and Transport of Explosives (Route Option R3)



2.2 PROJECT LOCATION

The Project is located at the existing TLEM in Tai Shu Ha, Yuen Long District, New Territories. *Figure 2.7* shows the location and site plan of the Project and *Figure 2.8* details the Project Boundary.

The Tai Tong East Borrow Area was excavated in the 1990s and then subjected to reinstatement and management. To restore the borrow area, fast growing exotic species (e.g. *Acacia* spp., *Melaleuca quinquenervia*) were planted extensively in the area and it has been maintained by AFCD from 2003 until 2015. More recently, native species (e.g. *Machilus* spp., *Reevesia thyrsoidea, Schefflera heptaphylla,* and *Phyllanthus emblica*) were planted to increase diversity. This Conservation Area (CA) is zoned to protect and retain the existing natural landscape, ecological or topographical features of the area for conservation, educational and research purposes. The zoning ordinances also separate sensitive natural environments, such as the Tai Lam Country Park, from the adverse effects of development.

Given the loss of a small plantation area under the XRL project that was part of the restoration planting in the Tai Tong East Borrow area within the CA, the XRL EIA made provision for reinstatement planting at the TLEM that would be carried out upon completion of the XRL project. How this Project will affect the reinstatement planting is further discussed in *Section 3 Ecology*.

2.3 PROJECT SCHEDULE

The TLEM will be available for use from late 2015 or early 2016 (expected January 2016) to December 2017 with delivery of explosives to the TLEM expected to start in January 2016 and go through to December 2017. The decommissioning TLEM will be conducted after the operation and is expected to be completed in one month.

2.4 DESCRIPTION OF PROJECT FACILITIES, COMPONENTS AND ACTIVITIES

No construction activity will be carried out at the TLEM site.

The existing TLEM is composed of the following components as illustrated in *Figure 2.9*a & b:

(i) Two stores each with a capacity of 400 kg explosives and dimensions of about 4.7 m (length) x 2.7 m (width) x 2.7 m (height);
(ii) Secure fence;
(iii) CCTV system;
(iv) Guard house (standard container office, with dimensions of about 6 m (length) x 2.4 m (width) x 2.4 m (height)); and
(v) Street fire hydrant water tank (245 m^3) and 2 pumps.

The magazine operation will remain the same as under the current MTR XRL 824 Contractor and the Mines Division of the CEDD (Mines) will deliver a

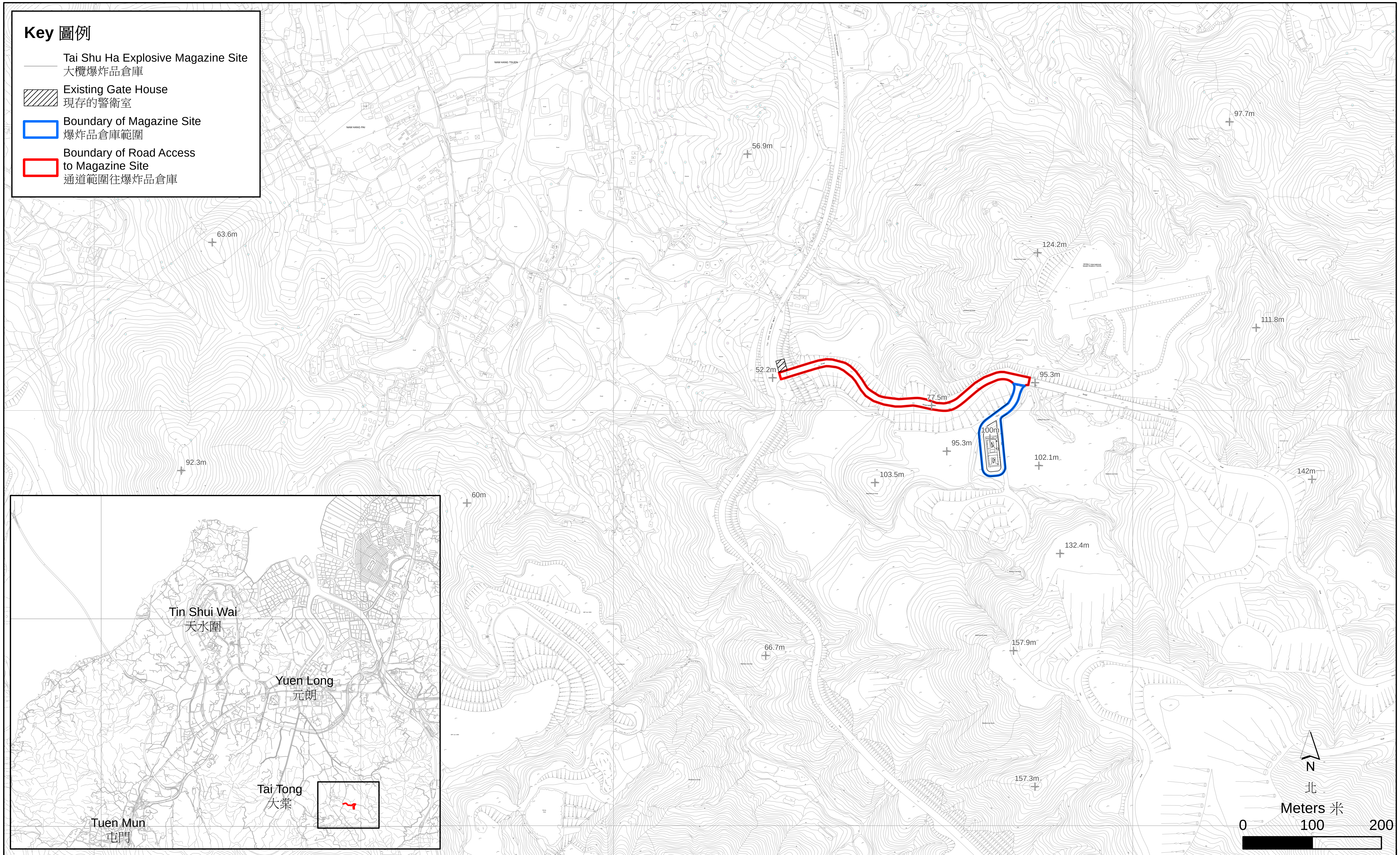


Figure 2.7
圖 2.7

Site Plan of the Existing Tai Lam Explosives Magazine
大欖爆炸品倉庫位置

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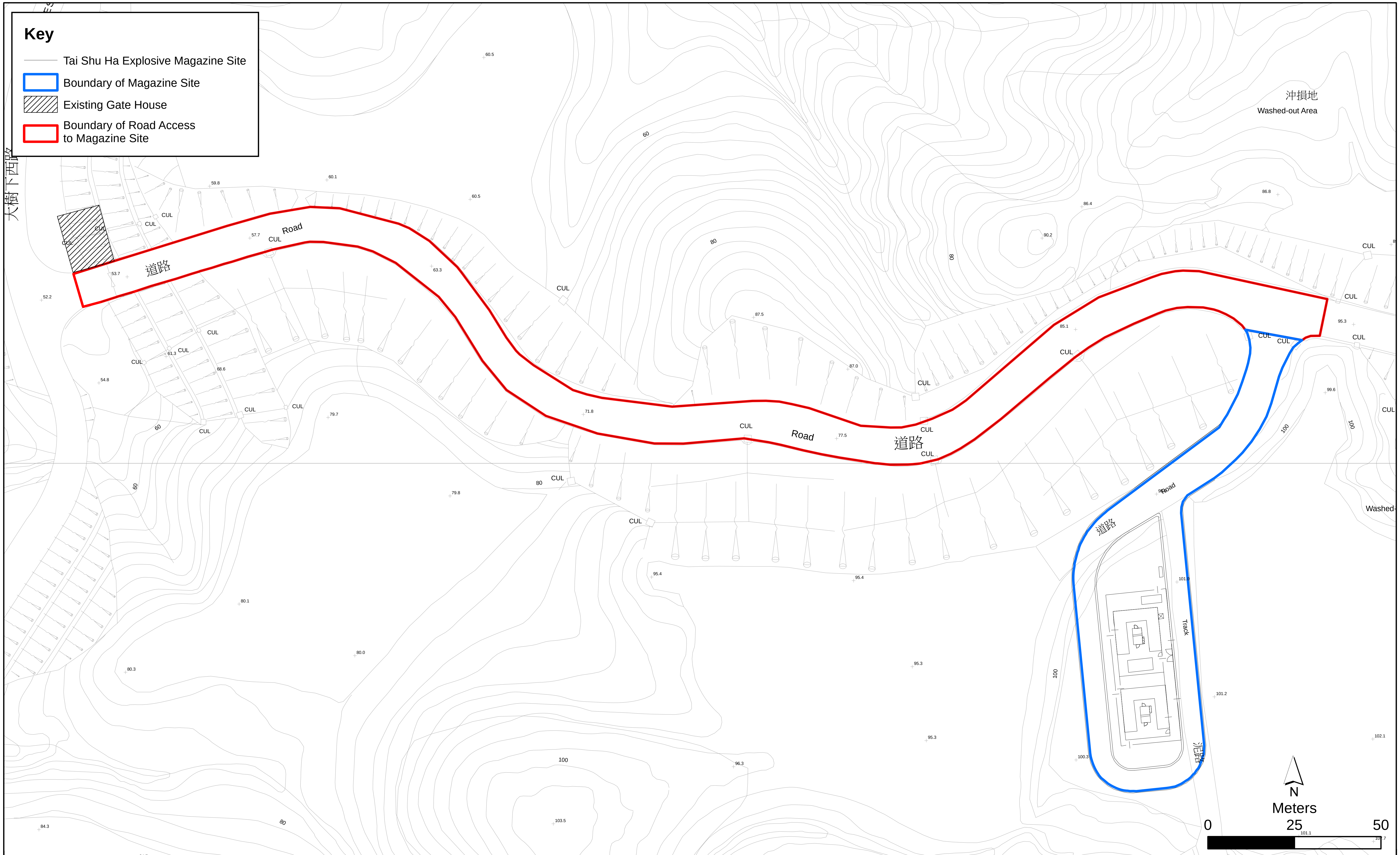

Figure 2.8

Project Boundary of Different Components

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Explosives store with Earth Bund

Earth Bund around the two explosives stores

Explosives store

Guard house and fire hydrant water tank

Figure 2.9a

Photographs of Tai Lam Explosives Magazine Components (Sheet 1 of 2)

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maximum of 800 kg explosives daily to the TLEM along with initiation devices (detonators). The transportation of explosives by Mines either to the Magazine or directly to sites, is under Mines' responsibility and falls outside the scope of this EIA study. Only the amount of explosives required for blasting work will be delivered to TLEM by CEDD Mines Division. Explosives will then be withdrawn by DHK as required and delivered using trucks approved by Mines, to three HKLTH worksites located at:

- Sha Tau Kok Road – Wo Hang Section (North Portal);
- Po Kat Tsai Road (Mid Ventilation Portal); and
- Tong Hang Tung Chuen (South Portal)

For this Project, explosives transport will be scheduled with less than 200 kg of explosives per truck (North Portal: 20 - 90 kg, Mid Ventilation Portal: 40 - 70 kg, South Portal: 15 - 140 kg) and a total of two to eight (2 – 8) deliveries per day will be carried out to the worksites (explosives are required at two to three [2 – 3] worksites per day) and maximum seven (7) days per week. Further details of these delivery routes and scheduling can be found in *Chapter 8 Hazard to Life*.

Only the amount of explosives required for blasting work will be delivered to TLEM by CEDD Mines Division. Before the commencement of decommissioning works, no surplus explosives will be stored at the explosives magazine. Based on this, no hazard to life impact is anticipated.

The key activities of the decommissioning works which will expect to last for about one month include:

- Dismantle and remove E&M, fire services, CCTV and lighting installed for the two explosive stores;
- Demolish the earth bunds and the two explosive stores;
- Frame cut the re-bar and remove the concrete debris;
- Remove all fire service facilities and all ground services including guard house, road furniture and lighting;
- Remove fire hydrant water tank ($245m^3$);
- Remove the container guard house and any temporary steel works; and
- Demolish the paved road for reinstatement of planting.

As seen from the above, work activities involved would mainly be dismantling and removal of structures currently used for the explosive magazine. Some of the work activities would be conducted simultaneously, as illustrated in the Decommissioning Plan as shown in *Annex 2A*. Powered mechanical equipment that would generally be used for carrying out the abovementioned work activities is also shown in *Annex 2A*.

As the decommissioning works will only involve dismantling, demolition and removal of the existing temporary structures, and removal of existing vegetation will not be required, no landscape and visual impact and terrestrial ecology impact are anticipated.

As the site is used as a magazine for storage of explosives only, there is no chemical store and use of lubricant or other chemicals are not required. The magazine is paved. No surplus explosives will be stored at the explosives magazine before the commencement of the decommissioning works. Based on the above-mentioned, no land contamination impact is anticipated due to the decommissioning works.

Due to the small scale of decommissioning works, site runoff and drainage from the works areas will be very minimal, and water quality impact is not anticipated due to the decommissioning works, as discussed further in Section 7.

3 ECOLOGY

3.1 INTRODUCTION

This chapter presents the potential ecological impacts associated with the operation and decommissioning of the Project in accordance with the requirement stated in *Section 3.4.2* of the EIA Study Brief.

The ecological findings of the previously approved XRL EIA report (No. AEIAR-143/2009) are reviewed and updated on the understanding that the Project Site is currently being used as an explosive magazine site for the construction of the XRL and therefore there will be no construction phase of this project, with no land conversion. Operation of the site is also intended to remain similar to the current operating procedure described in the approved XRL EIA.

3.2 RELEVANT ENVIRONMENTAL REGULATORY FRAMEWORK

Legislative requirements concerning the protection of species and habitats of terrestrial ecological importance such as the *Wild Animals Protection Ordinance (Cap 170)*, and *Protection of Endangered Species of Animals and Plants Ordinance (Cap 586)* are not considered of key importance to this study given there is no construction phase and operation will remain similar to existing.

The XRL EIA does include mitigation measures to be carried out at the site upon completion of the XRL project and carrying out planting in the TLEM site. Therefore overall the following is considered the key legislation for this Study.

- *Environment Impact Assessment Ordinance (Cap. 499)* and *Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO-TM), Annexes 16 and 8;*
- *Forests and Countryside Ordinance (Cap 96);* and
- *DEVB TCW No. 10/2013 – Tree Preservation.*

Details on each of the above are presented below.

3.2.1 Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO-TM)

The criteria for evaluating terrestrial ecological impacts are laid out in the *EIAO-TM*. *Annex 16* of the *EIAO-TM* sets out the general approach and methodology for the assessment of impacts to ecological resources arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* of the *EIAO-TM* recommends the criteria that can be used for evaluating such ecological impacts.

3.2.2 *Forests and Countryside Ordinance (Cap 96)*

The *Forests and Countryside Ordinance (Cap 96)* prohibits the felling, cutting, burning or destroying of trees and growing plants in forests and plantations on Government land. The subsidiary *Forestry Regulations* prohibit the picking, felling or possession of listed rare and protected plant species. The list of protected species in Hong Kong which comes under the *Forestry Regulations* was last amended on 11 June 1993 under the *Forestry (Amendment) Regulation 1993* made under *Section 3* of the *Forests and Countryside Ordinance*.

3.2.3 *DEVB TCW No. 10/2013 – Tree Preservation*

DEVB TCW No. 10/2013 – Tree Preservation supersedes *ETWB TC(W) No. 3/2006* and sets out the policy on tree preservation from feasibility, planning, design, construction to post-construction stages of a development, the procedures for control of tree felling, transplanting and pruning in Government projects, and departmental responsibilities in handling proposals on tree preservation and removal. It also covers the reporting of unauthorised tree removal or damage of trees, on both private and unleased Government land and its *Appendix A* details the requirements for compensatory planting.

3.3 *BASELINE CONDITIONS AND BACKGROUND*

Figure 3.1 gives an overview of the Project Study Area, 500 m from the Project Site boundary. The Project falls within the Tai Tong East Borrow Area and the statutory Tai Tong Outline Zoning Plan (S/YL-TT/16) Conservation Area (CA). It is also near (approximately 300 m from) the Tai Lam Country Park.

The Tai Tong East Borrow Area was excavated in the 1990s and then subjected to reinstatement and management. To restore the borrow area, fast growing exotic species (e.g. *Acacia* spp., *Melaleuca quinquenervia*) were planted extensively in the area and it has been maintained by AFCD from 2003 until 2015. More recently, native species (e.g. *Machilus* spp., *Reevesia thyrsoidea, Schefflera heptaphylla,* and *Phyllanthus emblica*) were planted to increase diversity.

This CA is zoned to protect and retain the existing natural landscape, ecological or topographical features of the area for conservation, educational and research purposes. The zoning ordinances also separate sensitive natural environments, such as the Tai Lam Country Park, from the adverse effects of development.

The habitat map in *Figure 3.2* is taken from the approved XRL EIA (No. AEIAR-143/2009) with minor revisions following a site visit in November 2014 and shows the approach to the TLEM as an existing tarmacked road and the area around the TLEM to be dominated by plantation with a stream flowing nearby to the south. The key change to baseline condition since the XRL EIA is that the area now occupied by the TLEM was previously relatively mature plantation habitat dominated by exotic plant species with some native

Figure 3.1

Project Study Area

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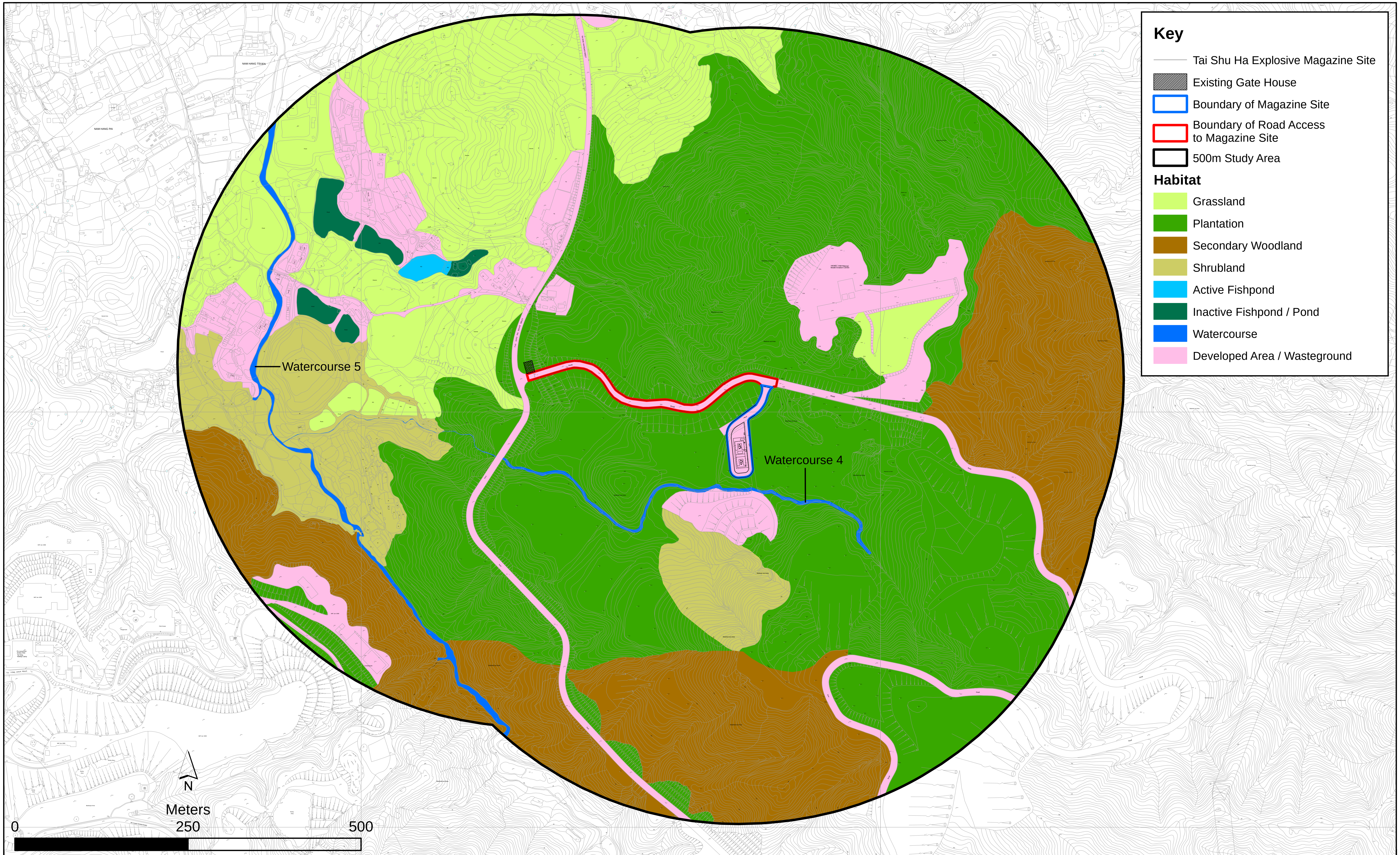

Figure 3.2

Habitat Map
(Habitat Map extracted from the approved XRL EIA (No. AEIAR-143/2009) with minor revisions)

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species in the understorey (e.g. *Melastoma candidum*, *Psychotria asiatica*) and this area was cleared for the construction of the TLEM.

3.4 IDENTIFICATION AND EVALUATION OF IMPACTS

The construction of the TLEM was conducted under the EP from the approved XRL EIA and there will be no construction phase for this Project.

Operation of the existing facility will remain similar to the existing operation as described in the XRL EIA and the decommissioning works will only affect the existing TLEM which classified as developed areas of negligible ecological value, and therefore is not considered to cause any direct ecological impacts to habitats including streams or to species.

Given the loss of a small plantation area under the XRL project that was part of the restoration planting in the Tai Tong East Borrow area within the CA, the XRL EIA made provision for reinstatement planting at the TLEM that would be carried out upon completion of the XRL project. As part of the XRL EIA and EP (latest XRL EP no . : EP-349/2009/L) requirements, a detailed *Vegetation Survey Report for Tai Shu Ha Road West* have been submitted under XRL EP condition 2.12(iii) and *Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha)*, submitted under XRL EP condition 2.14, has been drawn up including details of the reinstatement of the TLEM site. These reports under the XRL project are publically available at the following sites http://www.epd.gov.hk/eia/register/english/permit/ep3492009/documents/vsrr1/pdf/vsrr1.pdf and http://www.epd.gov.hk/eia/register/english/permit/vep3232010/documents/tplpyldtsh/pdf/tplpyldtsh.pdf, and for ease of reference, the key details of these reports are provided as *Annexes 3A* & *3B* to this report.

The current Project extends the operating time of the TLEM. The XRL project use of the TLEM was due to be up to the end of 2014 and has been extended until end 2015. Under the proposed Project the TLEM site will remain in operation up to December 2017 i.e. reinstatement planting will be postponed by three years.

The reinstatement of the TLEM is principally in order to restore the habitat back to borrow area reinstatement plantation and relative to the whole borrow area reinstatement plantation, it is a very small area. With respect to fauna, the area is ecologically connected to nearby Country Parks and Conservation Areas and may host a number of woodland species. The XRL EIA baseline surveys recorded six species of conservation interest with the Study Area including Little Egret *Egretta garzetta*, Chinese Pont Heron *Ardeola bacchus*, Red-Throated Pipit *Anthus cervinus*, Eurasian Jay *Garrulus glandarius*, Pale Palm Dart *Telicota colon stinga* and Chinese Pangolin *Manis pentadactyla auritus*. All these species were recorded outside the direct TLEM footprint area and with the exception of the Chinese Pangolin all to the west off the Study Area in habitats separated from the TLEM by the Tai Shu Ha Road West. The

Chinese Pangolin was recorded in grassland to the south of the TLEM site but across the watercourse from the site. Though the area near the TLEM is dominated by plantations with a canopy of mainly introduced species, it is possible that fauna from nearby woodland habitats would occasionally use this plantation habitat once it was reinstated but it is not considered to be a key habitat to any particular species of conservation interest. Since there is also a relatively large area of existing plantation in the surrounding area, to postpone the reinstatement by three years is therefore not thought to have any adverse impact on fauna that will use this area in the future.

With regard to the impact of postponing the reinstatement planting by three years on habitat, this time period is relatively small with regards to vegetation succession and establishment of soils. Therefore assuming that the same reinstatement plan as set out in the *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* and *Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha)* can be adhered to, no adverse impact is expected on habitats.

3.5 PROPOSED MITIGATION MEASURES

For the XRL EM&A no water monitoring points were proposed for the watercourses within the TLEM Study Area. Since operation activities will remain similar to existing it is therefore not considered necessary to carry out any monitoring of the watercourses. *Chapter 7* provides further detail on the potential impacts to water quality from this Project.

Upon completion of the Project at the end of 2017 and the removal of the TLEM, reinstatement planting should be carried out at the site according to the *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* (hereafter *Vegetation Survey Report)* and the *Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha)* (hereafter *TLP*).

The *Vegetation Survey Report* and the *TLP* detail criteria for selection of suitable vegetation species for this planting and the selected species are listed in *Table 3.1* below. Six tree species were recommended to compensate for the loss of trees and four shrub species for the loss of understorey species, all being species that existed previously in the TLEM site before the magazine construction.

Table 3.1 *Recommended Species for Reinstatement Planting at TLEM*

Scientific Name	Growth Form	Native / Exotic to Hong Kong
Castanopsis fissa	Tree	Native
Celtis sinensis	Tree	Native
Cinnamomum parthenoxylon	Large Tree	Native
Litsea rotundifolia	Shrub	Native
Mallotus paniculatus	Tree	Native
Melastoma sanguineum	Shrub	Native
Psychotria asiatica	Tree or shrub	Native
Reevesia thyrsoidea	Tree	Native
Rhodomyrtus tomentosa	Shrub	Native
Schefflera heptaphylla	Tree	Native

Other native trees/shrubs that are generally well self-established and suitable for mitigation planting can also be considered to further promote the flora biodiversity of TLEM site, as recommended in *Table 3.2*

Table 3.2 *Additional Recommended Species for Reinstatement Planting at TLEM*

Scientific Name	Growth Form	Native / Exotic to Hong Kong
Bischofia favanica	Tree	Native
Elaeocarpus sylvestis	Tree	Native
Gordonia axillaris	Shrub or tree	Native
Schima suberba	Tree	Native
Viburnum odoratissimum	Shrub or tree	Native

In addition, the *TLP* provides a list of general tree/ palm species that are suitable for Native Woodland Planting (not on SIMAR Slopes). Those not listed already in *Table 3.1* or *Table 3.2,* are listed in *Table 3.3*.

Table 3.3 *Additional Species generally suitable for Native Woodland Planting (not on SIMAR Slopes)*

Scientific Name	Common Name	Native / Exotic to Hong Kong
Ailanthus fordii	Ailanthus	Native
Broussonetia papyrifera	Paper Mulberry	Native
Choerospondias axillaris	Hog Plum	Native
Cinnamomum burmannii	Cinnamon tree	Native
Cleistocalyx operculatus	Water Banyan	Native
Ficus microcarpa	Chinese banyan	Native
Ficus superba var. *japonica*	Superb fig	Native
Ficus variegata var. *chlorocarpa*	Common red-stem	Native
Ficus virens var. sublanceolata	Big-leaved fig	Native
Liquidambar formosana	Sweet gum	Native
Litsea glutinosa	Pond spice	Native
Litsea monopetala	Persimmon–leaved Litsea	Native
Machilus chekiangensis	Chekiang Machilus	Native
Machilus chinensis	Hong Kong Machilus	Native

Scientific Name	Common Name	Native / Exotic to Hong Kong
Machilus pauhoi	Many-nerved Machilus	Native
Machilus thunbergii	Red Machilus	Native
Phoenix hanceana	Spiny date-palm	Native
Sapium discolor	Mountain tallow	Native
Sapium sebiferum	Tallow-tree	Native
Sterculia lanceolata	Scarlet Sterculia	Native

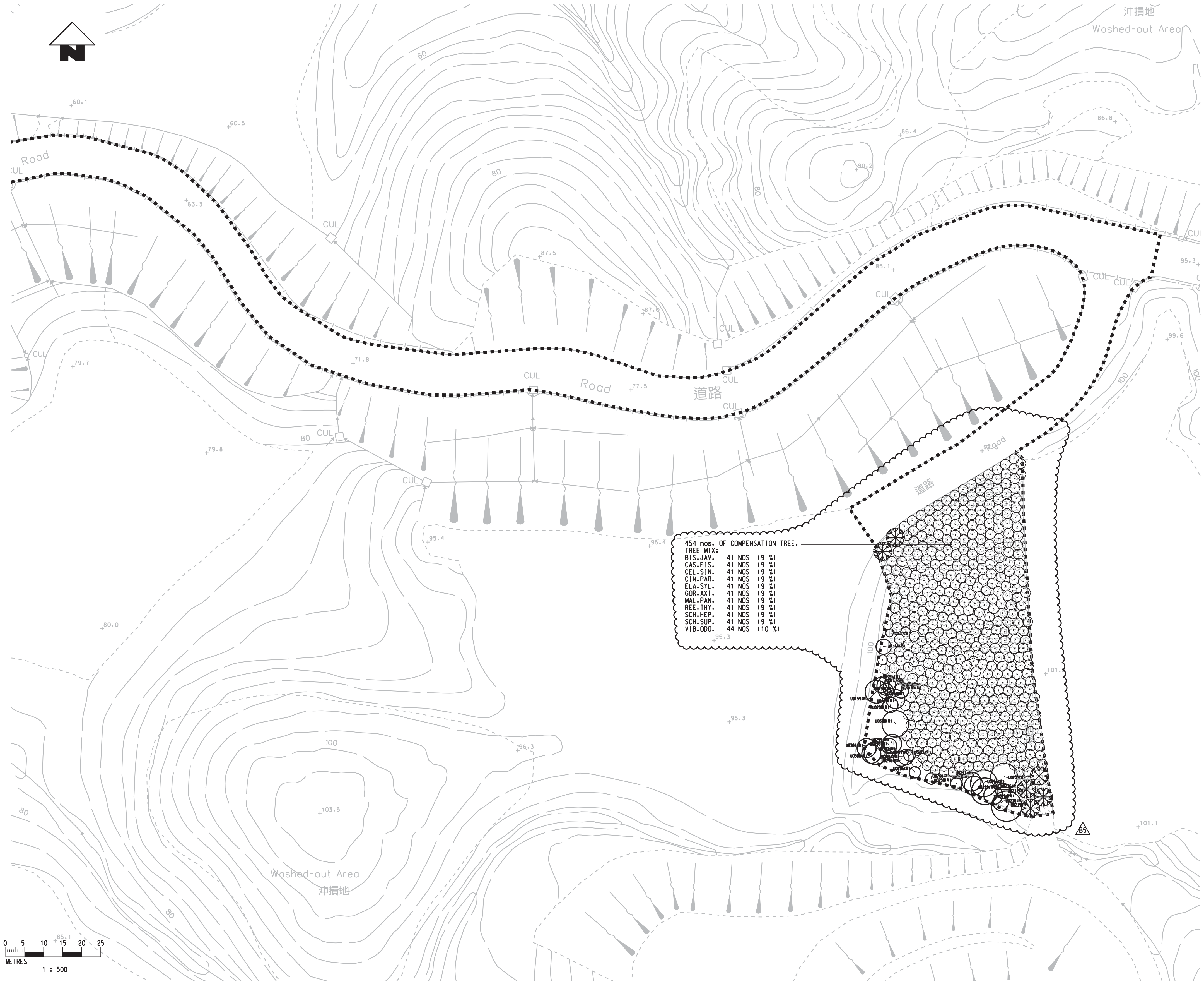
Figure 3.3a and *b* taken from the *Vegetation Survey Report* and *TLP* show the proposed location of tree and shrub planting respectively and include the proposed number of individuals to be planted. These plans should be adopted for the future reinstatement planting process.

Vegetation Survey Report, Appendix C and *TLP Appendix V* also provide relevant specification for the site restoration works at the TLEM, including restoration of the soil, to ensure suitable conditions for planting are reached once operation of the TLEM stops and prior to planting starting. This *Vegetation Survey Report, Appendix C* and *TLP Appendix V* should also be adhered to for the future reinstatement planting process.

Under the Project Implementation Schedule of the approved XRL EIA (provided in the XRL EIA Report *Appendix A*), MTR are the party responsible for the reinstatement planting works. For the proposed Project, DHK should liaise with MTR and will take over the responsibility of this reinstatement planting works (as laid out in the *Vegetation Survey Report* as well as the *TLP,*) including application for a Further Environmental Permit (FEP) of XRL, to cover the planting obligation.

3.6 CONCLUSION AND RECOMMENDATIONS

Reinstatement planting at the TLEM site will be carried out upon completion of the Project in 2017 and the removal of the TLEM. Assuming that this reinstatement planting is carried out by DHK as recommended in the approved XRL EIA report (according to the *Vegetation Survey Report* and the *TLP,* which both fall under the requirements of the XRL EIA study, with approval from DEP as necessary for any revisions to these approved documents), no adverse impacts on ecology are expected from this Project.



LEGEND:

Type 種類	Botanical Name 學名	Chinese Name 中文名稱	Standard 規格	Spacing 種植闊度	Size (HxSPRxDIA) 規格	Quantity 數量
TREE 樹類						
BIS.JAV.	BISCHOFIA JAVANICA	重陽木	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
CAS.FIS.	CASTANOPSIS FISSA	裂斗錐栗	STANDARD	2.5M	4Mx2.5Mx0.06M	41
CEL.SIN.	CELTIS SINENSIS	朴樹	STANDARD	2.5M	3.5Mx2Mx0.06M	41
CIN.PAR	CINNAMOMUM PARTHENOXYLON	黃樟	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
ELA.SYL.	ELAEOCARPUS SYLVESTRIS	山杜英	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
GOR.AXI.	GORDONIA AXILLARIS	大頭茶	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
MAL.PAN.	MALLOTUS PANICULATUS	白楸	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
REE.THY.	REEVESIA THYRSOIDEA	梭羅樹	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
SCH.HEP.	SCHEFFLERA HEPTAPHYLLA	鴨腳木	STANDARD	2.5M	4Mx2Mx0.06M	41
SCH.SUP.	SCHIMA SUPERBA	木荷	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
VIB.ODO.	VIBURNUM ODORATISSIMUM	珊瑚樹	STANDARD	2.5M	3.5Mx2.5Mx0.06M	44

B5

Figure 3.3a

Proposed XRL EIA Vegetation Survey Report Compensatory Planting at Magazine Site (Trees)

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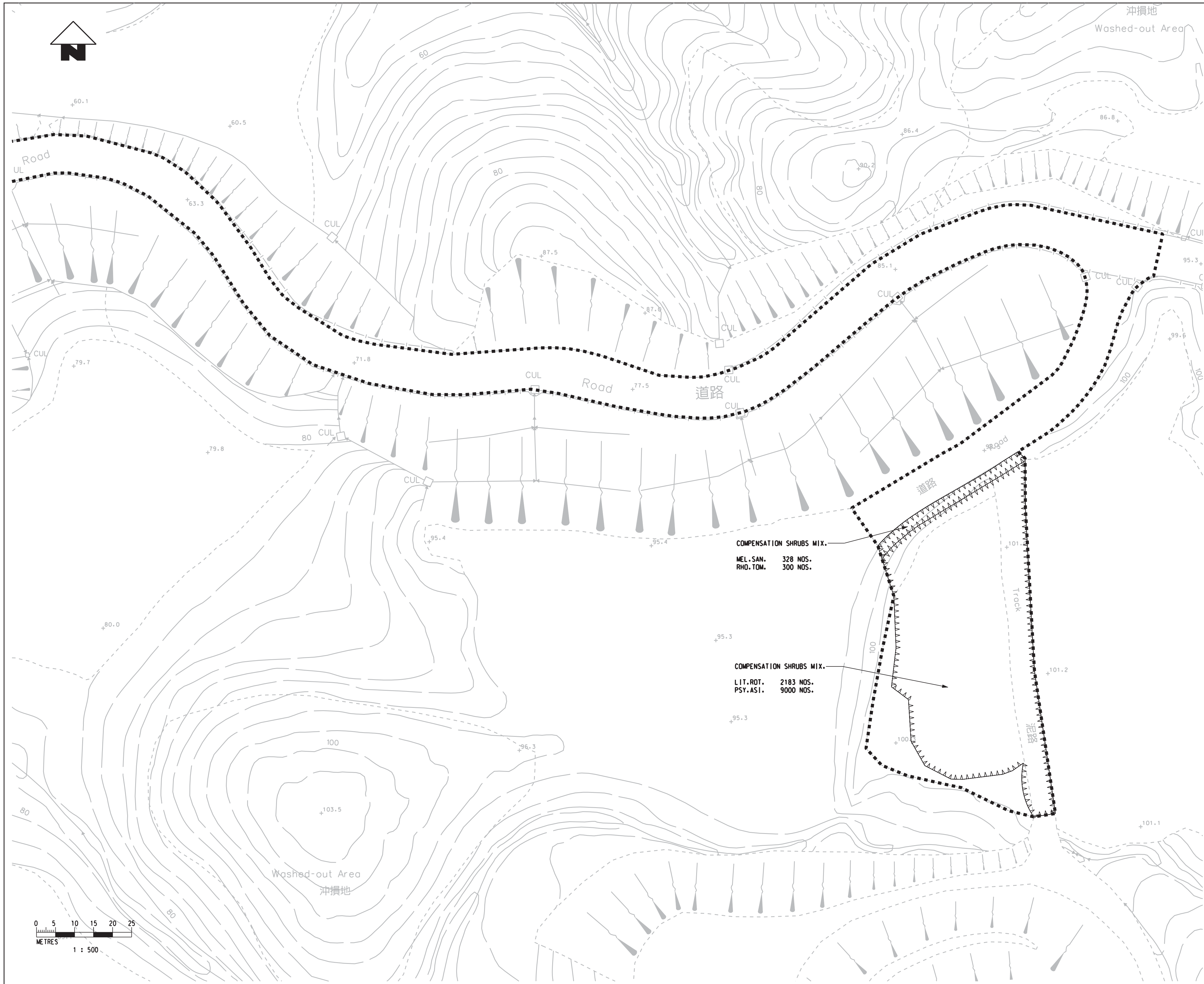

LEGEND:

Type 種類	Botanical Name 學名	Chinese Name 中文名稱	Spacing 種植闊度	Standard 規格	Quantity 數量
SHRUB 灌木類					
LIT.ROT.	LITSEA ROTUNDIFOLIA	豺皮樟	500 mm	300H x 250S	2183
MEL.SAN.	MELASTOMA SANGUINEUM	毛木念	500 mm	400H x 300S	328
PSY.ASI.	PSYCHOTRIA ASIATICA	九節	500 mm	500H x 400S	9000
RHO.TOM.	RHODOMYRTUS TOMENTOSA	桃金孃	500 mm	300H x 250S	300

SHRUB

Figure 3.3b

Proposed XRL EIA Vegetation Survey Report Compensatory Planting at Magazine Site (Shrubs)

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4 AIRBORNE OPERATIONAL NOISE IMPACT

4.1 INTRODUCTION

This chapter presents the potential noise impacts to the identified Noise Sensitive Receivers (NSRs) associated with the decommissioning and operation of the Project in accordance with the requirement stated in *Section 3.4.2* of the EIA Study Brief. The findings of the previously approved XRL EIA report (No. AEIAR-143/2009) XRL) are reviewed and updated as necessary.

4.2 RELEVANT ENVIRONMENTAL REGULATORY FRAMEWORK

4.2.1 Operation Phase

Fixed Plant Noise

The *EIAO-TM* and *Technical Memorandum on Noise From Places Other than Domestic Premises, Public Places or Construction Sites* (*IND-TM*) specifies the applicable ANLs for the fixed noise sources from the Project. The ANLs are dependent on the ASR and the time of the day and are presented in *Table 4.1***.**

Table 4.1 Acceptable Noise Levels

Time Period	$L_{Aeq\ 30min}$ (dB(A))		
	ASR "A"	ASR "B"	ASR "C"
Day-time (i.e. 07:00-19:00 hrs)	60	65	70
Evening (i.e. 19:00-23:00 hrs)	60	65	70
Night-time (i.e. 23:00-07:00 hrs of the next day)	50	55	60

Fixed plant noise is controlled under *Section 13* of the *NCO* and the predictions will be undertaken in accordance with the *IND-TM*. The noise criteria stipulated in the *IND-TM* are also dependent on the ASR of the NSR. As the Project Site is located in a rural area and no influencing factors affect the NSRs, an ASR of "A" has been assigned.

Road Traffic Noise

The traffic noise standards for planning purposes specified in *Table 1* under *Annex 5* of the *EIAO-TM* was employed as the noise limits for the road traffic noise impact assessment. The applicable road traffic noise standards are 70dB(A) $L_{10,\ 1hr}$ for domestic premises and 65dB(A) $L_{10,\ 1hr}$ for education institutions and church, respectively. These noise limits were applied for the peak hour traffic flows and for uses that rely on opened windows for ventilation.

4.2.2 Decommissioning of the Magazine Site

The principal legislation relating to the control of construction noise is the *Environmental Impact Assessment Ordinance* (*EIAO*) (Cap. 499). The *Technical*

Memorandum on Environmental Impact Assessment Process (*EIAO-TM*), issued under the *EIAO*, stipulates assessment standards of $L_{eq(30 \text{ minutes})}$ 75 dB(A) for all domestic premises and 70/65 dB(A) for educational institutions during normal school term/examination periods for daytime (i.e. 0700 to 1900 hours on any day not being a Sunday or general holiday) construction activities (1). These criteria apply to Noise Sensitive Receivers (NSRs) relying only on openable windows for ventilation.

The *Noise Control Ordinance* (*NCO*) (*Cap 400)* also provides means to assess construction noise impacts. Various Technical Memoranda (TMs), which stipulate control approaches and criteria during the restricted hours, have been issued under the *NCO*. The following TMs are applicable to the control of noise from construction activities:

- *Technical Memorandum on Noise from Percussive Piling* (PP-TM);
- *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (GW-TM); and
- *Technical Memorandum on Noise from Construction Work in Designated Areas* (DA-TM).

The *NCO* provides statutory controls on general construction works during the restricted hours (i.e. 19:00 – 07:00 hrs of the next day, Monday to Saturday and any time on Sundays and public holidays). The use of Powered Mechanical Equipment (PME) for the carrying out of demolition or construction works during the restricted hours requires a Construction Noise Permit (CNP). The EPD is guided by the GW-TM and DA-TM when assessing such an application.

Percussive piling is prohibited at any time on Sundays and public holidays and during the weekday evening and night-time hours (19:00-07:00 hrs of the next day, Monday through Saturday). A CNP is required for such works during the weekday daytime hours (07:00 – 19:00 hrs, Monday through Saturday). The EPD is guided by the PP-TM in considering applications of a CNP for such works.

The Noise Control Authority will consider a well-justified CNP application, for construction works within restricted hours as guided by the relevant TMs issued under the *NCO*. The Noise Control Authority will take into account adjoining land uses and any previous complaints against construction activities at the site before making a decision. Nothing in this *EIA Report* shall bind the Noise Control Authority in making its decision. The Noise Control Authority may include any conditions in a CNP that it considers appropriate. Failure to comply with any such conditions may lead to cancellation of the CNP and prosecution action under the *NCO*.

(1) Construction activities in this instance refer to the decommissioning works

4.3 NOISE SENSITIVE RECEIVER

In accordance with *Table 5.5* of the XRL EIA Report, one representative Noise Sensitive Receiver (NSR) was identified within the Study Area (i.e. within 300m of the Project boundary) and is listed in *Table 4.2*. No new or planned NSRs were identified since the approval of the XRL EIA Report. The location of the identified NSR is presented in *Figure 4.1*.

Table 4.2 Identified NSRs

NSR No.	Description	Type	Distance from the Magazine Site	No. of Storey
TS1	Village House next to Tai Shu Ha Road West	Residential	297 m (1)	1

Note:

(1) The distance between the magazine site and the NSR was reported as 244 m in approved XRL EIA Report. This distance is further reviewed in this ERR and is found to be approximately 297 m.

4.4 IDENTIFICATION AND EVALUATION OF IMPACT

4.4.1 Decommissioning Phase

The magazine site comprises two magazine structures storing 400kg of explosives each, a secure fence, CCTV system, guard house, street fire hydrant tank (245m^3) and two water pumps. Layout plan of the magazine site is presented in *Figure 4.2*.

The major activities are summarised as follows:

- Dismantle and remove E&M, fire services, CCTV and lighting installed for the two explosive stores;
- Demolish the earth bunds and the two explosive stores;
- Frame cut the re-bar and remove the concrete debris;
- Remove all fire service facilities and all ground services including guard house, road furniture and lighting;
- Remove fire hydrant water tank (245m^3);
- Remove the container guard house and any temporary steel works; and
- Demolish the paved road for reinstatement planting.

The normal working hours of the Contractor will be between 07:00 and 19:00 hrs from Monday to Saturday (except public holidays). Construction activities during restricted hours are not expected. Should evening and night works between 19:00 and 07:00 hrs or on public holidays (including Sundays) be required, the Contractor will submit a CNP application which will be assessed by the Noise Control Authority.

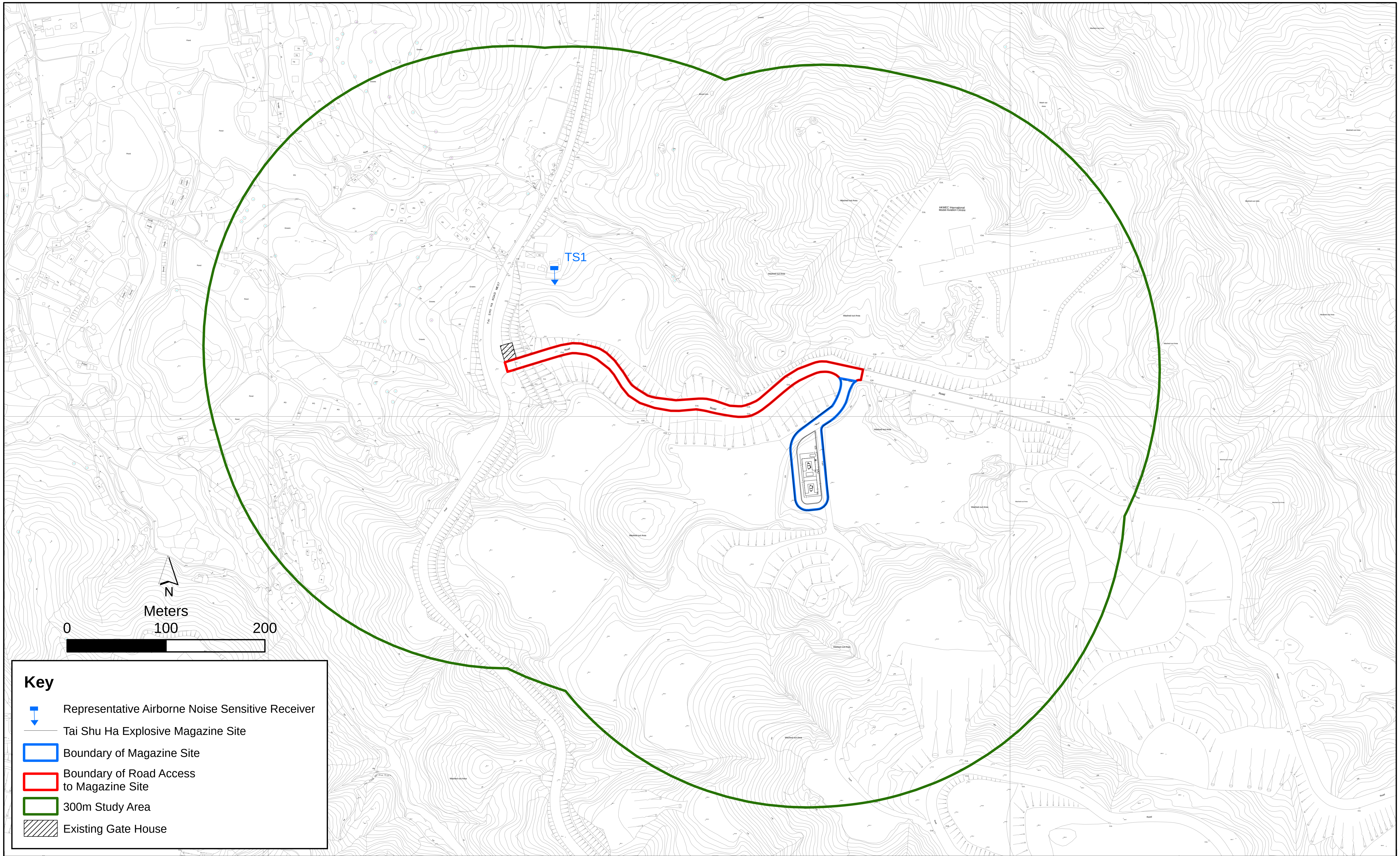

Figure 4.1

Locations of Representative Airborne Noise Sensitive Receiver

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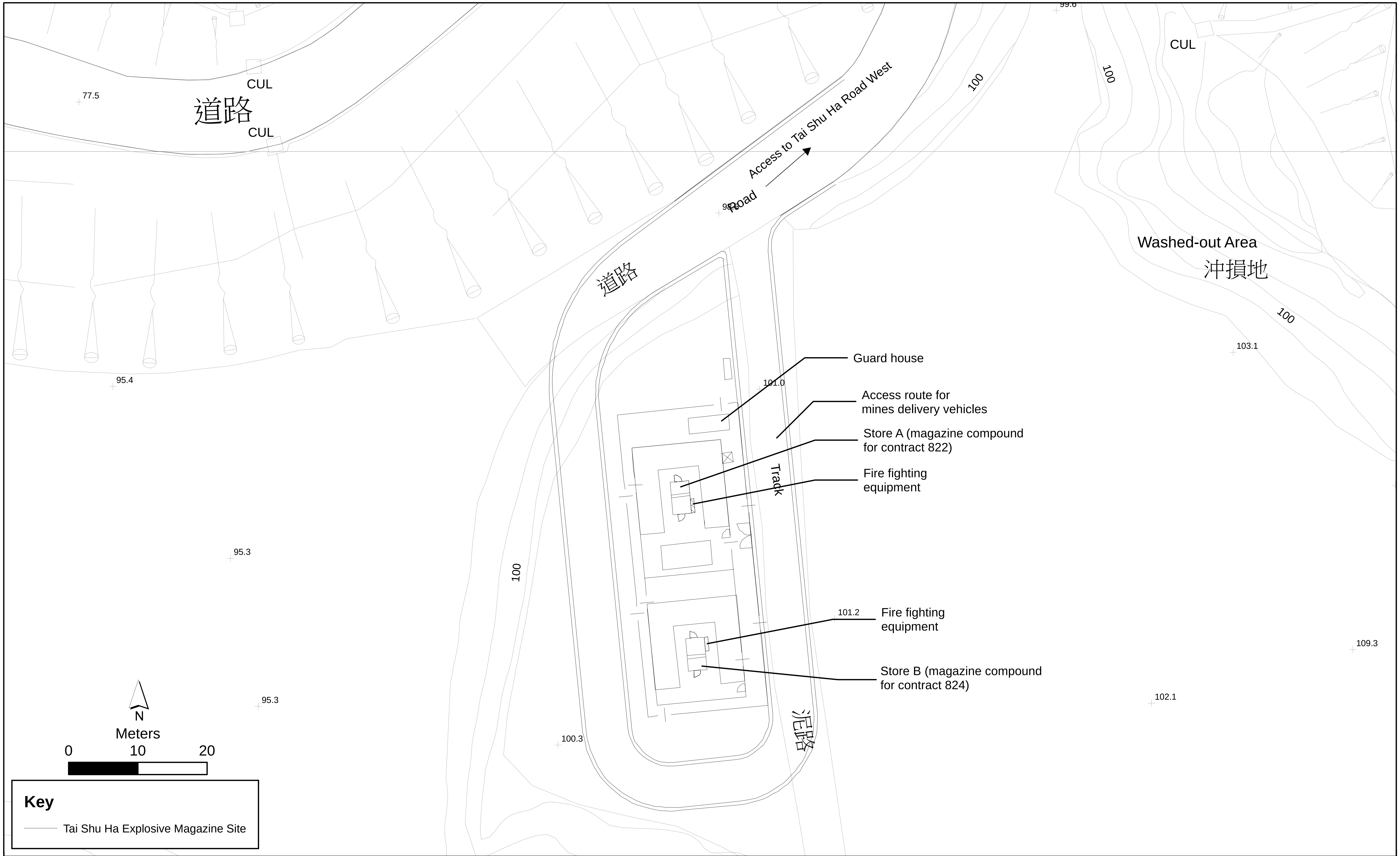

Figure 4.2

Layout Plan of Magazine Site

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It is envisaged that major noise sources will be associated with various PME including lorries, dump trucks, drills/grinders and breakers etc to be used for the decommissioning of the magazine site.

It is recommended that the general noise control measures as listed in *Recommended Clauses for Construction Contracts – Section 3 - Noise Control* (available on EPD website at http://www.epd.gov.hk/epd/english/environmentinhk/eia_planning/guide_ref/rpc_3.html), should also be incorporated in the works contract to ensure that the Contractor will adopt good site practices and minimise noise generation. Given that the decommissioning works will only last for 4 weeks, the nearest NSR is located at ~297 m from the magazine site, and good site practices to minimise noise generation will be adopted, no adverse noise impact is anticipated from the decommissioning works.

4.4.2 *Operational Phase*

Operation of the magazine site will remain the same as the current XRL project. Potential sources of noise include fixed plant noise impact from the operation of the water pumps and street fire hydrant tank. The nearest NSR is located at approximately 297 m from the fixed plant noise sources. As such, no adverse noise impact to the NSR is expected.

The operational activities involve the delivery of explosives to the Magazines by Mines Division on a daily basis and the transfer of the explosives to the work areas by the contractors daily. Traffic generated from the site is insignificant as a total of two to eight (2 – 8) deliveries per day will be carried out to the worksites. Three proposed explosive transport routes have been identified for this Project, i.e. Proposed Routes R1, R2 and R3, from the magazine site to the three worksites (i.e. Mid-Ventilation Adit, North Portal and South Portal). *Figure 2.1, Figure 2.2* and *Figure 2.3* show the proposed explosive transport routes R1, R2 and R3 respectively. With consideration of the low traffic arising from the Project, no traffic noise impact is anticipated.

4.5 CONCLUSION

No adverse noise impacts are anticipated during operation or decommissioning, assuming general noise control measures, as listed in *Recommended Clauses for Construction Contracts – Section 3 - Noise Control*, are adopted during decommissioning. Noise monitoring at the NSR is not required as part of the EM&A programme during operation and decommissioning.

5 AIR QUALITY

5.1 INTRODUCTION

This chapter presents an assessment of the potential air quality impacts associated with the operation of the Project in accordance with the requirement stated in *Sections 3.4.2* of the EIA Study Brief. The findings of the previously approved Hong Kong Section of the XRL EIA report (No. AEIAR-143/2009) were reviewed and updated in this assessment.

5.2 RELEVANT ENVIRONMENTAL REGULATORY FRAMEWORK

The principal legislation for the management of air quality in Hong Kong is the *Air Pollution Control Ordinance* (APCO) (Cap 311). The APCO Amendment was passed in July 2013 and a set of new Air Quality Objectives (AQOs) has been effective from 1 January 2014. The new AQOs stipulate statutory ambient limits for air pollutants and the maximum allowable number of exceedances over specific averaging periods. The new AQOs are presented in *Table 5.1* and they were used as the evaluation criteria for this assessment. As stipulated in *Annex 4* of the *Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM)*, the AQOs and other relevant standards established under the APCO should be met.

Table 5.1 Hong Kong Air Quality Objectives *($\mu g\ m^{-3}$)* [(a)]

Air Pollutant	Averaging Time	Concentration ($\mu g m^{-3}$) [(a)]	No. of Exceedances Allowed per Year
Sulphur Dioxide (SO_2)	10 minute	500	3
	24-hours	125	3
Respirable Suspended Particulates (RSP) [(b)]	24-hours	100	9
	Annual	50	-
Fine Suspended Particulates (FSP) [(c)]	24-hours	75	9
	Annual	35	-
Nitrogen Dioxide (NO_2)	1-hour	200	18
	Annual	40	-
Ozone (O_3)	8-hours	160	9
Carbon Monoxide (CO)	1-hour	30,000	-
	8-hours	10,000	-
Lead	Annual	0.5	-

Notes:

(a) Measured at 293K and 101.325 kPa.

(b) Suspended particles in air with a nominal aerodynamic diameter of 10 μm or less

(c) Suspended particles in air with a nominal aerodynamic diameter of 2.5 μm or less

Annex 4 of the *EIAO-TM* also stipulates that any predictive assessment of the odour impact should meet 5 odour units based on an averaging time of 5 seconds.

5.3 *BASELINE CONDITIONS*

The Project Site is located in rural area and no major air emission source is identified in the area. Since the continued operation of the magazine site for the HKLTH will commence in 2015, the hourly ambient pollutant concentration data predicted by the PATH (Pollutants in the Atmosphere and their Transport over Hong Kong) model for Year 2015 has been adopted to reflect the future background air quality in the Project Site area during the operation of the Project. *Table 5.2* summarizes the annual average concentrations of the air pollutants in 2015 predicted by the PATH model.

Table 5.2 Annual Averaged Concentrations of Air Pollutants in 2015 Predicted by the PATH Model

Air Pollutant	**Annual Averaged Concentration (μg m^{-3})**	
	PATH Background in 2015 (a)	**Annual AQO**
SO_2	7	- (c)
NO_2	21	40
RSP	42	50
FSP (b)	30	35

Notes:

(a) The annual averaged concentrations of the air pollutants were extracted from PATH grid (19, 35) in which the Project Site is located.

(b) FSP data are not available in the hourly PATH background concentration results. A recommended FSP to RSP ratio of 0.71 is applied for the estimation of annual FSP results according to EPD's "*Guidelines on the Estimation of $PM_{2.5}$ for Air Quality Assessment in Hong Kong*".

(c) No annual AQO for SO_2.

According to the PATH-predicted background air quality in the Project Site area in 2015, the annual averaged concentrations of all concerned air pollutants after commencement of operation of the magazine site are anticipated to be below their respective AQOs.

5.4 *STUDY AREA AND IDENTIFICATION OF AIR SENSITIVE RECEIVERS*

The Study Area for the air quality impact assessment is generally defined by a distance of 500m from the boundary of the Project Site as shown in *Figure 5.1*. Air Sensitive Receivers (ASRs) were identified based on the landuses, latest Outline Zoning Plan (OZP) and with reference to *Table 12.5* of the XRL EIA Report. Four ASRs were identified which are presented in *Table 5.3* and their locations are shown in *Figure 5.1*.

Table 5.3 Air Sensitive Receivers

ASR	**Description**	**Type of Use**	**Approximate Separation Distance from the nearest site boundary (m)**	**No. of storey(s)**
TSA1	Village House next to Tai Shu Ha Road West	Residential	54	1
HKMEC	Hong Kong Model Engineering Club	Recreational	200	N/A
NHT1	Temple at Nam Hang Tsuen	Temple	338	1

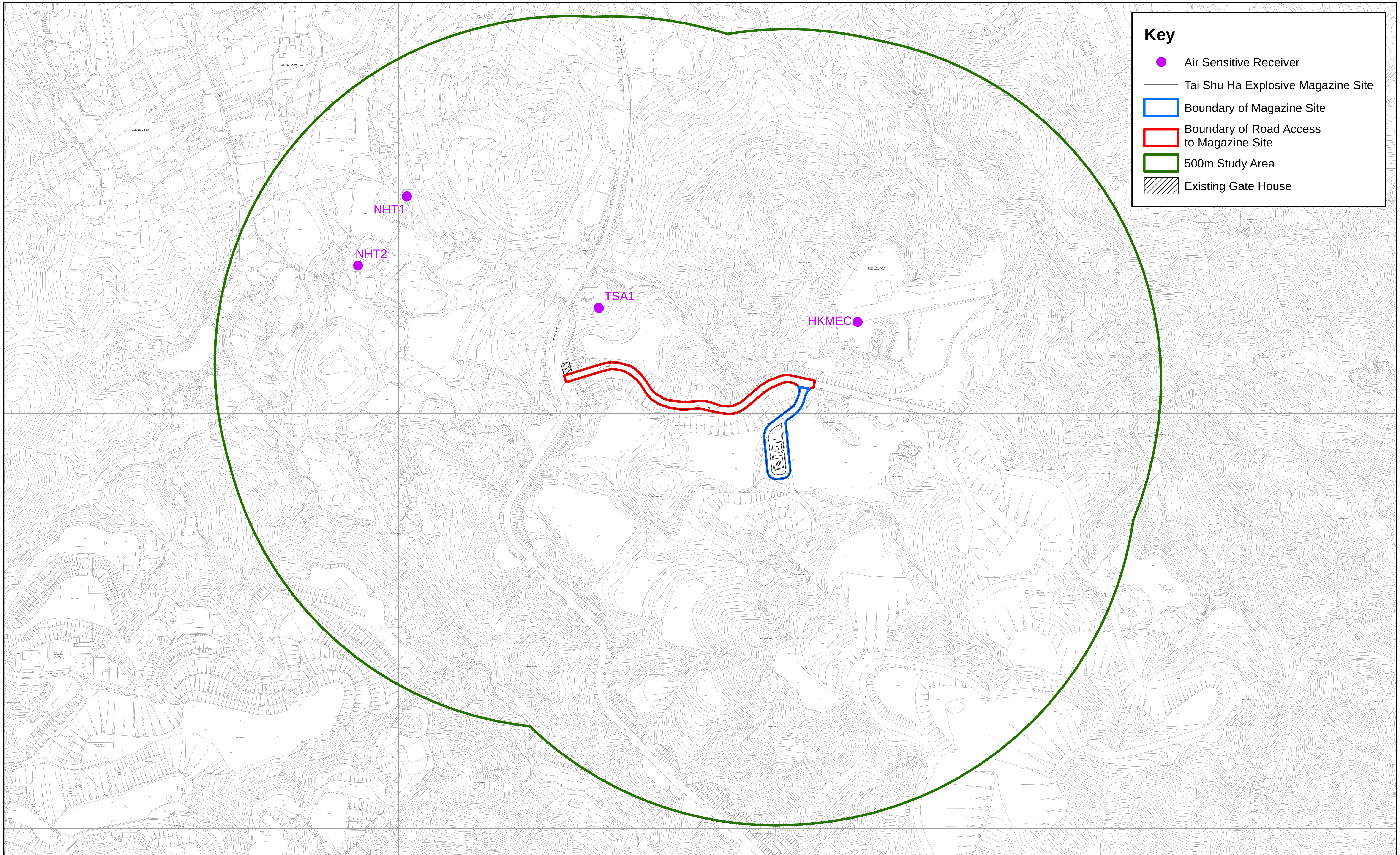

Figure 5.1

Locations of Air Sensitive Receivers and Dust Emission Sources

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ASR	Description	Type of Use	Approximate Separation Distance from the nearest site boundary (m)	No. of storey(s)
NHT2	Village House at Nam Hang Tsuen	Residential	332	1

5.5 *IDENTIFICATION OF IMPACTS*

The magazine site comprises two magazine structures storing 400kg of explosives each, a secure fence, CCTV system, guard house, street fire hydrant tank (245m^3) and two pumps.

Operation of the magazine site will remain the same as the current XRL project. The operational activities involve the delivery of explosives to the Magazines by Mines Division on a daily basis and the transfer of the explosives to the work areas by the contractors daily.

Potential sources of air quality impacts include dust emissions from the operation of explosives delivery vehicles. About two to eight trips per day are expected for the transportation of explosives to the work areas.

The magazine site will be decommissioned after the completion of the construction works for the Liantang/Heung Yuen Wai Boundary Control Point (BCP) project. Potential dust emissions may also arise during the decommissioning works.

5.6 *EVALUATION OF IMPACTS*

With reference to *Section 12.45* of the XRL EIA Report, the major activities causing dust impacts during operation would be the vehicles entering or leaving the magazine site. As the roads to/from and within the magazine site will be paved, dust impact from the operation of the magazine sites is anticipated to be insignificant. Hence, adverse air quality impact from the operation of the Project is not anticipated. Cumulative impact during the operation of the Project is also not anticipated as no significant air pollution source is identified within the Study Area. Since no adverse air quality impact is anticipated during the operation of the Project, no mitigation measures are deemed necessary.

The works for the decommissioning of the magazine site will only involve dismantling, demolition and removal of the existing structures and reinstatement of site. The decommissioning work is expected to take about one month. The decommissioning works may cause potential dust emissions. With respect to the nature and the small scale of the decommissioning works, the number of mobile plant to be used on site at any one time will be small, and all works will be conducted on a paved site. Since the site is concrete paved and no excavation or filling works would be required for the reinstatement of site. Therefore, the potential air quality impact to the identified ASRs is expected to be minimal. With the implementation of dust suppression measures stipulated under the *Air Pollution Control (Construction Dust) Regulation* and the adoption of good site practice, which includes covering of dusty stockpiles with impervious sheeting and regular watering of any exposed excavated soil surfaces during breaking activities, no adverse air quality impact associated with the decommissioning works is expected.

5.7 CONCLUSION AND RECOMMENDATIONS

Operation of the magazine site will remain the same as the current XRL project. The operational activities involve the delivery of explosives to and from the Project Site on a daily basis. Potential sources of air quality impact include dust emissions from the operation of explosives delivery vehicles from the magazine to the work areas, with about two to eight trips per day. Roads to/from and within the Project Site will be paved, thus dust impact from the operation of the magazine site is anticipated to be insignificant. Decommissioning of the magazine site has the potential to cause dust emissions. Since the decommissioning works will be small scale, the potential air quality impact is expected to be minimal with the implementation of proper dust control measures. Air quality monitoring and audit is not considered necessary during the operation of the Project as no adverse air quality impact is anticipated.

6 *WASTE MANAGEMENT*

6.1 *INTRODUCTION*

This chapter presents the potential impacts from waste generated by the operation and decommissioning of the Project. While the previously approved Hong Kong Section of the XRL EIA report (No. AEIAR-143/2009) XRL) covers waste management implications of the whole XRL Project, it does not include details specifically for the TLEM site and therefore an independent assessment of the operational and decommissioning waste implications for the current Project have been undertaken.

6.2 *RELEVANT ENVIRONMENTAL REGULATORY FRAMEWORK*

The following legislation covers the handling, treatment and disposal of wastes in Hong Kong, and has been considered in the assessment.

- *Waste Disposal Ordinance* (WDO) (Cap 354);
- *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* (Cap 354N);
- *Waste Disposal (Chemical Waste) (General) Regulation* (Cap 354C);
- *Land (Miscellaneous Provisions) Ordinance* (Cap 28); and
- *Public Health and Municipal Services Ordinance (Cap 132) - Public Cleansing and Prevention of Nuisances Regulation*.

6.2.1 *Waste Disposal Ordinance (Cap 354)*

The *Waste Disposal Ordinance* (*WDO)* prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Construction waste is not directly defined in the *WDO* but is considered to fall within the category of 'trade waste'. Trade waste is defined as waste from any trade, manufacturer or business, wasted building, civil engineering materials, but does not include animal waste. Under the *WDO*, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or a prison sentence. The *WDO* also provides for the issuing of licences for the collection and transport of wastes. Licences for the collection and transport of construction waste or trade waste, however, are not issued currently. For general waste there is no charge and this needs to be disposed in a licensed facility.

6.2.2 *Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap 354N)*

The *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* (*Cap 354N*) defines construction waste as any substance, matters or things that is generated from construction work and abandoned, whether or not it has been processed or stockpiled before being abandoned. It does not include any sludge, screening or matter removed in or generated from any desludging, desilting or dredging works. The *Construction Waste Disposal Charging Scheme* entered into operation on 1 December 2005. Starting from 1 December 2005, a main contractor who undertakes construction work with a contract value of HK$1 million or above is required to open a billing account solely for the contract for waste disposal. Depending on the percentage of inert C&D materials in the waste, it can be disposed of at public fill reception facilities. However mixed construction waste can be disposed of at construction waste sorting facilities, landfills and Outlying Islands Transfer Facilities which have different disposal costs. The scheme encourages reducing, reusing and sorting of construction waste such that the waste producer can reduce their disposal fee. *Table 8.2* summarises the government construction and demolition waste disposal facilities and types of waste accepted.

Table 6.1 Government Facilities for Disposal of Construction & Demolition Waste

Government Waste Disposal Facilities	Type of Construction & Demolition (C&D) Waste Accepted
Public fill reception facilities	Consisting entirely of inert C&D materials
Sorting facilities	Containing more than 50% by weight of inert C&D materials
Landfills	Containing not more than 50% by weight of inert C&D materials
Outlying Islands Transfer Facilities	Containing any percentage of inert C&D materials

6.2.3 *Waste Disposal (Chemical Waste) (General) Regulation*

Chemical waste as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation*, if such a substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

Chemical waste producers shall register with the EPD. Any person who contravenes this requirement commits an offence and is liable to a fine and imprisonment. Producers of chemical wastes must treat their wastes, utilising on-site plants licensed by the EPD or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The system is designed to allow the transfer of wastes to be traced from cradle-to-grave.

The *Regulation* prescribes the storage facilities to be provided on site including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. He/she must also provide employees with training in such procedures.

6.2.4 *Land (Miscellaneous Provisions) Ordinance (Cap 28)*

The inert C&D materials (also called public fill) may be taken to public fill reception facilities. Public fill reception facilities usually form part of land reclamation schemes and are operated by the Civil Engineering and Development Department (CEDD) and others. The *Land (Miscellaneous Provisions) Ordinance* requires that individuals or companies who deliver public fill to the public fill reception facilities to obtain Dumping Licences. The licences are issued by CEDD under delegated authority from the Director of Lands.

Individual licences and windscreen stickers are issued for each vehicle involved. Under the licence conditions, public fill reception facilities will only accept earth, soil, sand, rubble, brick, tile, rock, boulder, concrete, asphalt, masonry or used bentonite. In addition, in accordance with paragraph 11 of *DEVB TC(W) No. 6/2010 "Trip Ticket System for Disposal of Construction and Demolition Materials*", the Public Fill Committee will advise on the acceptance criteria (e.g. no mixing of construction waste, nominal size of the materials less than 250mm, etc). The material will, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical wastes, animal and vegetable matter and any other materials considered unsuitable by the public fill reception facility supervisor.

6.2.5 *Public Cleansing and Prevention of Nuisances Regulation*

This *Regulation* provides further control on the illegal dumping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to a fine and/or imprisonment.

6.2.6 *Other Relevant Guidelines*

Other 'guideline' documents, which detail how the Project Proponent or Contractor should comply with the local regulations, are as follows:

- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* (1992), EPD, Hong Kong Government;
- New Disposal Arrangements for Construction Waste (1992), EPD & CED, Hong Kong SAR Government;
- *WBTC No. 2/93, Public Dumps*, Works Branch, Hong Kong Government;
- WBTC No. 2/93B, Public Filling Facilities, Works Branch, Hong Kong Government;
- *WBTC Nos. 25/99, 25/99A and 25/99C,* Incorporation of Information on Construction and Demolition Material Management in Public Works Sub-committee Papers; Works Bureau, Hong Kong SAR Government;
- *WBTC No. 12/2000,* Fill Management; Works Bureau, Hong Kong SAR Government;

- *ETWBTC(W) No. 33/2002, Management of Construction and Demolition Material Including Rock,* Environment, Transport and Works Bureau, Hong Kong SAR Government;
- *ETWB TC(W) No. 19/2005 Environmental Management on Construction Site,* Environment, Transport and Works Bureau, Hong Kong SAR Government.
- *DEVB TC(W) No. 6/2010, Trip Ticket for Disposal of Construction and Demolition Materials;*
- *DEVB TC(W) No. 8/2010, Enhanced Specification for Site Cleanliness and Tidiness;*
- *DEVB TC(W) No.2/2011, Encouraging the Use of Recycled and Other Green Materials in Public Works Projects;* and
- *DEVB TC(W) No. 9/2011, Enhanced Control Measures for Management of Public Fill.*

6.3 IDENTIFICATION OF IMPACTS

6.3.1 Operation Phase

The major types of solid waste likely to be generated from the operation of the Project at the magazine site, is general refuse. The operation works will involve only a very small amount of equipment including delivery vehicles for explosives transport and two pumps for the Street Fire Hydrant Water Tank.

The quantities of chemical waste to be generated from regular maintenance of equipment will be minimal. *Table 6.2* indicates the different waste types and estimated quantities generated throughout the operation of the Project and how these will be handled and disposed of. All chemical waste will be handled in accordance with the EPD's Code of Practice on the Packaging Labelling and Storage of Chemical Waste and a licenced collector will be employed for the collection of the chemical waste generated to the licenced disposal facilities. Hence, no adverse environmental impact is anticipated due to the management of a small quantity of chemical waste to be generated from the Project.

Table 6.2 Waste Types Generated throughout Operation and Decommissioning of the Project

Waste Type	Quantity Generated	Handling & Disposal Options
Operation		
General refuse	Up to 5 kg per day	As per (2)
C&D materials	None	n/a
Chemical waste	Minimal (< 1kg/month) (regular maintenance of equipment will be carried out offsite)	As per (3)
Decommissioning		
General refuse	Up to 5 kg per day	As per (2)
C&D materials	Total 350 m^3	As per (1) & (2)
- Inert	*325m^3*	

Waste Type	Quantity Generated	Handling & Disposal Options
- Non-inert	*25m³*	
Chemical waste	Minimal (< 10kg) (maintenance of equipment will be carried out offsite)	As per (3)

(1) Inert C&D materials will be disposed of at Tuen Mun Area 38 Fill Bank
(2) Non-insert C&D materials will be disposed of at WENT Landfill
(3) General refuse will be disposed of at WENT Landfill or via transfer station
(4) All chemical waste will be handled in accordance with the EPD's *Code of Practice on the Packaging Labelling and Storage of Chemical Waste*. Employ a licenced collector for collection of chemical waste and disposal at the licenced disposal facilities (eg Chemical Waste Treatment Facility at Tsing Yi)

6.3.2 Decommissioning Phase

The major types of solid waste likely to be generated from the decommissioning works include construction and demolition (C&D) materials (both inert and non-inert materials), chemical wastes and general refuse. No decommissioning materials will be considered for reuse except: metal scrap/re-bar collected by the recycler; fire extinguishers collected by the fire service provider; and fire hydrant water tank and water pumps. Negligible amount of rock or spoil will be generated, and only small amount of metal will be generated from the decommissioning works. Owing to the small scale of works, the amount of C&D materials generated will be limited, approximately 350 m^3.

Currently the TLEM is operated under Contract CV/2012/08, and all non-inert waste will be disposed at NENT landfill using the existing billing account of the Contract i.e. NENT landfill is the designated disposal site of the Contract. *Table 6.2* indicates the different waste types and estimated quantities generated from the decommissioning of the Project and how these will be handled and disposed of.

Based on the above, the potential impacts associated with the handling and disposal of C&D materials due to the decommissioning works are considered minor.

6.4 PREDICTION AND EVALUATION OF IMPACTS

With proper housekeeping measures and refuse collection in place, minimal or no impact is expected to result from refuse generated during the operational phase.

The decommissioning works will involve only a very small number of construction equipment. The quantities of chemical waste generated will also be minimal. All chemical wastes will be handled in accordance with the EPD's *Code of Practice on the Packaging Labelling and Storage of Chemical Waste* and a licenced collector will be employed for the collection of the chemical waste generated to the licenced disposal facilities (eg Chemical Waste Treatment Facility at Tsing Yi). Hence, no adverse environmental impact is anticipated due to the management of a small quantity of chemical waste to be generated from the Project. With proper housekeeping measures and refuse collection in place, minimal or no impact is expected to result from refuse generated (up to about 5 kg per day) during the decommissioning works. The inert and non-inert C&D materials will be disposed of at Tuen Mun Area 38 Fill Bank and WENT Landfill, respectively. The general refuse will be disposed of at WENT Landfill or via transfer station.

6.5 *PROPOSED MITIGATION MEASURES*

To minimise the amount of waste, careful design, comprehensive planning and good site management practice will be adopted by the contractors of the Project and waste on-site will be properly segregated to increase the potential for reuse and recycling. Chemical waste generated from equipment operation and demolition works will be properly stored in accordance with *Code of Practice on the Packaging, Labelling and Storage of Chemical Waste* published by the EPD before collection for disposal by a licensed Chemical Waste Collector. The quantity of general refuse generated on-site will be minimal owing to the nature of the operation activities and the small number of workers involved during decommissioning.

6.6 *CONCLUSION AND RECOMMENDATIONS*

The amount of general refuse generated from the operation and decommissioning of the magazine site is expected to be small. General refuse will be stored and disposed of separately from chemical waste. C&D materials from the decommissioning will also be handled and disposed of appropriately. Provided that general refuse is removed from the Project Site regularly during operation and decommissioning (e.g. once per day) and C&D materials is disposed of appropriately, no adverse environmental impact related to handling and disposal of wastes is expected.

7 OTHER ENVIRONMENTAL CONSIDERATIONS

7.1 WATER QUALITY

This section presents the potential impacts from the operation and decommissioning of the Project on water quality. While the previously approved Hong Kong Section of the XRL EIA report (No. AEIAR-143/2009) XRL) covers the implication of potential water quality impacts from the whole XRL Project, this does not include details specifically at the TLEM site. *Section 3* Ecology of the XRL EIA addresses impacts to two watercourses in the TLEM project site, watercourse 4 and watercourse 5, and equally these are addressed in *Chapter 3 Ecology* of this report.

7.1.1 Relevant Environmental Regulatory Framework

The following relevant legislation and associated guidance are applicable to the evaluation of water quality impacts associated with the Project:

- *Water Pollution Control Ordinance (WPCO);*
- *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM- ICW);*
- *Environmental Impact Assessment Ordinance (Cap. 499. S.16) and the Technical Memorandum on EIA Process (EIAO-TM), Annexes 6 and 14.*

Water Pollution Control Ordinance (WPCO)

The *Water Pollution Control Ordinance (WPCO)* is the primary legislation for the control of water pollution and water quality in Hong Kong. Under the *WPCO*, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs).

Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM- ICW)

All discharges during both the operation phase of the proposed Project are required to comply with the *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-ICW)* issued under *Section 21* of the *WPCO*.

The *TM-ICW* defines acceptable discharge limits to different types of receiving waters. Under the *TM-ICW*, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for specified discharge volumes. These are defined by the Environmental Protection Department (EPD) and are specified in license conditions for any new discharge within a WCZ.

Environmental Impact Assessment Ordinance (Cap. 499. S.16) and the Technical Memorandum on EIA Process (EIAO-TM), Annexes 6 and 14

Under Section 16 of the EIAO, Environmental Protection Department (EPD) issued the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM) which specifies the assessment methods and criteria for environmental impact assessment. This section follows the EIAO-TM to assess the potential water quality impacts that may arise during the operation and decommission phases of the Project. Sections in the EIAO-TM relevant to the water quality impact assessment include: Annex 6 - Criteria for Evaluating Water Pollution; and Annex 14 - Guidelines for Assessment of Water Pollution.

7.1.2 Baseline Water Quality Conditions

The Project is located in Tai Shu Ha, which is within the water catchment of the Yuen Long Creek. As shown in *Figure 7.1*, there are two minor watercourses within 500 m from the Project boundary. Both of these watercourses run into a tributary of Yuen Long Creek, which is continuously monitored by EPD at YL2 and YL3 as also shown in *Figure 7.1*. The 2013 river water quality at EPD monitoring stations YL2 and YL3 downstream of the Project Site is summarized below in *Table 7.1*.

Yuen Long Creek's overall compliance rate in 2013 was 51%, compared with 53% in 2012. The compliance rate for the more upstream YL2 station (which is still downstream of the Project Site) was 60% in 2013 as compared 62% in 2012. The compliance rate for the YL3 station in the middle of Yuen Long township was 42% in 2013 as compared with 42% in 2012. This river is subject to discharges from livestock farms, unsewered village houses and industrial establishments.

Table 7.1 River Water Quality at Yuen Long Creek Downstream to the Project Site in 2013

Parameter	Unit	Yuen Long Creek YL2	YL3
Dissolved oxygen	mg/L	6.7 (3.0 - 9.6)	5.0 (2.6 - 6.9)
pH		7.3 (7.2 - 7.6)	7.6 (7.1 - 8.4)
Suspended solids	mg/L	10 (4 - 27)	27 (9 - 140)
5-day Biochemical Oxygen Demand	mg/L	9 (4 - 40)	38 (4 - 82)
Chemical Oxygen Demand	mg/L	29 (11 - 69)	45 (9 - 180)
Oil & grease	mg/L	0.6 (<0.5 - 1.6)	1.3 (<0.5 - 5.0)
Faecal coliforms	cfu/ 100mL	<130,000 (<1,000 - 740,000)	870,000 (250,000 - 2,800,000)
E. coli	cfu/ 100mL	<93,000 (<1,000 - 630,000)	330,000 (71,000 - 1,200,000)
Ammonia-nitrogen	mg/L	13.50 (0.76 - 20.00)	2.90 (0.36 - 11.00)
Nitrate-nitrogen	mg/L	1.85 (0.19 - 6.40)	<0.01 (<0.01 - 1.30)
Total Kjeldahl nitrogen	mg/L	16.00 (1.30 - 23.00)	4.10 (0.87 - 14.00)
Ortho-phosphate	mg/L	2.40 (0.22 - 3.10)	0.35 (<0.01 - 1.10)
Total phosphorus	mg/L	2.45 (0.28 - 3.40)	0.56 (0.21 - 1.90)

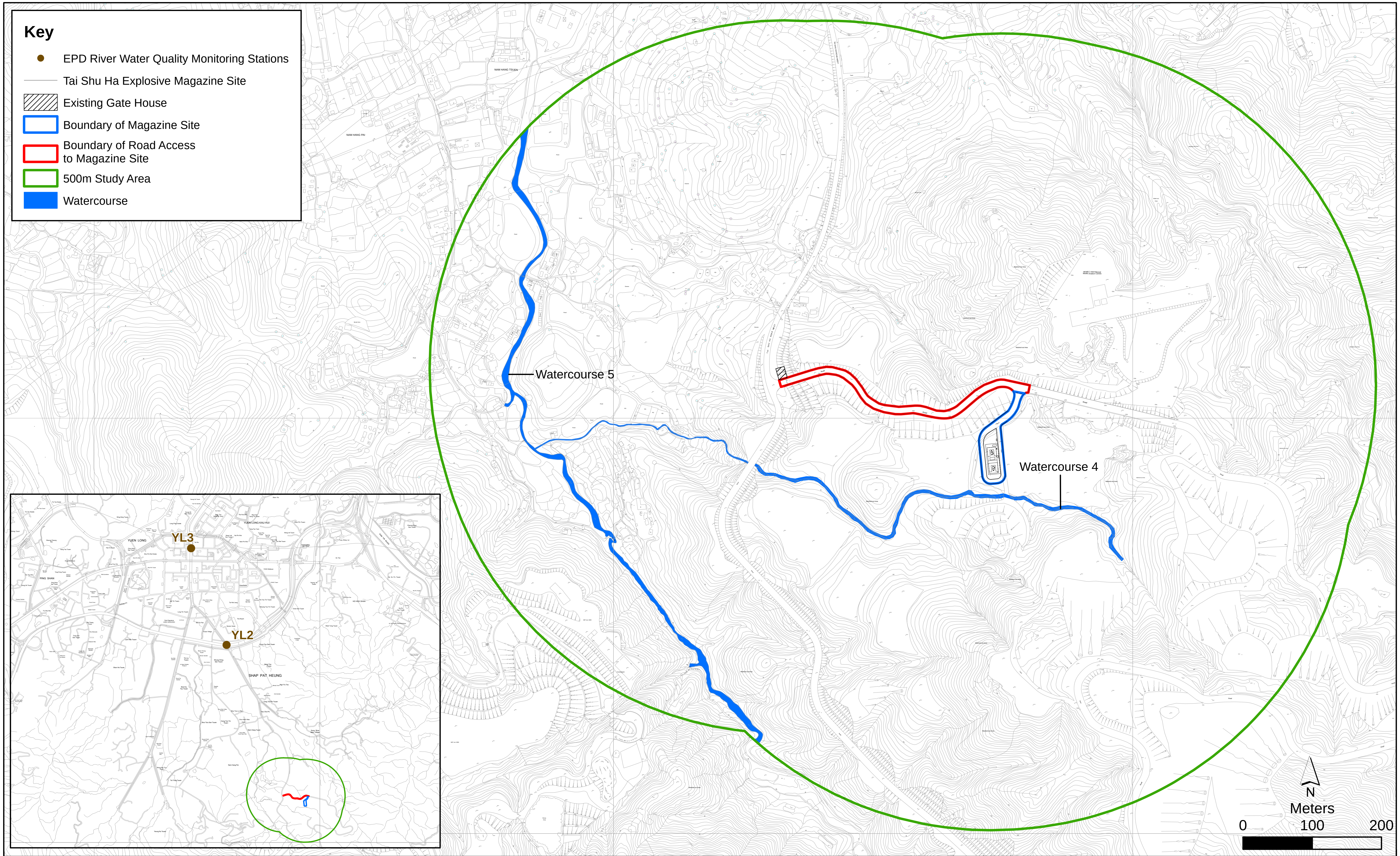

Figure 7.1

Project Boundary and Nearby Waterbodies

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Date: 27/5/2015

Environmental Resources Management

ERM

Parameter	Unit	Yuen Long Creek	
		YL2	YL3
Total sulphide	mg/L	<0.02 (<0.02 - 0.05)	<0.02 (<0.02 - 0.07)
Aluminium	μg/L	110 (70 - 330)	355 (134 - 520)
Cadmium	μg/L	<0.1 (<0.1 - 1.0)	0.2 (<0.1 - 1.0)
Chromium	μg/L	<1 (<1 - <1)	<1 (<1 - 8)
Copper	μg/L	4 (3 - 7)	5 (2 - 10)
Lead	μg/L	<1 (<1 - 8)	5 (1 - 17)
Zinc	μg/L	31 (20 - 120)	45 (18 - 96)
Flow	L/s	18 (10 - 504)	450 (135 - 1,100)

Notes:

1. Data presented are in annual medians of monthly samples; except those for faecal coliforms and E. coli which are in annual geometric means.
2. Figures in brackets are annual ranges.
3. cfu - colony forming unit.
4. Values at or below laboratory reporting limits are presented as laboratory reporting limits.
5. Equal values for annual medians (or geometric means) and ranges indicate that all data are the same as or below laboratory reporting limits

7.1.3 *Identification and Evaluation of Impacts*

The Project Site is currently being used as an explosive magazine site for the construction of the XRL. As such, there will not a construction phase for this Project.

The operation of the magazine site is expected to be similar to the previous operation under the XRL, which involves only storage of explosive within Project Site and transportation of explosive to / from the Project Site. Such operation activities are not expected to involve any discharges or effluent to streams. Appropriate surface drainage has been provided by the previous occupant of the site following the requirements stipulated under *ProPECC PN 5/93 "Drainage Plans subject to Comment by the Environmental Protection Department"* and storm water would be discharged into the surface drainage system. The nearby roads connecting the Project Site are already paved and adverse water quality impact from storm runoff from unpaved roads is not expected. There will not be a significant number of staff staying at the Project Site, with the exception of only a few security guards. One chemical toilet would be provided on site and night soil would be regularly collected by a licensed contractor. No adverse water quality impact is expected from the operation of the proposed magazine site.

A brief description on the decommissioning works required is provided in *Annex 2A*. The decommissioning works that may have the potential to generate silty surface runoff are expected to include minor dismantling, demolition and removal of temporary structures. No major civil works would be required. Adverse water quality impact is therefore not expected with the implementation of proper site runoff control measures considering the small scale and short duration of works activities. Water quality impact on other fresh water courses from the works is also unlikely. Any discharge from the site would be expected to be in compliance with the requirements of the Water Pollution Control Ordinance.

Appropriate measures will be implemented in accordance with the guidelines stipulated in EPD's *Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)* during the decommissioning works to properly control site run-off and drainage and to minimise potential water quality impacts. Major relevant measures include those listed below

- Surface run-off from construction site should be discharged into storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels or earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities. Perimeter channels at site boundaries should be provided where necessary to intercept storm run-off from outside the site so that it will not wash across the site. Catchpits and perimeter channels should be constructed in advance of site formation works and earthworks.

- Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times.

- Earthworks final surfaces should be well compacted and the subsequent permanent work or surface protection should be carried out immediately after the final surfaces are formed to prevent erosion caused by rainstorms. Appropriate drainage like intercepting channels should be provided where necessary.

- Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system, and to prevent storm run-off from getting into foul sewers. Discharge of surface run-off into foul sewers must always be prevented in order not to unduly overload the foul sewerage system.

- Precautions and actions, as stipulated in Appendix A2 of *ProPECC PN1/94,* should be taken at any time of year when rainstorms are likely, when a rainstorm is imminent or forecast, or during and after rainstorms.

In addition, to minimize erosion of exposed soil in between the removal of paved area and the re-vegetation / plantation, exposed soil should be covered with geotextile promptly after the removal works.

7.2 LANDSCAPE AND VISUAL

This section presents the potential impacts from the operation and decommissioning of the Project on landscape and visual elements.

The Project Site is currently being used as an explosive magazine site for the construction of the XRL and therefore there will be no change to the current landscape and visual elements. The TLEM site, as well as the two one-storey stores, is largely shielded by topography and trees in the area which *Figure2.9b* helps illustrate, with *Figures 2.7* and *3.1* collectively illustrating the surrounding topography and extent of trees. No adverse landscape and visual impacts are anticipated from the operation and decommissioning of the proposed magazine site.

The previously approved Hong Kong Section of the XRL EIA report (No. AEIAR-143/2009) XRL) proposed that the magazine site be re-planted upon completion of the XRL project, to help compensate for the felling of trees that had been necessary initially to construct this magazine site. *Chapter 3 Ecology* of this report addresses this matter.

7.3 OTHER ENVIRONMENTAL MEDIA FROM XRL EIA

The scope of the approved XRL EIA was far broader than just the TLEM since it covered a much larger area. This EIA included assessments on impacts to Cultural Heritage, Fisheries, Ground-borne Noise, Land Contamination, Landfill Gas Hazard and Impacts on the Restored Ngau Tam Mei Landfill. None of these media are considered relevant to this Project giving its situation and size, absence of any tunnelling work nor generation of significant waste.

7.4 CONCLUSION AND RECOMMENDATIONS

No adverse water quality or landscape and visual impacts from operation and decommissioning of the Project are anticipated. Mitigation measures and environmental monitoring and audit during the operational and decommissioning phase are not considered necessary for landscape and visual impacts. Additional mitigation measures are proposed under *section 7.1.3* to minimize any potential water quality impact from the decommissioning works under this Project.

This Project is also considered to have no impacts on certain environmental media covered in the XRL EIA, namely Cultural Heritage, Fisheries, Ground-borne Noise, Land Contamination, Landfill Gas Hazard and the Restored Ngau Tam Mei Landfill.

8 *HAZARD TO LIFE*

8.1 *INTRODUCTION*

This chapter of the EIA presents a summary of the analysis and findings of the Hazard to Life Assessment (also referred as Quantitative Risk Assessment (QRA)) undertaken for the proposed operation of the existing TLEM for this Project, in accordance with the EIA Study Brief (ESB-280/2014), *Section 3.4.3*.

The TLEM operation will remain the same as the current MTR XRL 824 Contractor with explosives delivered by DHK to three worksites located at Sha Tau Kok Road – Wo Hang Section (North Portal), Po Kat Tsai Road (Mid Ventilation Portal) and Tong Hang Tung Chuen (South Portal). Mines will deliver explosives and initiation devices (detonators) to the Magazine on a daily basis and these will be withdrawn by the contractors as required. The transportation of explosives by Mines either to the Magazine or directly to sites is under Mines' responsibility and falls outside the scope of this EIA study.

The Hazard to Life/ QRA assessment under this chapter of the EIA, addresses, in particular, the following:

- Storage of explosives at the proposed magazine (cartridged emulsion, detonating cord, cast boosters and detonators) including handling of explosives within the magazine site; and
- Transport of explosives to the three worksites.

Further details of the QRA for the Project are presented in the *Annex 8A*.

8.2 *LEGISLATION REQUIREMENT AND EVALUATION CRITERIA*

The key legislation and guidelines that are considered relevant to the Project are as follows:

- *Dangerous Goods Ordinance*, Chapter 295; and
- *Environmental Impact Assessment Ordinance (EIAO)*, Chapter 499.

8.2.1 *EIAO Technical Memorandum (EIAO-TM)*

The requirement for a QRA of projects that involve the storage and transport of dangerous goods where a risk to life is a key issue with respect to the Hong Kong Government Risk Guidelines (HKRG) is specified in *Section 12* of the *Environmental Impact Assessment Ordinance Technical Memorandum* (*EIAO-TM*).

The relevant authority for a QRA study relating to an explosives magazine storage facility and the transport of the explosives is the Environmental Protection Department (EPD), as specified in *Annex 22* of the *EIAO-TM*.

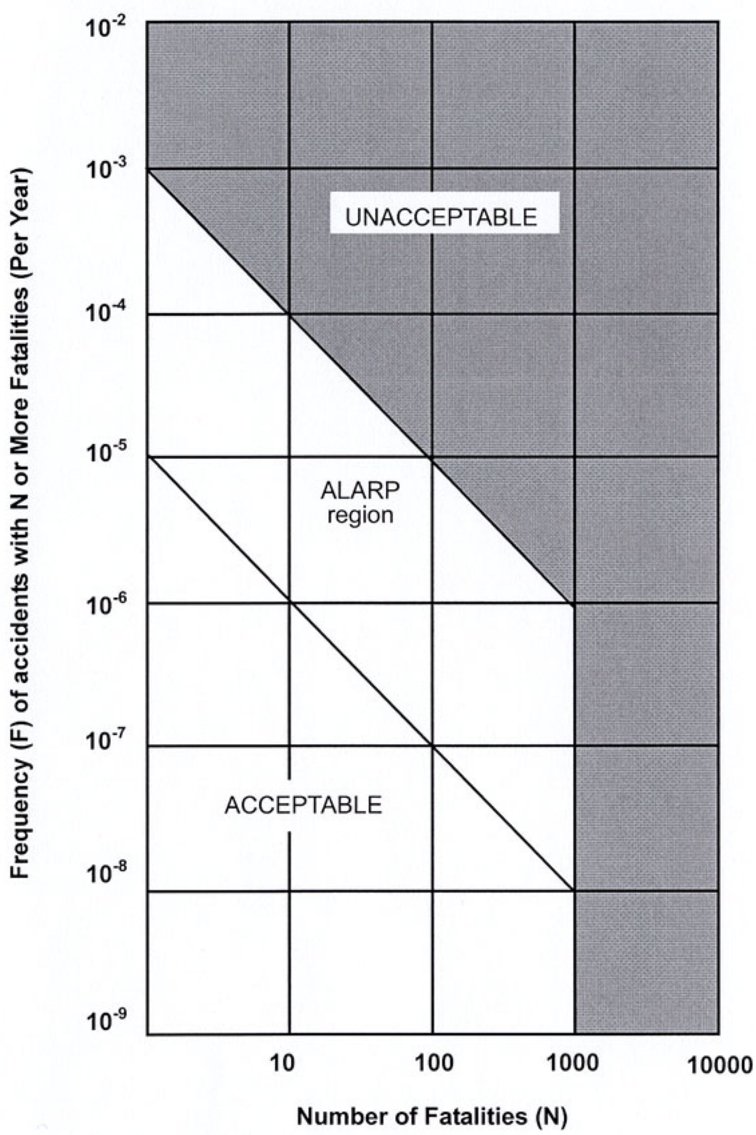
Annex 4 of the *EIAO-TM* specifies the Individual and Societal Risk Guidelines.

8.2.2 *Hong Kong Government Risk Guidelines (HKRG), EIAO TM Annex 4*

Individual risk is the predicted increase in the chance of fatality per year to an individual due to a potential hazard. The individual risk guidelines require that the maximum level of individual risk should not exceed 1 in 100,000 per year i.e. 1×10^{-5} per year.

Societal risk expresses the risks to the whole population. The HKRG is presented graphically in *Figure 8.1*. It is expressed in terms of lines plotting the frequency (F) of N or more deaths in the population from incidents at the installation. Two F-N risk lines are used in the HKRG that demark "acceptable" or "unacceptable" societal risks. The intermediate region indicates the acceptability of societal risk is border-line and should be reduced to a level which is "as low as is reasonably practicable" (ALARP). It seeks to ensure that all practicable and cost effective measures that can reduce risk will be considered.

Figure 8.1 *Societal Risk Criteria in Hong Kong*



8.2.3 *Statutory / Licensing Requirements with Respect to Explosives*

The statutory / licensing requirements with respect to the explosives (Cat. 1 Dangerous Goods) or the oxidizing substances (Cat. 7 Dangerous Goods) used to prepare explosives at the construction work area as well as relevant government departments/ authorities' advice and practice on the proposed transport and storage of explosives for the blasting activities are summarized below.

Category 1 Explosives and Blasting Agents

The Commissioner of Mines Division is the responsible authority for this and applicable regulations/ guidance notes include:

- Supply of detonators, cast boosters and cartridged emulsion explosives (under the Dangerous Goods (General) Regulations Cap. 295B);
- Approved explosives for blasting in Hong Kong (under the Dangerous Goods (General) Regulations Cap. 295B);
- Blast design (under the Dangerous Goods (General) Regulations Cap. 295B);
- Blast loading and execution (under the Dangerous Goods (General) Regulations Cap. 295B);
- Removal of explosives (under Regulation 4 of the Dangerous Goods (General) regulations Cap. 295B);
- Approval of an explosives delivery vehicle (under CEDD's "Guidance Note on Requirements for Approval of an Explosive Delivery Vehicle" (ref.34));
- Explosive delivery vehicle design features and safety requirements (under CEDD's "Guidance Note on Requirements for Approval of an Explosive Delivery Vehicle"(ref.34);
- Explosive magazine (under CEDD's document "How to Apply for a Mode A Explosives Store Licence" (ref.35));
- Explosives produced at site (under Regulation 31A of the Dangerous Goods (General) Regulations Cap. 295B); and
- Explosives load per truck (in accordance with the Removal Permit under the Dangerous Goods (General) Regulations Cap. 295B).

Category 7 Strong Supporters of Combustion

The Fire Services Department is the responsible authority for this and applicable regulations include:

- Storage of oxidizing agents (under Dangerous Goods (General) Regulations Cap. 295B)

8.3 *STUDY OBJECTIVES AND METHODOLOGY*

The objective of the QRA study is to assess the risk to life of the general public from the hazards that arise from the storage and transport of the explosives of the Project. The results of the QRA are then compared with the HKRG.

The detailed requirements of the study are given in *Section 3.4.3* of the EIA Study Brief. The main requirements are:

- Identify hazardous scenarios associated with the storage and transport of explosives and then determine a set of relevant scenarios to be included in a Quantitative Risk Assessment (QRA);
- Execute a QRA of the set of hazardous scenarios, expressing population risks in both individual and societal terms;
- Compare individual and societal risks with the criteria for evaluating hazard to life stipulated in *Annex 4* of the TM; and
- Identify and assess practicable and cost-effective risk mitigation measures.

The methodology used in the hazard assessment is consistent with previous studies having similar issues (e.g. Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA report (Register No. AEIAR-143/2009)).

The elements of the QRA study are shown schematically in *Figure 8.2* and include:

- Collection and review of relevant data for the TLEM Site, the transport from TLEM Site, as well as population and vulnerable receptors, such as slopes, retaining walls etc., in the vicinity of the worksites and proposed transport routes;
- Hazard identification. A review of literature and accident databases was undertaken and updated. These formed the basis for identifying all the hazardous scenarios for the QRA study;
- Frequency estimation. The frequencies, or the likelihood, of the various outcomes that result from the hazards associated with the storage and transport of explosives was taken primarily from previous EIA studies that have been accepted by the relevant authorities;
- For all identified hazards, the frequency assessment has been documented and the consequences of the event has been modelled;
- The consequence model employed in this study is the ESTC model (ESTC, 2000) developed by the UK Health and Safety Commission (HSC). Although, there have been a number of recent studies suggesting that the ESTC (2000) models should be reviewed for applicability to explosive

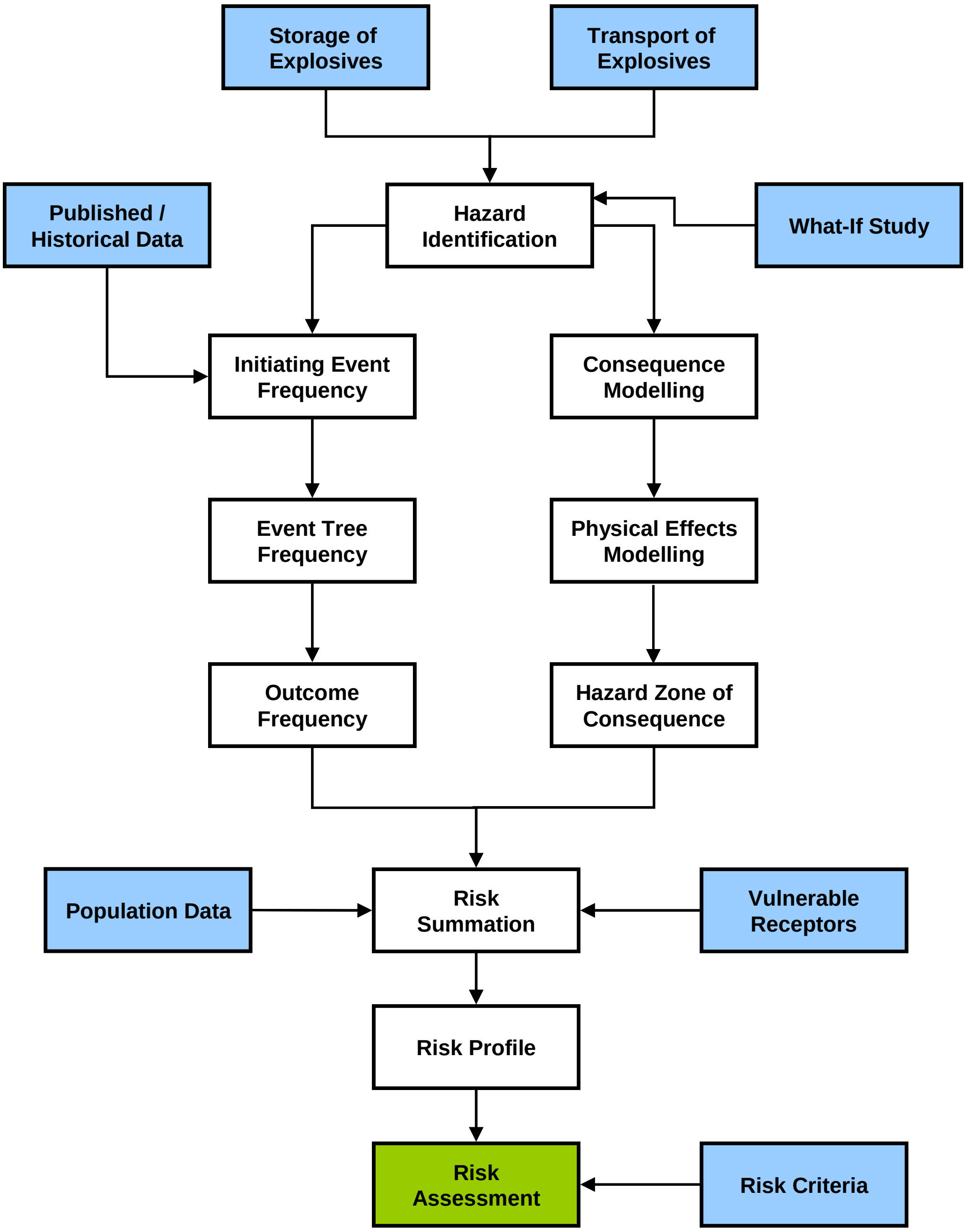
stores and transport, these models are still the recommended models in the UK and have been adopted in previous Hong Kong EIA studies;

- The same frequency model was adopted in this study as that of ERM (2009) study, which has been derived to reflect the current Transport Department statistics, Fire Services Department statistics, specific design features applicable for the project and current knowledge of explosives;

- The consequence and frequency data were subsequently combined using ERM's in-house Explosive Transport GIS Risk Assessment tool (E-TRA), which has been developed to account for three-dimensional blast effects on buildings and the effect of accidental explosions on elevated roads. It also accounts for traffic jam scenarios which could occur in some accidental scenarios as reported in the DNV (1997) study. The model is summarised in the next section and has been validated against ERM in-house proprietary software Riskplot ™. This risk assessment tool has been employed in the ERM (2009) study; and

- Finally, the results from the risk assessment were compared to the *EIAO-TM* Criteria. Recommendations have been made where required to ensure compliance with *EIAO-TM* Criteria, relevant best practice, and work to reduce the overall risk levels.

Figure 8.2 Schematic Diagram of the QRA Process



8.4 FACILITY DETAILS

The TLEM site and transport route options are described in *Chapter 2 Project Description* and the estimated project period for explosives storage and transport would be from late 2015 or early 2016 (expected January 2016) to December 2017.

8.4.1 TLEM site

The TLEM is designed to store sufficient quantities of explosives for two days so as to allow blasting to be carried out 24 hours per day and provide a buffer in the event of delivery interruption to the Magazine by Mines Division.

The magazine at Tai Lam (Tai Lam Explosives Magazine or TLEM) serves three worksites in the Northern New Territories. The site comprises two individual magazine stores, each with a single structure storing 400 kg of explosives such as cartridged emulsion, cast boosters and detonating cord. A storage chamber for detonators holding 1900 detonators, equivalent to two days' supply, is provided next to each explosives chamber. The detonators have a very low explosive mass and contain less than 1 gram of high explosives per detonator. Therefore, the net explosive quantity within the detonator chamber is less than 2 kg.

Each of the magazine buildings is a single-storey, detached and bunded structure, which is fenced and secured in accordance with the Commissioner of Mines' requirements. Details of the requirements are defined in the CEDD document "How to Apply for a Mode A Explosives Store Licence" (ref.35). Surface road access suitable for 11-tonne trucks is also provided for delivery of explosives. Mines Division will deliver explosives to the Magazine on a daily basis, from where explosives will be transferred to the work areas by the contractors for the daily or twice-daily blasts depending on requirements for construction. Loads will be limited to a maximum of 200 kg per truck or less in accordance with the Removal Permit issued by Mines Division.

8.4.2 Transport

The proposed explosives transport routes to the three worksites are shown in *Figure 8.3* (Route Option R1, Route Option R2 and Route Option R3 respectively).

In Route Options R1 and R3, the explosives delivery truck will pass through Pok Oi Interchange and Shap Pat Heung Interchange. During the Fourth Meeting of Traffic and Transport Committee under Yuen Long District Council on 24 July 2014 (Thursday), members expressed concerns on the traffic conditions of Pok Oi Interchange. Currently there is road improvement work which leads to serious traffic jams, thus temporary road diversion and traffic control measures are enforced. The road improvement work is expected to be completed in 2015 but may be delayed due to the flyover foundation. Therefore, members generally did not prefer the use of Pok Oi Interchange by the explosives delivery truck during the road improvement work, and recommended to use Tong Yan San Tsuen Interchange and Yuen Long Road, which is Route Option R2.

The explosives delivery routes will be:

- At early stage of this project, during road improvement work at Pok Oi Interchange (expected to be completed in 2015 but may be delayed), Route Option R2 will be used. Route Options R1 and R3 are not feasible since they both route via Pok Oi Interchange.

- After road improvement work at Pok Oi Interchange is completed, all three routes will be available for use. The Route Option with minimum transport risk will be used.

In addition to cartridged emulsion, cast boosters and detonating cord, detonators will also be transported. Detonators will be transported in a separate and dedicated licenced vehicle.

The licensed explosives delivery vehicles (LGV pick-up trucks) for delivery of explosives from the Magazine to the worksites, used as the basis for this QRA, will have the following safety features:

- Diesel powered;
- Driver's cabin is separated by a distance of not less than 150 mm from the cargo compartment of the vehicle;
- Manual fuel isolation switch;
- The exhaust system is located as far from the cargo compartment as possible. The modification of the exhaust system will be approved by the Transport Department;
- All electrical wiring and fittings will be shrouded in fire resisting conduits;
- Fuel tank will be protected from accidental damage, and designed to prevent accumulation of spilt fuel on any part of the vehicle;
- The required number of fire extinguishers shall be agreed with Mines Division;
- Fire resistant material shall be fitted between the wheel arches and the goods compartment;
- Hand-held lightning detector provided in the vehicle for lightning detection during loading and unloading of explosives;
- Lockable wood lined steel or aluminium receptacles mounted on the vehicle tray; and
- Fold down / up explosives warning signs and red strobe beacons.

In addition to the minimum requirements, a fire screen will be fitted between the cab and the load compartment, both between the cab and the load compartment and underneath the load compartment. The fire screen shall be 3 mm; extend to 150 mm above [all sides of] and run completely under the load compartment; to at least 100 mm behind the cab of the vehicle.

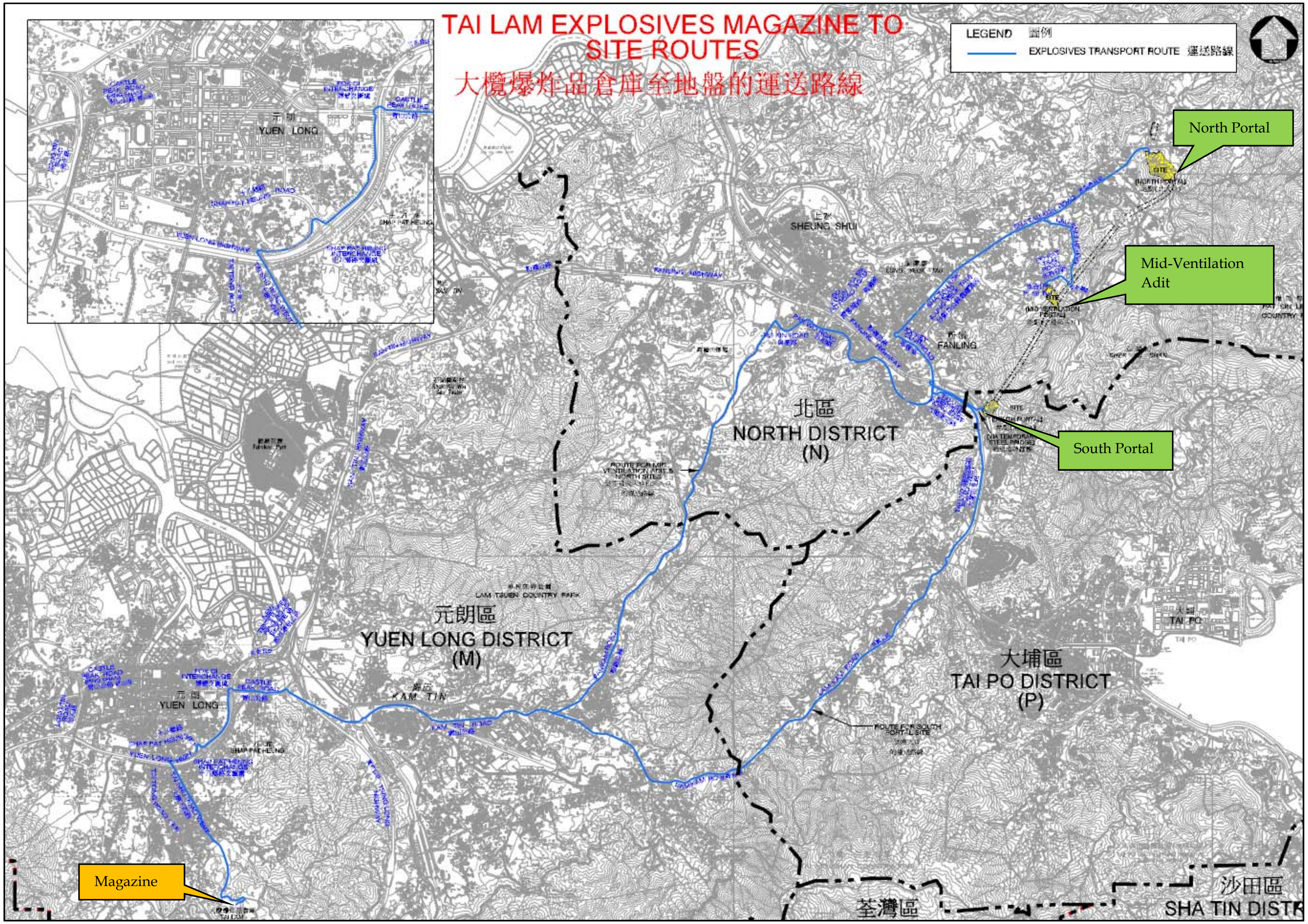
The explosives to be stored and transported from the Magazine to the worksites will include detonators, detonating cord, cast boosters and cartridged emulsion.

Cartridged emulsion, cast boosters and detonating cord will be delivered from the explosives Magazine to the worksites by the appointed contractor (i.e. DHK) using Mines Division licenced trucks. These explosives are classified as an explosive Class 1.1D under United Nation (UN) Classification (ref.7) and as a Category 1 (Explosive and Blasting Agents) Dangerous Goods under the *Hong Kong Dangerous Goods Ordinance*.

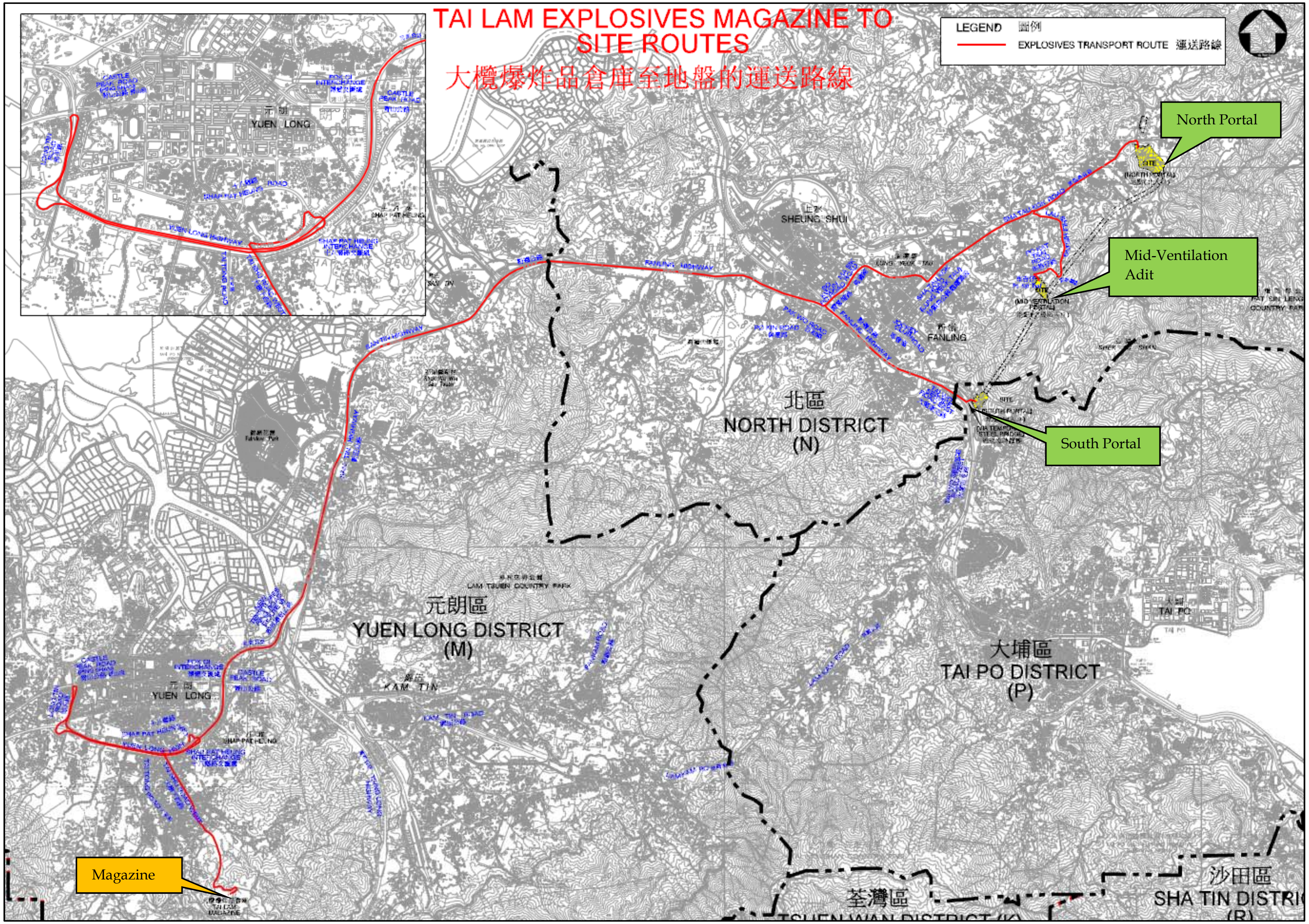
Detonators will also be used to initiate the blast at the working face. They are classified as Class 1.4B or 1.4S explosives under the UN classification system and Category 1 (Explosives and Blasting Agents) under the *Hong Kong Dangerous Goods Ordinance*, and will be transported from the Magazine to worksites by a dedicated truck, which is identical to, but independent of the truck carrying the emulsion explosives and detonating cord.

Figure 8.3 Proposed Explosive Transport Routes Option R1, R2 and R3

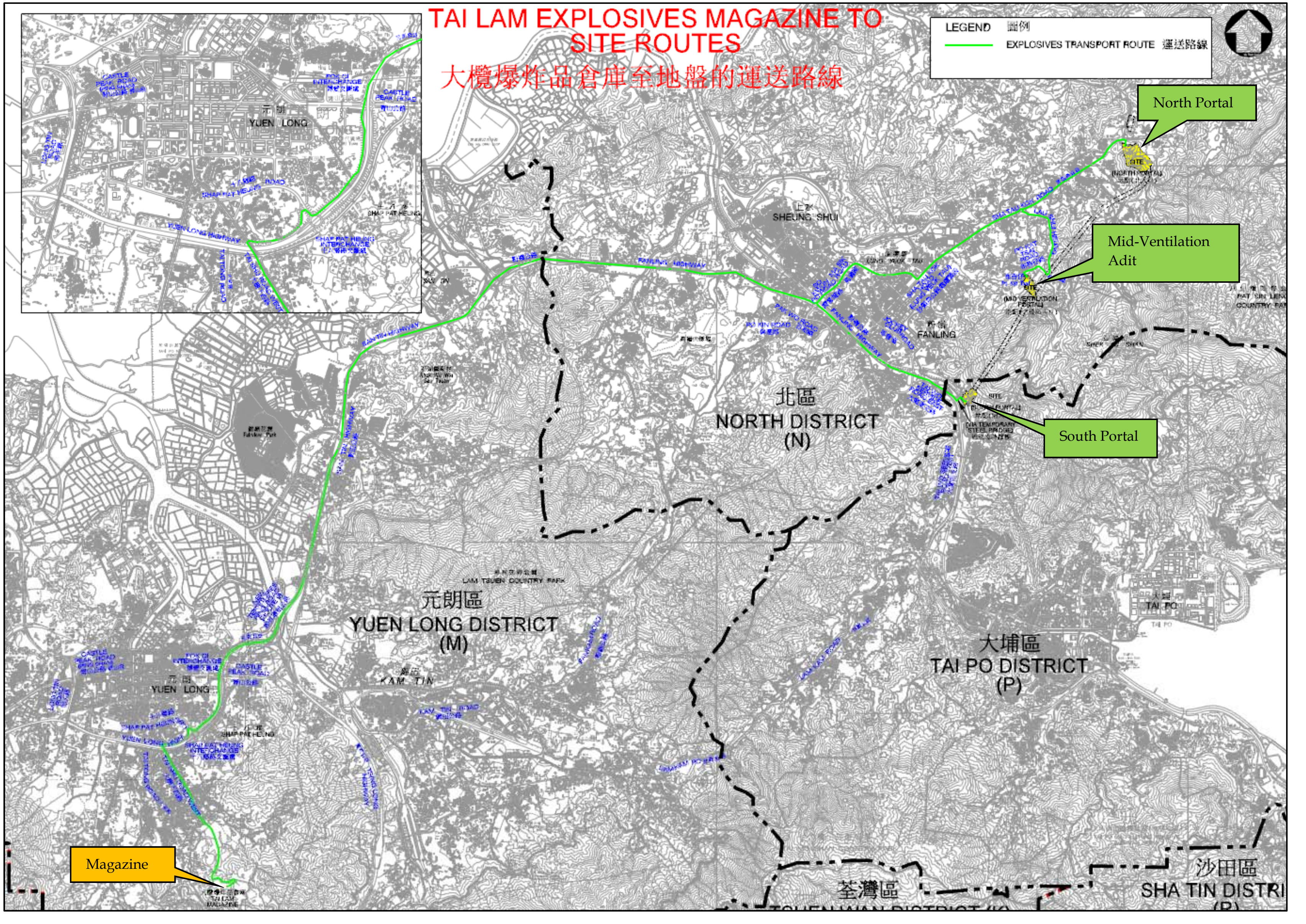
Route Option R1



Route Option R2



Route Option R3



8.5 *BASE CASE AND WORST CASE FOR QUANTITATIVE RISK ASSESSMENT*

The actual explosives requirements will depend on the construction programme and the detailed design. It may also depend on the actual achievable progress rates which may vary due to specific site conditions (e.g. geology). To consider the uncertainty in the envisaged construction programme, a Base Case, which accounts for expected programme variations, and a Worst Case, which presents the worst programme scenario (i.e. a 20% increase in the number of deliveries compared to the Base Case scenario), have been considered for the assessment.

In this study, three Route Options have been presented as the Base Case as summarised in *Section 2.1.2* with details found in *Annex 8A Full Hazard Assessment Report*.

8.5.1 *Base Case Programme for Hazard to Life Assessment*

Based on the envisaged construction programme and sequence of works, the annual travel distance by explosive vehicles, carrying cartridged emulsion, cast boosters and detonating cord, will reach a peak in the period between March 2016 and February 2017. Within this period, taking Route Option R1 as an example, the annual number of deliveries is 2,100 while the explosive trucks travel distance is around 53,165 km. This period is referred to as the peak explosive delivery period which is taken to represent the Base Case scenario for the Hazard to Life Assessment. The delivery frequency has been estimated on the basis that, for a given delivery point, each delivery will be made to each worksite independently of the other worksites even if the load could be transported on the same truck. This approach, although slightly conservative, accounts for expected delivery variations during the peak delivery period, within which, separate deliveries will be generally undertaken.

In the Base Case, it was considered that explosives delivery could be carried out at any time of the day depending on the blasting programme to allow for flexibility to the blasting programme.

In this project, for a particular delivery point, it is possible that the explosive load required for each delivery will be higher than that indicated in the envisaged programme due to particular site conditions and blasting requirements; however, the truck load is conservatively assumed to be 200 kg in each trip. The actual truck load is 42 – 83 kg for North Portal, 43 – 65 kg for Mid-Ventilation Portal and 84 – 132 kg for South Portal, which are significantly lower than the maximum truck load of 200 kg.

In this Project, explosives transport will be scheduled with a total of two to six deliveries per day to the three worksites (explosives are required at two to three worksites per day) and maximum seven (7) days per week. CEDD Mines Division will supply the explosives to the magazine site on weekdays (Monday to Friday) and on Saturday if necessary.

The Base Case programme is summarized in *Table 8.1*.

Table 8.1 *Summary of Explosives Deliveries and Transport Quantities (Base Case)*

Works Area	**Delivery Point**	**Blast Face**	**Explosive Deliveries in Peak Period (trips/yr)**	**Explosive Load (kg/trip)**
North Portal	Sha Tau Kok Road	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	570	200 (Actual load is 42 – 83 kg/trip)
Mid-Ventilation Portal	Po Kat Tsai Road	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	450	200 (Actual load is 43 – 65 kg/trip)
South Portal	Tai Wo Service Road East	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway)	1080	200 (Actual load is 84 – 132 kg/trip)

8.5.2 Worst Case Programme for Hazard to Life Assessment

The Hazard to Life Assessment also covers the Worst Case scenario. It addresses the possibility that, due to construction uncertainties or contractors' methods of working, the contractors propose an actual construction programme which differs from the envisaged construction programme. Such a case may result in a higher number of delivery trips. Return trips loaded with explosives will generally be avoided, however, due to some construction uncertainties, a number of return trips could be made. Overall, in the worst case, a 20% increase in the number of deliveries compared to the Base Case scenario may result based on previous project experience.

The Worst Case programme is summarized in *Table 8.2*.

Table 8.2 *Summary of Explosives Deliveries and Transport Quantities (Worst Case)*

Works Area	**Delivery Point**	**Blast Face**	**Explosive Deliveries in Peak Period (trips/y)**	**Explosive Load (kg/trip)**
North Portal	Sha Tau Kok Road	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	684	200 (Actual load is 42 – 83 kg/trip)
Mid-Ventilation Portal	Po Kat Tsai Road	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	540	200 (Actual load is 43 – 65 kg/trip)
South Portal	Tai Wo Service Road East	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway)	1296	200 (Actual load is 84 – 132 kg/trip)

8.6 POPULATION DATA

Population within the vicinity of the Magazine is estimated based on site surveys and information gathered from Geographic Information System (GIS) database 2014 data (ref.22) and aerial maps. There are no known (current or future) buildings or any other structures in the hazard zone of the proposed Magazine.

Population data used for the transport risk assessment have been collected by a combination of site survey, Annual Traffic Census 2013 (ref.26), Centamap (2015) and GIS tools. For areas where information is not available, assumptions have been used consistently with the previously approved studies. Three types of population have been considered.

- Pedestrian population on footpaths and pavements next to delivery routes;
- Road population; and
- Building population.

The approach to modelling the risks during transport of explosives is fully 3-dimensional and GIS based. It also accounts for the potential increased risk when explosives truck travel on elevated roads.

The population data adopted in the QRA is detailed in *Annex 8A*.

8.7 HAZARD IDENTIFICATION

Hazard identification consisted of a review of the following:

- Explosives properties;
- Scenarios presented in previous relevant studies;
- Historical accidents; and
- Discussions with explosives and blasting specialists.

8.7.1 Hazards of Explosives

Explosives present a hazard to both property and people. This hazard manifests itself in the following ways:

- Blast and pressure wave;
- Flying fragments or missiles;
- Thermal radiation; and
- Ground shock.

In the case of explosions, the biggest damage is usually caused by the blast effects. The blast and pressure waves can cause injury to sensitive human organs such as the ears and lungs. However, considerable overpressures are required for fatalities to occur, and consequently people need to be fairly close to the scene of the direct explosion effects to be significant.

Other effects due to the blast or overpressure are associated with damage to buildings and other structures/ objects or the impact of debris and fragments from damaged building structure, and the vehicle or container in which the explosives are held. Moreover, injury may occur when people are displaced or swept away, or due to the violent movement of internal organs within the body.

An explosion may result in the formation of a short duration fireball since the fuel content of the emulsion is oxidised. However, although it is generally the case that the thermal hazards from an explosives detonation event is of less concern than the blast and fragment hazards.

An explosion may produce a shock wave in the solid material with significant confinement such as rock excavation. Considering explosive transport and storage will be carried out aboveground with much less confinement than rock excavation, consequence of ground shock induced by explosion should not be of much concern compared to the hazards posed by the overpressure wave and debris generated.

8.7.2 Review of Incidents

A review of reported safety incidents involving storage, transport and disposal of explosives (in industrial applications) was carried out. Records were retrieved mainly from the UK Health and Safety Executive (UK HSE)'s Explosives Incidents Database Advisory Service (EIDAS) , US Mine Safety and Health Administration (MSHA) and Western Australia's Department of Consumer and Employment Protection (DOCEP). The records provided are also supplemented with information obtained from various sources. An analysis of accident data is provided in *Annex 8A, Sections 5* and *Section 6*.

8.7.3 Scenarios for Hazard Assessment

The following *Table 8.3* provides a summary of the scenarios considered in this QRA.

Table 8.3 Scenarios Considered in the QRA study

Tag	Scenario
Storage of Explosives	
01	Detonation of full load of explosives in one store in the Tai Lam Explosives Magazine Site
02	Detonation of full load of explosives in one contractor truck on the access road within Tai Lam Explosives Magazine Site boundary
Transport of Explosives	

Tag	Scenario
03	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to Mid Ventilation Adit delivery point
04	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to North Portal delivery point
05	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to South Portal delivery point

8.7.4 Frequency Analysis

Deflagration or detonation explosion may occur during the transportation of explosives from the Magazine to the worksites. This accidental explosion can be caused by spontaneous fire (non-crash fire), fire after a vehicle crash (crash fire), impact initiation in crash (crash impact), or spontaneous explosion during the normal condition of transport which may occur if the cargo load contains 'unsafe explosives'.

In this study, a fault tree has been developed to assess the overall explosion frequency as applicable to the Project contractors' trucks based on the latest information available on the explosives properties, vehicle incident frequencies provided by the Transport Department and Fire Services Department, and the specific explosive transport vehicle design and operation to be used as part of the Project. The details of the frequency assessment are provided in *Annex 8A, Section 6.* The frequency analysis is consistent with the approved XRL EIA QRA study.

Frequency Analysis for Transport of Explosives

Based on Hong Kong vehicle accident data, the frequencies of explosives initiation during road transport are estimated as 7.69×10^{-10}/km for the truck on non-expressway and 6.87×10^{-10}/km on expressway, using a fault tree approach. The fault tree model has considered the frequencies of non-crash fire, crash fire, crash impact and unsafe explosive. Adjustment factors were applied to the model to account for the probabilities of explosive initiation due to thermal stimulus or crash impact.

Frequency Analysis for Storage of Explosives

The overall initiating event frequency within the storage magazine is based upon the UK HSE recommended value of 1×10^{-4} per storehouse year. Additional risk due to manual transfer of explosives, lightning strike, aircraft crash, hill/ vegetation fire, earthquake and other site specific considerations to this project were also considered but their contribution was negligible (see *Annex 8A, Section 6*).

8.7.5 Consequence Analysis

The probability of fatality due to blast over-pressure, have been estimated using the method detailed by the UK HSE Explosives Storage and Transport Committee (ESTC) (ref.9). The fatality contours are calculated at 90%, 50%, 10%, 3% and 1% fatality. Details of the model and the results are given in *Annex 8A, Section 7*.

Special features such as slopes and service reservoirs along the transport routes or near the Magazine site were identified with respect to the potential secondary hazards. These aspects of risk were evaluated separately, and were found either insignificant or already covered by applying the blast overpressure-fatality model (i.e. ESTC model (ref.9)).

8.8 SUMMARY OF RISKS

8.8.1 Individual Risk Results

The individual risk (IR) contours associated with the Project are shown in *Figure 8.4, Figure 8.5, Figure 8.6* and *Figure 8.7*. In *Figure 8.7*, the 'indoor' refers to the population located inside buildings, and the 'outdoor' refers to the population located outside buildings i.e. in open area. At the same distance from a potential explosion, persons located inside buildings are more vulnerable to explosion than persons located outside buildings as they are exposed to more hazards such as debris from broken windows, etc. This explains a higher individual risk for indoor population.

For the delivery routes, the IR data represent the highest individual risk, occurring on the road in the same lane as the explosives delivery truck. It is observed that the maximum IR is about 1.8×10^{-7} per year. This is a low risk when compared to Hong Kong Risk Guidelines which require the offsite IR from a fixed installation to be below 1×10^{-5} per year.

The Magazine is in remote areas. The individual risk contours of 1×10^{-5} per year extend outside the site boundary. However this impacts only on woodland areas where there is no continuous presence of people. The presence of people in these areas will be rare and only temporary leading to a very small presence factor. The most exposed population group will be people potentially present adjacent to the Magazine site fence. Such persons are not expected to be present more than 1% of the time. Therefore, no member of the public will be exposed to an IR of 1×10^{-5} per year. The actual risk to any individual will be much less than 1×10^{-5} per year and is deemed to be acceptable.

Figure 8.4 Maximum IR for the Delivery Routes from Tai Lam Explosives Magazine Site (Base Case Route Option R1)

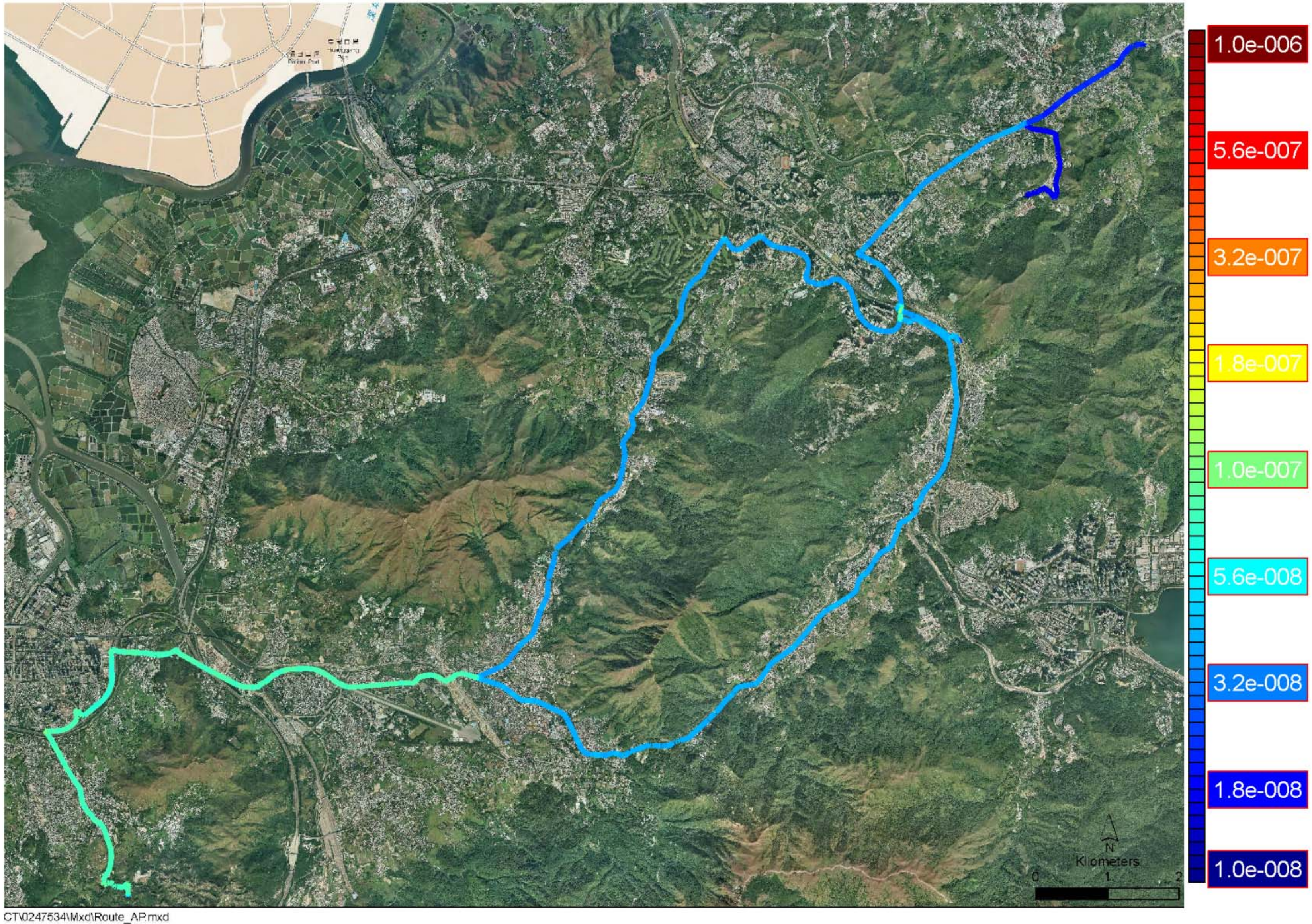


Figure 8.5 Maximum IR for the Delivery Routes from Tai Lam Explosives Magazine Site (Base Case Route Option R2)

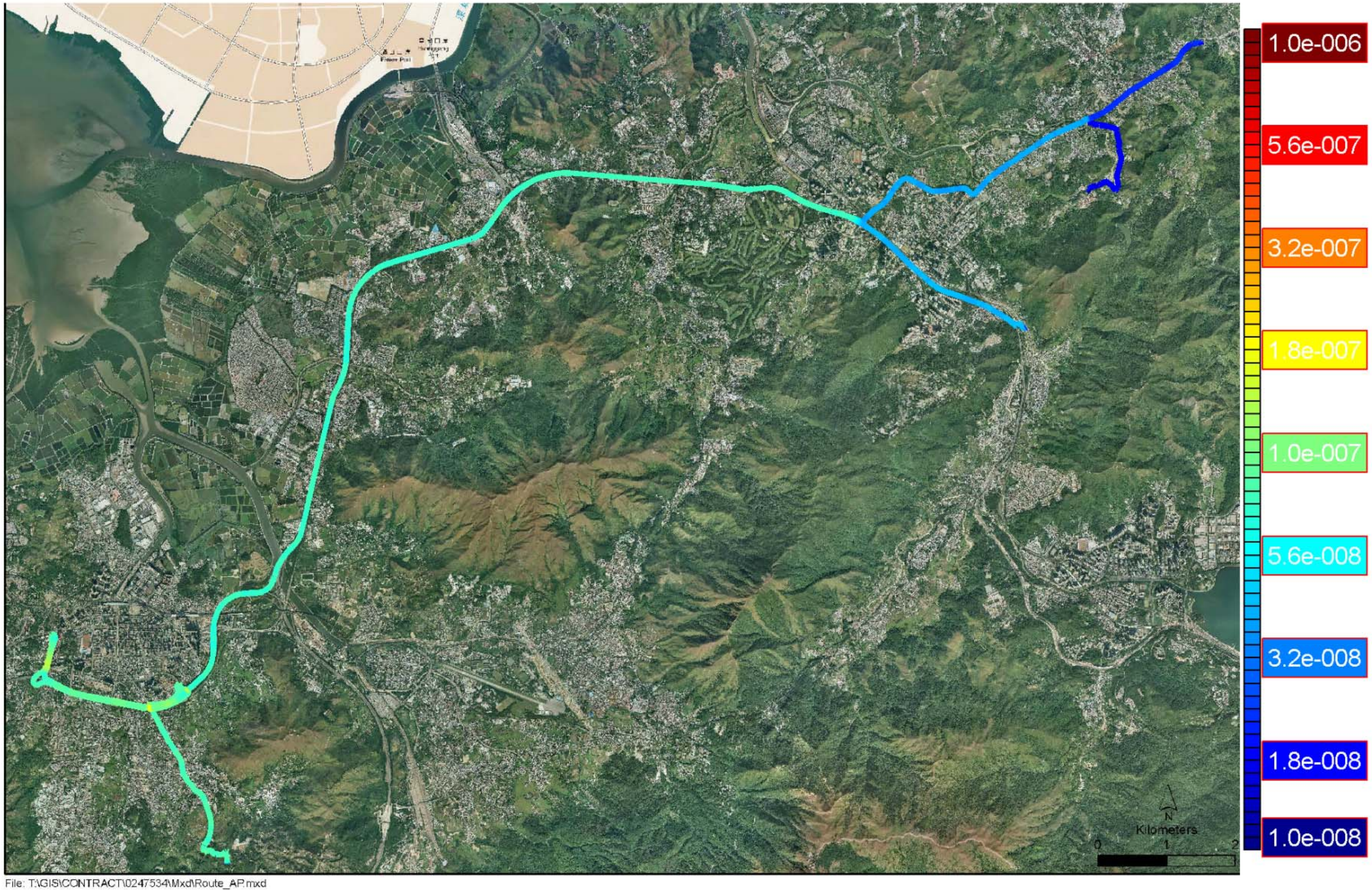


Figure 8.6 Maximum IR for the Delivery Routes from Tai Lam Explosives Magazine Site (Base Case Route Option R3)

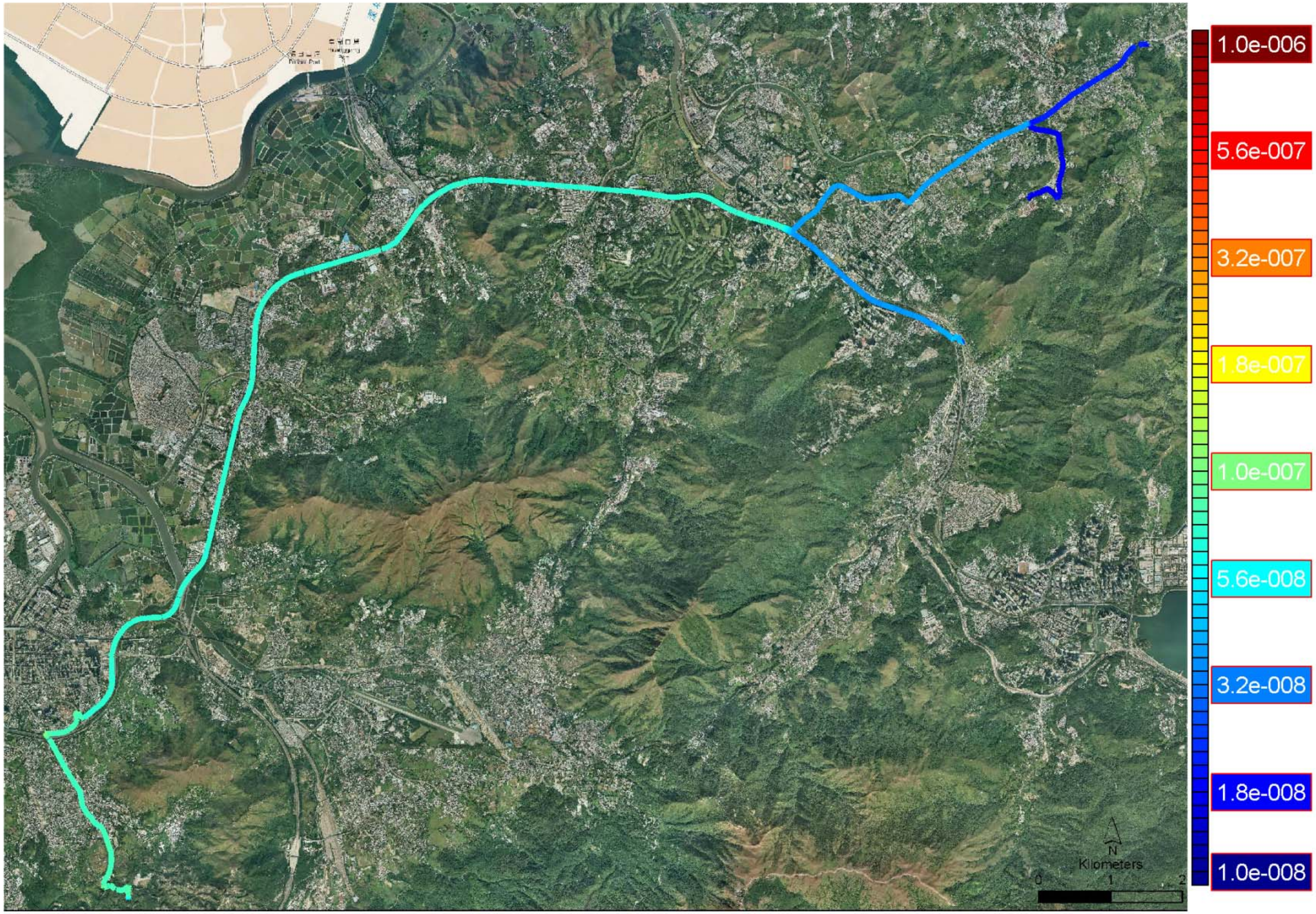


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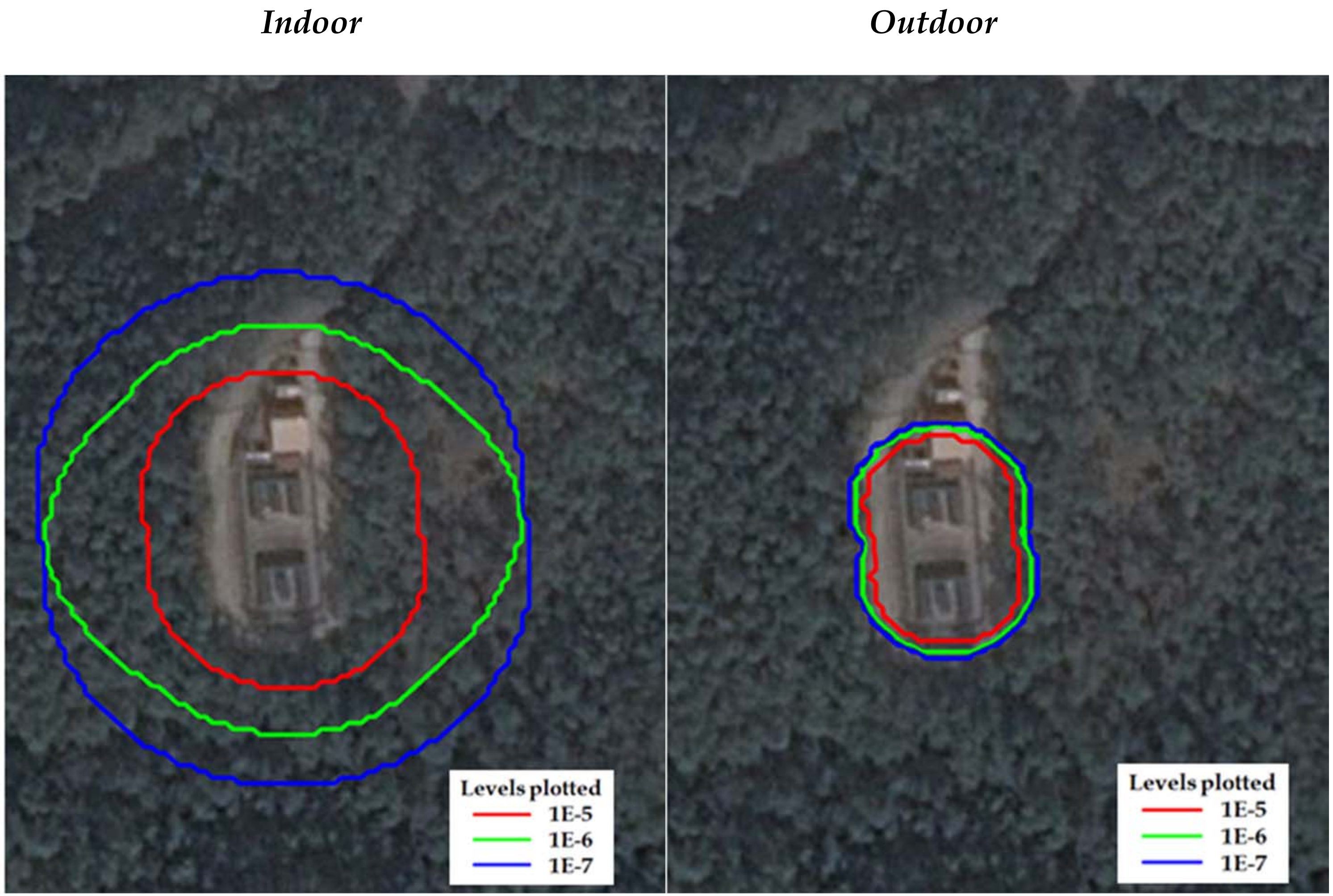
Figure 8.7 IR of the Tai Lam Explosives Magazine Site



8.8.2 *Societal Risk Results*

The societal risk results for explosives storage and transport have been combined to produce the overall societal risk results for the Base Case and the Worst Case (*Figure 8.8, Figure 8.9* and *Figure 8.10*). These include the Magazine site at Tai Lam and the associated transport routes to the three worksites.

The Base Case represents the risks associated with the envisaged blasting programme. It can be seen that the risks lie in the upper ALARP region.

The Worst Case represents the maximum risks associated with the worst blasting scenario, i.e. a 20% increase in the number of deliveries compared to the Base Case scenario. The risks, as expected, are higher than the base case but still within the ALARP region.

Figure 8.11, Figure 8.12 and *Figure 8.13* show the F-N curves for the Base Case with a breakdown by storage and transport. It is observed that risks from the Magazine are negligible compared to the transport risks since the Magazine is located in remote area with very low population density nearby.

The F-N curves for both Base Case and Worst Case are within the As Low as Reasonably Practicable (ALARP) Region as per HK *EIAO-TM*. Therefore, mitigation measures need to be considered to reduce the risk. The ALARP assessment is provided in *Annex 8A, Section 9*.

The potential Loss of Life (PLL) for the base case and the worst case are given in *Table 8.4, Table 8.5, Table 8.6* and *Table 8.7, Table 8.8, Table 8.9* respectively. The PLL for Base Case has been evaluated at 6.75×10^{-4}/year, 1.30×10^{-3}/year, 7.83×10^{-4}/year for Route Option R1, Route Option R2 and Route Option R3 respectively. The PLL value for the Worst Case is estimated at 8.10×10^{-4}/year, 1.56×10^{-3}/year, 9.40×10^{-4}/year for Route Option R1, Route Option R2 and Route Option R3 respectively.

Figure 8.8 F-N Curve for Storage and Transport of Explosives (Route Option R1)

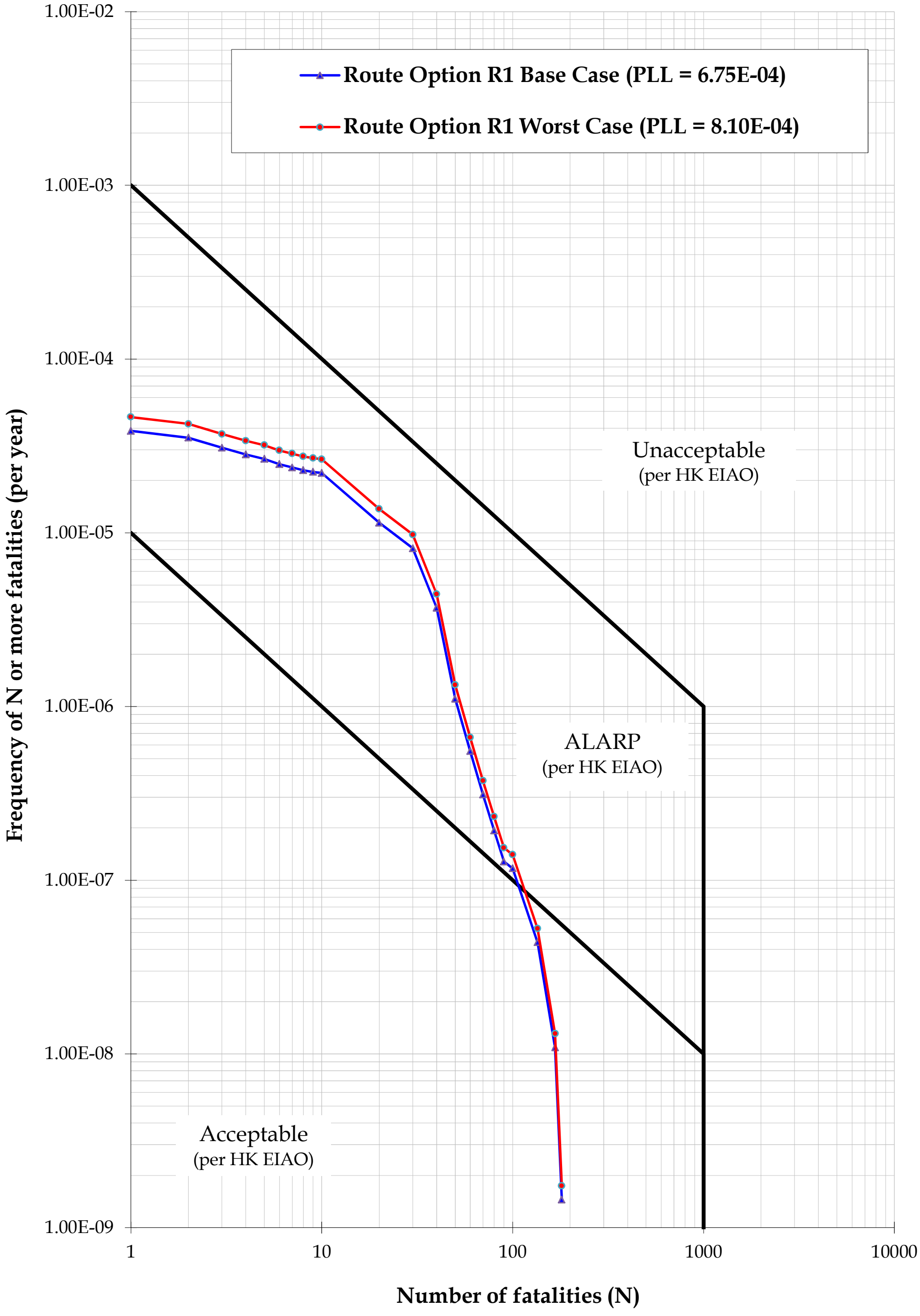


Figure 8.9 F-N Curve for Storage and Transport of Explosives (Route Option R2)

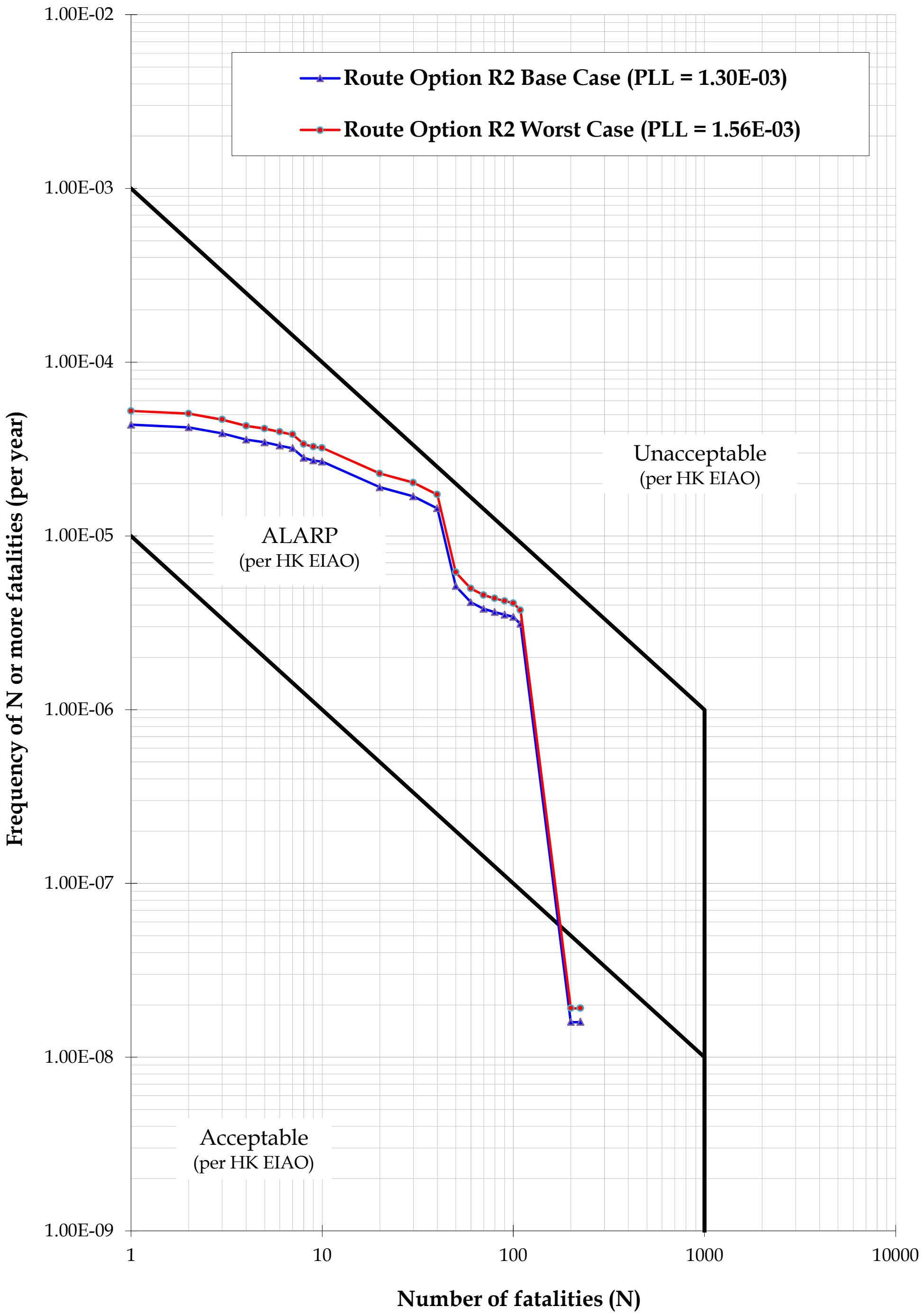


Figure 8.10 F-N Curve for Storage and Transport of Explosives (Route Option R3)

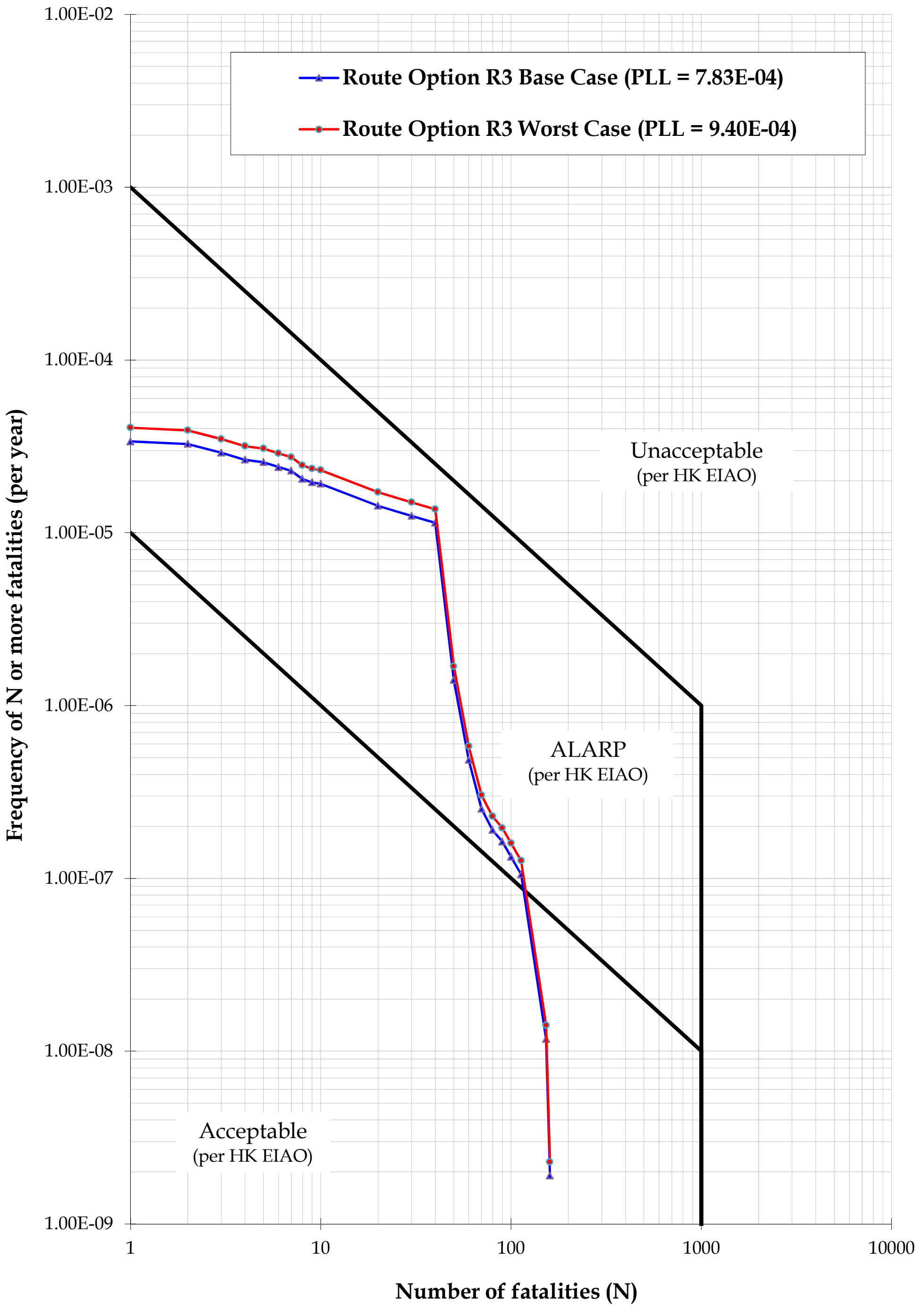


Figure 8.11 F-N Curve for the Base Case with Breakdown by Storage and Transport (Route Option R1)

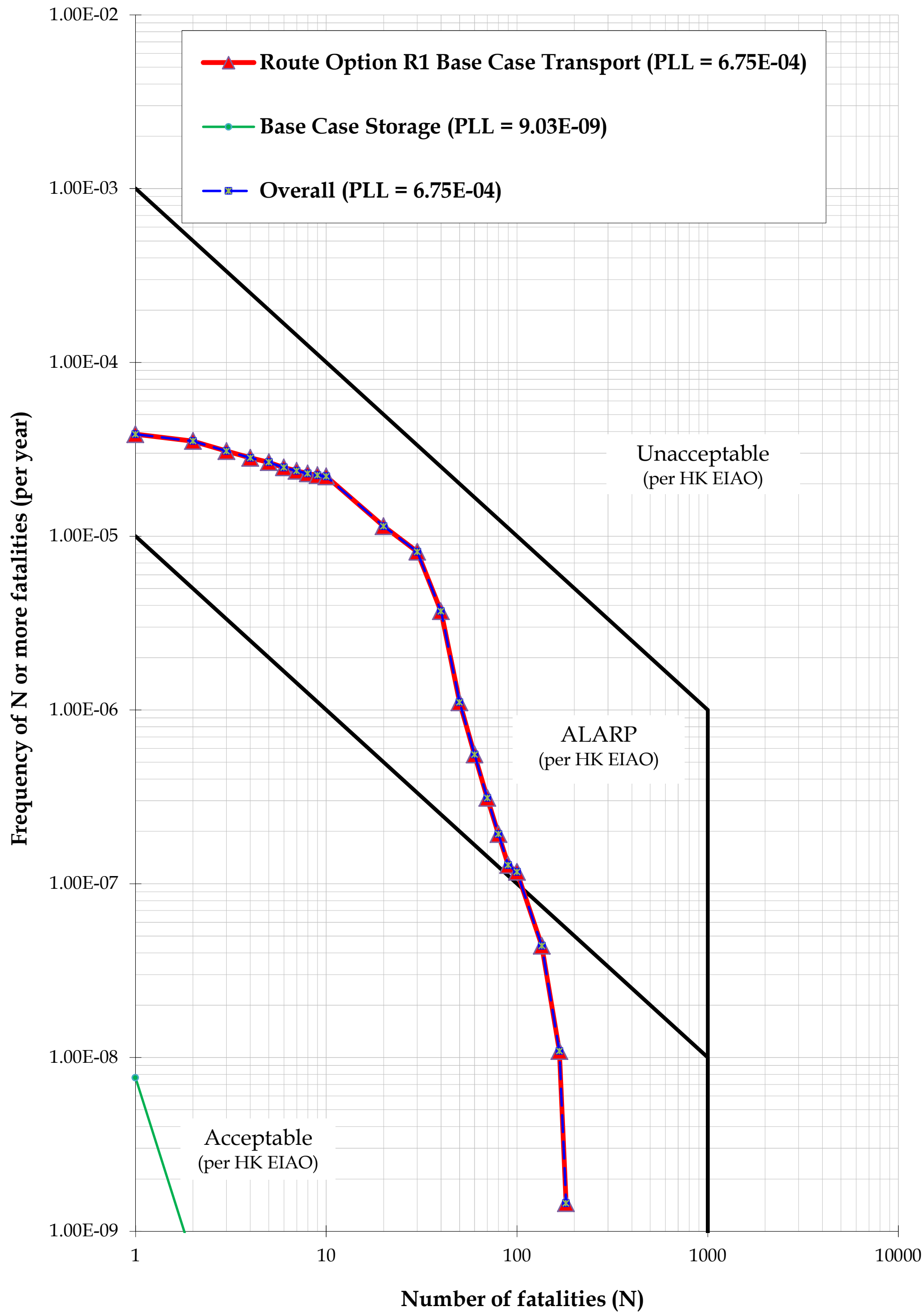


Figure 8.12 F-N Curve for the Base Case with Breakdown by Storage and Transport (Route Option R2)

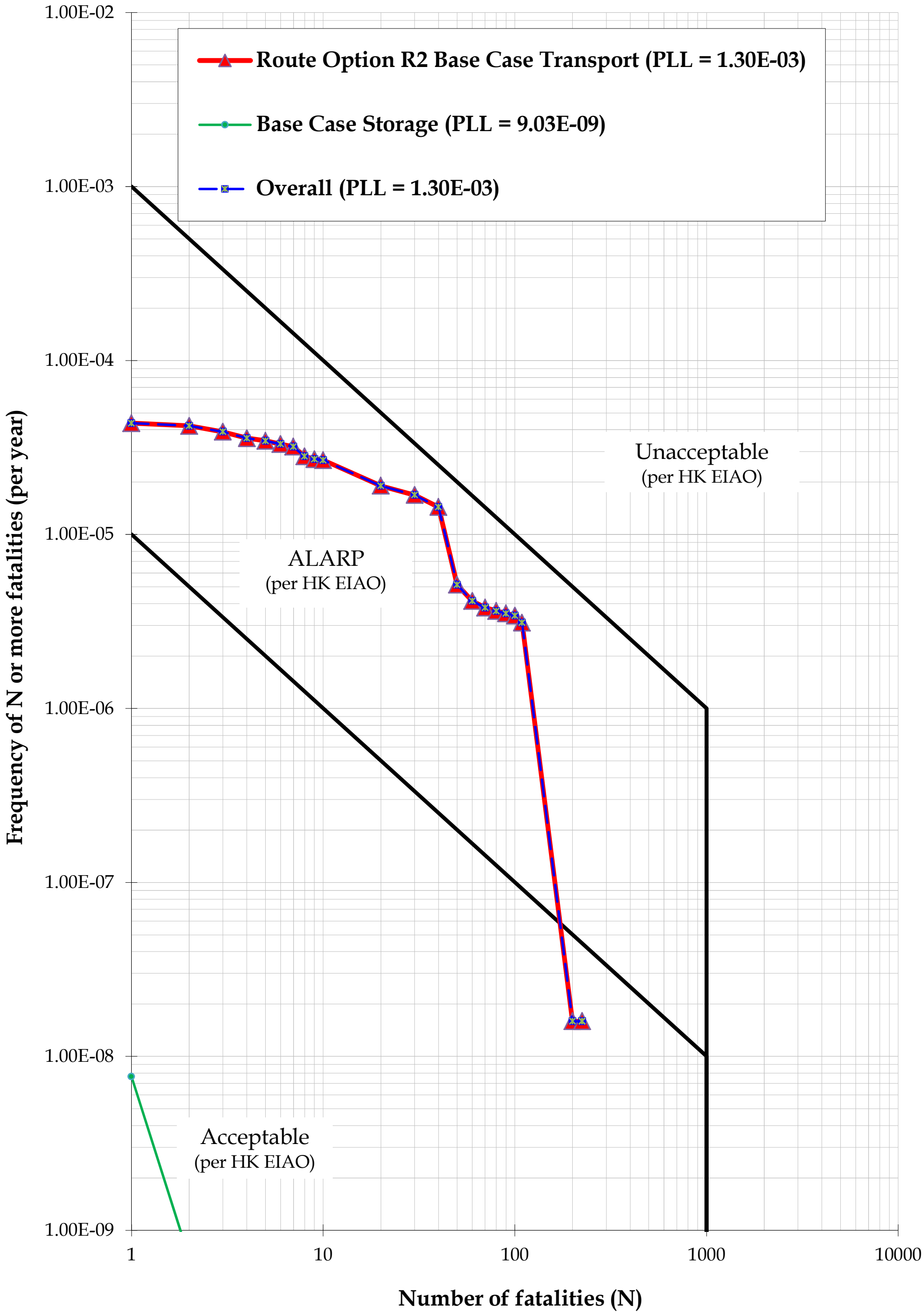


Figure 8.13 F-N Curve for the Base Case with Breakdown by Storage and Transport (Route Option R3)

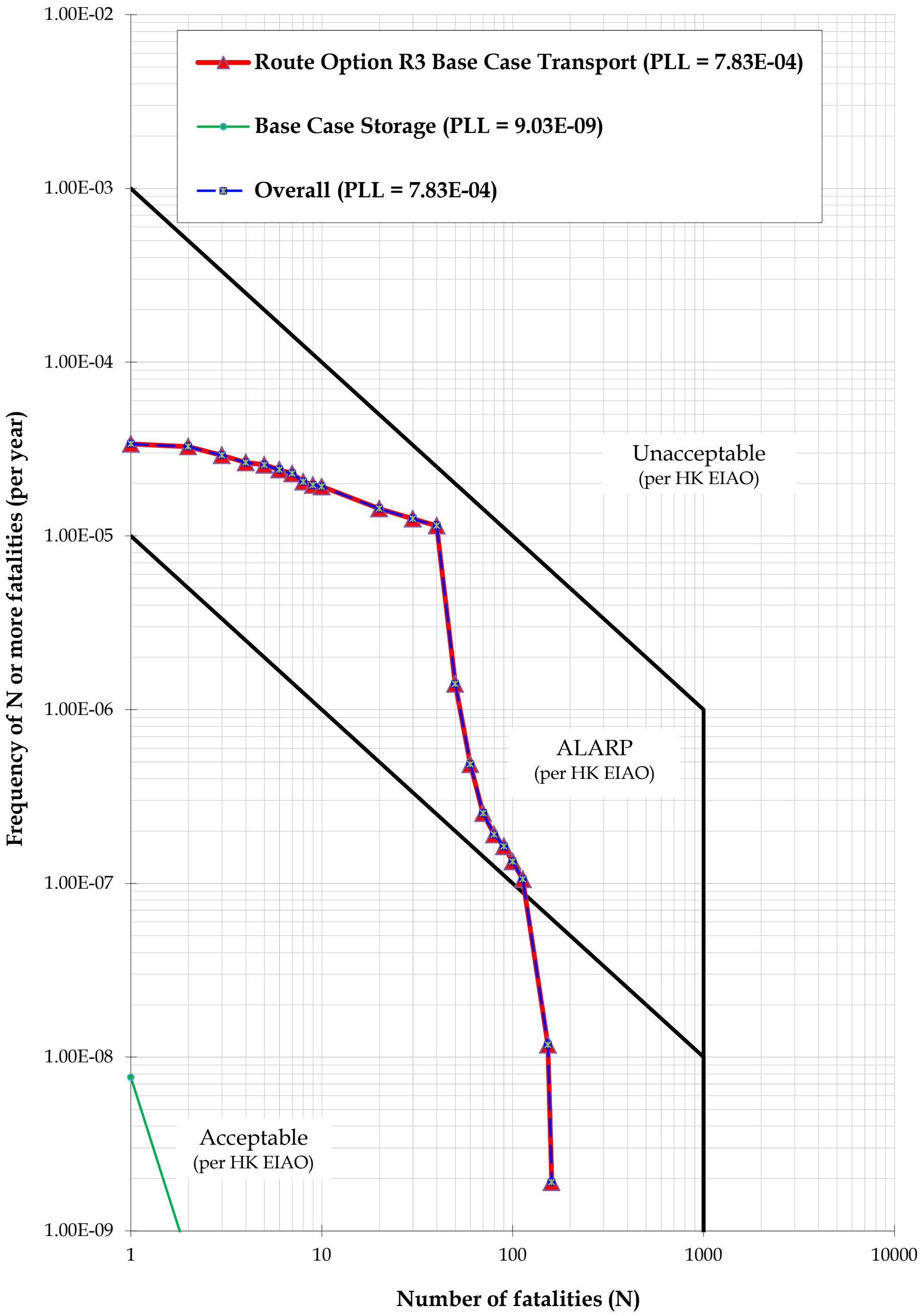


Table 8.4 PLL for Base Case Route Option R1

Case: Base Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	1.68E-04	24.90%
Tai Lam Explosives Magazine Site to North Portal	2.13E-04	31.55%
Tai Lam Explosives Magazine Site to South Portal	2.94E-04	43.55%
Total	**6.75E-04**	**100.00%**

Table 8.5 PLL for Base Case Route Option R2

Case: Base Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	2.83E-04	21.83%
Tai Lam Explosives Magazine Site to North Portal	3.58E-04	27.61%
Tai Lam Explosives Magazine Site to South Portal	6.56E-04	50.55%
Total	**1.30E-03**	**100.00%**

Table 8.6 PLL for Base Case Route Option R3

Case: Base Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	1.73E-04	22.04%
Tai Lam Explosives Magazine Site to North Portal	2.18E-04	27.84%
Tai Lam Explosives Magazine Site to South Portal	3.93E-04	50.12%
Total	**7.83E-04**	**100.00%**

Table 8.7 *PLL for Worst Case Route Option R1*

Case: Worst Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	2.02E-04	24.90%
Tai Lam Explosives Magazine Site to North Portal	2.56E-04	31.55%
Tai Lam Explosives Magazine Site to South Portal	3.53E-04	43.55%
Total	**8.10E-04**	**100.00%**

Table 8.8 *PLL for Worst Case Route Option R2*

Case: Worst Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	3.40E-04	21.83%
Tai Lam Explosives Magazine Site to North Portal	4.30E-04	27.61%
Tai Lam Explosives Magazine Site to South Portal	7.87E-04	50.55%
Total	**1.56E-03**	**100.00%**

Table 8.9 *PLL for Worst Case Route Option R3*

Case: Worst Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	2.07E-04	22.04%
Tai Lam Explosives Magazine Site to North Portal	2.62E-04	27.84%
Tai Lam Explosives Magazine Site to South Portal	4.71E-04	50.12%
Total	**9.40E-04**	**100.00%**

8.8.3 *ALARP Assessment*

Since the risks posed by the project, for both Base and Worst Cases considered, are within the ALARP region specified in *EIAO-TM Annex 4*, this implies that risk reduction measures and/ or alternate options should be explored for the Project.

It was found that the risks arising from explosives transport are much more significant than that of explosives storage; hence the ALARP assessment focuses on the transportation aspects of explosives.

Where the risk falls into the ALARP region, the risks associated with each probable hazardous event should be reduced to a level 'as low as reasonably practicable'. This firstly requires the identification of any 'practicable' options regardless of their cost. A mitigation option is considered 'practicable' if an engineering solution exists and can be implemented on the Project regardless of the cost without affecting the project construction programme. Secondly, the extent to which the risk should be reduced is usually measured as a trade-off between the risk reduction, i.e. the safety benefits and the cost of the risk reduction measure. A mitigation option is considered 'reasonable' if the cost of implementing the option is not grossly disproportionate to the achieved safety benefits.

Risk mitigation measures may take the form of engineered measures, controls in the zones most impacted by the hazardous scenarios presented by this project, or operation and procedural controls.

Approach to ALARP Assessment

The approach consists of identifying potential justifiable mitigation measures, assessing their practicability for this project and evaluating their cost and comparing with the safety benefits of implementing the measures. Combinations of mitigation measures are also considered.

The safety benefits are evaluated as follows:

Safety Benefits = Value of Preventing a Fatality × Aversion Factor × Reduction in PLL value × Design Life of Mitigation Measure

The Value of Preventing a Fatality (VPF) reflects the tolerability of risk by the society and therefore the monetary value that the society is ready to invest to prevent a fatality. For the purpose of this assessment and for consistency with previous studies, the Value of Preventing a Fatality is taken as HK$33M per person, which is the same figure as used in previous XRL EIA QRA study.

Depending on the level of risk, the value of preventing a fatality may be adjusted to reflect people's aversion to high risks or scenarios with potential for multiple fatalities. The methodology for application of the 'aversion factor' follows that developed by EPD (ref.25), in which the aversion factor is calculated on a sliding scale from 1 (risks at the lower boundary of the ALARP region of the Risk Guidelines) up to a maximum of 20 (risks at the upper boundary of the ALARP region). The adjusted VPF using the aversion factor of 20 is HK$660M. This value is a measure of how much the society is willing to invest to prevent a fatality, where there is potential for an event to cause multiple fatalities.

The maximum justifiable expenditure for this Project is calculated as HK$ 2.1M assuming the design life of mitigation measure is 2 years (Jan 2015 to Dec 2017, 24 months) based on the Project during which storage and transport of explosives will be involved, with the maximum PLL of 1.56 x 10^{-3} per year, which is obtained from the Worst Case.

For an 'achievable' mitigation measure to be potentially justifiable, its cost should be less than the Maximum Justifiable Expenditure.

Potential Justifiable Mitigation Measures

The potential options that have been examined in the ALARP assessment include the following categories.

- Options eliminating the need for a Magazine or eliminating the risk (eg. Use of alternative methods of construction ('hard rock' TBMs));
- Options reducing significantly the quantities of explosives to be used such as use of 'hard rock' TBM or alternatives to cartridged emulsion;
- Options significantly reducing the distance run by contractors' explosive trucks such as closer magazine site and alternative routes. The magazine and route options considered are summarised below:
  - The alternative magazine sites to Tai Lam have been considered by DHK but they are not available for the Project. The existing TLEM is the best option considering the shortest transportation distance, stakeholders' acceptance situation and its availability with the blasting schedule of the project.
  - On-site magazines were also considered (at the Mid Ventilation Portal and North Portal). DHK had preliminary consultation with CEDD Mines Division. After review with the necessary site setups and subsequent application process, Mines Divisions advised that it would not be feasible in managing interfaces with adjacent construction activities, safety of the site could be compromised and match with the program of project.
  - Based on the review of the possible transport routes for this project and discussion with Yuen Long District Council, due to limitation imposed by the current road improvement work at Pok Oi Interchange, (1) At early stage of this project with road improvement work at Pok Oi Interchange (expected to be completed in 2015 but may be delayed), Route Option R2 will be used. Route Options R1 and R3 are not feasible during this period since they both route via Pok Oi interchange. (2) After road improvement work at Pok Oi Interchange is completed, all three routes will be available for use, thus further cost-benefit evaluation is conducted. The Route Option with minimum transport risk, i.e. Route Option R1, will be used. Route Option R3 can only be used as a contingency alternative route in the event that Route Option R1 is infeasible due to road blockage by traffic accidents.

- Options reducing significantly the number of trips to be carried out by contractors' explosive trucks;

- Options considering improved explosive truck design; and

- Options considering better risk management systems and procedures.

In summary, various options have been either recommended for implementation or assessed comparing the implementation cost with the maximum justifiable expenditure for the safety benefit gained.

ALARP Assessment Results

The PLL for Route Option R1, Route Option R2 and Route Option R3 are presented in *Table 8.10*. These were used as the basis for the cost-benefit analysis/ ALARP assessment presented in *Table 8.11*.

Various options considered practicable have been either recommended for implementation or assessed comparing the implementation cost with the maximum justifiable expenditure. The evaluation for each option is shown in *Table 8.11.* More details are available in *Annex 8A, Section 9*.

By adopting the feasible explosives delivery routes with the lowest risk, the risk has been reduced as low as practicable considering the impact of road improvement work at Pok Oi Interchange. The risk will be further reduced by implementation of the other selected mitigation measures.

Table 8.10 Potential Loss of Life for all three Route Options

Case	PLL (Per Year)
Route Option R1 (Worst Case)	8.10×10^{-4}
Route Option R2 (Worst Case)	1.56×10^{-3}
Route Option R3 (Worst Case)	9.40×10^{-4}

Table 8.11 ALARP Assessment Results

Option Description	Practicability	Implementation Cost	Safety Benefits or Justifiable Expenditure	ALARP Assessment Result
Use of alternative methods of construction (TBMs)	Not Practicable	> HK$ 100M	HK$ 2.1M	Neither practicable nor justified.
Use of Magazine Closer to the Worksites	Not Practicable	-	-	Closest practicable Magazine site to the worksites has been selected
Use of different explosive types (different types of detonating cord)	Pose some limitations	HK$ 2.4M	No safety benefit	Not justified
Alternative Routes (at early stage of this project with road improvement work at Pok Oi Interchange)	Not Practicable	-	-	Neither practicable nor justified.
Alternative Routes (after road improvement work at Pok Oi Interchange is completed)	Practicable	< HK$ 10k	Negative	Route Option R1 is the preferred option. Route Option R3 can only be used as a contingency alternative route.
Use of Smaller Explosives Quantities	Not Practicable	-	-	Neither practicable nor justified.
Safer explosive truck (reduced fire load)	Practicable	-	-	This option has been directly incorporated in recommendations
Reduction of Accident Involvement Frequency (training programme etc.)	Practicable	-	-	This option has been directly incorporated in recommendations
Reduction of Fire Involvement Frequency (better emergency response, extinguisher types etc.)	Practicable	-	-	This option has been directly incorporated in recommendations

8.9 CONCLUSION AND RECOMMENDATIONS

A QRA has been carried out to assess the hazard to life issues arising from the storage and transport of explosives from Tai Lam Explosives Magazine site to the three blasting worksites.

The criterion of *Annex 4* of the *EIAO-TM* for Individual Risk is met. The assessment results show that the societal risk lies within the ALARP region when compared to the criteria stipulated in the *EIAO-TM*. A detailed ALARP assessment has been undertaken considering a wide range of mitigation measures and the results show compliance with the ALARP principles provided that the following recommendations are followed.

8.9.1 *General Recommendations*

Following the ALARP principles, the following recommendations are justified and should be implemented to meet the *EIAO-TM* requirements.

- The truck design should comply with the Requirements for Approval of an Explosives Delivery Vehicle (CEDD 2) and limit the amount of combustibles in the cabin. The fuel carried in the fuel tank should also be minimised to reduce the duration of any fire;

- The explosive truck accident frequency should be minimized by implementing a dedicated training programme for both the driver and his attendants, including regular briefing sessions, implementation of a defensive driving attitude. In addition, drivers should be selected based on good safety record, and medical checks;

- The contractor should as far as practicable combine the explosive deliveries for a given work area;

- Only the required quantity of explosives for a particular blast should be transported to avoid the return of unused explosives to the Magazine.

- Whenever practicable, a minimum headway between two consecutive truck convoys of 10 min is recommended;

- The explosive truck fire involvement frequency should be minimized by implementing a better emergency response and training to make sure the adequate fire extinguishers are used and attempt is made to evacuate the area of the incident or securing the explosive load if possible. All explosive vehicles should be equipped with the required amount and type of fire extinguishers and shall be agreed with Mines Division; and

The following general recommendation should also be considered for the storage and transport of explosives:

- The security plan should address different alert security level to reduce opportunity for arson/ deliberate initiation of explosives. The corresponding security procedure should be implemented with respect to prevailing security alert status announced by the Government.

- Emergency plans (i.e. magazine operational manual) shall be followed and amended if necessary to address uncontrolled fire in magazine area and transport. The case of fire near an explosive carrying truck in jammed traffic should also be covered. Drill of the emergency plan should be carried out at regular intervals.

- Adverse weather working guideline should be followed and amended if necessary to clearly define procedures for transport explosives during thunderstorm.

- The Magazine storage quantities need to be reported on a monthly basis to ensure that the two day storage capacity is not exceeded.

Specific recommendations for storage and transport of explosives are given below.

8.9.2 For Storage of Explosives in the Magazine Store

The Magazine should be operated and maintained in accordance with Mines Division guidelines and appropriate industry best practice. In addition, the following recommendations should be implemented:

- A suitable work control system should be followed and amended if necessary, such as an operational manual including Permit-to-Work system, to ensure that work activities undertaken during the operation of the Magazine are properly controlled.

- There should be good house-keeping within the Magazine to ensure that combustible materials are not allowed to accumulate.

- The Magazine shall be without open drains, traps, pits or pockets into which any molten ammonium nitrate could flow and be confined in the event of a fire.

- The Magazine building shall be regularly checked for water seepage through the roof, walls or floor.

- Caked explosives shall be disposed of in an appropriate manner.

- Delivery vehicles shall not be permitted to remain within the secured fenced off magazine store area.

- Good housekeeping outside the Magazine stores to be followed to ensure combustibles (including vegetation) are removed.

- A speed limit within the magazine area should be enforced to reduce the risk of a vehicle impact or incident within the Magazine area.

- Traffic Management should be implemented within the Magazine site, to ensure that no more than 1 vehicle will be loading/loaded at any time, in order to avoid accidents involving multiple vehicles within the site boundary.

8.9.3 For Transport of Explosives

General Recommendations:

The following measures should be considered for safe transport of explosives:

- Detonators shall not be transported in the same vehicle with other Class 1 explosives.
- Separation of vehicles should be maintained during the whole trip.
- Location for stopping and unloading from truck to be provided as close as possible to shaft, free from dropped loads, hot work, etc. during time of unloading.
- Develop procedure to ensure that parking space on the site is available for the explosive truck. Confirmation of parking space should be communicated to truck drivers before delivery. If parking space on site cannot be secure, delivery should not commence.
- Ensure lining is provided within the transportation box on the vehicle and in good condition before transportation.
- Ensure that packaging of detonators remains intact until handed over at blasting site.
- Emergency plan to include activation of fuel and battery isolation switches on vehicle when fire breaks out to prevent fire spreading and reducing likelihood of prolonged fire leading to explosion.
- Use only experienced driver(s) with good safety record.
- Ensure that cartridged emulsion packages are damage free before every trip.
- Ensure that explosives will be offloaded and stored away from the railway protection area according to the MTRCL railway protection area plan.

Contractors Licenced Vehicle Recommended Safety Requirements:

- Battery isolation switch;
- Front mounted exhaust with spark arrestor;
- Fuel level should be kept as far as possible to the minimum level required for the transport of explosives;
- Minimum 1 × 9 kg water based AFFF fire extinguisher to be provided;
- Minimum 1 × 9 kg dry chemical powder fire extinguisher to be provided;

- Horizontal fire screen on cargo deck and vertical fire screen mounted at least 150mm behind the drivers cab and 100mm from the steel cargo compartment, the vertical screen shall protrude 150mm in excess of all three (3) sides of the steel cargo compartment;

- Cigarette lighter removed;

- Two (2) battery powered torches for night deliveries;

- Vehicles shall be dedicated explosive transport vehicles and should be maintained in good operating condition;

- Daily checks on tyres and vehicle integrity;

- Regular monthly vehicle inspections;

    - Fuel system

    - Exhaust system

    - Brakes

    - Electrics

    - Battery

    - Cooling system

    - Engine oil leaks

- Vehicle log book in which monthly inspections and maintenance requirements are recorded; and

- Mobile telephone equipped.

Recommended Requirements for the Driver of the Explosive Vehicles:

The driver shall:

- be registered by the Commissioner of Mines and must be over the age of 25 years with proven accident free records and more than 7 year driving experience without suspension.

- hold a Driving License for the class of vehicle for at least one (1) year;

- adopt a safe driving practice including having attended a defensive driving course;

- pass a medical check and is assessed as fit to drive explosives vehicles; and

- not be dependent on banned substances;

Some of the following requirements may also apply to the vehicle attendant(s).

- The driver is required to attend relevant training courses recognized by the Commissioner of Mines. The training courses should include the following major subjects, but not limited to:
  - the laws and Regulations relating to the transport of explosives;
  - security and safe handling during the transport of explosives;
- Attend training courses provided by the explosives manufacturer or distributor, covering the following:
  - explosives identification;
  - explosion hazards; and
  - explosives sensitivity;
  - the dangers which could be caused by the types of explosives;
  - the packaging, labelling and characteristics of the types of explosives;
  - the use of fire extinguishers and fire fighting procedures; and
  - emergency response procedures in case of accidents.

The driver should additionally be responsible for the following:

- The driver shall have a full set of Material Safety Data Sheets (MSDS) for each individual explosive aboard the vehicle for the particular journey;
- The MSDS and Removal Permit (where applicable) shall be produced to any officer of the Mines Division of CEDD upon request;
- A card detailing emergency procedures shall be kept on board and displayed in a prominent place on the driver's door;
- Before leaving the magazine the driver together with and/or assisted by the shotfirer shall check the following:
  - Packaging integrity and labelling;
  - Check that the types and quantities of explosives loaded onto the vehicle are as stipulated in the Removal Permit(s);
  - Check that the explosive load does not exceed the quantities stated in the removal permit;
  - Check the condition and integrity of the cargo compartment or box;

- Check that detonators are not loaded in the explosives cargo compartment and vice versa;

- Check that the cargo is secured and cannot be damaged during the delivery;

- Ensure that the appropriate placards and a red flag are displayed before leaving the magazine;

- Be competent to operate all equipment on board the vehicle including fire extinguishers and the vehicle emergency cut-off switches;

- Prohibit smoking when the vehicle is loaded with explosives;

- When explosives are loaded, ensure the vehicle is not left unattended;

- Be conversant with emergency response procedures.

Specific Recommended Requirements for the Explosive Vehicle Attendants:

When the vehicle is loaded with explosives, it shall be attended by the driver and at least one (1) other person authorized by the Commissioner of Mines. The vehicle attendant shall:

- Be the assistant to the driver in normal working conditions and in case of any emergency

- Be conversant with the emergency response procedures

- Be competent to use the fire extinguishers and the vehicle emergency cut-off switches

- One of the vehicle attendant(s) should be equipped with mobile phones and the relevant MSDS and emergency response plan.

Type of Explosives & their Disposal

For explosive selection, the following should be considered

- Cartridged Emulsions with perchlorate formulation should be avoided;

- Cartridged Emulsions with high water content should be preferred.

Disposal Recommendations:

If disposal is required for small quantities, disposal should be made in a controlled and safe manner by a Registered Shotfirer.

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9 ENVIRONMENTAL MONITORING & AUDIT REQUIREMENTS

This chapter summarises any environmental monitoring and audit requirements that have arisen from the EIA study.

No adverse impacts are expected prior to mitigation for airborne noise, air quality and water quality, and therefore there are no monitoring or audit requirements for these environmental media.

9.1 OPERATION AND DECOMMISSIONING OF THE PROJECT

For waste management, comprehensive planning and good site management practice will be adopted by the contractors of the Project during operation and decommissioning and waste on-site will be properly segregated to increase the potential for reuse and recycling. Chemical waste generated from equipment operation and decommissioning will be properly stored in accordance with *Code of Practice on the Packaging, Labelling and Storage of Chemical Waste* published by the EPD before collection for disposal by a licensed Chemical Waste Collector. The quantity of general refuse generated on-site will be minimal owing to the nature of the operation and decommissioning activities and provided general refuse is removed from the Project Site regularly (e.g. once per day), no adverse environmental impact related to handling and disposal of general refuse is expected.

Adverse water quality impact is not expected during decommissioning, considering the small scale and short duration of works activities and the implementation of proper site runoff control measures. Water quality impact on other fresh water courses from the works is also unlikely and any discharge from the site expected to be in compliance with the requirements of the Water Pollution Control Ordinance. However as good practice, appropriate measures will be implemented in accordance with the guidelines stipulated in EPD's *Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)* during the decommissioning works to properly control site run-off and drainage and to minimise potential water quality impacts. Equally for good practice, general noise control measures, as listed in *Recommended Clauses for Construction Contracts – Section 3 - Noise Control* will be adopted.

The Hazard To Life assessment has recommended various measure during operation to ensure that societal risks remain as low as is reasonably practicable (ALARP) according to the *Hong Kong Government Risk Guidelines (HKRG), EIAO-TM Annex 4*. These include measures to be implemented around the TLEM site such as regularly checking for water seepage through the roof, walls or floor of the magazine building, as well as measures for the transport route such as regular monthly vehicle inspections for fuel system, exhaust system, brakes, electrics, battery, cooling system and engine oil leaks.

To ensure these general measures for waste management and hazard to life are complied with throughout operation as well as decommissioning, it is recommended that regular general inspection by carried out by the Environmental Team and competent site staff, and be verified by an Independent Environmental Checker.

9.2 *UPON COMPLETION OF THE PROJECT*

For ecology (and also relevant to landscape), re-instatement planting, following the approved *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* and *TLP* (which stated the responsibility, procedures and requirements for the reinstatement planting and the subsequent maintenance, etc.), has been recommended as a mitigation measure once the Project is complete and TLEM removed.

Annex 9A provides the Implementation Schedule of Recommended Mitigation Measures and further details will be provided in the EM&A Manual.

10 CONCLUSION

This section provides a conclusion to the EIA report and a summary of the environmental outcomes of the EIA, with *Table 10.1* summarizing any predicted environmental impacts due to the Project and the associated recommended mitigation measures.

The existing TLEM in Tai Shu Ha, Yuen Long District, New Territories has been licensed and is currently in use by the MTRC for the construction of the XRL until end of 2014 (Environmental Permit No. EP-349/2009/L). It is being used by the MTR XRL 824 Contractor. The TLEM will be available for use from late 2015 or early 2016 (expected January 2016) to December 2017 and DHK intends to continue using it for the Liantang/Heung Yuen Wai Boundary Control Point (BCP) project (hereafter 'HKLTH') tunnel construction works.

This section provides a summary of key environmental outcomes, including the recommended environmental protection measures, for this EIA study which has been carried out according to EIA Brief ESB-280/2014 to examine the continued operation and decommissioning of the existing TLEM for the HKLTH tunnel construction works (the Project).

The EIA Report largely follows the approved XRL EIA which assessed the impacts from the construction and operation of the TLEM, reviewing the relevant information and updating it as necessary. The approved XRL EIA had a far broader scope than just assessing the environmental impacts of the TLEM and after review of the full XRL EIA the environmental media relevant to the TLEM are Ecology, Airborne Noise, Air Quality and Waste Management with other media of minor importance, including Water Quality and Landscape and Visual. A new hazard to life assessment has also been undertaken for this EIA Report.

This section also summarizes the environmental benefits of the Project, any population and environmentally sensitive areas that have been protected and the key environmental problems avoided.

Since there is no construction phase for the Project, given the TLEM has been built and its operation will remain largely the same as its use for the current XRL project, no environmentally friendly designs have been recommended for this Project.

No key activities are known to take place concurrently and therefore it is assumed there will be no cumulative impacts from the Project.

10.1 ENVIRONMENTAL BENEFITS OF THE PROJECT AND THE ENVIRONMENTAL PROTECTION MEASURES RECOMMENDED

Environmental benefits of the Project are summarised below and any environmental monitoring and audit requirements considered necessary during the operation and decommissioning of the Project are summarized in *Chapter 10*.

10.1.1 *Environmental Considerations*

The selection of the TLEM site for the current Project offers a number of environmental benefits, namely that: it is already constructed so there are no construction impacts or land conversion issues; and it is being used for exactly the required purpose now under EP-349/2009/L which would imply any operational and decommissioning impacts associated with the current Project will be acceptable. In addition, since there is no requirement to build a new magazine site, the timeline for the tunnel Project may be expedited as well as there being no requirement to build a new magazine site which may cause more significant environmental impacts elsewhere.

During operation and decommissioning of the Project, with respect to all environmental media (including for ecology, airbourne noise, air quality, waste, water quality and landscape and visual), adverse impacts are minimal. Only measures to ensure proper waste management, general noise control measures (e.g as listed in *Recommended Clauses for Construction Contracts – Section 3 - Noise Control*) and good site practice (e.g. in accordance with the guidelines stipulated in EPD's *Practice Note for Professional Persons on Construction Site Drainage [ProPECC PN1/94]*) are recommended, as well as measures to ensure societal risks remain low. No specific environmental benefits of the Project are envisaged at this stage but similarly no adverse residual environmental impacts are expected.

Reinstatement planting following the approved *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* and *TLP* will be carried out at the TLEM site as soon as possible after decommissioning of the Project. This is a key mitigation measure that will benefit ecology (and landscape) and will now be carried out by DHK.

10.1.2 *Hazard to Life*

The storage and transport of explosives for the Project have been assessed in a Quantitative Risk Assessment. Practical route options were assessed in the study. The impact of road improvement work at Pok Oi Interchange was considered in route selection. The practical route option with minimum transport risk will be used.

The criterion of the EIAO-TM for Individual Risk is met. The assessment results show that the societal risk lies within the As Low As Reasonably Practicable (ALARP) region when compared to the criteria stipulated in Annex 4 of the EIAO-TM. An ALARP assessment has been carried out by identifying all practicable mitigation measures and assessing the cost effectiveness of each measure in terms of the risk reduction achieved and the cost of implementing the measures. The results show compliance with the ALARP principles and Risk Guidelines (EIAO-TM Annex 4) provided recommendations are implemented.

10.2 POPULATION PROTECTION

This project has the potential to influence populations including on-site workers and drivers of the explosives vehicles, as well as populations along the proposed explosive transport routes. With the implementation of relevant mitigation measures, as outlined in *Chapter 8 Hazard to Life* and summarized in *Chapter 10*, these people would be protected from any potential hazards and not be significantly affected by the Project.

10.3 PROTECTION OF ENVIRONMENTALLY SENSITIVE AREAS

The TLEM has already been built and is currently in use for the XRL project. The site falls in Conservation Area (CA) of the statutory Tai Tong Outline Zoning Plan (S/YL-TT/16) and is also near (approximately 300 m from) the Tai Lam Country Park. This CA is zoned to protect and retain the existing natural landscape, ecological or topographical features of the area for conservation, educational and research purposes and also acts as a buffer between the more sensitive natural environment of Tai Lam Country Park and the potentially adverse effects of development. The Project's operation will remain largely the same as its use for the current XRL project where no particular measure are considered necessary to protect the CA or nearby country park due to lack of impacts to these from the Project.

10.4 KEY ENVIRONMENTAL PROBLEMS AVOIDED

The following key environmental problems have been avoided:

- Loss of reinstatement planting at TLEM site that was to be carried out by MTRC at the end of their project (i.e. originally at the end of 2014 but now extended to 2015) in the approved XRL EIA report. DHK will now take on the responsibility of this reinstatement; and

- Hazard to life impacts to populations near the TLEM site and along the explosives transport routes, from the storage and transport of potentially harmful explosives to the works areas. A number of mitigation measures as set out in *Chapter 8* and summarised in *Chapter 10* minimise the risks from these potential impacts.

10.5 COMPENSATION AREAS

Since the Project has already been constructed and its operation will remain largely the same as its current use for the XRL project, no new compensation areas are required. The TLEM site itself, however, forms part of the compensation planting area for the XRL Project where re-instatement planting would be carried out. With the operation of the Project, reinstatement planting would be postponed and measures have been put in place to ensure the reinstatement planting plan is implemented as soon as possible upon completion and decommissioning of the Project (predicted in 2017).

10.6 CONCLUSION

Overall, this EIA study predicts that the Project, with the implementation of the mitigation measures, would be environmentally acceptable with no adverse residual impacts on the population and environmentally sensitive resources, as assessed in accordance with relevant criteria stipulated in the *EIAO (TM)*.

Table 10.1 Summary of Environmental Impacts

Assessment Points	Results of Impact Prediction	Relevant Standard/ Criteria	Extent of Exceedances Predicted	Recommended Mitigation including Avoidance	Residual Impacts (after mitigation)
Ecological Impact (Operation & Completion of Project)					
Ecological Sensitive Receivers within 500 m of the Project Site boundary	To restore the habitat back to borrow area reinstatement plantation, as it was prior to the construction of the TLEM for the MTRC's use. To ensure the proposed mitigation recommended in the approved XRL EIA for loss of green areas affected by the XRL Project, is implemented.	• *EIAO-TM; Annexes 8 & 16* • *DEVB TCW No. 10/2013 – Tree Preservation (supersedes ETWB TC(W) No. 3/2006)* • *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* • *Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha)*		Reinstatement planting To be carried out at the site following the approved *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West*, and *TLP*.	No adverse residual impacts are predicted
Air Quality Impact (Operation & Decommissioning)					
Air Sensitive Receivers within 500 m of the Project Site boundary	No adverse impacts are predicted	• *EIAO-TM Annex 4 & 12* • *Air Pollution Control Ordinance (APCO) (Cap 311)* • *Air Pollution Control (Construction Dust) Regulation*	No exceedances anticipated.	n/a	No adverse residual impacts are predicted

Assessment Points	Results of Impact Prediction	Relevant Standard/ Criteria	Extent of Exceedances Predicted	Recommended Mitigation including Avoidance	Residual Impacts (after mitigation)
Noise Impact (Operation & Decommissioning)					
Noise Sensitive Receivers within 300 m of the Project Site boundary	No adverse impacts are predicted	• *EIAO-TM; Annexes 5 & 13* • *Noise Control Ordinance (NCO)* • *Technical Memorandum on Noise From Places Other than Domestic Premises, Public Places or Construction Sites (IND-TM)* • *Technical Memorandum on Noise from Percussive Piling (PP-TM);* • *Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM); and* • *Technical Memorandum on Noise from Construction Work in Designated Areas (DA-TM).* • *Recommended Clauses for Construction Contracts – Section 3 - Noise Control*	No exceedances anticipated.	For good practice, adopt general noise control measures, as listed in *Recommended Clauses for Construction Contracts – Section 3 - Noise Control*	No adverse residual impacts are predicted

Assessment Points	Results of Impact Prediction	Relevant Standard/ Criteria	Extent of Exceedances Predicted	Recommended Mitigation including Avoidance	Residual Impacts (after mitigation)
Waste Management (Operation Waste & Decommissioning)					
Project Site	No adverse impacts are predicted	• *EIAO-TM Annexes 7 & 15* • *Waste Disposal Ordinance (WDO) (Cap 354);* • *Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap 354N)* • *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C);* • *Land (Miscellaneous Provisions) Ordinance (Cap 28)* • *Public Health and Municipal Services Ordinance (Cap 132) - Public Cleansing and Prevention of Nuisances Regulation.* • *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* (1992), EPD, Hong Kong Government	No exceedances anticipated.	For good measure, during regular site inspections, ensure refuse is appropriately treated and that general refuse is removed from the Project Site regularly (e.g. once per day). For decommissioning, during regular site inspections, ensure all waste is properly segregated and different waste (e.g. general waste, chemical waste and C&D materials (both inert and non-inert materials) are handled and disposed of appropriately.	No adverse residual impacts are predicted
Other (Operation & Decommissioning)					
Water sensitive Receivers within 500 m of the Project Site	No adverse impacts are predicted during operation. During decommissioning, appropriate measures should be implemented to properly control site run-off and drainage and minimise potential water quality impacts.	• *EIAO-TM Annexes 6 & 14* • *Water Pollution Control Ordinance (WPCO)* • *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-ICW)* • *Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)*	No exceedances anticipated.	n/a during operation. For good measure, during decommissioning, regular site inspections ensure appropriate measures are being implemented in accordance with stipulated guidelines. Exposed soil should be covered with geotextile before the re-vegetation / plantation to minimize soil erosion.	No adverse residual impacts are predicted

Assessment Points	Results of Impact Prediction	Relevant Standard/ Criteria	Extent of Exceedances Predicted	Recommended Mitigation including Avoidance	Residual Impacts (after mitigation)
Landscape resources, landscape character areas and Visual Sensitive Receivers within 500 m of the Project Site	No adverse impacts are predicted	• *EIAO-TM Annexes 10 & 18* • *DEVB TCW No. 10/2013 – Tree Preservation (supersedes ETWB TC(W) No. 3/2006)*	No exceedances anticipated.	n/a	No adverse residual impacts are predicted
Hazard to Life (Operation- Storage)					
Risk due to storage of explosives in the Tai Lam Explosives Magazine.	The Individual Risk level is below 1×10^{-5} per year considering low presence factor; and Societal Risk level is in the acceptable region.	Annex 4 of EIAO-TM	N/A	Mitigation measures are not necessary due to the fact that the societal risk level is in the acceptable region. Although mitigation measures are not required due to the fact that the societal risk level is in the acceptable region, general measures are recommended in keeping with best practice as presented in Section 9 of Annex 8A and summarised in the Project Implementation Schedule in Annex 9A.	Adverse residue impact is not predicted.

Assessment Points	Results of Impact Prediction	Relevant Standard/ Criteria	Extent of Exceedances Predicted	Recommended Mitigation including Avoidance	Residual Impacts (after mitigation)
Hazard to Life (Operation - Transport)					
Risk due to transport of explosives from the Tai Lam Explosives Magazine to worksites.	The Individual Risk level is below 1×10^{-5} per year; and Societal Risk level is in ALARP region.	Annex 4 of EIAO-TM	N/A	Individual risk levels are below the recommended level and societal risk level is in the ALARP region. The following measures are proposed after cost benefit analysis: • Follow the proposed Routes recommended in Chapter 8 of the EIA Report (both before and after completion of road improvement work at Pok Oi Interchange) • Implement improvement measures for safer explosive trucks (e.g. reduced fire load) • Reduce Accident Involvement Frequency (e.g. training programme etc.) • Reduce Fire Involvement Frequency (e.g. ensure appropriate emergency response system, extinguisher types, etc.) Details of above measures are presented in Section 9 of Annex 8A and general measures are also recommended for general best practice in the Project Implementation Schedule in Annex 9A.	The Individual Risk level is below 1×10^{-5} per year; and Societal Risk level is in ALARP region

Annex 2A

Decommissioning Plan

(Key details)

1. Brief introduction of the works required for decommissioning of the Magazine Site.

Item	Work Activity
1	Dismantle and remove E&M, fire services, CCTV and lighting installed for the two explosive stores
2	Demolish the earth bunds and the two explosive stores
3	Frame cut the re-bar and remove the concrete debris
4	Remove all fire service facilities and all ground services including guard house, road furniture and lighting
5	Remove fire hydrant water tank (245m^3)
6	Remove the container guard house and any temporary steel works
7	Demolish the paved road for reinstatement of a woodland

2. Due to small scale of demolition works, some of the activities could be conducted simultaneously, as illustrated in the program below:

<table>
<tr><th rowspan="2">Item</th><th rowspan="2">Activity</th><th colspan="4">Month</th><th rowspan="2">PME</th><th rowspan="2">No.</th><th rowspan="2">On-time</th></tr>
<tr><th>wk1</th><th>wk2</th><th>wk3</th><th>wk4</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Dismantle and remove E&M, fire services, CCTV and lighting installed for the two explosive stores</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>Crane lorry</td><td>1</td><td>25%</td></tr>
<tr><td>Lifting platform</td><td>1</td><td>25%</td></tr>
<tr><td>Hand-held drill/grinder</td><td>4</td><td>25%</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Demolish the earth bunds and the two explosive stores</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>Breaker</td><td>1</td><td>25%</td></tr>
<tr><td>Excavator</td><td>1</td><td>25%</td></tr>
<tr><td>3</td><td>Frame cut the rebar and remove the concrete debris</td><td></td><td></td><td></td><td></td><td>Dump truck with grab</td><td>1</td><td>15%</td></tr>
<tr><td rowspan="3">4</td><td rowspan="3">Remove all fire service facilities and all ground services including guard house, road furniture and lighting</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>Crane lorry</td><td>1</td><td>25%</td></tr>
<tr><td>Lifting platform</td><td>1</td><td>25%</td></tr>
<tr><td>Hand-held drill/grinder</td><td>4</td><td>25%</td></tr>
<tr><td>5</td><td>Remove fire hydrant water tank (245m^3)</td><td></td><td></td><td></td><td></td><td>Crane lorry</td><td>1</td><td>50%</td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Remove the container guard house and any temporary steel works</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>Crane lorry</td><td>1</td><td>25%</td></tr>
<tr><td>Lifting platform</td><td>1</td><td>25%</td></tr>
<tr><td>Hand-held drill/grinder</td><td>2</td><td>25%</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Demolish the paved road for reinstatement of a woodland</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>Breaker</td><td>1</td><td>25%</td></tr>
<tr><td>Excavator</td><td>1</td><td>25%</td></tr>
</table>

Annex 3A

Approved XRL EIA (No. EP-349/2009) Vegetation Survey Report for Tai Shu Ha Road West (Rev 1) [16 August 2010]

(Key details)

MTR Corporation Limited

HONG KONG SECTION OF GUANGZHOU - SHENZHEN - HONG KONG EXPRESS RAIL LINK

(No. EP-349/2009)

Vegetation Survey Report for Tai Shu Ha Road West (Rev 1)

Certified by: ______________________

Position: Independent Environmental Checker

Date: 16 August 2010

MTR Corporation Limited

HONG KONG SECTION OF GUANGZHOU - SHENZHEN - HONG KONG EXPRESS RAIL LINK

(No. EP-349/2009)

Vegetation Survey Report for Tai Shu Ha Road West (Rev 1)

Certified by: ____________________

Position: Environmental Team Leader

Date: 12 AUG 2010

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Appendices

1 INTRODUCTION

1.1 Background

1.1.1 The "Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL)" project (hereinafter known as "the Project") comprises a 26 km long underground rail line on a dedicated track. The track runs from the terminus at West Kowloon to the Hong Kong boundary at Huanggang, where it connects with the Mainland section of the Guangzhou-Shenzhen-Hong Kong Express Rail Link. The Project also comprises construction and operation of ventilation buildings, emergency access point, stabling sidings, maintenance facilities, and an emergency rescue station (**Figure C8016/C/XRL/ENS/M50/001** to **003**).

1.1.2 An Environmental Impact Assessment (EIA) study for the Project was conducted in accordance with EIA Study Brief No. ESB-197/2008. It was based on the available information obtained during preliminary design stage. The EIA study concluded that the Project would be environmentally acceptable with the implementation of recommended mitigation measures.

1.1.3 The EIA Report (Register No.: AEIA-143/2009) was approved on 28 September 2009 under the Environmental Impact Assessment Ordinance (EIAO). Following the approval of the EIA Report, an Environmental Permit (EP) was granted on 16 October 2009 (EP No: EP-349/2009) for the construction and operation of the Project.

1.1.4 Under the Project, Tai Shu Ha Road West Magazine Site (TSW) was selected as one of the explosive magazine sites (as referred to **Figure C8016/C/XRL/ENS/M51/001**). TSW is located at the Tai Tong East Borrow Area. The works area of TSW is located entirely within a Conservation Area (CA) zoned under the Tai Tong Outline Zoning Plan (OZP) (Statutory Plan No. S/YL-TT/14) (as referred to **Figure C8016/C/XRL/ENS/M51/301**). The CA is zoned to protect and retain the existing natural landscape, ecological or topographical features of the area for conservation, educational and research purposes. The zoning ordinances also separate sensitive natural environments, such as the Tai Lam Country Park, from adverse effects of development. To restore the borrow area, fast growing exotic species (e.g. *Acacia* spp., *Melaleuca quinquenervia*) were planted extensively in the area. The area is maintained by AFCD from 2003 to 2012. Recently, native species (e.g. *Machilus* spp*., Reevesia thyrsoidea, Schefflera heptaphylla,* and *Phyllanthus emblica*) were planted to increase diversity.

1.1.5 Although construction works for TSW would be small in scale, direct impact on trees and understorey vegetation would be inevitable. According to the requirements as stated in the EIA Report paragraph 3.371 and EP condition 2.12 (iii), in order to mitigate the loss of green areas, ecological enhancement in form of planting should be provided in the places affected by the Project at TSW.

1.1.6 A detailed vegetation survey covering the affected habitats should be conducted in TSW, prior to the commencement of site clearance, for formulating effective mitigatory planting proposal in TSW. Species chosen for planting should be similar to those identified *in situ*, native to Hong Kong, food source for local wildlife, and available in local nurseries. The proposed site planting measures should also be provided in accordance with ETWB TCW No. 3/2006.

1.1.7 Based on the detailed vegetation survey results, a Vegetation Survey Report (hereinafter known as 'the Report') should be prepared for TSW; and a Planting Proposal should be developed accordingly.

1.1.8 Mature trees to be felled would be covered under a separate study conducted by another consultant of MTR. Comprehensive information on tree survey and tree transplanting proposal would be presented in *Tree Removal Application for XRL – TRA-10: Works in Yuen Long District (Tai Shu Ha).*

1.2 Purpose of the Report

1.2.1 This Report presents the results of the detailed vegetation survey conducted in TSW, and proposes vegetation species suitable for mitigatory planting. Detailed planting plans are also provided as a blueprint for the future compensatory planting process.

2 METHODOLOGY

2.1.1 Vegetation species within the scheme boundary of TSW (as referred to **Figure C8016/C/XRL/ENS/M51/301**) were identified as far as practicable, with their relative abundance recorded. The species name (both scientific and Chinese names), form, rarity in Hong Kong, and protection status were also recorded. Identification of vegetation species and status in Hong Kong were made reference to Hong Kong Herbarium (2004) and Corlett *et al.* (2000).

3 VEGETATION SURVEY RESULTS

3.1.1 Detailed vegetation survey was conducted in April 2010 within and in the vicinity of the TSW site boundary. Vegetation species within the survey area were identified and recorded. Photographic record of general site condition is presented in **Appendix A**.

3.1.2 The TSW was largely covered by exotic plantation (e.g. *Acacia auriculiformis*, *Casuarina equisetifolia*, and *Eucalyptus* spp. etc.), with an understorey of shrubs, herbs and climbers beneath the tree canopy, where exposed bare ground surface was very limited. During the survey, a total of 39 understorey vegetation species were recorded, including 25 trees/small trees/shrubs, 9 herbs and 5 climbers/vines. Nearly 90% of the identified species are native to Hong Kong, with only 4 exotic species (*Araucaria heterophylla*, *Bidens alba*, *Sonchus oleraceus* and *Thunbergia grandiflora*). Among the native plants, *Dicranopteris pedata*, *Machilus chekiangensis*, *Melastoma sanguineum* and *Schefflera heptaphylla* were the dominant species at TSW; while *Bidens alba* was the most abundant exotic species. Details of the recorded plant species are presented in **Appendix B**.

4 MITIGATORY PLANTING

4.1 Proposed Vegetation Species for Mitigatory Planting

4.1.1 Upon the completion of XRL construction works, the TSW would be reinstated to mitigate the loss of green areas. Mitigatory planting of vegetation would be carried out within the boundary of TSW.

4.1.2 According to the aforementioned criteria for selection of vegetation species for mitigatory planting, recommendations for the affected tree and understorey species are made and should be adopted as far as practicable.

Table 4.1 Recommended Existing Vegetation Species for Mitigatory Planting at TSW

Scientific Name	Growth Form	Native / Exotic to Hong Kong
Castanopsis fissa	Tree	Native
Celtis sinensis	Tree	Native
Cinnamomum parthenoxylon	Large tree	Native
Litsea rotundifolia	Shrub	Native
Mallotus paniculatus	Tree	Native
Melastoma sanguineum	Shrub	Native
Psychotria asiatica	Tree or shrub	Native
Reevesia thyrsoidea	Tree	Native

Scientific Name	Growth Form	Native / Exotic to Hong Kong
Rhodomyrtus tomentosa	Shrub	Native
Schefflera heptaphylla	Tree	Native

4.1.3 Within the 10 recommended native vegetation species, 6 tree species have been recommended to compensate for the loss of tree species, and 4 shrub species have been recommended to compensate for the loss of understorey species. All of these species currently exist within TSW site boundary (**Appendix B** refers).

4.1.4 Apart from the above proposed species, other native trees/shrubs that are generally well self-established and suitable for mitigatory planting would also be considered to further promote the flora biodiversity of TSW (**Table 4.2** refers). Recommendation is made with reference to *Clause 1.4.2*, *Part (iii) Compensatory Tree Planting Proposal* of *Tree Protection Plan*, which was submitted under EP Condition 2.15 in June 2010.

Table 4.2 Recommended Non-existing Vegetation Species for Mitigatory Planting at TSW

Scientific Name	Growth Form	Native / Exotic to Hong Kong
Bischofia javanica	Tree	Native
Elaeocarpus sylvestris	Tree	Native
Gordonia axillaris	Shrub or tree	Native
Schima superba	Tree	Native
Viburnum odoratissimum	Shrub or tree	Native

4.1.5 Based on the above recommendations for species selection, detailed mitigatory planting plans for the recommended tree and understorey species are proposed, and are presented in **Figure 822/W/PHV/ATK/A58/843** and **822/W/PHV/ATK/A58/847** respectively. The number of individuals to be planted is also presented in the figures. The plans should be adopted as a blueprint for the future mitigatory planting process.

4.2 Proposed Site Restoration Measures

4.2.1 During construction phase, the TSW site would be cleared and hard-paved for the construction of magazine, and the soil would therefore be compacted. To provide a suitable site condition for mitigation planting, specific site restoration measures are proposed and would be carried out prior to the commencement of mitigation planting. The relevant specification for the above site restoration works is provided in **Appendix C**.

5 CONCLUSION

5.1.1 The proposed magazine site at Tai Shu Ha Road West (TSW) was largely covered by exotic plantation, with an understorey of shrubs, herbs and climbers beneath the tree canopy, where exposed bare ground surface was very limited. A total of 39 understorey species were recorded during the detailed vegetation survey within the site boundary of the proposed magazine site at Tai Shu Ha Road West. Nearly 90% of the identified species are native to Hong Kong.

5.1.2 Based on the selection criteria that species to be adopted for mitigatory planting in TSW site should be similar to the species identified *in situ*, native to Hong Kong, food source for local wildlife, and available in local nurseries, 15 native plant species would be adopted in mitigatory planting, comprising 11 tree and 4 shrub species to mitigate for the loss of green areas in the places affected by the Project.

6 REFERENCE

Corlett, R.T., Xing, F., Ng, S.C., Chau, L.K.C. and Wong, L.M.Y. 2000. Hong Kong Vascular Plants: Distribution and Status. *Memoirs of the Hong Kong Natural History Society* 23: 1-5

Hong Kong Herbarium. 2004. *Check List of Hong Kong Plants 2004*. Agriculture, Fisheries and Conservation Department, HKSAR.

APPENDIX A

REPRESENTATIVE PHOTOGRAPHS OF GENERAL SITE CONDITION AND TYPICAL VEGETATION AT TSW

General site condition at TSW

General site condition at TSW

AECOM	Consultancy Agreement No. C8016 Express Rail Link (XRL) Environmental Term Consultancy **Representative Photographs of General Site Condition and Typical Vegetation at TSW**	SCALE	N.T.S.	DATE	May-10	
		CHECK	-	DRAWN	YYG	
		JOB NO.	60150393	Appendix No.	Appendix A	Rev -

APPENDIX B

VEGETATION SPECIES RECORDED AND RECOMMENDED FOR MITIGATORY PLANTING AT TSW

Appendix B
Understorey Vegetation Species Recorded and Recommended for Mitigatory Planting at TSW

Family(科名)	中文名	Scientific Name	Growth Form (1)	Native / Exotic to Hong Kong	Distribution in Hong Kong	Abundance on Site	Suitable Species for Mitigatory Planting	Species Selected for Mitigatory Planting (2)
THEACEAE (山茶科)	黃瑞木	*Adinandra millettii*	shrub or small tree	native	common	x	✓	
APOCYNACEAE (夾竹桃科)	念珠藤	*Alyxia sinensis*	climber	native	common	x		
EUPHORBIACEAE (大戟科)	銀柴	*Aporusa dioica*	tree	native	very common	x	✓	
THYMELAEACEAE (瑞香科)	牙香樹	*Aquilaria sinensis*	tree	native	common (listed under Protection of Endangered Species of Animals and Plants Ordinance Cap. 586; Wild Plant under State protection: Category II; China Plant Red Data Book; and Illustration of Rare & endangered plant in Guangdong Province)	x	✓	
ARAUCARIACEAE (南洋杉科)	異葉南洋杉,南洋杉	*Araucaria heterophylla*	tree	exotic	introduced, common	x		
MYRTACEAE (桃金娘科)	崗松	*Baeckea frutescens*	tree	native	very common	x	✓	
ASTERACEAE (菊科)	白花鬼針草	*Bidens alba*	herb	exotic	very common	xx		
BLECHNACEAE (烏毛蕨科)	烏毛蕨	*Blechnum orientale*	herb	native	very common	x		
BLECHNACEAE (烏毛蕨科)	蘇鐵蕨	*Brainea insignis*	herb	native	common (Status in China: Vulnerable; and Wild Plant under State protection: Category II)	x		
EUPHORBIACEAE (大戟科)	黑面神, 鬼畫符	*Breynia fruticosa*	shrub	native	very common	x		
FAGACEAE (殼斗科)	黧蒴錐, 裂斗錐栗	*Castanopsis fissa*	tree	native	common	x	✓	#
ULMACEAE (榆科)	朴樹	*Celtis sinensis*	tree	native	common	x	✓	#
LAURACEAE (樟科)	黃樟	*Cinnamomum parthenoxylon*	large tree	native	common	x	✓	#
GLEICHENIACEAE (裏白科)	芒萁	*Dicranopteris pedata*	herb	native	very common	xxx		
EUPHORBIACEAE (大戟科)	黃桐, 黃蟲樹	*Endospermum chinense*	tree	native	restricted	xx		
THEACEAE (山茶科)	大頭茶	*Gordonia axillaris*	shrub or small tree	native	common	x	✓	#
LAURACEAE (樟科)	豺皮樟	*Litsea rotundifolia*	shrub	native	very common	xx	✓	#
LYGODIACEAE (海金沙科)	海金沙，羅網藤	*Lygodium japonicum*	climber	native	very common	xx		
LYGODIACEAE (海金沙科)	小葉海金沙，石韋藤	*Lygodium scandens*	climber	native	common	xx		
LAURACEAE (樟科)	浙江潤楠	*Machilus chekiangensis*	tree	native	common	xxx		
LAURACEAE (樟科)	楠屬	*Machilus* spp.	tree	n/a	n/a	xx	✓	
EUPHORBIACEAE (大戟科)	白楸	*Mallotus paniculatus*	tree	native	very common	x	✓	#
MELASTOMATACEAE (野牡丹科)	毛棯	*Melastoma sanguineum*	shrub	native	common	xxx	✓	#
POACEAE (禾本科)	剛莠竹	*Microstegium ciliatum*	perennial procumbent herb	native	very common	xx		
GRAMINEAE (禾本科)	五節芒	*Miscanthus floridulus*	perennial herb	native	common	x		
LIDACEAE (酢漿草科)	酢漿草	*Oxalis corniculata*	perennial herb	native	very common	x		
RUBIACEAE (茜草科)	九節, 山大刀	*Psychotria asiatica*	tree or shrub	native	very common	x	✓	#
RUBIACEAE (茜草科)	蔓九節，穿根藤	*Psychotria serpens*	climber: vine	native	very common	xx		
PTERIDACEAE (鳳尾蕨科)	長葉甘草蕨, 蜈蚣草	*Pteris vittata*	herb	native	very common	x		
STERCULIACEAE (梧桐科)	梭羅樹	*Reevesia thyrsoidea*	tree	native	common	xx	✓	#
MYRTACEAE (桃金娘科)	桃金娘，崗棯	*Rhodomyrtus tomentosa*	shrub	native	very common	x	✓	#
ANACARDIACEAE (漆樹科)	野漆	*Rhus succedanea*	shrub or small tree	native	common	x		

Appendix B

Understorey Vegetation Species Recorded and Recommended for Mitigatory Planting at TSW

Family(科名)	中文名	Scientific Name	Growth Form [1]	Native / Exotic to Hong Kong	Distribution in Hong Kong	Abundance on Site	Suitable Species for Mitigatory Planting	Species Selected for Mitigatory Planting [2]
ARALIACEAE (五加科)	鵝掌柴, 鴨腳木	*Schefflera heptaphylla*	tree	native	very common	xxx	✓	#
ASTERACEAE (菊科)	苦苣菜，苦藚菜	*Sonchus oleraceus*	herb	exotic	very common	x		
STERCULIACEAE (梧桐科)	假蘋婆, 七姐果	*Sterculia lanceolata*	semi-deciduous tree	native	very common	x	✓	#
ACANTHACEAE (爵床科)	大花老鴉嘴	*Thunbergia grandiflora*	herbaceous vine	exotic	common, cultivated or naturalized	x		
ULMACEAE (榆科)	山黃麻	*Trema tomentosa*	shrub or small tree	native	common	xx	✓	
VERBENACEAE (馬鞭草科)	山牡荊	*Vitex quinata*	small tree	native	common	x	✓	
RUTACEAE (芸香科)	簕欓花椒，簕欓	*Zanthoxylum avicennae*	tree or shrub	native	common	x	✓	

Note: (1) Hong Kong Herbarium (2004). (2) Based on availability from plant nusery.

Code for Abundance: xxxx=abundant; xxx=frequent; xx=occasional; x=scarce

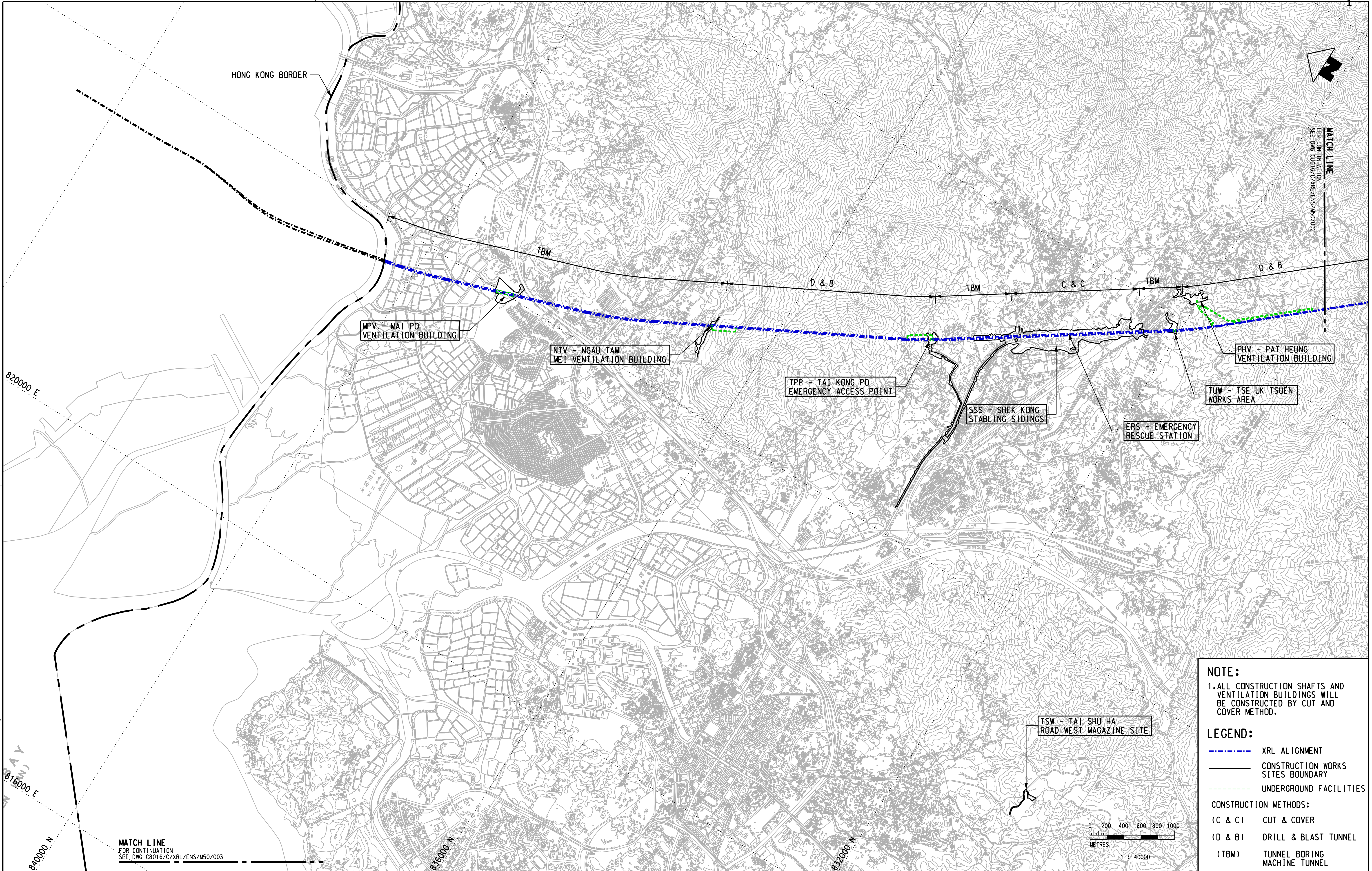
APPENDIX C

RELEVANT SPECIFICATION ON SITE RESTORATION WORKS FOR TSW

In the Approved XRL *Vegetation Survey Report for Tai Shu Ha Road West (Rev 1)*, Appendix C '**RELEVANT SPECIFICATION ON SITE RESTORATION WORKS FOR TSW'** specifications for the following are provided:

AN2.6.01	Preparatory works
AN2.6.02	Cleaning Ground
AN2.6.03	Ripping
AN2.6.04	Contaminated ground
AN2.6.05	Excavation to soil formation level
AN2.6.09	Soiling
AN2.6.10	Cultivation
AN2.6.12	Protection of prepared ground
AN2.6.13	Removal of Materials

Details of these can be found in the current EIA Report's ***Annex 3B Tree Planting and Landscape Plan Tlp-10: Works In Yuen Long District (Tai Shu Ha)****, Appendix V-Tree Works, Soft Landscape Works and Related Works*



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CHECKED	KCC
APPROVED	PL
DATE	17/MAY/2010

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AECOM

CADD REF. C8016_C_XRL_ENS_M50_001A.dgn

TITLE

C8016

ENVIRONMENTAL TERM CONSULTANCY FOR XRL

OVERALL VIEW OF ALIGNMENT

SCALE 1 : 40000 (A3)

FIGURE NO. C8016/C/XRL/ENS/M50/001

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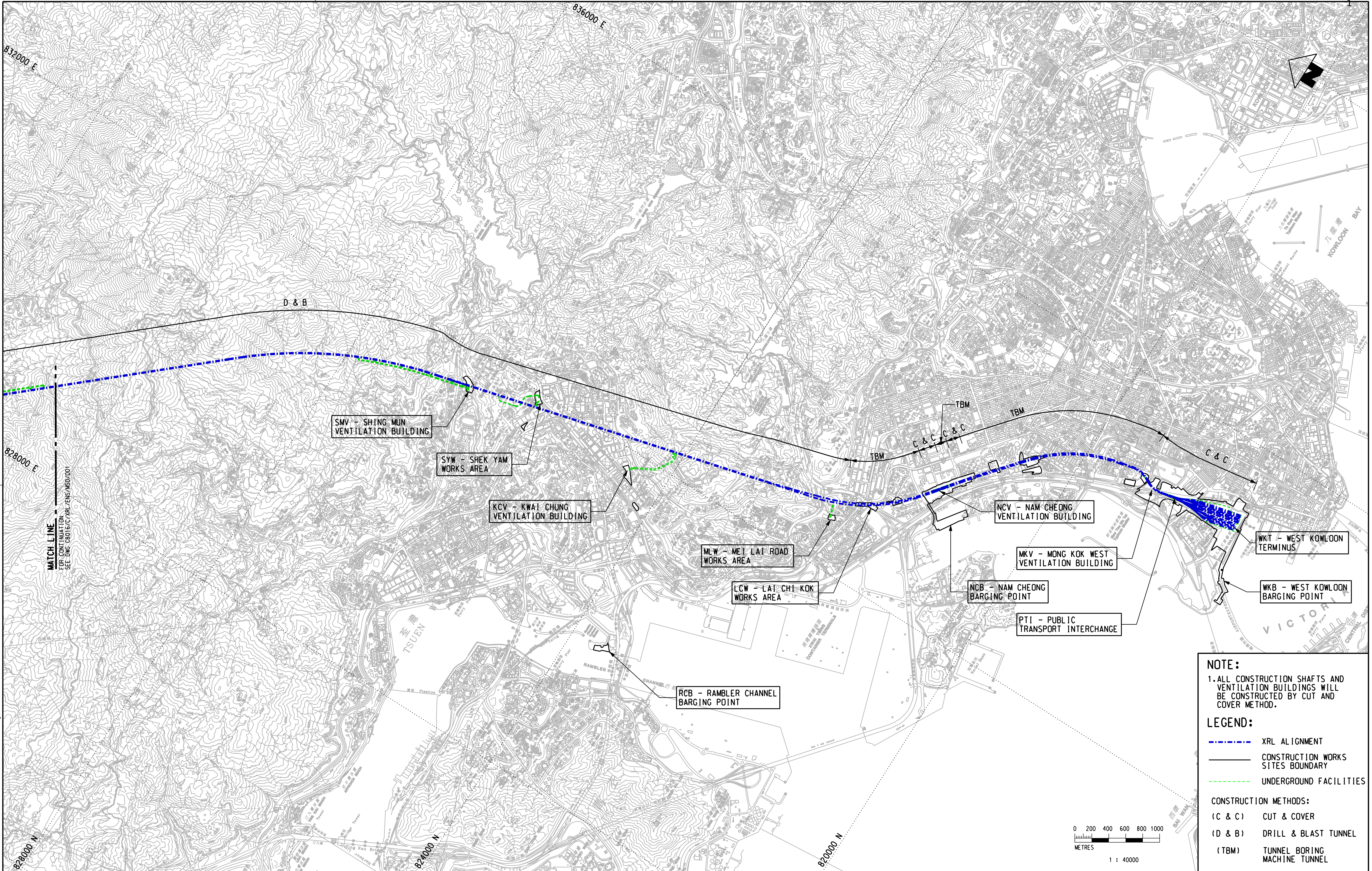

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TITLE

C8016

ENVIRONMENTAL TERM CONSULTANCY FOR XRL

OVERALL VIEW OF ALIGNMENT

SCALE 1 : 40000 (A3)

FIGURE NO. C8016/C/XRL/ENS/M50/002

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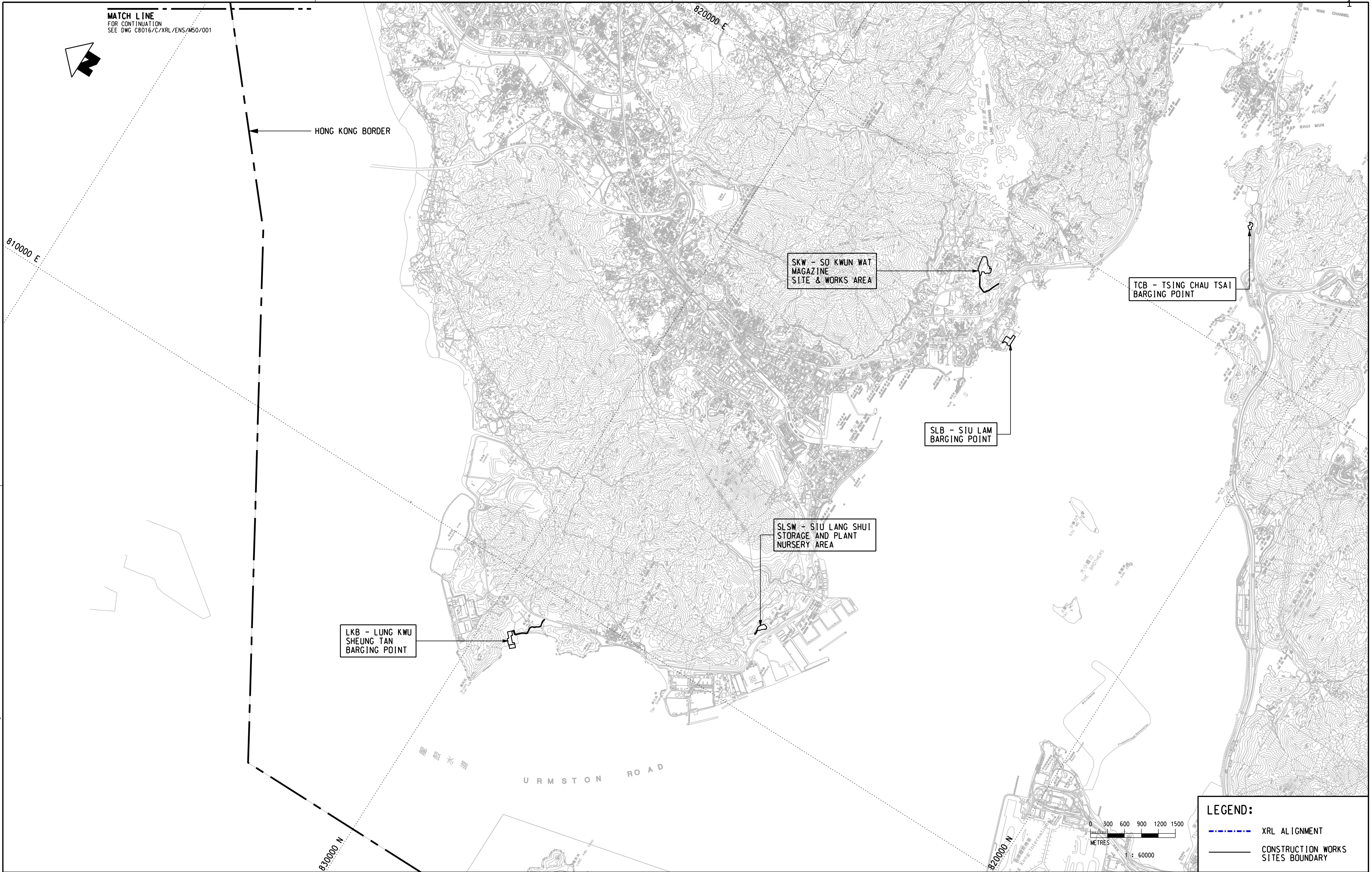

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TITLE

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OVERALL VIEW OF ALIGNMENT

SCALE 1 : 60000 (A3)

FIGURE NO. C8016/C/XRL/ENS/M50/003

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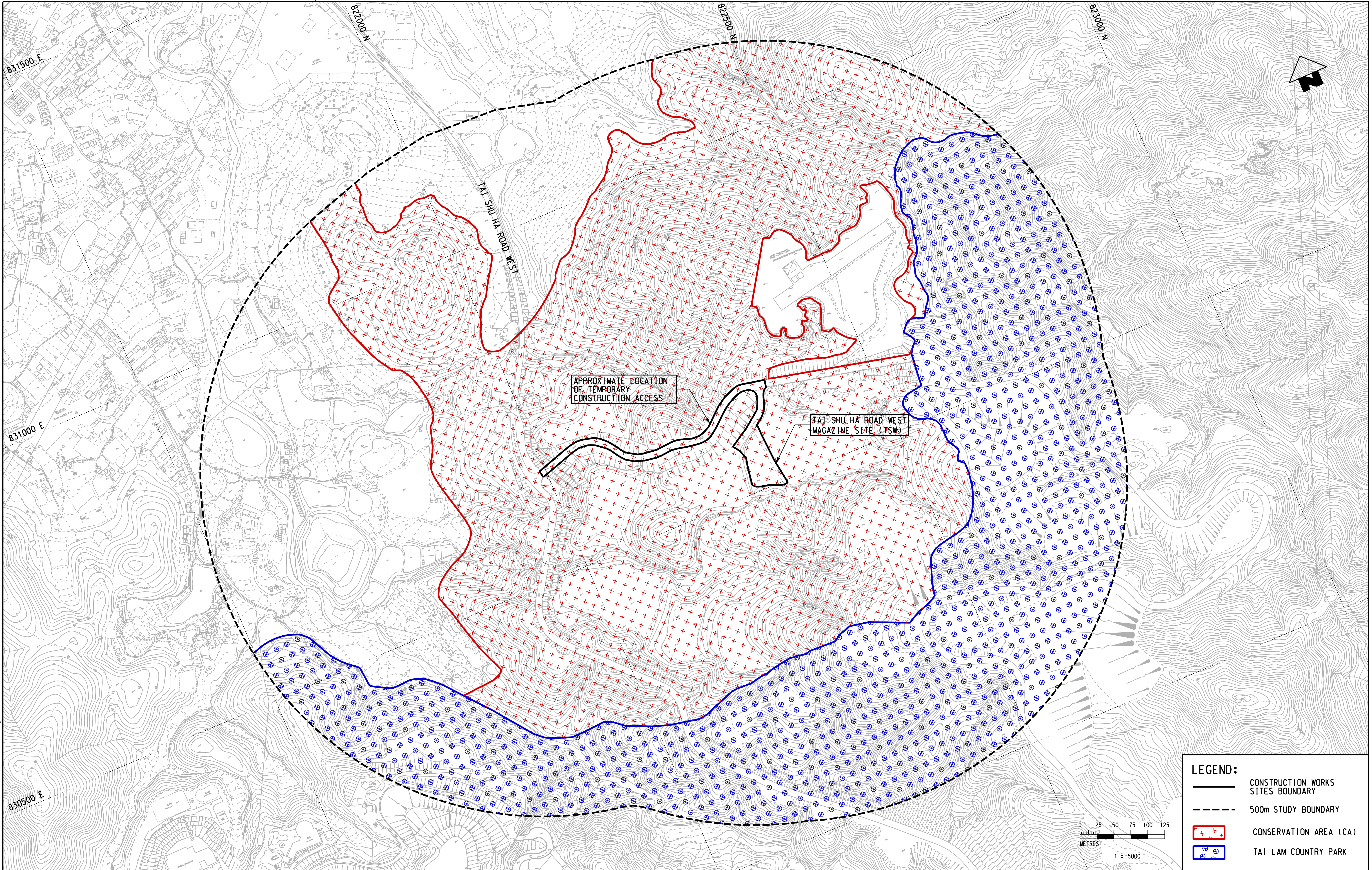

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TITLE

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PROPOSED LAYOUT PLAN AND SCHEME BOUNDARY OF TSW

SCALE 1 : 5000 (A3)

FIGURE NO. C8016/C/XRL/ENS/M51/301

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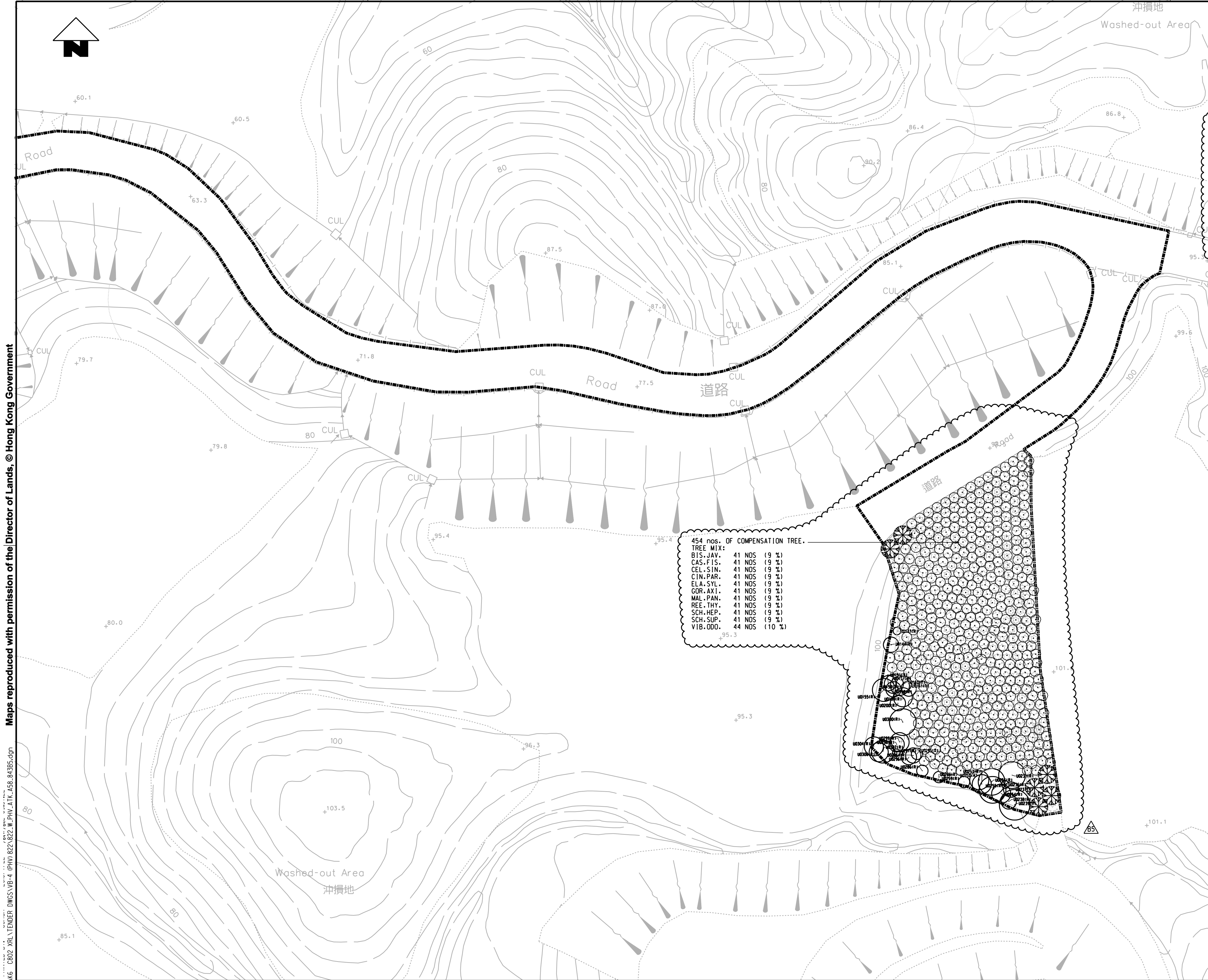

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TREE	樹類					
BIS.JAV.	BISCHOFIA JAVANICA	重陽木	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
CAS.FIS.	CASTANOPSIS FISSA	裂斗錐栗	STANDARD	2.5M	4Mx2.5Mx0.06M	41
CEL.SIN.	CELTIS SINENSIS	朴樹	STANDARD	2.5M	3.5Mx2Mx0.06M	41
CIN.PAR	CINNAMOMUM PARTHENOXYLON	黃樟	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
ELA.SYL.	ELAEOCARPUS SYLVESTRIS	山杜英	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
GOR.AXI.	GORDONIA AXILLARIS	大頭茶	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
MAL.PAN.	MALLOTUS PANICULATUS	白楸	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
REE.THY.	REEVESIA THYRSOIDEA	梭羅樹	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
SCH.HEP.	SCHEFFLERA HEPTAPHYLLA	鴨腳木	STANDARD	2.5M	4Mx2Mx0.06M	41
SCH.SUP.	SCHIMA SUPERBA	木荷	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
VIB.ODO.	VIBURNUM ODORATISSIMUM	珊瑚樹	STANDARD	2.5M	3.5Mx2.5Mx0.06M	44

B5

0 5 10 15 20 25
METRES
1 : 500

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B4	REVISION TO PLANTING SCHEDULE	AC	JUN10	TM
B3	REVISION TO PLANTING SCHEDULE	AC	MAY10	TM
B2	REVISION TO PLANTING SCHEDULE	AC	MAR10	TM
B1	REVISION TO PLANTING SCHEDULE	AC	FEB10	TM
A	WORKING DRAWING ISSUE	AC	MAR10	TM

DRAWN	SH
DESIGNED	AC
CHECKED	KN
APPROVED	TM
DATE	DEC/2009

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Arup, TFP Farrells, DLS
Knight Frank, BMT, Kenneth Ng

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TITLE
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TSE UK TSUEN TO SHEK YAM TUNNELS
TAI SHU HA (YUEN LONG) MAGAZINE SITE
LANDSCAPE PLAN

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REV. B5

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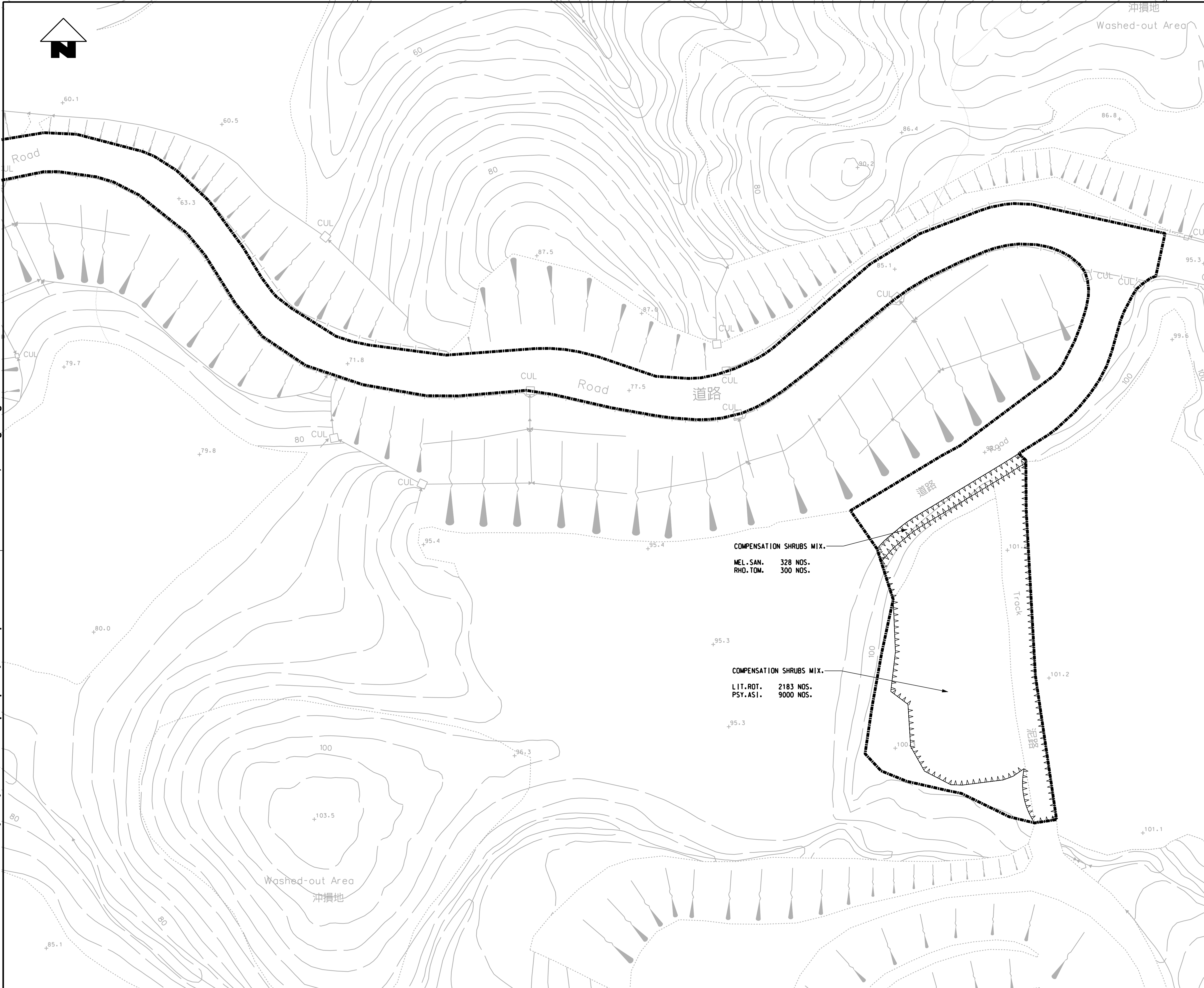

LEGEND:

Type 種類	Botanical Name 學名	Chinese Name 中文名稱	Spacing 種植闊度	Standard 規格	Quantity 數量
SHRUB 灌木類					
LIT.ROT.	LITSEA ROTUNDIFOLIA	豺皮樟	500 mm	300H x 250S	2183
MEL.SAN.	MELASTOMA SANGUINEUM	毛木念	500 mm	400H x 300S	328
PSY.ASI.	PSYCHOTRIA ASIATICA	九節	500 mm	500H x 400S	9000
RHO.TOM.	RHODOMYRTUS TOMENTOSA	桃金孃	500 mm	300H x 250S	300

SHRUB

0 5 10 15 20 25
METRES
1 : 500

REV	DESCRIPTION	BY	DATE	APPROVED
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A1	WORKING DRAWING ISSUE	AC	MAR10	TM

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DESIGNED	AC
CHECKED	KN
APPROVED	TM
DATE	MAR/2010

MTR

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ORIGINATOR
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Supported by
Arup, TFP Farrells, DLS
Kenneth Ng

CADD REF. 822_W_PHV_ATK_A58_847A3.DGN

TITLE
CONTRACT 822
TSE UK TSUEN TO SHEK YAM TUNNELS
TAI SHU HA (YUEN LONG) MAGAZINE SITE
SHRUB PLANTING PLAN

SCALE 1 : 500 (A1)
DRAWING NO. 822/W/PHV/ATK/A58/847
REV. A3

Annex 3B

Approved XRL EIA (No. EP-349/2009) Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha) (Revision 1-Addendum Pages) [27 October 2010]

(Key details)

HONG KONG SECTION OF GUANGZHOU - SHENZHEN - HONG KONG EXPRESS RAIL LINK
(No. EP-349/2009/A)

TREE PLANTING AND LANDSCAPE PLAN
TLP-10: WORKS IN YUEN LONG DISTRICT (Tai Shu Ha)
(Revision 1-Addendum Pages)

Our ref KMY/PEJ/AFK/TK/pw/T264090/22.01/L-0106
T 2828 5757
E anne.kerr@mottmac.com.hk
Your ref

MTR Corporation Ltd.,
8/F MTR Fo Tan Railway House,
No. 9, Lok King Street,
Fo Tan,
Shatin, N.T.

28 October 2010
By email

Attn : Dr. Glenn Frommer

Dear Sir

Express Rail Link
Consultancy Agreement No. C806
Independent Environmental Checker (IEC)
Environmental Permit No.: EP-349/2009/A
Condition 2.14 - Tree Planting and Landscape Plan TLP-10 Works in Yuen Long District (Tai Shu Ha)

Pursuant to the EP Condition 2.14, I hereby verify the addendum pages of the Tree Planting and Landscape Plan – TLP-10 Works in Yuen Long District (Tai Shu Ha) (Revision 1) for the Project.

Yours faithfully,
for MOTT MACDONALD HONG KONG LIMITED

Anne Kerr

Dr. Anne Kerr
Independent Environmental Checker (IEC)

20/F Two Landmark East, 100 How Ming Street, Kwun Tong, Kowloon, Hong Kong
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Mott MacDonald Hong Kong Limited

MTR Corporation Limited

HONG KONG SECTION OF GUANGZHOU –

SHENZHEN – HONG KONG EXPRESS RAIL LINK

(No. EP-349/2009/A)

Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha) Revision 1

– Addendum Pages

Certified by: Glenn Frommer

Position: Environmental Team Leader

Date: 27 Oct 2010

TABLE OF CONTENTS

LIST OF APPENDICES

Chapter 1

Introduction

1 INTRODUCTION

1.1 THE XRL PROJECT

1.1.1 The Guangzhou-Shenzhen-Hong Kong Express Rail Link is a committed cross boundary transport infrastructure project to provide high-speed rail services between Hong Kong (HK) and Guangzhou, and a connection to the national high-speed passenger rail network serving major mainland cities outside of Guangdong province. This network, which will comprise some 12,000 km, is now under construction in the Mainland. It is understood that the section from Guangzhou to Shenzhen (Futian) will start operation in 2010. The Hong Kong section of the Express Rail Link (XRL) is scheduled for urgent implementation, following the announcement by the Chief Executive (CE) of the HKSAR in the 2007- 08 Policy Address. The XRL, measuring about 26 km from West Kowloon to the boundary, will use a dedicated corridor to ensure that the required line capacity can be achieved and to ensure operational compatibility with the Mainland.

1.1.2 The XRL Scheme consists of an underground terminus in West Kowloon, approximately 26 km of tunnels from the terminus to the boundary at Mai Po, tunnel ventilation shafts/adits and associated buildings and facilities, an emergency rescue siding, stabling sidings and associated facilities in Shek Kong, approach tunnel to the stabling sidings, and access roads to the ventilation buildings. After crossing the boundary, the Mainland section of the high-speed railway runs north for a further 116 km to Guangzhou, with new stations at Futian, Longhua (New Shenzhen Station), Gongming, Dongchung, Humen and Shibi (New Guangzhou Station). Trains on the Hong Kong section are intended to operate at speed up to 200 kmph.

1.1.3 With a footprint of about 10 ha., the XRL West Kowloon Terminus (WKT) is an underground station located immediately north of the proposed West Kowloon Cultural District (WKCD) between the Airport Railway Kowloon Station to the west and the future West Kowloon (Austin) Station to the east.

1.1.4 The XRL tunnel configuration will vary depending upon the geological conditions and methods of construction. The TBM tunnels will adopt a twin cell tunnel configuration with interconnecting cross passages. Twin bore tunnels are envisaged for the section of tunnel underneath the Mai Po Marshes and the RAMSAR Site for final crossing over into the Mainland.

1.1.5 Seven intermediate ventilation shafts/adits, with associated ventilation buildings, are proposed along the alignment of the XRL tunnel alignment providing ventilation for the main tunnels. The ventilation shafts/adits also function as emergency access points (EAPs) for emergency rescue teams in case of incident or emergency inside the tunnels. One additional EAP (EAP3) is provided at Tai Kong Po.

1.1.6 A depressed emergency rescue siding (ERS) is to be provided in Shek Kong for emergency evacuation of passengers from an incident train. Two tunnel ventilation plants will also be located at either end of the SSS. The Shek Kong Stabling Sidings (SSS) will provide at grade stabling sidings and running maintenance tracks to the east of the ERS.

1.1.7 The XRL Project will resume about 114 ha surface land area together with underground strata on a permanent and temporary basis for construction of the XRL related facilities.

1.2 TREE PLANTING AND LANDSCAPE PLAN

1.2.1 In accordance with the Environmental Permit (EP No. 349/2009/A) of the Express Rail Link (XRL), the Permit holder is required to submit a Tree Planting and Landscape Plan, including the compensatory woodland, in consultation with the Planning Department and Agriculture, Fisheries and Conservation Department, for approval by the Director.

1.2.2 A number of trees will be affected by the proposed work, and it is proposed to fell some trees and transplant others, following the rationale described later in this plan.

1.2.3 The Plan for the XRL project will be split into ten submissions based on the District boundaries and the work program. There will be separate strategies as follows:

a) TLP-1: Works in Yau Tsim Mong District
b) TLP-2: Works in Sham Shui Po District
c) TLP-3: Works in Kwai Tsing District
d) TLP-4: Works in Tsuen Wan District
e) TLP-5: Works in Tuen Mun District
f) TLP-6: Works in Yuen Long District - Mai Po
g) TLP-7: Works in Yuen Long District - Remainder
h) TLP-8: Works in Yuen Long District – Siu Lang Shui
i) TLP-9: Works in Yuen Long District – Yick Yuen
j) TLP-10: Works in Yuen Long District - Tai Shu Ha

1.2.4 A Key Plan (Dwg. No. C8001/T/XRL/URB/C04/901) is attached in Appendix IV showing the XRL alignment, the locations of the survey sheet numbers, and the District boundaries.

1.2.5 The current plan is for TLP-10: Works in Yuen Long District (Tai Shu Ha).

1.3 STRUCTURE OF THE PLAN

1.3.1 The plan contains a Tree Survey and a Proposal for Tree Transplanting and Compensatory Tree Planting.

1.3.2 Chapter 2 summarises the findings and recommendations of the Tree Survey.

1.3.3 Chapter 3 presents the landscape mitigation measures of tree transplanting and compensatory planting.

1.3.4 Chapter 4 provides a summary of the total cumulative tree felling, tree transplanting and compensatory tree planting for the entire XRL Project.

1.3.5 The detailed findings and recommendations of the Tree Survey are tabulated in a Tree Assessment Schedule in Appendix I.

1.3.6 Survey sheets showing the locations of the trees, overlaid with the engineering layouts, are provided in Appendix II.

1.3.7 Drawings showing the Compensatory Tree Planting and Transplanting Proposals are provided in Appendix III.

1.3.8 Supplementary Information to support the TLP is provided in Appendix IV. This includes additional information explaining impacts on trees and layouts of temporary work areas.

1.3.9 The Particular Specification for Tree Works and Soft Landscape Works (including particular specification for protecting existing trees, pruning existing retained trees, and transplanting trees) is provided in Appendix V.

1.3.10 Photographs of all the trees within the work boundaries are provided in Appendix VI (in separate Volume 2).

1.4 TREE NUMBERING AND CROSS REFERENCE STYLE

1.4.1 For ease of cross-reference between drawings, schedules and photographs, and on site checking, the following tree numbering and cross reference system has been adopted:

- individual trees are numbered as T0001, T0002, T0003 etc. and have been labelled on site;
- all trees have been photographed and numbered on the photo of the tree;
- the Tree Assessment Schedule in Appendix I identifies the survey sheet number, tree number and photograph number for each tree;
- the trees in the Tree Assessment Schedule are listed first by survey sheet number and then by tree number - thus all trees found on one survey sheet are located together in the Tree Assessment Schedule for ease of cross reference between the schedule and the drawings;
- similarly, each page of the tree photographs in Appendix VI has a relevant survey sheet number at the bottom right corner; photographs are grouped by survey sheet for ease of cross reference and on site checking; and
- for ease of cross-reference, a colour coding is used in the tree survey plan – green for retain, grey for retain and prune, red for fell, blue for transplant and black for outside gazettal boundary.

Chapter 2

Tree Survey Findings and Recommendations

2 TREE SURVEY FINDINGS AND RECOMMENDATIONS

2.1 TREE SURVEY

2.1.1 A comprehensive survey of all potentially impacted trees on all work sites and work areas was conducted in mid 2008 under MTRCL consultancy NEX2110. The tree survey information presented herein is an extract from that survey.

2.1.2 Since the 2008 survey was undertaken, the XRL gazettal boundary has been slightly revised, necessitating an additional survey which has been undertaken in early 2009. The trees identified from this additional survey are identified in the tree survey drawings and schedules by a prefix "U" before the tree number (e.g. U0001).

2.1.3 The following technical circulars, practice notes and publications have been referenced:

- Forests and Countryside Ordinance (Cap. 96);
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586);
- Agriculture, Fisheries & Conservation Department – Nature Conservation Practice Note No. 02 (Rev. Jun 2006)
- Country Park Ordinance (Cap. 208);
- Environment, Transport and Works Bureau Technical Circular (Works) No. 2/2004 - Maintenance of Vegetation and Hand Landscape Features;
- Environmental, Transport and Works Bureau Technical Circular (Works) No. 2/2005 on Capital Works or Maintenance Works (including Tree Planting) Within or Adjacent to the Kowloon Canton Railway (Hong Kong) Section, Tsim Sha Tsui Extension and Ma On Shan Rail;
- Environment, Transport and Works Bureau Technical Circular (Works) No. 3/2006 – Tree Preservation;
- Environment, Transport and Works Bureau Technical Circular (Works) No. 29/2004 - Registration of Old and Valuable Trees and Guidelines for their Preservation;
- Highways Department Technical Circular No. 3/2008 - Independent Vetting of Tree Works under the Maintenance of Highways Department;
- General Regulation (GR) 740;
- Standing Interdepartmental Landscape Technical Group (SILTECH) Publication - 'Tree Planting and Maintenance in Hong Kong' (Webb, 1991);
- Agriculture, Fisheries & Conservation Department Publication - 'Rare and Precious Plants of Hong Kong' (2004) and
- Agriculture, Fisheries & Conservation Department Publication - 'Check List of Hong Kong Plants' (2004).
- Highways Department – Landscape Unit – Requirements for Handover of Vegetation to Highways Department (undated)
- HyD Guidelines HQ/GN/13 on Interim Guidelines for Tree Transplanting Works under HyD's Vegetation Maintenance Ambit

2.1.4 Trees were surveyed individually and the following characteristics are recorded in the Tree Schedule in Appendix I:

- Tree reference number;
- District within which tree is located;
- Photograph number;
- Botanical name;
- Chinese common name;
- Height (m);
- Trunk diameter at 1.3m above ground level (m);
- Crown spread (m);
- Form (good / fair / poor);
- Health (good / fair / poor);
- Amenity value (high / medium / low);
- Survival rate after transplanting (high / medium / low);
- Government Department responsible for maintenance of the tree. This is based on the ETWBTC(W) 2/2004 "Maintenance of Vegetation and Hard Landscape features", Appendix A "Areas of Responsibilities of Departments on Maintenance of Vegetation";
- Government Department responsible for providing expert advice to LandsD on removal of the tree. This is based on the ETWBTC(W) 3/2006 "Tree Preservation", Appendix B "Departmental Responsibilities for Providing Expert Advise to LandsD for vetting of Tree Removal Applications";
- Trees in the Register of Old and Valuable Trees are identified in accordance with ETWBTC(W) No. 29/2004 - Registration of Old and Valuable Trees and Guidelines for their Preservation;
- Trees considered as "Important Trees" in accordance with ETWBTC(W) 3/2006 "Tree Preservation";
- Trees considered as "Wall Trees" as defined in HyD TC No. 3/2008 on Independent Vetting of Tree Works under the Maintenance of Highways Department;
- Other remarks.

2.1.5 Following the assessment of the impacts from XRL work on the trees, the following information has been added to the Tree Schedule:

- Recommendation (Retain / Retain and Prune / Transplant / Fell); and
- Justification for the Recommendation (i.e. reason why the tree is unavoidably affected by the work)

2.2 TREE CLASSIFICATION CRITERIA

2.2.1 In the tree survey, trees have been assessed and classified in accordance with criteria for classification of form, health, survival rate and amenity value, as described below.

Form (Good / Fair / Poor)

2.2.2 Tree Form is classified as follows:

a) Good: trees with well-balanced form, upright, evenly branching, well-formed head and generally in accordance with the standard form for its species;

b) Fair: trees with generally balanced form with natural compensations for loss of branches or leaning trunks;

c) Poor: trees with very unbalanced form, leaning, contorted, bending trunk, suffering from loss of major branches with general damage and growing close to adjacent trees.

Health (Good / Fair / Poor)

2.2.3 The "Health and Condition" of trees is assessed by evaluating the following criteria:

a) Foliage

- Colour and general appearance; and
- Presence of insect and/or fungal infection.

b) Branches

- Presence of dead, broken, cut or crossing branches;
- Presence of heavy horizontal branches which may cause tree instability; and
- Presence of any special phenomena of the branches likely to cause hazard.

c) Trunk

- Presence of tightly forked or multi-ascending trunk may be a sign of weakness (depends on specie);
- Presence of cavities or internal/ external rot as may be evidenced by presence of moisture seeping through the trunk, and / or fungi growing on the trunk; and
- Serious bark damage.

2.2.4 Based on evaluation of above criteria, the classification of 'Health and Condition' is as follows:

d) Good: Trees with a low incidence of the less serious features listed above and a high chance of a fast recovery from such features.

e) Fair: Trees with a higher incidence of the less serious features and a medium chance of recovery from those features.

f) Poor: Trees with more serious health features listed above and with a low chance of recovery from those features, even with remedial treatment.

Survival Rate Following Transplanting (High / Medium / Low)

2.2.5 The assessment of the survival rate of trees following transplanting is evaluated as High, Medium or Low, taking account of the following criteria:

- the typical ability of that tree species to survive transplanting;
- the tree size, form and existing health condition;
- the presence of any physical impediments to the preparation of root balls, such as wall, utilities, manholes, rocks, foundations etc.; and
- the inclined angle of the tree roots – the steeper the incline, the less chance of survival.

2.2.6 The grading of "Survival Rate following Transplanting" is therefore as follows:

a) High: Over 60% chance of survival provided that proper preparation and transplanting methodology is adopted.

b) Medium: 30-60% chance of survival provided that proper preparation and transplanting methodology is adopted.

c) Low: Less than 30% chance of survival even if proper preparation and transplanting methodology is adopted.

Amenity Value (High/Medium/Low)

2.2.7 The positive contribution of trees to their surrounding urban and landscape context is expressed as their "Amenity Value". Factors that are taken into consideration in the assessment include:

- Functional value: provide screening, shade or shelter.
- Age and maturity.
- Visual impact: the degree of positive visual impact created by the tree, or conversely, the degree of adverse visual impact that would result from loss of the tree.
- Status & form: a good representative specimen of its species, present condition, potential hazard and stability.

2.2.8 The grading of "Amenity Value" is therefore as follows:

a) High: Mature trees with good health condition and form that have good functional attributes and create large positive visual impact.

b) Medium: Common species with average health, medium condition and acceptable form that have moderate functional attributes and create moderate positive visual impact.

c) Low: Young and small trees of common species in accordance with the mature size for its species, and common weedy species, with relatively small functional attributes and small positive visual impact.

Trees with conservational, ecological, historical value, rare and protected tree species

2.2.9 Trees with conservational, ecological, historical value, rare, protected tree species, and Fung Shui trees are identified in the remarks column of the assessment schedule.

"Old and Valuable Tree" or "Important Tree"

2.2.10 If the tree is listed on the Register of Old and Valuable Trees, it is identified in the schedule as an "Old and Valuable Tree" (OVT).

2.2.11 In accordance with ETWBTC(W) 29/2004 "Registration of Old and Valuable Trees and Guidelines for their Preservation", if a tree meets one or more of the following criteria, it is identified in the schedule as an "Important Tree" (IT):

- Trees of 100 years old or above;

- Trees of cultural, historical or memorable significance e.g. Fung Shui trees, trees as landmark of monastery or heritage monument, and trees in memory of an important person or event;
- Trees of precious or rare species;
- Trees of outstanding form (taking account of overall tree size, shape and any special features) e.g. tree with curtain like aerial roots, trees growing in unusual habitat; or
- Trees with trunk diameter equal or exceeding 1.0m (measured at 1.3m above ground level), or with height/canopy spread equal or exceeding 25m.

"Wall Trees"

2.2.12 Wall trees as defined in HyD TC No. 3/2008 on Independent Vetting of Tree Work under the Maintenance of Highways Department are identified in the remarks column in the schedule.

"Exempted Trees"

2.2.13 Certain types of trees are exempted from the control requirements of ETWBTC(W) 3/2006, including:

- Trees made hazardous due to natural causes such as lightning, typhoon, torrential rain or landslide;
- Dead, dying or diseased trees; and
- Self-seeded trees of undesirable 'weed' species such as *Leucaena leucocephala* as part of normal maintenance; and
- Woodland management work is carried out by respective tree maintenance departments.

2.3 ASSESSMENT OF IMPACTS ON TREES

Design Reference Documents

2.3.1 In order to determine whether or not the existing trees will be affected by the proposed work, reference has been made to the latest available engineering designs, prepared by the MTRCL's Design Consultants.

2.3.2 For ease of reference, the design for the engineering work has been overlaid on the tree survey drawings.

Description of Project Work in Yuen Long District (Tai Shu Ha)

2.3.3 Recognizing the necessity of adequate site area required for an extensive work of this nature, additional work areas have been reserved for the entire or part of the duration of the project in the following locations:

- Construction of Tai Lam Magazine Site

Necessity for Removal of Trees

2.3.4 In order for work to be constructed, a certain minimum number of trees must inevitably be removed.

2.3.5 Detailed discussions have been held with the design engineers to ensure that the impact on these existing trees along is minimised, and the total number of affected trees is kept to the minimum required to undertake the construction and operation.

2.3.6 The Tree Schedule, in Appendix I, includes a column providing the justification why a tree is unavoidably affected by the work.

Basis of Recommendations to Transplant

2.3.7 Trees that are unavoidably affected by the work and needed to be removed are selected for transplanting instead of felling on the basis of the principles outlined in ETWBTC(W) 3/2006, paras 17(b) and (c):

a) Transplanted trees that can be moved to permanent receptor locations within the project site (ref. ETWBTC(W) 3/2006, para 17(b)) are selected based on a combination of factors including the location of the tree; the species, form, health and amenity value of tree; the ease and cost of transplanting; the survival rate following transplanting and safety of transplanting operation. All of the following criteria must be satisfied for a tree to be recommended for transplanting instead of felling:

- Form and health should be at least "fair";
- One of the categories of "Amenity Value" or "Survival Rate" should be "high" and the other should at least "medium";
- The tree is of high conservation value, including rare and precious species;
- The tree is easily accessible, not on steeply sloping ground, and safe to transplant;
- No objects such as manholes, waterpoints, hydrants etc. that would interfere with rootball preparation (justification is provided); and
- Preparation for transplanting must be undertaken safely.

b) Transplanted trees that have to be permanently removed off-site (ref. ETWBTC(W) 3/2006, para 17(c)) because they cannot be transplanted within the project site are selected in accordance with ETWBTC(W) 3/2006, para 17(c)). To strike a balance between cost and benefit, only trees with high conservation value, or high amenity value including rare and precious tree species and which have a "high" success rate (i.e. have a good chance of recovering to its normal form) following transplanting should be considered for transplanting off–site. A proposed transplanted tree can be transplanted to a temporary holding nursery before transplanted to permanent location only if there is a prior agreement with the future maintenance department to do so.

2.3.8 In addition to the above considerations, and in accordance with LCSD practice, affected street trees that are under the jurisdiction of LCSD are recommended for transplanting if they are in good condition.

Basis of Recommendation to Fell

2.3.9 If a tree that has to be removed is not selected to be transplanted according to the criteria above, then it is recommended to be felled.

2.3.10 In addition, the following trees are recommended to be felled, irrespective of whether or not they are affected by the construction:

- All dead trees within the gazettal boundary;
- Trees within the gazettal boundary considered hazardous to public safety and which cannot be rendered safe by tree pruning work; and
- Trees within the gazettal boundary with contagious pests or diseases that cannot be eradicated by pest or disease control measures.

2.4 SUMMARY OF IMPLICATIONS FOR TREES

2.4.1 In summary, the Tree Survey reveals that:

a) There are 236 living trees identified inside, or just outside, the Gazettal Boundary in the Yuen Long District (Tai Shu Ha). In addition, there are 18 dead trees.

b) 34 of the trees can be retained in site during and after construction, none of which are recommended to be pruned.

c) No trees are recommended to be transplanted as a result of construction. (In addition, 18 dead trees are to be felled).

Old and Valuable Trees and Important Trees

2.4.2 There are no Old or Valuable Trees (as listed in the Register of Old and Valuable Trees) in the gazettal boundary in the Yuen Long District (Tai Shu Ha).

2.4.3 There are no Important Trees (as defined by ETWBTC(W) 3/2006) in the gazettal boundary in the Yuen Long District (Tai Shu Ha)

Wall Trees

2.4.4 There are no Wall Trees in the gazettal boundary in the Yuen Long District (Tai Shu Ha).

Breakdown of Affected Trees by Species

2.4.5 A breakdown of the affected trees by species is provided in Table 2.1.

Table 2.1 – Impacts on Trees by Species

TREE SPECIES	Retain	Retain & Prune	Transplant	Fell	TOTAL
Acacia auriculiformis	19			129	148
Acacia confusa				2	2
Acacia mangium	5			13	18
Castanopsis fissa				20	20
Casuarina equisetifolia	10			36	46
Eucalyptus spp.				2	2
Grand Total	34	0	0	202	236

Breakdown of Affected Trees by Government Department

2.4.6 A breakdown of the affected trees according to the Government department responsible to advise Lands Department under ETWBTC(W) 3/2006 is provided in Tables 2.2 – all trees are to be advised by AFCD.

Table 2.2 – Affected Trees for which AFCD advise DLO under ETWBTC(W) 3/2006

TREE SPECIES	Retain	Retain & Prune	Transplant	Fell	TOTAL
Acacia auriculiformis	19			129	148
Acacia confusa				2	2
Acacia mangium	5			13	18
Castanopsis fissa				20	20
Castanopsis equisetifolia	10			36	46
Eucalyptus spp.				2	2
Grand Total	34	0	0	202	236

Chapter 3

Compensatory Tree Planting & Transplanting Proposal

3 COMPENSATORY TREE PLANTING AND TRANSPLANTING PROPOSAL

3.1 INTRODUCTION

3.1.1 The compensatory tree planting and transplanting proposals are indicated on the drawings in Appendix III and described below. The drawings indicate:

- The existing trees that have been recommended to be retained;
- Proposed trees; and
- The locations of trees transplanted back to the site at the end of the construction.

3.2 FACTORS WHICH PRECLUDE COMPENSATORY TREE PLANTING

3.2.1 Along the XRL alignment, there are numerous factors which influence the potential for compensatory tree planting. The factors which affect the compensatory planting design in Yuen Long District (Tai Shu Ha) are described briefly below.

Land to be Reinstated and Returned to Government

3.2.2 The land shall be returned in similar condition to when it was occupied.

3.3 TREE PROTECTION, TREE PRUNING, AND TREE TRANSPLANTING PROPOSALS

Tree Protection Strategy

3.3.1 As identified in the Tree Survey, a number of trees that are proposed to be retained will be within the railway areas and great care will be taken during construction to ensure that no damage occurs to them. Tree protection measures written into the contract documents shall include the provision of sturdy protective fencing located underneath the edge of the tree canopy (not only around the tree trunk); prohibition of storage of any materials under the tree canopy; prohibition of construction traffic under the tree canopy; and prohibition of cleaning out of concrete mixers, or washing of equipment underneath the tree canopy. The specification for the tree protection work will be according to the Soft Landscape Work Particular Specification, attached in Appendix V.

Tree Pruning Strategy

3.3.2 During the course of construction, some trees which are recommended to be retained in their existing positions may need to have their roots or branches pruned to enable nearby construction work. The specification for the tree pruning will be according to the Soft Landscape Work Particular Specification, attached in Appendix V.

Tree Transplanting Strategy

3.3.3 Generally, whenever possible along the XRL, trees proposed to be transplanted during the course of XRL project will be moved directly to a final location within work boundary. However, such final receptor locations may not be immediately available for all transplanted trees due to the work program. In this case, trees that cannot be immediately located to a final receptor site will be transplanted to a Temporary Holding Nursery until such time as it is appropriate to transplant them to their final location.

3.3.4 The specification for tree transplanting works will be according to Particular Specification for Tree Works, Soft Landscape Works and Nursery Works, attached in Appendix V.

3.3.5 However, no trees are proposed to be transplanted in TLP-10

3.4 COMPENSATORY TREE PLANTING

Compensatory Tree Planting Strategy

3.4.1 In accordance with ETWBTC(W) 3/2006, the compensatory planting proposal has the primary objective of planting compensatory trees in a ratio not less than 1:1 in terms of quality and quantity.

Numbers of Compensatory Trees

3.4.2 A total of 202 trees are proposed to be felled (not including dead and "exempted" trees) . The aggregate girth of the 202 trees to be felled is 85 m.

3.4.3 To replace this amount of tree girth (as per ETWBTC(W) 3/2006) with Heavy Standard Trees with average diameter of 100mm (in accordance with the PS in Appendix V), it would required 454 Heavy Standard Trees.

3.4.4 Therefore, it is proposed to plant a minimum of 454 Heavy Standard Trees (or a mix of tree size with same total girth) within all the available planting areas. This represents a ratio of compensatory trees to felled trees of

- Tree numbers: 2.24 to 1
- Tree girth: 1 to 1

3.4.5 The trees should be mostly native species selected from Table 3.1 below, that are available in local nurseries at Heavy Standard size.

Locations for Compensatory Tree Planting

3.4.6 The exact final locations for the compensatory trees will depend on detail design of the engineering work.

3.4.7 The approximate locations of the compensatory tree planting are indicated in the Compensatory Tree Planting Plans attached in Appendix III. Please note that these plans are not intended as detailed planting plans, which will be prepared later by the XRL Detail Design Consultants, once the detailed layouts of the permanent XRL structures and maintenance areas are finalised. However, the detailed planting plans prepared by C803 Detail Design Consultants will include the tree quantities specified herein as a minimum requirement.

Recommended Tree Species for use in XRL Project

3.4.8 Table 3.1, 3.2, 3.3 and 3.4 list suggested tree compensation species to be used along XRL. There are four lists for different primary functions – street / roadside avenue trees; native woodland planting (not on SIMAR Slope); ornamental planting (not on SIMAR Slope) and tree and shrub planting suitable for SIMAR Slope.

3.4.9 It should be noted that the list are not exhaustive or exclusive, and landscape designers responsible for the detailed design shall be permitted to propose suitable alternative species that meet the functional requirements of the landscape design.

Table 3.1: Tree / Palm Species suitable for Native Woodland Planting (not on SIMAR Slopes)

Native Species Only	
Ailanthus fordii (Ailanthus)	*Liquidambar formosana* (Sweet gum)
Broussonetia papyrifera (Paper Mulberry)	*Litsea glutinosa* (Pond spice)
Celtis sinensis (Chinese hackberry)	*Litsea monopetala* (Persimmon–leaved Litsea)
Choerospondias axillaries (Hog Plum)	*Machilus chekiangensis*
Cinnamomum burmannii (Cinnamon tree)	*Machilus chinensis* (Hong Kong Machilus)
Cleistocalyx operculatus (Water Banyan)	*Machilus pauhoi*
Ficus microcarpa (Chinese banyan)	*Machilus thunbergii* (Red Machilus)
Ficus superba var. japonica (Superb fig)	*Mallotus paniculatus (*Turn- in-the wind*)*
Ficus variegata var. Chlorocarpa (Common red-stem)	*Phoenix hanceana* (Spiny date-palm)
Ficus virens var. sublanceolata (Big-leaved fig)	*Reevesia thyrsoidea* (Reevesia)
	Schefflera heptaphylla (Ivy Tree)
	Sapium discolor (Mountain tallow)
	Sapium sebiferum (Tallow-tree)
	Sterculia lanceolata (Scarlet Sterculia)

Table 3.2: Tree / Palm Species suitable for Roadside and Street Tree Planting

Primarily Non-native Species (Native Species underlined)	
Aleurites moluccana (Candlenut tree)	*Melaleuca quinquenervia* (Paper-bark tree)
Bischofia javanica (Autumn maple)	*Falcataria moluccana* (Batai, Albizia)
Bombax ceiba (Cotton tree)	*Peltophorum pterocarpum* (Yellow Poinciana)
Cinnamomum camphora (Camphor tree)	*Ficus benjamina* (Weeping fig)
Crateva unilocularis (Spider tree)	*Tabebuia rosea* (Pink Trumpet)
Delonix regia (Flame of the forest)	*Terminalia mantaly* (Madagascar Almond)
Liquidambar formosana (Sweet gum)	

Table 3.3: Other Tree / Palm Species suitable for Ornamental Planting (not on SIMAR Slopes)

Primarily Non-native Species (Native Species underlined)	
Acacia auriculiformis (Ear-pod Wattle)	*Ficus religiosa* (Peepul Tree)
Acacia confusa (Acacia, Wattle)	*Ficus rumphii* (Mock Peepul Tree)
Acacia mangium (Acacia, Wattle)	*Grevillea banksii* (Bank's Grevillea)
Archontophoenix alexandrae (King palm)	*Grevillea robusta* (Silk oak)
Bauhinia blakeana (Hong Kong orchid tree)	*Lagerstroemia speciosa* (Queen crape-myrtle)
Bauhinia variegata (Camel's foot tree)	*Livistona chinensis** (Chinese fan-palm)
Callistemon viminalis (Tall bottlebrush)	*Magnolia grandiflora* (Lotus-flowered Magnolia)
Callistemon rigidus (Stiff bottlebrush)	*Melia azedarach* (Persian Lilac)

Primarily Non-native Species (Native Species underlined)	
Caryota ochlandra (Fishtail palm)	*Michelia x alba* (White champak)
Cassia fistula (Golden shower)	*Roystonea regia* (Royal palm)
Cassia siamea (Kassod tree)	*Spathodea campanulata* (African Tulip Tree)
Cassia surattensis (Sunshine tree)	*Syagrus romanzoffiana* (Queen Palm)
Casuarina equisetifolia (Horsetail tree)	*Syzygium cumuni* (Java Plum)
Cerbera manghas (Cerbera)	*Syzygium jambos* (Rose Apple)
Erythrina corallodendron (Coralbean tree)	*Tabebuia argentea* (Silver Trumpet Tree)
Erythrina crista-galli (Cockspur coral tree)	*Tamarindus indica* (Tamarind)
Erythrina speciosa (Common Coral tree)	*Terminalia catappa* (Indian almond)
Erythrina variegata (Indian Coral tree)	*Trachycarpus fortunei* (Windmill Palm)
Ficus elastica (India-rubber Tree)	*Washingtonia robusta* (Petticoat palm)

**Livistona chinensis is native to South China*

Table 3.4: Tree and Shrub Species suitable for Planting on SIMAR Slopes

Primarily Native with some Non-native Species (Native Species underlined)	
Trees*	**Shrubs**
Acacia auriculiformis (Ear Pod Wattle)	*Ardisia crenata* (Hilo Holly)
Acacia confusa (Acacia)	*Baeckia frutescens* (Dwarf Mountain Pine)
Acacia mangium(Acacia)	*Duranta repens* (Golden Dewdrop)
Celtis sinensis (Chinese hackberry)	*Gordonia axillaris* (Gordonia)
Ficus microcarpa (Chinese banyan)	*Ilex pubescens* (Downy Holly)
Ficus superba var. japonica (Superb fig)	*Ligustrum sinense* (Chinese Privet)
Ficus variegata var. Chlorocarpa (Common red-stem)	*Melastoma candida* (Melastoma)
Ficus virens var. sublanceolata (Big-leaved fig)	*Melastoma sanguineum* (Melastoma)
Litsea glutinosa (Pond spice)	*Microcos paniculata* (Microcos)
Litsea monopetala (Persimmon–leaved Litsea)	*Psychotria rubra* (Wild Coffee)
Machilus chinensis (Hong Kong Machilus)	*Raphiolepis indica* (Hong Kong Hawthorn)
Machilus thunbergii (Red Machilus)	*Rhododendron pulchrum* (Purple Azalea)
Reevesia thyrsoidea (Reevesia)	*Rhodomyrtus tomentosa* (Rose Myrtle)
Schefflera heptaphylla (Ivy Tree)	*Uvaria microcarpa* (Uvaria)
Sapium discolor (Mountain tallow)	*Vitex negundo* (Negundo Chaste Tree)
Sapium sebiferum (Tallow-tree)	
Sterculia lanceolata (Scarlet Sterculia)	

**The ability to use tree species in the planting will depend on the angle of slope.*

Recommended Understorey Species for use in Tai Shu Ha.

3.4.10 Table 3.5 contains full list of mitigatory understorey vegetation proposed in Consultancy Agreement No. C8016 – Environmental Term Consultancy for Express Rail Link (XRL) - Vegetation Survey Report for Tai

Shu Ha Road West, prepared by AECOM Asia Co. Ltd. in June 2010. In compliance with Environmental Permit (EP) condition 2.12 (iii), those species have to be used for Tai Shu Ha (TRA-10).

Table 3.5 : Recommended understorey vegetation species for mitigatory planting as required under EP condition 2.12 (iii) *(as specified in Consultancy Agreement No. C8016 – Environmental Term Consultancy for Express Rail Link (XRL) - Vegetation Survey Report for Tai Shu Ha Road West)*

Native Species Only	
Trees	*Shrubs*
Bischofia javanica (Autumn Maple)	*Gordonia axillaris (Hong Kong Gordonia)*
Castanopsis fissa (Castanopsis)	*Litsea rotundifolia (Round-leaved Litsea)*
Celtis sinensis (Chinese hackberry)	*Melastoma sanguineum (Blood-red Melastoma)*
Cinnamomum parthenoxylon (Yellow Cinnamomum)	*Psychotria asiatica (Wild coffee)*
Elaeocarpus spp.	*Rhodomyrtus tomentosa (Rose Myrtle)*
Gordonia axillaris (Hong Kong Gordonia)	
Mallotus paniculatu (Turn-in-the-wind)	
Psychotria asiatica (Wild coffee)	
Reevesia thyrsoidea (Reevesia)	
Schefflera heptaphylla (Ivy tree)	
Schima superba,(Schima)	
Sterculia lanceolata (Lance-leaved Sterculia)	
Viburnum odoratissimum (Sweet Viburnum)	

Tree and Shrub Planting on SIMAR Slopes

3.4.10 Tree and shrub planting will be applied on SIMAR Slopes to achieve an attractive greening effect. Tree planting on steep SIMAR Slopes will normally not use large plant stock (Heavy Standard Tree) but will normally use whips. Whip planting will normally be undertaken at spacings of 1.2m to 1.5m, depending on circumstances, and a mix of tree and shrub species will be planted in a matrix. Species will be selected from Table 3.4. Other species may be used subject to agreement with Highways Department. On very steep SIMAR Slopes tree planting may not be acceptable from a geotechnical standpoint and planting will be limited to shrubs.

Programme for Compensatory Tree Planting

3.4.11 The compensatory tree planting will be undertaken as part of the XRL work contracts. The compensatory planting will be programmed to be completed by the time of the opening of the railway, so that the mitigation effect of the planting is felt from day one of the railway operation. The detailed program for the compensatory tree planting will be determined by the works contractors to meet this requirement. The trees will be planted at the earliest possible time.

3.5 CONSOLIDATED FINDINGS OF TREE SURVEY AND COMPENSATORY PROPOSALS IN THIS PLAN

3.5.1 Table 3.6 summarises the consolidated findings and recommendations of the tree survey and compensatory planting proposals.

Table 3.6 : Summary of Tree Totals for TLP-10: Works in Yuen Long District (Tai Shu Ha)

(1)	(2)	(3)	(4)	(5)	(6)
Total Trees in Tsuen Wan Yuen Long District (Tai Shu Ha)	Trees to be retained	Trees to be retained and pruned	Trees to be transplanted	Trees to be felled (excludes 1 dead tree)	Proposed Compensatory Tree Planting (Minimum)
236	34	0	0	202	454

3.5.2 A total of 236 trees (plus18 dead trees) currently exist in the area covered by TLP-10.

3.5.3 There are no Old or Valuable Trees (as listed in the Register of Old and Valuable Trees), no 'Important Trees' and no 'Wall Trees'.

3.5.4 34 trees will be retained, 202 trees will be felled, no trees will be transplanted, and a minimum 272 Heavy Standard Trees (or mix of tree sizes with same total girth) will be planted as compensation for the trees felled.

3.5.5 The exact final locations of the compensatory trees will depend on the detailed design of the engineering work.

Chapter 4

Cumulative Tree Impacts and Tree Compensation

4 CUMULATIVE TREE FELLING AND TREE COMPENSATION FOR THE XRL

4.1.1 *Table 4.1* summarises the total tree felling, transplanting and compensatory tree planting incorporated in the Tree Planting and Landscape Plan submitted up to now and planned for submission in future. The contribution of this TLP to the cumulative total is highlighted in bold italics.

Table 4.1 Summary of Tree Felling, Transplanting and Compensation

	(1)	(2)	(3)	(4)	(5)	(6)
Tree Planting and Landscape Plan	Trees Surveyed in Gazettal Boundary	Trees to be Retained	Trees to be Retained and Pruned	Trees to be transplanted	Trees to be Felled	Compensatory Tree Planting
TLP-1: Works in Yau Tsim Mong District	2410 (2540)*	1497 (1533)*	4	373	536 (630)*	835
TLP-2: Works in Sham Shui Po District	1116 (1458)*	427 (580)*	2 (3)*	474	213 (391)*	281
TLP-3: Works in Kwai Tsing District	54(67)*	36(38)*	0	4	14(25)*	26
TLP-4: Works in Tsuen Mun District	372 (386)*	297 (309)*	0	42	33(35)*	51
TLP-5: Works in Tuen Mun District	1084 (1150)*	897 (954)*	9(16)*	0	178 (180)*	240
TLP-6: Works in Yuen Long District – Mai Po	109(121)*	16(20)*	1	8	84(92)*	99
TLP-7: Works in Yuen Long District - Remainder	4084 (4776)*	1071 (1281)*	0	206	2807 (3289)*	4700
TLP-8: Works in Tuen Mun District – Siu Lang Shui	154# (589)*	145# (162)*	0	3#	6# (424)*	11#
TLP-9: Works in Yuen Long District – Yick Yuen	16(27)*	6(12)*	0	0	10(15)*	22
*****TLP-10: Works in Yuen Long District – Tai Shu Ha***	***236***	***34***	***0***	***0***	***202***	***454***
CUMULATIVE TOTAL	9635 (11350)*	4426 (4923)*	16(24)*	1110	4083 (5283)*	6719

*Under ETWBTC(W)3/2006 *Leucaena leucocephala* is considered a self-seeded weed tree and can be felled w/o compensation. Totals without brackets exclude *Leucaena*. Totals in brackets include *Leucaena.*

** *Current Submission*

\# *Estimated Tree Numbers Based on Latest Information in Hand*

Appendix I

Tree Assessment Schedule

Part 1: Schedule for AFCD

EXPRESS RAIL LINK

CONSULTANCY AGREEMENT NO. C8001 - TREE TRANSPLANTING / FELLING

TLP-10: WORKS IN YUEN LONG DISTRICT - TAI SHU HA

Part 1 - Existing Tree Assessment Schedule for AFCD

SURVEY SHEET No. C8001/T/XRL /URB/	TREE No.	PHOTO No.	BOTANICAL NAME	CHINESE / COMMON NAME	MAINTENANCE DEPARTMENT	DEPARTMENT TO ADVISE LandsD (ArchSD, AFCD, LCSD, HyD, HD)	SIZE (m) OVERALL HEIGHT	TRUNK DIAMETER	CROWN SPREAD	FORM (Good/Fair/Poor)	HEALTH (Good/Fair/Poor)	AMENITY VALUE (High/Med/Low)	Old & Valuable Tree or Important Tree (OVT/IT)	SURVIVAL RATE AFTER TRANSPLANTING (High/Med/Low)	RECOMMENDATION	JUSTIFICATION	REMARKS
C04/634	U0001	1	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.23	7	Fair	Good	Low		Low	Fell	L	-
C04/634	U0002	2	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.12	5	Fair	Fair	Low		Low	Fell	L, M	Broken branches
C04/634	U0003	3	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.21	5	Fair	Poor	Low		Low	Fell	L, M	Broken branches, few leaves
C04/634	U0004	4	*Acacia auriculiformis*	耳果相思	DLO	AFCD	4	0.16	4	Poor	Poor	Low		Low	Fell	L, M	Broken trunk
C04/634	U0005	5	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.17	5	Fair	Fair	Low		Low	Fell	L, M	Slight leaning, die-back branches
C04/634	U0006	6	*Eucalyptus spp.*	桉屬植物	DLO	AFCD	12	0.15	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0007	8	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.16	5	Fair	Good	Low		Low	Fell	L	Slight leaning
C04/634	U0008	7	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	9	0.10	4	Fair	Fair	Med		Low	Fell	L, M	Slight leaning, die-back branches
C04/634	U0009	9	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	8	0.11	4	Good	Fair	Med		Low	Fell	E, L	Water sprouts observed
C04/634	U0010	10	Dead Tree	枯樹	DLO	AFCD	4	0.12	2	-	-	-		-	Dead	-	-
C04/634	U0011	11	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	8	0.11	5	Good	Good	Med		Low	Fell	E, L	-
C04/634	U0012	12	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	6	0.11	4	Good	Fair	Med		Low	Fell	L, M	Die-back branches
C04/634	U0013	13	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	9	0.12	5	Poor	Poor	Low		Low	Fell	L, M	Die-back trunk
C04/634	U0014	14	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	10	0.20	7	Fair	Fair	Med		Low	Fell	L, M	Bifurcating trunk, weak fork
C04/634	U0015	15	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.17	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0016	16	*Acacia auriculiformis*	耳果相思	DLO	AFCD	5	0.12	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0017	17	*Acacia auriculiformis*	耳果相思	DLO	AFCD	5	0.14	2	Poor	Poor	Low		Low	Fell	L, M	Bending trunk, unbalanced crown, die-back branches
C04/634	U0018	18	*Acacia auriculiformis*	耳果相思	DLO	AFCD	3	0.10	1	Poor	Poor	Low		Low	Fell	L, M	Broken trunk
C04/634	U0019	19	Dead Tree	枯樹	DLO	AFCD	4	0.11	1	-	-	-		-	Dead	-	-
C04/634	U0020	20	Dead Tree	枯樹	DLO	AFCD	5	0.10	1	-	-	-		-	Dead	-	-
C04/634	U0021	21	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	5	0.10	3	Poor	Poor	Low		Low	Fell	L, M	Leaning trunk, die-back branches
C04/634	U0022	22	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.13	4	Poor	Poor	Low		Low	Fell	L, M	Few leaves observed
C04/634	U0023	23	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	6	0.11	5	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0024	24	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.13	6	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0025	25	Dead Tree	枯樹	DLO	AFCD	6	0.11	4	-	-	-		-	Dead	-	-
C04/634	U0026	26	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.20	5	Fair	Fair	Low		Low	Fell	L	MEASURED AT 0.90
C04/634	U0027	27	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	3	Poor	Poor	Low		Low	Fell	L, M	Die-back branches, few leaves
C04/634	U0028	28	Dead Tree	枯樹	DLO	AFCD	5	0.10	2	-	-	-		-	Dead	-	-
C04/634	U0029	29	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.13	5	Poor	Poor	Low		Low	Fell	L, M	Few leaves, die-back branches
C04/634	U0030	30	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.14	4	Poor	Poor	Low		Low	Fell	L, M	Few leaves, die-back branches
C04/634	U0031	31	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.11	3	Poor	Poor	Low		Low	Fell	L, M	Few leaves, die-back branches
C04/634	U0032	32	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.11	6	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0033	33	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.16	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0034	34	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	3	Poor	Poor	Low		Low	Fell	L, M	Die-back branches, wound found on trunk
C04/634	U0035	35	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.15	6	Poor	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0036	36	Dead Tree	枯樹	DLO	AFCD	3	0.10	1	-	-	-		-	Dead	-	-
C04/634	U0037	37	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.11	4	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0038	38	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.13	2	Poor	Poor	Low		Low	Fell	L, M	Die-back branches, watersprout observed
C04/634	U0039	39	*Acacia auriculiformis*	耳果相思	DLO	AFCD	14	0.13	6	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0040	40	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.10	6	Poor	Poor	Low		Low	Fell	L, M	Crack found on trunk
C04/634	U0041	41	Dead Tree	枯樹	DLO	AFCD	3	0.14	1	-	-	-		-	Dead	-	-
C04/634	U0042	42	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.18	7	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0043	43	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.13	6	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0044	44	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.15	5	Poor	Poor	Low		Low	Fell	L, M	Die-back branches, few leaves
C04/634	U0045	45	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.21	9	Fair	Fair	Med		Low	Fell	L, M	Die-back branches, Slight bending
C04/634	U0046	46	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.13	8	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0047	47	*Acacia auriculiformis*	耳果相思	DLO	AFCD	14	0.16	7	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0048	49	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	10	0.10	5	Fair	Good	Med		Low	Fell	L	-
C04/634	U0049	49	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	8	0.11	4	Fair	Good	Med		Low	Fell	L	-
C04/634	U0050	48	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.12	7	Poor	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0051	50	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.12	5	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0052	51	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	10	0.10	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0053	51	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.13	7	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0054	52	*Acacia auriculiformis*	耳果相思	DLO	AFCD	15	0.16	8	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0055	53	*Acacia auriculiformis*	耳果相思	DLO	AFCD	15	0.16	7	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0056	54	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.10	3	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0057	55	*Acacia mangium*	大葉相思	DLO	AFCD	9	0.13	15	Poor	Poor	Low		Low	Fell	L	Toppled
C04/634	U0058	56	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	9	0.10	3	Fair	Poor	Low		Low	Fell	L, M	Few leaves

Part 1 - Existing Tree Assessment Schedule for AFCD

SURVEY SHEET No. C8001/T/XRL /URB/	TREE No.	PHOTO No.	BOTANICAL NAME	CHINESE COMMON NAME	MAINTENANCE DEPARTMENT	DEPARTMENT TO ADVISE LandsD (ArchSD, AFCD, LCSD, HyD, HD)	SIZE (m) OVERALL HEIGHT	TRUNK DIAMETER	CROWN SPREAD	FORM (Good/Fair/Poor)	HEALTH (Good/Fair/Poor)	AMENITY VALUE (High/Med/Low)	Old & Valuable Tree or Important Tree (OVT/IT)	SURVIVAL RATE AFTER TRANSPLANTING (High/Med/Low)	RECOMMENDATION	JUSTIFICATION	REMARKS
C04/634	U0059	56	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.11	4	Fair	Poor	Low		Low	Fell	L, M	Few leaves
C04/634	U0060	57	Dead Tree	枯樹	DLO	AFCD	4	0.12	2	-	-	-		-	Dead	-	-
C04/634	U0061	58	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	8	0.10	3	Fair	Fair	Med		Low	Fell	L	Watersprouts observed
C04/634	U0062	59	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.16	4	Fair	Poor	Low		Low	Fell	L	-
C04/634	U0063	59	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	9	0.10	6	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0064	60	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	11	0.10	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0065	61	*Acacia auriculiformis*	耳果相思	DLO	AFCD	17	0.19	6	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0066	62	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	3	Poor	Poor	Low		Low	Fell	L, M	Die-back branches, few leaves
C04/634	U0067	63	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	3	Poor	Poor	Low		Low	Fell	L	Slightly leaing trunk
C04/634	U0068	64	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	13	0.18	5	Fair	Fair	Med		Low	Fell	L	-
C04/634	U0069	65	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	10	0.13	4	Good	Fair	Med		Low	Fell	L	-
C04/634	U0070	66	*Acacia auriculiformis*	耳果相思	DLO	AFCD	3	0.10	1	Poor	Poor	Low		Low	Fell	L, M	Die-back trunk, watersprout observed
C04/634	U0071	67	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.15	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0072	68	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.15	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0073	69	*Acacia auriculiformis*	耳果相思	DLO	AFCD	6	0.11	4	Poor	Poor	Low		Low	Fell	L, M	Die-back trunk, watersprout observed
C04/634	U0074	69	*Acacia auriculiformis*	耳果相思	DLO	AFCD	14	0.13	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0075	70	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.11	3	Fair	Fair	Low		Low	Fell	L	Slightly leaning
C04/634	U0076	71	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.10	2	Poor	Poor	Low		Low	Fell	L, M	Die-back brances, watersprout observed
C04/634	U0077	72	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	4	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0078	73	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.10	1	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0079	74	*Acacia confusa*	台灣相思	DLO	AFCD	10	0.11	4	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0080	75	*Acacia confusa*	台灣相思	DLO	AFCD	12	0.16	8	Fair	Fair	Low		Low	Fell	L	Twin-trunk
C04/634	U0081	76	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.12	2	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0082	77	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.19	6	Fair	Fair	Med		Low	Fell	L, M	Die-back branches
C04/634	U0083	78	*Eucalyptus spp.*	桉屬植物	DLO	AFCD	13	0.31	6	Fair	Fair	Med		Low	Fell	L	Trifurcated trunk,
C04/634	U0091	79	Dead Tree	枯樹	DLO	AFCD	6	0.10	1	-	-	-		-	Dead	-	-
C04/634	U0092	80	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.11	4	Poor	Poor	Low		Low	Fell	L	Bending trunk
C04/634	U0093	81	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.10	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0094	82	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.11	4	Poor	Poor	Low		Low	Fell	L, M	Few leaves, die-back branches
C04/634	U0095	83	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.15	5	Fair	Fair	Low		Low	Fell	L	Twin trunk
C04/634	U0096	84	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.13	4	Poor	Poor	Low		Low	Fell	L	Twin trunk
C04/634	U0097	85	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	10	0.10	5	Fair	Fair	Med		Low	Fell	L	Slightly leaning trunk
C04/634	U0098	86	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.19	5	Fair	Fair	Low		Low	Fell	L	Twin trunk
C04/634	U0099	87	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.20	8	Fair	Fair	Low		Low	Fell	L	Twin trunk
C04/634	U0100	88	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.12	3	Poor	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0101	89	Dead Tree	枯樹	DLO	AFCD	7	0.13	3	-	-	-		-	Dead	-	-
C04/634	U0102	91	*Acacia auriculiformis*	耳果相思	DLO	AFCD	5	0.11	3	Poor	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0103	91	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.10	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0104	90	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	8	0.10	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0105	91	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	10	0.10	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0106	92	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.16	5	Poor	Poor	Low		Low	Fell	L, M	Twin-trunk, die-back branches
C04/634	U0107	93	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.14	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0108	94	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.15	4	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0109	95	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.14	5	Fair	Poor	Low		Low	Fell	L	Twin-trunk
C04/634	U0110	96	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.11	4	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0111	96	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.13	4	Poor	Poor	Low		Low	Fell	L, M	Leaning trunk, die-back branches
C04/634	U0111A	97, 98	*Acacia mangium*	大葉相思	DLO	AFCD	10	0.16	3	Poor	Poor	Low		Low	Fell	L	Toppled and uprooted
C04/634	U0112	99	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.11	3	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0113	100	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.16	4	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0114	101	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.14	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0115	101	*Acacia mangium*	大葉相思	DLO	AFCD	10	0.20	5	Fair	Good	Med		Low	Fell	L	-
C04/634	U0116	103	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.13	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0117	102	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.17	4	Poor	Poor	Low		Low	Fell	L, M	Die-back trunk, MEASURED AT 1.10
C04/634	U0118	104	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.11	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0119	105	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.14	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0120	106	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	7	0.11	2	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0121	106	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	5	0.10	3	Fair	Fair	Med		Low	Fell	L	-
C04/634	U0122	106	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.10	4	Fair	Fair	Low		Low	Fell	L	-

Part 1 - Existing Tree Assessment Schedule for AFCD

SURVEY SHEET No. C8001/T/XRL /URB/	TREE No.	PHOTO No.	BOTANICAL NAME	CHINESE / COMMON NAME	MAINTENANCE DEPARTMENT	DEPARTMENT TO ADVISE LandsD (ArchSD, AFCD, LCSD, HyD, HD)	SIZE (m) OVERALL HEIGHT	TRUNK DIAMETER	CROWN SPREAD	FORM (Good/Fair/Poor)	HEALTH (Good/Fair/Poor)	AMENITY VALUE (High/Med/Low)	Old & Valuable Tree or Important Tree (OVT/IT)	SURVIVAL RATE AFTER TRANSPLANTING (High/Med/Low)	RECOMMENDATION	JUSTIFICATION	REMARKS
C04/634	U0124	107	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.13	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0125	108	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	7	0.24	5	Fair	Fair	Med		Low	Fell	L	-
C04/634	U0126	109	*Acacia auriculiformis*	耳果相思	DLO	AFCD	6	0.11	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0127	110	Dead Tree	枯樹	DLO	AFCD	7	0.10	3	-	-	-		-	Dead	-	-
C04/634	U0128	111	*Acacia auriculiformis*	耳果相思	DLO	AFCD	5	0.17	4	Poor	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0129	112	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	9	0.14	5	Good	Good	Low		Low	Fell	L	-
C04/634	U0130	113	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	11	0.10	4	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0131	114	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.11	5	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0132	115	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.10	6	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0133	116	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.12	4	Poor	Poor	Low		Low	Fell	L, M	Broken branhes, bending trunk
C04/634	U0134	117	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	8	0.10	4	Good	Fair	Med		Low	Fell	L	Watesprout
C04/634	U0135	118	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.16	5	Fair	Fair	Low		Low	Fell	L	Twin-trunk
C04/634	U0136	119	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.10	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0137	120	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	11	0.17	6	Good	Good	Med		Low	Fell	L	-
C04/634	U0142	121	Dead Tree	枯樹	DLO	AFCD	7	0.11	4	-	-	-		-	Dead	-	-
C04/634	U0143	122	*Acacia auriculiformis*	耳果相思	DLO	AFCD	5	0.10	2	Poor	Poor	Low		Low	Retain	-	Lay on by U0144
C04/634	U0144	123	*Acacia mangium*	大葉相思	DLO	AFCD	5	0.24	4	Poor	Poor	Low		Low	Retain	-	Twin-trunk, toppled and uprooted, lay on U0143
C04/634	U0155	124	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.14	6	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0156	126	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.14	4	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0157	126	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.14	5	Fair	Fair	Low		Low	Retain	-	Bending trunk
C04/634	U0158	125	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	11	0.13	4	Good	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0159	127	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.15	5	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0160	127	*Acacia mangium*	大葉相思	DLO	AFCD	10	0.15	4	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0161	128	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	10	0.10	4	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0162	129, 130	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.10	3	Fair	Fair	Low		Low	Fell	L	Leaning trunk and uprooted
C04/634	U0163	131	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.11	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0164	131	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.10	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0165	132	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	10	0.11	2	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0166	133, 134	*Acacia mangium*	大葉相思	DLO	AFCD	9	0.20	5	Fair	Fair	Low		Low	Fell	L, M	Die-back branches, uprooted, a branch broken
C04/634	U0166A	135	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.11	2	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0166B	135	*Acacia auriculiformis*	耳果相思	DLO	AFCD	8	0.12	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0167	136	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.11	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0168	137	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.14	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0169	138	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.13	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0170	139, 140	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.12	3	Poor	Fair	Low		Low	Fell	L	Leaning trunk and uprooted
C04/634	U0171	141	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.12	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0172	142, 144	*Acacia mangium*	大葉相思	DLO	AFCD	10	0.14	4	Poor	Fair	Low		Low	Fell	L	-
C04/634	U0173	143	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.10	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0174	143	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	11	0.10	2	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0175	145	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	10	0.10	2	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0176	146	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.16	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0177	147	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.13	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0178	148	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.16	6	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0179	149	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.15	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0180	150	*Acacia auriculiformis*	耳果相思	DLO	AFCD	6	0.10	2	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0181	151	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.16	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0182	152	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.11	2	Good	Fair	Low		Low	Fell	L	-
C04/634	U0183	153	*Acacia auriculiformis*	耳果相思	DLO	AFCD	15	0.28	7	Good	Fair	Med		Low	Fell	L	-
C04/634	U0184	154	*Acacia auriculiformis*	耳果相思	DLO	AFCD	15	0.22	7	Fair	Good	Low		Low	Fell	L	-
C04/634	U0185	155	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.17	6	Good	Good	Med		Low	Fell	L	-
C04/634	U0186	155	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.14	5	Good	Good	Low		Low	Fell	L	-
C04/634	U0187	156	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	13	0.11	3	Fair	Good	Low		Low	Fell	L	-
C04/634	U0188	158	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.11	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0189	158	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.11	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0190	157	Dead Tree	枯樹	DLO	AFCD	5	0.13	2	-	-	-		-	Dead	-	-
C04/634	U0191	159, 160	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.16	5	Poor	Fair	Low		Low	Fell	L	-
C04/634	U0192	163	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.14	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0193	163	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.13	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches

Part 1 - Existing Tree Assessment Schedule for AFCD

SURVEY SHEET No. C8001/T/XRL /URB/	TREE No.	PHOTO No.	BOTANICAL NAME	CHINESE COMMON NAME	MAINTENANCE DEPARTMENT	DEPARTMENT TO ADVISE LandsD (ArchSD, AFCD, LCSD, HyD, HD)	SIZE (m) OVERALL HEIGHT	TRUNK DIAMETER	CROWN SPREAD	FORM (Good/Fair/Poor)	HEALTH (Good/Fair/Poor)	AMENITY VALUE (High/Med/Low)	Old & Valuable Tree or Important Tree (OVT/IT)	SURVIVAL RATE AFTER TRANSPLANTING (High/Med/Low)	RECOMMENDATION	JUSTIFICATION	REMARKS
C04/634	U0194	161, 163	Dead Tree	枯樹	DLO	AFCD	6	0.14	2	-	-	-		-	Dead	-	-
C04/634	U0195	162	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	9	0.10	2	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0196	164	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	11	0.10	2	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0197	165	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.30	8	Good	Fair	Low		Low	Fell	L	-
C04/634	U0198	166	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.13	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0199	167	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.14	5	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0200	168	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.13	4	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0201	169	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.15	2	Poor	Fair	Low		Low	Fell	L	-
C04/634	U0202	170	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.095	2	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0203	171, 172	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.16	5	Fair	Fair	Low		Low	Fell	L	Wound found on trunk
C04/634	U0204	173	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.16	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0205	175	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.16	8	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0206	174	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0207	175	*Castanopsis fissa*	黧蒴錐	DLO	AFCD	9	0.11	3	Good	Good	Med		Low	Fell	L	-
C04/634	U0208	176, 177	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.13	5	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0212	181, 182	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.12	2	Fair	Fair	Low		Low	Fell	L, M	Broken branches, surface root exposed
C04/634	U0213	183	*Acacia mangium*	大葉相思	DLO	AFCD	8	0.12	4	Fair	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0214	183	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.20	7	Good	Good	Med		Low	Fell	L	-
C04/634	U0215	184	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.11	2	Poor	Poor	Low		Low	Fell	L, M	Die-back branches
C04/634	U0216	184	*Acacia mangium*	大葉相思	DLO	AFCD	11	0.14	4	Fair	Good	Low		Low	Fell	L	-
C04/634	U0217	184	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.12	4	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0218	185	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.13	5	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0219	186	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	4	Fair	Good	Low		Low	Fell	L	-
C04/634	U0220	187	*Acacia auriculiformis*	耳果相思	DLO	AFCD	15	0.18	8	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0221	187	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	15	0.10	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0222	188	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.11	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0223	189	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	15	0.10	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0224	189	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	15	0.11	4	Good	Fair	Low		Low	Fell	L	-
C04/634	U0225	190	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.13	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0226	191	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.10	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0227	191	*Acacia auriculiformis*	耳果相思	DLO	AFCD	14	0.16	4	Fair	Good	Low		Low	Fell	L	-
C04/634	U0228	192	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	15	0.11	3	Good	Good	Low		Low	Fell	L	-
C04/634	U0229	192	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	13	0.18	3	Fair	Good	Med		Low	Fell	L	-
C04/634	U0230	193	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.13	4	Good	Good	Low		Low	Fell	L	-
C04/634	U0231	194	Dead Tree	枯樹	DLO	AFCD	6	0.14	1	-	-	-		-	Dead	-	-
C04/634	U0232	195	*Acacia auriculiformis*	耳果相思	DLO	AFCD	14	0.13	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0233	196	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.13	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0234	197	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.15	3	Fair	Good	Low		Low	Fell	L	-
C04/634	U0235	198	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.11	7	Fair	Good	Low		Low	Retain	-	-
C04/634	U0236	199	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.13	2	Fair	Fair	Low		Low	Retain	-	Broken branches
C04/634	U0237	200	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.11	4	Fair	Good	Low		Low	Retain	-	-
C04/634	U0238	201	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.14	4	Fair	Good	Low		Low	Retain	-	-
C04/634	U0239	201	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.16	8	Good	Good	Med		Low	Retain	-	-
C04/634	U0246	202	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.16	6	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0247	203	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.15	7	Good	Good	Low		Low	Fell	L	-
C04/634	U0248	204	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	14	0.12	4	Good	Good	Low		Low	Fell	L	-
C04/634	U0249	204	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.20	8	Fair	Good	Low		Low	Fell	L	-
C04/634	U0250	204	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.16	6	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0251	205	*Acacia auriculiformis*	耳果相思	DLO	AFCD	7	0.12	2	Fair	Fair	Low		Low	Fell	L, M	Pruned branches, die-back branches
C04/634	U0252	205	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.19	7	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0253	206	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.15	4	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0254	207	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.12	5	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0255	208	*Acacia auriculiformis*	耳果相思	DLO	AFCD	9	0.12	7	Fair	Fair	Low		Low	Retain	-	Unbalanced crown
C04/634	U0256	209	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.17	7	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0257	210	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.15	5	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0258	210	*Acacia auriculiformis*	耳果相思	DLO	AFCD	15	0.13	5	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0259	211	*Acacia auriculiformis*	耳果相思	DLO	AFCD	10	0.11	3	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0267	212	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.15	3	Fair	Fair	Low		Low	Fell	L	Toppled

EXPRESS RAIL LINK

CONSULTANCY AGREEMENT NO. C8001 - TREE TRANSPLANTING / FELLING

TLP-10: WORKS IN YUEN LONG DISTRICT - TAI SHU HA

Part 1 - Existing Tree Assessment Schedule for AFCD

SURVEY SHEET No. C8001/T/XRL /URB/	TREE No.	PHOTO No.	BOTANICAL NAME	CHINESE COMMON NAME	MAINTENANCE DEPARTMENT	DEPARTMENT TO ADVISE LandsD (ArchSD, AFCD, LCSD, HyD, HD)	SIZE (m) OVERALL HEIGHT	TRUNK DIAMETER	CROWN SPREAD	FORM (Good/Fair/Poor)	HEALTH (Good/Fair/Poor)	AMENITY VALUE (High/Med/Low)	Old & Valuable Tree or Important Tree (OVT/IT)	SURVIVAL RATE AFTER TRANSPLANTING (High/Med/Low)	RECOMMENDATION	JUSTIFICATION	REMARKS
C04/634	U0268	213	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.20	3	Fair	Fair	Low		Low	Retain	-	Die-back branches
C04/634	U0269	212	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.18	3	Poor	Poor	Low		Low	Fell	L, M	Toppled, lay on to U0272
C04/634	U0286	214	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.12	3	Fair	Fair	Low		Low	Retain	-	Insect infested
C04/634	U0287	215	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	15	0.11	3	Good	Fair	Low		Low	Fell	L	-
C04/634	U0288	216	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	3	Fair	Fair	Low		Low	Fell	L, M	Die-back branches
C04/634	U0289	217	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.18	7	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0290	218	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.12	3	Poor	Poor	Low		Low	Fell	L	-
C04/634	U0291	219	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.10	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0292	220	Dead Tree	枯樹	DLO	AFCD	7	0.19	4	-	-	-		-	Dead	-	-
C04/634	U0293	221	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.10	3	Fair	Fair	Low		Low	Fell	L	-
C04/634	U0294	222	Dead Tree	枯樹	DLO	AFCD	7	0.10	2	-	-	-		-	Dead	-	-
C04/634	U0295	223	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.10	3	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0296	224	*Acacia auriculiformis*	耳果相思	DLO	AFCD	12	0.10	4	Fair	Fair	Low		Low	Retain	-	Slight leaning trunk
C04/634	U0296A	226, 227	*Acacia mangium*	大葉相思	DLO	AFCD	12	0.12	4	Poor	Poor	Low		Low	Retain	-	Toppled and uprooted
C04/634	U0297	225	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	10	0.10	2	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0298	228	*Acacia auriculiformis*	耳果相思	DLO	AFCD	11	0.13	4	Fair	Poor	Low		Low	Retain	-	-
C04/634	U0299	228	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	11	0.095	5	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0300	230	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.17	7	Fair	Poor	Low		Low	Retain	-	Die-back branches
C04/634	U0301	229	Dead Tree	枯樹	DLO	AFCD	6	0.21	6	-	-	-		-	Dead	-	-
C04/634	U0304	231	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	11	0.11	5	Fair	Fair	Low		Low	Retain	-	-
C04/634	U0306	232	*Casuarina equisetifolia*	木麻黃	DLO	AFCD	12	0.10	5	Poor	Poor	Low		Low	Retain	-	-
C04/634	U0307	232	*Acacia auriculiformis*	耳果相思	DLO	AFCD	13	0.10	6	Poor	Poor	Low		Low	Retain	-	Die-back trunk, watersprout observed, few leaves observed

Key to notation in "Justification" column

Note A: Affected by Temporary Traffic Management works (TTM)
Note B: Affected by Retaining Walls, Slope Works construction and New Road/ Road Widening Works
Note C: Affected by Vent Building, Emergency Access and Crossing Point construction
Note E: Affected by contractors works area
Note F: Affected by Public Transport Interchange (PTI) construction
Note G: Affected by Footbridge Demolition/ Reconstruction
Note H: Affected by Ground Treatment works
Note I: Affected by Utilities Diversion, Box Culvert Reconstruction, Pile Removal, Pier Demolition
Note J: Affected by Tunnel Boring Machine (TBM) Launch Shaft Construction, Temporary Construction Shaft
Note K: Affected by Barging Point Area
Note L: Affected by Explosive Magazine Site
Note M: Poor Tree Health

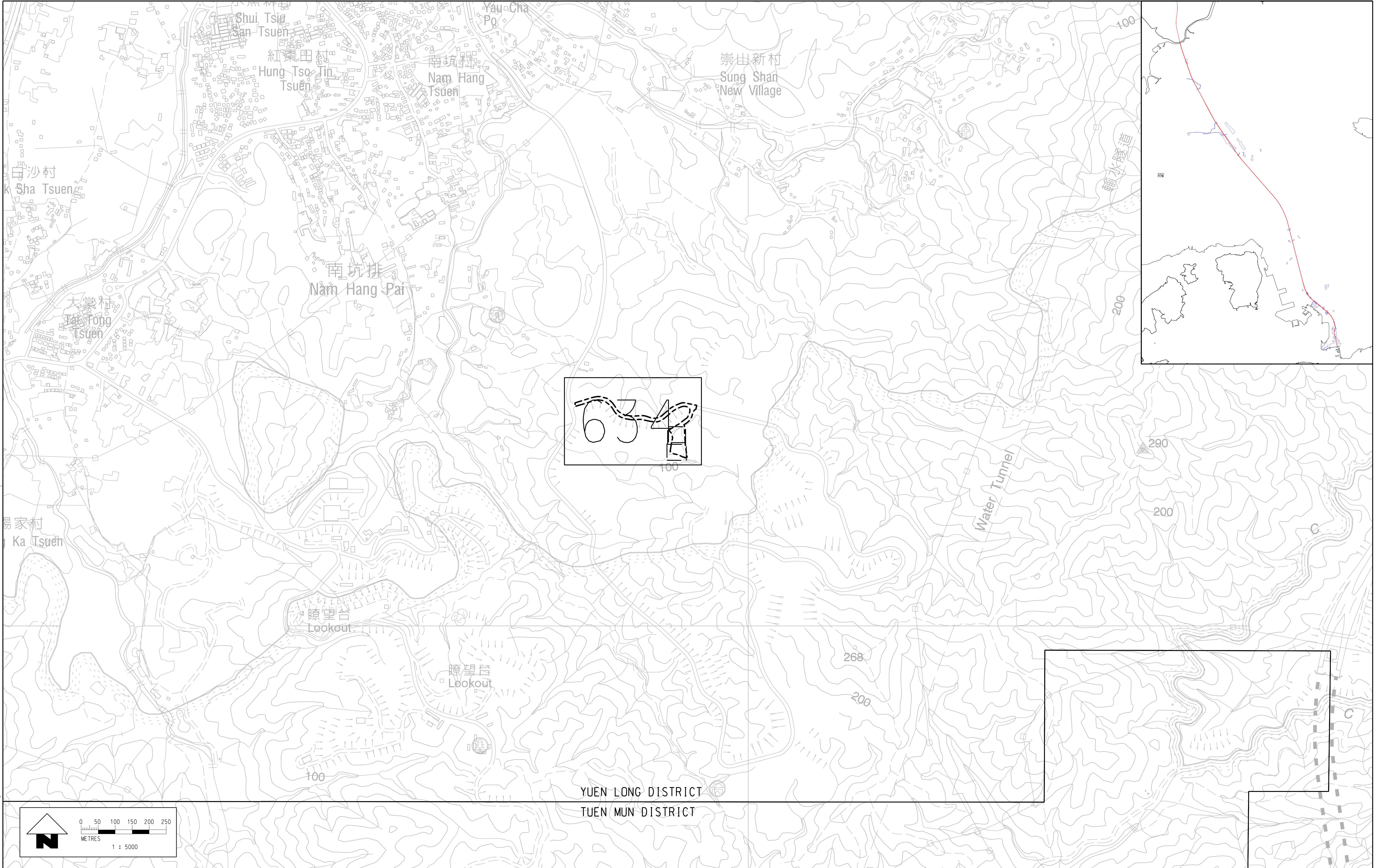
Summary of trees	Including Leu.Leu	excluding Leu.Leu
Retained trees	34	34
Retain and Pruned	0	0
Transplanted trees	0	0
Felled trees	202	202
Total trees	236	236
* excluding 18 nos. of Dead trees.		

Decription of Highlighted Area

Revision shown in toned areas

Appendix II

Tree Survey Drawings (with Engineering Design overlaid)



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REV	DESCRIPTION	BY	DATE	APPROVED
A1	FIRST ISSUE	SAN	27APR10	AD

DRAWN	SAN
DESIGNED	JP
CHECKED	TO
APPROVED	AD
DATE	27.APR.2010

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ORIGINATOR

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Urbis Limited, 11/F Siu On Centre, 188 Lockhart Road, Wan Chai, Hong Kong.
Tel 2802 3333 Fax 2802 8662

CADD REF. C8001_T_XRL_URB_C04_911A1.dgn

TITLE
CONSULTANCY AGREEMENT NO. C8001
TREE TRANSPLANTING / FELLING
TREE SURVEY KEYPLAN OF YUEN LONG DISTRICT - TAI SHU HA

SCALE	DRAWING NO.	REV.
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A2	SECOND ISSUE	SAN	18MAR10	AD
A1	FIRST ISSUE	SAN	09NOV09	AD

DRAWN	SAN
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APPROVED	AD
DATE	09.NOV.2009

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CADD REF. C8001_T_XRL_URB_C04_634A3(with crown).dgn

TITLE

CONSULTANCY AGREEMENT NO. C8001

TREE TRANSPLANTING / FELLING

TREE SURVEY PLAN OF YUEN LONG DISTRICT - TAI SHU HA (SHEET 1 OF 1)

SCALE	DRAWING NO.	REV.
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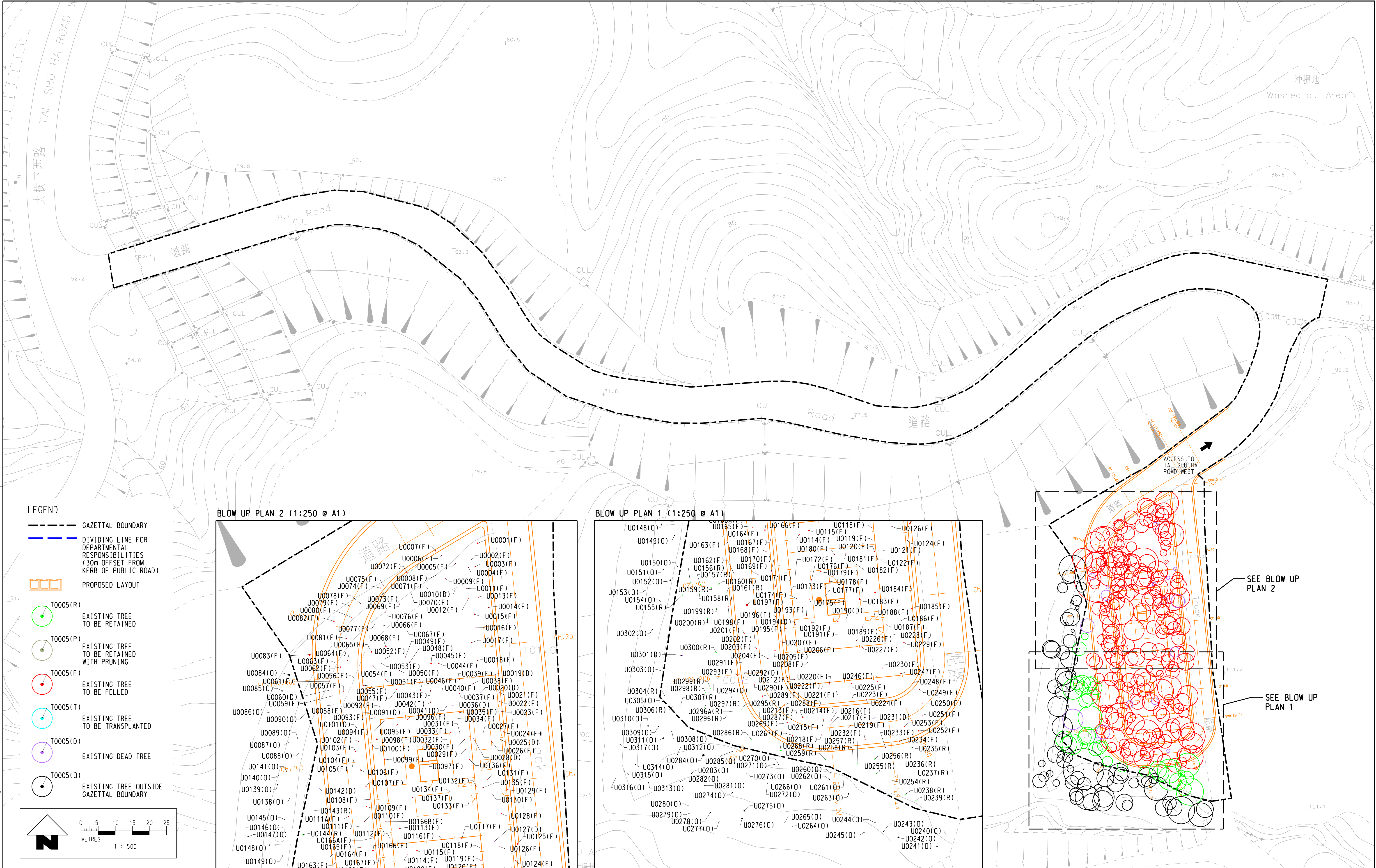

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A1	FIRST ISSUE	SAN	09NOV09	AD

DRAWN	SAN
DESIGNED	JP
CHECKED	TO
APPROVED	AD
DATE	09.NOV.2009

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Tel 2802 3333 Fax 2802 8662

CADD REF. C8001_T_XRL_URB_C04_634A3.dgn

TITLE

CONSULTANCY AGREEMENT NO. C8001
TREE TRANSPLANTING / FELLING
TREE SURVEY PLAN OF YUEN LONG DISTRICT - TAI SHU HA (SHEET 1 OF 1)

SCALE 1 : 500 @ A1 | DRAWING NO. C8001/T/XRL/URB/C04/634 | REV. A3

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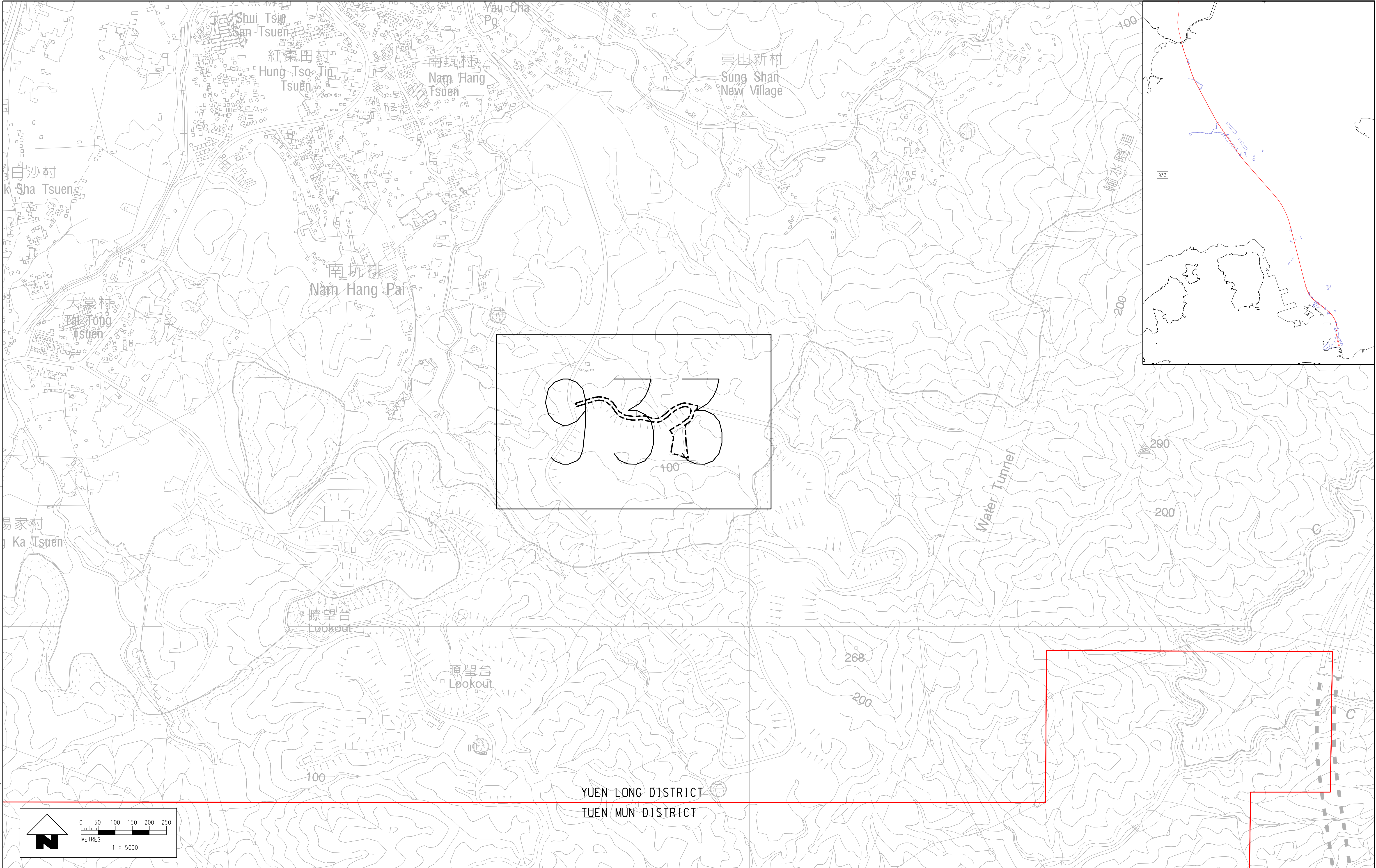
Appendix III

Compensatory Tree Planting & Transplanting Plans & Mitigation Measures

Drawing List of Appendix III

Compensatory Tree Planting & Transplanting Plans for Yuen Long District (Tai Shu Ha)



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APPROVED	AD
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CADD REF. C8001_T_XRL_URB_C04_932A1.dgn

TITLE

CONSULTANCY AGREEMENT NO. C8001
TREE TRANSPLANTING / FELLING
COMPENSATORY TREE PROPOSAL KEY PLAN FOR
YUEN LONG DISTRICT - TAI SHU HA

SCALE 1 : 5000 @ A1

DRAWING NO. C8001/T/XRL/URB/C04/932

REV. A1

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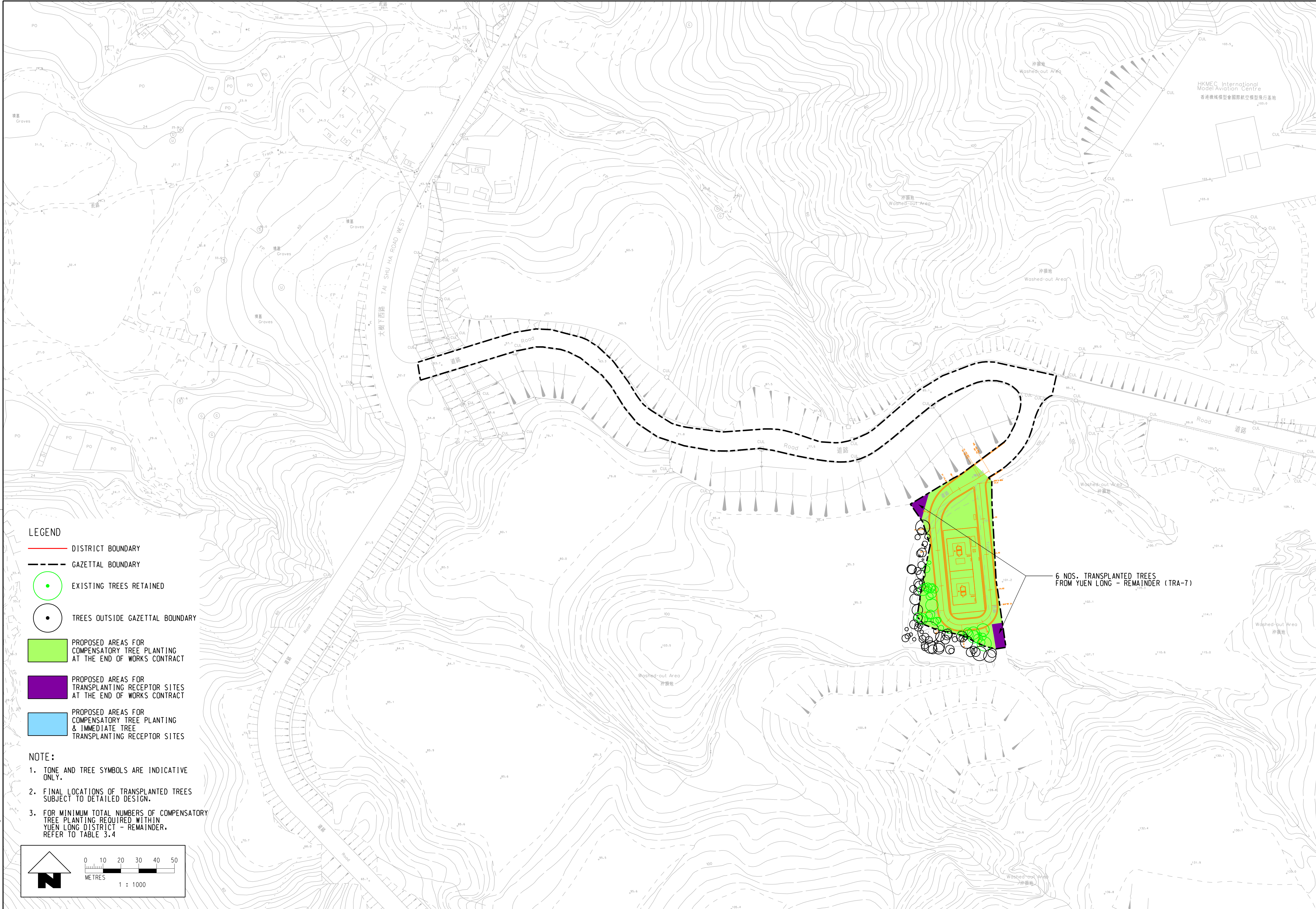

LEGEND

DISTRICT BOUNDARY

GAZETTAL BOUNDARY

EXISTING TREES RETAINED

TREES OUTSIDE GAZETTAL BOUNDARY

PROPOSED AREAS FOR COMPENSATORY TREE PLANTING AT THE END OF WORKS CONTRACT

PROPOSED AREAS FOR TRANSPLANTING RECEPTOR SITES AT THE END OF WORKS CONTRACT

PROPOSED AREAS FOR COMPENSATORY TREE PLANTING & IMMEDIATE TREE TRANSPLANTING RECEPTOR SITES

NOTE:

1. TONE AND TREE SYMBOLS ARE INDICATIVE ONLY.
2. FINAL LOCATIONS OF TRANSPLANTED TREES SUBJECT TO DETAILED DESIGN.
3. FOR MINIMUM TOTAL NUMBERS OF COMPENSATORY TREE PLANTING REQUIRED WITHIN YUEN LONG DISTRICT - REMAINDER. REFER TO TABLE 3.4

0 10 20 30 40 50
METRES
1 : 1000

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CHECKED	TO
APPROVED	AD
DATE	27.APR.2010

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Tel 2802 3333 Fax 2802 8662

CADD REF. C8001_T_XRL_URB_C04_933A1.dgn

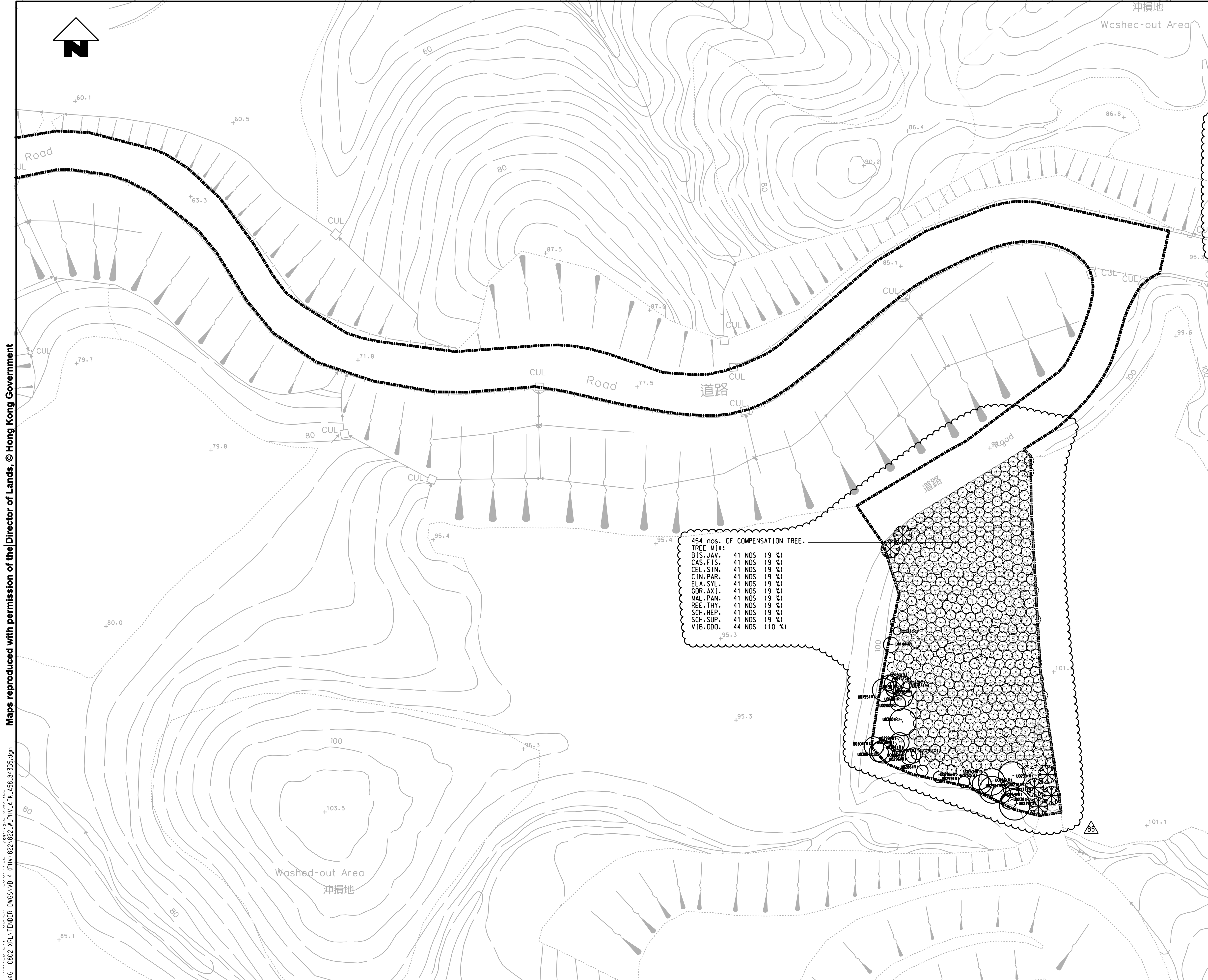
TITLE

CONSULTANCY AGREEMENT NO. C8001
TREE TRANSPLANTING / FELLING
COMPENSATORY TREE PROPOSAL FOR YUEN LONG DISTRICT
- TAI SHU HA
(SHEET 1 OF 1)

SCALE 1 : 1000 @ A1

DRAWING NO. C8001/T/XRL/URB/C04/933

REV. A1



LEGEND:

Type 種類	Botanical Name 學名	Chinese Name 中文名稱	Standard 規格	Spacing 種植闊度	Size (HxSPRxDIA) 規格	Quantity 數量
TREE	樹類					
BIS.JAV.	BISCHOFIA JAVANICA	重陽木	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
CAS.FIS.	CASTANOPSIS FISSA	裂斗錐栗	STANDARD	2.5M	4Mx2.5Mx0.06M	41
CEL.SIN.	CELTIS SINENSIS	朴樹	STANDARD	2.5M	3.5Mx2Mx0.06M	41
CIN.PAR	CINNAMOMUM PARTHENOXYLON	黃樟	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
ELA.SYL.	ELAEOCARPUS SYLVESTRIS	山杜英	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
GOR.AXI.	GORDONIA AXILLARIS	大頭茶	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
MAL.PAN.	MALLOTUS PANICULATUS	白楸	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
REE.THY.	REEVESIA THYRSOIDEA	梭羅樹	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
SCH.HEP.	SCHEFFLERA HEPTAPHYLLA	鴨腳木	STANDARD	2.5M	4Mx2Mx0.06M	41
SCH.SUP.	SCHIMA SUPERBA	木荷	STANDARD	2.5M	3.5Mx2.5Mx0.06M	41
VIB.ODO.	VIBURNUM ODORATISSIMUM	珊瑚樹	STANDARD	2.5M	3.5Mx2.5Mx0.06M	44

B5

0 5 10 15 20 25
METRES
1 : 500

REV	DESCRIPTION	BY	DATE	APPROVED
B5	REVISION TO PLANTING SCHEDULE	AC	JUL10	TM
B4	REVISION TO PLANTING SCHEDULE	AC	JUN10	TM
B3	REVISION TO PLANTING SCHEDULE	AC	MAY10	TM
B2	REVISION TO PLANTING SCHEDULE	AC	MAR10	TM
B1	REVISION TO PLANTING SCHEDULE	AC	FEB10	TM
A	WORKING DRAWING ISSUE	AC	MAR10	TM

DRAWN	SH
DESIGNED	AC
CHECKED	KN
APPROVED	TM
DATE	DEC/2009

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Knight Frank, BMT, Kenneth Ng

CADD REF. 822_W_PHV_ATK_A58_843B5.DGN

TITLE

CONTRACT 822
TSE UK TSUEN TO SHEK YAM TUNNELS
TAI SHU HA (YUEN LONG) MAGAZINE SITE
LANDSCAPE PLAN

SCALE 1 : 500 (A1)

DRAWING NO. 822/W/PHV/ATK/A58/843

REV. B5

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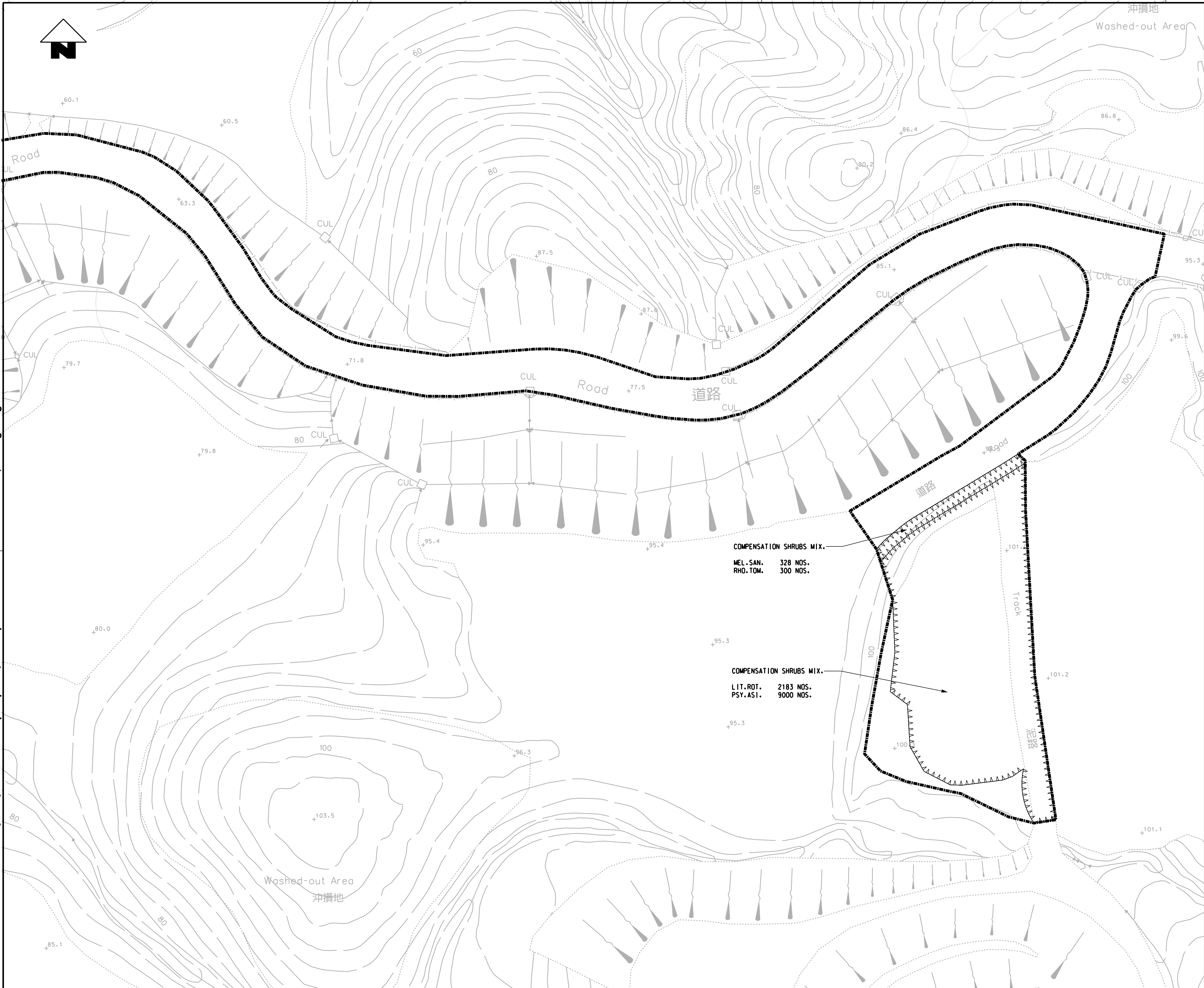

LEGEND:

Type 種類	Botanical Name 學名	Chinese Name 中文名稱	Spacing 種植闊度	Standard 規格	Quantity 數量
SHRUB 灌木類					
LIT.ROT.	LITSEA ROTUNDIFOLIA	豺皮樟	500 mm	300H x 250S	2183
MEL.SAN.	MELASTOMA SANGUINEUM	毛木念	500 mm	400H x 300S	328
PSY.ASI.	PSYCHOTRIA ASIATICA	九節	500 mm	500H x 400S	9000
RHO.TOM.	RHODOMYRTUS TOMENTOSA	桃金孃	500 mm	300H x 250S	300

SHRUB

0 5 10 15 20 25
METRES
1 : 500

REV	DESCRIPTION	BY	DATE	APPROVED
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A2	WORKING DRAWING ISSUE	AC	JUN10	TM
A1	WORKING DRAWING ISSUE	AC	MAR10	TM

DRAWN	SH
DESIGNED	AC
CHECKED	KN
APPROVED	TM
DATE	MAR/2010

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ATKINS
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Kenneth Ng

CADD REF. 822_W_PHV_ATK_A58_847A3.DGN

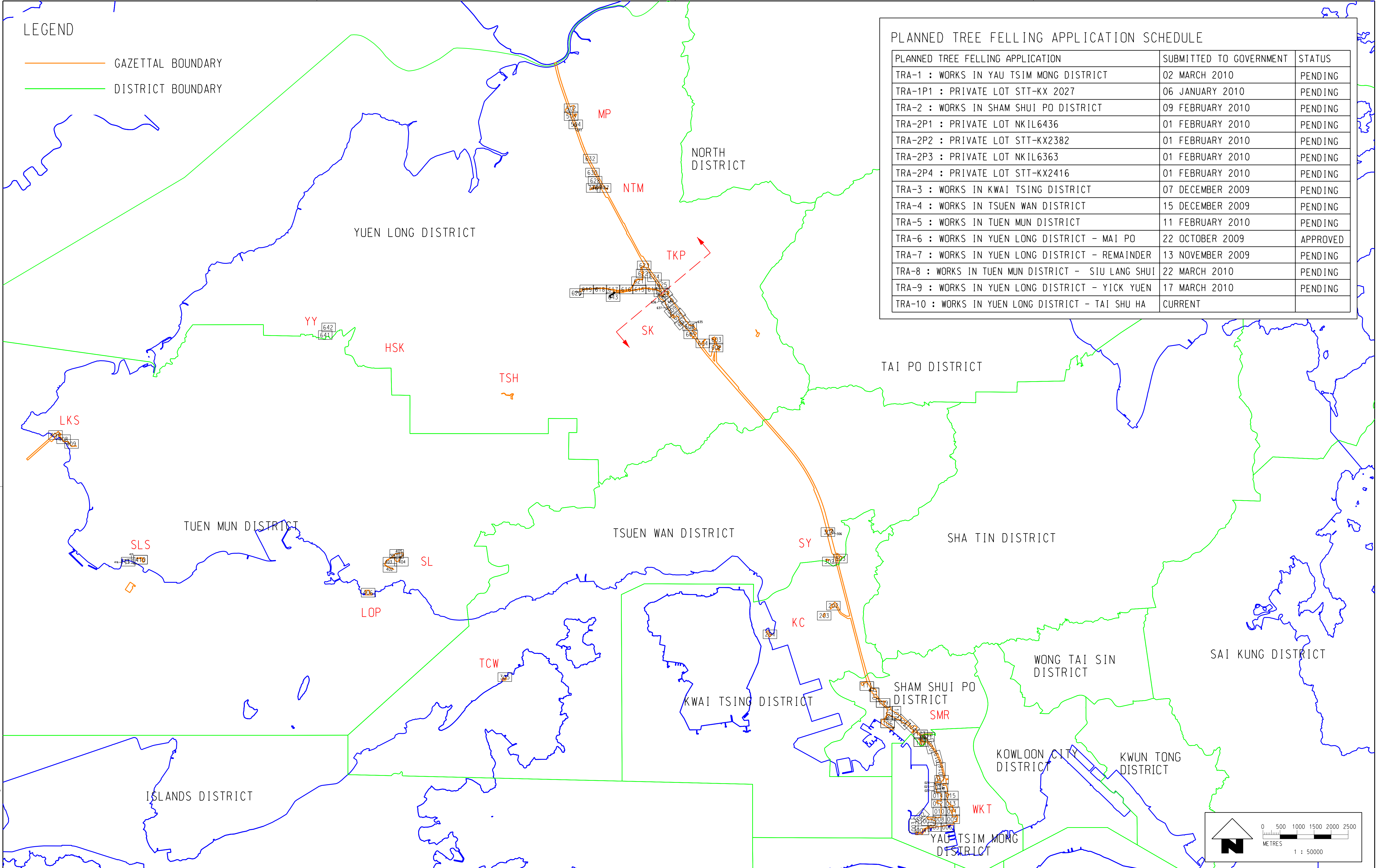
TITLE
CONTRACT 822
TSE UK TSUEN TO SHEK YAM TUNNELS
TAI SHU HA (YUEN LONG) MAGAZINE SITE
SHRUB PLANTING PLAN

SCALE 1 : 500 (A1)
DRAWING NO. 822/W/PHV/ATK/A58/847
REV. A3

Appendix IV

Supporting Information

Key Plan for XRL Tree Planting and Landscape Plan



PLANNED TREE FELLING APPLICATION SCHEDULE

PLANNED TREE FELLING APPLICATION	SUBMITTED TO GOVERNMENT	STATUS
TRA-1 : WORKS IN YAU TSIM MONG DISTRICT	02 MARCH 2010	PENDING
TRA-1P1 : PRIVATE LOT STT-KX 2027	06 JANUARY 2010	PENDING
TRA-2 : WORKS IN SHAM SHUI PO DISTRICT	09 FEBRUARY 2010	PENDING
TRA-2P1 : PRIVATE LOT NKIL6436	01 FEBRUARY 2010	PENDING
TRA-2P2 : PRIVATE LOT STT-KX2382	01 FEBRUARY 2010	PENDING
TRA-2P3 : PRIVATE LOT NKIL6363	01 FEBRUARY 2010	PENDING
TRA-2P4 : PRIVATE LOT STT-KX2416	01 FEBRUARY 2010	PENDING
TRA-3 : WORKS IN KWAI TSING DISTRICT	07 DECEMBER 2009	PENDING
TRA-4 : WORKS IN TSUEN WAN DISTRICT	15 DECEMBER 2009	PENDING
TRA-5 : WORKS IN TUEN MUN DISTRICT	11 FEBRUARY 2010	PENDING
TRA-6 : WORKS IN YUEN LONG DISTRICT - MAI PO	22 OCTOBER 2009	APPROVED
TRA-7 : WORKS IN YUEN LONG DISTRICT - REMAINDER	13 NOVEMBER 2009	PENDING
TRA-8 : WORKS IN TUEN MUN DISTRICT - SIU LANG SHUI	22 MARCH 2010	PENDING
TRA-9 : WORKS IN YUEN LONG DISTRICT - YICK YUEN	17 MARCH 2010	PENDING
TRA-10 : WORKS IN YUEN LONG DISTRICT - TAI SHU HA	CURRENT	

REV	DESCRIPTION	BY	DATE	APPROVED	REV	DESCRIPTION	BY	DATE	APPROVED
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A27	TWENTY-SEVENTH ISSUE FOR TRA-7	SAN	23APR10	AD	A20	TWENTIETH ISSUE FOR TRA-1	SAN	01MAR10	AD
A26	TWENTY-SIXTH ISSUE FOR TRA-2	SAN	16APR10	AD	A19	NINETEENTH ISSUE FOR TRA-8	SAN	12FEB10	AD
A25	TWENTY-FIFTH ISSUE FOR TRA-7	SAN	17MAR10	AD	A18	EIGHTEENTH ISSUE FOR TRA-9	SAN	11FEB10	AD
A24	TWENTY-FOURTH ISSUE FOR TRA-4	SAN	17MAR10	AD	A17	SEVENTEENTH ISSUE FOR TRA-2	SAN	10FEB10	AD
A23	TWENTY-THIRD ISSUE FOR TRA-8	SAN	15MAR10	AD	A16	SIXTEENTH ISSUE FOR TRA-5	SAN	09FEB10	AD
A22	TWENTY-SECOND ISSUE FOR TRA-3	SAN	12MAR10	AD	A15	FIFTEENTH ISSUE FOR TRA-1	SAN	29JAN10	AD

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APPROVED	AD
DATE	01.APR.2009

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Tel 2802 3333 Fax 2802 8662
Urbis Limited 雅邦

CADD REF. C8001_T_XRL_URB_C04_901A28.dgn

TITLE
CONSULTANCY AGREEMENT NO. C8001
TREE TRANSPLANTING / FELLING
XRL TREE FELLING APPLICATIONS
KEY PLAN

SCALE 1 : 50000 @ A1

DRAWING NO. C8001/T/XRL/URB/C04/901

REV. A28

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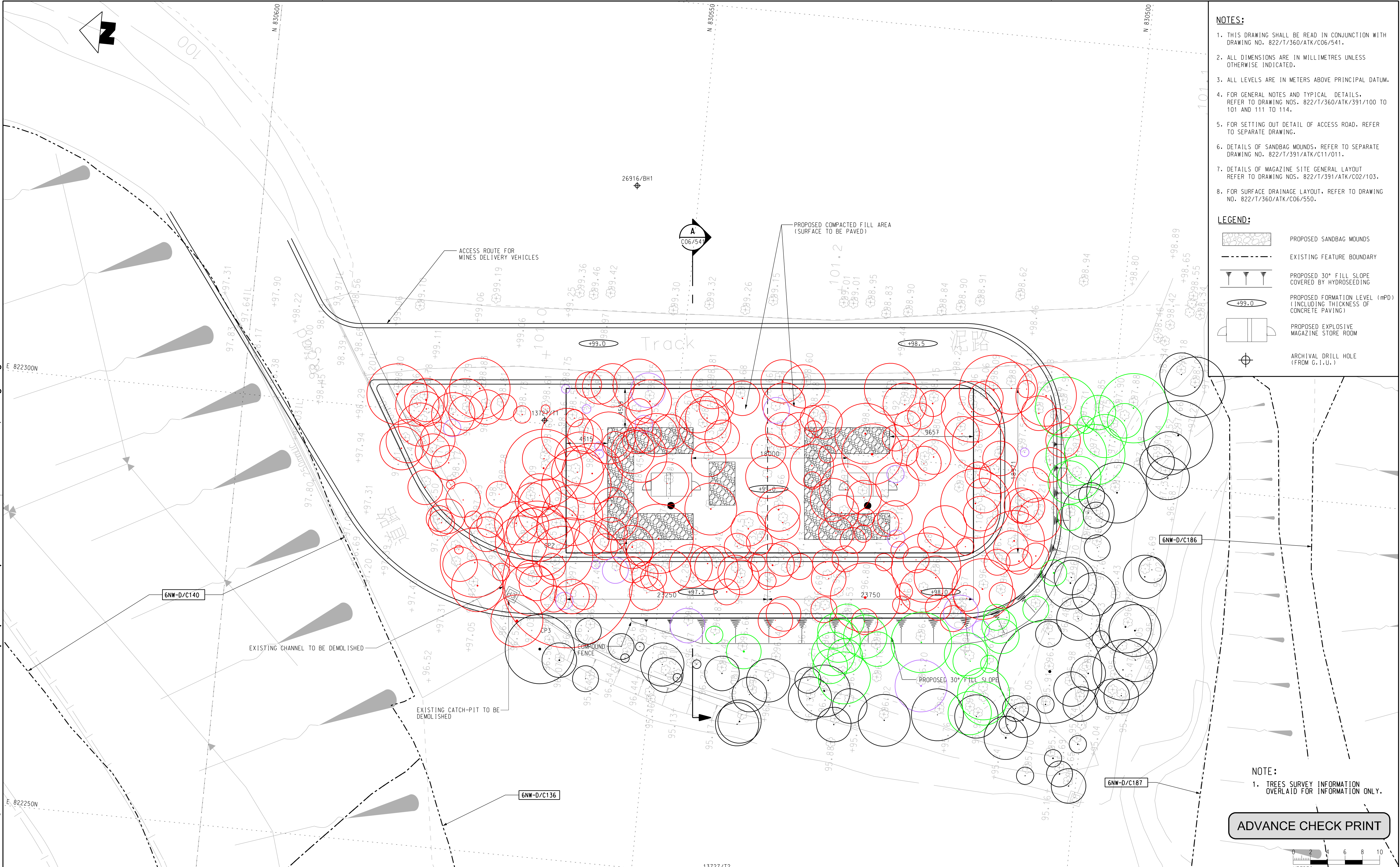

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NOTES:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRAWING NO. 822/T/360/ATK/C06/541.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE INDICATED.
3. ALL LEVELS ARE IN METERS ABOVE PRINCIPAL DATUM.
4. FOR GENERAL NOTES AND TYPICAL DETAILS, REFER TO DRAWING NOS. 822/T/360/ATK/391/100 TO 101 AND 111 TO 114.
5. FOR SETTING OUT DETAIL OF ACCESS ROAD, REFER TO SEPARATE DRAWING.
6. DETAILS OF SANDBAG MOUNDS, REFER TO SEPARATE DRAWING NO. 822/T/391/ATK/C11/011.
7. DETAILS OF MAGAZINE SITE GENERAL LAYOUT REFER TO DRAWING NOS. 822/T/391/ATK/C02/103.
8. FOR SURFACE DRAINAGE LAYOUT, REFER TO DRAWING NO. 822/T/360/ATK/C06/550.

LEGEND:

- PROPOSED SANDBAG MOUNDS
- EXISTING FEATURE BOUNDARY
- PROPOSED 30° FILL SLOPE COVERED BY HYDROSEEDING
- +99.0 PROPOSED FORMATION LEVEL (mPD) (INCLUDING THICKNESS OF CONCRETE PAVING)
- PROPOSED EXPLOSIVE MAGAZINE STORE ROOM
- ARCHIVAL DRILL HOLE (FROM G.I.U.)

NOTE:

1. TREES SURVEY INFORMATION OVERLAID FOR INFORMATION ONLY.

ADVANCE CHECK PRINT

822 - TEMPORARY WORKS AT TAI SHU HA (YUEN LONG) MAGAZINE SITE (SHEET 1 OF 2)

REV	DESCRIPTION	BY	DATE	APPROVED
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DRAWN	JN
DESIGNED	CKF
CHECKED	KL
APPROVED	TM
DATE	27/APR/2009

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Kenneth Ng

CADD REF. $FILEA$

TITLE
CONTRACT 822
PAT HEUNG TO SHEK YAM
TAI SHU HA (YUEN LONG) EXPLOSIVE MAGAZINE SITE
SITE FORMATION LAYOUT PLAN

SCALE 1 : 200 (A1)
DRAWING NO. 822/T/391/ATK/C06/540
REV. A1

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NOTES:

1. ALL DIMENSIONS IN METER UNLESS OTHERWISE SPECIFIED.
2. ROAD PAVEMENT CONSTRUCTION DETAILS TO BE CONSTRUCTED IN ACCORDANCE WITH HyD STANDARD DRAWING H1102 TO H1112.
3. FOR ROAD DRAINAGE PLANS, REFER TO DRAWING NO. 822/391/ATK/P06/171.

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CONCRETE PAVEMENT. FOR DETAILS REFER TO DRAWING NO. 822/T/391/ATK/C24/142

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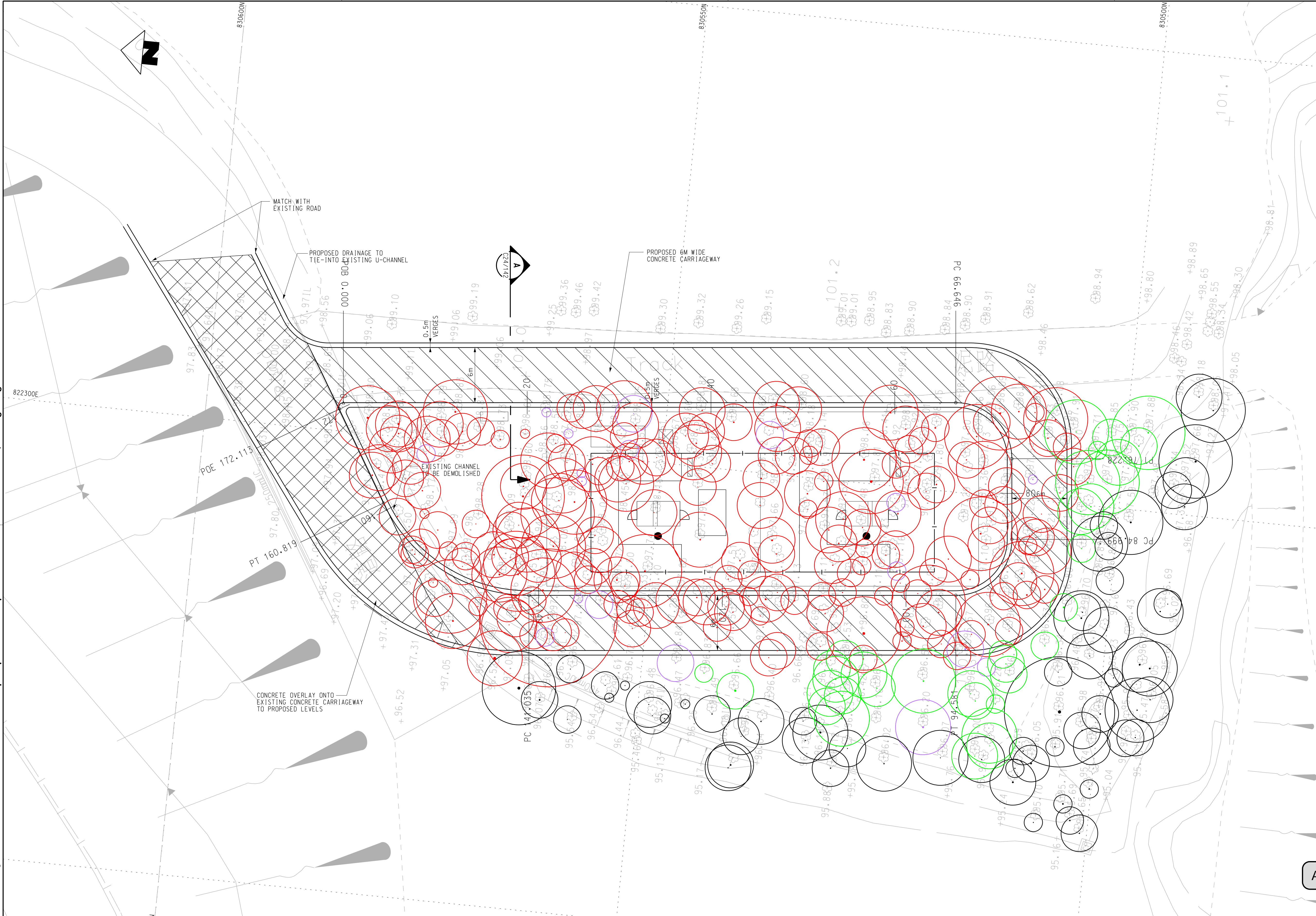

NOTE:

1. TREES SURVEY INFORMATION OVERLAID FOR INFORMATION ONLY.

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REV	DESCRIPTION	BY	DATE	APPROVED
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DRAWN	CCM
DESIGNED	PSC
CHECKED	KP
APPROVED	TM
DATE	29/MAY/2009

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ATKINS

Supported by Arup, TFP Farrells, DLS Kenneth Ng

CADD REF. $FILEA$

TITLE

CONTRACT 822

PAT HEUNG TO SHEK YAM

TAI SHU HA (YUEN LONG) MAGAZINE SITE

ROADWORKS LAYOUT PLAN

SCALE 1 : 200 (A1)

DRAWING NO. 822/T/391/ATK/C24/140

REV. A1

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27-Apr-2010 15:05:30

Appendix V

Particular Specification for Tree Works, Soft Landscape Works & Related Works

APPENDIX AN

TREE WORKS, SOFT LANDSCAPE WORKS AND RELATED WORKS

TABLE OF CONTENTS

Works to be done by specialist landscape contractor	All works as described in this Appendix AN, shall be undertaken by a specialist landscape sub-contractor approved by the Engineer. In addition to the general requirements of the Contract the Contractor shall demonstrate that the proposed specialist landscape sub-contractor has sufficient experience.

AN1 PRESERVATION AND PROTECTION OF EXISTING TREES AND VEGETATION

AN1.1 GENERAL

Definitions regarding trees AN1.1.01

(1) "Tree" means a plant with tree-like growth habit with diameter measuring 95mm or more at breast height. Plants growing on retaining structures shall also be measured and considered.

(2) "Diameter at breast height" means the diameter of the trunk of the plant measured at a height of 1.3m above ground level. For trunk with an obviously elliptical cross-section, the diameter at breast height shall be the average of any two-diameter measurements taken at right angle.

(3) "Tree crown spread" means the diameter of the tree crown defined by the outermost branches of the tree. For tree crown with an obviously elliptical cross-section, the diameter of the tree crown shall be the average of any two- diameter measurements taken at right angle.

(4) "Tree height" means the height from ground level to the top of the tree.

(5) "Dripline" of a tree means the imaginary vertical plumb line that extends downward from the tips of the outermost tree branches and intersects the ground.

(6) "Tree protection zone" means an area the perimeter of which is defined by the dripline of the tree.

(7) "Preserved tree," means an existing tree not earmarked to be felled, which may be a tree to be retained at its existing location, a tree at its existing location before transplanting, or a tree transplanted within the Site.

(8) "Arboricultural work" means any work related to the cultivation and care of trees for any purpose other than timber production, including but not limited to planting, replanting, transplanting, tree surgery work and control of pest and disease.

(9) "Removal of trees" means either felling or transplanting of trees.

(10) "Transplanting of trees" means tree transplanting to be carried out under Contract No. 801.

Specialist Contractor AN1.1.02

If the Contractor is not included in the "List of Approved Suppliers of Materials and Specialist Contractors for Public Works" under the category of "Landscaping: Class I - General Landscape Work", he shall enter into a written sub-contract with a specialist contractor to carry out the arboricultural work to trees, including planting, replanting, transplanting, tree surgery work, and control of pest and disease.

General requirements AN1.1.03

(11) The Contractor shall submit a method statement for Tree Preservation and Protection, including tree protection plans before commencing any works on site, which may affect any tree.

(12) The Contractor shall make all necessary allowance for the preservation and protection of existing trees in his programming of, and method of construction of the works, including the full extent of all temporary works and vehicular access arrangements.

(13) The Contractor shall assign a person to oversee the implementation of Tree Preservation and Protection Plan and delegate to that person the full authority to make all decisions related to such works. The person assigned shall be working full time on the Site but not necessarily working solely for matters related to preservation and protection to existing trees. The assigned person shall have attended relevant training on the subject organised by training institutes (such as Construction Industry Training Authority), or similar courses as considered appropriate by the Engineer. The Contractor shall submit to the Engineer for approval within 45 days of the date of the Employer's letter of acceptance of the Tender particulars of the assigned person (including his name, experience and position) together with a copy of the certificate issued by the training institute confirming `his satisfactory completion of the relevant course.

(14) The limits of site clearance shall be agreed by the Engineer on the Site before site clearance commences.

Reference Standards AN1.1.04

(15) The latest editions of the following reference standards are applicable:

(a) BS 3998 : Recommendations for Tree Work

(b) BS 4428 : General Landscape Operations.

(c) BS 4043:1989 : Transplanting

(d) BS 5837 : Guide for trees in relation to construction

(16) For any inconsistencies, the provisions contained in this Particular Specification and the Drawings shall prevail over the provisions contained in the documents listed in sub-clause (1) of this clause.

AN1.2 SITE CLEARANCE

Demolition AN1.2.01

(1) Areas adjacent to demolition works shall be protected from damage resulting from the demolition.

(2) Structures that are to be demolished shall be surveyed by the Contractor and the result given to the Engineer, before demolition starts.

(3) Particulars of the proposed methods of carrying out demolition works, handling and sorting of recyclable materials and disposal of construction and demolition waste shall be submitted to the Engineer for information at least 14 days before the demolition starts.

(4) The proposed methods shall enhance site safety, maximize recovery of recyclable materials and minimize generation of construction and demolition waste. The recommendations of the Code of Practice for Demolition of Buildings (year 2004), issued by the Buildings Department shall be followed.

Pipes and cables AN1.2.02

The Contractor shall make all arrangements with and obtain the necessary approvals from the relevant authorities for disconnecting utilities inside and outside the Site. The ends of disconnected utilities shall be made good and sealed; the positions of the ends shall be marked with marker posts or by other methods agreed by the Engineer.

Trees AN1.2.03

The Contractor shall comply with the requirements of preservation and protection of existing trees stipulated in Sections AN1.3 to AN1.6 before commencing site clearance.

Reinstatement AN1.2.04

(1) Unless otherwise permitted by the Engineer, areas affected by site clearance shall be reinstated as stated in Clause AN1.2.04(2) to (5).

(2) Fine fill material shall be deposited and compacted in voids that are left in the ground.

(3) Holes that are left in structures and pavements shall be made good using material similar to that in the adjoining area.

(4) The ends of fences, walls, structures, utilities and other items shall be made good in such a manner that the affected parts will not corrode or deteriorate, and will remain stable.

(5) Straining posts shall be fixed at the end of strained fences that have been cut, and the fences shall be restrained.

Materials and equipment for re-use and storage AN1.2.05

(1) Items that are to be re-used or taken to store shall be dismantled and removed by a suitable method so as to avoid damage or minimise the damage if this is unavoidable. The items shall be cleaned before re-use or taking to store.

(2) Items that are to be re-used in the Works shall be kept in storage areas provided by the Contractor. Storage areas shall be on levelled, well drained and maintained hard-standing ground to facilitate cleansing and minimize dust generation.

(3) Items that are to be taken to the Employer's store shall be delivered by the Contractor.

(4) Materials or equipment which are to be re-used or taken to store and which are damaged due to the Contractor's negligence shall be repaired by the Contractor by a method agreed by the Engineer. Materials or equipment that are lost or, in the opinion of the Engineer, are not capable of being repaired satisfactorily shall be replaced by the Contractor. Except for items which are to be re-used or taken to store, demolished items, trees, shrubs, vegetation, boulders, debris, rubbish and other items arising from site clearance shall be disposed of by the Contractor and shall become the property of the Contractor when they are removed from the Site.

AN1.3 SURVEY AND IDENTIFICATION OF EXISTING TREES

Tree Survey AN1.3.01

(1) The Employer has carried out a tree survey (hereinafter called "previous tree survey") and obtained a Permit for the removal of certain trees within the site, in some cases by transplanting and in others by felling. The trees which are to be transplanted and felled are identified in the Tree Removal Application prepared by the Employer.

(2) The Contractor shall carry out a detailed check of the previous tree survey and submit the results to the Engineer within 28 days of the date for commencement of the Works, identifying any discrepancies between the previous tree survey and the site condition at the date of the Contractor taking possession of the site.

(3) If discrepancies are found in the previous tree survey and actual site conditions the Contractor shall carry out a tree survey to correct the discrepancies. Each tree shall be assigned a unique identification number according to a numbering system agreed with the Engineer beforehand. The tree survey record shall be in the form of an A4-sized, bound report which shall bear a report cover indicating the Contract number, Contract title, and date of the report and shall include the following documents, the format of which shall be agreed by the Engineer before submission of the report:

(e) A tree survey plan showing the locations of all existing individual trees in the area where discrepancies have been found in the previous tree survey and identifying:

(i) Trees which are earmarked under the Contract for retention at their existing locations,

(ii) Trees which are earmarked under the Contract for retention at their existing locations, and which require to be pruned,

(iii) Trees which are earmarked under the Contract for transplanting,

(iv) Trees which are earmarked under the Contract for felling and

(v) Any other trees which have not been reported/identified under the Contract and their treatment has yet to be instructed by the Engineer,

(f) A tree schedule for all the trees under sub-clause (a) of this Clause comprising the following information of each individual tree:

(i) Botanical name of the tree species and the identity code/number as shown on the tree survey plan and marked on the Site,

(ii) Diameter of the tree at 1.3m above ground level,

(iii) Tree crown spread,

(iv) Tree height,

(v) Condition of the tree including its form and health (highlighting any structural defects or unhealthy or decaying symptoms which may pose danger to the public if the tree falls), amenity value, survival rate after transplanting and special features, and

(vi) Existing ground level at the trunk base;

(g) Photographic record for each individual tree under sub-clause (a) of this Clause complying with the following:

(i) All photographs shall be date-stamped to indicate the dates that the photographs are taken and shall be well-annotated, and

(ii) The photograph of each tree or tree group shall show clearly the whole tree or entire tree group as far as possible, the identification number of the tree or tree group, and the status of the tree as identified by the labelling or marking system on the Site as required in Clause AN1.3.02.

Labelling of Trees AN1.3.02

(1) The Contractor shall mark on the Site with labelling or marking systems to identify trees of different status in accordance with the classification in sub-clauses (3)(a)(i) to (v) of Clause AN1.3.01. The Contractor shall comply with the following in providing the identification labelling or marking systems:

(h) If applicable, the Contractor shall follow the labelling or marking system adopted in the previous survey;

(i) The identification labelling or marking systems for different tree status shall be in different colours and be clearly distinguishable,

(j) The tree identification number of each tree or tree group shall be clearly shown on the label or mark.

(k) The identification labelling or marking system for the trees shall be made of durable materials that are non-injurious to preserved the trees, be placed at a position not easily accessible but clearly visible to the public, and be attached in such a manner that allows for the growth of the trees and does not injure the trees.

(l) The identification labelling or marking systems and the on-site status identification of trees shall be agreed by the Engineer and installed before commencing site clearance, demolition, construction of permanent or temporary works, and any other site operations which may affect the trees, and

(m) The Contractor shall reinstate or replace, where necessary, the identification labelling or marking systems for the preserved trees and shall remove these identification labelling or marking systems from the Site upon completion of the Works, or earlier if so directed by the Engineer.

(2) For those individual trees or tree groups identified under sub-clause (a)(v) of Clause AN1.3.01, the Contractor shall change the label or mark on them to reflect their updated status immediately once the Engineer has instructed the treatment to them.

AN1.4 REMOVAL OF EXISTING TREES

Felling of existing trees

AN1.4.01 (1) Site clearance should be carried out in stages to suit the actual clearance requirement as works progress. The limits of site clearance for any part of the Site shall be agreed by the Engineer before site clearance at the respective part commences. No clearance shall be carried out until such requirement is met.

(2) The Contractor shall comply with the following requirements in respect of tree felling:

(a) Fell only those trees earmarked for such purposes under the Contract and labelled for such purposes on the Site pursuant to Clause AN1.3.02 or those as directed or approved by the Engineer,

(b) Take all necessary precautions to protect the people engaged in the tree felling work as well as the people and property in the vicinity,

(c) Adopt working methods that avoid any damage to adjacent plants to be retained, including damage to their root systems,

(d) Completely remove the tree to be felled including the stumps and rootballs,

(e) If, in the opinion of the Engineer or as required in the Contract, removal of stumps and rootballs is not necessary, fell the trees by cutting them near the ground, with their stumps ground rather than pulled,

(f) Remove all debris, cut wood, and roots pursuant to sub-clauses (2)(d) and 2(e) of this Clause, from the trees felled from the Site as soon as possible, and

(g) Reinstate where appropriate the ground around the adjacent plants to be retained to ensure their continued healthy growth and stability.

Transplanting of existing trees

AN1.4.02 (1) If tree transplanting is to be done by a separate designated tree transplanting contractor, the Contractor shall provide attendance and access to the tree transplanting contractor to carry out transplantation.

(2) If tree transplanting is to be done by the Contractor, the Contractor shall comply with the following requirements in respect of tree transplanting, either within or off the Site:

(a) Transplant only those trees earmarked for such purposes under the Contract and labelled for such purposes on the Site pursuant to Clause AN1.3.02 or those as directed or approved by the Engineer,

(b) Commence any work related to tree transplanting on the Site only after the Engineer is satisfied that the Contractor has complied with the requirements stipulated for completion before tree transplanting work commences; and

(c) Undertake tree transplanting work in accordance with Section AN2.11.

Unplanned tree removal

AN1.4.03 Where it is found necessary for the completion of the Works to remove, either by felling or by transplanting, any trees other than those earmarked for such purposes under the Contract and labelled purposes on the Site pursuant to Clause AN1.3.02 or those directed or approved purposes during the progress of the Works by the Engineer, the Contractor shall comply with the following requirements:

(a) Report to the Engineer the necessity on such tree removal,

(b) Prepare and submit to Government, and obtain Government approval of, a Tree Removal Application in accordance with the relevant Government Technical Circular(s)

(c) Fell or transplant the trees only after the Engineer's approval of the tree removal has been given. Such approval shall normally be given after the Tree Removal Application has been approved by the Government approving authority, and

(d) Make due allowance in his programme for the time required to obtain the Engineer's approval and Government approval of the Tree Removal Application.

(e) Undertake approved tree transplanting work in accordance with Section AN2.11. The Contractor shall submit a proposal, with justification, for the root cutting period for each unplanned tree to be transplanted, in accordance with one of the Groups listed in Clause AN2.11.05(3). No root cutting works shall proceed until the proposal is approved by the Engineer and the Tree Removal Application is approved by Government.

AN1.5 PRESERVATION AND PROTECTION OF EXISTING TREES

General Precautionary Measures to Preserved Trees

AN1.5.01 (1) The Contractor shall submit a Tree Preservation and Protection Plan for the Engineer's approval before commencing any works on site.

(2) The Contractor shall exercise the greatest care to avoid any damage to the preserved trees and shall comply with the following in respect of all the preserved trees during the Construction Period and Establishment Period:

(a) Take all necessary precautions to ensure that:

(i) No nails or other fixings shall be driven into the trees, including the exposed tree roots,

(ii) No fencing, services, or signs other than the identification labels or markings required under Clause AN1.3.02 shall be attached to any part of the trees,

(iii) No trees shall be used as anchorages for ropes or chains used in guying or pulling or for equipment used for removing stumps, roots or other trees, or for any other purposes,

(iv) No soil, materials, equipment or machinery shall be stockpiled or stored within the tree protection zones,

(v) No site offices, workshops, canteens, containers or similar structures shall be installed within the tree protection zones,

(vi) Petrol, oil, bitumen, creosote, cement and other materials likely to be injurious to the trees shall be kept away from the tree protection zones, and any accidental spills of these materials shall be cleaned up immediately,

(vii) Excessive water shall be drained away from the tree protection zones to prevent damage to tree roots by asphyxiation,

(viii) The surface on slopes shall be shaped so that water will not drain to the tree trunks but bypass them,

(ix) No passage or parking of vehicles and no operation of equipment or machinery shall take place within the tree protection zones unless otherwise agreed by the Engineer,

(x) No stripping of surface vegetation or top layer of soil, and no paving or earth filling shall be carried out within the tree protection zones unless otherwise agreed by the Engineer,

(xi) No fires shall be lit within the tree protection zones or in a position where the flames will likely extend to within 5m of foliage, branches or trunks of the trees, bearing in mind the size of the fire and the wind direction,

(xii) No concrete mixing, gas tank filling, paintbrush and tool cleaning, or equipment maintenance shall be carried out within the tree protection zones,

(xiii) Any necessary scarification or cultivation within the tree protection zones shall be carried out carefully by hand so as not to cause damage to the trees, in particular the bark and the roots,

(xiv) Any equipment, in particular delivery vehicles, overhead cranes, mechanical excavations, drilling rigs and piling rigs, shall be carefully operated so as not to cause striking of the trunks, branches, foliage or root collars of the trees,

(xv) The trees to be felled, which are adjacent to, or which lie within a continuous canopy of the preserved trees, shall be carefully removed, and if necessary in sections but not using bulldozers in any circumstances, so as not to cause damage to the preserved trees such as scraping bark off trunks or breaking branches of trees,

(xvi) Where it is necessary to use herbicides to kill any vegetation, herbicides that can leach through the soil, such as the products containing sodium chlorate, and any other herbicides that are injurious to the trees shall not be used,

(xvii) Allowance shall be made for the slope of the ground so that damaging materials such as concrete washings, mortar or diesel oil cannot run towards the trees,

(xviii) Alkaline clay or limestone shall not be used for filling or paving, concrete shall be mixed on a thick plastic tarpaulin, and mixing trucks shall not be rinsed out on the Site, so as not to cause changes, in particular increases, in the soil pH, and

(xix) All building debris and chemical wastes shall be hauled away for proper disposal, and in any circumstances shall not be burned or buried on the Site or be disposed of by pouring them on the soil within the Site,

(b) Repair any damage to the trees in accordance with the requirements stipulated in Section AN1.6,

(c) Where the passage or parking of vehicles or the operation of equipment or machinery within the tree protection zones as referred to in sub-clause (a)(ix) of this Clause is considered necessary and is agreed by the Engineer, carry out the following measures to reduce soil compaction:

(i) Minimize the traffic of the vehicles, equipment or machinery, and

(ii) Confine the passage or parking of vehicles or operation of equipment or machinery to the areas laid with temporary protective mulching as stipulated in sub-clause (5)(b) of Clause AN1.5.02 and with double, overlapping, thick metal sheet coverings, or other materials of equivalent strength as agreed by the Engineer placed on top,

(d) Where it is necessary to clear the existing undergrowth within the tree protection zones to allow access and visibility for, and operation of any construction work,

(i) Shrubs shall be pruned and grass or other herbaceous plants shall be cut to a height of not less than 50 mm above the ground level but not pulled out by equipment in any circumstances, and

(ii) The agreement of the Engineer shall be obtained before vegetation clearance commences,

(e) Protect the preserved trees, where necessary, from increased exposure to sun and wind due to removal of adjacent trees,

(f) Align all routes of the overhead services within the Site and all access routes to the Site or within the Site away from the preserved trees as far as possible and seek the Engineer approval to the alignment,

(g) Report to the Engineer any preserved tree that has structural defects or unhealthy or has decaying symptoms,

(h) Update the photographic record taken in accordance with Clause AN1.3.01(3)(c) and submit a report comprising the updated photographic records of all the preserved trees to the Engineer every two months or at intervals agreed by the Engineer, complying with the following:

(i) Each of the reports shall be in the form of an A4-sized,bound document which shall bear a report cover indicating the Contract number, Contract title, and date of the report,

(ii) The format of the reports shall be agreed by the Engineer before submission of the first report,

(iii) All photographs shall be date-stamped to indicate the dates that the photographs are taken and shall be well-annotated,

(iv) The photograph of each tree shall show clearly the whole tree as far as possible, the identification number of the tree, and the status of the tree as identified by the labelling or marking system on the Site as required in Clause AN1.3.02, and

(v) Each of the reports shall include details of any damage caused to the trees and any signs of health deterioration of the trees in the reporting period, accompanied with photographic record of the damage and the tree deterioration.

(vi) Each of the reports shall be submitted with details of the Contractor's proposed works for each tree in the forthcoming period, including but not limited to, excavation, protection, pruning, repair of damages, and establishment operation

Protection of preserved trees — AN1.5.02

(1) The Contractor shall erect, secure and maintain in good condition temporary protective fencing with a minimum height of 1.5m to protect the preserved trees. Details of the

from physical damage and soil compaction

temporary protective fencing are shown in Drawing Nos. TP001 and TP002 in Annex 1. The Contractor shall submit method statements including proposed design details of the temporary protective fencing to the Engineer for approval and obtain such approval before commencing the erection of the fencing.

(2) The temporary protective fencing shall be erected along or beyond the perimeter of the tree protection zone of each individual tree. Where the tree protection zones of two or more trees overlap with each other, the temporary protective fencing shall be erected along or beyond the perimeter of the aggregate tree protection zone of the trees or as directed by the Engineer.

(3) The Contractor shall complete erection of the temporary protective fencing before commencing of site clearance, demolition, construction of permanent or other temporary works, and any other site operations that may affect the trees.

(4) The Contractor shall remove the temporary protective fencing from the Site upon completion of the Works or earlier if so directed by the Engineer. The Contractor shall not remove or relocate the temporary protective fencing or enter the area enclosed by the temporary protective fencing without the prior agreement of the Engineer.

(5) If, in the opinion of the Engineer, erection of temporary of protective fencing is not practical, or the preserved tree grows on a retaining structure, then the following precautions shall be taken by the Contractor:

(a) The Contractor shall provide temporary protective hessian armouring around tree trunks to protect the preserved trees. When instructed by the Engineer, the Contractor shall provide temporary protective hessian and plank armouring as an alternative to the same trees for enhanced protection. The minimum height of the hessian armouring or hessian and plank armouring from the ground shall be 1.5m. Details of the temporary protective hessian armouring and hessian and plank armouring are shown in Drawing No. TP003 in Annex 1. The Contractor shall submit details of the temporary protective hessian armouring and hessian and plank armouring to the Engineer for approval and obtain such approval before commencing installing such protection measures.

(b) Unless otherwise agreed by the Engineer, the ground of the tree protection zones of the trees referred to in the sub-clause (5)(a) of this Clause shall be protected from damage by construction activities through the use of temporary protective mulching to cover the entire tree protection zone. When instructed by the Engineer, double, overlapping, thick metal sheet coverings, or other materials of equivalent strength as agreed by the Engineer, shall be laid on top of the temporary protective mulching to provide additional protection from soil compaction due to passage or parking of vehicles or operation of equipment or machinery. Details of the temporary protective mulching are shown in Drawing No. TP004 in Annex 1. The Contractor shall submit details of the temporary protective mulching to the Engineer for approval and obtain such approval before commencing installing such protection measures.

(c) The Contractor shall complete erection of the temporary protective armouring and application of the temporary protective mulching before commencing site clearance, demolition, construction of permanent or other temporary works, and any other site operations that may affect the trees.

(d) The Contractor shall remove the temporary protective armouring and the temporary protective mulching from the Site upon completion of the Works, or earlier if so directed by the Engineer. The Contractor shall not remove or relocate the temporary protective armouring or the temporary protective mulching without the prior agreement of the Engineer.

Protection of preserved trees from changes in ground levels

AN1.5.03

(1) Without the Engineer's prior approval, the Contractor shall not change the existing ground levels within the tree protection zones of the preserved trees unless the Contract explicitly requires such changes.

(2) Where it is necessary for completion of the Works and the Engineer's approval has been obtained for temporarily or permanently reducing the existing ground level around a preserved tree, but this will result in lowering the existing ground level within the tree protection zone, the Contractor shall comply with the following requirements:

(a) Construct a retaining wall as shown in Drawing No. TP005 in Annex 1 or similar measures as agreed by the Engineer to accommodate the reduction in the existing ground level around the tree and to ensure the stability of the tree,

(b) Before commencing implementation of the measures to accommodate reduction in the ground level pursuant to sub-clause 2(a) of this Clause, submit method statements for the measures, including the necessary engineering design, construction details, and associated precautionary works such as those noted in sub-clause 2(e) of this Clause, for the Engineer's approval,

(c) Commence implementation of the measures only after the Engineer's approval of the method statements has been given,

(d) Follow the requirements stipulated in Clause AN1.5.04 regarding excavation and cutting of tree roots, and

(e) Maintain balanced moisture content in the tree and in the soil after implementation of the measures, by carrying out necessary precautionary measures such as crown thinning, watering and mulching.

(3) Where it is necessary for completion of the Works and the Engineer's approval has been obtained for temporarily or permanently raising the existing ground level around a preserved tree, but this will result in a rise in the existing ground level within the tree protection zone, the Contractor shall comply with the following requirements:

(a) Construct a dry well and soil aeration system as shown in Drawing No. TP006 in Annex 1 or similar measures as agreed by the Engineer to accommodate minor to moderate rise of up to 300 mm in the existing ground level around the tree,

(b) Construct a dry well and soil aeration system as shown in Drawing No. TP007 in Annex 1 or similar measures as agreed by the Engineer to accommodate major rise of more than 300mm in the existing ground level around the tree,

(c) Before commencing implementation of the measures to accommodate raising the ground level pursuant to sub-clause (3)(a) or (b) of this Clause, the Contractor shall submit method statements, including the necessary engineering design, construction details, and associated precautionary works for the measures for the Engineer's approval, and

(d) Commence implementation of the measures only after the Engineer's approval to the method statements has been given.

Protection of preserved trees from excavation

AN1.5.04

(1) Without the Engineer's prior approval, the Contractor shall not carry out any excavation within the tree protection zones of the preserved trees unless the Contract explicitly requires such excavation work to be carried out. For the approved excavation work within

including trenching

the tree protection zones, the Contractor shall comply with the following requirements:

(a) Obtain agreement from the Engineer about the detailed locations and extent of the excavations before commencing any excavation work,

(b) Carry out the following work before commencing any cutting work to the aerial roots or underground roots of the preserved trees:

(i) Determine the locations of the major roots and the bulk of their absorbing roots so as to keep the cutting of tree roots to a minimum and to preserve the tap roots, sinker roots and support roots of the trees in any circumstances,

(ii) Obtain agreement from the Engineer about the extent of root cutting on the Site, and

(iii) Where the stability of the trees is likely to be jeopardised, comply with the requirements stipulated in Clause AN1.5.06.

(c) Submit to the Engineer photographic records showing the condition of the affected trees and the agreed extent of excavations and root cuttings as marked on the Site before commencing the excavation work and root-cutting work and thereafter submit photographic records showing the condition of the affected trees and the progress of the excavation work and root-cutting work at weekly intervals until backfilling of the excavation is complete,

(d) Excavate the trench on the paved side of the tree if one exists

(e) Tunnel the service in the following manner and as shown in Drawing No. TP008 in Annex 1 close to the tree trunk on one side:

(i) excavate a trench as narrow as possible directly towards the tree along a radius to not closer than 1.0 m from the trunk or where roots larger than 25 mm in diameter are encountered, whichever distance is farther away from the trunk,

(ii) tunnel straight beneath the tree at a depth of not less than 750 mm and in a way to avoid damaging any tap root, sinker roots or support roots,

(iii) exit on the opposite side along another radius, and

(iv) sleeve the service where it passes beneath the tree to reduce the risk of damage to the service and facilitate future servicing and repair,

(f) Pile the excavated materials outside the tree protection zones to reduce soil compaction,

(g) Carry out the excavation work carefully so as not to damage the bark and root collars of the preserved trees,

(h) Maintain balanced moisture content in the trees and in the soil after backfilling of the excavation, by carrying out necessary precautionary measures such as crown thinning, watering and mulching, and

(i) Move the temporary protection fencing stipulated in Clause AN1.5.02 to the edge of the intended excavation area, between the excavation area and the rest of the tree protection zone, during the duration of excavation work, and move back the same to its original location after backfilling.

(2) The Contractor shall take the following precautions when carrying out excavation that involves cutting of the roots of the preserved trees:

(a) Excavation shall be carried out using only hand-held tools such as hoe and spade, but not mechanical diggers or bulldozers in any circumstances,

(b) Whenever roots are encountered and before root cutting is carried out, soil shall be carefully forked away from the roots using hand-held tools up to the edge along which root cutting is required,

(c) Root cutting shall be carried out carefully using sterilised hand-held pruning tools, and roots greater than 25mm in diameter shall be pruned carefully so as not to result in shattered and frayed roots,

(d) Any roots damaged during excavation shall be cut back cleanly with sharp tools to undamaged tissue and treated with an approved fungicidal dressing before backfilling,

(e) All cut and exposed roots shall be prevented from drying out during excavation by adopting the following measures until backfilling, unless otherwise agreed by the Engineer:

(i) Wrap the tap roots, sinker roots, support roots, and roots with diameter exceeding 50mm with hessian, straw or other porous, absorbent fabric once they are exposed,

(ii) Hang thick hessian or other porous, absorbent fabric from top of the cut surface over the exposed roots and soil immediately after root cutting, and

(iii) Mist the hessian or fabric in a frequency that keeps the roots and the soil at the cut surface moist all the time,

(f) The hessian, straw or other porous, absorbent fabric stipulated in sub-clause (2)(e)(i) of this Clause and the hessian or fabric stipulated in sub-clause (2)(e)(ii) of this Clause shall be removed immediately before backfilling, and

(g) Excavations shall be backfilled with soil mix incorporated with slow release fertiliser at a rate of 500g/m3 or at a rate as directed by the Engineer to a level equivalent to the original soil level at the root collar after settlement.

Protection of preserved trees from drilling — AN1.5.05

(1) Without the Engineer's prior approval, the Contractor shall not carry out drilling, such as soil nailing and drilling for bore holes, rock bolts or dowels, within the tree protection zones of the preserved trees unless the Contract explicitly requires such drilling work within the tree protection zones. For the approved drilling work within the tree protection zones, the Contractor shall comply with the following requirements:

(a) Obtain agreement from the Engineer about the detailed locations and extent of the drill holes before commencing any drilling work. The Contractor should bear in mind that the drill holes shall be located in such a way that the structures to be placed into the drill holes, including the surface elements of the structures such as soil nail heads, are at a minimum distance of 500mm from the trunks of the preserved trees unless otherwise agreed by the Engineer in exceptional circumstances, and

(b) Carry out the following before commencing any cutting work to the aerial roots or underground roots of the preserved trees:

(i) Determine the locations of their major roots and the bulk of their absorbing roots so as to keep the cutting of tree roots to a minimum and to preserve the tap roots, sinker roots and support roots of the trees in any circumstances,

(ii) Obtain agreement from the Engineer about the extent of root cutting on the Site,

(iii) Where the stability of the trees is likely to be jeopardised, comply with the requirements stipulated in Clause AN1.5.06,

(c) Carry out the drilling work carefully so as not to damage the branches, foliage, trunk, bark and root collars of the preserved trees when gaining access for, supporting, mobilising, positioning and operating the drilling rig, and

(d) Maintain balanced moisture content in the trees and in the soil after the drilling work, by carrying out necessary precautionary measures such as crown thinning, watering and mulching. Crown thinning shall be by prior approval from the Engineer.

(2) The Contractor shall take the following precautions when carrying out drilling work that involves cutting of the roots of the preserved trees:

(a) Drilling work and root cutting work shall be carried out carefully,

(b) Roots greater than 25mm in diameter shall be pruned carefully in order to prevent shattered and frayed roots, and

(c) Any roots damaged during drilling shall be cut back cleanly with sharp tools to undamaged tissue and treated with an approved fungicidal dressing.

Protection of preserved trees from instability AN1.5.06

(1) Where the Works involve cutting of any major roots or other major parts of the preserved trees or any other works that may jeopardise the stability of the preserved trees, the Contractor shall install all necessary physical support measures that will ensure the stability of the preserved trees. The Contractor shall pay particular attention to the preserved trees growing on retaining structures in order to prevent the trees from being dislodged from its position as a result of inadequate support.

(2) The physical support measures for the preserved trees shall be installed securely before commencing root cutting, tree pruning or any other works that may affect the stability of the trees. Before commencing installation of these measures, the Contractor shall submit the method statements of these measures to the Engineer for approval. The Contractor shall commence installation of the support measures only after the Engineer's approval to the method statements has been given.

(3) The physical support for the preserved trees shall be securely founded in footings independent of existing walls or building structures or in other supporting systems as appropriate, without interfering with other works, other existing features, and the preserved trees. Where the affected tree is growing on a retaining structure, the Contractor shall make a detailed assessment to estimate the weight of the tree and identify the best position of supporting the tree in relation to its overall spread and centre of gravity. The method statements of the support measures designed by the Contractor in respect of the trees growing on retaining structures shall include the following information:

(a) Details of the form of construction for the support measures to demonstrate the bearing capacity of each element,

(b) Details of the foundation of the support measures to demonstrate that the support measures shall not interfere with other works, other existing features, and the preserved trees and shall not affect the stability of the retaining structure,

(c) Means of securing the tree to the supporting measures, including how cups and ties are adjusted to the form of the tree, and

(d) Method of fabrication and erection on the Site.

(4) The Contractor shall remove the physical support for the preserved trees from the Site upon completion of the Works, or earlier if so directed by the Engineer. The Contractor shall not remove or relocate the physical support for the trees without the Engineer's prior agreement. The Contractor shall ensure the true is stable before removing or relocating the physical support for the trees.

Pruning of preserved trees AN1.5.07

(1) The Contractor shall not carry out pruning to the preserved trees unless the pruning work is required under the Contract or is directed by the Engineer. The Contractor shall notify the Engineer of any preserved trees whose branches interfere with the Works and thus require pruning. Pruning shall only commence after the Engineer's approval has been obtained. The Contractor shall carry out the approved pruning work during the site clearance stage unless otherwise instructed or agreed by the Engineer.

(2) The Contractor shall comply with the requirements in Clause AN2.9.10 when carrying out the pruning work.

Control of pest and disease for preserved trees AN1.5.08

(1) The Contractor shall take all necessary precautionary measures to protect the preserved trees from pest and disease attack and all necessary control measures to eradicate pest and disease from the infected trees in the execution of the Works. The Contractor shall regularly check for any pest and disease attack particularly during known periods of activity and shall report to the Engineer on any such occurrence.

(2) Before commencing application of the pest and disease control measures, the Contractor shall submit the method statements of the control measures to the Engineer for approval. The Contractor shall commence application of the control measures only after obtaining the Engineer's approval for the method statements.

(3) The method statements for the pest and disease control measures shall cover, amongst other aspects as required by the Engineer, the pesticide, insecticide or fungicide to be used and any other necessary associated arboricultural work to the infected areas.

(4) The Contractor shall comply with the requirements in Clause AN2.9.14 in applying the pest and disease control measures.

AN1.6 REPAIR OF DAMAGE

Repair of damage to preserved trees and other affected plants AN1.6.01

(1) The Contractor shall carry out all necessary work of repair of any damage to the preserved trees and any other plants affected. All necessary work of repair of damage shall be carried out at the Contractor's own costs if the necessity for such work is, in the opinion of the Engineer, due to negligence or failure on the part of the Contractor to comply with any obligation expressed or implied on the Contractor's part under the Contract.

(2) The work of repair of damage as referred to in sub-clause (1) of this Clause shall include the following:

(a) All necessary arboricultural work to the preserved trees and any other plants damaged, which may include:

(i) Tree surgery work to remove dead, damaged, diseased or hazardous parts, to repair wounds, or to provide cables or braces for additional support,

(ii) Watering and/or mulching in case of water deficiency,

(iii) Applying appropriate fertilizers in case of nutrient deficiency, and

(iv) Applying appropriate pest and disease control measures in case of pest and disease attack;

(b) The replacement planting pursuant to sub-clause (7)(b) of this Clause for the trees and any other plants damaged to an extent as described in sub-clause (6) of this

Clause and the subsequent Establishment Works for the new plants for 1 year, when instructed by the Engineer, and

(c) Any other reinstatement work necessary to bring the damaged plants to their original condition before occurrence of the damage, as directed by the Engineer.

(3) The Contractor shall notify the Engineer of any damage to the preserved trees and other affected plants within the same day of the occurrence of damage and shall submit to the Engineer within 3 days of the occurrence of damage, a report comprising the following information in a format agreed by Engineer:

(a) The timing of the damage,

(b) The nature and extent of the damage,

(c) Photographic records of the damage,

(d) The proposed work of repair of the damage, and

(e) The proposed protection measures to avoid recurrence of similar incident.

(4) When directed by the Engineer, the Contractor shall firm up and secure all dislodged trees and any other dislodged plants and shall treat all wounds of the damaged trees/plants within 3 days of the occurrence of the damage.

(5) Save as stated in sub-clause (4) of this Clause, the Contractor shall not carry out any work of repair of the damage before the Engineer's acceptance of the report as required in sub-clause (3) of this Clause.

(6) The Contractor shall provide replacement planting of the damaged trees and any other affected plants under the following circumstances

:

(a) In the opinion of the Engineer the damaged trees or other affected plants are dead,

(b) In the opinion of the Engineer, the trees/plants have been substantially damaged, resulting in one or more of the following conditions:

(i) That imminent death of the trees or other affected plants within the coming growing season is predicted,

(ii) That the structural integrity of the damaged trees or other affected plants is permanently compromised and consequently the trees or other affected plants become an irreparable public hazard,

(iii) That any major parts of the damaged trees or other affected plants have been lost and consequently their form, habit and balance have been grossly altered so that their function cannot be reasonably recovered or the trees or other affected plants are causing harm to other preserved trees.

(7) When instructed by the Engineer, the Contractor shall carry out the following work:

(a) Removal of the damaged trees or other affected plants for which replacement planting as sub-clause (6) of this Clause is required, in accordance with the following requirements:

(i) For the removal of the damaged trees, the Contractor shall prepare and submit to Government, and obtain Government approval of, a Tree Removal Application in accordance with the relevant Government Technical Circular(s)

(ii) The Contractor shall fell the damaged trees only after the Engineer's approval to the tree felling, which shall normally be given only after the Tree Removal Application has been approved by the Government approving authority, and

(iii) The Contractor shall remove the damaged plants from the Site, and

(b) Unless otherwise agreed by the Engineer, replacement planting of new plants in accordance with the following requirements:

(i) The Contractor shall complete the replacement planting within 28 days of the Engineer's instruction or other time duration as agreed by the Engineer, and

(ii) For replacement planting, the Contractor shall plant new plants of the same species and of similar size and form as the damaged plants before the damage or provide other alternative replacement planting as agreed by the Engineer.

AN2 LANDSCAPE SOFTWORKS

AN2.1 GENERAL

General requirements AN2.1.01 (1) This Section takes precedence over any other landscape softworks specification contained within any other General Specification referenced in the Contract.

(2) The works and materials specified in Clauses AN2.1.03 to AN2.1.07 shall comply with the sections stated, unless otherwise stated in this Section.

Specialist Contractor AN2.1.02 If the Contractor is not included in the "List of Approved Suppliers of Materials and Specialist Contractors for Public Works" under the category of "Landscaping: Class I - General Landscape Work", he shall enter into a written sub-contract with a specialist contractor to carry out the landscape softworks.

Site clearance AN2.1.03 Site clearance shall comply with PS Section AN1. During site clearance, where appropriate and as required by the Engineer, existing soil shall be stripped and stockpiled by a method agreed by the Engineer and in an area designated or agreed by the Engineer.

Tree Protection AN2.1.04 All clearance of existing vegetation, tree felling, pruning, transplanting and new planting shall be undertaken by a specialist landscape contractor in accordance with PS Section AN1. In addition to the general requirements of the Contract the Contractor shall demonstrate that the proposed specialist landscape sub-contractor has sufficient experience and skilled labour to undertake the tree work specified.

Nursery Works AN2.1.05 Nursery Works shall comply with PS Section AN3.

Drainage Works AN2.1.06 Drainage Works shall comply with M&W Specification Section 5.

Earthworks AN2.1.07 Earthworks shall comply with M&W Specification Section 6.

Planting Season AN2.1.08 Unless otherwise permitted by the Engineer, planting shall be carried out between 1st April and 30th September except as stated in Clause AN2.1.09. If planting is permitted at other times, particulars of changes to the materials and methods for planting shall be submitted to the Engineer for approval.

Weather and ground conditions AN2.1.09 (1) Soiling, cultivation, planting and other similar landscape softworks and establishment works operations shall not be carried out at times when weather or ground conditions may in the opinion of the Engineer adversely affect the permanent works. Ideally planting shall take place in overcast or moist conditions, but not in weather conditions which will result in initial drying out of root systems and/or scorching of leaves. If planting has to be carried out in hot sun or drying winds, plants awaiting planting shall at all times be shaded to prevent drying out.

(2) The Contractor shall cease the soiling, cultivation, planting and other similar landscape softworks and establishment works operations immediately when in the opinion of the Engineer the weather or ground conditions may adversely affect the permanent works.

Reference Standards AN2.1.10 The latest editions of the following reference standards are applicable:

(a) BS 3936 – Part 1 : Nursery Stock, Tree and Shrubs;

(b) BS 3998 : Recommendations for Tree Work

(c) BS 4428 : General Landscape Operations.

(d) BS 4043:1989 : Transplanting

(e) BS 5837 : Guide for trees in relation to construction

(f) American National Standards Institute ANSI Z60.1- American Standard for Nursery – Stock.

(g) "General Guidelines on Tree Pruning" issued by Development Bureau,

(h) "Arborists' Certification Study Guide" and "Best Management Practices - Tree Pruning" issued by International Society of Arboriculture.

Environmental Sustainability AN2.1.11 The use of organic, eco-friendly and environmentally sustainable products for the soft landscape works shall be incorporated.

Integrated Pest Management AN2.1.12 An Integrated Pest Management strategy that minimizes the use and dependence on chemicals shall be operated.

Use of inorganic chemicals AN2.1.13 Inorganic chemicals shall not be used for landscape softworks and establishment works unless approved by the Engineer. Inorganic chemicals shall be used, stored, mixed and applied in accordance with the manufacturer's recommendations. Containers for inorganic chemicals shall be disposed of off Site by methods agreed by the Engineer.

AN2.2 GLOSSARY

Landscape softworks AN2.2.01 Landscape softworks are all works of a horticultural nature, and shall include the placing, cultivation and preparation of soil-mix and subsoil layers, and the supply and planting of trees, shrubs and other plant material, and any work essentially associated with these.

Landscape hardworks AN2.2.02 Landscape hardworks are the tree grilles, tree guards and tree rings and any other items stated as such in the Contract and described in General Specification.

Establishment works AN2.2.03 Establishment works are the regular inspections, cultivation, watering, fertilizing and other operations specified to be performed during the period stated in the Contract for such inspections and operations.

AN2.3 SUBMISSIONS

Contractor's Programme AN2.3.01 The Contractor's Detailed Programme of soft landscaping works execution and completion shall be submitted to the Engineer for approval within 4 weeks of the commencement of the contract.

Method Statement AN2.3.02 The Contractor's Detailed Method Statement of soft landscaping works execution and completion shall be submitted to the Engineer for approval at least 4 weeks before the commencement of the relevant soft landscape works.

Shop Drawings AN2.3.03 The Contractor's Shop drawings of planting plans and details of installation shall be submitted to the Engineer for approval at least 4 weeks before the commencement of the relevant soft landscape works.

Particulars of materials AN2.3.04 (1) The following particulars of the proposed materials for landscape softworks and establishment works shall be submitted to the Engineer for approval:

(a) Origin of trees, shrubs, turfs, sprigs and other plant materials,

(b) Details of supplying nurseries or other plant sources,

(c) Source of water for irrigation.

(d) Sources of completed decomposed granite, imported subsoil, topsoil and soil conditioner.

(e) A certificate of analysis for completely decomposed granite including details of the composition and results of tests for the characteristics specified in Clause AN2.4.34

(f) A certificate of analysis for topsoil including details of the composition and results of tests for the characteristics specified in Clause AN2.4.36

(g) A certificate of analysis for soil-mix including details of the composition and results of tests for the characteristics specified in Clause AN2.4.37

(h) A certificate of analysis for soil conditioner including details of the composition and results of tests for the properties stipulated for compliance in Clause AN2 4.36 and the following properties,

(i) Organic carbon content (using loss of ignition 'Ashing' Method of testing); and

(ii) Nitrogen content (using 'Kjeldahl' Method),

(2) The particulars shall be submitted to the Engineer at least 2 weeks before the relevant work starts.

(3) The Contractor shall not deliver the relevant materials to the Site, unless the written approval of the Engineer for the particulars referred to in sub-clause (1) of this Clause is obtained.

Samples of materials — AN2.3.05

(1) Samples of the following proposed materials shall be submitted to the Engineer for approval at the same time as particulars of the material are submitted and before confirming orders, and delivery to and use on the Site:

(a) 0.5kg sample of each seed mixture,

(b) A sample of 5 turfs (each turf 300mm x 300mm with a minimum thickness of 50mm),

(c) A sample of 10 sprig individuals of each grass species,

(d) 0.027m^3 of completely decomposed granite.

(e) 0.027m^3 of imported subsoil.

(f) 0.027m^3 of topsoil.

(g) 0.027m^3 sample of soil conditioner,

(h) 0.027m^3 sample of each soil-mix,

(i) 0.027m^3 sample of each mulch,

(j) 0.5kg sample of each fertilizer,

(k) A sample of tree stake,

(l) A sample of tree tie,

(m) A sample of tree guy,

(n) A sample of tree guying stake,

(o) A sample of underground tree guy anchor.

(p) A sample of tree guy cover.

(q) 0.5kg sample of water absorbing soil additive.

(r) A sample of root barrier.

(s) A sample of salt barrier.

(t) A sample of each planter drainage and planter liner component.

(u) 0.5kg sample of sand.

(v) 5kg sample of lime.

(2) Samples of materials for landscape works and establishment works may be inspected by the Engineer at nurseries and other sources before the materials are delivered to the Site.

As Built Drawings — AN2.3.06

As Built Drawings showing all completed works (or completed section of the works) shall be submitted to the Engineer for approval within 4 weeks of the practical completion of the works (or completed section of the works).

Operation and Maintenance Manual — AN2.3.07

An Operation and Maintenance Manual for all completed works (or completed section of the works) shall be submitted to the Engineer for approval within 4 weeks of the practical completion of the works (or completed section of the works).

AN2.4 MATERIALS

Seedling trees — AN2.4.01

Seedling trees shall have the following characteristics:

(a) Aged between 1 and 2 years,

(b) A single slender stem,

(c) A well developed vigorous root system,

(d) Total height above soil level of at least 150mm but not exceeding 900 mm,

(e) Grown and supplied in a container at least 75mm in diameter and 150mm deep, or a tube at least 60mm in diameter and 150mm long, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Whip trees — AN2.4.02

Whip trees shall have the following characteristics:

(a) Aged between 2 and 3 years,

(b) A single central stem well furnished with side branches according to species,

(c) A well developed vigorous root system,

(d) Total height above soil level exceeding 900mm but not exceeding 2000mm,

(e) Grown and supplied in a container at least 125mm in diameter and 200mm deep, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Light standard trees — AN2.4.03

Light standard trees shall have the following characteristics:

(a) A sturdy straight stem at least 1500mm high from the root collar to the lowest branch,

(b) Stem diameter of at least 25mm but not exceeding 45mm measured at a height of 1 m from the root collar,

(c) According to species, either a well balanced branching head or a well defined straight and upright leader with branches growing out from the stem with reasonable symmetry,

(d) Total height above the root collar exceeding 2000mm but not exceeding 3000mm,

(e) A rootball at least 300mm in diameter and 300mm deep,

(f) When container-grown trees are required, grown in a container at least 350mm in diameter and 400mm deep, and

(g) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Standard trees AN2.4.04 Standard trees shall have the following characteristics:

(a) A sturdy straight stem at least 1800mm high from the root collar to the lowest branch,

(b) Stem diameter exceeding 45mm but not exceeding 75mm measured at a height of 1m from the root collar,

(c) According to species, either a well balanced branching head or a well defined straight and upright leader with branches growing out from the stem with reasonable symmetry, and a minimum length of 600mm,

(d) Total height above the root collar exceeding 2750mm but not exceeding 3500mm,

(e) A rootball at least 450mm in diameter and 300mm deep,

(f) When container grown trees are required, grown in a container at least 500mm in diameter and 500mm deep, and

(g) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Heavy standard trees AN2.4.05 Heavy standard trees shall have the following characteristics:

(a) A sturdy straight stem at least 2000mm high from the root collar to the lowest branch,

(b) Stem diameter exceeding 75mm but not exceeding 125mm measured at a height of 1m from the root collar,

(c) According to species, either a well balanced branching head or a well defined straight and upright leader with branches growing out from the stem with reasonable symmetry, and a minimum length of 800mm,

(d) Total height above the root collar exceeding 3500mm but not exceeding 5000mm,

(e) A rootball at least 750mm in diameter and 400mm deep,

(f) When container grown trees are required, grown in a container at least 750mm in diameter and 600mm deep, and

(g) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts / cankers.

Extra Heavy standard trees AN2.4.06 Extra Heavy standard trees shall have the following characteristics:

(a) A sturdy straight stem at least 2000mm high from the root collar to the lowest branch,

(b) Stem diameter exceeding 125mm but not exceeding 175mm measured at a height of 1m from the root collar,

(c) According to species, either a well balanced branching head or a well defined straight and upright leader with branches growing out from the stem with reasonable symmetry, and a minimum length of 1200mm,

(d) Total height above the root collar exceeding 5000mm but not exceeding 6500mm,

(e) A rootball at least 1000mm in diameter and 500mm deep,

(f) When container grown trees are required, grown in a container at least 750mm in diameter and 600mm deep, and

(g) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Semi-mature trees AN2.4.07 Semi-mature trees shall have all the following characteristics:

(a) A sturdy straight stem at least 2200mm high from the root collar to the lowest branch,

(b) Stem diameter exceeding 175mm measured at a height of 1m from the root collar,

(c) According to species, either a well balanced branching head or a well defined straight and upright leader with branches growing out from the stem with reasonable symmetry, and a minimum length of 1500mm,

(d) Total height above the root collar exceeding 6500mm,

(e) A rootball at least 1500mm in diameter and 600mm deep,

(f) A root system previously undercut a minimum of one year before lifting, to encourage compact fibrous growth, and

(g) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Small shrubs AN2.4.08 Small shrubs shall have the following characteristics:

(a) A minimum of three vigorous, one-year old shoots with a well balanced shape and bushy habit,

(b) A well developed, vigorous root system,

(c) Total height above soil level at least 300mm but not exceeding 600mm,

(d) Grown and supplied in a container at least 125mm in diameter and 150mm deep, and

(e) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Large shrubs AN2.4.09 Large shrubs shall have the following characteristics:

(a) A minimum of five vigorous, one-year old shoots, with a well balanced shape and bushy habit to produce a diameter 2/3 of the height,

(b) A well developed, vigorous root system,

(c) Total height above soil level exceeding 600mm,

(d) Grown and supplied in a container at least 200mm in diameter and 250mm deep, and

(e) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Conifers AN2.4.10 Conifers shall have the following characteristics:

(a) A well developed, upright stem well furnished with vigorous leaf or needle bearing side shoots with good symmetry,

(b) A well developed, vigorous root system,

(c) For small conifers, total height above the root collar at least 1500 mm but not exceeding 2500mm,

(d) For large conifers, total height exceeding 2500mm but not exceeding 3500mm,

(e) Grown and supplied in a container at least 350mm in diameter and 400mm deep for small conifers and at least 500mm in diameter and 500mm deep for large conifers, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Palms AN2.4.11 Palms shall have the following characteristics:

(a) A well developed, upright habit and vigorous fronds with good symmetry,

(b) A well developed, vigorous root system,

(c) For small palms, a minimum height from soil level to the base of the lowest frond as stated in the Contract and a rootball at least 300mm in diameter and 300mm deep, and

(d) For medium palms, a minimum height from soil level to the base of the lowest frond as stated in the Contract and a rootball at least 500mm in diameter and 450mm deep.

(e) For large palms, a minimum height from soil level to the base of the lowest frond as stated in the Contract and a rootball at least 700mm in diameter and 600mm deep, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Multi-stem Palms AN2.4.12 Palms shall have the following characteristics:

(a) A well developed, upright habit and vigorous fronds with good symmetry,

(b) A well developed, vigorous root system,

(c) A minimum of five stems each with a clear trunk height of 1.5m from the root collar to the base of the leaf sheath. There shall be at least three fronds on each stem and evidence of one new growing shoot per stem. An overall height above ground as specified in the drawings.

(d) A rootball at least 500mm in diameter and 500mm deep, and

(e) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Heavy Palms AN2.4.13 Heavy Palms shall have the following characteristics:

(a) A well developed, upright habit and vigorous fronds with good symmetry,

(b) A well developed, vigorous root system,

(c) No less than 7 fronds,

(d) A sturdy straight stem not less than 3000mm in trunk height from soil level to the base of the crown shaft. An overall height as specified in the Plant Schedule or drawing,

(e) A rootball not less than 800mm in diameter and 600mm deep, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Semi-Mature Palms AN2.4.14 Semi-mature Palms shall have the following characteristics:

(a) A well developed, upright habit and vigorous fronds with good symmetry,

(b) A well developed, vigorous root system,

(c) No less than 10 fronds,

(d) A sturdy straight stem not less than 5000mm in trunk height from soil level to the base of the crown shaft. An overall height as specified in the Plant Schedule or drawing.

(e) A rootball not less than 1000mm in diameter and 800mm deep, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Uniformity of trees and palms AN2.4.15 (1) The Contractor shall ensure that individual specimens of each species of trees and palms used for avenue planting are uniform in size and shape. Variations in overall height of no more than 500mm, and in stem diameter of no more than 20mm will be permitted, within the specified tree sizes.

(2) The Contractor shall ensure that any replacement of trees or palms required in these areas at a later date will allow for additional growth the planted trees have made and shall still meet the variation tolerances stated above.

Bamboos AN2.4.16 Bamboos shall have the following characteristics:

(a) A well developed, vigorous root system, with a healthy rhizome capable of shooting fresh culm,

(b) For diffuse clump species, a single stem with total height above soil level not less than the size stated in the schedule.

(c) For unicaepitose and pluricaespitose species, a clump of at least five stems with total height above soil level not less than the size stated in the schedule,.

(d) Grown and supplied in container at least 450mm in diameter and 450mm deep, and

(e) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Herbaceous plants AN2.4.17 Herbaceous plants shall have the following characteristics:

(a) A minimum of four well developed, vigorous shoots,

(b) A well developed, vigorous root system,

(c) Total height above soil level or diameter of plant for clumps not less than the height or diameter stated in the Contract,

(d) Healthy well developed bulbs, corms, rhizomes or tubers,

(e) Grown and supplied in a container at least 125mm in diameter and 150mm deep, and

(f) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Ground covers AN2.4.18 Ground cover plants shall have the following characteristics:-

(a) A minimum of four well developed, vigorous shoots,

(b) A well developed, vigorous root system,

(c) Total height above soil level at least 150mm,

(d) Grown and supplied in a container at least 125mm in diameter and 150mm deep, and

(e) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Climbers AN2.4.19 Climbers shall have all the following characteristics: -

(a) A minimum of four vigorous, one-year old shoots at least 600mm long unless otherwise specified,

(b) A well developed, vigorous root system,

(c) Grown and supplied in a container at least 125mm in diameter and 150mm deep, and

(d) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Aquatic Plants AN2.4.20 Aquatic Plants shall have all the following characteristics: -

(a) Vigorous well developed main stems and healthy foliage,

(b) Pot grown in humus rich compost, and

(c) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Hedging Plants AN2.4.21 Hedging Plants shall have all the following characteristics: -

(a) A seedling or rooted cutting which has been undercut and transplanted or container grown,

(b) Good symmetry and bushiness encouraged by pruning,

(c) Vigorous lateral shoots starting no more than 100mm above the root collar,

(d) Total height above soil level at least 450mm or not less than the height stated in the Plant Schedule or drawings, and

(e) Free of any pest, non-symbiotic fungi, disease, rubbing branches, inwardly growing branches, bark tears/abrasion and tie cuts/cankers.

Bulbs AN2.4.22 Bulbs shall have all the following characteristics: -

(a) Plump and firm to touch,

(b) Sufficient nutrient reserves to ensure healthy growth and flowering, and

(c) Free of any pest, non-symbiotic fungi and disease.

Containerised plants AN2.4.23 Containerised plants shall be grown in open ground and then lifted and placed in a rigid or semi-rigid container of dark colour; plants shall be left to grow in the containers for at least 3 months before being delivered to the Site. The dimensions of containers shall not be less than the relevant rootball or container dimensions stated in Clauses AN2.4.01 to AN2.4.21. Containerised plants shall be well watered before despatch from the nursery and shall remain in the containers until required for planting.

Turf AN2.4.24 (1) Turf shall possess the following characteristics:-

(a) Free of sticky clay, weeds, impurities, pests, non-symbiotic fungi and disease with grass of even density, green colour and capable of healthy growth;

(b) With a sufficiently fibrous root system to hold together during handling;

(c) Size of 300mm x 300mm with a minimum thickness of 50mm and with an even thickness of grass sward and soil thickness.

(2) Turf species shall be one of the following species unless otherwise specified:

(a) Axonopus compressus

(b) Cynodon dactylon

(c) Paspalum vaginatum ‘Salam’

(d) Zoysia japonica

(e) Zoysia matrella

Sprigs AN2.4.25 (1) Sprigs shall be at least 100mm long and shall be free of pests, non-symbiotic fungi and disease.

(2) Sprigs shall be one of the following species unless otherwise specified:

(a) Axonopus compressus

(b) Cynodon dactylon

(c) Paspalum vaginatum ‘Salam’

(d) Zoysia japonica

(e) Zoysia matrella

Grass Seed AN2.4.26 (1) All seed shall be covered by an appropriately numbered seed analysis report or certificate. The date of testing as stated in the report or certificate shall be not more than one year before the date of use of the seeds. The numbered reports or certificates shall always refer to the number on the seed containers. The origin of all seed and the name of the supplier shall be stated on the seed containers.

(2) The quality of grass seed shall be gauged by purity, germination percentage and freedom from weeds. The total weed seed content shall not exceed 0.5% by mass and the total content of other crop seed shall not exceed 1% by mass. The germination capacity of each constituent of the mixture over a seven-day test period shall not be less than 80%, and the purity of the mixture shall not be less than 90%.

(3) The basic minimum grass seed mix for hydroseeding shall be as follows, unless otherwise specified: -

(a) Between April and August inclusive, the minimum spreading rate shall be 25g/sq.m. The mix proportions shall lie within the following limits:

Cynodon dactylon	13-15 g / sq.m.
Paspalum notatum	8-10 g / sq.m.
Other species from list below:	1-4 g / sq.m.
- *Chloris gayana*	

- *Eragrostis curvula* (0.5 g/sq m max.)
- *Eremochloa opihuroides*
- *Cenchius ciliaris*

TOTAL	25 g / sq.m. (minimum)

(b) Between September and March inclusive the minimum spreading rate shall be 30 g/sq.m. and shall consist of:

Cynodon dactylon	15 g / sq.m.
Paspalum notatum	10 g / sq.m.
Lolium perenne	5 g / sq.m.
TOTAL	30 g / sq.m. (minimum)

Grass and Tree Seed Mix AN2.4.27

(1) The hydroseeding mix in this Clause shall not be applied on slopes with gradient steeper than 35 degrees.

(2) All seed shall be covered by an appropriately numbered seed analysis report or certificate. The date of testing as stated in the report or certificate shall be not more than one year before the date of use of the seeds. The numbered reports or certificates shall always refer to the number on the seed containers. The origin of all seed and the name of the supplier shall be stated on the seed containers.

(3) The quality of seed shall be gauged by purity, germination percentage and freedom from weeds. The total weed seed content shall not exceed 0.5% by mass and the total content of other crop seed shall not exceed 1% by mass. The germination capacity of each constituent of the mixture over a seven-day test period shall not be less than 80%, and the purity of the mixture shall not be less than 90%.

(4) The basic minimum grass and tree seed mix for hydroseeding shall be as follows, unless otherwise specified: -

(a) Between April and August inclusive, the minimum spreading rate shall be 30g/sq.m, comprising 25g/sq.m. of grass seed and 5g/sq.m. of tree seed. The mix proportions shall lie within the following limits:

(i) The basic minimum grass seed component of the mix shall be in accordance with Clause AN2.4.26(3)(a).

(ii) The basic minimum tree seed component of the mix shall contain a minimum of 4 tree species from the list below:

Acacia mangium
Albizia lebbek
Alnus formosana
Cassia siamea
Macaranga tanarius
Mallotus paniculatus
Sapium discolor
Schefflera octophylla

(b) Between September and March inclusive, the minimum spreading rate shall be 35g/sq.m, comprising 30g/sq.m. of grass seed and 5g/sq.m. of tree seed. The mix proportions shall lie within the following limits:

(i) The basic minimum grass seed component of the mix shall be in accordance with sub-clause AN2.4.26(3)(b).

(ii) The basic minimum tree seed component of the mix shall contain a minimum of 4 tree species from the list below:

Acacia mangium
Albizia lebbek
Alnus formosana
Cassia siamea
Macaranga tanarius
Mallotus paniculatus
Sapium discolor
Schefflera octophylla

(5) All tree seeds, except the Acacia species, shall be soaked for 4-8 hours in water at room temperature immediately before mixing with other ingredients of the hydroseeding mix.

(6) Seeds of *Acacia mangium* shall be put into water which is then brought to the boil and then removed immediately. The drained seed shall then be mixed with other ingredients of the hydroseeding mix.

(7) The Contractor shall note that in order to provide the tree seeds as specified it shall be necessary to collect the tree seeds in advance of commencing hydroseeding works on Site.

Plant name AN2.4.28

In the event that botanical name, English common name and Chinese common name are given for any plant specified, the botanical name shall always take precedence.

Plant materials to be as specified AN2.4.29

(1) All plant materials and seeds shall be true to species as specified.

(2) All plant materials shall exhibit the habit of growth as specified and shall not be less than the minimum size specified in this Section or the Plant Schedule or the Drawings.

Plant materials and seeds to be free of pest AN2.4.30

All plant materials shall be healthy, and free of pests, disease, disease-causing fungi, parasites, discolouration and mechanical damage.

Source of plant materials AN2.4.31

(1) The Contractor shall obtain all plant materials from a recognised cultivated source and not from the wild. Native plants that are not commercially available may be propagated from seeds collected in the wild without damaging the wild plants.

(2) In exceptional circumstances plants may be transplanted from sites where existing plants have to be removed to make way for development. Prior written approval of the Engineer must be obtained before any plants are sourced in this manner.

(3) The Contractor shall state the source of all plant materials, in good time before planting so that the Engineer may inspect the nursery and agree on a selection of all plant materials for approval. All plant materials subsequently delivered to the Site shall be to at least the same standard in all respects as that approved. The Contractor shall note that in order to provide all the plant materials as specified it may be necessary for him to grow the materials in his own nursery in advance of commencing planting works on the Site.

Substitution of AN2.4.32

(1) In the event of plant material as specified herein not being available due to special

Plant Material

circumstances, the Contractor shall notify the Engineer at the beginning of the Contract in order that suitable substitutes can be considered. The Contractor shall propose substitutes which are similar in height, shape, flowering characteristics and function as the original species.

(2) The Contractor shall have photographs taken of approved samples for each species and plant size to be used. The photographs shall be used as a standard to which similar species to be supplied and planted in the Contract shall be equivalent.

(3) Any changes, such as planting densities, as necessitated by the need for substituting plant species requested by the Contractor shall be carried out at no extra cost to the Contract.

(4) No substitution of plants shall be made without the prior written approval of the Engineer.

Depth of rootballs or containers of plant materials AN2.4.33

Soil above the root collar shall not be included in the rootball or container depth measurement. If the resulting depth measurement of the rootball or containers does not meet the specified minimum, the plant material can be rejected.

Completely Decomposed Granite AN2.4.34

Completely Decomposed Granite (CDG) shall have the following characteristics:

(a) Free from grass or weed growth, sticky clay, salt, chemical contamination, and any other deleterious materials and stones exceeding 25mm in diameter in any dimension,

(b) Original rock texture preserved,

(c) Can be crumbled by hand and finger pressure into constituent grains,

(d) Easily indented by point of geological pick,

(e) Slakes in water,

(f) Completely discoloured compared with fresh rock, Yellowish brown to reddish brown in colour,

(g) Feldspars powdery to soft,

(h) Hand penetrometer shear strength index <250 kPa, and

(i) Zero rebound from N Schmidt hammer.

Imported Subsoil AN2.4.35

(1) Imported subsoil shall be evenly textured, good clean material, free from all impurities including pernicious weeds, roots, sticky clays, salt, non-soil material, chemical contamination such as oils and cement, stones exceeding 25mm in any dimension, and any other deleterious materials.

(2) Imported subsoil shall be free of gypsum or any saline deposits.

Topsoil AN2.4.36

Topsoil shall be a fertile, free draining material of sandy loam character taken from the top 300mm of land previously supporting vegetation growth but not from recent paddy field cultivation and shall have the following properties:

(a) Free from impurities, grass or weed growth, substances injurious to plants, other foreign matter or contamination and stones exceeding 25mm diameter in any dimension,

(b) Evenly textured,

(c) Dark brown or black colour,

(d) Organic matter not less than 7.5%, and

(e) pH value between 5.5 and 7.0.

Soil-Mix / Lightweight Soil-Mix AN2.4.37

(1) The Contractor shall prepare soil-mix or lightweight soil-mix on Site. Mixing shall not take place during periods of heavy rain, nor when the soil is saturated. Mixing shall cease if the moisture content is too high to achieve even, thorough mixing.

(2) Soil-mix shall consist of friable, completely decomposed granite and soil conditioner in the proportions of 2:1 by volume. Soil-mix shall be free of grass or weed growth, roots, pathogens, sticky clay, salt, chemical contamination, and any other deleterious materials and stones exceeding 25mm diameter in any direction.

(3) Lightweight soil-mix shall consist of friable, completely decomposed granite, expanded clay or vermiculite pellets with a maximum particle size of 5mm and soil conditioner in the proportions of 2:1:1 by volume, and shall have a maximum weight of 1000 kg per m^3. Lightweight soil-mix shall be free of grass or weed growth, sticky clay, salt, chemical contamination, and any other deleterious materials and stones exceeding 25mm diameter in any direction.

(4) Mixing of the soil-mix components should be carried out in the specified proportions, with thorough mixing (manual or mechanical) ensuring an even distribution of the components. Over compaction must be avoided. In the event of over compaction, remediative aeration is required.

(5) Soil-mix / lightweight soil-mix shall possess the following properties:

(a) pH value between 5.5 and 7.0,

(b) Organic matter more than 10%,

(c) Organic carbon content 2.0% to 3.0%,

(d) Nitrogen content 0.09% to 0.15%,

(e) Carbon:Nitrate ratio 25:1 to 45:1,

(f) Extractable phosphorous (P) content 70 mg/kg to 100 mg/kg,

(g) Extractable potassium (K) content 150 mg/kg to 300 mg/kg,

(h) Extractable magnesium (Mg) content more than 80 mg/kg,

(i) Cation Exchange Capacity 16 to 20 m.e. %, and

(j) Soil texture content:

(i) Sand (0.05 - 2.0 mm) in the range 20-75%

(ii) Silt (0.002 – 0.05 mm) in the range 5-60%

(iii) Clay (< 0.002 mm) in the range 0-10%

(6) Soil-mix / lightweight soil-mix delivered and installed on site shall be tested for N.P.K. value, organic matter content, Cation Exchange Capacity ratio, organic carbon, pH value, physical content of sand, silt and clay, and water content. Soil testing shall be arranged by the Contractor and carried out by an approved reputable firm or institute at the contractor's cost, and the report shall be submitted to the Engineer for approval.

(7) Should the results of the soil analysis show that the soil-mix does not meet the nutrient and organic status required for plantings soil mix, then the Contractor shall make good the soil mix by bringing it to the nutrient and organic status specified. The Contractor shall obtain approval for his proposed remedial measures from the Engineer before undertaking any work.

(8) The Contractor shall ensure that planting soil mix heaps are properly maintained and that planting soil mix shall be placed in its final position within 12 months of importation to Site or, for site strip material, deposition for storage on Site. Weed control shall be carried out by spraying with approved weed killer.

(9) If the period between the analysis of the soil mix as above and the commencement of any deposition of soil mix exceeds 12 months then the Contractor shall carry out a second analysis of the soil mix. If this second analysis shows that the soil mix has deteriorated in the nutritional requirements for soil mix the Contractor shall make good the soil mix by bringing it to the nutrient and organic status specified.

(10) The Contractor shall give the Engineer four weeks notice of his intention to commence deposition of soiling operations in order to allow for the results of the analysis to be available before commencing soiling.

(11) No change in the source of soil mix shall be allowed without the prior approval of the Engineer based on such tests and samples as specified herein.

Soil conditioner AN2.4.38

(1) Soil conditioner shall be properly composted organic material and shall be free of weed growth, impurities, foreign materials, contamination and substances injurious to plants. Soil conditioner shall have the following properties:

(a) PH value between 4.0 and 7.0,

(b) Moisture content between 30% and 50%,

(c) Fine and freely flowing consistency,

(d) Stable composition and not liable to further decomposition,

(e) Not capable of raising the temperature of the treated soil more than 5°C above the temperature of the untreated soil,

(f) Not giving off toxic nor obnoxious fumes,

(g) Organic matter content not less than 85% (dry matter), and

(h) Carbon: nitrogen ratio between 20 and 55.

(2) The Contractor shall produce a certificate of analysis stating the composition and physical and chemical characteristics. The analysis shall be carried out by a laboratory approved by the Engineer.

Water absorbing soil additive AN2.4.39

(1) Water absorbing soil additive shall be a proprietary type approved by the Engineer and shall have the following properties:

(a) Capable of absorbing water up to 400 times its weight in de-ionized water and releasing the water later,

(b) Have a quick soil wetting ability and capable of lasting for at least five years with at least 95% of its original storage capacity retained in the first two years,

(c) Physically stable, resisting fast natural degradation processes and not degradable by chemicals,

(d) Compatible with all fertilisers and soil ameliorants and with a neutral pH value,

(e) Environmentally friendly with no short or long term impacts on the environment, non toxic and non-hazardous to any ecosystem, soil organisms, humans, animals and underground water.

(f) Not contain levels of any element above those specified in the rules and regulations of local authorities, particularly heavy metals.

(g) Not hinder plant nutrient uptake or interfere with / affected by application of fertilizers, pesticides or any treatment whether chemical or biological.

(h) Belong to one of the following categories:

(i) Organic co-polymers,

(ii) Acrylamides,

(iii) Acrylic polymers,

(iv) Volcanic ash/Basaltic volcanic parent material,

(v) Amorphous silica or

(vi) Coated silica.

(i) Have a minimum absorption capacity of 75-100 ml water/ gm of material with a minimum of 85-90% available as plant water.

(j) Reduce irrigation water consumption by a minimum of 45%.

(2) Water absorbing soil additive shall be supplied in sealed, water-proof containers and kept dry at all times.

Sand AN2.4.40

(1) Sand shall be a clean, coarse grained and angular material with a minimum 1mm diameter section. It should be well graded, free from soluble salts ranging in size so that 80–100% passes the 3mm sieve and 0–50% passes the 2mm sieve, with 0% passing through a 1mm sieve.

(2) Sand shall be river sand from fresh-water courses or shall be from terrestrial sources. Sand shall not be marine sand or from tidal river sources.

(3) The Contractor shall inform the Engineer of the source of all sand used and shall submit a laboratory report for review by the Engineer to identify its structural composition (as defined in Standard Specification for Civil Works as amended by this Section) as well as identifying the salt content of the Sand. All laboratory testing shall be at the Contractor's own cost.

(4) A 0.5kg sample of Sand shall be submitted to the Engineer for Approval prior to its use in the Works.

Lime AN2.4.41

Ground dolomitic limestone not less than 80% total carbonates, minimum 20% calcium and 10% magnesium. Ranging in size so that 50% passes through the 250 microns sieve and 90% passes through the 1mm sieve. Coarser materials will be acceptable provided the specified rates of application are increased proportionally on the basis of 1 quantities passing the 250 micron sieve.

Peat Moss AN2.4.42

Peat Moss shall not be used as it is not a sustainable resource.

Organic Mulch AN2.4.43

(1) Organic mulch shall be a fully composted, stable, non-toxic organic material comprising shredded bark, wood chips, rice straw, decomposed leaf litter or similar approved, or a combination of these. The mulch shall be free from impurities and be heavy enough to prevent dispersal by wind.

(a) Wood chips shall be of a nominal size of 5mm to 20mm,

(b) Pine tree bark shall be of a nominal length of 60mm to 100mm and a nominal width of 50mm to 70mm,

(c) Any wood content shall be inert and free of resinous toxins and the pH of the Mulch shall be not less than 6.0, and

(d) Composting shall entail that the material is held at 60°C for a period of at least six weeks, kept moist and turned regularly.

(2) The Engineer shall be invited to inspect production techniques and the suppliers' facilities, prior to any approvals.

Inorganic Mulch AN2.4.44 Inorganic mulch shall be granite, limestone or slate based aggregate approved by the Engineer.

Organic Fertilizer AN2.4.45

(1) Organic fertilizer shall be from a source approved by AFCD.

(2) Organic fertilizer shall be fermented, heat treated, odourless, free of noxious weeds, soil or sand, free of any harmful pathogens/nematodes, and free of any toxic heavy metals (lead, mercury, cadmium, etc.).

(3) Organic fertilizer analysis shall have the following chemical properties:

(a) Organic Matter (OM) 40-50%

(b) PH value between 6 and 7

(c) Moisture content up to 25% of its weight

(d) Electrical conductivity (EC) not to exceed 10mmhos/cm

(e) C/N ratio not to exceed 20:1

(f) Sodium chloride not more than 2%

(g) Soluble sodium not more than 0.8%

(4) Organic fertilizer shall be supplied in sealed waterproof bags under shelter away from water and direct sunlight.

(5) Peanut cake or any other substance likely to encourage vermin shall not be used.

Inorganic Fertilizer AN2.4.46

(1) Inorganic fertiliser shall not be used without prior written approval of the Engineer. It is strongly preferred that organic fertilizer is used instead of inorganic fertilizer. However, use of inorganic fertiliser may be accepted by the Engineer if suitable justification from the Contractor is provided.

(2) Inorganic fertilizer shall be chloride free, environmentally friendly, slow release and in the lower PH range.

(3) Inorganic fertilizer shall be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked.

(4) Pre-planting fertilizers shall be slow release granular NPK chemical fertilizer with a minimum four month release period at 32°C with the following formula or an equivalent approved by the Engineer:

(a) 14-18 parts N (Nitrogen)

(b) 7-12 parts P (Phosphorous)

(c) 12-16 parts K (Potassium)

(d) 1-3 parts MgO_2 (Magnesium Oxide) plus other trace

(5) Post-planting fertilizers shall be granular NPK chemical fertilizer with a minimum two week release period at 32°C with the following formula or an equivalent approved by the Engineer:

(a) 14-16 parts N (Nitrogen)

(b) 14-16 parts P (Phosphorous)

(c) 14-16 parts K (Potassium)

(6) Phosphate fertilizer shall be triple superphosphate powder or an equivalent approved by the Engineer.

(7) Inorganic fertilizer shall be supplied in sealed waterproof bags under shelter away from water and direct sunlight.

(8) Peanut cake or any other substance likely to encourage vermin shall not be used.

Hydroseeding Fertiliser AN2.4.47 Hydroseeding fertiliser shall be post-planting fertilizer and applied at a rate of at least 100 g/sq m

Root activator AN2.4.48 Root activator shall be a chemical which can activate root growth and which contains plant hormones at the approved dilution e.g. IAA / IBA / NAA, which shall be approved by the Engineer.

Soil binder AN2.4.49 Soil binder shall be a proprietary type approved by the Engineer and shall consist of a binding medium applied in aqueous suspension by spraying onto the surface of the soil to stabilise and condition the soil. The binding agent shall not be injurious to plant growth.

Sacks, bags, containers etc. AN2.4.50 The Contractor shall retain for inspection by the Engineer all sacks, bags, containers and the like in which fertiliser, mulch, grass-seed, pesticides, herbicides and the like are supplied and shall not dispose of these without the consent of the Engineer. Sacks, bags and containers shall be cleaned and recycled as far as possible, without causing contamination.

Tree stakes and ties AN2.4.51

(1) Metal stakes shall be 40 mm x 40 mm x 4 mm thick galvanized mild steel angle painted with one coat of approved primer and one coat of approved finishing coat before installation. Total length of stake shall be 1800 mm or as specified to suit the height of the plant being supported. All sharp edges of the metal stakes shall be removed to avoid damage to the plant. The primer and finishing coat shall be approved by the Engineer before its application.

(2) Bamboo tripod staking shall comprise three nos. of 50mm diameter x 1800mm long bamboo poles or as specified to suit the height of the plant being supported.

(3) Ties shall be of dark colour and shall be one of the following which shall be capable of adjustment after fixing, and shall be fitted with flexible rubber or plastic sleeves to prevent chafing, rubbing or abrasion of the plant:

(a) 5mm diameter rot-proof rope,

(b) 3mm overall diameter plastic coated wire,

(c) 3mm diameter stainless steel braided wire with 20mm adjustable stainless steel screw clamp.

Tree Wire Guys AN2.4.52

(1) Trees larger than Heavy Standard size shall be tied with wire guys. Three guys per tree shall be used and guys shall be adjustable. Guys shall be of dark colour and shall be fitted with a flexible rubber or plastic sleeve to prevent chafing, rubbing or abrasion of the plant, and a 100mm long stainless steel turnbuckle for adjustment. Guys shall be one of the following:

(a) 8 mm diameter rot-proof rope,

(b) 4 mm overall diameter plastic coated wire,

(c) 4mm to 6mm diameter stainless steel braided wire with 20mm adjustable stainless steel screw clamp.

(2) Guying stakes shall be 25mm x 25mm x 5mm thick galvanized mild steel angle with 5mm to 10mm diameter hole drilled 30mm from the top before galvanizing, painted with one coat of approved primer and one coat of approved finishing coat before installation. The primer and finishing coat shall be approved by the Engineer before its application.

Underground Guying — AN2.4.53

(1) Trees larger than Heavy Standard size with large rootballs may be secured using underground wire guys tied to secure underground anchors. Underground guying may be appropriate for large trees in locations where stakes and guys may cause hazard to pedestrians.

(2) Underground wire guys shall be 4mm to 6mm diameter stainless steel braided wire with 20mm adjustable stainless steel screw clamp.

(3) Anchors may be timber railway sleepers, heavy concrete slabs or metal pieces as approved by the Engineer.

(4) Sturdy protective timber slats shall be provided to sit on the surface of the rootball, to spread the pressure imposed by the guys evenly over the whole rootball surface and to protect the rootball surface from any downward cutting action that would otherwise be caused by the guys.

Trunk Protection Material — AN2.4.54

(1) Trunk protection materials shall be used to protect the trunk from any abrasion from ties and / or guy wires.

(2) Trunk protection materials shall be one of the following:

(a) Clear unplasticised polyvinyl chloride (uPVC) plastic hosing, 10mm to 25mm in diameter, as guy cover and trunk protection hosing, or

(b) Flexible rubber pad, 2mm thick and 150mm wide with length enough to wrap twice round the trunk as trunk protection.

Mowing Edge — AN2.4.55

(1) Plastic edger shall be used, where gravel/pebbles areas are interfaced with planting beds. It shall also be used to separate lawn areas from planting beds. A plastic mowing whip edge shall be placed around all trees/palms planted in lawn areas.

(2) Material shall be 3.5-4% Carbon Black for UV stabilization, height 10-15cm, and thickness 2-2.5mm.

(3) Concrete blocks, clay bricks or aluminium edging shall be used whenever specified on the Drawings.

Pots — AN2.4.56

(1) Pots for Herbaceous Plants which are to remain in their pots shall be unglazed fireclay free from cracks or damage and with adequate drainage holes in the base. Pots shall have a diameter of 250mm and a minimum depth of 300mm.

(2) Pots for Aquatic Plants shall be unglazed fireclay free from cracks or damage with adequate drainage holes in the base. They shall have a diameter and depth of the dimensions stated on the Drawings.

(3) The base of each pot shall have a drainage layer of clean pea gravel, broken fireclay or equal and approved material to a depth of 50mm.

(4) Dragon Pots for feature plants shall be 450mm in diameter at the tip and 400mm in depth and shall be free from cracks, damage or other imperfections.

Root Barrier — AN2.4.57

Root barrier shall be a composite, non woven geotextile and HDPE material, that prevents the penetration of tree roots.

Stackable Load Bearing Cells — AN2.4.58

Stackable Load Bearing Cells shall be 'Silva Cell' manufactured by Deep Root, or equal and approved by the Engineer.

Drainage Cell — AN2.4.59

Drainage cells shall be subsoil drainage honeycomb modules produced out of recycled 60% polypropylene. They shall weigh approximately 2.7kg/m2, and carry a load of >100t/m2. The modules shall be resistant to biological attacks and to chemicals. They shall not allow root penetration.

Drainage aggregate — AN2.4.60

Drainage aggregate shall be clean crushed rock 6mm to 19mm nominal size.

HDPE Waterproof Liner — AN2.4.61

High Density Polyethylene waterproof liner shall have a thickness of 1.00mm, with break strength of 40kN/m, carbon black content of 2.0-3.0%, and 50% UV resistance.

Filter membrane — AN2.4.62

Filter membrane shall be a permeable non-woven, thermally bonded geotextile filter fabric, which is not affected by salinity, acids, alkalis, bacteria, humidity, or rotting, and shall meet performance requirements for a minimum 12 years.

U Pins — AN2.4.63

U-pins for securing erosion control mat around planting pits in the hydroseeded area shall be aluminium wire, bent to form a 'U' shape, with a diameter, length spacing of prongs sufficient to securely attach the mat to the slope face. The Contractor shall demonstrate to the satisfaction of the Engineer that the size and shape of the u-pins is sufficient to ensure that the specified erosion control mat is securely fastened.

Salt barrier — AN2.4.64

Salt barrier shall be a geotextile composite product, non-woven, thermally laminated either side to a drainage core, enabling permeable capillary break and barrier to salt. It shall have a tensile strength of 30 KN/m, mass per unit area 850g.m2, and a thickness of 5.5mm.

Structural Soil — AN2.4.65

(1) Structural soil shall be a uniformly blended mixture of crushed stone, clay loam and hydrogel mixed to following proportion:

(a) 100% 1-1/2" to 3" crushed highly angular stone, with no fines.

(b) 20% Clay Loam consisting of 25-30% Sand, 20-40% Silt and 25-50% Clay. Organic matter not to exceed 5%.

(c) 0.03% hydrogel polymer (dry weight).

(2) Hydrogel for Structural Soil shall be a non-toxic potassium propenoate-propenamide copolymer, proprietary made product for horticultural usage.

AN2.5 HANDLING, STORAGE AND TRANSPORT

Handling and storage of rootballed stock — AN2.5.01

(1) Plants grown in open ground shall be well watered before lifting and shall be lifted in such a manner that the specified rootball is obtained with minimum disturbance to the roots. The rootball shall be securely wrapped immediately after lifting to prevent loss of soil and moisture using hessian, straw or other material agreed by the Engineer. The wrapping material shall not be removed until the plant is required for planting.

(2) Root pruning and undercutting of the root system of rootballed stock to the specified size of root-ball shall be carried out 12 months before lifting from the nursery.

Handling and storage of — AN2.5.02

Container grown and containerised stock shall be well watered before despatch from the nursery and shall remain in the containers until required for planting.

container grown and containerised stock

Transport of plants AN2.5.03

(1) Plant material shall be lifted or moved in such a manner that the roots are not disturbed. Plant material shall be lifted or moved by holding the container and not the above ground portion of the plant.

(2) Plants shall be wrapped and protected to prevent mechanical damage during lifting and transport. The trunk from soil level to the lower branches of trees in the light standard, standard, heavy standard and semi-mature categories shall be securely wrapped to prevent moisture loss using hessian, straw or other material agreed by the Engineer.

(3) Immediately prior to lifting, palm trees shall have their fronds reduced in length by 30%, sprayed with anti-desiccant and tied up with 3 layers of hessian to enclose the growing tip. The roots shall be pruned and the root ball protected with three layers of hessian tied up with wire and kept moist.

(4) Root systems of all plants shall not be allowed to dry out at any time and shall not be exposed to excessive or artificial heat.

(5) All plant materials that are to be lifted and transported while in leaf shall be treated with anti-desiccant prior to transportation and shall be covered with tarpaulin during transport to reduce excessive transpiration.

(6) All materials used for protection of plants during transport shall be removed before planting or as directed or agreed by the Engineer. Damaged plant material may be rejected by the Engineer and the Contractor shall replace such damaged material. Damaged material which is not so rejected shall be carefully pruned using sharp clean implements to give a single flat sloping face.

Storage of plants AN2.5.04

(1) Prior to planting, plants shall be maintained healthy and vigorous and shall be protected from exposure to conditions which may affect the plants adversely. This includes, but is not limited to, maintaining root balls with adequate moisture. Plants grown in shade conditions shall be stored and maintained in equivalent shade conditions prior to planting.

(2) Plants stored on-site shall be spaced to allow clearance for light and air and not be spaced together such that limbs may die or wilt.

(3) Plants shall be protected from damage and damaged plants shall not be used in the permanent work unless permitted by the Engineer. If the Engineer permits damaged plants to be used, damaged material shall be pruned and treated as stated in Clause AN2.9.10. Any additional costs and time involved in the replacement of damaged plants which are rejected by the Engineer or in the treatment of damaged plants which are permitted by the Engineer shall be borne by the Contractor.

(4) The Contractor shall seek the written approval of the Engineer on the storage of plants, method, equipment and storage facilities on Site.

Storage of trees and shrubs AN2.5.05

Plants which are not immediately planted in their permanent positions shall be maintained in good condition and shall be stored as follows:

(a) Trees, palms, bamboos and shrubs shall be supported upright on level ground, regularly watered and maintained in good condition.

(b) Bare-rooted trees, palms, bamboos or shrubs which shall be heeled into the ground at an angle to the horizontal with all the roots covered by soil-mix, and

(c) Where trees and shrubs are delivered to the Site with shoots and branches bundled, all tying materials shall be removed immediately after arrival to the Site to prevent heating up and subsequent defoliation.

Handling and storage of turf and sprigs AN2.5.06

Turf and sprigs shall not be lifted when waterlogged or very dry and shall be packed to avoid drying out. Turf and sprigs shall be stored by spreading out and shall not be stacked. Turf and sprigs shall be kept moist and in good condition and shall be delivered and laid within 36 hours after lifting.

Storage of grass seed AN2.5.07

Grass seed shall be stored in bags off the ground in a clean, dry, well-ventilated location free of vermin. Prolonged storage shall be carried out under controlled conditions of temperature and humidity.

Storage of fertilizer AN2.5.08

Fertilizer shall be stored off the ground in sealed waterproof bags and shall be protected from exposure to conditions that may adversely affect the fertilizer.

AN2.6 PRE-PLANTING WORKS

Preparatory works AN2.6.01

(1) Before soiling or planting for landscape softworks and establishment works starts, preparatory works shall be carried out by one or more of the treatments stated in this Section AN2.6, as appropriate or as stated elsewhere in the Contract.

(2) Location of existing underground services shall be determined prior to the start of any excavation and preparatory works.

Cleaning ground AN2.6.02

(1) Weeds and any unwanted vegetation as confirmed by the Engineer, rubbish, litter, stones exceeding 25mm diameter and all deleterious material shall be removed from the surface of the ground and the soil for planting.

(2) The Contractor shall not use chemicals including herbicide or fire for clearance of vegetation, unless otherwise instructed or approved by the Engineer. When the use of herbicide is approved by the Engineer, the Contractor shall comply with the requirements in Clause AN2.9.09.

(3) Clearance of vegetation by cutting grass and vines, if specified or if instructed or agreed by the Engineer, shall include cutting of grass and vines to within 25mm of ground level on either sloping ground or flat ground around trees or other vegetation.

(4) Clearance of vegetation by cutting and grubbing out vines and undergrowth, if specified or if instructed or agreed by the Engineer, shall include severing of the stems of all vines and undergrowth stumps on either sloping ground or flat ground within woodland. Prior to commencement of vegetation clearance, the Contractor shall clearly confirm with the Engineer which vegetation, if any, is to be retained.

(5) All cut materials resulting from vegetation clearance shall be disposed of from the Site to locations approved by the Engineer.

(6) Any voids left by the operation of cleaning ground shall be backfilled with imported subsoil.

Ripping AN2.6.03

The ground shall be ripped by drawing a tine through the soil to a depth of 300mm at 500mm centres. All obstructions to cultivation or deleterious material brought to the surface shall be removed and voids left by the ripping operation shall be filled with soil of the same type as existing. Ground at a slope exceeding 15° to the horizontal shall not be ripped.

Contaminated AN2.6.04

Ground that is contaminated by oil, chemicals or other substances, which in the opinion of the ground — Engineer may affect plant growth adversely, shall be excavated to 500mm below the contaminated depth and beyond the extent of the contamination. Voids left by excavation shall be filled with uncontaminated soil of the same type as existing.

Excavation to soil formation level — AN2.6.05

(1) Areas to be filled with uniform layers of topsoil and / or soil-mix shall be excavated to the soil formation levels as indicated in the Drawings. If not specified in the Drawings, soil formation levels shall be as follows:

(a) shrub planting – 600mm below finished soil level;

(b) ground cover planting – 300mm below finished soil level;

(c) turfing - 150mm below finished soil level;.

(2) At-grade tree pits shall be excavated to the specified tree pit depth.

(3) The base of the planting area / tree pit shall be broken up to a further depth of 300mm to ensure proper drainage.

(4) All excavated subsoil material shall be removed from site unless it satisfies the criteria for imported subsoil, in which case it may be used for creation of soil-mix.

Root barrier — AN2.6.06

(1) If specified, root barriers layers shall be installed prior to soiling in the locations shown on the drawings.

(2) Proprietary root barriers shall be installed according to the manufacturer's instruction.

Drainage layer — AN2.6.07

(1) If specified, drainage layers shall be installed prior to soiling in the locations shown on the drawings.

(2) Proprietary drainage layers shall be installed according to the manufacturer's instruction.

Stackable load bearing cells — AN2.6.08

(1) If specified, stackable load bearing cells shall be installed prior to soiling in the locations shown on the drawings.

(2) Stackable load bearing cells shall be installed according to the manufacturer's instruction.

Soiling — AN2.6.09

(1) No topsoil or soil-mix shall be spread before the soil formation level and subsoil condition has been checked and approved by the Engineer.

(2) Placing and spreading of soil shall not take place during periods of heavy rains, nor when the topsoil and / or soil-mix is saturated. When, in the opinion of the Engineer, conditions are unsuitable for placing and spreading of soil, operations shall cease and shall only be resumed when authorised by the Engineer.

(3) The Contractor shall ensure that the topsoil or soil-mix heaps are properly maintained, including weed control where necessary, until such time as the topsoil or soil-mix is placed in its final position.

(4) Topsoil and / or soil-mix shall be spread and levelled to the depth stated in the Contract unless otherwise directed. The loose depth of the applied material shall be sufficient to allow the level of the area to comply with the finished levels as specified after natural settlement and natural compaction have taken place. After natural settlement and natural compaction, the finished level of the applied material shall be 50mm below all edges of the planting area unless otherwise specified or directed. The finished level of soil-mix over areas to be hydroseeded shall be 25mm above adjacent kerbs, paving, covers, frames and other hardware.

(5) After soiling, the Contractor shall take all necessary preventative measures to control erosion and siltation. The Contractor shall restore or replace any portion of the Site, including those which have been both the subject of a certificate of completion of a Section, which erodes, silts up or is otherwise damaged. The Contractor shall be responsible for ensuring that the topsoil or soil-mix maintains its specified quality between the time after deposition and the planting operations.

Cultivation — AN2.6.10

(1) Cultivation is the controlled de-compaction of the upper layer of soil to provide an evenly textured, friable planting medium with sufficient air penetration and water retention for favourable plant growth.

(2) Cultivation of areas stated in the Contract or instructed by the Engineer shall be carried out in accordance with the following or as stated elsewhere in the Contract:

Minimum depth of cultivation	Pre-planting fertilizer	Thickness of pre-planting fertilizer and soil conditioner over the surface before cultivation
(mm)	(g/m^2)	(mm)
150	25	100
300	50	200
450	75	300

(3) Cultivated soil shall be hand picked to remove any stones exceeding 25mm diameter and all other deleterious materials. All such materials shall be disposed of from the Site.

(4) Cultivation shall not be carried out on slopes of gradient 1:2 or steeper so as to maintain the slope stability and to prevent erosion.

Scarifying — AN2.6.11

(1) Scarifying shall be carried out by loosening the soil to a depth of between 10mm and 20mm using a pronged implement such as a rake but without turning the soil.

(2) All slopes to be grassed shall be scarified. Ground at a slope exceeding 15 degrees to the horizontal shall be scarified parallel to the contours.

Protection of prepared ground — AN2.6.12

(1) Prepared ground shall be protected from compaction, erosion and siltation and shall not be used by construction plant, other vehicles or pedestrian traffic.

(2) Prepared ground that becomes compacted, eroded, silted up or damaged shall be replaced or dealt with by methods agreed by the Engineer.

Removal of material — AN2.6.13

Weeds, rubbish, litter, stones exceeding 25mm diameter and deleterious material removed during ground preparation shall be disposed of by the Contractor by methods agreed by the Engineer.

AN2.7 PLANTING

General — AN2.7.01

Planting for landscape softworks and establishment works shall be carried out as stated in this Section AN2.7.

Notice of operation, inspection of Works, and instruction for remedial works — AN2.7.02

In respect to Landscape Softworks and Establishment Works, the Contractor shall give at least two working days' notice or such period of notice so instructed by the Engineer, to the Engineer, of his intention to carry out any critical operation, including ground preparation, soiling, setting out, planting, grassing, pruning of existing and newly planted vegetation, fertilising, visits to carry out Establishment Works, and any other operations as required by the Engineer, or to cover up or put out of view of any works to enable the Engineer's staff to attend for the purpose of examining such works.

Setting out — AN2.7.03

(1) The Contractor shall be responsible for accurately setting out according to the Drawings all

areas to be planted to the satisfaction of the Engineer prior to the commencement of planting, and shall rectify errors in setting out at his own expense. Any discrepancy in Site area between that shown on the plans and the actual area on the ground shall be notified to the Engineer as soon as it is discovered and prior to commencement of any relevant operations.

(2) Tree and shrub areas shall be marked in outline with pegs, spaced not less than 15m apart. The pegs shall be not less than 750mm long and 50mm in thickness and shall be firmly driven into the ground. The top 300mm of each peg shall be painted white.

(3) The Contractor shall mark out the required planting interval with canes, stones, chalk or other suitable markers along the longest edge of the area to be planted.

(4) The first row of plants shall be the required distance from this edge and directly in line with each marker. In the case of planting areas edged by kerbs or walls, the first row of plants shall be planted as close to the edge as foundations will permit. In the case of planting areas adjacent to other planting areas, the first row of plants shall be planted at a distance which is half the specified planting distance for that species from the edge.

(5) The second row shall be required distance from the first. The pattern will be repeated over the whole planting area.

(6) In the case of woodland mix and shrub mix planting, the plants shall be planted in positions indicated on the Drawings.

(7) The approximate numbers of plants to be planted per half day shall be set out by laying them down beside the hole in which they are to be planted. Plants shall not be removed from their containers until planting is taking place. All setting out shall be to the approval of the Engineer.

(8) During the setting out of the planting, the Contractor shall notify the Engineer or the Engineer's Representative of the position of any tree or group of trees which occur within the following tolerance:

(a) trees to be planted in verges adjacent to major and secondary roads which distance from the edge of the road is less than 1.3 m,

(b) trees to be planted in verges adjacent to minor roads (design speed 50 km/hr or less) which distance from the edge of the road is less than 0.8 m,

(c) large shrubs to be planted within 1.0 m of the road edge; medium shrubs to be planted within 0.6 m of the road edge and small shrubs to be planted within 0.3 m of the road edge. (The above dimensions do not apply where crash barriers are provided between the planting and the carriageway or where planting is located within a raised planting bed),

(d) trees within 10 m of the end of a central divider,

(e) trees within 5 m of a road lamp stand,

(f) trees which because their location serve to obscure traffic signs, signals etc., and

(g) trees within 1.5 m of a fire hydrant.

(9) The Contractor shall notify the Engineer or the Engineer's Representative of any of the above situations prior to carrying out any relevant works in those areas.

Use of excavated material — AN2.7.04

Material excavated from planting pits, which complies with the specified requirements for topsoil, may be used for soiling. Material excavated from planting pits, which complies with the specification for either imported subsoil or completely decomposed granite may be used in the fabrication of soil-mix. Material excavated from planting pits, which does not comply with the specified requirements for topsoil or imported subsoil or completely decomposed granite, shall be disposed of by the Contractor.

Planting — AN2.7.05

(1) Rootballs of light standard trees, standard trees, heavy standard trees, semi-mature trees, conifers and palms shall be thoroughly soaked with water before planting. If rootballs or containers are very dry, the roots shall be immersed in water until air bubbles cease to rise. The soil in the container or rootball shall be moist and cohesive. Containers or rootball wrapping shall not be removed until the time of planting and the rootball shall not be disturbed by loosening or breaking. After removal of containers or rootball wrapping and before planting, any broken roots shall be cut and any encircling roots or kinked roots that may compress the stem tissues shall be straightened or pruned. Root cutting or pruning shall be carried out using clean, sharp secateurs or knife.

(2) Each plant shall be placed upright in the pit and set at the same level as planted in the nursery or container, except for trees which shall be set at a level so that the root collars are exposed just above the finished soil level.

(3) Planting soil-mix or backfilling materials shall be deposited in layers and tamped gently around the rootball until level with surrounding ground in such a manner that the rootball is not disturbed. Plants shall be well watered to soak the rootballs and the backfilling materials immediately after planting.

(4) Container or rootball wrapping shall be completely removed and disposed of off the Site properly.

(5) Plants shall be planted in staggered rows unless otherwise specified or instructed.

Timing of Planting — AN2.7.06

All plants shall be planted in their final position within one day of delivery to the Site, unless otherwise approved by the Engineer.

Tree Staking and Tying — AN2.7.07

(1) Metal stakes shall be driven into the ground after the pit has been excavated and before planting in such a manner that the rootball and aerial parts of the plant are not damaged. The stake shall be secure after driving and shall not be higher than 30% of the overall height of the plant.

(2) Bamboo stakes shall be used in locations stated in the Contract and where in the opinion of the Engineer it is impracticable to use steel stakes or guys. Bamboo stakes shall be driven into the ground before planting so as not to damage the rootball or aerial parts of the tree. Bamboo stakes shall be securely tied with "scaffold tie" to form a tripod not exceeding 60% of the overall height of the plant.

(3) Stakes shall be secured to the tree so as not to cause any chafing, rubbing or abrasion of the tree of restrict its growth,

(4) The method of staking and tying shall be subject to approval by the Engineer.

Tree Wire Guying — AN2.7.08

(1) Trees larger than Heavy Standard size shall be tied with wire guys. Guys and sleeves shall be fixed in such a manner that chafing, rubbing and abrasion of the plant is prevented and shall be secured to a well driven steel stake or other anchor. Each plant shall be fitted with three adjustable guys secured at a point not higher than 60% of the overall height of the plant. Guying stakes shall be driven 600mm into the ground with 200mm remaining above the ground. Turnbuckles shall be adjusted as necessary after planting.

(2) The method of guying shall be subject to approval by the Engineer.

Tree Underground — AN2.7.09

(1) Trees larger than Heavy Standard size with large rootballs may be secured using underground wire guys tied to secure underground anchors. Underground guying may be

Wire Guying

appropriate for large trees in locations where stakes and guys may cause hazard to pedestrians.

(2) A minimum of 4 wire guys shall be bolted to underground structure or tied securely to heavy underground anchors. Large rootballs may require more guys. Guys shall be distributed evenly over the rootball surface and shall be positioned to maximise the guying effect, relative to the rootball size.

(3) Anchors shall be buried at a depth not less than the total rootball depth, and shall be distributed evenly around the rootball.

(4) Sturdy protective timber slats shall be provided to sit on the surface of the rootball, to spread the pressure imposed by the guys evenly over the whole rootball surface and to protect the rootball surface from any downward cutting action that would otherwise be caused by the guys. Guys must not rest on the rootball surface, nor cut into the edges of the rootball, nor damage the rootball in any way.

(5) Anchors, slats and guys shall be positioned and guys tightened before any backfilling around the rootball is undertaken. The adjustable screw clamps shall be positioned over the rootball at an easily accessible location.

(6) The underground guying methodology shall be submitted to the Engineer for prior approval.

Mulching — AN2.7.10

(1) After planting and watering, mulch shall be spread to a consolidated thickness of at lease 75mm in planters and all planted areas except those areas with creeping rooting ground covers.

(2) Mulch shall be dished around the base of the plants. The Contractor shall take care not to damage the plant material during mulching operations. Mulch shall be applied after planting and watering have taken place.

Notch planting of seedlings — AN2.7.11

Notch planting of seedlings shall be carried out by forming a notch making two cuts at approximately 90° using a hand held pick or spade with the apex pointing up any slope; the notch shall be sufficiently deep to accommodate the root system of the seedling. The notch shall be opened on the second cut to receive the plant and shall then be pushed firmly back into place.

Pit planting of seedlings, whips, shrubs, climbers, ground covers and herbaceous plants — AN2.7.12

(1) The diameter of pits for whips, seedlings, shrubs, ground covers, herbaceous plants and climbers shall be 100mm greater than the specified rootball or container diameter. The depth of the pits shall be 50mm deeper than the specified rootball or container.

(2) The following materials shall be mixed into the topsoil / soil-mix or backfilling materials for each pit :

(a) 50 g of pre-planting fertilizer (or at rate specified by manufacturer); and

(b) if specified or instructed by the Engineer, 5g of water absorbing soil additive (or at rate specified by manufacturer).

(3) Where the existing materials excavated from the pits shall be used as backfilling materials, the excavated materials shall be mixed with soil conditioner in the proportions of 2:1 by volume before backfilling.

(4) Each of the seedlings and whips, which require to be staked as specified or as instructed by the Engineer, shall be secured using one stake as Clause AN2.4.51(2) with one tie as Clause AN2.4.51(3) or using other securing method as approved by the Engineer.

(5) Unless otherwise instructed by the Engineer, the Contractor shall remove the staking or other securing measures from the Site at the end of the period for establishment works or when instructed by the Engineer.

Pit planting of light standard trees and standard trees — AN2.7.13

(1) The diameter of pits for light standard and standard trees shall be 200mm greater than the specified rootball or container diameter. The depth of the pits shall be 100mm deeper than the specified rootball or container. The following materials shall be mixed into the topsoil / soil-mix or backfilling materials for each pit :

(a) 150 g of pre-planting fertilizer; and,

(b) if specified or instructed by the Engineer, 50 g of water absorbing soil additive.

(2) Where the existing materials excavated from the pits shall be used as backfilling materials, the excavated materials shall be mixed with soil conditioner in the proportions of 2:1 by volume before backfilling.

(3) Each of the light standard trees and standard trees, which require to be staked as specified or as instructed by the Engineer, shall be secured using stakes and ties as Clause AN2.7.07 or using other securing method as approved by the Engineer:

(4) Unless otherwise instructed by the Engineer, the Contractor shall remove the staking or other securing measures from the Site at the end of the period for establishment works or when instructed by the Engineer.

Pit planting of heavy standard tree and semi-mature trees — AN2.7.14

(1) The diameter of pits for heavy standard and semi-mature trees shall be 300mm greater than the specified rootball or container diameter. The depth of the pits shall be 150mm deeper than the specified rootball or container. The following materials shall be mixed into the soil-mix or backfilling materials for each pit :

(a) 250 g of pre-planting fertilizer; and

(b) if specified or instructed by the Engineer, 100 g of water absorbing soil additive.

(2) Where the existing materials excavated from the pits shall be used as backfilling materials, the excavated materials shall be mixed with soil conditioner in the proportions of 2:1 by volume before backfilling.

(3) Each of the heavy standard trees not exceeding 4m overall height, which require to be staked as specified or as instructed by the Engineer, shall be secured using stakes and ties as Clause AN2.7.07 or using other securing method as approved by the Engineer:

(4) Each of the heavy standard trees exceeding 4 m overall height and the semi-mature trees, which require to be staked as specified or as instructed by the Engineer, shall be secured using tree wire guys as Clause AN2.7.08 or tree underground wire guys as Clause AN2.7.09 or using other securing method as approved by the Engineer.

(5) Unless otherwise instructed by the Engineer, the Contractor shall remove the staking or guying or other securing measures from the Site at the end of the period for establishment works or when instructed by the Engineer.

Pit planting of bamboo, conifers and palms — AN2.7.15

Bamboos, conifers and palms shall be planted in accordance with the following:

(a) Height not exceeding 2000mm	Clause AN2.7.12
(b) Height exceeding 2000mm and not exceeding 4000mm	Clause AN2.7.13

(c) Height exceeding 4000mm Clause AN2.7.14

Pit planting on slopes — AN2.7.16 — Pits excavated for planting on or adjacent to slopes shall not be left open during wet weather.

Planting into previously hydroseeded areas — AN2.7.17 — In programming the planting works, sufficient time shall be allowed for the hydroseeding to establish and provide 90% cover, to the satisfaction of the Engineer, and when instructed by the Engineer grass shall then be cut to a height of not less than 50mm above ground level, before the notch/pit planting operations commence.

Planting into and adjacent to existing vegetation — AN2.7.18

(1) Where planting works are required within and adjacent to existing vegetation, existing shrubs shall be pruned and existing grass or other herbaceous plants shall be cut to a height of not less than 50mm above ground level but not pulled out by equipment in any circumstances.

(2) The Contractor shall obtain agreement of the Engineer prior to commencing the vegetation clearance.

(3) The Contractor shall be responsible for removing all rubbish and cut vegetation from the Site and reinstating any existing planted areas affected by the planting works to the satisfaction of the Engineer.

Planting through erosion control mat — AN2.7.19

(1) In areas where erosion control mat has been laid, the Contractor shall prepare trial panels demonstrating the technique for pit planting through the erosion control mat (panel size min. 4m x 4m / 9 no. pits) in-situ, as instructed by the Engineer. Approval of the sample should be obtained from the Engineer prior to commencement of planting through erosion control mat generally.

(2) The Contractor shall comply with the following in pit planting through erosion control mat:

(a) Erosion control mat shall be cut in 'T' shape with sharp knife and flaps folded back to allow pit to be excavated. Complete holes shall not be cut in the erosion control mat.

(b) Plants shall be planted at correct level with respect to surrounding slope face and heeled in to create slight depression in slope around plant.

(c) Flaps folded back into original position and secured with 200mm long aluminium U-pin as Clause AN2.4.63.

Watering — AN2.7.20 — Immediately after planting, all plants shall be thoroughly watered with fresh water such that the roots of the plants are soaked.

Insect and disease control — AN2.7.21

(1) The Contractor shall use integrated pest management techniques to control pests.

(2) The Contractor shall regularly check for any insect attraction or fungal infestation particularly during periods of known activity.

(3) The Contractor shall report to the Engineer any such occurrence and shall carry out remedial eradication.

(4) If the Contractor considers that it is necessary to use chemical insecticide or fungicide, he shall obtain prior written approval of the Engineer. Chemical insecticide or fungicide shall be used in accordance with the manufacturer's instructions. Use of sprays is to be with care and with due regard to the health, safety and convenience of the general public and in accordance with Government guidelines. Spraying shall be carefully controlled to avoid unnecessary dispersion.

Notices and instructions — AN2.7.22

(1) In respect to Landscape Works, the Contractor shall give forty-eight hours notice to the Engineer , of his intention to commence any one of the following operations: soiling, setting out, planting, grassing, sprigging, turfing, fertilising, use of inorganic chemicals, visits to carry out Establishment Works.

(2) The Contractor shall undertake any remedial Landscape Works within twenty-four hours of notice by the Engineer.

Post planting works — AN2.7.23 — After planting, all planted areas and grassed areas shall be kept free of weed and rubbish and all plants and grass shall continue to be watered thoroughly as necessary to maintain a sufficiently moist soil for healthy plant growth at all times for the duration of the Works.

Cultural operations prior to the commencement of Establishment Works — AN2.7.24 — During the period between planting and the issue of the Practical Completion Certificate and/or Certificate of Commencement of Establishment Works, the Contractor shall perform all works as specified for the healthy establishment of plants in accordance with the requirements as specified.

Replacement planting prior to the commencement of Establishment Works — AN2.7.25 — The Contractor shall ensure that at the time of application for the Practical Completion Certificate and / or Certificate of Commencement of Establishment Works that all planted areas are clean, free of rubbish and weeds and in a healthy growing condition. The Contractor shall be responsible for any replacement planting which is necessary prior to the issue of the certificate.

AN2.8 GRASSING

Hydroseeding — AN2.8.01

(1) Hydroseeding for landscape softworks and establishment works shall be carried out as stated in this Section.

(2) Unless otherwise permitted by the Engineer, hydroseeding shall be carried out between 1st March and 30th September except as stated in Clause AN2.1.09. If hydroseeding is permitted at other times, particulars of changes to the materials and methods for hydroseeding shall be submitted to the Engineer for approval.

Hydroseeding Cover — AN2.8.02 — Hydroseeding shall achieve a cover by grass species of at least 90% of the surface area of each 10sq m of the area to be hydroseeded not more than 100 days after the area has been hydroseeded. The grass cover shall be healthy, vigorous and free of perennial and other weeds. The method of determining the cover shall be as stated in Clauses AN2.10.01 and AN2.10.02.

Surface Conditions for Hydroseeding — AN2.8.03 — The surface to be hydroseeded shall be finished to a coarse open textured surface and shall not be smooth or glazed. Finishing work on slopes by machines shall be carried out across the slope. Vehicle track marks and bucket teeth marks shall not be left parallel to the line of maximum gradient of the slope.

Application of hydroseeding — AN2.8.04

(1) Hydroseeding shall be carried out using a proprietary type of hydroseeding equipment unless otherwise approved by the Engineer.

(2) Materials for hydroseeding shall be well mixed on the Site in the hydroseeding equipment immediately before spraying, ensuring that seed is not damaged. The area to be hydroseeded shall be moistened immediately prior to hydroseeding.

(3) At the time of spraying, fertilizer shall be applied at a minimum rate of 100 g/sq m. Mulch shall be applied at a minimum rate of 200 g/sq m. Soil binders shall be applied at the rate 25 g/sq m or as recommended by the manufacturer, modified as necessary to suit

conditions in Hong Kong. Dye shall be used to demonstrate that adequate cover has been achieved, unless in the opinion of the Engineer runoff or water-courses will be coloured to an unacceptable level. Where used, dye shall be applied at a maximum rate of 0.05 g/sq m.

(4) The hydroseeding mixture shall be constantly agitated during spraying to keep it homogeneous and avoid blockage to pipes. Measures shall be taken during application to ensure that material is not lost due to runoff.

(5) Walking on areas that have been hydroseeded shall be restricted to access for fixing protective material and for patching up. After spraying, the Contractor shall water the hydroseeded areas as often as is required to keep the ground evenly moist.

Protective Material AN2.8.05 Immediately following spraying of hydroseeding slurry, protective fabric material shall be laid and spiked or stapled to the soil surface with a minimum of 150mm overlap to prevent soil erosion. On sloping ground, the material shall be laid along the greatest slope and shall be made to fully adhere to the hydroseeded surface by sprinkling with water with an approved spray. Care must be taken not to sprinkle excessive water onto the slope causing erosion of the slope. The material shall also be applied to all areas to be subsequently re-sprayed. The protective material shall be biodegradable non-toxic, porous, translucent and 1mm or less thick. Unless otherwise instructed by the Engineer, the Contractor shall remove the material from the Site at 10 weeks after placement or when instructed by the Engineer.

Patching Up AN2.8.06 (1) Immediately after germination and a general greening of the hydroseeded area is apparent, areas where in the opinion of the Engineer germination has been unsuccessful shall be re-sprayed. Areas affected by repairs to washout and gullies and other erosion on slopes shall be re-sprayed.

(2) Areas that in the opinion of the Engineer are not accessible or are too small for the use of a hydroseeder may be patched up by broadcasting seed. The area shall be lightly scarified with a rake or similar implement and the seed and fertilizer shall be broadcast over the area at a rate of not less than $75g/m^2$. The seed shall be covered by lightly working into the surface or by spreading sufficient soil to just cover the seed. Broadcast seeding shall be carried out using the appropriate seed species.

Post Planting Fertiliser AN2.8.07 Unless otherwise directed or agreed by the Engineer, post-planting fertilizer shall be applied not less than 100 days, and not more that 300 days, after application of hydroseeding and, unless otherwise permitted by the Engineer, shall be applied between 1st March and 30th September.

Turfing AN2.8.08 (1) Turf shall not normally be laid on slopes exceeding 25° to the horizontal.

(2) The area to be turfed shall be cultivated by applying pre-planting fertilizer at a uniform rate of $40g/m^2$ and shall then be raked and consolidated to the required level. The finished level after turfing shall be 25 mm above adjacent kerbs, paving, covers, frames and other hardware.

(3) The turfs shall be laid on the prepared soil and shall be firmed into position using wooden beaters; the beaters shall be frequently scraped clean of accumulated soil or mud. A top dressing of soil-mix shall be applied and well worked into joints and spaces. Irregularities in finished levels due to variation in turf thickness or uneven consolidation of the soil shall be adjusted.

(4) Turfed areas shall be watered immediately after turf has been laid and as often as is necessary to ensure establishment. If shrinkage occurs and the joints open, soil-mix shall be worked in and well watered.

(5) Turf edges and margins shall be laid with whole turfs.

Sprigging AN2.8.09 (1) Sprigging shall not be used on slopes exceeding 45° to the horizontal.

(2) The area to be sprigged shall be scarified before sprigging and sprigs shall be evenly spread over the area at approximately 50mm centres. The area shall be top-dressed with soil-mix to just cover the sprigs and pre-planting fertilizer shall be applied at a uniform rate of $40g/m^2$.

Completion of Turfing AN2.8.10 The Contractor shall deliver at Practical Completion an excellent turf surface that satisfies the following requirements:

(a) Purity: turfgrass shall be 100% pure specified grass variety, totally free from weeds and unspecified grass species and varieties;

(b) Coverage: there shall be 100% grass cover;

(c) Health: all turf shall be healthy and free from disease and pests;

(d) Uniformity: turf shall be uniform in density, texture, colour and appearance;

(e) Colour: turfgrass shall have consistent colour with no patchiness;

(f) Density: turf shall have uniform density; and

(g) Smoothness: junctions between turf sods shall not be discernable, and the surface texture of the turf shall be smooth without any unevenness or bumps.

Completion of sprigging AN2.8.11 (1) Sprigging shall be considered to be complete when the first flush of growth achieves 95% cover. The method of determining the cover shall be as stated in PS Section AN2.10.

(2) Bare patches or areas that in the opinion of the Engineer fail to become established shall be returfed or resprigged to maintain at least 98% cover throughout the establishment period. Areas affected by repairs to washouts and gullies and other erosion shall be returfed or resprigged.

AN2.9 ESTABLISHMENT WORKS

Establishment Works AN2.9.01 (1) The Contractor shall be required to maintain the planting works for a period of 12 months or as specified after the date certified by the Engineer that the Landscape Works have been satisfactory completed and in that time will be required to carry out establishment works whether or not instructed by the Engineer.

(2) Establishment works shall be carried out as stated in this Section AN2.9.

(3) All necessary measures shall be taken to ensure that grass, trees and other plants become established and to keep the landscape softworks neat and tidy and free of litter and rubbish.

(4) The Contractor shall report to the Engineer before and after carrying out any Establishment Works. Reports shall be submitted in duplicate on forms provided by the Contractor and of a style approved by the Engineer.

(5) The Contractor shall submit a programme to the Engineer for approval before the commencement of Establishment Works. The programme shall include all the items of operations as defined below. Other than the items of mulching, pruning and fertilising, the Contractor shall propose in the programme the number of operations for the other items to be carried out during the Establishment Period. Once the programme is approved, the Contractor shall carry out all the operations unless subsequently instructed otherwise by

the Engineer.

Inspection of establishment works AN2.9.02 An inspection of landscape softworks and establishment works shall be carried out jointly by the Contractor and the Engineer at monthly intervals to determine the establishment works which are required. The Engineer shall instruct the Contractor to carry out establishment works which in the opinion of the Engineer are necessary; the work instructed shall be completed within 14 days of the date of the Engineer's instruction.

Replacement of plants and grass AN2.9.03

(1) Plants that in the opinion of the Engineer are dead, dying, not conforming to the original specification or otherwise unsatisfactory shall be replaced. Replacement planting shall be carried out in season as stated in Clause AN2.1.08, except as stated in Clause AN2.1.09, unless otherwise agreed by the Engineer, using plant material of a similar size to that already established. Measures shall be taken to ensure satisfactory establishment of the replacement plants before the end of the period for establishment works.

(2) At least 98% cover of the grass area shall be maintained throughout the period for establishment works and the grass shall provide effective cover of 100% of the area at the end of the period for establishment works. The grass shall be healthy, vigorous and free of perennial and other weeds. Areas that in the opinion of the Engineer are unsatisfactory shall be re-turfed or sprigged as stated in Section AN2.8. Measures shall be taken to ensure satisfactory establishment of the replacement grass or turf before the end of the period for establishment works.

Repair of damage by vandalism AN2.9.04

(1) Within the same day of discovery of the damage by vandalism, the Contractor shall notify the Engineer in writing of the vandalism.

(2) Within two days of discovery of the damage by vandalism, the Contractor shall provide the Engineer with a report comprising information to prove that the damage was caused by circumstances beyond his control and also the following information of the damage:

(a) Location of the damage,

(b) Nature of the damage,

(c) Photographic records of the damage, and

(d) Proposed works of repair of damage.

(3) Within five days of submission of the report required in sub-clause (2) of this Clause unless otherwise agreed by the Engineer, the Contractor shall complete the works of repair of damage proposed in the report and clearance of the Site of all damaged plants that have been replaced and all other debris, and shall provide the Engineer with a report including photographic records showing the completion.

(4) Apart from the works of repair completed under sub-clause (3) of this Clause, the Contractor shall complete any other works of repair that are considered necessary by the Engineer within three days of the Engineer's instruction or other time duration as agreed by the Engineer.

Repair of damage by Tropical Cyclone or Adverse Weather AN2.9.05

(1) Within 48 hours of a Tropical Cyclone or other adverse weather conditions being over, the Contractor shall carry out the following:

(a) Complete firming up and tightening of stakes, tie and guys to secure all dislodged plants, and replanting of all blown-over plants, and

(b) Provide the Engineer with a report comprising the following information of all plants that have been damaged by the adverse weather, including those being blown over, dead, dying or having structural damage:

(i) locations of the damaged plants,

(ii) nature of the damage,

(iii) photographic records of the damage,

(iv) photographic records showing completion of the work of repair required in sub-clause (1)(a) of this Clause, and

(v) other proposed works of repair of damage that will be carried out, including plant surgery to remove and treat the damaged parts and replacement of plants that are dead, dying or having irreparable damage.

(2) Within five days of submission of the report required in sub-clause (1)(b) of this Clause unless otherwise agreed by the Engineer, the Contractor shall complete other works of repair of damage proposed in the report and clearance of the Site of all damaged plants that have been replaced and all other debris, and shall provide the Engineer with a report including photographic records showing the completion.

(3) Apart from the works of repair completed under sub-clauses (1) and (2) of this Clause, the Contractor shall complete any other works of repair that are considered necessary by the Engineer within three days of the Engineer's instruction or other time duration as agreed by the Engineer.

Security and adjustment of stakes, ties and guys AN2.9.06

(1) The Contractor shall be responsible for the security and, where necessary, adjustment of the stakes, ties and guys throughout the period for Establishment Works, for the healthy growth of the plants. The Contractor shall carry out an inspection of stakes, ties and guys each month for this purpose.

(2) Any broken, damaged or unsatisfactory stakes, ties and guys shall be replaced. Any ties which are causing chafing or abrasion of the plant shall be appropriately slackened. Any ties which are loosened shall be appropriately tightened. Guying turnbuckles shall be adjusted as necessary to ensure guys are taut. The Contractor shall carry out an inspection of the stakes, ties and guys each month for this purpose. The Contractor shall carry out the necessary replacement or adjustment within two days of identification or the Engineer's instruction or any other period as agreed by the Engineer.

(3) The Contractor shall remove stakes, ties and guys at the end of the period for Establishment Works when the plant root systems has sufficiently developed to support the plants, unless otherwise instructed by the Engineer.

Firming up plants AN2.9.07

(1) Plants which become loose as a result of wind rock or other causes shall be firmed up.

(2) The Contractor shall inspect the Site regularly for this purpose and after each storm or adverse weather occurrence, to assess damage, which shall be reported to the Engineer. Any damaged branches shall be carefully pruned.

Irrigation AN2.9.08

(1) The Contractor shall provide irrigation to promote healthy growth of all plants. The irrigation water shall be of a quality and standard suitable for both plant material and for handling by workers.

(2) If a permanent irrigation system is proposed, the irrigation system shall be in full working order prior to any planting works.

(3) In the event that the permanent irrigation system is not fully operational during or after planting works, the Contractor shall provide temporary watering to promote healthy growth

of plants until such time as the irrigation system is fully operational.

(4) Plants reaching permanent wilting point shall be watered immediately.

Weeding AN2.9.09

(1) All grassed and planted areas shall be kept free of weeds throughout the period for establishment works. Any unwanted plant found within the Site is considered a weed and shall be removed by the Contractor once it is identified or when instructed by the Engineer throughout the period for establishment works.

(2) Weeding shall be carried out by hand or by mechanical methods agreed by the Engineer in such a manner that damage to the grass and planted areas will not be caused. The Contractor shall not use chemicals or fire for weeding operation, unless otherwise instructed or approved by the Engineer. All weeds, litter and other rubbish resulting from the weeding operation shall be disposed of from the Site by the Contractor. Any ground cover plants, herbaceous plants, climbers, mulch or soil disturbed or removed during the weeding operation shall be replaced.

(3) Planted areas in bare ground shall be weeded to remove all unwanted vegetative growth including aerial parts and roots, over the complete area. Planted areas other than in bare ground shall be weeded to remove all competing and overhanging vegetative growth within 300mm radius of the base of each plant by cutting the growth down to not more than 50mm above soil level. All areas shall be kept in a weed/grass free and tidy condition.

(4) When the use of herbicide is approved by the Engineer, the Contractor shall comply with the following requirements in applying the herbicide:

(a) The herbicide shall be of proprietary type approved by the Agriculture, Fisheries and Conservation Department and the Certificate of Approval shall be submitted to the Engineer,

(b) Application of herbicide shall not commence without the Engineer's approval to the type of herbicide to be used, and

(c) Application of herbicide shall be in strict accordance with the manufacturer's recommendations.

Pruning AN2.9.10

(1) Prune shrubs, ground cover and climbers to encourage bushy growth, improve flowering and remove dead damaged branches and dead flower heads at the appropriate time of the year depending on species or as instructed by the Engineer. An inspection of pruning requirements shall be made at monthly intervals.

(2) The Contractor shall not carry out pruning to any trees without the prior approval from the Engineer, unless the pruning work is required under the Contract or is directed by the Engineer. The Contractor shall notify the Engineer of any trees whose branches interfere with the Works and thus require pruning

(3) The Contractor shall provide all necessary tools and equipment for the pruning works, to comply with the following:

(a) All necessary physical support and all necessary safety precautions shall be provided to protect the people engaged in the pruning work as well as the people and property in the vicinity, and

(b) Cut limbs shall not be left in the crown of a tree upon completion of pruning, at times when the tree will be left unattended, or at the end of the workday.

(4) The Contractor shall carry out pruning works in accordance with good horticultural practice and recommendations of the reference documents listed in Clause AN2.1.10, including BS 3998 : Recommendations for Tree Work, the "General Guidelines on Tree Pruning" issued by Development Bureau, the "Arborists' Certification Study Guide" and "Best Management Practices - Tree Pruning" issued by International Society of Arboriculture, and comply with the following pruning standards:

(a) Pruning and removal of branches shall be done using sharp, clean implements to give a single flat, sloping face.

(b) Thinning cuts instead of heading cuts shall be used,

(c) Pruning cut shall be made just above and sloping away from an outward facing healthy bud.

(d) Branch bark ridge shall not be damaged, branch collar shall not be cut off, and no flush cut shall be made,

(e) No topping (cutting off all branches to the same height) or lion-tailing of the tree shall be made in any circumstances,

(f) No more than 25% of the live foliage of a single limb on mature trees shall be removed,

(g) The total extent of crown thinning should be minimised and in any case, no more than 25% of the total tree live foliage on mature trees shall be removed,

(h) At least 50% of the foliage shall be evenly distributed in the lower 66% of the canopy on mature trees after pruning,

(i) Cuts shall be neatly made so that there is no splintering or tearing of bark and no snags or stumps are left behind,

(j) Any branch larger than 25mm diameter shall be removed in stages using a three-cut method as follows:

(i) the first cut shall be an undercut made approximately one-third to halfway through the branch at 300mm to 400mm from the branch union,

(ii) the second cut shall be made from the above at 50 to 75mm out past the first cut, removing the branch but preventing the weight of the branch from tearing the bark below the branch collar,

(iii) the third cut shall be a final cut just outside the branch collar without injuring the branch collar and branch bark ridge, and

(k) Ragged, rough edges of bark or wood shall be trimmed cleanly from around wounds with a sharp knife to the minimum extent necessary in order to hasten wound closure, and twigs less than 15mm diameter shall be cut with sharp secateurs.

(5) All cuts shall be made to avoid splintering or tearing of bark that would catch water and encourage rot, and any cracks, cavities or rotten wood shall be cut back with a clean, sharp implement to remove the dead, damaged and decayed tissue without damaging the living tissue.

(6) Unless otherwise instructed by the Engineer, any cuts or wounds shall be left uncovered and no wound dressing shall be applied.

(7) Any material pruned from the trees shall be removed from the Site as soon as possible, and any areas affected by the pruning work shall be reinstated.

Grass cutting AN2.9.11

(1) Grassed areas shall be cut by manual or mechanical methods agreed by the Engineer and in a manner that does not cause pulling of roots or damage to planting in or near the

grassed area. All cuttings shall be raked off and disposed of within 24 hours after cutting.

(2) Category 1 grass shall be as stated in the Contract and shall be reduced by cutting to a height of 50mm when it reaches 100mm high.

(3) Category 2 grass shall be as stated in the Contract and shall be reduced by cutting to a height of 100mm when it reaches 300mm high.

(4) Category 3 grass cutting shall be cutting of areas of grass seeding stated in the Contract to be subsequently maintained as mown grass.

(5) Grassed areas shall be weed free in accordance with Clause AN2.9.09 before any grass cutting is carried out.

Litter collection AN2.9.12 All litter exposed by grass cutting shall be gathered up and disposed of within 24 hours. Any other litter within the grassed or planted areas shall also be removed by the Contractor once it is identified or when instructed by the Engineer throughout the period for establishment works. Litter removal shall be completed within seven days of inspection or instruction.

Post-planting fertilizer AN2.9.13 Post-planting fertilizer shall be applied not less than 100 days, and not more than 300 days, after grassing or planting. The fertilizer shall be applied at a rate of:

(a) 200 g per semi-mature tree, extra heavy standard tree, heavy standard tree, large conifer and large palm,

(b) 100 g per standard tree, light standard tree, small conifer, multi-stem palm, and medium palm,

(c) 50 g per whip tree, seedling tree, bamboo, small palm, large and small shrub, ground cover, herbaceous plant and climber,

(d) 100 g/sq m for grassed area formed by turfing or sprigging, and

(e) 40g/ sq m for grass on slopes and grass grown by hydroseeding or broadcast seeding.

Control of pests, fungi and disease AN2.9.14 (1) The Contractor shall use integrated pest management techniques to control pests.

(2) The Contractor shall take all necessary precautionary measures to protect the plants from pest, fungal and disease attack and all necessary control measures to eradicate pests, fungi and disease from the infected and/or infested plants.

(3) The Contractor shall regularly check for any pest, fungal and disease attack, particularly during known periods of activity.

(4) The Contractor shall report to the Engineer any such occurrence and shall carry out remedial eradication.

(5) If the Contractor considers that it is necessary to use of chemical insecticide or fungicide, he shall obtain prior written approval of the Engineer. Chemical insecticide or fungicide shall be used in accordance with the manufacturer's instructions. Use of sprays is to be with care and with due regard to the safety and convenience of the general public and in accordance with AFCD guidelines. Spraying shall be carefully controlled to avoid unnecessary dispersion.

(6) If termite infestation is found, the Contractor shall employ a termite specialist at his own cost to propose and implement remedial action to the satisfaction of the Engineer.

(7) The Contractor shall comply with the following requirements in applying the pest, fungal and disease control measures:

(a) Environmentally friendly measures shall be adopted,

(b) All pesticides, insecticides, fungicides and chemicals to be used shall be proprietary products registered in Hong Kong,

(c) Safety precautions as the manufacturer's instruction shall be strictly followed in using pesticides, insecticides, fungicides and chemicals so as to avoid causing danger or harm to the public and the environment, and

(d) Plant parts pruned from diseased plants shall not be stockpiled anywhere on the Site and shall be disposed of from the Site.

Forking over AN2.9.15 Surfaces of bare ground which in the opinion of the Engineer are subject to surface panning or compaction of the soil shall be forked over in such a manner that roots are not disturbed and plants are not loosened; plants which are disturbed or loosened shall be firmed up and well watered immediately.

Mulching AN2.9.16 (1) All mulch which is disturbed by replacement planting, weeding or watering shall be made good. Additional mulching over areas of forking over and over areas disturbed by others shall be carried out if instructed by the Engineer.

(2) During the Establishment Period, the Contractor shall carry out three applications of mulch each to a thickness necessary to bring the total depth of mulch of 75mm unless otherwise specified after the application. The final mulching operation is to be carried out in the last month of the Establishment Period.

(3) Mulching to ground cover areas shall not be undertaken once ground cover plants have successfully established and there are no bare areas of soil.

Completion of work AN2.9.17 Immediately before the end of the period for establishment works:

(a) All tree and shrub planting shall be free of weeds,

(b) All planted and grassed areas shall be free of litter,

(c) All replacement planting and patching up of grass shall be completed,

(d) All guys, stakes and ties shall be secure,

(e) All grassed areas shall be cut and the edges trimmed, and

(f) All temporary fencing shall be removed by the Contractor at the end of the Establishment Period unless otherwise directed by the Engineer.

AN2.10 TESTING : GRASS COVER BY SPRIGGING

Testing : grass cover AN2.10.01 (1) Tests shall be carried out to determine the grass cover by sprigging. The tests shall be carried out 100 days after grassing and at the end of the period for establishment works. The grass shall be cut to a height of 300mm if necessary over the parts of the area to be tested.

(2) The number of tests shall be as instructed by the Engineer.

(3) Testing to determine the grass cover will be carried out by the Engineer.

(4) Tests shall be carried out at locations, which in the opinion of the Engineer are representative of the grassed area as a whole. At each test location an approximately square area of $10m^2$ shall be marked.

(5) The percentage of bare ground other than rock and other hard material in each 10m² test area shall be measured.

Compliance criteria: grass cover — AN2.10.02 At least 95% of each test area shall be covered with grass.

AN2.11 TREE TRANSPLANTING

General — AN2.11.01

(1) For the purpose of this Clause, palms and conifers are also considered as trees.

(2) Existing trees, which the Contract requires to transplant, are indicated in the Existing Tree Schedule. Existing trees to be transplanted shall be clearly marked as specified in PS Section AN1.

(3) Pre-determined receptor sites shall receive existing trees to be transplanted. These receptor sites, and the final locations of each transplanted tree, are indicated on the Contract Drawings for reference only. The Contractor shall agree the precise final locations of trees with the Engineer and relevant Government departments before commencement of tree transportation works.

(a) These receptor sites are within the maintenance jurisdictions of the various Government departments listed in the Tree Schedule. The Contractor shall give clear and advance notification to these Government departments, and make all necessary arrangements with these Government departments, prior to delivering the transplanted trees to these receptor sites.

(b) If the designated receptor sites are not ready to receive transplanted trees at a time when the trees must be removed from the Site; the Contractor shall, subject to the approval of relevant authorities, temporarily transplant the trees to the temporary holding nursery where they shall be maintained in an acceptable healthy and vigorous condition until such time as the receptor sites are available and prepared to receive the trees. The Contractor shall submit detailed proposals of all works involving transplanting to the temporary holding nursery, together with a programme of transplanting works to the designated receptor sites, for the Engineer's approval.

(4) Trees shall be maintained and established immediately after transplanting to their receptor sites in accordance with Section AN2.9, and establishment works shall continue for a period of minimum twelve (12) months or as specified in the Contract. Such establishment works shall include all measures necessary to establish and maintain all plants in an acceptable vigorous and healthy growing condition.

Safety — AN2.11.02

(1) The Contractor shall take all precautions necessary to protect the people engaged in the tree transplanting work as well as the people and property in the vicinity,

(2) The Contractor shall take all precautions necessary to ensure that no damage is done to the trees during, lifting, transportation, and any other stages of the transplanting process.

Method Statement and programme — AN2.11.03 Before commencing any work to the trees on the Site, the Contractor shall submit and obtain approval from the Engineer a detailed method statement and programme for transplanting the existing trees, outlining the method, sequencing, timing of operations, and the location and type of machinery to be used for the following operations:

(a) Protection before lifting and transplanting,

(b) Root pruning, including the rootball size, and the number of stages, the operations involved in each stage, and the period between each stage of root pruning,

(c) Crown pruning,

(d) Excavating trenches for rootball preparation,

(e) Design and construction of rootball boxes,

(f) Design and construction of supporting measures,

(g) Attaching lifting gear to the trees,

(h) Protection during transit,

(i) Temporary holding nursery, if required,

(j) Lifting,

(k) Transportation to new location, including routing,

(l) Preparation of receptor site,

(m) Placement, backfilling, mulching and securing at receptor site,

(n) Backfilling and making good the donor site,

(o) Schedule of establishment works during the period for establishment works.

Crown Pruning — AN2.11.04

(1) Crown pruning shall be carried out, as proposed in the Contractor's method statement and approved by the Engineer, at the programme times to reduce the tree mass to balance that of the reduced root mass as a result of root pruning. Crown pruning should be carried out in stages to reflect the stages of root pruning.

(2) Crown pruning shall produce a well-shaped and well-balanced form. Dead, decayed, dying, diseased, infected, broken, crossed, competing and dangerous branches shall be removed as priority. Foliage reduction shall be kept to a minimum where possible and in any case shall not exceed 25% of the original crown density without prior written permission of the Engineer.

(3) Crown pruning shall achieve foliage reduction by means of branch pruning and or leaf picking, and shall be categorised as follows:

(a) Hard Prune. This shall include removal of a substantial number of branches up to 200mm in diameter. The objectives for hard pruning may include removal of hazardous or structurally undesirable branches. Hard pruning shall not be permitted solely to facilitate ease of transplantation. The final shape of the reduced crown shall be even and balanced and provide the basis for the growth of a well shaped new crown. The central main leader of the tree shall not be pruned or interfered without prior written permission from the Engineer. Hard pruning shall not be permitted except as directed by the Engineer.

(b) Light Prune. This shall include the removal of a few branches up to 75mm in diameter with the extent not to exceed 25% of the original tree crown size. The central main leader of the tree shall not be pruned or interfered with.

(c) Thin Crown. This shall include the picking of leaves of the crown with the extent not to exceed 25% of the original tree crown size and leaf density. This minimum-impact approach will prevent loss of the original tree form.

(4) Pruning shall be undertaken in accordance with Clause AN2.9.10.

Root pruning and under-cutting AN2.11.05

(1) The Contractor shall allow the tree transplanting works in his programme of Works in such a way that the root pruning to the approved size of rootball shall commence as early as possible so as to ensure maximum fibrous root growth before the transplanting operations.

(2) Root cutting shall be done in three stages. Each stage to be directed by the Engineer.

(a) The first stage shall involve cutting two parallel straight trenches on opposite sides of the proposed rootball.

(b) The second stage involves cutting two parallel straight trenches on the remaining opposite sides of the proposed rootball.

(c) The last stage is the cutting of the underside of the rootball and the uplifting of the tree. Roots shall be cut free from the ground, not pulled, using a suitable implement to give a clean cut.

(3) The period between each root cutting stage shall be as follows, unless otherwise directed by the Engineer :

(a) Group A Trees = 0 days (trees may be root-cut and uplifted in same day),

(b) Group B Trees = 30 days,

(c) Group C Trees = 45 days.

(d) Group D Trees = 60 days,

(e) Group E Trees = 75 days,

(f) Group F Trees = 90 days.

(g) Group G Trees = 120 days,

(h) Group H Trees = 150 days, and

(i) Group I Trees = 180 days.

(4) In the case of unplanned tree transplanting, as described in Clause AN1.4.03, the Contractor shall submit a proposal, with justification, for the root cutting period for each unplanned tree to be transplanted, in accordance with one of the Groups listed in sub-clause (3) of this clause. No root cutting works shall proceed until the proposal is approved by the Engineer.

(5) The Contractor shall give two days notice of his intention to carry out root pruning operations. All root pruning operations shall be carried out in the presence of the Engineer.

(6) All cutting works shall be carried out in accordance with Section AN1.5.

Rootball Size AN2.11.06

(1) The dimensions of the rootball of trees to be transplanted shall be determined by the Contractor so as to ensure survival of the plant.

(2) As a minimum, the rootball diameter shall be at least 8 times the tree stem diameter, or 67% of the tree crown diameter, whichever is less.

(3) The rootball area shall be marked out and approved by the Engineer prior to trench excavation.

(4) The rootball depth shall normally be in the following range:

(i)	Trees with DBH less than 150mm	800mm
(ii)	Trees with DBH of 150-299mm	1000mm
(iii)	Trees with DBH of 300-499mm	1200mm
(iv)	Trees with DBH of 500mm or more	1500mm

(5) For trees with roots surrounded by hard material, e.g. planter wall, the hard material shall be demolished, if permitted by the Engineer, to allow for more roots to be preserved. The Contractor shall exercise the greatest care when removing the hard material to preserve as many roots as possible.

(6) The rootball of trees surrounded by irregularly-shaped hard materials may be asymmetrical in order to ensure that the maximum volume of roots is preserved during transplanting.

(7) For trees with DBH less than 300mm, the rootball shall be firmed wrapped with hessian burlap and on the outside with sturdy wire mesh to ensure that the soil is kept in full contact around the root system at all times.

(8) Trees with DBH of 300mm or larger shall be transplanted using a rootball box.

Rootball Box AN2.11.07

(1) Rootball box shall be constructed of sturdy materials and shall be capable of holding the entire weight of the tree without support. Anchors shall be fixed into the box to allow for guying of the rootball. Handles or ringlets shall be fixed on the upper side, or outside, of the box to permit lifting of the tree, by the rootball box, from the ground.

(2) Rootball box shall have drain holes at its bottom to allow for free-drainage of the rootball soil.

(3) Rootball box shall be constructed of independent panels with joints capable of being assembled together, *in situ*, around the rootball, while maintaining structural integrity. The panel which forms the bottom of the box shall be slid in and out of the bottom of the box through glides along the bottom of the side panels, as required before uplifting and after transplanting.

(4) Rootball box shall be constructed with an internal dimension 150mm larger than the rootball size in each horizontal direction, and be equal in depth as the rootball.

(5) The Contractor shall submit a proposal of the rootball box, and obtain the approval of the Engineer, prior to their use on Site.

(6) During the first and second stages of root cutting, as outlined in sub-clauses AN2.11.05(2)(a) and (b), a side panel of the rootball box shall be inserted within each trench and be supported 150mm away from the edge of the rootball. The 150mm gap left between the rootball box and rootball soil shall be backfilled with good quality soil from the ground in the vicinity of the tree (so as to match the soil within the rootball), which shall be mixed with slow release fertiliser and root activator in accordance with Clause AN2.11.10, and covered with 50mm deep mulch of soil conditioner. Soil shall be placed in maximum 300mm deep layers and each layer shall be firmly heeled in. Sufficient water shall be applied to assist in the settling of backfilled material.

(7) The bottom of the rootball box shall be slid into place following the final excavation as outlined under Clause AN2.11.08(5) and root cutting as outlined under Clause AN2.11.05(2)(c).

Trenches AN2.11.08

(1) The width of the trenches shall be determined by the Contractor. They shall be at least 300mm and of sufficient width to allow for all necessary root cutting operations, and, if applicable, the placement of a side panel of the rootball box at 150mm away from the cut face of the rootball. The lengths of trenches shall be at least 300mm longer than the approved rootball size in both directions.

(2) The depth of the trenches shall be 150mm deeper than the approved rootball depth.

(3) All trenches shall be backfilled following completion of the root cutting operations and insertion of the rootball box, if applicable, in accordance with Clause AN2.11.07(6). No holes shall be left open to attract the danger of accidental falling-in of persons using the adjacent areas.

(4) Trenches shall be re-opened as necessary to permit the next stage of root cutting and, if applicable, the assembly of the rootball box joints.

(5) Trenches shall be further enlarged as necessary to permit the excavation of the underside of rootball. Excavation and root cutting of the underside of the rootball shall progress from the outside inward, and from the bottom upward. No excavation or loosening of the soil within the approved size of the rootball shall be permitted.

Uplifting AN2.11.09

(1) Uplifting shall be performed immediately after the third stage root cutting and, for trees of 300mm DBH or greater, after the complete assembly of the rootball box including its bottom panel.

(2) Trees with ball and burlap shall have their rootball tied with stainless steel chain net with wooden spacer for uplifting.

(3) Trees with rootball box shall be uplifted by the rootball box only.

(4) The lifting chains and harnesses shall be only be anchored to either the rootball box or the steel chain net wrapping around the rootball for the ball and burlap method.

(5) The use of any above-ground portion of the tree, including it trunk, as a point of uplift will cause trunk or branch breakage and the stripping of bark, and is not permitted.

(6) Plants shall be lifted carefully to avoid damage to any portion of the tree. For trees with rootball box, the rootball shall be firmly resting within the rootball box and tied to the rootball box with guy wires attached to fixed anchors within the rootball box.

(7) The upper part of the lifting cable shall be spread out by frame spacer to prevent the cable from touching the stem and branch at the time of lifting. Guying rope shall be tied to the lifting cable to stabilise the tree at the time of lifting.

(8) The tree stem and main branches shall be protected during uplifting by burlap wrapping.

(9) Trees may be leaf-picked prior to transplanting in order to reduce transpiration. Such leaf picking shall be carried out only upon prior written approval of the Engineer, and according to Clause AN2.11.04(3)(c).

(10) Immediately prior to lifting record photographs shall be taken and the tree shall be tagged to note the tree's natural angle of growth and compass orientation, so that this may be replicated at either the receptor site or temporary holding nursery, as appropriate.

Root Activator AN2.11.10

Root activator shall be applied after the first stage and second stage root cutting, and at regular intervals during the maintenance operations, according to the manufacturer's instruction.

Timing AN2.11.11

(1) Transplanting operations shall be timed so as to enable transplanting of the trees direct to the areas of proposed planting, either in the final receptor site or the temporary holding nursery. No lifting and transplanting operations shall commence until either the receptor sites or the holding nursery, as appropriate, are fully prepared as specified.

(2) Lifting and transplanting operations shall be carried out only following a period of consistent rainfall which has thoroughly watered the trees to the satisfaction of the Engineer or following a thorough watering of the trees by the Contractor at a rate agreed by the Engineer.

(3) Any tree lifted must be transplanted and watered on the same day.

Watering of Transplanted Trees AN2.11.12

(1) Watering of the rootball and trenches, during stages of root cutting and before uplift from the ground, shall be carried out daily during the dry season; and in any case regularly to ensure that trees that have been root pruned or crown pruned do not dry out and suffer irreparable damage. The contractor shall submit proposed frequency of watering during stages of root cutting as part of his detailed method statements and programme for the Engineer's approval.

(2) Immediately after transplanting, the bases of all trees are to be well watered, using enough water to thoroughly soak the rootball to field capacity. Trees should be watered during evenings and early mornings only.

(3) Watering shall be more frequent during the first three months of the Establishment Period.

(4) Watering shall be carried out daily during the dry season, generally September to April. Watering shall be undertaken to field capacity.

(5) Watering shall be carried out as required during the wet season.

(6) Watering shall be done after checking soil water content, so as to avoid potential water-logging damage to roots.

(7) Evergreen trees with large canopies and girth of 2000mm or greater shall have mist system irrigation installed within the canopy head. The contractor shall submit a proposed system of mist irrigation as part of his detailed method statement.

Protection During Transit AN2.11.13

(1) Trees shall be transported in open top containers suitable for the tree size. Care shall be taken in packing trees to prevent over-heating with resultant loss of foliage.

(2) Tree stems and main branches shall be protected during transit by burlap wrapping.

(3) Tree crowns and rootballs shall be protected during transit against excessive sunlight, wind, drought, mechanical damage, smoke, artificial heat and other damage.

(4) Damaged plant material may be rejected by the Engineer. Damaged material which is not so rejected shall be carefully pruned using sharp clean implements to give a single flat sloping face cut.

Transportation of Very Large Transplanted Trees AN2.11.14

(1) Transportation of very large transplanted trees on public roads shall be undertaken during the hours from 8pm to 5am unless agreed otherwise by the Engineer, Transport Department and Police.

(2) The Contractor shall be responsible for obtaining all necessary approvals from relevant authorities for his temporary traffic management schemes and shall employ qualified traffic consultant to make submissions to relevant authorities.

Planting in Holding Nursery AN2.11.15

(1) When the receptor site is not available at the time of the tree transplanting, trees shall be planted in a temporary holding nursery until such time as the permanent receptor site is available and prepared to receive the trees.

(2) Trees with ball and burlap shall be planted with burlap in place, in an upright position, exactly as per their original growing angle and compass orientation, allowing adequate space for growth, and guyed and staked securely to avoid damage to the tree stems and rootballs, all to the satisfaction of the Engineer.

(3) Trees with rootball boxes shall be kept in their rootball boxes and shall be placed on flat level ground in an upright position, exactly as per their original growing angle and compass

orientation, allowing adequate space for growth, and guyed securely to avoid movement of the rootball box and tree, all to the satisfaction of the Engineer.

(4) Immediately following planting or placing the plants shall be watered thoroughly to ensure a thorough soaking of the roots to field capacity.

Planting Direct to Receptor Site AN2.11.16

(1) Plants transplanted direct to the permanent receptor site are to be planted in accordance with PS Section AN2 unless otherwise specified. The receptor site shall be prepared in advance of the uplifting and transplanting of the tree.

(2) Tree pits shall be of a saucer shape with flat centre and slightly sloping sides. The flat bottom centre shall be as wide as the rootball, and each sloping edge shall be as wide as the rootball width, or 1000mm, whichever is smaller, on all sides.

(3) Tree pit bases shall be broken up and loosened to a depth of 300mm.

(4) Trees shall be planted in upright position exactly as per their original growing angle and compass orientation, as recorded in accordance with Clause AN2.11.09(10).

(5) Trees shall be secured in position either by guys and stakes or by underground guying, as appropriate, all as described in Section AN2.7, and to the approval of the Engineer.

(6) Immediately following planting, a soil saucer of 150mm depth shall be formed on the soil surface around the edge of the rootball circumference to permit rain or irrigation water to be retained and slowly infiltrate into the rootball perimeter. Immediately thereafter, the trees shall be watered in accordance with Clause AN2.11.12(2).

Planting to Receptor Site outside Works Boundary AN2.11.17

Where trees are to be transplanted to sites outside the Works boundary that are within the maintenance jurisdictions of the various Government departments, the Contractor shall agree the precise final location with the relevant Government departments, and give clear and advance notification to these Government departments, and make all necessary arrangements with these Government departments, prior to delivering the transplanted trees to these receptor sites.

Maintenance Works to Transplanted Trees in Temporary Holding Nursery AN2.11.18

(1) Trees shall be treated with maintenance works immediately after transplanting to the temporary holding nursery, until such time as the tree is transplanted to the permanent receptor site. Such maintenance works shall include all measures necessary to maintain the trees in an acceptable vigorous and healthy growing condition. Maintenance operations as stipulated under Section AN2.9 shall be required during the entire period the trees are maintained in the temporary holding nursery. The maintenance works shall be carried out in accordance with the requirements in Section AN2.9 unless otherwise proposed in the Contractor's method statement and approved by the Engineer.

(2) One application of fertiliser shall be made in early Spring (March) and September each year, or as directed by the Engineer.

Establishment Works to Transplanted Trees in Receptor Site AN2.11.19

(1) Trees shall be treated with establishment works immediately after transplanting to their final receptor site, for a period of 12 months. Such establishment works shall include all measures necessary to establish and maintain the trees in an acceptable vigorous and healthy growing condition. Establishment operations as stipulated under Section AN2.9 shall be required during the Construction Period and Establishment Period. The establishment works shall be carried out in accordance with the requirements in Section AN2.9 unless otherwise proposed in the Contractor's method statement and approved by the Engineer.

(2) One application of fertiliser shall be made in early Spring (March) and September each year, or as directed by the Engineer.

Cordon Zone for Transplanted Trees AN2.11.20

(1) Where specified on the drawings or instructed by the Engineer, very large solitary transplanted trees or groups of transplanted trees shall have a Cordon Zone created around them to protect them.

(2) The Cordon Zone shall be delimited by a 2000mm high chain-link fence with a pad-locked gate, and access to it shall be restricted to workers involved in tree work.

(3) No construction worker shall enter the Cordon Zone. No construction equipment or materials should breach the Cordon Zone. No artificial heat or fumes shall impinge into the Cordon Zone. No lifted materials shall sail above the Cordon Zone.

(4) The base of the chain link fence shall be sealed by a waterproof rim such as sand bag at least 300mm tall to prevent the entry of contaminated construction water and other effluent into the Cordon Zone.

Monitoring of Transplanted Trees AN2.11.21

(1) The performance of the transplanted trees shall be monitored by the Contractor throughout the root preparation period, maintenance period in holding nursery and establishment period in receptor site on a monthly basis by recording the following data in report format:

(a) tree growth condition with reference to trunk, branches, foliage, soil and root,

(b) any arboricultural problems and associated remedial measures.

(c) Photographic record at stages listed in sub-clause (4) of the clause.

(2) Any construction activities that may impact the trees negatively shall be reported well in advance to the Engineer for planning of preventive tree work to avoid possible damage.

(3) The contractor shall report to the management office before and after carrying out each day's maintenance works on the transplanted trees and a countersigned record log book of the work carried out shall be kept at the site office and made available for inspection. All non-routine tree problems are to be promptly reported to the Engineer.

(4) The Contractor shall submit a record photographic report of each of the following stages:

(a) Before commencement, showing the existing growth angle and compass orientation of the tree, so that this may be replicated after transplanting.

(b) After any crown pruning / thinning.

(c) The rootball trenches after each stage of root cutting and before backfilling, showing clearly all major roots that had been cut.

(d) Forming of the root ball (and rootball box if applicable).

(e) The rootballs of all trees after lifting from ground.

(f) Excavating tree pit at holding nursery (if applicable).

(g) Transit to holding nursery (if applicable).

(h) After planting at holding nursery (if applicable).

(i) Monthly record photo during maintenance period in holding nursery (if applicable).

(j) Excavating tree pit at receptor site.

(k) Transit to receptor location.

(l) After transplanting into receptor sites and after guying and staking are installed.

(m) Monthly record photo during 12 months establishment period.

Replacement of Dead or Damaged Trees	AN2.11.22	(1) The contractor shall be responsible for the removal and replacement at his own cost of any transplanted tree which dies during the contract, or is seen to be dying at the end of the establishment period, which is, in the opinion of the Engineer, as a result of his poor workmanship, poor quality materials, neglect, or failure to comply with any obligation expressed or implied under the Contract. (2) The Contractor shall provide replacement planting of new trees of the same species and of similar size and form as the dead or damaged ones before the death or damage or provide other alternative replacement planting as agreed by the Engineer. (3) The Contractor shall complete the replacement planting within 28 days of the Engineer's instruction or other time duration as agreed by the Engineer.
Handover of Transplanted Trees	AN2.11.23	At the end of the Establishment Period, the Contractor shall be responsible for the handover of the transplanted trees to the relevant Government departments, and shall arrange all necessary handover inspections with the Government departments.

AN3 NURSERY WORKS

AN3.1 GENERAL

General requirements	AN3.1.01	The works and materials specified in Clauses AN3.1.04 to AN3.1.06 shall comply with the sections stated, unless otherwise stated in this Section.
Specialist Contractor	AN2.1.02	If the Contractor is not included in the "List of Approved Suppliers of Materials and Specialist Contractors for Public Works" under the category of "Landscaping: Class I - General Landscape Work", he shall enter into a written sub-contract with a specialist contractor to carry out the landscape softworks.
Photographic Record	AN3.1.03	The Contractor shall make a photographic record of the nursery site at the time of site possession so that the site can be returned to its former condition at the end of the contract.
Site Clearance	AN3.1.04	(1) Site clearance shall comply with PS Section AN1. During site clearance, where appropriate and as required by the Engineer, any existing topsoil shall be stripped and stockpiled by a method agreed by the Engineer and in an area designated or agreed by the Engineer. (2) Concrete hard standing shall not be broken out unless by prior written approval from the Engineer. Any hard standing so broken out shall be reinstated at the decommissioning of the Nursery to a standard to match the original hard standing.
Tree and Vegetation Protection	AN3.1.05	All clearance of existing vegetation, tree felling, pruning, transplanting required for the creation of the Nursery shall be undertaken by a specialist landscape contractor in accordance with PS Section AN1. In addition to the general requirements of the Contract the Contractor shall demonstrate that the proposed specialist landscape sub-contractor has sufficient experience and skilled labour to undertake the tree work specified.
Soft Landscape Works	AN3.1.06	All soft landscape works shall comply with PS Section AN2.
Environmental Sustainability	AN3.1.07	The use of organic, eco-friendly and environmentally sustainable products is required for all plant procurement and nursery works.
Integrated Pest Management	AN3.1.08	An Integrated Pest Management strategy that minimizes the use and dependence on chemicals shall be adopted.
Use of Inorganic Chemicals	AN3.1.09	Inorganic chemicals shall not be used for the nursery works unless approved by the Engineer. Inorganic chemicals shall be used, stored, mixed and applied in accordance with the manufacturer's recommendations. Containers for inorganic chemicals shall be disposed of off Site by methods approved by the Engineer.
Government Approvals	AN3.1.10	The Contractor shall obtain all necessary import licences, and Government approvals for the nursery works and the establishment, operation and decommissioning of the nursery.

AN3.2 GLOSSARY

Nursery Works	AN3.2.01	Nursery works are all the works undertaken in the establishment, operation, management, administration and decommissioning of the Nursery.
Temporary Holding Nursery (THN)	AN3.2.02	(1) The Temporary Holding Nursery (THN) is an on-site nursery established and operated by the Contractor for the sole purpose of undertaking the Contract works. (2) The purpose of the THN is to provide a facility to hold transplanted trees and maintain them in a healthy and vigorous condition until such time as their receptor sites and available and prepared to receive them. (3) The THN shall be subdivided between separate site locations as indicated in the Contract drawings, and any additional locations provided by the Contractor at his own expense. (4) The THN shall be decommissioned by the Contractor at the end of the Contract. (5) Under no circumstances shall the THN be used by the Contractor for any purpose other than described or implied under the Contract.

AN3.3 MATERIALS

Building Materials	AN3.3.01	All building materials used in the construction of buildings, offices, stores in the THN shall be fit for purpose in creating a safe and comfortable environment for users.
Soft Landscape Materials	AN3.3.02	Soft landscape materials shall comply with the specification in Section AN2.3 as a minimum requirement.
General Plant Quality Standards	AN3.3.03	(1) The following standards are applicable: (a) BS 3936 – Part 1 : Nursery Stock, Tree and Shrubs; (b) BS 3998 : Recommendations for Tree Work (c) BS 4043:1989 : Transplanting (d) BS 4428 : General Landscape Operations. (e) BS 5837 : Guide for trees in relation to construction (f) American National Standards Institute ANSI Z60.1- American Standard for Nursery Stock (2) Plants shall be free of pests and disease including viruses, nematodes, non-symbiotic fungi, phytophera, scale, mealy bug, red spider, aphis, white fly and thrips. (3) Plants shall be free of mechanical, physical or insect damage including leaf burn, chewing insect, stem marks. (4) Plants shall be healthy and showing consistent vigour during the growth period. (5) Plants shall be well hardened off with consistent even growth typical of the species. (6) Plants shall be correctly and clearly labelled with tree identification number.

AN3.4 TEMPORARY HOLDING NURSERY WORKS

General	AN3.4.01	The Contractor shall establish, operate and decommission an on-site Temporary Holding Nursery (THN) for the sole purposes of the Contract.
THN Location and Size	AN3.4.02	(1) The THN shall be located in one or both of the following sites indicated in the contract drawings: (a) So Kun Wat (2.13 ha) (b) Siu Lang Shui (1.03 ha)

(2) The Contractor shall be deemed to have inspected the nursery site(s) at tender stage and determined that the sites are sufficient for the purpose of the THN. If the Contractor deems that additional site(s) are required he shall provide these at his own expense.

Purpose — AN3.4.03 — The purpose of the THN is to provide a facility to hold transplanted trees in a healthy and vigorous condition until such time as their receptor sites are available and prepared to receive them.

THN Duration — AN3.4.04 — The THN shall be temporary and shall remain operational until the date of transplanting the final transplanted tree to its permanent receptor location.

THN Design — AN3.4.05

(1) The Contractor shall design the THN to satisfy the purpose of the THN and requirements of the Contract. Within two weeks of the commencement of the Contract, the Contractor shall submit the detailed design for the THN for review and approval by the Engineer.

(2) The Contractor shall provide a THN layout design which retains flexibility over the Contract duration and permits the efficient and wise temporary holding of stock within the spatial limitations of the available site(s).

(3) As a minimum requirement, the THN shall include the following:

(a) Site clearance and formation of the land to suit the purpose of the THN.

(b) Site office and administration facilities, including meeting room, washroom, toilet, first aid facilities, etc.

(c) Covered plant, equipment and materials storage.

(d) Dangerous goods store.

(e) Hard stand holding areas for transplanted trees in rootball boxes, with slight falls to surface channels / soakaways to prevent water ponding. Sloping sites shall be terraced as necessary to create these flat level areas.

(f) Soft ground holding areas for transplanted trees in ball and burlap that are flat and level with slight falls to drainage channels / soakaways to prevent water-logging of soils and surface water ponding. Sloping sites shall be terraced as necessary to create these flat level areas.

(g) Hard stand areas for plant delivery / collection without interference with other nursery operations.

(h) Security perimeter fence and gate facility.

(i) Rubbish collection point.

(j) Composting facility.

(k) Comprehensive irrigation system.

(l) Illumination that provides a safe working environment and avoids light pollution and energy wastage.

(m) An anchoring / support system for trees that is able to withstand wind forces as approved by the Engineer.

(n) All services and utilities required for nursery construction, operation and decommission.

Growing Medium in THN — AN3.4.06

(1) The Contractor shall provide a suitable growing medium for the healthy and vigorous growth of all plants held within the THN. If necessary, imported soiling materials including completely decomposed granite, subsoil, topsoil, and / or soil-mix shall be used to augment the existing soil condition to create the suitable growing medium during the holding period.

(2) The Contractor shall be deemed to have inspected the nursery site(s) at tender stage and determined and allowed for the soil remedial measures required to create a suitable growing medium for healthy and vigorous plant growth during the holding period.

(3) All imported soiling materials shall be as specified in Section AN2.3.

(4) Soiling materials delivered and installed in the THN shall be tested for N.P.K. value, organic matter content, Cation Exchange Capacity ratio, organic carbon, pH value, physical content of sand, silt and clay, and water content. Soil testing shall be arranged by the Contractor and carried out by an approved reputable firm or institute at the contractor's cost, and the report shall be submitted to the Engineer for approval.

THN Operation & Maintenance Manual — AN3.4.07

(1) Within four weeks of the commencement of the Contract the Contractor shall submit a comprehensive THN Operations and Maintenance Manual which shall address how the plants will be maintained in a healthy and vigorous condition during the holding period, including a description of the following:

(a) Layout Plans of the THN facilities including entrance point, gates and fencing, internal roads, hard standings and soft ground areas, gravel areas, buildings, stores, covered areas, water tanks, irrigation layout and pumps, lighting and drainage.

(b) Soiling strategy to provide a suitable growing medium for plants planted into the ground, with specific reference to any remedial treatments to the existing site condition necessary to create the appropriate growing medium for healthy and vigorous plant growth during the holding period.

(c) Integrated pest management strategy using organic products that do not conflict with the EP and other environmental and drainage regulations and requirements.

(d) Fertilizing Strategy - including fertilizer descriptions, application rates and programmes. Inorganic fertilizers shall not be used without prior written approval of the Engineer. It is strongly preferred that organic fertilizer is used in preference to inorganic fertilizer. However, use of inorganic fertilizer may be accepted by the Engineer if suitable justification is provided by the Contractor.

(e) General Tree Maintenance Strategy - including crown thinning, root pruning, staking and tying, watering, weeding, litter removal, etc.

(f) Equipment inventory, equipment maintenance procedures and manufacturers' maintenance manuals.

(g) Personnel.

(2) Three bound copies of the manual in A4 format and scanned copy PDF shall be submitted to the Engineer.

THN Security and access — AN3.4.08

(1) The THN shall have 24 hour security executed by security guard(s) who shall be housed in an office cabin near the THN entrance, and who shall be responsible for recording weather conditions, visitors, delivery / collection and vehicle registration for reporting procedures.

(2) The THN shall be enclosed by hoarding and / or a secure chain link fence in accordance with MTRCL Site Regulations and approved by the Engineer.

THN Infrastructure — AN3.4.09

(1) The following infrastructure shall be provided by the Employer:

(a) (no infrastructure shall be supplied by the Employer)

(2) All other necessary infrastructure shall be supplied and maintained with necessary permits by the Contractor including but not limited to:

(a) electricity supply;

(b) potable water supply;

(c) flushing water supply;

(d) irrigation water supply;

(e) Telephone lines and modem;

(f) Sewage, storm water and general drainage.

(3) The Contractor shall be responsible for the upkeep and maintenance of the THN infrastructure and utilities for the duration of the Contract. The Contractor shall be responsible to pay all utility charges imposed by utility companies for the construction, operation and decommissioning of the THN.

(4) The Contractor shall immediately advise the Engineer of any difficulty experienced in providing the necessary infrastructure for the establishment and operation of the THN.

THN Sign Boards AN3.4.10

(1) The Contractor shall provide prominent attractive signboards written in both English and Chinese at suitable visible locations proposed by the Contractor and approved by the Engineer. Nursery Sign Boards shall be prepared for each separate nursery site.

(2) They shall be sign written by a skilled sign writer to show the details described in the Contract plus any other relevant details to the approval of the Engineer. Signage graphics shall be in accordance with MTRCL brand logo and graphic design style, which shall be provided by the Engineer upon request.

(3) Under no circumstances, shall sub-contractors' or suppliers' name-boards be fixed on hoardings or elsewhere on the site. The Contractor is responsible for obtaining all necessary approvals for the erection of these notice boards. They shall be well maintained during the period of operation of the THN.

(4) Upon decommissioning of the THN, the signboards and supports shall be dismantled.

Irrigation System AN3.4.11

(1) The Contractor shall provide an irrigation system for the adequate servicing of the THN and to promote healthy and vigorous growth of the plants. This irrigation water shall be of a quality and standard suitable for both plant material and for handling by nursery workers.

(2) An intelligent irrigation system is required that will avoid excess water use and avoid discharge from the THN into surrounding areas, rivers or streams.

(3) Within four weeks of commencement of the Contract, the Contractor shall submit the irrigation design of the THN for review and approval by the Engineer.

Weed Suppressant Membrane AN3.4.12

All soft ground tree and plant holding areas in the THN shall be covered with a geo-textile / weed suppressant membrane to discourage weed growth and enable the efficient removal of debris.

Plant Organisation AN3.4.13

(1) Transplanted trees shall be stored in the nursery in a neat, tidy, well organised manner, with trees grouped together according to a system to be agreed by the Engineer, for ease of inspection and approval, and for ease of extraction of the trees at the appropriate time without interference with other trees.

(2) Transplanted trees shall be clearly labelled with their tree ID number.

(3) Transplanted trees in rootball boxes shall be stored on hard standing areas and transplanted trees not in rootball boxes shall be stored in soft ground areas with weed suppressant membrane as per Clause AN3.4.12.

(4) Trees shall be spaced to allow for their healthy and vigorous growth, and the anticipated increased spread of their crowns based on their planned duration in the THN.

(5) Trees shall be spaced to allow for their extraction by heavy lifting equipment without interference with adjacent trees.

Plant Maintenance AN3.4.14

Plants shall be treated with maintenance works immediately after locating to the THN, until such time as they are removed to their permanent receptor site(s). Such maintenance works shall include all measures necessary to maintain the plants in an acceptable vigorous and healthy growing condition. Establishment operations as stipulated under Section AN2.9 shall be required during the entire period the plants are maintained in the THN. The maintenance works shall be carried out in accordance with the requirements in Section AN2.9 unless otherwise proposed in the Contractor's Nursery Operation and Maintenance Manual and approved by the Engineer.

Root Pruning of Trees in Ball and Burlap AN3.4.15

Trees in ball and burlap shall be root pruned at regular intervals to maintain the feeding roots at the perimeter of the rootball for the duration of the trees' stay in the nursery. The frequency of the root pruning exercise shall be proposed by the Contractor in his Nursery Operation and Maintenance Manual (Clause AN3.4.07) for approval by the Engineer.

Integrated Pest management AN3.4.16

(1) The Contractor shall use integrated pest management techniques to control pests.

(2) The Contractor shall take all necessary precautionary measures to protect the plants from pest, fungal and disease attack and all necessary control measures to eradicate pests, fungi and disease from the infected and/or infested plants.

(3) The Contractor shall regularly check for any insect attraction or fungal infestation particularly during periods of known activity.

(4) The Contractor shall report to the Engineer any such occurrence and shall carry out remedial eradication.

(5) If the Contractor considers that it is necessary to use of chemical insecticide or fungicide, he shall obtain prior written approval of the Engineer. Chemical insecticide or fungicide shall be used in accordance with the manufacturer's instructions. Use of sprays is to be with care and with due regard to the safety and convenience of the general public and in accordance with AFCD guidelines. Spraying shall be carefully controlled to avoid unnecessary dispersion.

(6) If termite infestation is found, the Contractor shall employ a termite specialist at his own cost to propose and implement remedial action to the satisfaction of the Engineer.

(7) The Contractor shall comply with the following requirements in applying the pest, fungal and disease control measures:

(a) Environmentally friendly measures shall be adopted,

(b) All pesticides, insecticides, fungicides and chemicals to be used shall be proprietary products registered in Hong Kong,

(c) Safety precautions as the manufacturer's instruction shall be strictly followed in using pesticides, insecticides, fungicides and chemicals so as to avoid causing danger or harm to the public and the environment, and

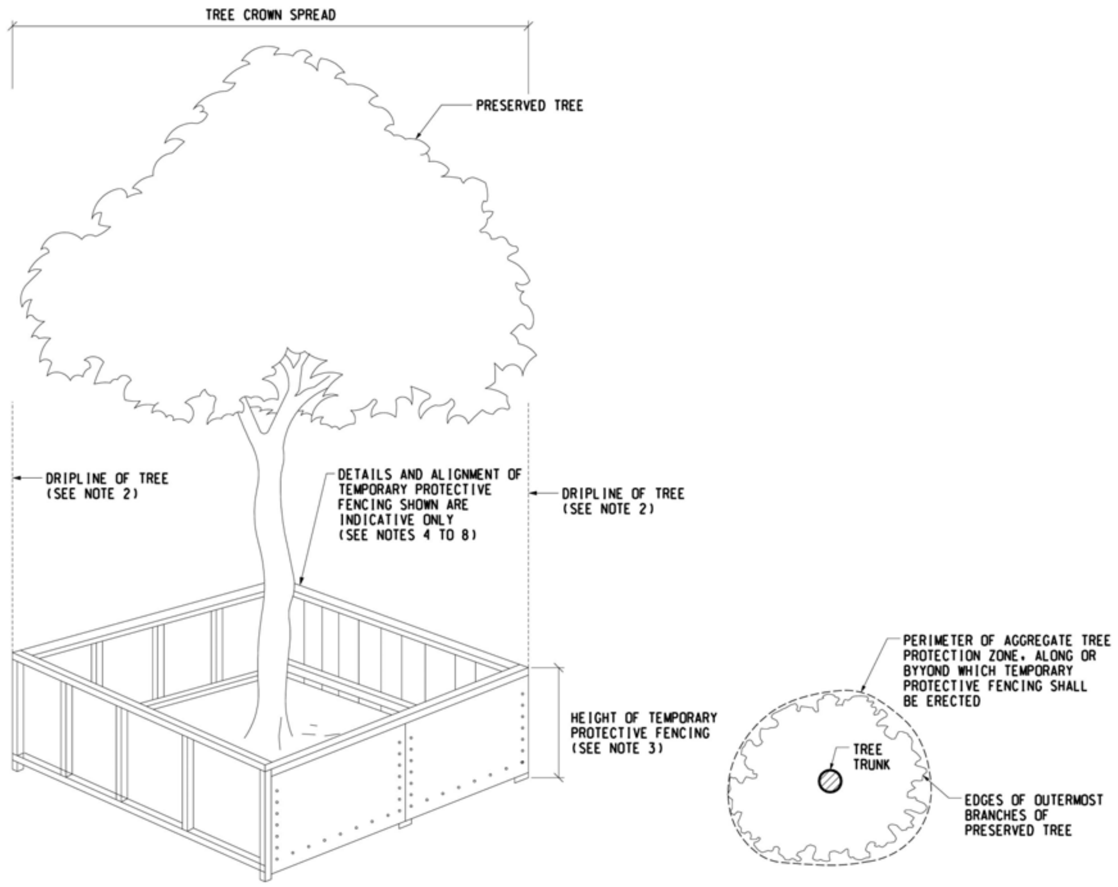
(d) Plant parts pruned from diseased plants shall not be stockpiled anywhere on the Site and shall be disposed of from the Site.

Daily Record	AN3.4.17	The Contractor shall keep a daily log book record of the work carried out which shall be available for inspection by the Engineer at the THN office. Failure to adequately maintain the work log book will result in a reduced certified payment on that part of work considered to be unsatisfactory or in-complete.
Record Photos	AN3.4.18	Monthly record photos shall be taken of all plants in the THN, and submitted to the Engineer in report format.
Decommissioning of THN	AN3.4.19	(1) The THN shall be decommissioned at the vacation dates of the nursery sites as stipulated in the contract to enable the Employer to handover the land back to Government. (2) Decommissioning of the THN shall entail the removal of all superstructure, substructure, fencing, signage and utilities from the site, and a levelling / grading of the area to reinstate the site condition and levels that existed prior to the construction of the THN, except as stated in sub-clauses (3) and (4) of this clause. (3) Any concrete hard standing that was broken out shall be reinstated to a standard to match the original hard standing, unless prior written permission is granted by the Engineer not to reinstate it. (4) Topsoil or soil-mix that was imported for the creation of the nursery may not be retained on site after decommissioning, unless prior written permission is granted by the Engineer, in which case it shall be spread evenly over the site or as directed by the Engineer. (5) The site shall be left in a vacant, clean and tidy state.
THN Compliance with Environmental Permit and Government Regulations	AN3.4.20	(1) The Contractor shall be liable for all THN daily activities which must conform to requirements (if any) in the Environmental Permit (EP) as revised/ issued throughout the duration of the Contract. (2) Any costs or penalties imposed by Government due to the Contractor's non-compliance with the Environmental permit (EP) or any other Government regulation will be borne by the Contractor.

ANNEX 1
Tree Protection Drawings

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRIPLINE OF TREE / TREE GROUP EXTENDS TO THE OUTERMOST BRANCHES OF THE TREE / TREE GROUP DEFINING THE PERIMETER OF THE TREE PROTECTION ZONE / AGGREGATE TREE PROTECTION ZONE.
3. HEIGHT OF TEMPORARY PROTECTIVE FENCING SHALL BE 1500 MINIMUM, BUT THE REQUIRED HEIGHT SHALL BE DETERMINED BY THE ENGINEER WHEN APPROVING THE CONSTRUCTION DETAILS OF THE FENCING AS REFERRRED TO IN NOTE 8.
4. TEMPORARY PROTECTIVE FENCING SHALL BE STRONG AND APPROPRIATE FOR RESISTING THE IMPACTS OF CONSTRUCTION ACTIVITIES ON THE SITE. IT SHALL BE MADE OF ROBUST MATERIALS AND SHALL COMPRISE A VERTICAL AND HORIZONTAL SCAFFOLDING FRAMEWORK WELL BRACED AND SUPPORTING CLEFT WOODEN PALETTE FENCING OR CHAN LINK FENCING / WOODEN BOARD FENCING OR STEEL SHEET FENCING OR OTHER FENCING AS APPROVED BY THE ENGINEER ONLY IN EXCEPTIONAL CIRCUMSTANCES SHALL PLASTIC WEBBING BE CONSIDERED.
5. THE ALIGNMENT OF TEMPORARY PROTECTIVE FENCING CAN BE IN CIRCULAR, SQUARE, RECTANGULAR OR ANY OTHER SHAPE SO LONG AS THE FENCING DOES NOT ENCROACH INTO THE TREE PROTECTION ZONE.
6. A LOCKABLE GATE SHALL BE PROVIDED TO THE TEMPORARY PROTECTIVE FENCING TO ALLOW ENTRY FOR CARRYING OUT THE NECESSARY ARBORICULTURAL WORKS OR MAINTENANCE WORKS TO THE TREE OR ANY OTHER APPROVED WORKS WITHIN THE TREE PROTECTION ZONE.
7. WARNING NOTICE GUARDING AGAINST UNAUTHORISED OPERATIONS WITHIN FENCED AREA SHALL BE ERECTED ON THE TEMPORARY PROTECTIVE FENCING.
8. THE CONTRACTOR SHALL SUBMIT THE CONSTRUCTION DETAILS OF THE TEMPORARY PROTECTIVE FENCING TO THE ENGINEER FOR APPROVAL PRIOR TO ERECTION OF THE FENCING.



PERSPECTIVE - INDIVIDUAL TREE
(DIAGRAMMATIC)

PLAN - INDIVIDUAL TREE
(DIAGRAMMATIC)

TP001 - TEMPORARY PROTECTIVE FENCING TO PRESERVED TREE (INDIVIDUAL TREE)

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRIPLINE OF TREE / TREE GROUP EXTENDS TO THE OUTERMOST BRANCHES OF THE TREE / TREE GROUP DEFINING THE PERIMETER OF THE TREE PROTECTION ZONE / AGGREGATE TREE PROTECTION ZONE.
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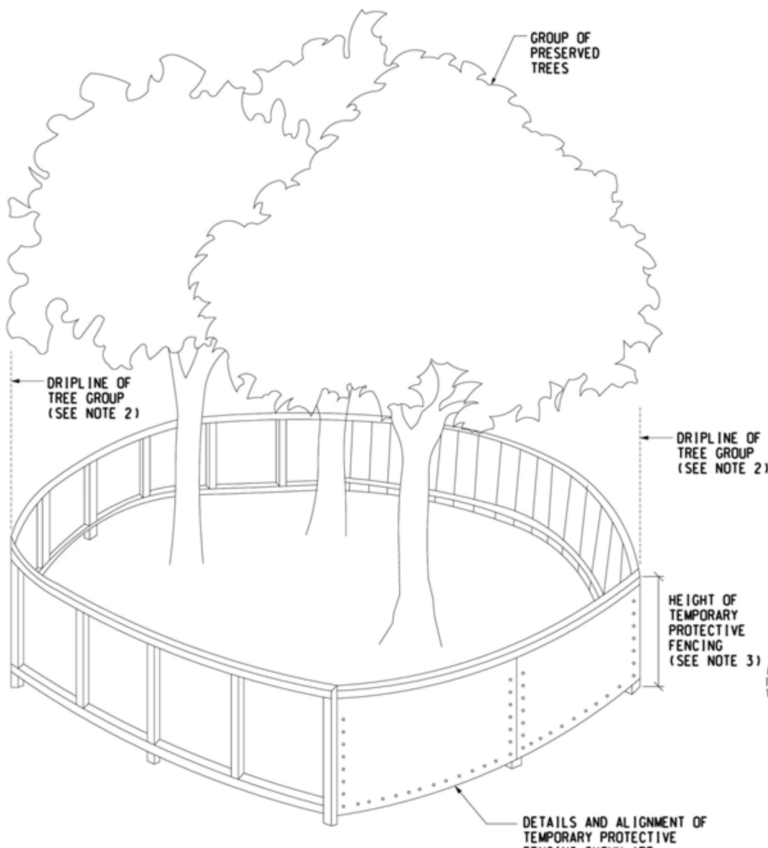
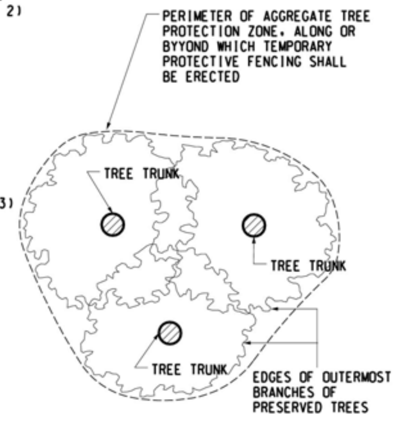
4. TEMPORARY PROTECTIVE FENCING SHALL BE STRONG AND APPROPRIATE FOR RESISTING THE IMPACTS OF CONSTRUCTION ACTIVITIES ON THE SITE. IT SHALL BE MADE OF ROBUST MATERIALS AND SHALL COMPRISE A VERTICAL AND HORIZONTAL SCAFFOLDING FRAMEWORK WELL BRACED AND SUPPORTING CLEFT WOODEN PALETTE FENCING OR CHAN LINK FENCING / WOODEN BOARD FENCING OR STEEL SHEET FENCING OR OTHER FENCING AS APPROVED BY THE ENGINEER ONLY IN EXCEPTIONAL CIRCUMSTANCES SHALL PLASTIC WEBBING BE CONSIDERED.
5. THE ALIGNMENT OF TEMPORARY PROTECTIVE FENCING CAN BE IN CIRCULAR, SQUARE, RECTANGULAR OR ANY OTHER SHAPE SO LONG AS THE FENCING DOES NOT ENCROACH INTO THE TREE PROTECTION ZONE.
6. A LOCKABLE GATE SHALL BE PROVIDED TO THE TEMPORARY PROTECTIVE FENCING TO ALLOW ENTRY FOR CARRYING OUT THE NECESSARY ARBORICULTURAL WORKS OR MAINTENANCE WORKS TO THE TREE OR ANY OTHER APPROVED WORKS WITHIN THE TREE PROTECTION ZONE.
7. WARNING NOTICE GUARDING AGAINST UNAUTHORISED OPERATIONS WITHIN FENCED AREA SHALL BE ERECTED ON THE TEMPORARY PROTECTIVE FENCING.
8. THE CONTRACTOR SHALL SUBMIT THE CONSTRUCTION DETAILS OF THE TEMPORARY PROTECTIVE FENCING TO THE ENGINEER FOR APPROVAL PRIOR TO ERECTION OF THE FENCING.



PERSPECTIVE - GROUP OF TREES
(DIAGRAMMATIC)

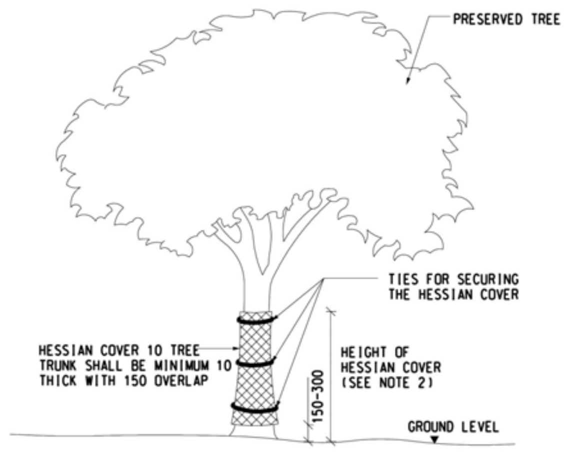


PLAN - GROUP OF TREES
(DIAGRAMMATIC)

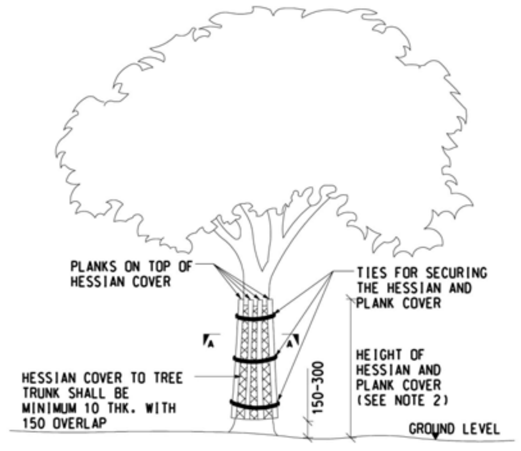
TP002 - TEMPORARY PROTECTIVE FENCING TO PRESERVED TREE (GROUP OF TREES)

NOTES

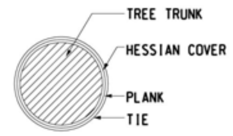
1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. HEIGHT OF *HESSIAN COVER / HESSIAN AND PLANK COVER TO THE TRUNK SHALL BE 1500 MIN. BUT THE REQUIRED HEIGHT FOR DIFFERENT INDIVIDUAL TREES SHALL BE DETERMINED BY THE ENGINEER ON SITE.



TEMPORARY PROTECTIVE HESSIAN ARMOURING TO PRESERVED TREE
(DIAGRAMMATIC)



TEMPORARY PROTECTIVE HESSIAN AND PLANK ARMOURING TO PRESERVED TREE
(DIAGRAMMATIC)



SECTION A-A

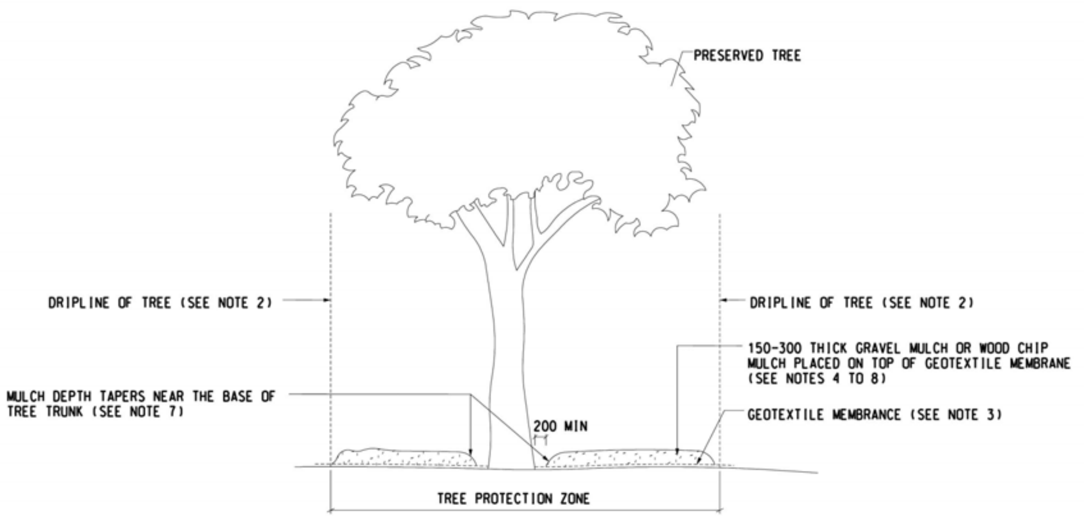
TP003 - TEMPORARY PROTECTIVE ARMOURING TO PRESERVED TREE (HESSIAN AND PLANK)

Tree Removal Application for XRL – TRA-10: Works in Yuen Long District (Tai Shu Ha)

APPENDIX V : Particular Specification for Tree Works, Soft Landscape Works & Related Works [rev 11]

NOTES

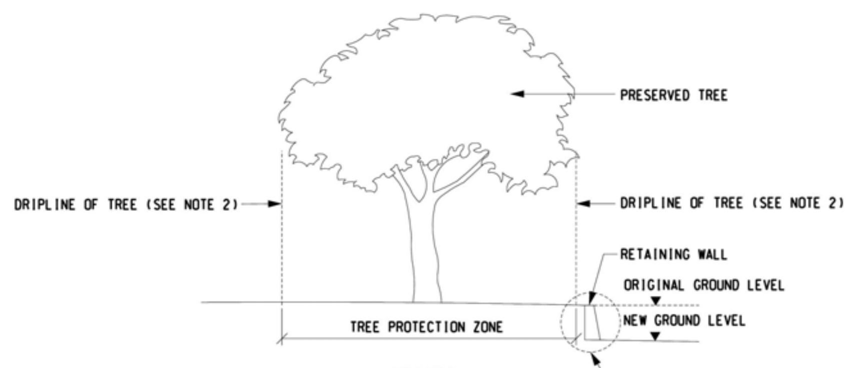
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRIPLINE OF TREE / TREE GROUP EXTENDS TO THE OUTERMOST BRANCHES OF THE TREE / TREE GROUP DEFINING THE PERIMETER OF THE TREE PROTECTION ZONE / AGGREGATE TREE PROTECTION ZONE.
3. THE GROUND BENEATH THE CEDTEXTILE MEMBRANE WITHIN THE TREE PROTECTION ZONE SHALL BE LEFT UNDISTUBRED BUT THE DEBRIS AND THE EXISTING UNDERGROWTH ON THE GROUND SHALL BE CLEARED PRIOR TO APPLYING THE GEOTEXTILE MEMBRANE. THE ENGINEER AGREEMENT SHALL BE OBTAINED PRIOR TO CLEARANCE OF THE EXISTING UNDERGROWTH.
4. WHERE GRAVEL MULCH IS USED THE NOMINAL SIZE OF GRAVEL SHALL BE OF 20 DIAMETER AND THE GRAVEL SHALL BE OF INERT. LIME-FREE MATERIALS WITH NO FINES.
5. WHERE WOOD CHIP MULCH IS USED. THE NOMINAL PARTICLE SIZE SHALL BE IN THE RANGE 2MM TO 20MM AND THE WOOD CHIPS SHALL BE FREE FROM PERNICIOUS WEEDS. CHEMICAL CONTAMINATION. RUBBISH AND OTHER DELETERIOUS MATERIAL.
6. TEMPORARY PROTECTIVE MULCHING SHALL BE INSPECIED AT MONTHLY INTERVALS AND IF NECESSARY SHALL BE REPLENISHED TO THE SPECIFIED THICKNESS.
7. WHERE IN ADDITION TO PREDESTRIAN LOADS. THE PASSAGE OR PARKING OF VEHICLES OR THE OPERATION OF EQUIPMENT OR MACHINERY WITHIN THE TREE PROTECTION ZONE HAS BEEN AGREED BY THE ENGINEER DOUBLE OVERLAPPING THICK METAL SHEETS SHALL BE LAID ON TOP OF THE TEMPORARY PROTECTIVE MULCHING TO PROVIDE ADDITIONAL PROTECTION FROM SOIL COMPACTION.
8. MULCH SHALL BE KEPT AWAY FROM THE BASE OF TREE TRUNK TO PREVENT ROOT COLLAR ROT.
9. WHERE THE PRESERVED TREE IS ON SLOPING GROUND. 300 HIGH TIMBER EDGE SHALL BE PEGGED ON DOWNSLOPE SIDE OF THE TREE PROTECTION ZONE TO HOLD THIS MULCH.



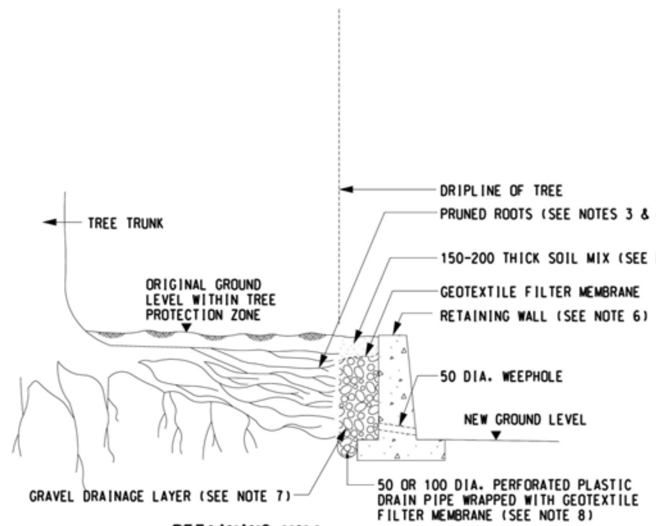
TEMPORARY PROTECTIVE MULCHING TO PRESERVED TREE
(DIAGRAMMATIC)

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRIPLINE OF TREE EXTENDS TO THE OUTERMOST BRANCHES OF THE TREE DEFINING THE PERIMETER OF THE TREE PROTECTION ZONE.
3. THE FOLLOWING PROCEDURES SHALL BE FOLLOWED IN ROOT PRUNING TO AVOID TEARING AND SHREDDING OF THE ROOTS BY GRADING EQUIPMENT:
   I) BEFORE GRADING. TRENCH AROUND THE TREE AT LEAST 200 BEYOND THE PERIMETER OF THE TREE PROTECTION ZONE WITH A BLACKHOE.
   II) CAREFULLY FORK THE SOIL AWAY FROM THE ROOTS USING HAND HELD TOOLS UP TO THE EDGE DEFINED BY THE PERIMETER OF THE TREE PROTECTION ZONE AND
   III) PRUNE THE ROOTS USING HAND HELD TOOLS UP TO THE EDGE DEFINED BY THE PERMETER OF THE TREE PROTECTION ZONE.
4. THE FOLLOWING PROCEDURES SHALL BE FOLLOWED IMMEDIATELY AFTER ROOT PRUNING UNTIL BACKFILLING IS COMPLETE TO PREVENT THE CUT AND EXPOSED ROOTS FROM DRYING OUT:
   I) HANG THICK HESSIAN OR OTHER POROUS ABSORBENT FABRIC FROM THE TOP OF THE CUT SURFACE OVER THE EXPOSED ROOTS AND SOIL AND
   II) MIST THE HESSIAN OR FABRIC IN A FREQUENCY THAT KEEPS THE ROOTS AND SOIL AT THE CUT SURFACE MOIST ALL THE TIME
5. SLOW RELEASE FERTILIZER SHALL BE INCORPORATED INTO THE SOIL MIX AT A RATE OF 500 G / M 37/64 OR AT A RATE AS DIRECTED BY THE ENGINEER.
6. THE ALIGNMENT OF THE RETAINING WALL MAY VARY TO ACCOMMODATE THE ROOTS THAT ARE TO BE RETAINED.
7. THE NOMINAL SIZE OF GRAVEL SHALL BE OF 20 DIAMETER AND THE GRAVEL SHALL BE OF INERT. LIVE-FREE MATERIALS WITH NO FINES.
8. THE DRAIN PIPE SHALL BE CONNECTED TO A SUITABLE NEARBY DRAINACE OUTLET SUCH AS SURFACE CHANNEL OR STORM WATER DRAIN AS AGREED BY THE ENGINEER.



SECTION
(DIAGRAMMATIC)



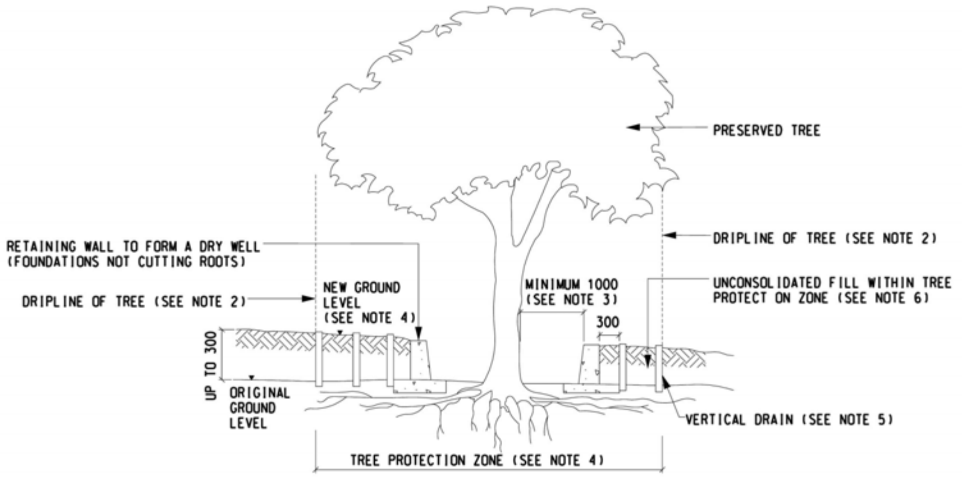
RETAINING WALL NEAR TREE PROTECTION ZONE
(DIAGRAMMATIC)

TP004 - TEMPORARY PROTECTIVE MULCHING TO PRESERVED TREE

TP005 - MEASURE TO ACCOMODATE REDUCTION IN GROUND LEVEL AROUND PRESERVED TREE

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRIPLINE OF TREE EXTENDS TO THE OUTERMOST BRANCHES OF THE TREE. DEFINING THE PERIMETER OF THE TREE PROTECTION ZONE.
3. UNDER NO CIRCUMSTANCES SHALL THE FILL BE PLACED AGAINST THE TREE TRUNK WHERE ONLY PART OF THE DRY WELL IS FORMED SUCH THAT PART OF THE AREA NEXT TO THE TRUNK BASE IS CONNECTED TO THE ADJACENT PAVING AREA AT THE ORIGINAL GROUND LEVEL THE AREA NEXT TO THE TRUNK BASE SHALL BE COVERED WITH OPEN JOINT PAVING OR LOOSE COBBLES.
4. GRADING WITHIN THE TREE PROTECTION ZONE SHALL DRAIN AWAY FROM THE TREE TRUNK WHERE THE TREE IS ON SLOPING GROUND A SOIL BERM SHALL BE FORMED BETWEEN THE RETAINING WALL OF THE DRY WELL AND THE PERIMETER OF THE TREE PROTECTION ZONE ON THE UPSLOPE SIDE OF THE WELL TO DIRECT EXCESSIVE WATER FROM ENTERING THE WELL.
5. THE VERTICAL DRAINS SHALL BE 50 OR 100 DIAMETER PERFORATED PLASTIC DRAIN PIPES WRAPPED WITH GEOTEXTILE FILTER MEMBRANCE. THE OPENINGS OF THE DRAINS TO THE AIR SHALL BE COVERED WITH A TIGHTLY FITTED GRATE OR THE DRAINS SHALL BE FILLED WITH COARSE GRAVEL OF INERT, LIME FREE MATERIALS WITH NO FINES, FOR SAFETY EXCLUSION OF ANIMALS, AND TO ALLOW AIR AND WATER MOVEMENT THE VERTICAL DRAINS SHALL BE PLACED IN 600 MAXIMUM HORIZONTAL SPACING WITHIN THE TREE PROTECTION ZONE AND SHALL EXTEND AT LEAST TO THE DRIPLINE OF THE TREE.
6. THE SOIL FOR FILLING WITHIN THE TREE PROTECTION ZONE SHALL BE OF A COARSER TEXTURE THAT THE UNDERLYING SOIL BELOW THE ORIGINAL GROUND LEVEL.
7. THE DETAILS OF THE RETAINING WALL FOUNDATION SHOWN ARE INDICATIVE ONLY. TO MINIMIZE ROOT DAMAGE, EXCAVATION FOR FOUNDATION SHALL BE CARRIED OUT BY HAND AND SLAB FOUNDATION SHALL BE AVOIDED. WHERE DISCONTINUOUS FOUNDATION IS USED, THE LOCATION OF THE FOUNDATION SHALL BE AGREED BY THE *ARCHITECT / ENGINEERING / SUPERVISING OFFICER.



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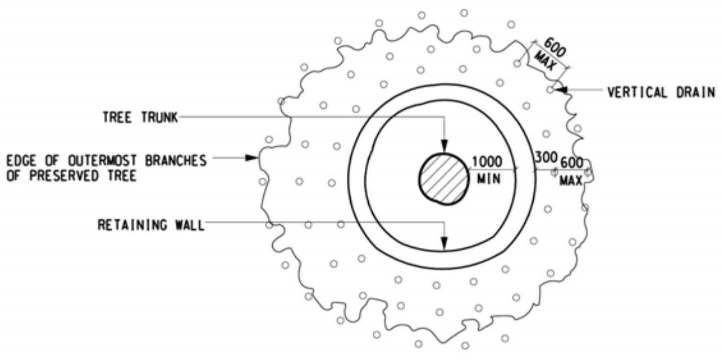
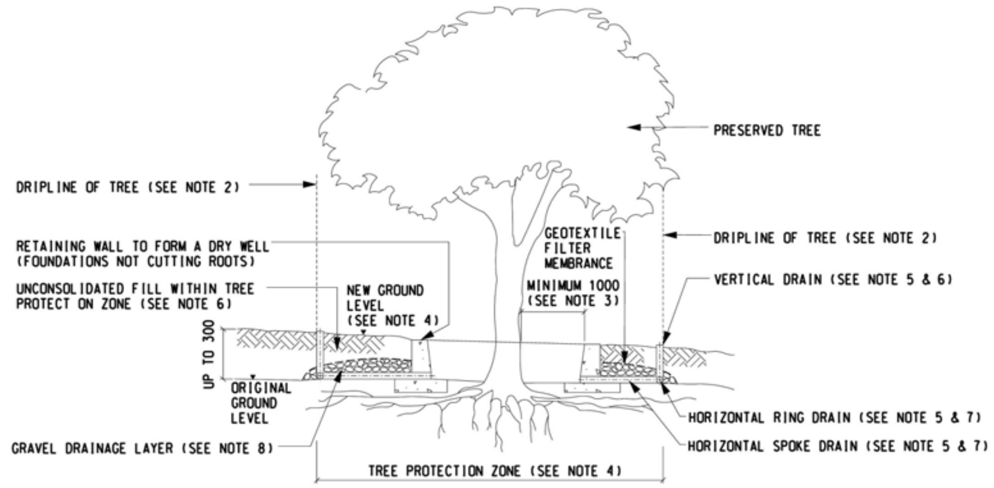


PLAN
(DIAGRAMMATIC)

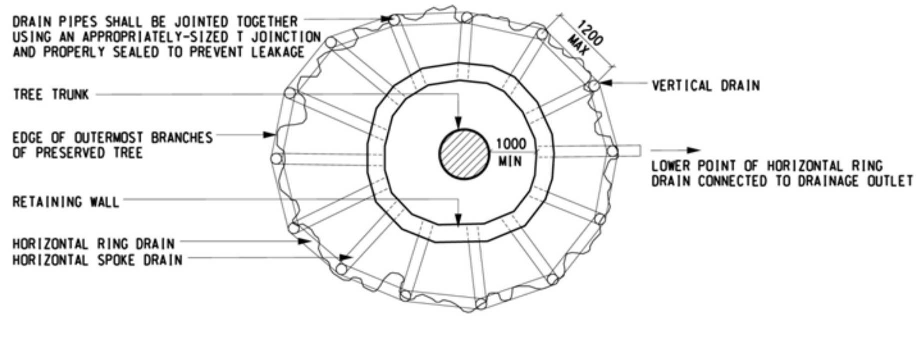
TP006 - MEASURES TO ACCOMMODATE MINOR TO MODERATE RISE (UP TO 300mm) IN GROUND LEVEL AROUND PRESERVED TREE

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. DRIPLINE OF TREE EXTENDS TO THE OUTERMOST BRANCHES OF THE TREE. DEFINING THE PERIMETER OTHE TREE PROTECTION ZONE.
3. UNDER NO CIRCUMSTANCES SHALL THE FILL BE PLACED AGAINST THE TREE TRUNK WHERE ONLY PART OF THE DRY WELL IS FORMED SUCH THAT PART OF THE AREA NEXT TO THE TRUNK BASE IS CONNECTED TO THE ADJACENT PAVING AREA AT THE ORIGINAL GROUND LEVEL THE AREA NEXT TO THE TRUNK BASE SHALL BE COVERED WITH OPEN JOINT PAVING OR LOOSE COBBLES.
4. GRADING WITHIN THE TREE PROTECTION ZONE SHALL DRAIN AWAY FROM THE TREE TRUNK WHERE THE TREE IS ON SLOPING GROUND A SOIL BERM SHALL BE FORMED BETWEEN THE RETAINING WALL OF THE DRY WELL AND THE PERIMETER OF THE TREE PROTECTION ZONE ON THE UPSLOPE SIDE OF THE WELL TO DIRECT EXCESSIVE WATER FROM ENTERING THE WELL.
5. BOTH VERTICAL DRAINS AND HORIZONTAL DRAINS SHALL BE 100 DIAMETER PERFORATED PLASTIC DRAIN PIPES WRAPPED WITH GEOTEXTILE FILTER MEMBRANE. HORIZONTAL DRAINS SHALL HAVE NON-PERFORATED INVERT TO HELP DIRECTION OF WATER TO THE DRAINAGE OUTLET. THE OPENING OF THE VERTICAL DRAINS TO THE AIR SHALL BE COVERED WITH A TIGHTLY-FITTED GRATE OR THE DRAINS SHALL BE FILLED WITH COARSE GRAVEL OF INERT, LIME-FREE MATERIALS WITH NO FINES, FOR SAFETY, EXCLUSION OF ANIMALS, AND TO ALLOW AIR AND WATER MOVEMENT.
6. THE VERTICAL DRAINS SHALL BE PLACED IN 1200 MAXIMUM HORIZONTAL SPACING ALONG THE PERIMETER OF THE TREE PROTECTION ZONE.
7. THE HORIZONTAL SPOKE DRAINS SHALL DRAIN TOWARDS THE HORIZONTAL RING DRAIN. THE LOWEST POINT OF THE HORIZONTAL RING DRAIN SHALL BE CONNECTED TO A SUITABLE NEARBY DRAINAGE OUTLET SUCH AS SURFACE CHANNEL OR STORM WATER DRAIN AS AGREED BY THE *ARCHITECT / ENGINEER / SUPERVISING OFFICER.
8. THE GRAVEL DRAINAGE LAYER IS NOT REQUIRED IF THE RISE IN GROUND LEVEL IS NOT MORE THAN 450, WHERE THE DRAINAGE LAYER IS REQUIRED, THE NOMINAL SIZE OF GRAVEL SHALL BE OF 20 DIAMETER AND THE GRAVEL SHALL BE OF INERT, LIME-FREE MATERIALS WITH NO FINES.
9. THE CAP OF FILL ABOVE THE GRAVEL DRAINAGE LAYER, IF PRESENT, SHALL BE 300 THICK.
10. THE FILL SHALL BE CAREFULLY ADDED TO BUILD THE NEW GROUND LEVEL, SO THAT THE INTEGRITY OF THE DRAIN SYSTEM SURROUNDING THE DRY WELL IS MAINTAINED. THE SOIL FOR FILLING WITHIN THE TREE PROTECTION ZONE SHALL BE OF A COARSE TEXTURE THAN THE UNDERLYING SOIL BELOW THE ORIGINAL GROUND LEVEL.
11. THE DETAILS OF THE RETAINING WALL FOUNDATION SHOWN ARE INDICATIVE ONLY. TO MINIMIZE ROOT DAMAGE, EXCAVATION FOR FOUNDATION SHALL BE CARRIED OUT BY HAND AND SLAB FOUNDATION SHALL BE AVOIDED. WHERE DISCONTINUOUS FOUNDATION IS USED, THE LOCATION OF THE FOUNDATION SHALL BE AGREED BY THE *ARCHITECT / ENGINEER / SUPERVISING OFFICER.



SECTION
(DIAGRAMMATIC)



PLAN
(DIAGRAMMATIC)

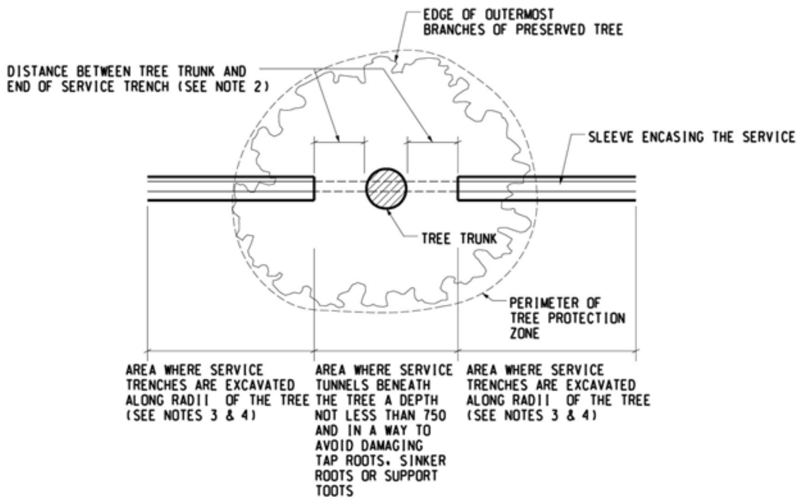
TP007 - MEASURES TO ACCOMMODATE MAJOR RISE (>300mm) IN GROUND LEVEL AROUND PRESERVED TREE

NOTES

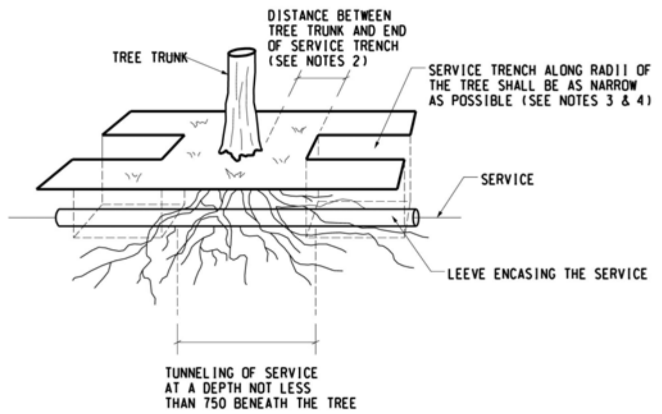
1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. THE SERVICE TRENCH SHALL BE EXCAVATED DIRECTLY TOWARDS THE TREE ALONG A RADIUS TO AT LEAST 100 FROM THE TRUNK OR TO A DISTANCE WHERE ROOTS LARGER THAN 25 DIAMETER ARE ENCOUNTERED, WHICHEVER DISTANCE IS FARTHER AWAY FROM THE TRUNK.
3. THE SERVICE TRENCH WITHIN TREE PROTECTION ZONE SHALL BE EXCAVATED USING HAND-HELD TOOLS.
4. ANY ROOT CUTTING DURING TRENCH EXCAVATION WITHIN TREE PROTECTION ZONE SHALL BE CARRIED OUT USING HAND-HELD TOOLS, AND THE FOLLOWING PROCEDURES SHALL BE FOLLOWED IMMEDIATELY AFTER ROOT PRUNING UNTIL BACKFILLING IS COMPLETE TO PREVENT THE CUT AND EXPOSED ROOTS FROM DRYING OUT:

   I) HANG THICK HESSIAN OR OTHER POROUS ABSORBENT FABRIC FROM THE TOP OF THE CUT SURFACE OVER THE EXPOSED ROOTS AND SOIL AND

   II) MIST THE HESSIAN OR FABRIC IN A FREQUENCY THAT KEEPS THE ROOTS AND SOIL AT THE CUT SURFACE MOIST ALL THE TIME



PLAN
(DIAGRAMMATIC)



PERSPECTIVE
(DIAGRAMMATIC)

TP008 - TRENCHING AND TUNNELING ADJACENT TO PRESERVED TREE

Annex 8A

Full Hazard to Life/ Quantitative Risk Assessment Report (Rev 3)

[August 2015]

ANNEX 8A - CONTENTS

ANNEX 8A – LIST OF TABLES

ANNEX 8A – LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND

Dragages Hong Kong Limited (DHK) is undertaking the construction of a dual two-lane trunk road connecting the Liantang / Heung Yuen Wai Boundary Control Point (BCP) with Tolo / Fanling Highway for the Liantang / Heung Yuen Wai Boundary Control Point Work. Explosives are required for the blasting operation for tunnel construction. To enable a timely delivery of explosives to worksites and in order to meet the proposed construction work programme, an Explosives Storage Magazine (Magazine) is required. The purpose of the magazine is to maintain progress rate for construction activities, i.e. to meet multiple blasts per day and also act as a buffer in case of delivery interuptions by Mines Division (Mines) from the Geotechnical Engineering Office (GEO), Civil Engineering and Development Department (CEDD). Mines will deliver explosives and initiation devices (detonators) to the magazine on a daily basis and these will be withdrawn by the contractors as required. The transportation of explosives by Mines either to the magazine or directly to sites is under Mines' responsibility and falls outside the scope of this EIA study.

The existing Tai Lam Explosives Magazine (TLEM) (Tai Shu Ha, Yuen Long District, New Territories, Land Allocation GLA-TYL 1288) has been licensed and currently in use by MTR XRL 824 Contractor until end of 2015. It will be available for use from late 2015 or early 2016 (expected January 2016) to December 2017 by the Dragages Hong Kong Limited (DHK) for Hong Kong Liantang / Heung Yuen Wai Boundary Control Point Project (HKLTH). The magazine operation will remain the same as the current MTR XRL 824 Contractor. Explosives will be delivered by DHK to three worksites located at Sha Tau Kok Road – Wo Hang Section (North Portal), Po Kat Tsai Road (Mid-Ventilation Portal) and Tong Hang Tung Chuen (South Portal).

The appointed contractor DHK will transport explosives in the Mines Division licensed trucks to be operated by the contractors, from the Magazine to a particular construction site for one to three blasts per day depending on the requirements for construction. Generally, the quantity of explosives that can be transported in any third party contractor's truck is limited by the Mines Division to maximum 200 kg.

The explosives to be stored and transported from the Magazine to the worksites will include detonators, detonating cords, cast boosters and cartridged emulsion.

Under *Section 5(7)* of the Environmental Impact Assessment (EIA) Ordinance *(Cap. 499)* (EIAO), the Director of Environmental Protection (Director) from the Environmental Protection Department (EPD) has issued a Study Brief No. ESB-280/2014 for this project (EIA Study Brief). *Section 3.4.3* of the EIA Study

Brief specifies that a Hazard to Life Assessment should be conducted for the Project.

ERM-Hong Kong, Limited (ERM) was commissioned by DHK to undertake the Hazard to Life Assessment (also referred to as Quantitative Risk Assessment (QRA)) for the storage and transport of explosives from the proposed Tai Lam Explosives Magazine site to the three worksites and propose risk mitigation measures if necessary. The criteria and guidelines applicable for the Hazard to Life Assessment are stated in Annexes 4 and 22 of the Technical Memorandum (EIAO-TM Criteria).

The Hazard to Life Assessment requirements for the EIA Study Brief are shown below in *Table 1.1*.

Table 1.1 EIA Study Brief – Hazard to Life Requirements

3.4.3	**Impact of Hazard to Life**	
3.4.3.1	The Applicant shall follow the criteria for evaluating hazard to life as stated in Annex 4 of the TM.	
3.4.3.2	The hazard assessment for the operation of the Project shall follow the detailed technical requirements given in Appendix B of this EIA Study Brief.	
Appendix B	Requirements for Hazard to Life Assessment	
1	The Applicant shall carry out hazard assessment as follows:	
	(i)	Identify hazardous scenarios associated with the storage and transport of explosives and then determine a set of relevant scenarios to be included in a Quantitative Risk Assessment (QRA);
	(ii)	Execute a QRA of the set of hazardous scenarios determined in (i), expressing population risks in both individual and societal terms;
	(iii)	Compare individual and societal risks with the criteria for evaluating hazard to life stipulated in Annex 4 of the TM; and
	(iv)	Identifiy and assess practicable and cost-effective risk mitigation measures.
2	The methodology to be used in the hazard assessment should be consistent with previous studies having similar issues (e.g. Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA report (Register No. AEIAR-143/2009))	

This section of the EIA presents:

- The basis for the assessment;
- Description of the detailed methodology;
- The results for each QRA step; and
- The assessment of the risk against the EIAO-TM Risk Criteria.

The details of the methodology are elaborated further in various sections of this report.

1.2 *SCOPE OF HAZARD TO LIFE ASSESSMENT FOR THE STORAGE AND TRANSPORT OF EXPLOSIVES*

The Hazard to Life Assessment under this section of the EIA, addresses, in particular, the following:

- Storage of explosives at the existing Tai Lam Explosives Magazine (cartridged emulsion, detonating cord, cast boosters and detonators) including handling of explosives within the Magazine site; and
- Transport of Explosives to the three worksites.

The scope of the study concerns the transport of explosives (cartridged emulsion, detonating cord, cast boosters and detonators) from Tai Lam Explosives Magazine to the worksites.

Detonators are used in relatively small quantities and transported separately. Cartridged emulsion will be used to initiate the blasting explosive and transported together with the detonating cords and cast boosters.

To be consistent with previously approved projects (West Island Line Project (ERM 2008), Express Rail Link Project (ERM 2009), and Shatin to Central Project (ERM 2011)), the risks associated with transport of explosives are limited to the delivery by Contractor trucks up to the blasting sites' boundaries and exclude the transport from the delivery point to the blast face.

The Hazard to Life Assessment presented in this section relates to the storage and transport of explosives from the Tai Lam Explosives Magazine site to the three worksites.

1.3 *HAZARD TO LIFE ASSESSMENT OBJECTIVES AND RISK CRITERIA*

The main objective of this Hazard to Life Assessment is to demonstrate that the EIAO-TM Criteria will be met during the Project period and to identify, where applicable, practical mitigation measures to ensure the EIAO-TM Criteria are met.

The study will particularly focus on the following:

- Identification of hazardous scenarios associated with the transport and storage of explosives for blasting operations;
- Preparation of a Quantitative Risk Assessment (QRA) to estimate risks to the surrounding population in both individual and societal terms;
- Comparison of individual and societal risks with the EIAO-TM Criteria to determine the acceptability of the assessed risk (i.e. the Hong Kong Risk Guideline (HKRG)); and

- Identification and assessment of practicable and cost effective risk mitigation.

1.3.1 *EIAO-TM Risk Criteria*

The individual risk guidelines and societal risk guidelines specified in Annex 4 of the EIAO-TM are shown below.

Individual Risk (IR)

Individual risk is defined as the frequency of fatality per year to a specific individual due to the realisation of specified hazards, with account taken of presence factors.

The maximum level of off site individual risk should not exceed 1 in 100,000 per year, i.e. 1×10^{-5} per year.

Societal risk

Societal risk is defined as the risk to a group of people due to all hazards arising from a hazardous operation. The simplest measure of societal risk is the Rate of Death or Potential Loss of Life (PLL), which are the predicted equivalent fatalities per year.

Societal risk is also expressed in the form of an F-N curve, which represents the cumulative frequency (F) of all event outcomes leading to N or more fatalities. This representation of societal risk highlights the potential for accidents involving large numbers of fatalities.

The societal risk guidelines expressed in the form of F-N curve is shown in *Figure 1.1*. There are three regions identified:

- Unacceptable region where risk is so high that it should be reduced regardless of the cost of mitigation or the hazardous activity should not proceed;

- ALARP region where risk is tolerable providing it has been reduced to a level As Low As Reasonably Practicable (ALARP);

- Acceptable region where risk is broadly acceptable and does not require further risk reduction.

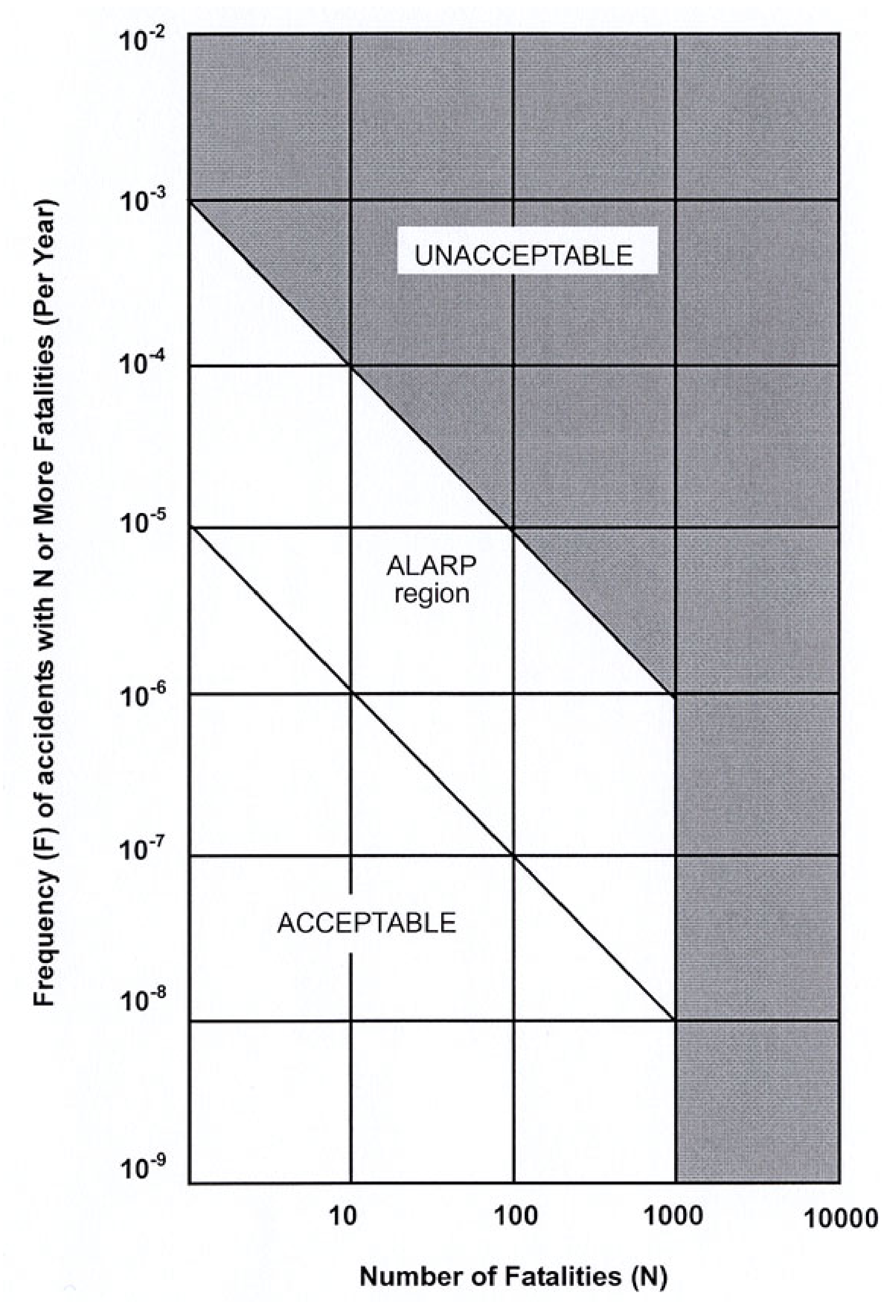
The risk guidelines incorporate a special requirement (as seen in *Figure 1.1*), that no hazardous scenario shall cause more than 1,000 fatalities. If so, the risks are deemed 'unacceptable' and need to be reduced regardless of the cost.

Application of Criteria

Making reference to other studies which involved the transportation of explosives in Hong Kong (ERM 2011, ERM 2009, ERM 2008), the risk guidelines specified in the EIAO-TM Criteria have been applied to the combined risk of fatality associated with the storage and transport of explosives. Injuries are not considered in the assessment and similarly, hazards due to operations within the construction site and Magazine operation other than those involving explosives are also not considered.

The risk guidelines have been generally applied for the public outside the boundary of the hazardous installation. In the context of this study, the risk guidelines are applied to the public outside the construction site and Magazine. Risk to workers on the project construction site, DHK staff or its contractors have not been included in the assessment.

Figure 1.1 *Societal Risk Criteria in Hong Kong*



2 PROJECT DESCRIPTION AND BASIS FOR THE ASSESSMENT

2.1 PROJECT OVERVIEW

Dragages Hong Kong Limited (DHK) is undertaking the construction of a dual two-lane trunk road connecting the Liantang / Heung Yuen Wai Boundary Control Point (BCP) with Tolo / Fanling Highway for the Liantang / Heung Yuen Wai Boundary Control Point Work. Explosives are required for the blasting operation for tunnel construction. To enable a timely delivery of explosives to worksites and in order to meet the proposed construction work programme, an Explosives Storage Magazine (Magazine) is required. The most suitable Magazine site location has been identified as the existing Tai Lam Explosives Magazine.

The Project comprises the following key elements:

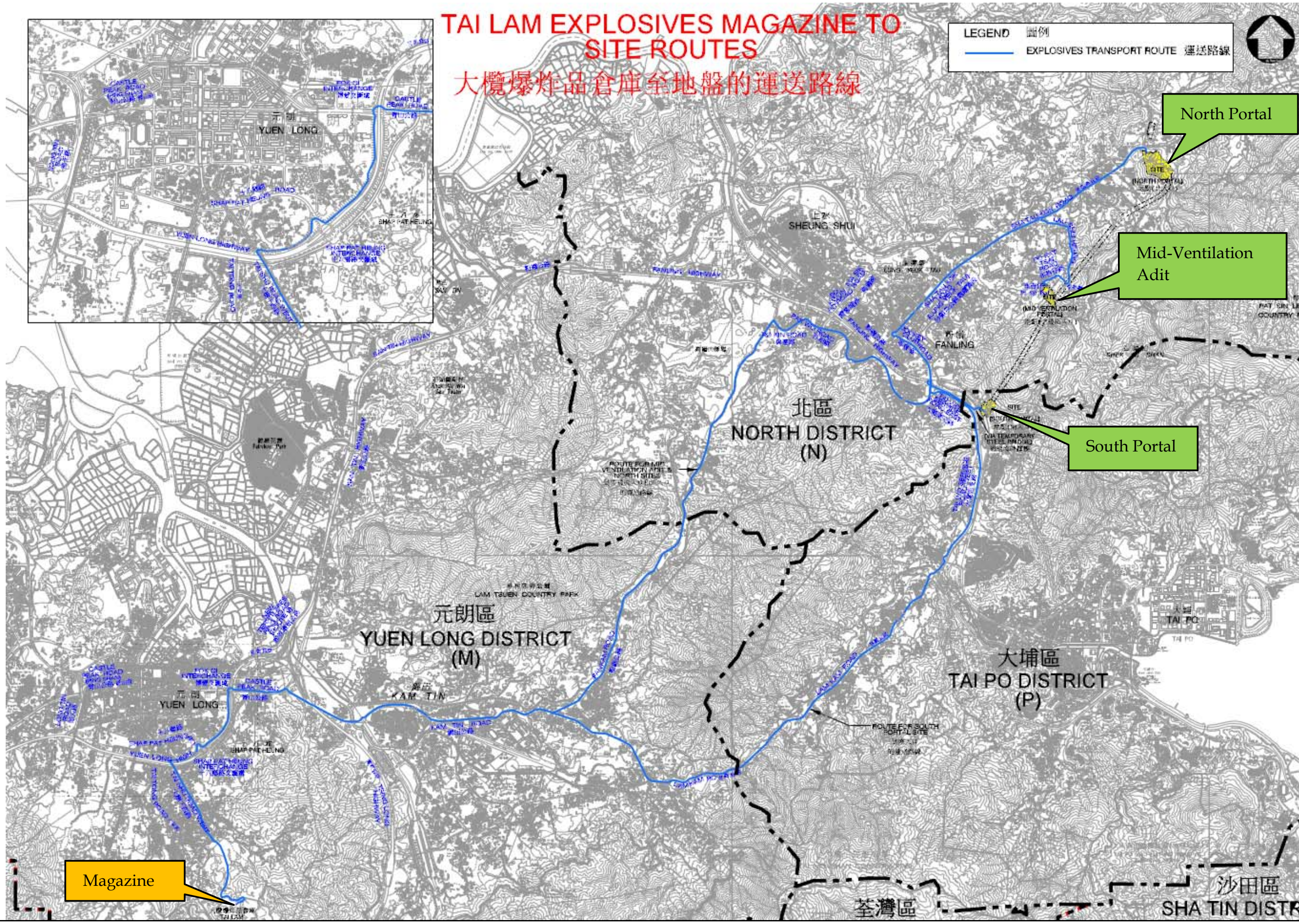
- Use of the existing Tai Lam Explosives Magazine from late 2015 or early 2016 (expected January 2016) to December 2017 with the same operation as current users; and

- Explosives transport from the existing Tai Lam Explosives Magazine to the three worksites by DHK using trucks approved by CEDD Mines Division.

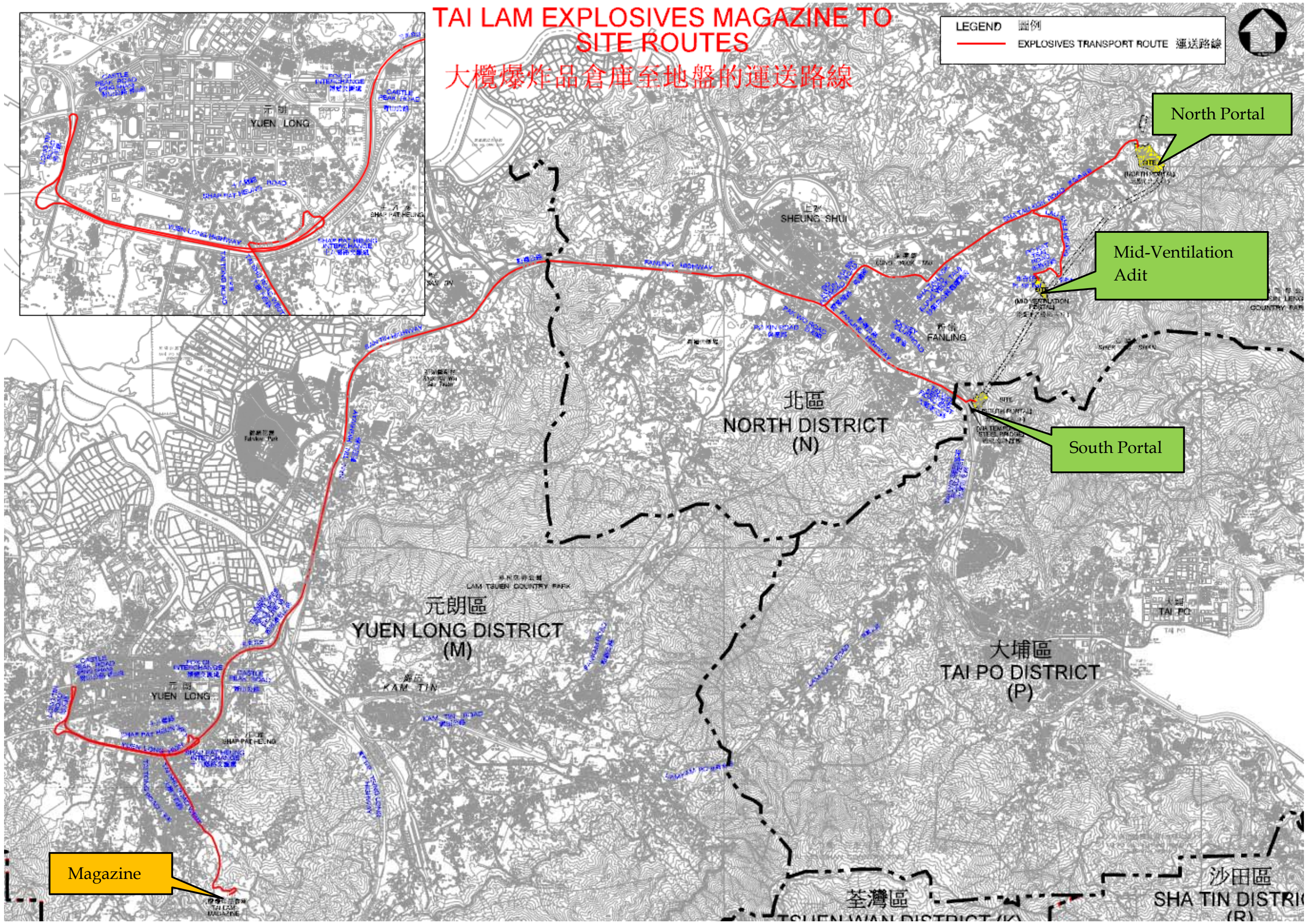
The proposed explosives transport routes to the three worksites are shown in *Figure 2.1*(Route Option R1, Route Option R2 and Route Option R3 respectively).

Figure 2.1 Proposed Explosive Transport Routes Option R1, R2 and R3

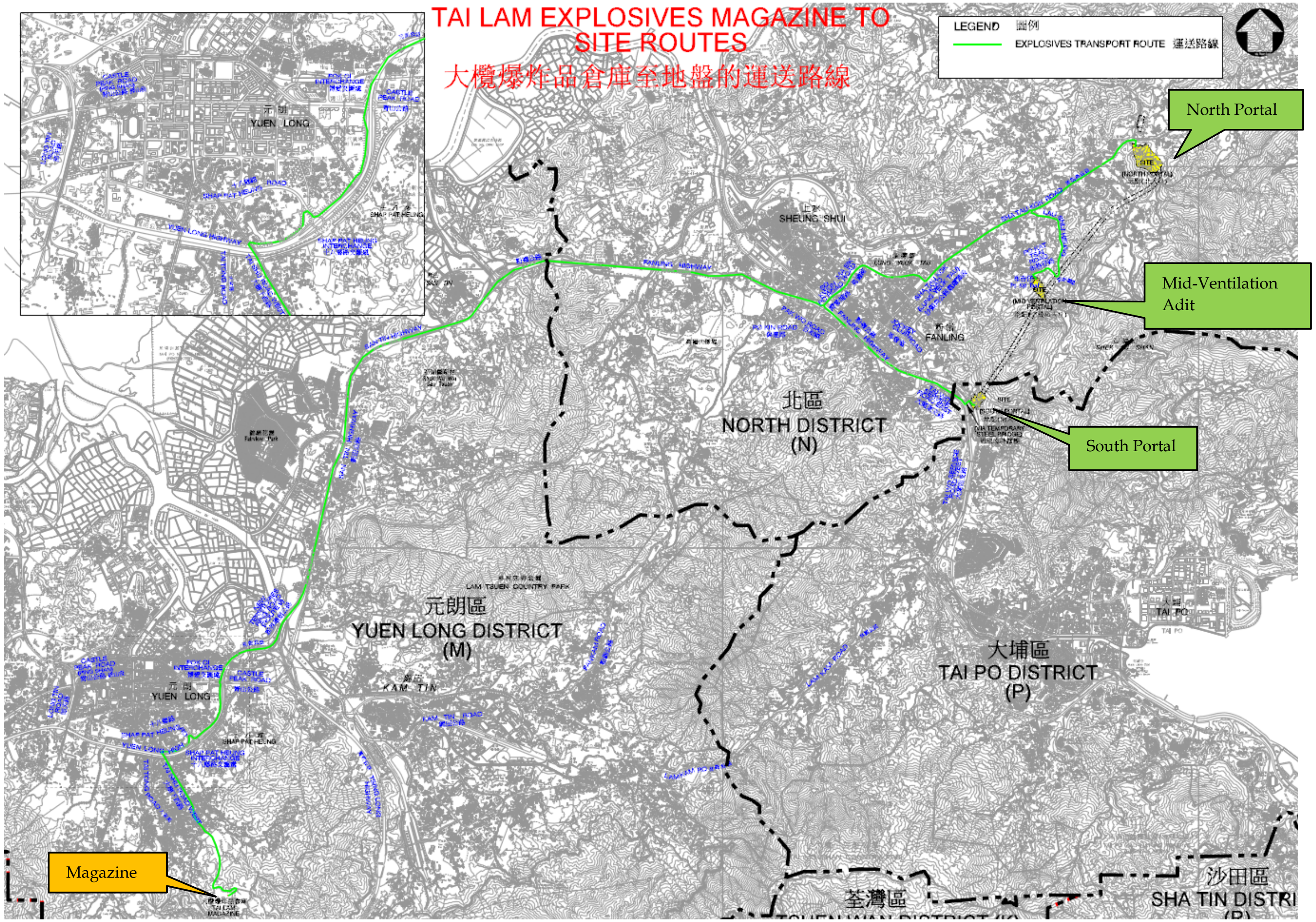
Route Option R1



Route Option R2



Route Option R3



The estimated project period for explosives storage and transport would be from late 2015 or early 2016 (expected January 2016) to December 2017.

The explosives required for the three worksites are envisaged to be delivered from the existing Tai Lam Explosives Magazine. The worksites are shown in *Table 2.1* below. The quantities (kg) of explosives mentioned in the report are represented in gross weight, unless they are clearly specified as TNT eqv. kg.

Table 2.1 ***Project Works Areas Requiring Delivery by Contractor***

Storage Magazine	Magazine Storage Requirement per Contract	Works Area	Blast Faces	Delivery Point
Tai Lam	800 kg (400 kg × 2 stores)	North Portal	Dual two-lane trunk road connecting the BCP with Tolo / Fanling Highway	Sha Tau Kok Road – Wo Hang Section
		Mid-Ventilation Portal	Dual two-lane trunk road connecting the BCP with Tolo / Fanling Highway	Po Kat Tsai Road
		South Portal	Dual two-lane trunk road connecting the BCP with Tolo / Fanling Highway	Tai Wo Service Road East

Note:
1. Two days storage to be maintained as much as possible in line with DHK's operating practice
2. During periods of peak explosives requirements one day storage capacity is envisaged.
3. If storage capacity is not able to satisfy demand direct delivery by Mines Division can be requested, or a blast can be delayed until the following day.

The Tai Lam Explosives Magazine consists of two stores of 400 kg each. Detonators are stored in a separate chamber within each store. Mines Division will deliver explosives and detonators to Tai Lam Explosives Magazine on a daily basis.

The appointed contractor DHK will transport explosives in licenced trucks (licenced by Mines Division) to be operated by the contractors, from Tai Lam Explosives Magazine to a particular worksite for one to three blasts per day depending on requirements for construction. Generally, the quantity of explosives that can be transported in any third party Contractor's truck is limited by Mines Division to a maximum of 200 kg.

2.2 EXPLOSIVE TYPES FOR THE PROJECT

2.2.1 *Proposed Explosives*

The explosives to be stored and transported from Tai Lam Explosives Magazine to the worksites will include detonators, detonating cord, cast boosters and cartridged emulsion. Detonators will be stored in dedicated chambers and transported separately on dedicated trucks.

Cartridged emulsion contains an oxidising agent mainly ammonium nitrate (single salt), water, and a hydrocarbon such as fuel oil. Cartridged emulsion contains 2-3% aluminium powder, which has been added at manufacture to increase the explosion temperature and hence its power.

Cartridged emulsion will be delivered from Tai Lam Explosives Magazine to the three worksites by the appointed contractor using Mines Division licenced trucks.

Detonators, cast boosters and detonating cord will be used to initiate the blast at the working face.

2.2.2 *Explosives Properties and Regulations*

Explosives that are relevant to the Project can be classified into two types:

- Blasting explosives; and
- Initiating explosives.

Their properties are shown in *Table 2.2*.

Table 2.2 Explosive Types

Type	Function	Use	Examples
Blasting explosives	A main blasting explosive	General blasting, shattering rock/structures	Cartridged emulsion
Initiating explosives	To initiate the main blasting explosives	Initiation of secondary explosive	Detonators, Cartridged emulsion, Detonating cord and cast boosters

2.2.3 *Cartridged Emulsion*

The cartridged explosive is designed as a small diameter packaged emulsion, which can be used for both priming and full column applications, particularly in underground mining. It is used for mining, quarrying and general blasting work.

It is packaged in a range of plastic films with the tips clipped at each end to form a cylindrical sausage, or wrapped in waxed paper. It is classified as a UN Class 1.1D explosive and Dangerous Goods (DG) Category 1 explosive under the Hong Kong classification system. It has a TNT equivalence of 0.96, i.e. 0.96 kg of TNT per 1 kg of emulsion.

Like all ammonium nitrate based blasting explosives, cartridged emulsion consists of a mixture of oxidisers and fuel. What makes emulsion unique is the high quantity of water it contains – typically around 10-14%. The oxidisers are typically ammonium nitrate, calcium nitrate or sodium nitrate. For cartridged emulsion used in Hong Kong, there is no perchlorate within the formulation. The fuels are waxes or oils such as diesel fuel. The mixture is complete with small amounts of emulsifiers (less than 1%), which keep the water and oil mixture homogeneous. Cartridged emulsion is detonator sensitive.

2.2.4 *Detonating Devices (Detonators, Detonating cord)*

Detonators

Detonators are small devices that are used to safely initiate blasting explosives in a controlled manner. In the past, electric detonators were used. Since these are no longer used, this study is limited to non-electric, or shock tube detonators. Detonators are classified as either UN 1.1B, 1.4B, or 1.4S, or DG Category 1 explosive under the Hong Kong classification system.

Although detonators contain the most sensitive types of explosives in common use, they are constructed and packaged in a manner such that they can be handled and used with minimal risk. If accidentally initiated, they should have no serious effects outside the package.

Detonators are manufactured with in-built delays that are of various durations. This is to facilitate effective blasting to allow blast holes to be initiated sequentially one at a time, rather than instantaneously, thereby enhancing the practical effects of the blast and reducing the effects of vibration. The detonators to be used in this project will be either millisecond delay period detonators (MS Series) or half second delay detonators (Long Period or LPD).

The delay time of a detonator is controlled by the burning time of a pyrotechnic ignition mixture pressed into a 6.5 mm diameter steel tube, which is the delay element. This element causes the primary explosive, which is typically a small amount of lead azide, to detonate. This in turn, causes the secondary, or output, explosive to detonate, which is usually PETN (Pentaerythritol Tetranitrate). The quantity of PETN within each detonator is approximately 0.9 g. Each detonator has a delay time that is based upon the length of steel tube and the compaction of the pyrotechnic mixture within it. In designing the blasting of a tunnel face, the general principle is to select the required detonators to ensure that no two blastholes will detonate less than 8 ms apart.

The ignition of the pyrotechnic mixture is achieved by the use of shock tubes. This is a small diameter plastic tube that has a light dusting of explosive powder on the inside surface along its length. When ignited by a hot, high pressure impulse the explosive powder combusts at a rate of over 2000 m/s ± 200 m/s, and causes ignition of the pyrotechnic mixture within the detonator.

Detonating Cord

Detonating cord is a thin, flexible tube with an explosive core. It detonates continually along its length and is suitable for initiating other explosives that are detonator sensitive, such as cartridged emulsion. Detonating cord along cartridged emulsion is used in perimeter pre-split holes to provide a smooth tunnel profile. It can also be used for synchronising multiple charges to detonate different charges almost simultaneously. It is used to chain together multiple explosive charges. The core of the cord is a compressed powdered explosive, usually PETN, and it is initiated by the use of a detonator.

Cast Boosters

Cast boosters are small devices, usually containing 12 gram in weight of high explosive into which a detonator is inserted and the whole assembly is then placed in the end of the blasthole, and once assembled is called a primer.

Cast boosters are usually manufactured from a 50/50% mixture TNT and PETN, termed Pentolite. Cast boosters detonate at speeds of 6,000m/sec and provide sufficient 'shock' energy to reliably detonate the bulk emulsion, after firstly being initiated by the delay detonator.

2.3 STATUTORY/ LICENCING REQUIREMENTS AND BEST PRACTICE

The Commissioner of Mines is the authority for the approval of explosives for use in Hong Kong, the transportation, storage and use of explosives, Cat. 1 under *Dangerous Goods Ordinance (Cap. 295)* or are prepared from *Cat. 7 Dangerous Goods*.

Mines Division is responsible for giving approval for the issue of the Mine Blasting Certificate, Removal Permits for Explosives, Mode A Explosives Store Licence, Mode B Explosives Store Licence and Blasting Permits. A Mine Blasting Certificate permits the shotfirer to use explosives in blasting. A Removal Permit allows a person to move any explosives by land transport within Hong Kong. Mode A Explosives Store Licence permits the storage of blasting explosives. Mode B Explosives Store Licence permits the storage of certain types of explosives such as safety cartridges for industrial fastening tools, cartridges for small arms and marine distress signals. A Blasting Permit allows the Contractor to use explosives at a worksite for carrying out blasting. The Division is responsible for regulating the delivery of explosives to blasting sites and carrying out audit inspections on the blasting works at times that match with the work activities of the contractors.

2.3.1 *Transport of Explosives*

Supply of Detonators and Cartridged Emulsion Explosives

Detonators are imported into Hong Kong. Destructive product sample tests are conducted by the manufacturer before each order leaves the factory. These tests record the actual delay firing time of each sample detonator and must fall within the manufacturers upper and lower tolerances as dictated by their quality control and quality assurance (QC /QA) system. In the event that the tested sample falls outside of the delay time control, or tolerance limits the batch will be destroyed. The delay time, detonator shock tube length, batch number and date of manufacture are printed on each vacuum bag (inner packaging) and the delay time is printed on the aluminium shell and the coil tag of each detonator, where the detonator shock tube length is also shown. The detonators will be imported into Hong Kong and stored at the Mines Division Kau Shat Wan (KSW) magazine. Users will then place orders from Mines Division for delivery to their temporary on-site explosives magazine or to their blasting site as appropriate.

Class 1.1D (Cat. 1) explosives are imported into Hong Kong and stored at the KSW magazine and delivered to end users (magazines or delivery points) by Mines Division on a daily basis as required.

Approved Explosives for Blasting in Hong Kong

Under Dangerous Goods (General) Regulations *Cap. 295B*, conveyance and storage of explosives in Hong Kong shall not be allowed except under and in accordance with a licence or permit granted by the Authority. A permit to convey (Removal Permit) and a licence to store (Mode A or Mode B Store Licence) shall not be granted by the Commissioner of Mines unless suppliers of the explosives have submitted the necessary information related to safety, classification, and labelling and packing for vetting. After vetting by the Commissioner of Mines, the explosives will be included in the approved list. All the explosives to be transported in the project will be in the approved list. The current approved list is available from the Commissioner of Mines via CEDD website (CEDD 1).

Blast Design

The design of the blast will consider the quantity and type of explosives needed including MIC (maximum instantaneous charge), number of detonators required, as well as the sensitive receivers near the blasting location. The blast design will be prepared by the Blasting Engineer, in collaboration with the Registered Shotfirer, checked and approved by the Blasting Competent Supervisor, and then submitted to Mines Division for auditing prior to implementation. The blast plan will contain information covering the dimensions of the face to be blasted, MIC, location (generally tunnel chainage), size of blastholes, type and number of delay detonators required and powder factor (kg/ m^3), which is defined as the ratio of mass of explosives used to the volume of rock removed by the blast.

Blast Loading and Execution

Based on the blast design, immediately prior to loading, the required and approved amount of explosives, cartridged emulsion, detonating cord, cast boosters and detonators for the blast will be collected by the Registered Shotfirer and delivered to the blasting site by the licenced Contractors' Vehicles. The collection of the correct quantity of blasting explosives and initiating explosives will be checked by the Registered Shotfirer, a representative from the supervising engineer (i.e. Resident Explosives Supervisor) and a representative from the Contractor.

Licencing Requirements for Transportation of Explosives from the Magazine to the Work Areas

Application for Removal of Explosives

Under Regulation 4 of the Dangerous Goods (General) Regulations, a Removal Permit is required for any person to move explosives in and out of the explosive stores. Some removals are exempted from this requirement which include:

- the removal of safety cartridges for industrial fastening tools not exceeding 5,000 rounds or 5 kg of explosives content whichever is the less, or

- the removal of safety cartridges and cartridges for small arms not exceeding 1,000 rounds if such removal has already been licenced under the Firearms and Ammunition Ordinance (Cap. 238).

Application for Approval of an Explosives Delivery Vehicle

The explosive vehicle should comply with the safety requirements set in the Requirements for Approval of an Explosives Delivery Vehicle (Guidance Note) issued by Mines Division (CEDD 2). The Guidance Note includes the following provisions:

Any contractor intending to transport explosives from a Magazine to the blast sites on public roads shall submit an application to the Commissioner of Mines. The general conditions for approval are summarised as follows:

(a) Method statement including information on blast sites, duties of personnel, explosives delivery routes and procedures, design drawings of the proposed explosives delivery vehicle and emergency procedures;

(b) The vehicle shall have a valid 'Roads Worthiness Certificate' issued by the Transport Department, with a valid vehicle registration document and a valid licence issued by the Transport Department;

(c) The vehicle shall be tested by a testing body certifying the relevant weights, including the 'Permitted Gross Vehicle Weight' and 'Vehicle Net Weight', in order to determine the 'Permissible Laden Weight' of the approved explosives delivery vehicle; and

(d) The names of the driver and attendant with documentation indicating basic knowledge of safe handling of explosives, fire fighting and emergency procedures. The driver should be over the age of 25 years with less than 5 driving-offence points over the previous 3 years and more than 5 years driving experience and hold a current driving licence for the appropriate class of vehicle. The driver should also have attended a defensive driving course within the previous 12 months, passed a medical check and been assessed by a registered medical practitioner as being fit to drive explosives delivery vehicles.

Explosives Delivery Vehicle Design Features and Safety Requirements

The explosive delivery vehicle shall be designed and operated in accordance with the Requirements for Approval of an Explosives Delivery Vehicle (Guidance Note). Any improvements made to these requirements are permitted subject to approval by Mines Division. The minimum safety requirements are summarised below:

Condition of Vehicle:

(a) The vehicle shall be powered by a diesel engine;

(b) The vehicle's design, construction and strength must comply with the Road Traffic (Construction and Maintenance of Vehicles) Regulations, Chapter 374, Laws of Hong Kong;

(c) The vehicle shall be kept clean, in sound mechanical condition and roadworthy; and

(d) The vehicle shall be licensed to carry the maximum number of persons required for the delivery convoy. For example, if only one vehicle is going to be used for the delivery convoy, then the vehicle shall be licensed to carry at least 6 persons (including driver, registered shotfirer, Contractor's representative, RSS's resident explosives supervisor, armed security guard and Mines Division's representative). Subject to the agreement obtained from Mines Division and the Hong Kong Police Force, the armed security guard may be omitted provided that an approved Global Positioning System (GPS) has been installed in the vehicle. The applicant shall confirm the requirements with Mines Division.

Condition of Cargo Compartment:

(a) The cargo compartment of the vehicle, including the floor, shall be constructed with sheet metal at least 3 mm thick and lined internally with at least 13mm thick plywood, and there shall be no exposed ferrous metal in the interior of the goods compartment.

(b) The interior of the cargo compartment, including doors, shall be kept in good condition and free from defects or projections which might cause accidental damage to the packages.

(c) Electric wiring or electrical devices shall not be installed inside the cargo compartment.

(d) The door of the cargo compartment shall be capable of being locked using a padlock. The padlock shall meet BS EN 12320 Security Grade 4 or above requirements, or equivalent.

(e) Proper stowage facilities shall be provided to secure the load in a stable manner during transportation.

(f) If the vehicle is designed to carry both detonators and other types of blasting explosives at the same time, additional requirements for cargo compartment shall be required.

Safety Provisions:

(a) The driver's cabin shall be separated by a distance of not less than 150mm from the cargo compartment of the vehicle.

(b) The exhaust system must be located as far from the cargo compartment as possible, preferably at the front of the vehicle. The modification of the exhaust system shall be approved by the Transport Department.

(c) A quick-action cut-off at an easily accessible position shall be fitted to the fuel feed pipe and shall be clearly identified in Chinese and English languages, by a label prominently and legibly stating –

"EMERGENCY ENGINE STOP 緊急死火掣".

(d) The required number of fire extinguishers shall be agreed with Mines Division.

(e) All electrical installations shall be designed, constructed and protected so that they cannot cause any ignition or short-circuit under normal conditions of use of the vehicle or its electrical installations, and so that the risk of this occurring will be minimized in the event of an impact or deformation. All electrical wiring and fittings shall be shrouded in fire resisting conduits.

(f) The fuel tank shall be located either to the front or below the cargo compartment of the vehicle. It shall be protected from accidental damage, and designed to prevent accumulation of spilt fuel on any part of the vehicle.

(g) Fire resistant material shall be fitted between the wheel arches and the goods compartment.

(h) Detonators and other types of blasting explosives shall not be loaded or transported within the same cargo compartment of the vehicle.

(i) A hand-held lightning detector shall be provided in the vehicle for detection of lightning before and during loading and unloading of explosives. Should lightning be detected within a distance of 16 km from the loading/unloading point by the hand-held detector, loading or unloading of explosives shall cease until the lightning signal has cleared.

(j) At least one red strobe beacon is required.

(k) Laminated sheets containing (i) the Occupational Safety and Health information for first responders relating to the explosives being carried; (ii) the Emergency Procedures in the event of traffic accident or fire; and (iii) the Emergency Contact List shall be displayed in a conspicuous position in the driver's compartment. The applicant shall confirm the requirements with Mines Division. The driver and attendants shall be fully conversant with the safety/emergency procedures at all times.

Signage on Vehicle:

(a) Whenever the vehicle is carrying explosives, there shall be displayed:

(i) on both sides of the cargo compartment a placard (of minimum dimensions 250 mm × 250 mm) showing the label of the highest Hazard Code of explosives (see Specimen Labels of Hazard Code in *Section 2.2* of the document (CEDD 2), and

(ii) in a prominent position, a rectangular red flag of dimensions not less than 230mm x 300mm.

(b) A placard showing "EMPTY 空車" shall be displayed when the vehicle is empty.

(c) The vehicle shall be painted in white with warning words in the Chinese and English languages of at least 150mm height as follows:

"DANGER – EXPLOSIVES" and "危險 – 爆炸品"

The warning shall be in red or black and displayed on both sides and rear face of the cargo compartment. If possible, the warning shall also be displayed on the front face of the vehicle.

(d) The company name and contact telephone number of the Contractor/applicant together with the project name and contract number shall be displayed on the side doors of the vehicle in black.

A typical contractor's explosives vehicle and a typical Hong Kong Mode A Explosive Store is shown in *Figure 2.2*.

Figure 2.2 ***Typical Contractor's Explosive Truck and Magazine***

From top to bottom: A typical contractor's explosives vehicle; warning displays of loaded explosives vehicle; and a typical Magazine site.

2.3.2 *Storage of Explosives*

Tai Lam Explosives Magazine

The existing Tai Lam Explosives Magazine complies with the general requirements from the Commissioner of Mines with respect to the construction of the store and security measures to be adopted. These general requirements are defined in the document "How to Apply for a Mode A Store Licence for Storage of Blasting Explosives". The magazine is a single storey detached bunded structure with dimensions as specified on Mines and Quarries Division Drawing MQ1630 "Typical Details of Explosives Magazine – Plan A". The magazine building is fenced and secured in accordance with the Commissioner of Mines' requirements and surfaced road access suitable for 11 tonne trucks are provided for delivery of explosives. The main requirements are summarized below:

The following are the general requirements (CEDD 3) from the Commissioner of Mines in processing the application:

(a) The maximum storage quantity should normally not exceed 1000 kg.

(b) The safety distances requirements from the UK Explosives Regulations 2014 for an explosives magazine will be used to assess the suitability of the proposed store location. A store made of substantial brickwork surrounded by earth mound is recommended. If the proposed Mode A store is in a densely populated area, a minimum separation distance of 400 m from buildings is normally required.

(c) No proposed Mode A store shall be located within 45 m and 75 m on plan from any high tension power cables carrying 440 V or 1 KV respectively. Diversion of the cables will be required if there is no alternative location.

(d) Approval from the Commissioner of Police will be required on the security aspects of the Mode A store location and on the security company.

(e) No other materials, likely to cause or communicate fire or explosion, shall be transported in any vehicle carrying explosives and no passengers other than persons assigned to assist in handling explosives shall be permitted on a vehicle transporting explosives. The driver and all workers engaged in the loading, unloading or conveying of explosives shall be trained in fire fighting and precautions for the prevention of accident by fire or explosion.

The following are the general requirements for the construction of the blasting explosives Mode A store:

(a) The store shall be a single storeyed detached structure made of substantial brickwork, masonry or concrete to a design approved by the

Commissioner of Mines with lightning protection and outer steel Mode A store doors.

(b) All hinges and locks shall be of non-ferrous metal.

(c) No ferrous metal is to be left exposed in the interior of the Mode A store.

(d) The interior and exterior walls of the Mode A store shall be painted white.

(e) The outer steel doors shall be painted red. The words

"DANGEROUS – EXPLOSIVES" and "危險 – 爆炸品"

shall be written in white on the outside of each door. The letters and characters shall be at least 10 cm high.

(f) A security fence surrounding the Mode A store shall be installed and set back at least 6 m from the Mode A store. The fence shall be 2.5 m high, stoutly constructed of chain link fencing having a mesh size not exceeding 50 mm. The fence shall be firmly fixed to metal or concrete posts and topped with a 0.7 m outward overhang of razor-bladed wire. The base of the fence located between the posts shall be secured with pegs to prevent intrusion.

(g) The area between the security fence and the Mode A store shall be cleared of all vegetation. Vegetation clearance should also apply to a minimum distance of 1m on the exterior of the fence. A uniform cross-fall of at least 1 in 100 away from the Mode A store to a drainage system shall be constructed.

(h) Electric flood lighting, from at least eight light poles spaced along the security fence, shall be provided to illuminate the area between the Mode A store and the security fence and the area directly outside the security fence.

(i) The gate in the security fence shall be fitted with a lock of close shackle design with key-intention feature. A warning notice board with prohibited articles and substances painted in red and black, shown in symbols and in Chinese and English characters shall be posted at the gate. Each symbol shall be at least 10 cm in diameter. A sample of the warning notice board is available upon request from the Mines Division.

(j) A guard house for the Mode A store should be provided. Armed security guards shall be on duty outside the security fence adjacent to the gate. This guard house shall be protected by a separate fence.

(k) Inside the guard house, an arms locker constructed as an integral part of the house and fitted with a lock shall be required.

(l) A telephone shall be provided in the guard house.

(m) A watchdog should normally be provided for the store.

(n) The road leading to the Mode A store shall be concrete surfaced. It shall be constructed and maintained so that it can be used by 11 tonne trucks under all adverse weather conditions. A suitable turning circle or other alternative means for these trucks shall be provided so that the trucks can be driven up to the gate of the security fence.

(o) Fire fighting installations consisting of at least four 6 liter foam and one 4.5kg dry powder fire extinguishers, four buckets of sand to be positioned on two racks within the area between the security fence and the Mode A store and as near as is convenient to the Mode A store doors. In addition, the Fire Services Department (FSD) may require other additional fire fighting installations.

2.4 DESIGN AND LOCATION OF THE TAI LAM EXPLOSIVES MAGAZINE

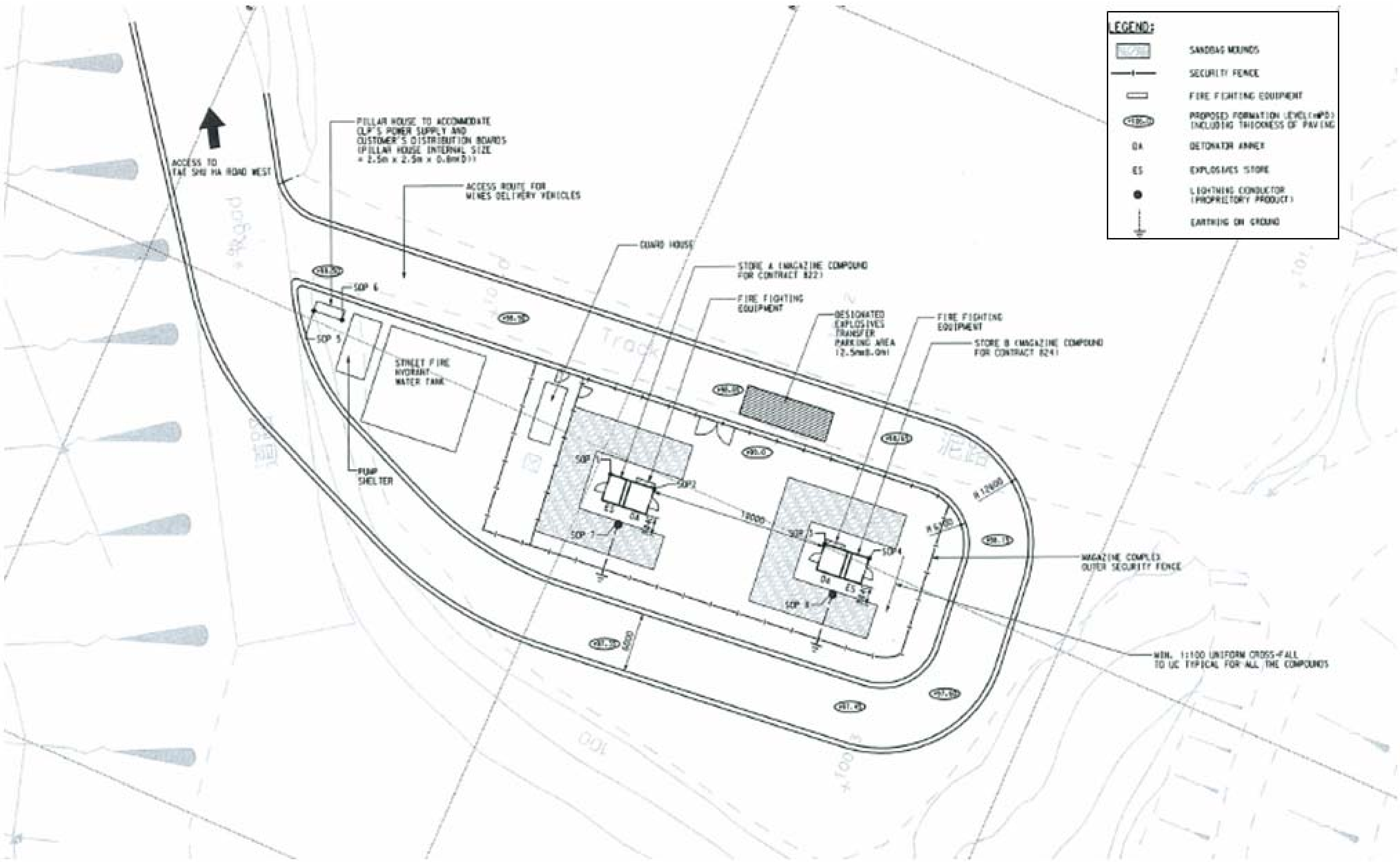
The existing Tai Lam Explosives Magazine has been identified as the most suitable site for explosive storage. The TLEM will serve the three worksites. The site complies with the separation requirements of Mines Division.

The magazine is designed to store sufficient quantities of explosives for two days so as to allow blasting to be carried out 24 hours per day and provide a buffer in the event of delivery interruption to the magazine by Mines Division. The storage quantity for the magazine has been determined with sufficient margin by the design consultant based on estimated project explosives consumption.

Tai Lam Explosives Magazine Site

A single site comprised of two magazine compounds, each with a single structure storing 400 kg explosives. The site is in an area of low population density, with little surrounding infrastructure. The site complies with the clearance requirements specified by UK HSE for storage of explosive (ER, 2014). The magazine site layout is provided in *Figure 2.3*. The location of the magazine is shown in *Figure 4.1*.

Figure 2.3 Tai Lam Explosives Magazine Site Layout



2.5 EXPLOSIVES DELIVERY PROGRAMME OF THE PROJECT

2.5.1 *Explosives Delivery-Storage-Blasting Cycle*

The proposed delivery-storage-blasting cycle will consist of the following elements:

1. Weekday morning deliveries of explosives and initiating systems to each Magazine by Mines Division as needed.

2. Storage in the Tai Lam Explosives Magazine Site stores.

3. Transfer from the explosives stores to the delivery points of the worksites utilizing public roads via routes as indicated in *Figure 2.7* and *Table 2.9*.

4. Transfer to the working face(s) of the excavation via the tunnels or underground adits.

5. Load and fire the face(s) to be blasted. Blasts in a particular area will be initiated from a common firing point once all personnel are clear and entry routes to each blast site are secured. All blasts are to be carried out underground.

2.5.2 *Drill and Blast Explosive Requirements*

Based on the envisaged construction programme, the blasting activities together with the required amount of explosives is summarised as shown in *Table 2.3*. The actual amount of explosives (cartridged emulsion and detonating cord) is based on the tunnel profiles described in *Table 2.4* and the types of explosives listed in *Table 2.5*.

Table 2.3 Project Drill and Blast Explosive Requirements (Summary)

Works Area	Delivery Point	Blast Face	Approximate No. of Blasts	Explosive Load (kg/ blast)
North Portal	Sha Tau Kok Road	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	570	35
Mid-Ventilation Portal	Po Kat Tsai Road	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	300	10-80
South Portal	Tai Wo Service Road East	Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway)	855	10-90

Table 2.4 Project Drill and Blast – Typical Tunnel Profiles

Profile	Description	Section Area (m^2)	No. of Production Holes	No. of Perimeter Holes	Cartridged Emulsion (kg)	Detonating Cord (kg per metre drilled)	Detonators (kg)	Cast Boosters (kg)
Dual two-lane trunk road connecting the BCP with Tolo/Fanling Highway	Typical section T1	125	109	44	17.6	0.08	0.138	3

Note 1: The following abbreviations apply: CE - Cartridged Emulsion, BE - Bulk Explosives
Note 2: Typical tunnel profile given for an assumed pull length of 5.0 m. For some tunnel sections, this is not achievable due to the proximity of sensitive receivers.

Table 2.5 Project Drill and Blast – Initiating Explosive Types

Explosives	Quantity per Production/ Perimeter Hole
Cartridged Emulsion	0.125 kg (125 g per cartridged emulsion) [1]
Detonating Cord	0.080 kg/m based on density of 0.040 kg/m (40 g/m)
Detonator	0.001 kg (0.9 g each)
Cast Booster	0.02 kg (20 g per mini cast booster)

Note 1: For blast where MIC is lower than 2 kg and Bulk Emulsion cannot be used; 0.208 kg cartridge types may be used.

2.5.3 *Explosive Transport Requirements Based on Blasting Programme*

Current Construction Programme

The approach adopted to derive the total number of trips and the total initiating explosives to be transported per trip is as follows:

- As far as practicable, the explosives (cartridged emulsion, cast boosters and detonating cord) required for all the blast faces of a given work area operated by the same Contractor will be transported on the same explosives delivery truck. Note that detonators are transported on dedicated trucks.

- Due to potential progress issues during the construction stage, arising from programme delay or change, it may not be possible to adhere strictly to the envisaged construction programme. This will result in blasts carried out at a different time for the various faces and separate deliveries.

- Loads will be limited to a maximum of 200 kg per truck in accordance with the Removal Permit issued by Mines Division.

- The quantity of Category 1 explosives on the roads has been minimised by using bulk emulsion, which will be manufactured on-site. The on-site manufacture of bulk emulsion will require the transportation of Cat. 7 Oxidising Substances which falls outside the scope of this study.

- It has been assumed in this report that the project will mostly require a separate explosives delivery from Tai Lam Explosives Magazine Site to each delivery point.

- The actual construction programme will depend on the detailed design and appointed contractors. It may also depend on the actual achievable progress rates which may vary due to site specific conditions (e.g. geology). To consider the uncertainty in the envisaged construction programme, a Base Case, which accounts for expected programme variations, and a Worst Case, which represents the worst programme scenario, have been considered for the assessment.

Base Case for the Hazard to Life Assessment

In this study, three Route Options were presented as the base case.

Based on the envisaged construction programme and sequence of works, the annual travel distance by explosive vehicles, carrying cartridged emulsion, cast boosters and detonating cord, will reach a peak in the period between March 2016 and February 2017, as shown in *Table 2.7*. This period is referred to the peak explosive delivery period which is taken to represent the Base Case scenario for the Hazard to Life Assessment. Within this period, taking Route Option R1 as an example, the annual number of deliveries is 2,100 while the explosive trucks travel distance is around 53,165 km. The delivery frequency has been estimated on the basis that, for a given delivery point, each delivery will be made to each blast face (or for a twin-track tunnel each two blast faces in the same direction) independently of the other blast faces even if the load could be transported on the same truck. This approach, although slightly conservative, accounts for envisaged delivery variations during the peak delivery period, within which, separate deliveries will be generally undertaken. The total number of trips has been estimated based on the typical licencing limit of 200 kg explosives per truck.

In the Base Case, it was considered that explosives delivery could be carried out at any time of the day depending on the blasting programme to allow for flexibility to the blasting programme.

The number of explosives delivery trips is estimated based on the blasts for the envisaged construction programme with contingency to take into account variation of geological conditions and construction programme affecting the number of explosives deliveries required.

It was generally assumed that explosives will not be returned to the Explosive Magazine.

The travel distance from Magazine site to each delivery point is provided in *Table 2.6*. The corresponding explosive load transported in the peak 12- month delivery period is shown in *Table 2.8* for each work area.

In this project, for a particular delivery point, it is possible that the explosive load required for each delivery will be higher than that indicated in the envisaged programme due to particular site conditions and blasting requirements; however, the truck load is conservatively assumed to be 200 kg in each trip as shown in *Table 2.8*. The actual truck load is 42 – 83 kg for North Portal, 43 – 65 kg for Mid-Ventilation Portal and 84 – 132 kg for South Portal, which are significantly lower than the maximum truck load of 200 kg.

In this Project, explosives transport will be scheduled with a total of two to six deliveries per day to the three worksites (explosives are required at two to three worksites per day) and maximum seven (7) days per week. CEDD Mines Division will supply the explosives to the magazine site on weekdays (Monday to Friday) and on Saturday if necessary.

Table 2.6 Travel Distance from Tai Lam Explosives Magazine Site to Each Delivery Point

Delivery Points	North Portal	Mid-Ventilation Portal	South Portal
Travel distance (km) from Tai Lam Explosives Magazine Site to Delivery Point (Route Option R1)	27.6	27.5	23.2
Travel distance (km) from Tai Lam Explosives Magazine Site to Delivery Point (Route Option R2)	30.8	30.9	27.8
Travel distance (km) from Tai Lam Explosives Magazine Site to Delivery Point (Route Option R3)	24.6	24.7	21.6

Table 2.7 Explosive Deliveries for Every 12-Month Period during Project Period

12-Month Delivery Period	Total Explosive Delivery Trips within the 12-Month Period			Total No. of Trips	Total Distance Travelled (km) Route Option R1	Total Distance Travelled (km) Route Option R2	Total Distance Travelled (km) Route Option R3
	North Portal	Mid-Ventilation Portal	South Portal				
Jan 2016 - Dec 2016	390	615	1075	2080	52607	60957	48061

12-Month Delivery Period	Total Explosive Delivery Trips within the 12-Month Period			Total No. of Trips	Total Distance Travelled (km) Route Option R1	Total Distance Travelled (km) Route Option R2	Total Distance Travelled (km) Route Option R3
	North Portal	Mid-Ventilation Portal	South Portal				
Feb 2016 - Jan 2017	480	525	1075	2080	52622	60945	48049
Mar 2016 - Feb 2017	570	450	1080	2100	53165	61535	48515
Apr 2016 - Mar 2017	660	360	1050	2070	52484	60688	47854
May 2016 - Apr 2017	750	270	1020	2040	51803	59840	47192
Jun 2016 - May 2017	820	180	990	1990	50569	58377	46039
Jul 2016 - Jun 2017	850	90	960	1900	48230	55681	43901
Aug 2016 - Jul 2017	850	0	930	1780	45062	52062	41026
Sep 2016 - Aug 2017	850	0	900	1750	44366	51227	40377
Oct 2016 - Sep 2017	840	0	870	1710	43394	50084	39482
Nov 2016 - Oct 2017	830	0	840	1670	42422	48941	38587
Dec 2016 - Nov 2017	820	0	750	1570	40058	46129	36395
Jan 2017 – Dec 2017	760	0	660	1420	36312	41776	32972

Note: (1) Peak delivery period selected for the Base Case based on total travel distance within the 12-Month Period

Table 2.8 Explosives Load Transported in the Peak 12-Month Delivery Period

Works Area	Explosive Load Transported (kg/ trip)
North Portal	200 (actual truck load is 42 – 83 kg)
Mid-Ventilation Portal	200 (actual truck load is 43 – 65 kg)
South Portal	200 (actual truck load is 84 – 132 kg)

Worst Case

The Hazard to Life Assessment also covers the Worst Case scenario. It addresses the possibility that, due to construction uncertainties or contractors' methods of working, the contractors propose an actual construction programme which differs from the envisaged construction programme. Such a case may result in a higher number of delivery trips. Return trips loaded with explosives will generally be avoided, however, due to some construction uncertainties, a number of return trips could be made. Overall, in the worst case, a 20% increase in the number of deliveries compared to the Base Case scenario may result based on previous project experience.

2.6 TRANSPORT OF BLASTING EXPLOSIVES AND INITIATION SYSTEMS

2.6.1 *Overview*

Blasting explosives (Bulk emulsion) will be manufactured on-site while the explosives required as part of the initiating system required for a particular Drill and Blast project will be delivered by Mines Division, stored within the contractor's Magazine and transported to the worksites by the contractor. Mines Division requires that blasthole loading is commenced immediately, as soon as practicable, upon receiving the explosives (it may take 2 to 4 hours to transport the explosives from the surface to the blast face, charge the face, evacuate the area and execute the blast). Storage of explosives at the work site is not permitted.

When approved by Mines Division, one or more dedicated Magazines can be constructed to service the particular needs of a project. This enables more than one blast per day.

Mines Division generally limits the amount of explosives that a contractor can transport from the Magazine to the blast site to 200 kg per explosive delivery truck. In some circumstances, this limit may necessitate more than one trip to deliver the required volume of explosives for a blast taking into account the Removal Permit licencing limit.

Detonators shall be transported in a separate licenced vehicle and are never to be carried together with explosives.

Mines Division allows any unused explosives or detonators from a blast to be returned to their Magazine store. However, in practice, any unused cartridged emulsion explosives is generally destroyed by burning in a controlled manner, and excess initiating systems (detonators) is also destroyed by linking them into the blast. Unused explosives may also result if a particular blast is delayed and hence the load needs to be returned to the Magazine.

2.6.2 *Transport Strategy – Magazine to Worksites*

Bulk emulsion will be manufactured on-site by an appointed third party supplier.

Explosives will be transferred from the relevant store by the relevant contractor. Two licenced explosive trucks will be required for each delivery - one will only transport detonators while the other will transport a cargo of cartridged emulsion, cast boosters and detonating cord. The explosives transport strategy is shown in *Figure 2.4*.

No more than one truck convoy loaded with explosives (made up of the truck carrying the cartridged emulsion, cast boosters and the detonating cord and the truck carrying the detonators) is generally expected within the explosives magazine complex at any one time. In any event, explosive trucks will maintain a separation headway of about 10 min.

2.6.3 *Transport Strategy - Worksites to Blasting Sites*

Explosives and detonators will be transported separately but in convoy from the Magazine to the designated access shafts / blasting sites by the contractors' licenced delivery vehicles under the escort of armed security guards.

To minimise the transport risk, the following principles have been observed in planning delivery routes between the Magazine and the various blasting sites:

- Routes have been planned to avoid areas of high population density and Potentially Hazardous Installations (PHIs) wherever possible.
- Explosive truck convoys for each work area will maintain, as far as possible, separation headway of around 10 min.
- The quantity of Category 1 Explosives on the roads has been minimised by using bulk emulsion wherever possible, which will be manufactured on-site. The manufacture of bulk emulsion will require the transportation of Category 7 Oxidizing Substances, which fall outside the scope of this study.

2.6.4 *Safety Features of Transport Vehicles*

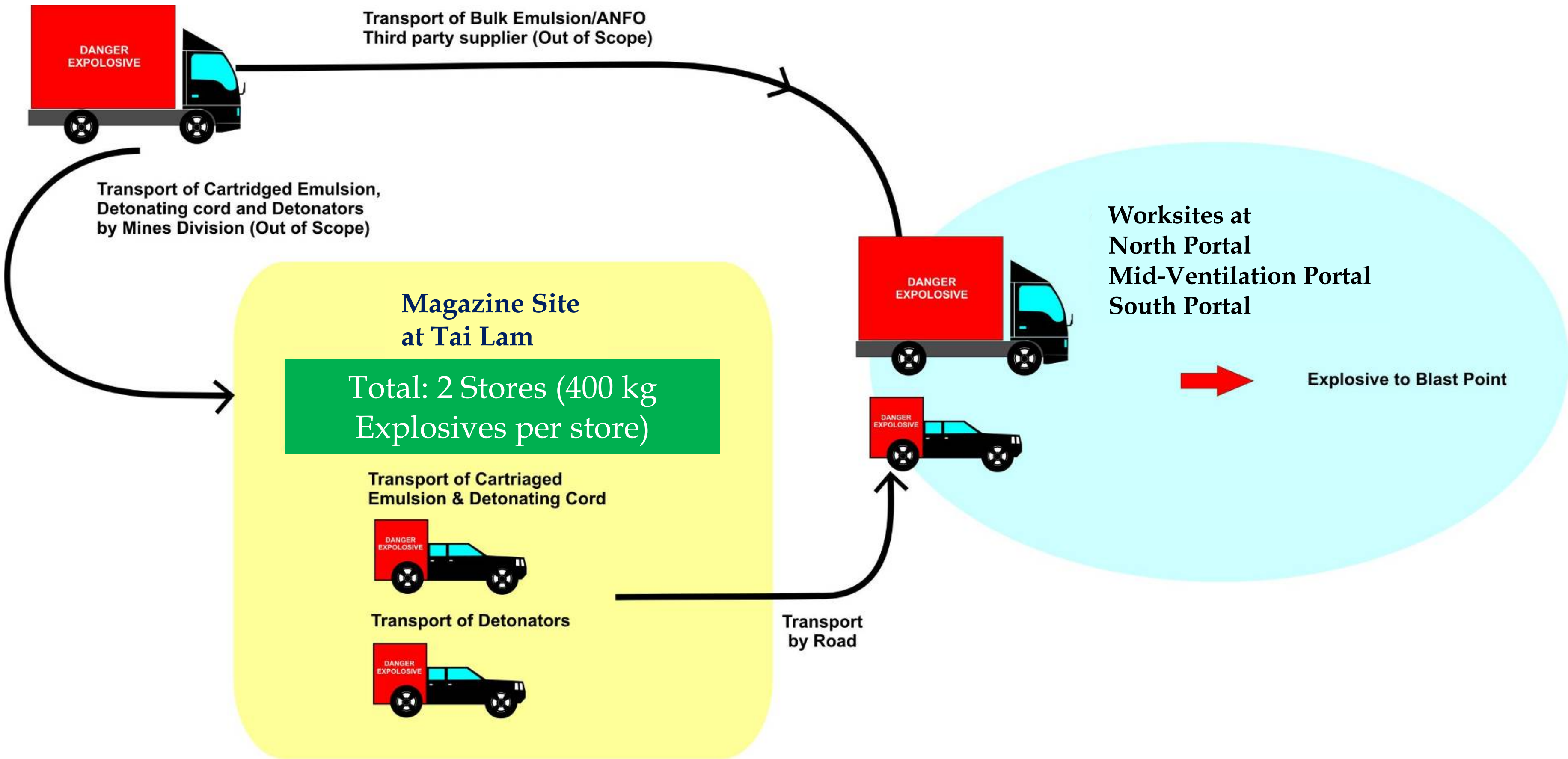
The contactors' pick up trucks (LGV pick up truck) for delivery of explosives from the Magazine to the blast faces will be licenced by Mines Division and will meet all regulatory requirements for that transport.

The proposed contractors' explosives delivery vehicle design, used as the basis for the QRA, will have the following safety features:

- Diesel powered;
- Driver's cabin is separated by a distance of not less than 150 mm from the cargo compartment of the vehicle;
- Manual fuel isolation switch;
- The exhaust system is located as far from the cargo compartment as possible. The modification of the exhaust system will be approved by the Transport Department;
- All electrical wiring and fittings will be shrouded in fire resisting conduits;
- Fuel tank will be protected from accidental damage, and designed to prevent accumulation of spilt fuel on any part of the vehicle;
- The required number of fire extinguishers shall be agreed with Mines Division;
- Fire resistant material shall be fitted between the wheel arches and the goods compartment;
- Hand-held lightning detector provided in the vehicle for lightning detection during loading and unloading of explosives;
- Lockable wood lined steel or aluminium receptacles mounted on the vehicle tray; and
- Fold down/ up explosives warning signs and red strobe beacons.

In addition to the minimum requirements, a fire screen will be fitted between the cab and the load compartment, both between the cab and the load compartment and underneath the load compartment. The fire screen shall be 3 mm; extend to 150 mm above [all sides of] and run completely under the load compartment; to at least 100 mm behind the cab of the vehicle.

Figure 2.4 Transport Strategy for the Explosives



2.6.5 *Details of Explosive Delivery Routes*

For the Base Case, the Explosives will be delivered from Tai Lam Explosives Magazine Site to the three work areas using the public roads as shown in *Figure 2.7* (Route Option R1), *Figure 2.8* (Route Option R2) and *Figure 2.9* (Route Option R3).

In Route Options R1 and R3, the explosives delivery truck will pass through Pok Oi Interchange and Shap Pat Heung Interchange. During the Fourth Meeting of Traffic and Transport Committee under Yuen Long District Council on 24 July 2014 (Thursday), members expressed concerns on the traffic conditions of Pok Oi Interchange. Currently there is road improvement work which leads to serious traffic jam, thus temporary road diversion and traffic control measures are enforced. The road improvement work is expected to be completed in 2015 but may be delayed due to the flyover foundation. Therefore, members generally did not prefer the use of Pok Oi Interchange by the explosives delivery truck during the road improvement work, and recommended to use Tong Yan San Tsuen Interchange and Yuen Long Road, which is Route Option R2.

The explosives delivery routes will be:

- At early stage of this project with road improvement work at Pok Oi Interchange (expected to be completed in 2015 but may be delayed), Route Option R2 will be used. Route Options R1 and R3 are not feasible.

- After road improvement work at Pok Oi Interchange is completed, all three routes will be available for use. The Route Option with minimum transport risk will be used.

The explosive delivery routes from the Tai Lam Explosives Magazine to the worksites (North Portal, Mid-Ventilation Portal, South Portal) will involve transportation on roads passing through mainly residential areas and commercial districts which can occasionally be crowded.

Since the explosive transport from the Magazine to the delivery points will cover between 20 - 30 kilometres of road with varying characteristics, each delivery route was broken down into sub-sections for the assessment. Route sectionalisation allows a more accurate determination of the population and of the risk.

The explosive delivery routes are listed in *Table 2.9.*

A temporary vehicular bridge has been constructed for the Project 'Liantang / Heung Yuen Wai Boundary Control Point and Associated Works' (EIA study has been approved and Environmental Permit has been issued). The temporary vehicular bridge has been constructed under Particular Specification of the Contract (Clause 1.17L(1)) , spanning across the East Rail Line of MTRC from the South Portal of Lung Shan Tunnel to a service road to the western side of East Rail Line, as shown in *Figure 2.5* and *Figure 2.6*. The design and construction of temporary vehicular bridge comply to the Transport Planning and Design Manual (TPDM), Highways standards and guidance, 'Code of Practice for Lighting, Signing and Guarding of Road Works' issued by the Hong Kong Government, Structures Design Manual for Highways and Railways issued by the Highways Department, as well as requirements imposed by MTR. The bridge will be used by CEDD Mines Division to transport explosives to the blasting worksites before Dragages Hong Kong obtains the approval for explosives transport from the Tai Lam Explosives Magazine site, and will be used by Dragages Hong Kong to transport explosive from the Tai Lam Explosives Magazine site after approval is obtained. Population affected by accidental detonation on the temporary vehicular bridge, such as passengers on the railway, are considered in the assessment.

Figure 2.5 Layout of the Temporary Vehicular Bridge

Figure 2.6 Site Photo of the Temporary Vehicular Bridge

Figure 2.7 Tai Lam Explosives Magazine Site Location and Explosives Transport Routes (Route Option R1)

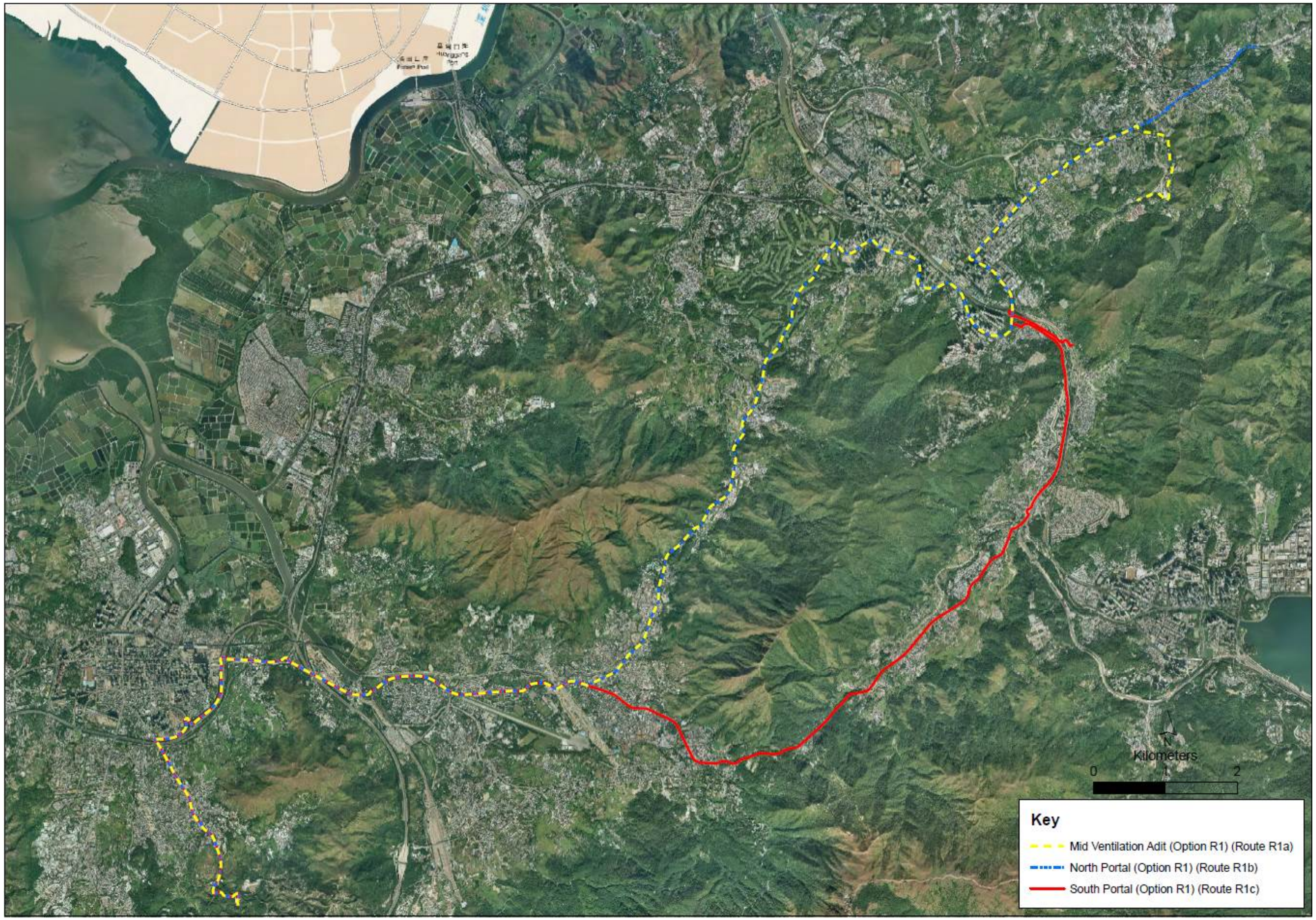


Figure 2.8 Tai Lam Explosives Magazine Site Location and Explosives Transport Routes (Route Option R2)

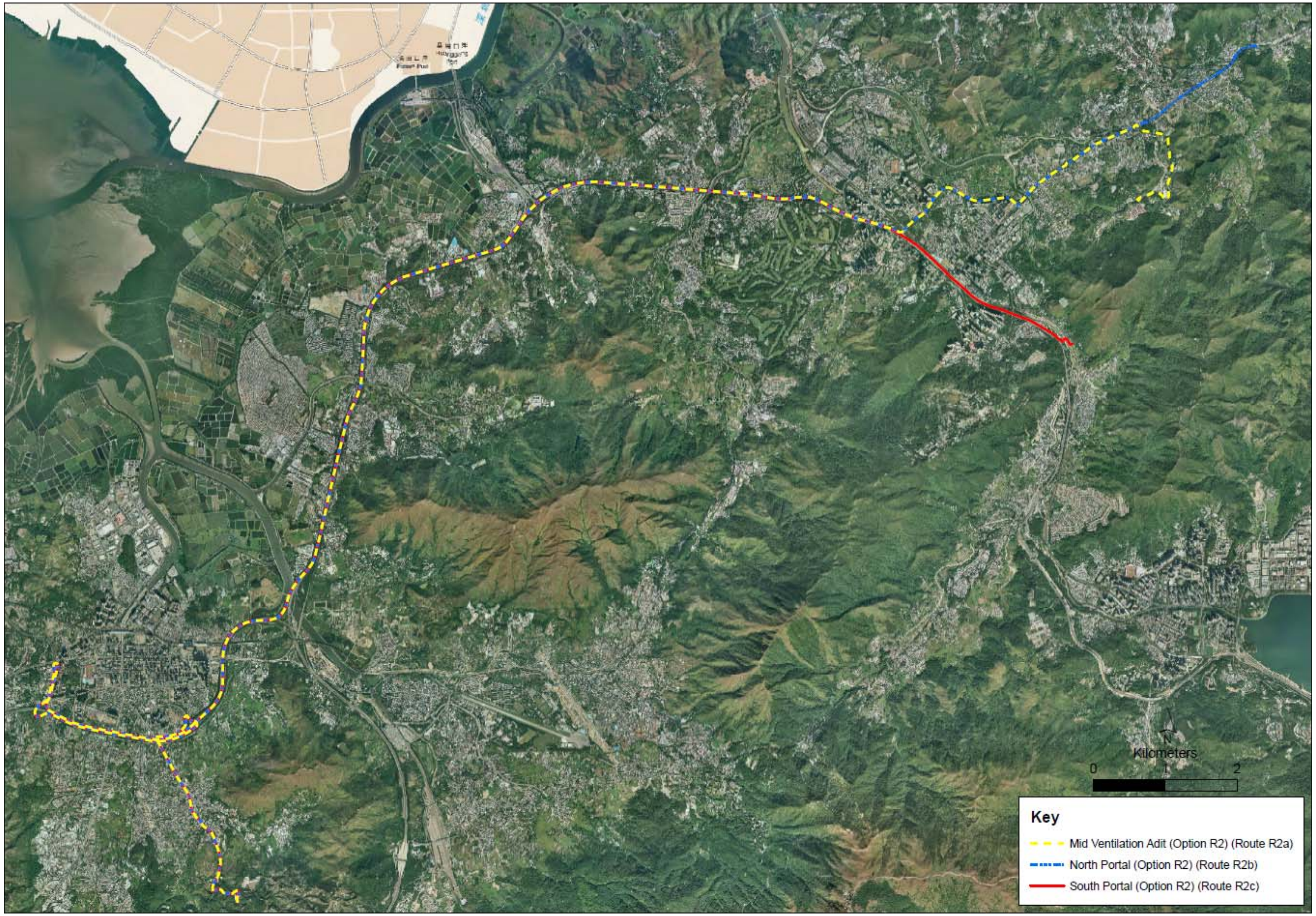


Figure 2.9 Tai Lam Explosives Magazine Site Location and Explosives Transport Routes (Route Option R3)

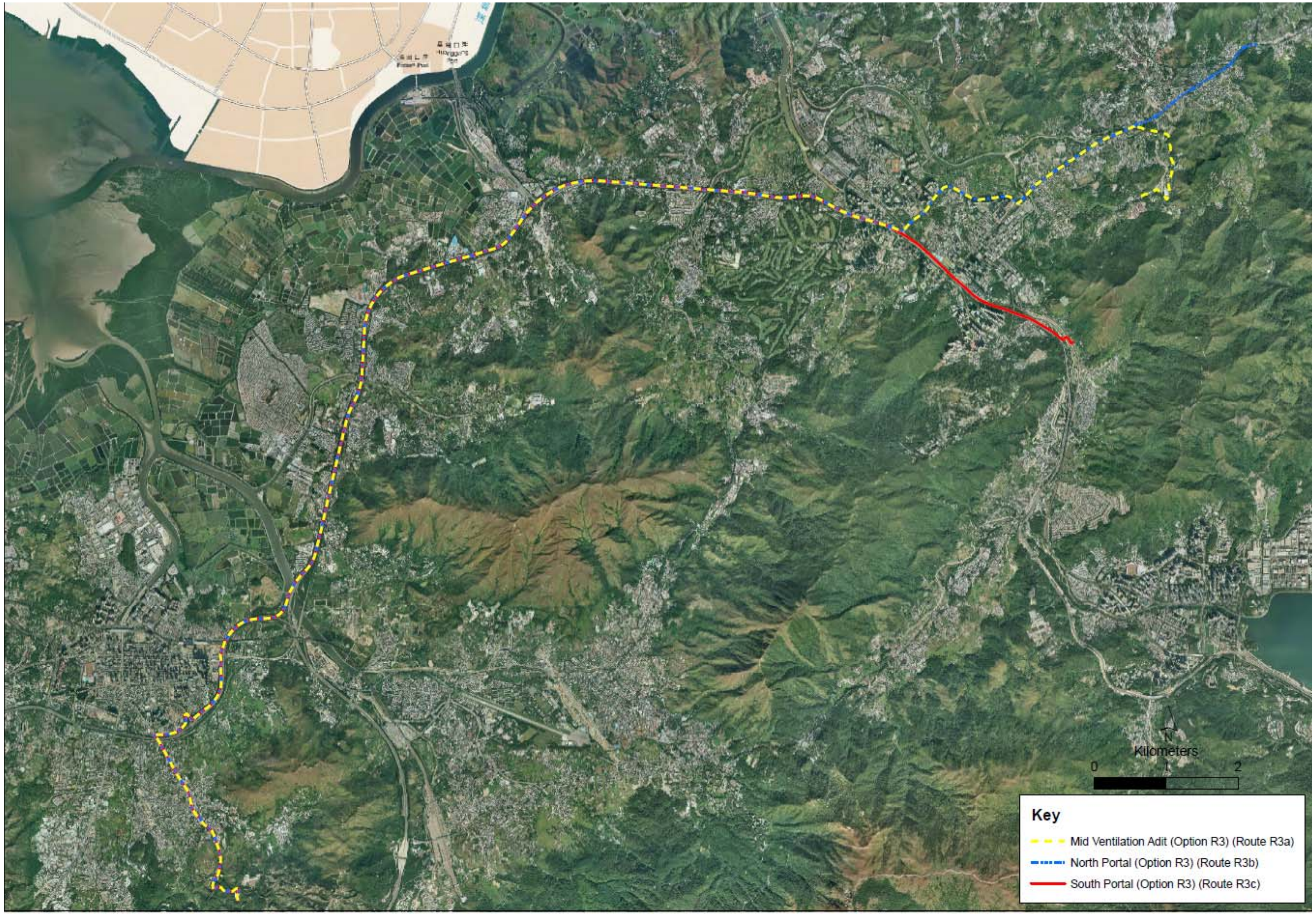


Figure 2.10 Tai Lam Explosives Magazine Site Location and Explosives Transport Routes (Yuen Long Highway and Pok Oi Interchange area close-up views)

Route Option R1

Route Option R2

Route Option R3

Table 2.9 Delivery Routes from Tai Lam Explosives Magazine Site to Worksites

Section ID	Description
Route R1a (Route Option R1: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)	
Road R1a1	Access road towards Tai Shu Ha Rd West
Road R1a2	Tai Shu Ha Road West 1
Road R1a3	Tai Shu Ha Road West 2
Road R1a4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R1a5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)
Road R1a6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)
Road R1a7	Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)
Road R1a8	Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)
Road R1a9	Kam Tin Bypass
Road R1a10	Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)
Road R1a11	Fan Kam Rd (Kam Tin Rd - Castle Peak Rd)
Road R1a12	Po Kin Rd (Fan Kam Rd - Pak Wo Rd)
Road R1a13	Pak Wo Rd (Po Kin Rd - Slip rd to So Kwun Po Int)
Road R1a14	Pak Wo Rd (Slip rd to So Kwun Po Int - Yu Tai Rd)
Road R1a15	Pak Wo Rd (Yu Tai Rd - Pak Wo Rd RA)
Road R1a16	Pak Wo Rd (Pak Wo Rd RA - Wah Ming Rd)
Road R1a17	Pak Wo Rd (Wah Ming Rd - Wai Ming St)
Road R1a18	Pak Wo Rd (Wai Ming St - Yat Ming Rd)
Road R1a19	Pak Wo Rd (Yat Ming Rd - Wo Hop Shek Int)
Road R1a20	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)
Road R1a21	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 2
Road R1a22	Jockey Club Rd (Lok Yip Rd - Sha Tau Kok Rd)
Road R1a23	Sha Tau Kok Rd (Lung Yeuk Tau) (Jockey Club Rd - Lok Yip Rd)
Road R1a24	Sha Tau Kok Rd (Lung Yeuk Tau) (Lok Yip Rd - Luen Shing St)
Road R1a25	Sha Tau Kok Rd (Lung Yeuk Tau) (Luen Shing St - On Kui St)
Road R1a26	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)
Road R1a27	Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)
Road R1a28	Po Kat Tsai Road (Lau Shui Heung Rd - Site)
Route R1b (Route Option R1: Tai Lam Explosives Magazine Site – North Portal)	
Road R1b1	Access road towards Tai Shu Ha Rd West
Road R1b2	Tai Shu Ha Road West 1
Road R1b3	Tai Shu Ha Road West 2
Road R1b4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R1b5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)
Road R1b6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)
Road R1b7	Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)
Road R1b8	Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)
Road R1b9	Kam Tin Bypass
Road R1b10	Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)
Road R1b11	Fan Kam Rd (Kam Tin Rd - Castle Peak Rd)
Road R1b12	Po Kin Rd (Fan Kam Rd - Pak Wo Rd)
Road R1b13	Pak Wo Rd (Po Kin Rd - Slip rd to So Kwun Po Int)
Road R1b14	Pak Wo Rd (Slip rd to So Kwun Po Int - Yu Tai Rd)
Road R1b15	Pak Wo Rd (Yu Tai Rd - Pak Wo Rd RA)
Road R1b16	Pak Wo Rd (Pak Wo Rd RA - Wah Ming Rd)
Road R1b17	Pak Wo Rd (Wah Ming Rd - Wai Ming St)
Road R1b18	Pak Wo Rd (Wai Ming St - Yat Ming Rd)
Road R1b19	Pak Wo Rd (Yat Ming Rd - Wo Hop Shek Int)
Road R1b20	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 1
Road R1b21	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 2
Road R1b22	Jockey Club Rd (Lok Yip Rd - Sha Tau Kok Rd)

Section ID	Description
Road R1b23	Sha Tau Kok Rd (Lung Yeuk Tau) (Jockey Club Rd - Lok Yip Rd)
Road R1b24	Sha Tau Kok Rd (Lung Yeuk Tau) (Lok Yip Rd - Luen Shing St)
Road R1b25	Sha Tau Kok Rd (Lung Yeuk Tau) (Luen Shing St - On Kui St)
Road R1b26	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1
Road R1b27	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2
Route R1c (Route Option R1: Tai Lam Explosives Magazine Site Magazine – South Portal)	
Road R1c1	Access road towards Tai Shu Ha Rd West
Road R1c2	Tai Shu Ha Road West 1
Road R1c3	Tai Shu Ha Road West 2
Road R1c4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R1c5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)
Road R1c6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)
Road R1c7	Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)
Road R1c8	Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)
Road R1c9	Kam Tin Bypass
Road R1c10	Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)
Road R1c11	Kam Tin Rd (Fan Kam Rd - Kam Sheung Rd eastern junction)
Road R1c12	Lam Kam Rd (Kam Sheung Rd - Lam Kam Rd Int)
Road R1c13	Lam Kam Rd (Lam Kam Rd Int - Tai Wo Service Rd W)
Road R1c14	Tai Wo Service Rd W (Lam Kam Rd Int - Kau Lung Hang FO)
Road R1c15	Tai Wo Service Rd W (Kau Lung Hang FO - Wo Hing Rd)
Road R1c16	Unnamed road (Wo Hing Rd - Pak Wo Rd)
Road R1c17	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)
Road R1c18	Slip Rd (Jockey Club Rd - Fanling Highway)
Road R1c19	Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)
Road R1c20	Tai Wo Service Rd East (Slip rd from Fanling Highway - Road to Site 1)
Road R1c21	Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)
Road R1c22	Road to Site 2 (Road to Site 1 - Site)
Route R2a (Route Option R2: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)	
Road R2a1	Access road towards Tai Shu Ha Rd West
Road R2a2	Tai Shu Ha Road West 1
Road R2a3	Tai Shu Ha Road West 2
Road R2a4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R2a5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)
Road R2a6	Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)
Road R2a7	Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)
Road R2a8	Connecting road from Tong Yan San Tsuen Int to Long Tin Road
Road R2a9	Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))
Road R2a10	Connecting road from Long Tin Road North Bound to South Bound
Road R2a11	Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)
Road R2a12	Connecting road from Long Tin Rd to Tong Yan San Tsuen Int
Road R2a13	Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)
Road R2a14	Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)
Road R2a15	Yuen Long Highway (to San Tin Highway 1)
Road R2a16	Yuen Long Highway (to San Tin Highway 2)
Road R2a17	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)
Road R2a18	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)
Road R2a19	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)
Road R2a20	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)
Road R2a21	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)
Road R2a22	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)
Road R2a23	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)
Road R2a24	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)
Road R2a25	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)

Section ID	Description
Road R2a26	Ma Sik Rd (Luen Chit St - Wo Tai St)
Road R2a27	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))
Road R2a28	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)
Road R2a29	Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)
Road R2a30	Po Kat Tsai Road (Lau Shui Heung Rd - Site)
Route R2b (Route Option R2: Tai Lam Explosives Magazine Site – North Portal)	
Road R2b1	Access road towards Tai Shu Ha Rd West
Road R2b2	Tai Shu Ha Road West 1
Road R2b3	Tai Shu Ha Road West 2
Road R2b4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R2b5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)
Road R2b6	Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)
Road R2b7	Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)
Road R2b8	Connecting road from Tong Yan San Tsuen Int to Long Tin Road
Road R2b9	Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))
Road R2b10	Connecting road from Long Tin Road North Bound to South Bound
Road R2b11	Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)
Road R2b12	Connecting road from Long Tin Rd to Tong Yan San Tsuen Int
Road R2b13	Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)
Road R2b14	Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)
Road R2b15	Yuen Long Highway (to San Tin Highway 1)
Road R2b16	Yuen Long Highway (to San Tin Highway 2)
Road R2b17	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)
Road R2b18	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)
Road R2b19	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)
Road R2b20	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)
Road R2b21	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)
Road R2b22	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)
Road R2b23	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)
Road R2b24	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)
Road R2b25	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)
Road R2b26	Ma Sik Rd (Luen Chit St - Wo Tai St)
Road R2b27	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))
Road R2b28	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1
Road R2b29	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2
Route R2c (Route Option R2: Tai Lam Explosives Magazine Site – South Portal)	
Road R2c1	Access road towards Tai Shu Ha Rd West
Road R2c2	Tai Shu Ha Road West 1
Road R2c3	Tai Shu Ha Road West 2
Road R2c4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R2c5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)
Road R2c6	Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)
Road R2c7	Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)
Road R2c8	Connecting road from Tong Yan San Tsuen Int to Long Tin Road
Road R2c9	Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))
Road R2c10	Connecting road from Long Tin Road North Bound to South Bound
Road R2c11	Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)
Road R2c12	Connecting road from Long Tin Rd to Tong Yan San Tsuen Int
Road R2c13	Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)
Road R2c14	Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)
Road R2c15	Yuen Long Highway (to San Tin Highway 1)
Road R2c16	Yuen Long Highway (to San Tin Highway 2)
Road R2c17	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)
Road R2c18	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)

Section ID	Description
Road R2c19	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)
Road R2c20	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)
Road R2c21	Fanling Highway (So Kwun Po Int - Wo Hop Shek Int)
Road R2c22	Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)
Road R2c23	Tai Wo Service Rd East (Slip rd from Fanling Highway - Kau Lung Hang FO)
Road R2c24	Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)
Road R2c25	Road to Site 2 (Road to Site 1 - Site)
Route R3a (Route Option R3: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)	
Road R3a1	Access road towards Tai Shu Ha Rd West
Road R3a2	Tai Shu Ha Road West 1
Road R3a3	Tai Shu Ha Road West 2
Road R3a4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R3a5	Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)
Road R3a6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)
Road R3a7	Yuen Long Highway
Road R3a8	Yuen Long Highway (to San Tin Highway 1)
Road R3a9	Yuen Long Highway (to San Tin Highway 2)
Road R3a10	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)
Road R3a11	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)
Road R3a12	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)
Road R3a13	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)
Road R3a14	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)
Road R3a15	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)
Road R3a16	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)
Road R3a17	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)
Road R3a18	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)
Road R3a19	Ma Sik Rd (Luen Chit St - Wo Tai St)
Road R3a20	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))
Road R3a21	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)
Road R3a22	Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)
Road R3a23	Po Kat Tsai Road (Lau Shui Heung Rd - Site)
Route R3b (Route Option R3: Tai Lam Explosives Magazine Site – North Portal)	
Road R3b1	Access road towards Tai Shu Ha Rd West
Road R3b2	Tai Shu Ha Road West 1
Road R3b3	Tai Shu Ha Road West 2
Road R3b4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R3b5	Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)
Road R3b6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)
Road R3b7	Yuen Long Highway
Road R3b8	Yuen Long Highway (to San Tin Highway 1)
Road R3b9	Yuen Long Highway (to San Tin Highway 2)
Road R3b10	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)
Road R3b11	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)
Road R3b12	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)
Road R3b13	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)
Road R3b14	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)
Road R3b15	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)
Road R3b16	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)
Road R3b17	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)
Road R3b18	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)
Road R3b19	Ma Sik Rd (Luen Chit St - Wo Tai St)
Road R3b20	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))

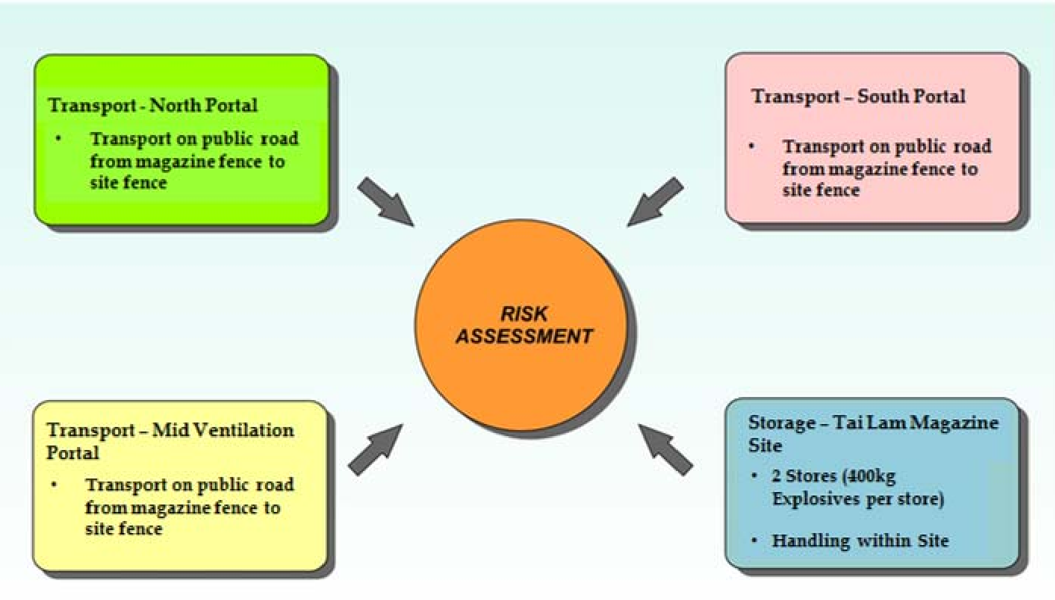
Section ID	Description
Road R3b21	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1
Road R3b22	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2
Route R3c (Route Option R3: Tai Lam Explosives Magazine Site – South Portal)	
Road R3c1	Access road towards Tai Shu Ha Rd West
Road R3c2	Tai Shu Ha Road West 1
Road R3c3	Tai Shu Ha Road West 2
Road R3c4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)
Road R3c5	Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)
Road R3c6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)
Road R3c7	Yuen Long Highway
Road R3c8	Yuen Long Highway (to San Tin Highway 1)
Road R3c9	Yuen Long Highway (to San Tin Highway 2)
Road R3c10	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)
Road R3c11	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)
Road R3c12	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)
Road R3c13	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)
Road R3c14	Fanling Highway (So Kwun Po Int - Wo Hop Shek Int)
Road R3c15	Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)
Road R3c16	Tai Wo Service Rd East (Slip rd from Fanling Highway - Kau Lung Hang FO)
Road R3c17	Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)
Road R3c18	Road to Site 2 (Road to Site 1 - Site)

3 HAZARD TO LIFE ASSESSMENT METHODOLOGY

3.1. OVERVIEW OF THE METHODOLOGY

The methodology presented in this section and used in the assessment is the same methodology which has been used on previously approved EIA projects (ERM 2011, ERM 2009, ERM 2008). The overall methodology for the Hazard to Life Assessment addresses the risk associated with the storage and transport of explosives for the Project (see *Figure 3.1*).

Figure 3.1 Components of the Risk Assessment



The potential hazards considered to pose a risk to the general population include overpressure and other effects such as projectiles.

The elements of the QRA are shown schematically in *Figure 3.2*. It includes the following steps.

- Collection and review of relevant data for the Tai Lam Explosives Magazine Site, the transport from Tai Lam Explosives Magazine Site, as well as population and vulnerable receptors, such as slopes, retaining walls etc., in the vicinity of the worksites and proposed transport routes;

- Hazard identification. A review of literature and accident databases was undertaken and updated. These formed the basis for identifying all the hazardous scenarios for the QRA study;

- Frequency estimation. The frequencies, or the likelihood, of the various outcomes that result from the hazards associated with the storage and transport of explosives was taken primarily from previous EIA QRAs that have been accepted by the relevant authorities. Where necessary, to consider specific factors applicable for the Project and to reflect the current knowledge on the explosives' properties, these frequencies were modified or updated making reference, as far as possible to published references; such as the previous Hong Kong studies, UK HSE, US DoD, Dutch TNO (TNO Purple Book), latest accident statistics from the Transport Department and Fire Services Department, etc.;

- For all identified hazards, the frequency assessment has been documented and the consequences of the event were modelled;

- The consequence model employed in this study is the ESTC model (ESTC, 2000) developed by the UK Health and Safety Commission (HSC). Although, there have been a number of recent studies suggesting that the ESTC (2000) models should be reviewed for applicability to explosive stores and transport, these models are still the recommended models in the UK and have been adopted in previous Hong Kong EIAs;

- The same frequency model was adopted in this study as that of ERM (2011) and ERM (2009) studies, which has been derived to reflect the current Transport Department statistics, Fire Services Department statistics, specific design features applicable for the Project and current knowledge of explosives;

- The consequence and frequency data were subsequently combined using ERM's in-house Explosive Transport GIS Risk Assessment tool (E-TRA), which has been developed to account for three-dimensional blast effects on buildings and the effect of accidental explosions on elevated roads. It also accounts for traffic jam scenarios which could occur in some accidental scenarios as reported in the DNV (1997) study. The model is summarised in the next section and has been validated against ERM in-house proprietary software Riskplot TM. This risk assessment tool has been employed in ERM (2011) and ERM (2009) studies; and

- Finally, the results from the risk assessment were compared to the EIAO-TM Criteria. Recommendations have been made where required to ensure compliance with EIAO-TM Criteria, relevant best practice, and to reduce the overall risk levels.

Making reference to other relevant Hong Kong QRA studies, this Hazard to Life Assessment has performed an update of the QRA parameters considered in other studies and reviewed their applicability to the transport and storage elements of the QRA as applicable for the Project. Although, some QRA parameters may differ from previous studies, as required by the EIA Study Brief, the methodology adopted is consistent with the following studies:

- Shatin to Central (SCL (TAW-HUH)) study (ERM 2011)

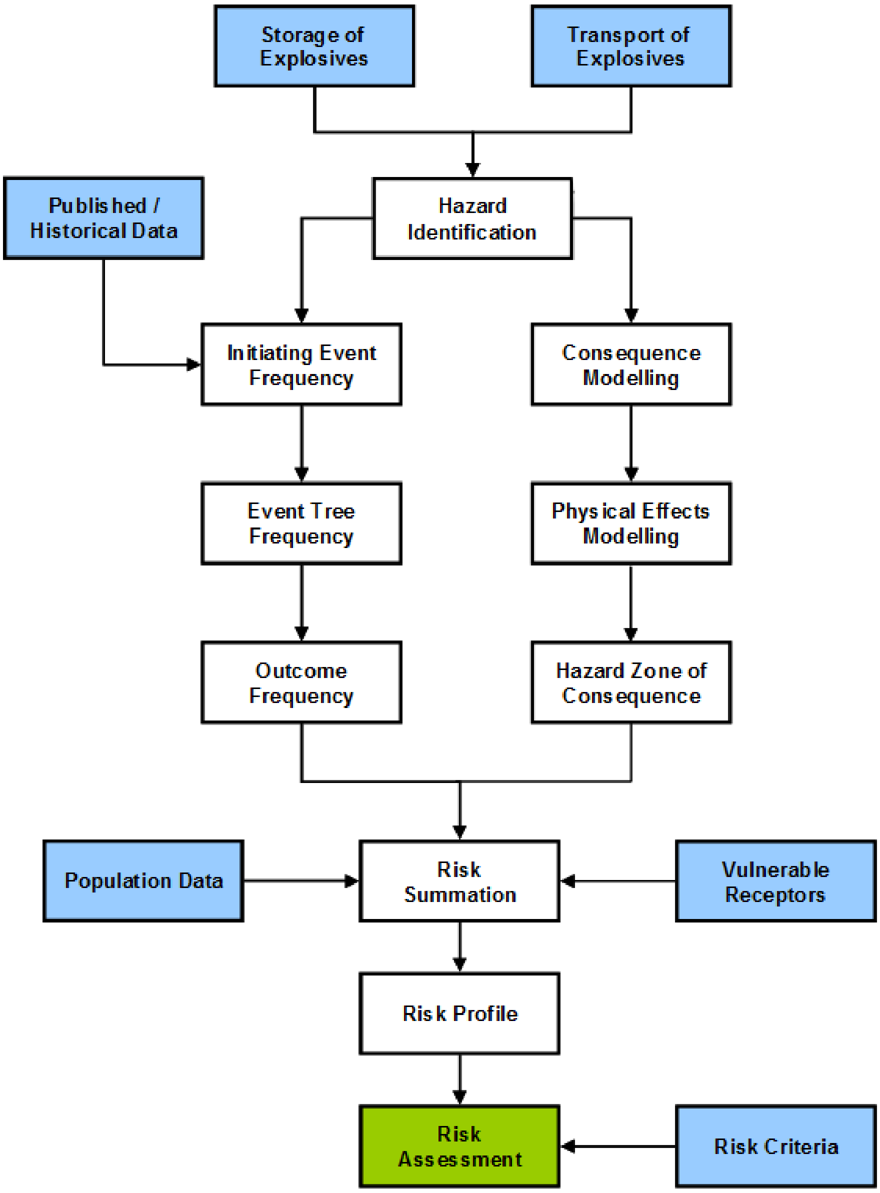
- South Island Line (East) (SIL(E)) study (ERM, 2010a);

- Kwun Tong Line Extension (KTE) study (ERM, 2010b);

- Express Rail Link (XRL) study (ERM, 2009);
- West Island Line (WIL) study (ERM, 2008);
- Hazard to Life Assessment section of the Ocean Park Development study (Maunsell, 2006);
- The territory wide study for the transport of explosives (DNV, 1997); which was the basis for the XRL study (ERM, 2009), and the ACDS study (ACDS, 1995) which was the basis for the DNV study (DNV, 1997). The basis for the frequency assessment data and methodology for the DNV study, as well as the ACDS study, has been reported separately by the UK HSE (Moreton, 1993); and
- Hazard to Life Assessment section of the Penny's Bay Rail Link EIA, (ERM, 2001).

According to Appendix B of the EIA Study Brief, ERM (2009) study for the XRL project is the primary reference for the Project Hazard to Life Methodology.

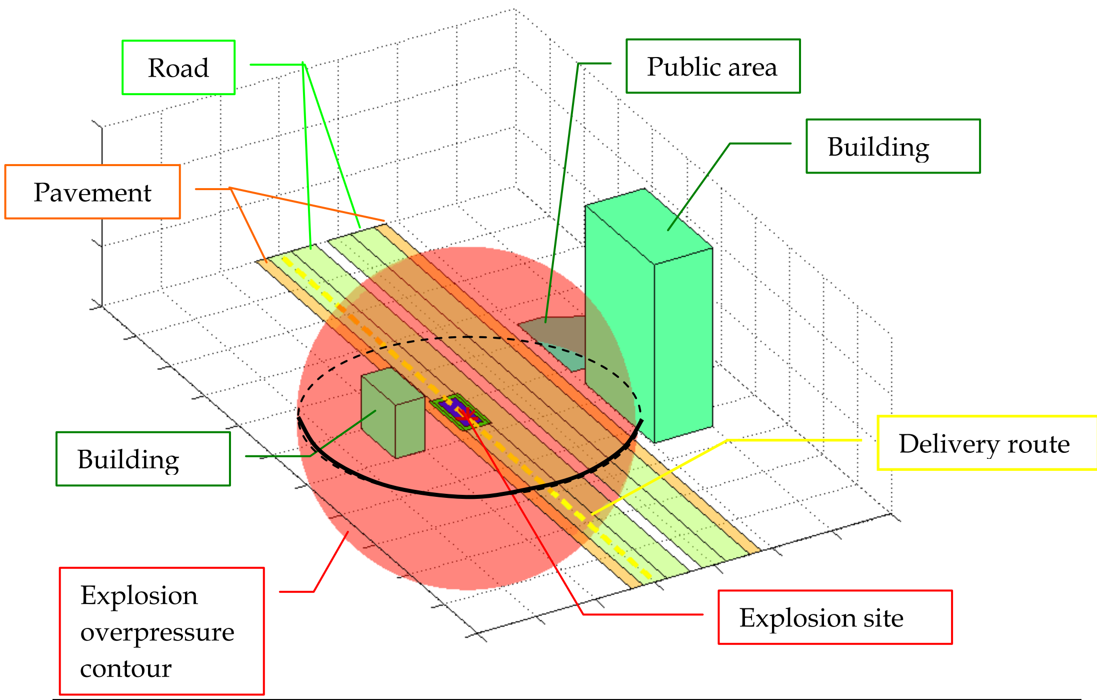
Figure 3.2 Schematic Diagram of the QRA Process



3.2. *OVERVIEW OF THE EXPLOSIVE TRANSPORT RISK ASSESSMENT TOOL AND METHODOLOGY*

The approach to modelling the risks for the transport of explosives is similar to that adopted in earlier studies (ERM, 2011) (ERM, 2009) and is fully 3-dimensional and GIS based. It accounts for the potential increased risk when the explosive truck travels on elevated roads. The route from the Magazine to each worksite is divided into sections for analysis, according to road characteristics. If initiation of the explosives on a delivery truck occurs, spherical blast waves and fragmentation may be produced which may impact on surrounding population such as other road users, buildings, as well as outdoor population on pavements and in public areas (*Figure 3.3*). The number of fatalities from an explosion at a particular location is determined by calculating the degree of overlap between explosion overpressure contours and populated areas.

Figure 3.3 *Explosion Impact on Surrounding Population*



2-Dimensional Calculations

In order to describe the 3-dimensional procedure, the 2-dimensional case at ground level is described first for illustration purposes (*Figure 3.4*). Polygons are used to define population areas for traffic lanes, pavement areas, buildings and public areas. A number of explosion effect levels are calculated to determine the hazard footprint and fatality probability at various distances from the explosives truck. These hazard footprints are then overlaid on the population polygons to determine overlap areas and the number of fatalities resulting from an explosion.

To improve accuracy and be ensured that the risk is not underpredicted, several explosion effect contours are generally used to describe different fatality probabilities (90%, 50%, 10%, 3% and 1%) at different distances from the truck. Geometric means have been applied in the model. Although the geometric means have no physical meaning, the levels calculated with the geometric means using the fatality probabilities listed above closely match the true average explosive effect distances.

To define the population polygons, each section of a route is characterised in terms of the number of traffic lanes on the nearside and the far side, the widths of the traffic lanes, the width of the centre divide and the widths of the nearside and far side pavements. Polygons describing buildings and public areas on each side of the road were obtained from a GIS database. The building types, such as high rise residential, low rise industrial, commercial etc., are used to estimate building population and a distinction is made between population indoors and outdoors. Road population densities are estimated for two traffic conditions: flowing traffic and traffic jam. Road traffic is based on the latest Annual Average Daily Traffic data (AADT) from 2013, available from the Transport Department. Further details of the population can be found in *Section 4*.

Although an initiation of an explosives truck could occur anywhere along the delivery routes, it is necessary to consider discrete locations in the modelling. Explosion sites are therefore considered with a spacing of about 10 m. This gives 100 potential explosion sites for each kilometre of the transport route.

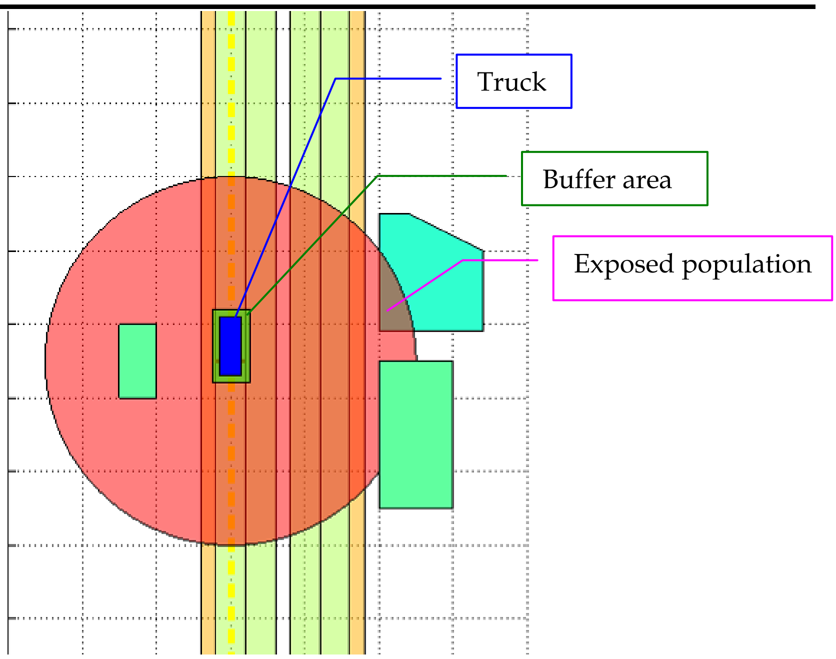
Other assumptions made in the model include:

- The explosives trucks are assumed to be located in the slow lane of multilane roads and hence the explosion site is assumed to be centred on the slow lane;

- The explosives trucks present a hazard only during delivery of explosives from the Magazine to the work area. The return journey to the Magazine presents no risk since the truck is empty. Partial deliveries of explosives i.e. delivery of partial load to worksite A, followed by direct routing to worksite B etc. are not considered in the model;

- The explosives trucks are expected to be a light truck e.g. a LGV pick-up truck. There will not be any member of the public located within the area occupied by the truck itself. Also, there will not be any other road vehicles within a couple of metres of the truck because of natural separation of vehicles and width of lanes. A buffer area (*Figure 3.4*) is therefore defined as 5 m × 10 m in which the population is taken to be zero. Consistent with the previously approved SCL (TAW-HUH) study (ERM, 2011) and XRL study (ERM, 2009), the explosives are assumed to be located at a position 2.5 m from the left edge and 7 m from the front edge of the buffer area. This buffer area has taken into account the area occupied by the truck and the normal separation among vehicles.

Figure 3.4 *Explosion Overpressure Footprint at Ground Level*



Extension to 3-Dimensional Modelling

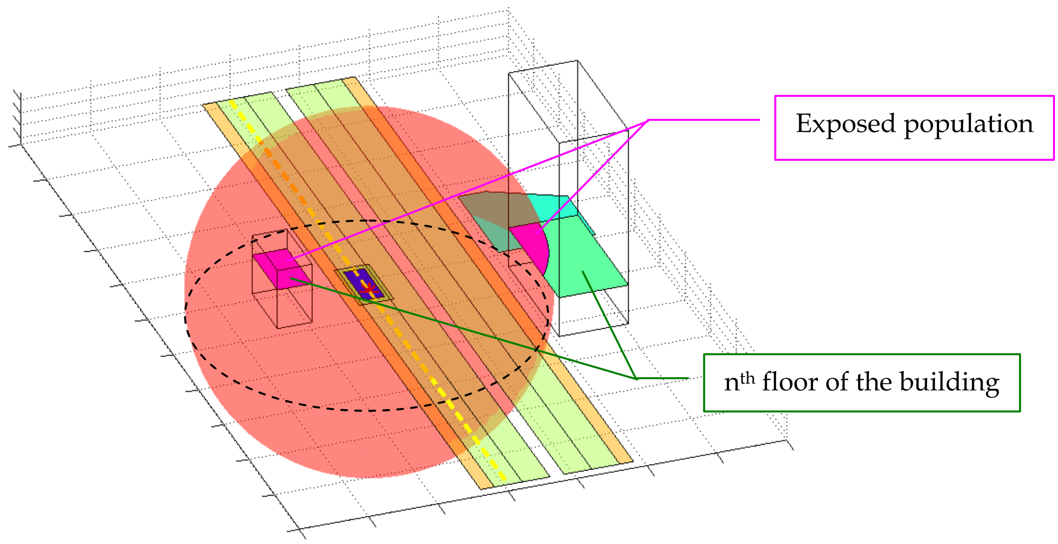
Buildings are modelled in 3-dimensions. This is achieved in essentially the same manner as the 2-D calculations, but the overlap areas between explosion overpressure contours and building polygons are calculated floor by floor (*Figure 3.5*). Since the explosion effects are spherical, the extent of the overpressure contours varies with height above the road. This is taken into account in the model. It is therefore possible that only a few floors of a building may be affected. Any elevation difference between the road and building is also allowed for since a fully 3-dimensional coordinate system is used to define roads and population polygons.

The GIS database of buildings includes details such as podiums on lower levels. These variations in building geometry are therefore captured by the model.

Buildings, in general, have multiple accommodation units, only half of which on average will overlook the road. The calculation of overlap areas therefore has a prescribed upper limit of 0.5 to reflect that at most half of each floor will be affected by a blast. The shielding provided by other buildings is not taken into account in the modelling, however, with explosion effect contours extending to a maximum of only about 60 m, there will be very few instances of impacts reaching the second line of buildings from the road. In any case, neglect of shielding by buildings is a conservative simplification.

Elevation differences between the explosion site on the road and surrounding areas such as parks and playgrounds is also taken into account in the modelling.

Figure 3.5 *3-Dimensional Treatment of Buildings*



The number of fatalities from an explosion is calculated by summing the fatalities in buildings with those outdoors and those on the road before pairing them to the *f* value in an f-N pair. The frequency of an explosion is calculated based on the number of trips for a particular route section and the probability of initiation per kilometre and the separation between explosion sites (about 10 m). This combination of number of fatalities *N*, and frequency *f* form one dataset pair for the explosion event. Summing over all explosion sites along the transport route gives the societal risk, calculated as either Potential Loss of Life (PLL) or presented as F-N curves.

$$PLL = \sum_i f_i N_i$$

F-N curves plot the frequency *F*, of *N* or more fatalities against *N*. The frequency *F* is therefore a cumulative frequency calculated from:

$$F_j = \sum_{N_i > N_j} f_i \ .$$

Individual risk is also calculated and presented as contours overlaid on transport routes.

4 POPULATION ESTIMATES

4.1 POPULATION ESTIMATE NEAR TAI LAM EXPLOSIVE MAGAZINE

The use of the existing Tai Lam Explosive Magazine is required in order to enable efficient delivery of explosives to work areas (see *Figure 4.1*).

The Tai Lam Explosive Magazine Site is located in the northern New Territories at Tai Lam and will supply explosives to all three worksites. The Tai Lam Explosive Magazine Site is located on a disused quarry near Yuen Long. This is a relatively remote location surrounded by woodland (*Figure 4.1*). The site sits at the top of a small plateau, with gentle gradients descending on all sides. Most of these slopes appear to be natural. There are no known (current or future) buildings or any other structures in the hazard zone of the Magazine.

The Hong Kong Model Engineering Club periodically flies model aircrafts at a site about 300 m from the Magazine. The distance of the entrance of the club to the magazine is about 200 m. According to the club staff, the population on the site will generally be about 100 during week day events, 200 at week-ends and public holidays. The club also occasionally hold 5 or 6 major events attracting a crowd of around 1,000 people. The populated area, however, being more than 200 m from the Magazine, is outside the area of interest, i.e. the separation distance for the Magazine.

This Magazine site has been selected based on consideration of separation distances from public areas and buildings, as well as practicality grounds for its proximity to works areas and transport routes.

Population within the vicinity of the Magazine site is based on surveys conducted by ERM in June 2014. Additional information was gathered from the XRL Study (ERM 2009), GIS tools and aerial maps. From these, potential sensitive receivers in the vicinity of each site were identified and their population estimated.

Table 7.1 of the consequence analysis (*Section 7*) demonstrated that the maximum effect radius from a blast at the Magazine which could produce 1% fatality is about 71 m. All population within 71 m radius from the Magazine was therefore estimated.

The only population within the effects radius is the transient population on the roads and pavements. This was estimated as a population density in the same manner as described in *Section 4.2.*

Figure 4.1 Aerial Photo of the Tai Lam Explosives Magazine Site

4.2 POPULATION ALONG EXPLOSIVES DELIVERY ROUTES

Three types of population have been considered:

- Pedestrian population on footpaths and pavements next to delivery routes;
- Road population; and
- Building population.

For areas not supported by surveys or where information is not available from other pertinent sources of information, the assumptions in *Table 4.1* have been used, consistent with the SCL study (ERM, 2011) and XRL study (ERM, 2009) .

Table 4.1 Population Assumptions

Type of Population	Assumption	Remarks
Residential Building	3 persons / flat	Government Territorial Population and Employment Data Matrices (TPEDM) indicate current Persons Per Unit (PPU) in the transport area of slightly less than 3. A value of 3 has been adopted as a conservative assumption.
Commercial Building	9 m^2/person	Code of Practice for the Provision of Means of Escape in Case of Fire indicates 9m^2/person as a minimum requirement. For buildings considered to bear an impact on the risk results, a specific survey has been conducted.
Footpath	0.5 persons /m^2	Density figure of 0.5 persons/m^2 is defined as footpath Level Of Service (LOS) in the Highway Capacity Manual. This is considered as a reasonable conservative density for the footpaths in the study area and will be used unless specific surveys indicate lower values.
Education Institute	500 persons / hall	

The methodology followed in establishing the population was, to a large degree, consistent with previously approved EIAs including the SCL study (ERM, 2011), XRL study (ERM, 2009), WIL study (ERM, 2008) and the LNG Receiving Terminal EIA (ERM, 2006), which included a detailed population survey for most parts of the explosive transportation route.

Population on the roads was estimated fromAnnual Traffic Census 2013 (ATC, 2013).

Population in buildings adjacent to transport routes was estimated from data obtained from:

- Centamap (2015); and
- Geographic Information System (GIS) database (2015 data).

In the event of an absence of data from either of these sources a site survey was carried out.

Accounting for the maximum licensing limit of 200 kg for the transport of explosives, all buildings within a 100 m corridor each side of the transport routes were included in the assessment. This corridor width is more than sufficient to describe the building population that may be affected by explosion from even the largest transport loads. The 1% fatality effects from the initiation of 200 kg of explosives, for example, does not extend as far as 100 m and all transport loads considered in this project are less than or equal to 200 kg.

All of the buildings along each delivery route have been entered individually into the E-TRA model, so as to accurately represent the population. Particular attention has been considered regarding the effects of accidental explosion on buildings where the vehicle is located on an elevated road.

A population density approach has been adopted for modelling the presence of pedestrians and road users.

Road users have been considered depending on the explosion scenarios as equally distributed, or under a slow / congested traffic. Referring to the frequency components of the transport QRA (see *Section 6*), an accidental explosion due to vehicle collision or transport of unsafe explosives will be spontaneous and can only impact on free flowing traffic. Explosive initiation following a vehicle fire (following a traffic accident or otherwise) could impact on queuing traffic conservatively assumed to occur within each lane on either side of the road in day or night conditions. Half jams are assumed in the analysis, whereby a traffic jam occurs behind the incident vehicle with a clear road in front. For such fire scenarios, traffic jam (half jam) is conservatively assumed to develop in 50% of the cases as, under low traffic conditions, such as during night time or day time at non-peak hours, road users may use alternative lanes or reverse which would not give rise to traffic jam.

In addition to road and building populations, the outdoor population on pavements was also estimated, based on a survey undertaken by ERM in June 2014.

The following sections present the approach taken for the Base Case scenario, where the deliveries could be scheduled at predetermined times during the entire day. For the Worst Case scenario, a 20% increase in the number of deliveries compared to the base case scenario was considered.

4.2.1 *Route Sectionalisation*

The explosives delivery routes from Tai Lam Explosives Magazine Site to the worksites (North Portal, Mid-Ventilation Portal, and South Portal) have been broken down into sub-sections for the assessment as described in *Section 2.6.5*.

4.2.2 *Road Population*

The traffic density information used in this study is based on the latest 2013 Annual Traffic Census. A growth of 1% per year to the year of completion of the blasting work (2017) has been assumed in the analysis for delivery to various points.

A population density approach was adopted for estimating the population within vehicles on the road. Vehicle occupants were conservatively estimated as indoor with regards to consequence models (i.e. subject to glass debris impact).

AADT data gives daily average traffic conditions and, for some stations, data are available at different times of the day. AADT data therefore appropriately represents normal traffic flows at non-peak hours.

Flowing Traffic Population

The traffic density information used in this study was based on the latest 2013 Annual Traffic Census (ATC, 2013) developed by the Transport Department. A growth of 1% per year was assumed to extrapolate current data to the year of excavation by blasting, 2017.

Road population density was calculated using the following expressions:

Annual Average Daily Traffic (AADT)

Population Density (persons/m^2) = AADT × P / 1000 / 24 / V / W

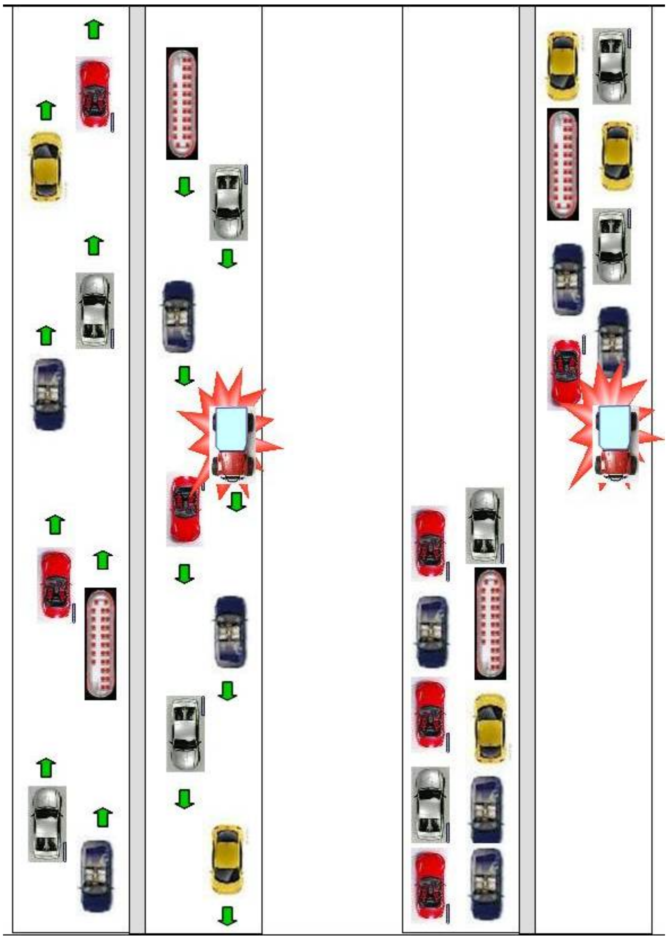
where:
P is the average number of persons per vehicle
W is the road width in metre, based on actual road width data
V is the vehicle speed in km/hr

Based on average vehicle occupancy reported in the Traffic Census for the relevant transportation routes, the average vehicle occupancy is around 3.2 persons per vehicle. This includes buses and trucks as well as taxis and private cars.

V has been selected as 60 km/hr for expressways and 50 km/hr for non-expressway route sections, consistent with previous Hong Kong studies.

The above formulae based on AADT provide population information for average and peak flowing traffic conditions respectively. There is a possibility of a traffic jam when explosive initiation occurs. For example, if the explosives truck catches fire either due to an accident or due to other causes, the incident could disrupt traffic flow and lead to a traffic jam before initiation occurs (*Figure 4.2*).

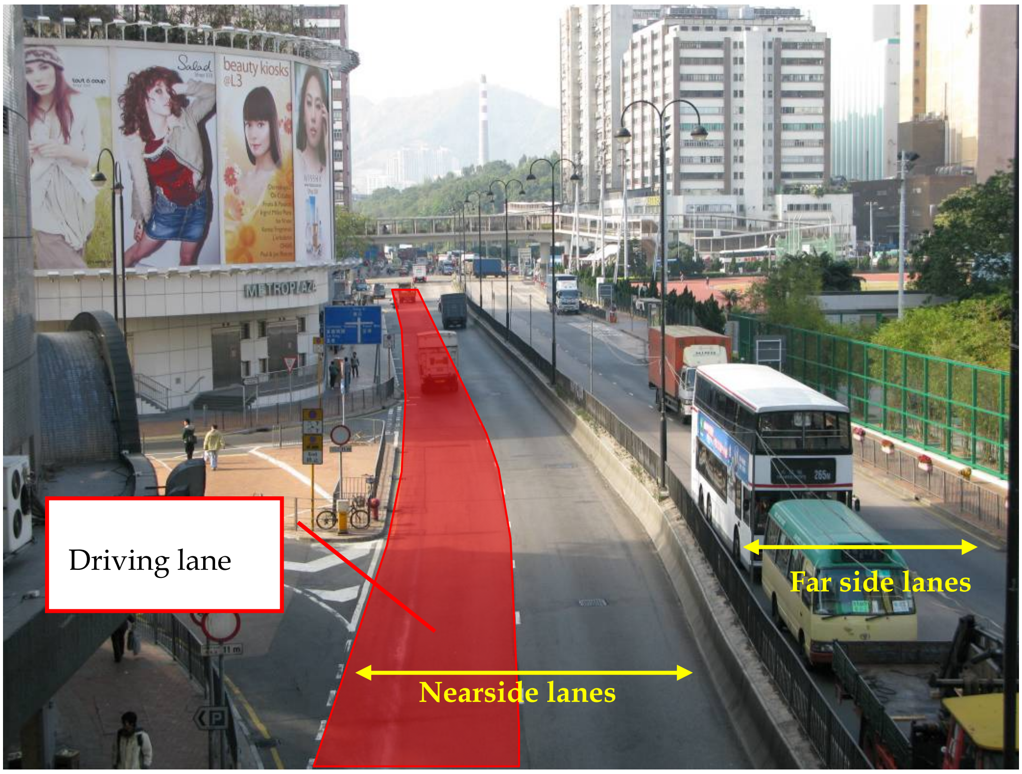
Figure 4.2 Road Traffic Conditions and Scenarios Considered



Free flowing traffic **Half Jam**

The road population estimates take into consideration the number of lanes and distinguishes between traffic on the nearside lanes and traffic flowing in the opposite direction to the explosives truck (the far side lanes) (*Figure 4.3*).

Figure 4.3 *Road Population Model*



Traffic Jam Population

It is possible that the traffic flow will be disrupted when an explosion initiation occurs on the delivery truck. If a traffic accident is severe enough to lead to a vehicle fire, for example, a traffic jam could develop before the fire spreads to the explosive load causing initiation. The transport model includes scenarios with traffic jam conditions which will in general have higher population densities compared to flowing traffic due to the reduced separation between vehicles.

The traffic jam population density depends only on vehicle mix and not on traffic volume. The length of road occupied by vehicles of different type is estimated as follows:

- Private cars, taxis and motorcycles – 5 m
- Public light buses – 10 m
- Goods vehicles – 20 m
- Buses – 20 m

The occupancies for each type of vehicle were taken from the Annual Traffic Census (ATC) for 2013. Two core stations were selected as representative of the transport routes from Tai Lam Explosives Magazine Site which are shown in *Table 4.2*. As a conservative measure, the peak occupancy numbers from these 2 core stations were used in the assessment.

Table 4.2 Core Stations along the Proposed Transport Routes

Core Station	Description	Applicable Transport Route
Stn 5003	Fanling Highway (So Kwun Po Int – Wo Hop Shek Int)	All routes
Stn 5016	San Tin Highway	All routes

Table 4.3 Vehicle Occupancy for Different Types of Vehicle

Vehicle Type	AADT Core Station		Average
	5003	5016	
Motorcycle	1.2	1.1	1.15
Private car	1.6	1.6	1.6
Taxi	2.5	2.6	2.55
Public light bus	0	16.1	8.05
Goods vehicle	1.7	1.6	1.65
Bus	25.9	69	47.45

The traffic jam population density depends on the vehicle mix. The vehicle mix was estimated from the Vehicle Kilometres Travelled (TD, 2013) (VKT) by each type of vehicle in 2013 (*Table 4.4*). This approach gives the average vehicle mix for the whole territory and was used as an estimate of the vehicle mix along the transport routes. As a check on the calculation, the results were compared with the vehicle mix recorded at the 2 core stations listed in *Table 4.2* and found to match closely, however the vehicle mix average for the whole territory gives a higher population density and therefore is used in order to be conservative. Combining the vehicle mix with vehicle occupancies from *Table 4.3* gives an average population density within vehicles of 0.440 persons per metre of road. For sections of the transport routes with multiple traffic lanes, a population density of 0.440 persons/m per lane was used. Road populations were further converted to a density per square metre using the lane width.

Table 4.4 Road Population Density

Vehicle Type	VKT in 2013 (million)	Fraction of VKT	Fraction of VKT Average of Core Stations	Occupants	Length of Road per Vehicle (m)	Population (persons/m)
Motorcycle	291	0.0229	0.0123	1.15	5	0.005
Private car	5315	0.4179	0.4353	1.6	5	0.134
Taxi	2399	0.1886	0.0585	2.55	5	0.096
Public light bus	335	0.0263	0.0272	8.05	10	0.021
Goods vehicle	3519	0.2767	0.4242	1.65	20	0.023
Bus	860	0.0676	0.0428	47.45	20	0.160
Total	**12719**	**1**	**1**			**0.440**

4.2.3 *Pedestrian Population*

Pedestrian flow on the pavement was assessed along the explosives delivery routes by site survey carried out in June 2014. The site survey also aimed to collect site specific information such as the width of pavement, surrounding conditions of the roads etc. The results from the survey were then analysed and used to calculate population densities for all the pavements along the delivery routes following the steps below:

- All roads along the delivery routes were selected for the survey (Table 4.5);
- Pavement population was collected and the population density calculated from:

$$\text{Pavement population (persons/m}^2\text{)} = P \,/\, 1000 \,/\, Q \,/\, W$$

where:
P is the number of pedestrians passing a given point
W is the pavement width (m)
Q is the pedestrian speed (km/ hr)

- Consistent with the SCL (TAW-HUH) study (ERM, 2011) and XRL Study (ERM, 2009), the calculated population density was further increased by 10% as a conservative measure and applied to the time periods. The results are shown in *Table 4.5*; and
- As with the road population in vehicles, a distinction is made between population on the nearside pavement and population on the far side pavement.

Table 4.5 Pavement Population Density on Roads Covered in Site Survey

Road Segments	Pavement Population Density (person/ m^2) (1)(2)
<u>*Route R1a (Route Option R1: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)*</u>	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	0 - 0
Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)	0.004 - 0.01
Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)	0 - 0.001
Kam Tin Bypass	0 - 0
Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)	0.001 - 0.002
Fan Kam Rd (Kam Tin Rd - Castle Peak Rd)	0.003 - 0.004
Po Kin Rd (Fan Kam Rd - Pak Wo Rd)	0.002 - 0.005
Pak Wo Rd (Po Kin Rd - Slip rd to So Kwun Po Int)	0.006 - 0.023
Pak Wo Rd (Slip rd to So Kwun Po Int - Yu Tai Rd)	0.003 - 0.006
Pak Wo Rd (Yu Tai Rd - Pak Wo Rd RA)	0.002 - 0.004
Pak Wo Rd (Pak Wo Rd RA - Wah Ming Rd)	0.005 - 0.033
Pak Wo Rd (Wah Ming Rd - Wai Ming St)	0.013 - 0.023
Pak Wo Rd (Wai Ming St - Yat Ming Rd)	0.004 - 0.006
Pak Wo Rd (Yat Ming Rd - Wo Hop Shek Int)	0 - 0
Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)	0 - 0
Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 2	0 - 0.002
Jockey Club Rd (Lok Yip Rd - Sha Tau Kok Rd)	0 - 0.001

Road Segments	Pavement Population Density (person/ m^2) (1)(2)
Sha Tau Kok Rd (Lung Yeuk Tau) (Jockey Club Rd - Lok Yip Rd)	0.025 - 0.031
Sha Tau Kok Rd (Lung Yeuk Tau) (Lok Yip Rd - Luen Shing St)	0.009 - 0.019
Sha Tau Kok Rd (Lung Yeuk Tau) (Luen Shing St - On Kui St)	0.006 - 0.007
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)	0.004 - 0.012
Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)	0 - 0
Po Kat Tsai Road (Lau Shui Heung Rd - Site)	0 - 0
Route R1b (Route Option R1: Tai Lam Explosives Magazine Site – North Portal)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	0 - 0
Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)	0.004 - 0.01
Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)	0 - 0.001
Kam Tin Bypass	0 - 0
Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)	0.001 - 0.002
Fan Kam Rd (Kam Tin Rd - Castle Peak Rd)	0.003 - 0.004
Po Kin Rd (Fan Kam Rd - Pak Wo Rd)	0.002 - 0.005
Pak Wo Rd (Po Kin Rd - Slip rd to So Kwun Po Int)	0.006 - 0.023
Pak Wo Rd (Slip rd to So Kwun Po Int - Yu Tai Rd)	0.003 - 0.006
Pak Wo Rd (Yu Tai Rd - Pak Wo Rd RA)	0.002 - 0.004
Pak Wo Rd (Pak Wo Rd RA - Wah Ming Rd)	0.005 - 0.033
Pak Wo Rd (Wah Ming Rd - Wai Ming St)	0.013 - 0.023
Pak Wo Rd (Wai Ming St - Yat Ming Rd)	0.004 - 0.006
Pak Wo Rd (Yat Ming Rd - Wo Hop Shek Int)	0 - 0
Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 1	0 - 0
Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 2	0 - 0.002
Jockey Club Rd (Lok Yip Rd - Sha Tau Kok Rd)	0 - 0.001
Sha Tau Kok Rd (Lung Yeuk Tau) (Jockey Club Rd - Lok Yip Rd)	0.018 - 0.056
Sha Tau Kok Rd (Lung Yeuk Tau) (Lok Yip Rd - Luen Shing St)	0.017 - 0.022
Sha Tau Kok Rd (Lung Yeuk Tau) (Luen Shing St - On Kui St)	0.004 - 0.01
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1	0.002 - 0.003
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2	0.003 - 0.004
Route R1c (Route Option R1: Tai Lam Explosives Magazine Site – South Portal)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	0 - 0
Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)	0.004 - 0.01
Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)	0 - 0.001
Kam Tin Bypass	0 - 0
Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)	0.001 - 0.002
Kam Tin Rd (Fan Kam Rd - Kam Sheung Rd eastern junction)	0.001 - 0.003
Lam Kam Rd (Kam Sheung Rd - Lam Kam Rd Int)	0.001 - 0.003
Lam Kam Rd (Lam Kam Rd Int - Tai Wo Service Rd W)	0 - 0
Tai Wo Service Rd W (Lam Kam Rd Int - Kau Lung Hang FO)	0 - 0.003
Tai Wo Service Rd W (Kau Lung Hang FO - Wo Hing Rd)	0 - 0
Unnamed road (Wo Hing Rd - Pak Wo Rd)	0 - 0
Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)	0 - 0

Road Segments	Pavement Population Density (person/ m^2) [(1)(2)]
Slip Rd (Jockey Club Rd - Fanling Highway)	0 - 0
Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)	0 - 0
Tai Wo Service Rd East (Slip rd from Fanling Highway - Road to Site 1)	0 - 0
Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)	0 - 0
Road to Site 2 (Road to Site 1 - Site)	0 – 0
Route R2a (Route Option R2: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	0 - 0
Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)	0 - 0
Connecting road from Tong Yan San Tsuen Int to Long Tin Road	0 - 0
Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))	0 - 0
Connecting road from Long Tin Road North Bound to South Bound	0 - 0
Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)	0 - 0
Connecting road from Long Tin Rd to Tong Yan San Tsuen Int	0 - 0
Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)	0 - 0
Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)	0 - 0
Yuen Long Highway (to San Tin Highway 1)	0 - 0
Yuen Long Highway (to San Tin Highway 2)	0 - 0
San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	0 - 0
San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	0 - 0
Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	0 - 0
Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	0 - 0
So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	0 - 0
So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	0 - 0
Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	0.005 - 0.041
Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	0.011 - 0.02
Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	0.005 - 0.008
Ma Sik Rd (Luen Chit St - Wo Tai St)	0.003 - 0.006
Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	0.004 - 0.007
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)	0.004 - 0.012
Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)	0 - 0
Po Kat Tsai Road (Lau Shui Heung Rd - Site)	0 - 0
Route R2b (Route Option R2: Tai Lam Explosives Magazine Site – North Portal)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	0 - 0
Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)	0 - 0
Connecting road from Tong Yan San Tsuen Int to Long Tin Road	0 - 0
Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))	0 - 0
Connecting road from Long Tin Road North Bound to South Bound	0 - 0
Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)	0 - 0
Connecting road from Long Tin Rd to Tong Yan San Tsuen Int	0 - 0
Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)	0 - 0
Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)	0 - 0
Yuen Long Highway (to San Tin Highway 1)	0 - 0

Road Segments	Pavement Population Density (person/ m^2) (1)(2)
Yuen Long Highway (to San Tin Highway 2)	0 - 0
San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	0 - 0
San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	0 - 0
Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	0 - 0
Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	0 - 0
So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	0 - 0
So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	0 - 0
Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	0.005 - 0.041
Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	0.011 - 0.02
Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	0.005 - 0.008
Ma Sik Rd (Luen Chit St - Wo Tai St)	0.003 - 0.006
Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	0.004 - 0.007
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1	0.003 - 0.004
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2	0.003 - 0.004
Route R2c (Route Option R2: Tai Lam Explosives Magazine Site – South Portal)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	0 - 0
Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)	0 - 0
Connecting road from Tong Yan San Tsuen Int to Long Tin Road	0 - 0
Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))	0 - 0
Connecting road from Long Tin Road North Bound to South Bound	0 - 0
Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)	0 - 0
Connecting road from Long Tin Rd to Tong Yan San Tsuen Int	0 - 0
Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)	0 - 0
Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)	0 - 0
Yuen Long Highway (to San Tin Highway 1)	0 - 0
Yuen Long Highway (to San Tin Highway 2)	0 - 0
San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	0 - 0
San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	0 - 0
Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	0 - 0
Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	0 - 0
Fanling Highway (So Kwun Po Int - Wo Hop Shek Int)	0 - 0
Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)	0 - 0
Tai Wo Service Rd East (Slip rd from Fanling Highway - Kau Lung Hang FO)	0 - 0
Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)	0 - 0
Road to Site 2 (Road to Site 1 - Site)	0 - 0
Route R3a (Route Option R3: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	0 - 0
Yuen Long Highway	0 - 0
Yuen Long Highway (to San Tin Highway 1)	0 - 0
Yuen Long Highway (to San Tin Highway 2)	0 - 0
San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	0 - 0

Road Segments	Pavement Population Density (person/ m^2) (1)(2)
San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	0 - 0
Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	0 - 0
Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	0 - 0
So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	0 - 0
So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	0 - 0
Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	0.005 - 0.041
Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	0.011 - 0.02
Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	0.005 - 0.008
Ma Sik Rd (Luen Chit St - Wo Tai St)	0.003 - 0.006
Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	0.004 - 0.007
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)	0.004 - 0.012
Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)	0 - 0
Po Kat Tsai Road (Lau Shui Heung Rd - Site)	0 - 0
Route R3b (Route Option R3: Tai Lam Explosives Magazine Site – North Portal)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	0 - 0
Yuen Long Highway	0 - 0
Yuen Long Highway (to San Tin Highway 1)	0 - 0
Yuen Long Highway (to San Tin Highway 2)	0 - 0
San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	0 - 0
San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	0 - 0
Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	0 - 0
Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	0 - 0
So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	0 - 0
So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	0 - 0
Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	0.005 - 0.041
Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	0.011 - 0.02
Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	0.005 - 0.008
Ma Sik Rd (Luen Chit St - Wo Tai St)	0.003 - 0.006
Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	0.004 - 0.007
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1	0.003 - 0.004
Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2	0.003 - 0.004
Route R3c (Route Option R3: Tai Lam Explosives Magazine Site – South Portal)	
Access road towards Tai Shu Ha Rd West	0 - 0
Tai Shu Ha Road West 1	0.003 - 0.009
Tai Shu Ha Road West 2	0.003 - 0.012
Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	0 - 0
Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)	0 - 0
Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	0 - 0
Yuen Long Highway	0 - 0
Yuen Long Highway (to San Tin Highway 1)	0 - 0
Yuen Long Highway (to San Tin Highway 2)	0 - 0
San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	0 - 0
San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	0 - 0
Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	0 - 0
Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	0 - 0
Fanling Highway (So Kwun Po Int - Wo Hop Shek Int)	0 - 0

Road Segments	Pavement Population Density (person/ m^2) (1)(2)
Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)	0 - 0
Tai Wo Service Rd East (Slip rd from Fanling Highway - Kau Lung Hang FO)	0 - 0
Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)	0 - 0
Road to Site 2 (Road to Site 1 - Site)	0 - 0

Note 1: Growth factor of 1% per year is taken into account in above data
Note 2: "0 - 0" is the road segment with no pavement or no pedestrian observed during the site survey.

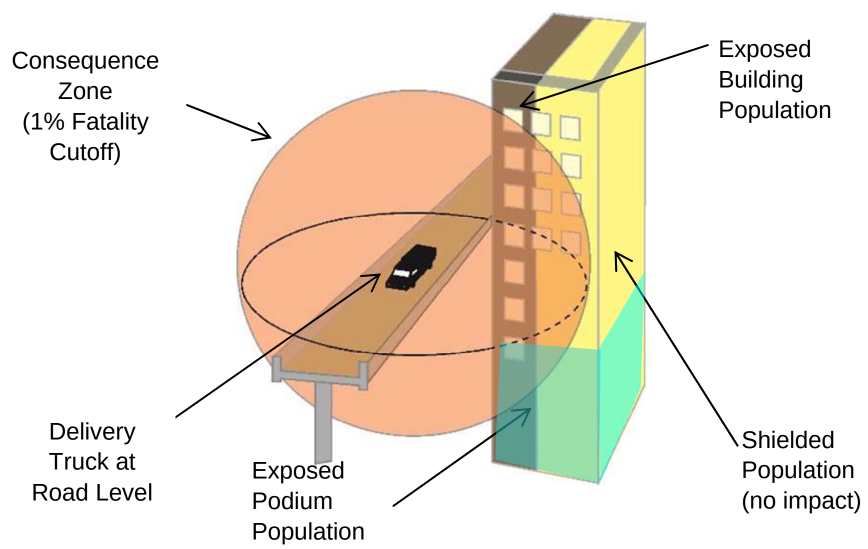
4.2.4 *Land and Building Population*

Buildings within a 200 m corridor (100 m either side) of each transport route were included in the assessment, to encompass the effects radius of all explosive transport loads. Buildings that extended only partly into this corridor were also included. Rather than considering density based averages of population, the analysis is based on individual buildings. This involves estimating the population for over 6900 buildings along the routes. The task of assessing population building-by-building is substantial but is necessary to accurately model the F-N pairs with high N values.

The hazards due to an explosion during the transport of explosives are principally overpressure and flying debris. For the purpose of this study, it is considered that people at the rear of the building will not be impacted by blast effects.

The hazard footprint was overlaid on the population polygons (road lanes, pavement areas and building areas) considering relative elevations to establish overlap area for each floor of the building impacted from which the number of fatalities could be estimated. A spherical vulnerability model was adopted.

Figure 4.4 ***Consideration of Population Inside Building***



A systematic methodology was employed to allow the estimation of present and future population of individual buildings along the transport routes. The methodology involves 4 steps:

- Step 1: Identify existing buildings within the study area
- Step 2: Identify buildings' attributes and usage, and estimate their population
- Step 3: Project the present population to the assessment year (2017) and distribute predicted future residential population data among identified residential buildings based on a uniform population growth factor of 1% per year
- Step 4: Adjust future population numbers of non-residential buildings

Following *Steps 3* and *4*, the occupancy of building populations was then determined for different time periods.

4.2.5 ***Step 1: Identify existing buildings that lie within the Study Area***

The Lands Department of the HKSAR Government maintains a Geographic Information System (GIS) database of buildings in Hong Kong. To identify buildings within the study area, ERM obtained a recent GIS map layer containing all buildings. Additionally, the GIS building height information for most of the buildings (but usually not podiums or other similar structures) were also obtained from Lands Department (LD, 2014). The buildings at least partly within 100 m of the defined explosives transport routes were selected for further processing. Each of the buildings was assigned a unique label and its grid coordinates were also recorded.

4.2.6 ***Step 2: Identify building attributes, usage and population***

There is no publicly available data on the population of individual buildings in Hong Kong. Therefore, to provide a basis for estimating the number of people in a building, it was necessary to identify each building's attributes and usage.

The buildings and structures in the GIS database are classified as: regular building (BP), building under elevated structure (BUP), open-sided structure (OSP), proposed building (PBP), podium (PD), podium under elevated structure (PDU), ruin (RU) and temporary structure (TSP). Using the above information, the information from property developers' websites as well as aerial photographs, the actual or likely usage category of buildings identified in *Step 1* was determined and each building was assigned to one of the following building usage categories:

- Abandoned / Unpopulated Building;
- Administrative / Commercial;

- Car Park;
- Clinic;
- College;
- Fire Station;
- Hospital;
- Industrial Building;
- Kindergarten;
- Leisure;
- MTR station/Bus terminus
- Petrol Station;
- Podium;
- Police Station;
- Residential Building;
- School;
- Station such as sewage treatment, electrical substation, pump house etc;
- Storage; and
- Temple / Church / Chapel.

Note that unless their usage could be determined from other available sources, the GIS categories OSP, TSP and RU, were assumed to be unpopulated.

Following this, the same information sources were used to sub-categorise buildings by other attributes, such as the number of floors. Details on the building attributes and categories and associated assumptions are presented below.

Number of Floors

Building height data was available from the GIS database for most buildings and the number of floors was estimated from these data, assuming 3 m height per floor. For most of the high-rise residential buildings (excluding the housing estates) the floor number information, considered more accurate, was also available from the property developer website. When neither of the above information was available and where it was possible, the number of floors was estimated from 3-dimensional aerial photos. In the event of an absence of data from any of the above sources a site survey was carried out.

Residential Buildings

Generally a population of 3 persons per unit was assumed. For most of the high-rise residential buildings, the total number of units was available from the property developers' websites. For all the remaining buildings, including the village houses and estate high-rises, the number of units per floor was estimated from the floor area, assuming 1 unit per about 65 m^2 (700 square feet). Based on this assumption, small structures in village setting of area less than about 30 m^2 were assumed to be unpopulated.

Other Buildings

While residential type buildings are well defined, less information is available for other types of buildings such as commercial, industrial etc. The approach to estimate other building population generally follows that adopted in the EIA for the Liquefied Natural Gas (LNG) Receiving Terminal (EIA 125/2006), and is based on typical Hong Kong building structure, usage, height, and typical capacity of public facilities. The details are presented in *Table 4.6.* In the application of typical values from *Table 4.6*, further refinements were made based on building height and area and taking into account the maximum density of people in most non-residential building as one person per 9 m^2 (the Code of Practice for the Provision of Means of Escape in Case of Fire).

Table 4.6 **Building Population Assumptions**

Category	**Building Height / Size(1)**	**Assumption**			**Total**
Car Park		Basic assumptions are listed below. In some cases the car park population was adjusted based on the building area. For car parks located in podiums of residential, commercial or industrial buildings, the podium population was assumed as 1% of the population of associated buildings.			
		Parking Levels	**Parking Spaces**	**People/Parking Space**	
	H	5	40	0.2	40
	L	1	20	0.2	4
Police Station		About 27750 Policemen are employed in Hong Kong. Assumed that they are evenly spread over 55 branches. It is also assumed that they will roster on 2 shifts each day and about 50% will be out for patrol.			125
Petrol Station		It is assumed that, there are 2 staff stationed in the convenience shop, 4 stationed in fuel area for filling, and 4 vehicles each with 3 people, parked into the Petrol Station for petrol filling			18
Fire Station & Ambulance Depots		About 8600 uniformed staff are employed in Hong Kong. It is assumed that members of fire stream are evenly spread over 76 fire stations and members of ambulance stream are over 33 ambulance depots. It is also assumed that members of fire stream will roster on 24 hours (on-duty) and 48 hours (off-duty) and members of ambulance stream will roster on 12 hours, 2 shifts each day.			30
Station	H	5 people in Refuse disposals, and Mortuaries			5
	M	2 people in Traffic Control Stations			2

Category	Building Height / Size(1)	Assumption			Total
	L	No people will stay in Sewage treatment works, Toilet, Electric substation, or pump house			0
Kindergarten		10 students per class, 4 classes for each grade, 3 grades in Kindergarten Total 10 staff employed by each kindergarten			130
College - Secondary School		For Form 1 – Form 5, 45 students per class, 4 classes per form. For Form 6 – Form 7, 30 students per class, 2 classes per form, Total 60 staff employed by a school			1080
School - Primary School	H	Same as College – Secondary School			
	L	30 students for each class, 2 classes per grade, 6 grades in primary school Total 30 staff employed by a school			390
Hospital		Assumed that the population for hospitals for each building height category is as follows:			
		Floors	**Unit**	**People/Unit**	
	H	10	15	7	1050
	M	5	10	5	250
	L	3	10	5	150
Clinic		Assumed that the population for Clinic for each building height category is as follows:			
		Floors	**Unit**	**People/Unit**	
	H	3	20	3	180
	M	2	10	2	40
	L	1	1	10	10
Temple	H	100 people for large sized temple			100
	M	50 people for medium sized temple			50
	L	10 people for small sized temple			10
MTR Station/Bus Terminus		Based on the building area			
Storage Building		Same as Car Park			
Industrial Building		**Floors**	**Units**	**People/unit**	
	H	25	8	8	1600
	M	15	6	8	720
	L	8	6	6	288
Administrative / Commercial		**Floors**	**Unit**	**People/Unit**	
	H	10	20	2	400
	M	5	20	2	200
	L	2	10	2	40
Leisure	H	200 people for large sized leisure facility			200
	M	100 people for medium sized leisure facility			100
	L	50 people for small sized leisure facility			50
	LL	10 people for very small sized leisure facility			10

ERM determined the type of buildings for population estimation based on the survey and experience.

Note:

(1) Legend for Building Height / Size
- H for Tall / Large,

- M for Medium,
- L for Low / Small
- LL for Very Low/Very Small

Using the above approach, a database providing characterisation of each building by their broad attributes including population was developed.

4.2.7 ***Step 3: Distribute predicted future residential population data among identified residential buildings***

A uniform population growth factor of 1% per year was assumed for the study area in line with the SCL study (ERM, 2011) and XRL study (ERM, 2009).

While the exact distribution of the future population between the existing and future buildings is unknown, it was assumed that the distribution of the new building population will be similar to that for the existing buildings. Thus, the population estimates of *Step 2* for the existing residential buildings identified in *Step 1* have been scaled up according to the population growth factor. In this way, while the locations of any new residential buildings are unknown, the population growth is taken into account and distributed according to the present building locations.

4.2.8 ***Step 4: Adjust future population numbers for non-residential buildings***

In the absence of information for non-residential population trends, it was assumed that population in non-residential buildings would follow trends of the residential population. In this way, an approach was adopted whereby the population of non-residential buildings was adjusted to be in line with residential population trends.

4.3 TIME PERIODS AND OCCUPANCY

Since population can vary during different time periods, the analysis considers 3 day categories (weekdays, Saturdays and Sundays) with 4 time periods for each day. These are summarised in *Table 4.7*.

Table 4.7 Population Time Periods

Day Category	Time Period	Description
Weekdays	AM Peak	7:00am to 9:00am
	Daytime	9:00am to 6:00pm
	PM Peak	6:00pm to 8:00pm
	Night	8:00pm to 7:00am
Saturdays	AM Peak	7:00am to 9:00am
	Daytime	9:00am to 6:00pm
	PM Peak	6:00pm to 8:00pm
	Night	8:00pm to 7:00am
Sundays	AM Peak	7:00am to 9:00am
	Daytime	9:00am to 6:00pm
	PM Peak	6:00pm to 8:00pm
	Night	8:00pm to 7:00am

The occupancy of buildings during each time period is based on assumptions as listed in *Table 4.8*. These are based on extensive surveys conducted in the Castle Peak LNG study (ERM, 2006). For vehicle and pavement populations, distribution across time periods were based on data provided in AADT and site surveys.

Table 4.8 Population Distribution (Based on extensive site survey conducted as part of the ERM (2006) Study)

Type	Occupancy					
	Night (Weekdays / Saturdays / Sundays)	AM Peak (Weekdays / Saturdays / Sundays)	PM Peak (Weekdays / Saturdays / Sundays)	Weekday Daytime	Saturday Daytime*	Sunday Daytime
Administrative/ Commercial (H)	10%	10%	10%	100%	100%	100%
Administrative/ Commercial (L)	10%	10%	10%	100%	100%	100%
Administrative/ Commercial (M)	10%	10%	10%	100%	100%	100%
Car Park/Podium - residential	10%	100%	100%	70%	70%	70%
Car Park/Podium – Commercial/Industrial	0%	100%	100%	70%	45%	20%
Car Park/Podium – MTR	10%	100%	100%	70%	60%	50%
Clinic (H)	0%	10%	10%	100%	100%	100%
Clinic (L)	0%	10%	10%	100%	100%	100%
Clinic (M)	0%	10%	10%	100%	100%	100%
College	0%	10%	10%	100%	55%	10%
Fire Station/Ambulance Depot	100%	100%	100%	100%	100%	100%
Hospital (H)	80%	80%	80%	100%	90%	80%
Hospital (L)	80%	80%	80%	100%	90%	80%
Hospital (M)	80%	80%	80%	100%	90%	80%
Hotel	90%	50%	50%	20%	50%	80%
Industrial Building (H)	10%	10%	10%	100%	55%	10%
Industrial Building (L)	10%	10%	10%	100%	55%	10%
Industrial Building (M)	10%	10%	10%	100%	55%	10%
Industrial/Warehouse	0%	1%	1%	100%	51%	1%
Kindergarten	0%	10%	10%	100%	55%	10%
Leisure (H)	0%	10%	10%	70%	85%	100%
Leisure (L)	0%	10%	10%	70%	85%	100%
Leisure (LL)	0%	10%	10%	70%	85%	100%
Leisure (M)	0%	10%	10%	70%	85%	100%
MTR/bus terminus	10%	100%	100%	70%	60%	50%
Petrol Station	1%	100%	100%	50%	50%	50%
Police Station	30%	30%	30%	100%	65%	30%
Power Station	10%	10%	10%	100%	55%	10%
Residential Building (H)	100%	50%	50%	20%	50%	80%
Residential Building (L)	100%	50%	50%	20%	50%	80%
Residential Building (LL)	100%	50%	50%	20%	50%	80%
Residential Building (M)	100%	50%	50%	20%	50%	80%
School (H)	0%	10%	10%	100%	55%	10%

Type	Occupancy					
	Night (Weekdays / Saturdays / Sundays)	AM Peak (Weekdays / Saturdays / Sundays)	PM Peak (Weekdays / Saturdays / Sundays)	Weekday Daytime	Saturday Daytime*	Sunday Daytime
School (L)	0%	10%	10%	100%	55%	10%
Station (H)	10%	10%	10%	100%	55%	10%
Station (L)	10%	10%	10%	100%	55%	10%
Station (M)	10%	10%	10%	100%	55%	10%
Storage Building (L)	0%	1%	1%	100%	51%	1%
Temple/ Church/ Chapel (H)	0%	10%	10%	50%	75%	100%
Temple/ Church/ Chapel (L)	0%	10%	10%	50%	75%	100%
University	90%	30%	30%	70%	60%	50%
Highway	20%	100%	100%	100%	100%	100%

* Estimated as average of Weekday daytime and Sunday daytime

4.4 *FEATURES CONSIDERED IN THIS STUDY*

A number of manmade slopes and retaining walls were identified in the vicinity of Tai Lam Explosive Magazine site as shown in *Table 4.9.* These have been considered in the Hazard to Life Assessment.

Table 4.9 Slopes Identified in the Vicinity of Tai Lam Explosive Magazine site

Slope Tag	Site	Distance from Explosive Store (m)	Population
6SW-D/F124	Tai Lam site	50	Adjacent to the magazine access road
6SW-D/C186	Tai Lam site	50	No road or population nearby
6SW-D/C187	Tai Lam site	55	No road or population nearby

5 HAZARD IDENTIFICATION

5.1 OVERVIEW

Hazard identification consisted of a review of:

- explosive properties;
- scenarios presented in previous relevant studies;
- historical accidents; and
- discussions with explosives and blasting specialists.

5.2 ACCIDENTAL INITIATION DUE TO HAZARD PROPERTIES OF EXPLOSIVES

5.2.1 *Explosive Type and Physical Properties*

The physical properties for the explosives to be stored and transported as part of this project are shown in *Table 5.1*.

Table 5.1 Explosive Types and Properties

Explosive Type	TNT Equivalency	Melting Point (°C) @ 1 atm	Bullet Test Sensitivity	Auto-ignition Point (°C) @ 1 atm	UN Hazard Division
Emulsion (packaged in cartridges)	0.96	170 *	>500 m/s	230-265**	1.1D
PETN (as provided for detonating cord)	1.4	135 - 145	> 450 m/s	190	1.1D
PETN (as provided within detonators)	1.4	120	> 450 m/s	190	1.4B 1.4S
Cast Boosters (75% PETN)	1.3	80	>450 m/s	299	1.1D

* This refers to the melting point of Ammonium Nitrate: Ammonium Nitrate undergoes phase changes at 32 - 83 °C and starts to melt at 170° C.

** Depends of type of oil used

Explosives are considered 'initiated' when a self sustaining exothermic reaction is induced. Such a reaction results in either a violent burning with no progression to explosion, a deflagration or a detonation. A deflagration may transit to detonation. The mechanism of transition from deflagration to detonation is still a subject of research. However, both modes of explosion can lead to significant injuries and fatalities and are considered in the Hazard to Life Assessment. The main difference between a deflagration and detonation is that a detonation produces a reaction front travelling at greater than sonic velocity, whereas a deflagration has a subsonic flame front. Both explosion types can cause extensive injury and damage.

Where explosives are stored under controlled conditions in purpose built and operated magazines or stores, the likelihood of accidental initiation in situ is remote. This is because the storage environment is unlikely to experience extremes of heat, shock, impact, or vibration of sufficient intensity to initiate detonation. The most common means of accidental initiation is principally the introduction of fire. Other means of initiation include severe impact and friction.

Generally, for an event to cause casualty concerns, a deflagration has to propagate. For a deflagration to occur, the explosive should be, at least but not only, subject to a stimulus which could be:

- Local stimulus: such as to generate a 'hot spot' (e.g. sparks, friction, impact, electrostatic discharge etc.);
- Shock stimulus: Subject to shock or high velocity impact: (e.g. bullet impact, detonation of other explosives etc.); or
- Thermal stimulus: Subject to mass heating leading to exothermic reaction (e.g. subject to intense heat or fire). For all systems, it can be envisaged that there can be no significant event until the medium becomes molten (and in the case of the emulsion, much of the water is lost).

For the types of explosives used in this project, not all of these causes necessarily lead to a deflagration or detonation.

In this study, accidental initiation of explosives has been categorised as either fire or non-fire induced.

The following sections briefly describe the initiation mechanisms and events applicable for this Hazard to Life Assessment.

5.2.2 *Hazardous Properties of Emulsion Type Explosives*

The family of emulsion explosives typically contains over 78% AN, which is a powerful oxidising agent. Emulsion based explosives will not explode due to friction or impact found in normal handling. However, it can explode under heat and confinement or severe shock, such as that from an explosion. The sensitivity of AN based explosives to deflagration or detonation is increased at elevated temperatures.

There are two broad categories of emulsions:

- Packaged emulsion (sensitised); and
- Bulk emulsion precursor (void-free liquid).

Cartridged emulsions are sensitised to fulfil their intended function (the emulsion is sensitised by either adding gassing solution or plastic microspheres) at the point of manufacture, they are then transported in a sensitised state. Bulk emulsions are sensitised at the point of use on sites. The chemical properties for these two categories of emulsion mainly differ due to the presence of sensitizer.

Matrix or bulk emulsion (no voids) is not sensitive to shock as there is no known mechanism for the shock front to propagate. Also, a very high pressure would be required to heat a void free liquid.

In normal atmospheric conditions, a local stimulus generating ‘hot spots’ including sparks, friction, impact, electrostatic discharge, extremes of ambient air temperature etc., does not cause packaged emulsions (sensitised) to readily deflagrate. A pressure in excess of 5 bar above atmospheric pressure, is additionally required in the "deflagrating mass" to generate a deflagration which may subsequently transit to a detonation.

The behaviour of packaged emulsion following a shock or thermal stimulus is discussed below.

5.2.3 *Accidental Packaged Emulsion Initiation by Fire*

In a fire, pools of molten AN may be formed, and may explode, particularly if they become contaminated with other materials e.g. copper. In a fire, AN may also melt and decompose with the release of toxic fumes (mainly oxides of nitrogen). Beyond 140 °C (ERP, 2009) or in its molten form, AN sensitivity to local stimuli increases.

A number of tests indicate that, when subjected to fire engulfment, many explosives ignite and burn, deflagrate, and in some cases detonate. The time for an explosive to ignite is dependent upon its physical characteristics and chemical composition.

It is generally considered that cartridged emulsions are generally less sensitive to fire engulfment as a means of initiation due to the high water content. However, when exposed to heat or fire, the water content of the emulsion will be driven off, leading to possible initiation if the energy levels are high enough, long duration and confinement pressure increases.

A fire surrounding the explosive load will clearly raise the temperature of any reactive media and enable evaporation of components e.g. water. The rate at which this occurs is dependent on the fire (extent) and the heat transfer considering the cargo container wall design. The external part of the container wall will heat by direct contact with the flame and heat will eventually be transferred to the explosive load.

Transport accident statistics for ANFO, another type of ammonium nitrate based explosive, indicate a minimum time to deflagration of about 30 minutes. Emulsion is considered more difficult to initiate than ANFO due to its water content.

The consequences of an accidental explosion due to thermal stimulus could be a thermal explosion (cook-off) or detonation or some combination of the two.

5.2.4 *Accidental Packaged Emulsion Initiation by Means Other Than Fire*

Non-fire initiation mechanisms are commonly divided into two distinct groups; mechanical and electrical energy. The term 'mechanical' encompasses both shock and friction initiation, because in most accidental situations, it is difficult to distinguish between them. It has been recorded that some explosives (not emulsion type) can initiate (in the absence of piercing) mechanically at an impact velocity as low as 15 m/s. If the explosives are pierced, for example by a sharp metal object, then it is likely that the required velocity will be far less than 15 m/s. This is due to localised heat generation resulting from frictional rubbing between layers of explosive, and is referred to as 'stab-initiation'.

However, cartridged emulsion is insensitive to initiation via impact, as demonstrated by the bullet impact test from a high velocity projectile. Based on the bullet impact test, it requires at least 10 times the energy level of that required to detonate nitroglycerine (NG) based explosive.

All explosives have a minimum ignition energy level, above which initiation will occur. Typically, minimum ignition energy levels range between 0.015 J and 1.26 J.

For the vast majority of explosives, including cartridged emulsions, the required ignition energy level is far exceeded by contact with mains electricity. In comparison, the energy levels possible from batteries or alternators fitted to motor vehicles, or that due to static build-up on clothing, are typically much less than that required to initiate most commercial explosives (e.g. 0.02 J or less). Hence, only very sensitive explosives are likely to ignite from these electrical energy sources. Therefore, electrical energy is not a possible energy source for the types of explosives intended to be used in this project.

Possible degradation of cartridged emulsion is from water loss and prolonged temperature cycling above and below 34 °C, which leads to potential caking or a change in ammonium nitrate crystalline state and increase in volume. Both modes of degradation do not lead to the detonation of the cartridged emulsion by means other than fire.

5.2.5 *Hazardous Properties of Detonating Devices*

These detonating devices may detonate when exposed to heat or flame, or with friction, impact, heat, low-level electrical current or electrostatic energy. Detonation produces shrapnel. Hazardous gases / vapours produced in fire could be lead fumes, nitrogen oxides and carbon monoxide. However, these gases depend on the type of material used in the detonators.

The main explosive contained in detonating devices including detonating cord and detonators is pentaerythritol tetranitrate (PETN). Detonators also contain a primary explosive substance, e.g. lead azide, which is very sensitive to initiation.

In the case of detonating cord PETN has similar sensitivities (somewhat less sensitive) to NG based explosives. It is generally more sensitive than emulsions.

PETN has the potential to deflagrate at ambient pressure following a local stimulus. Local initiation can lead to a deflagration (ambient pressure or higher) and from this to a detonation. As an explosive, it has a comparatively small critical diameter (i.e. the smallest physical size of a charge of an explosive that can sustain its own detonation wave) for detonation. When compared to emulsion, PETN can readily initiate by shock but its shock sensitivity is still low compared to NG based explosives. Based on the bullet impact test, it requires at least 10 times the energy level of that required to detonate an NG based explosive (ERP, 2009).

5.3 *ACCIDENTAL INITIATION ASSOCIATED WITH STORAGE AT MAGAZINE*

For the proposed Magazine, the possible means of accidental initiation of the explosives by fire are as follows:

- Inadequately controlled maintenance work (e.g. hot work);
- Poor housekeeping (e.g. ignition of combustible waste from smoking materials);
- Inappropriate methods of work;
- Electrical fault within the store, which ignites surrounding combustible material resulting in a fire; or
- Arson.

Possible means of accidental initiation of the explosives by means other than fire are as follows:

- Dropping of explosives during handling (for the detonators only); and
- Crushing of explosives under the wheels of vehicles during loading or off-loading (for detonators and detonating cord only).

The detonators supplied are packaged within plastic separating strips, such that the initiation of a single detonator will not propagate to the adjacent detonator. Packaged in this manner the detonators are classified as Class 1.4B Explosives. The total mass of detonators is negligible in terms of explosive mass.

5.4 *ACCIDENTAL INITIATION ASSOCIATED WITH TRANSPORTATION FROM THE MAGAZINE*

Cartridged emulsion, cast boosters and detonating cord will be transported within the same truck in the same compartment.

In accordance with the vehicle cargo specifications, the cargo will be designed to minimise all sources of local stimulus and as such will require a significant crash impact and/or a fire to cause a concern to the explosive load. As reported in the ACDS study (ACDS, 1995), a low speed traffic accident is not likely to cause a concern to the explosive load. Conservatively, such an event is still considered possible in this study but with a lower probability (ERP, 2009). Based on the review with explosives experts, the energy required to detonate PETN or emulsion based explosives is one order of magnitude higher (based on bullet tests) than NG. Since NG was considered as the basis for determining the probability of imitation under impact conditions in previous studies (assessed at 0.001), this probability can be reduced by one order of magnitude based on impact energy consideration (ERP, 2009).

The response of the explosive load to an accidental fire would depend on the time and possibility to full fire development on the vehicle (typically 5 - 10 minutes) and the amount of heat transferred to the load. In the case of emulsion, if isolated from detonating cord, based on accident statistics, it may take at least another 30 minutes for the explosive to reach critical conditions. This time may be considerably reduced for mixed loads of cartridged emulsion, cast boosters and detonating cord; however, no accurate time could be predicted from detonating cord transport accident data (ERP, 2009).

In this project, the behaviour of explosives as transported was considered to be similar to the XRL study (ERM, 2009), for which, the explosive properties were reviewed with assistance from experts in the explosives industry (ERP, 2009). The review was based on the current knowledge on the explosive properties taking into account recent knowledge on explosive behaviour under thermal stimulus as well as worldwide accident experience. The expert panel considered in detail what might happen in situations where an emulsion explosive load suffers a thermal stimulus (which could be via heat transfer or direct fire impingement). The main findings for emulsion based explosives are quoted below.

"The radical change in explosive properties at higher temperatures compared to the original emulsion must be taken into account. At high temperatures (> melting point), emulsion explosives would lose water content which may result in a refined explosive (small droplet/ crystal size Ammonium Nitrate). This could lead to a thermal explosion, deflagration or detonation and the probability of 0.1 may not therefore be applicable to emulsion. Also, some limited accident statistics have some bearing on this hazard scenario: these accidents may include a combination of both thermal and mechanical stimuli, which would likely have resulted in explosion or detonation. The consensus was that the probability of an explosion for the case of an emulsion was less than 0.5 but further refinement of this upper estimate would require additional data and more detailed analysis." (ERP, 2009).

This is consistent with recent accident experience as described in the next section.

On the subject of detonating cord (PETN based), there is no accident data directly relevant for PETN. The properties of detonating cord (PETN based) was reviewed by experts (ERP, 2009) by comparison with other commercial explosives such as NG-based blasting explosives, Plastic Explosives, etc. taking particularly care to exclude mixed load where the load was mixed with significantly more sensitive items such as detonators and safety fuses to offer a valid comparison for PETN. The review was based on accident events reported in the EIDAS which had an explosion confirmed to be caused by a fire event. The review showed that for incidents involving explosives with properties comparable to detonating cord (PETN based) a fire resulted in explosion in roughly 50% of the cases. Most of the cases involved dynamite known to be more sensitive than detonating cord (PETN based). The data set reviewed contained a number of uncertainties. In particular, for incidents which did not result in explosion, the degree of explosive involvement in fire is uncertain in a few cases. There could also be the presence of other factors which could have contributed to the explosion. On the other hand, it is likely that a number of fire incidents which did not result in explosion do not appear in the database. The panel concluded that a probability of 0.5 would be more appropriate for PETN based explosives.

5.5 *REVIEW OF INCIDENTS*

This section presents a review of reported safety incidents involving explosives (in industrial/commercial applications). Records were retrieved mainly from the UK Health and Safety Executive's (UK HSE's) Explosives Incidents Database Advisory Service (EIDAS), US Mine Safety and Health Administration (MHSA) and Western Australia's Department of Consumer and Employment Protection (DOCEP). The records provided are also supplemented with information obtained from various sources. Analyses of accident data are provided in the following sections.

For the purpose of this study, incidents were sorted according to the following categories to highlight causative factors to the incidents:

- Incidents involving storage of explosives; and
- Explosive transport incidents.

Further analysis has been performed for other types of explosives (e.g. NG based explosives, ANFO, Plastic (C4), etc.) as relevant for the Frequency Assessment part of this Hazard to Life Assessment.

5.5.1 *Explosives Storage Incidents*

In the UK a study of the risks associated with explosives manufacture and storage was undertaken based on the 79 major incidents identified during the period from 1950 to 1997 (Merrifield, 1998). A total of 16 major incidents were attributed to the storage of explosives. Thirteen (13) incidents related to the storage of gunpowder, ammunition, nitroglycerine, and fireworks. A further incident occurred in 1970 involved the storage of detonators and was attributed to corrosion of the detonators themselves. The remaining two (2) incidents related to the storage of blasting explosives in 1954 and 1964. One of these incidents involving blasting explosives was attributed to malicious activity, whilst the cause of the remaining incident in 1954 was not identified.

Based on the above study, and on the hazards of the explosive materials, it is apparent that the protection of explosives from malicious human activity, and the elimination of possible ignition sources are critical to maintaining storage facilities. From a review of the above records, some of the identified initiating causes of accidents in storage facilities are listed below:

- Impact;
- Friction;
- Overheating;
- Electrical effects (lightning/static discharges);
- Sparks;
- Spontaneous reactions; and
- Malicious action/mishandling.

Avoidance of incidents in the storage area can only be assured by maintaining good housekeeping practice, eliminating potential ignition sources and allocating safe and secure storage space for explosives.

However, not all of these causes are applicable to the types of explosives used in the Project. These are further discussed in *Section 6.1.2*.

5.5.2 *Explosives Transport Incidents*

In Hong Kong, there has not been any road transport related incidents on vehicles carrying explosives with significant consequences, i.e. fire and explosion. In September 2010, a minor incident involving a Mines Division Truck occurred on Queens Road West. The crash impact was not significant and the integrity of the explosives was not affected. The incident did not result in fire or explosion and therefore does not contribute towards the truck accident explosion frequency assumed in the frequency assessment.

The international experience of incidents involving the transport of explosives on the road has therefore been reviewed in detail.

A review of international incident databases indicates that the EIDAS database contains most of the worldwide incidents associated with the transport of commercial explosives. The incidents which were reported from 1950 to 2008 were scrutinised.

The EIDAS database identified one emulsion related transport incident in which a tyre fire on a truck spread to the emulsion load, which eventually detonated producing a substantial crater. However, there were no casualties as the truck crew had time to evacuate to a safe distance before the explosion occurred. Other than this incident, there have been a number of other incidents involving mixed cargoes of emulsion or water-gel carried with other types of explosives. One such event was the 1989 '*Peterborough* incident', involving a vehicle carrying Cerium fuseheads, detonators, NG-based explosives and water-gel (Peterborough, 1989). The explosion was initiated by fire and explosion from a box of Cerium fusehead combs destined for a local fireworks manufacturer. The combs were in unauthorised and unsafe packages. This incident initiated enactment of more stringent safety guidelines in the UK, specifically the Road Transport (Carriage of Explosives) Regulations of 1989, which came into force just 3-months after the incident.

Australia is a significant user and transporter of explosives, consuming approximately 900,000 tonnes of explosives per year (approximately 8% of the world's consumption of explosives). Of this total, approximately 3,000 tonnes (0.3%) is non-bulk explosives (boosters or cartridged emulsion) based on industry estimates. Western Australia consumes approximately 30% of Australia's explosives and publishes accident data (DOCEP). Within the data recorded by DOCEP, there was one accident reported: a vehicle carrying blasting explosive and detonators overturned (DOCEP, 2001). No ignition (i.e. no fire or explosion) occurred. In the 1990s there were several accidents in Western Australia involving ammonium nitrate or Ammonium Nitrate Emulsion (UN3375) (UN Class 5 Dangerous Goods, used as a precursor for manufacturing explosives). All three incidents involved articulated vehicles overturning with no fire or explosion. None of these incidents are directly comparable to the situation in Hong Kong where explosives vehicles are not articulated. In the EIDAS database, two fire incidents involving explosive delivery trucks were recorded in 1998 and 2007 in Australia, however none of these incidents resulted in fatality or injury.

In the US, explosives transport has a good safety record. In a recent study released by the National Institute of Occupational Safety and Health (NIOSH, 2008), analysis of data from 1998 to 2006 revealed that accidents related to the transport of explosives and ammonium nitrate used in mining and construction have resulted in only 5 major injuries, 11 minor injuries, and no fatalities. The safe history of explosives and ammonium nitrate transport is attributed to diligent efforts by government, labour and industry.

Other pertinent statistics could be summarised below:

- There have not been any known transport related explosions involving purely packaged emulsion, hence, accident data has been examined for other types of explosives having similar properties to bulk emulsion although they may be subject to different explosion mechanisms;

- There have been numerous accidents involving crash impact and even with more sensitive explosives such as nitroglycerine based explosives, there are no reported instances of explosion following a crash impact for either nitroglycerine based explosives, or less sensitive explosives such as PETN and emulsion. Amongst those incidents, several have resulted in truck overturn or significant scenarios but no explosion occurred purely due to the shock impact (October 2008 (US), August 2008 (US), July 2008 (US), May 2008 (Spain), etc.); and

- There have been only six reported transport related accidents involving emulsion (June 2004 in Russia and March 2007 in Chile) and bulk ANFO (which would behave like emulsion in a fire condition) (April 1959 in USA, August 1998 in Canada, December 1998 in Australia and September 2007 in Mexico). All of these are reported in the EIDAS database and listed in *Table 5.2* Each of these six accidents were caused by a vehicle fire (50% crash related) and most of them led to explosion. Although a high probability (nearly 100%) exists based on accident statistics, the actual probability is less including the number of potentially unreported incidents and at least four known burning tests in Canada, Sweden and Norway in which burning is known to have occurred instead of explosion.

A summary of transport fire incidents involving unmixed loads of ammonium nitrate based commercial explosives is shown in *Table 5.2*.

Table 5.2 ***Summary of Transport Fire Incidents Involving Unmixed Loads of Ammonium Nitrate Based Commercial Explosives***

Date	Country	Type of Explosives	Type of Event	Cause
Apr 1959	USA	ANFO	Explosion	Vehicle Fire
Aug 1998	Canada	ANFO	Explosion	Vehicle Crash/ Collision
Dec 1998	Australia	ANFO	Explosion	Vehicle Fire
Jun 2004	Russia	Emulsion	Explosion	Vehicle Fire
Mar 2007	Chile	Emulsion	Fire	Vehicle Crash/ Collision
Sep 2007	Mexico	ANFO	Explosion	Vehicle Crash/ Collision

It is also relevant to note the experience of cartridged emulsion disposal, reported in the EIDAS database, in burning grounds in controlled burning grounds conditions (typically involving maintenance of separation distances, controlled fire, and in many cases removal of the explosives from their package), where, although the causes may have potentially included contamination i.e. mixing explosives with other materials e.g. waste copper, five events are known to have led to explosions. It is however difficult to correlate these events to transport or storage conditions under uncontrolled fire conditions with potential confinement. It is also worth noting that a number of explosive packages have been disposed by way of burning in which no explosion occurred. However, the information is scattered and the number of such events could not be determined to estimate a probability of explosion.

It is also worth noting a high number (over 20) of known pumping accidental explosions associated with emulsions or slurries which occurred in combination of overheating and confinement (high pressure) (ISEE, 1996).

5.6 SCENARIOS FOR HAZARD ASSESSMENT

The following hazardous scenarios were identified:

5.6.1 *Proposed Magazine*

A Magazine site typically contains more than one explosive store. Tai Lam Explosives Magazine Site, for example, have 2 stores in total. Within each store, explosives and detonators are stored in segregated compartments. The stores are designed with separation and enclosed walls so that initiation of the contents of one store will not affect other stores. The internal separation distances between the Magazine stores meet the safety distances requirements from the UK Explosives Regulations 2014. Therefore, the study considers the possibility to initiate adjacent store's explosives due to escalation or domino effects to be negligible compared to the overall explosion frequency of the Magazine. The analysis considers the scenario to be the detonation of the full contents of each store. This, together with accidents involving the delivery trucks leads to the following scenarios that were considered in the assessment:

- Detonation of a full load of explosives on a delivery truck within the magazine access road; and
- Detonation of the full quantity of explosives within a store; or a series of stores.

The explosives transport within the Magazine site has conservatively considered the maximum load and the maximum delivery frequency throughout the project as a simplification. In addition, in cases where the explosives trucks are allowed to load explosives at the same time, it was simplistically and conservatively assumed that an accidental explosion of one truck load can lead to domino effects to the other trucks resulting in a potential 2 fold increase in truck load explosion frequency for a Magazine with 2 stores.

The explosive loads considered are listed in Table 5.3. The detonator explosive load has been considered in the total explosive load.

Table 5.3 Explosives Storage Quantities

Magazine Site	Mass of Explosive per Site (kg)(1,2)	No. of Detonators per Site (No.) (3)	TNT Equivalent per Site (kg) (4)	No. of Stores	TNT Equivalent per Store (kg)
Tai Lam	800	3800	934	2	467

Notes:

1 Assuming the worst case storage scenario, in which the store contains 40% detonating cord, 60% cartridged emulsion; number of detonators based on a typical pull length of 5 m and face area of 125 m^2 (extracted from the Project blasting programme)

2 Detonating cord are made of PETN

3 Each detonator contains about 0.9g of PETN

4 1 kg of cartridged emulsion equals 0.96 kg of TNT, 1kg of cast boosters equals 1.3 kg of TNT and 1 kg of PETN equals 1.4 kg of TNT

5.6.2 *Transport of Explosives*

Hazardous scenarios considered for the transport of explosives are:

- Accidents involving explosives delivered and transferred from the Magazine to each delivery point from the gate of the Magazine to the gate of the blasting face.

Explosion of the detonator load during transport is not quantified for the following reasons:

- Detonators will be transported on a separate truck within the same convoy; and

- Detonator packages will be classified as UN 1.4B or UN 1.4S (articles which present no significant hazard outside their packaging). Packaged in such a way, the consequences potentially leading to fatalities will be limited to remain within the explosive truck boundaries. The UK HSE has estimated the consequences for small quantities of explosives in workrooms. For a detonator load of less than 200 g per trip to be transported in HKLTH, an accidental explosion will lead to approximately 1% chance of eardrum rupture at a distance of 3.5 metres; approximately 50% chance of eardrum rupture at 1.5 metres. Persons in very close proximity to the explosion (e.g. holding the explosives) would almost certainly be killed (HSE, Explosion of Small Quantities of Explosives).

The drill and blast activities for the Project will be carried out over a 24 month period during which the explosive load requirement and delivery frequency is expected to vary (see *Section 2.5*). Risks, however, are defined on a per year basis and represent one year construction programme; the base case scenario for the Hazard to Life Assessment was therefore defined to cover different risk levels and possible construction programme deviations throughout the project period.

5.6.3 *Scenarios Considered in the Assessment*

A Base Case and a Worst Case were considered in the risk assessment; the assessed scenarios are summarised in the following tables.

Table 5.4 *Scenarios Considered in the Base Case Assessment*

Tag	Scenario	Explosives Load (TNT eqv. kg)	No. of Trips per year	Remarks
Storage of Explosives				
01	Detonation of full load of explosives in one store in the Tai Lam Explosives Magazine Site	467	-	Store capacity is 400 kg
02	Detonation of full load of explosives in one contractor truck on the access road within Tai Lam Explosives Magazine Site boundary	206	2100	
Transport of Explosives				
03	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to Mid-Ventilation Adit delivery point	206	450	
04	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to North Portal delivery point	206	570	
05	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to South Portal delivery point	206	1080	

Table 5.5 *Scenarios Considered in the Worst Case Assessment*

Tag	Scenario	Explosives Load (TNT eqv. kg)	No. of Trips per year	Remarks
Storage of Explosives				
01	Detonation of full load of explosives in one store in the Tai Lam Explosives Magazine Site	467	-	Store capacity is 400 kg
02	Detonation of full load of explosives in one contractor truck on the access road within Tai Lam Explosives Magazine Site boundary	206	2520	
Transport of Explosives				
03	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to Mid-Ventilation Adit delivery point	206	540	
04	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to North Portal delivery point	206	684	
05	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to South Portal delivery point	206	1296	

6 FREQUENCY ASSESSMENT

6.1 STORAGE OF EXPLOSIVES

6.1.1 *Explosion in Contractor's Collection Truck within the Magazine Site*

The risk associated with accidental explosion during transportation within the Magazine site was assessed using the same methodology as described for explosive transport, which will be discussed in detail in *Section 6.2* and is consistent with the approach considered in the SCL Study (ERM, 2011) and XRL Study (ERM, 2009). The base frequency for accidental explosion during transport has been taken as 7.69×10^{-10}/km for normal roads, and the same frequency has been assumed while the Contractor's truck is onsite at the magazine. For cases where several explosives trucks are allowed to operate within the Magazine site, this frequency has been multiplied by the number of stores to account for potential domino effects (refer to *Section 5.6.1*). This is considered conservative accounting for low speeds, lack of other vehicles and hence low collision probability. The lengths of the magazine access roads and the number of trips considered are provided in *Table 6.1*.

Table 6.1 Length of Magazine Access Roads (within the Magazine Sites) and Number of Trips Considered

Magazine Site	Route Length (km)	Total Number of Deliveries (/year)
Tai Lam	0.196	2100

6.1.2 *Explosive Magazine Explosion*

In this analysis, the following possible causes of accidental initiation have been considered. Each is discussed in further detail below.

Table 6.2 Potential Causes of Accidental Initiation in the Magazine

Generic causes (included in base frequency)
Explosion during manual transfer from store to contractor's collection truck
Lightning strike
Fixed wing aircraft crash onsite
Hill /vegetation fire
Earthquake
Escalation (explosion of one Magazine storeroom triggers another)
Other site specific considerations

Generic Causes

A base frequency of 1×10^{-4} /yr for the Magazine site has been taken for generic causes of explosion during storage in the Magazine site based on the UK historical records (Merrifield, 1998) as detailed in the WIL Study (ERM, 2008). An analysis of the UK explosive storage experience shows that all explosions in UK magazines (other than military stores and ordnance factories) were caused by one of the following:

- unstable explosive material caused by product degradation, corrosion, and contamination;
- escalation of an external incident, e.g. fire; or
- malicious acts, e.g. vandalism or attempted theft.

The explosives types to be used in the Project are stable and less likely to undergo initiation due to degradation or impact. However, the explosives stored in this project are detonator sensitive, and hence the detonators are to be stored and transported separately, within a dedicated chamber in the Magazine.

The magazine is protected from external fire due to the location of explosives inside a concrete or brick wall building and the provision of fire fighting measures (described in *Section 2.3.2*), and therefore the probability of initiation due to external fire is considered to be lower than that implicit in the UK HSE event frequency.

Hence, it is considered that the most significant causative event that leads to an explosion within the magazine is that posed by malicious activities, such as vandalism or robbery. The magazine is provided with a comprehensive security system as elaborated in a previous section (*Section 2.3.2*) and thus the possibility of vandalism may be reduced.

The installation of fire fighting measures within the magazine store will reduce the probability of initiation due to fire. The proposed security system will also reduce the frequency of initiation of an explosion due to vandalism or robbery. Nevertheless, this conservative figure of 1×10^{-4} for the Magazine site per year was retained to represent all generic causes of explosion that are common to nearly all magazines. Other causes such as on-site transportation and aircraft impact will vary between sites and have therefore been addressed separately.

Explosion during Manual Transfer from Store to Contractor's Truck

Since transfer of explosive from the store to the truck or vice versa will be carried out manually without involving any tools susceptible to initiate explosives, mishandling is deemed to be the only cause leading to an explosion. There is no significant cause of explosive mishandling identified specific to the project magazine compared to international practice; hence risks due to manual transfer are taken to be covered in the generic failure causes.

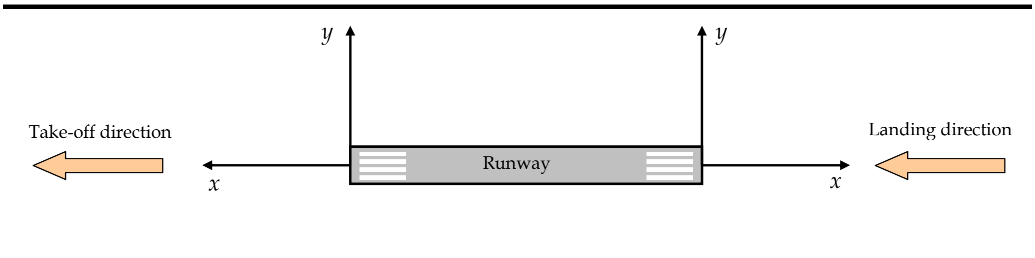
Lightning Strike

The magazine will be protected with lightning conductors to safely earth direct lightning strikes. The potential for a lightning strike to hit the facility and cause a detonation of explosives is therefore deemed to be unlikely although possible. Given that lightning protection will be provided for each store, lightning strike does not present an additional risk compared to the risk considered as part of the base frequency estimation in the UK. Explosive initiation due to lightning strikes is taken to be covered by the generic failure frequency.

Fixed Wing Aircraft Crash

The probability of a civilian aeroplane crashing onsite can be estimated using the HSE methodology (Byrne, 1997). The same model has been used in previous assessments of aircraft accidents (ERM, 2006). The model takes into account specific factors such as the target area of the proposed site and its longitudinal (*x*) and perpendicular (*y*) distances from the airport runway thresholds of the Hong Kong International Airport (*Figure 6.1*).

Figure 6.1 Aircraft Crash Coordinate System



The crash frequency per unit ground area (per km²) is calculated as:

$$g(x,y) = NRF(x,y) \qquad (1)$$

where *N* is the number of runway movements per year and *R* is the probability of an accident per movement (landing or take-off). *F*(*x*,*y*) gives the spatial distribution of crashes and is given by:

Landings

$$F_L(x,y) = \frac{(x+3.275)}{3.24} e^{\frac{-(x+3.275)}{1.8}} \left[\frac{56.25}{\sqrt{2\pi}} e^{-0.5(125y)^2} + 0.625 e^{-\frac{|y|}{0.4}} + 0.005 e^{-\frac{|y|}{5}} \right] \qquad (2)$$

for $x > -3.275$ km

Take-off

$$F_T(x,y) = \frac{(x+0.6)}{1.44} e^{\frac{-(x+0.65)}{1.2}} \left[\frac{46.25}{\sqrt{2\pi}} e^{-0.5(125y)^2} + 0.9635 e^{-4.1|y|} + 0.08 e^{-|y|} \right] \qquad (3)$$

for $x > -0.6$ km

Equations 2 and *3* are valid only for the specified range of *x* values, as defined in *Figure 6.1* for take-offs and landings. If *x* lies outside this range, the impact probability is zero.

National Transportation Safety Board (NTSB) data for fatal accidents in the US involving scheduled airline flights during the period 1992-2011 show a downward trend with recent years showing a rate of about 8.5×10^{-8} per flight. However, only 18.7% of accidents are associated with the approach to landing, 14.0% are associated with take-off and 4.7% are related to the climb phase of the flight (NTSB, 2006). The accident frequency for the approach to landings hence becomes 1.6×10^{-8} per flight and for take-off/climb 1.6×10^{-8} per flight. The Civil Aviation Department (CAD) reports an annual number of flights at Chek Lap Kok is about 380,000.

Chek Lap Kok has 2 runways, but with take-offs and landings from each direction, the runway designations are 07L, 07R, 25L and 25R. Half the plane movements are taking-offs (190,000 per year) and half are landings (190,000 per year). Assuming each runway is used with equal probability, the frequency of crashes at the Magazine site may be calculated as summarised in *Table 6.3*. The footprint area of each store and associated sand mound is estimated at 120 m^2, suggesting a target area of 240 m^2 for the 2 stores at Tai Lam Explosive Magazine.

From *Table 6.3,* the combined frequencies of all take-off and landing crashes amount to much less than 10^{-9} per year for the Magazine site. The risk of aircraft crash is therefore negligible compared to the risks considered in this project.

Table 6.3 Airplane Crash Frequencies

Magazine Site	Distance from Runway Threshold (km)				Crash Frequency (/km²/yr)*					Magazine Store Area (m²)	Impact Frequency (/yr)
	07L/25R		**07R/25L**		**07L**	**25R**	**07R**	**25L**	**Total**		
	x	*y*	*x*	*y*	**Take-off**	**Landing**	**Take-off**	**Landing**			
Tai Lam	12.5	7.5	12.5	9	5.3×10^{-12}	4.7×10^{-10}	1.2×10^{-12}	6.4×10^{-10}	1.1×10^{-9}	240	2.7×10^{-13}

* Take-offs to the west on runways 25L/R, and landings from the west on runways 07L/R will not contribute to the crash frequencies impacting on the Magazine site

Hill/Vegetation Fires

Hill/vegetation fires are relatively common in Hong Kong, and could potentially occur near the Magazine site. Recent statistics for these fires in Hong Kong country parks have been reviewed. Although the magazine is not actually located in a country park, some of the surrounding terrain and vegetation is similar to those typically found in country parks**.** According to Agriculture, Fisheries and Conservation Department (AFCD) statistics, the average number of hill fires is 32.4 per year during the five years 2008-2012 (range: 16 to 49). The area affected by fire each year is available from AFCD annual reports for 2009-2013 (*Table 6.4*). These are compared to the total area of country parks in Hong Kong of 44004 - 44239 Ha.

Averaging the data for the 5-year period suggests that 1% of vegetation areas are affected by fire each year, or equivalently, the frequency of a hill fire affected a specific site is 0.01 per year.

Table 6.4 Hill Fire Data for Hong Kong

Year	Area Affected (Ha)	Country Park Area (Ha)	% of Total Country Park Affected
2012	79	44239	0.18
2011	27	44239	0.06
2010	897	44239	2.03
2009	275	44004	0.62
2008	501	44004	1.14

With respect to the explosive magazine design, the land within the compound will be cleared of vegetation to remove combustible materials (see *Section 2.3.2*). The magazine, referring to *Section 2.3.2*, will be constructed from fire resistance materials such as bricks, cement rendering and steel doors. The ground surface will be made of either concrete or stone to prevent fire ingress to explosive stores. Since the magazine will be protected from fire by design, together with other fire-fighting measures in place, the chance of explosive initiation due to hill fire will be much lower than the generic explosion frequency and will be at no greater risk than other explosive magazines worldwide. Thus the generic explosion frequency is considered to include hill fire scenarios.

Earthquake

Studies by the Geotechnical Engineering Office (GEO Report 65) and Civil Engineering Services Department (GCO, 1991) conducted in the last decades indicate that Hong Kong SAR is a region of low seismicity. The seismicity in Hong Kong is considered similar to that of areas of Central Europe and the Eastern areas of the USA. As Hong Kong is a region of low seismicity, an earthquake is an unlikely event. The generic failure frequencies adopted in this study are based on historical incidents that include earthquakes in their cause of failure. Since Hong Kong is not at disproportionate risk from earthquakes compared to similar explosive magazines worldwide, it is deemed appropriate to use the generic frequencies without adjustment. There is no need to address earthquakes separately as they are already included in the generic failure rates.

Escalation

Referring to the WIL study (ERM, 2008), it is not considered possible that an explosion within one magazine store will directly initiate an explosion within an adjacent store (i.e. leading to mass explosion). This is based on the results obtained from the Ardeer Double Cartridge (ADC) test for cartridged emulsion that show that beyond a separation distance of 2 cartridge diameters the consequence of a detonation are not able to propagate. Therefore the direct propagation by blast pressure wave and thermal radiation effects of an explosion within one store initiating an explosion within the adjacent store is not considered. However, the ground shock induced from an explosion may cause damage within the adjacent stores leading to subsequent explosion.

Explosive stores are made of substantial brickwork surrounded by earth mounds between each store. Referring to a previous assessment (ERM, 2008), a building can withstand a vibration level lower than 229 mm/s without significant structural damage.

Ground vibration distances R can be assessed using the formula

$$A = K\,Q^{d}\,R^{-b}$$

where

A is the vibration threshold (mm/s)
Q is the mass of explosive detonated.
K = 1200, d = 0.5, b = 1.2.

The above equation applies to explosives fully coupled with hard rock as typically found in Hong Kong. The magazine store building will provide some confinement which would result in explosion energy being transmitted through the ground by ground shock effects due to the direct contact of explosives with the ground. The WIL study (ERM, 2008) defines a methodology for assessing the ground shock effects in underground explosive stores. Although the criteria for underground store of the DoD 6055.9-STD will not be reached given the thickness of the walls, the same approach is conservatively adopted to evaluate the ground shock effects in the absence of other relevant correlation. This gives a K value circa 200 ± 10%for the Project considering the amount of explosives to be stored in each storeroom at the Magazine site.

Applying the above equation and the ground coupling correlation of the WIL study (ERM, 2008), the maximum ground vibration generated from detonating of 467 kg TNT equivalent explosive is calculated at 155 mm/s for a separation of 16 m which is less than 229mm/s . Hence, this study considers the possibility to initiate adjacent store’s explosives due to escalation or domino effect to be negligible compared to the overall explosion frequency.

Other Site Specific Considerations

It is assessed that model aircraft (aeroplanes and helicopters) operating from the enthusiasts' club airfield adjacent to the Tai Lam site are too light, and carry too little fuel, to cause any consequence on impact.

Conclusion on Accidental Initiation in the Magazine

All external hazards make either negligible additional contribution to the risks or are deemed to be already included in the generic frequency of 10^{-4} per year.

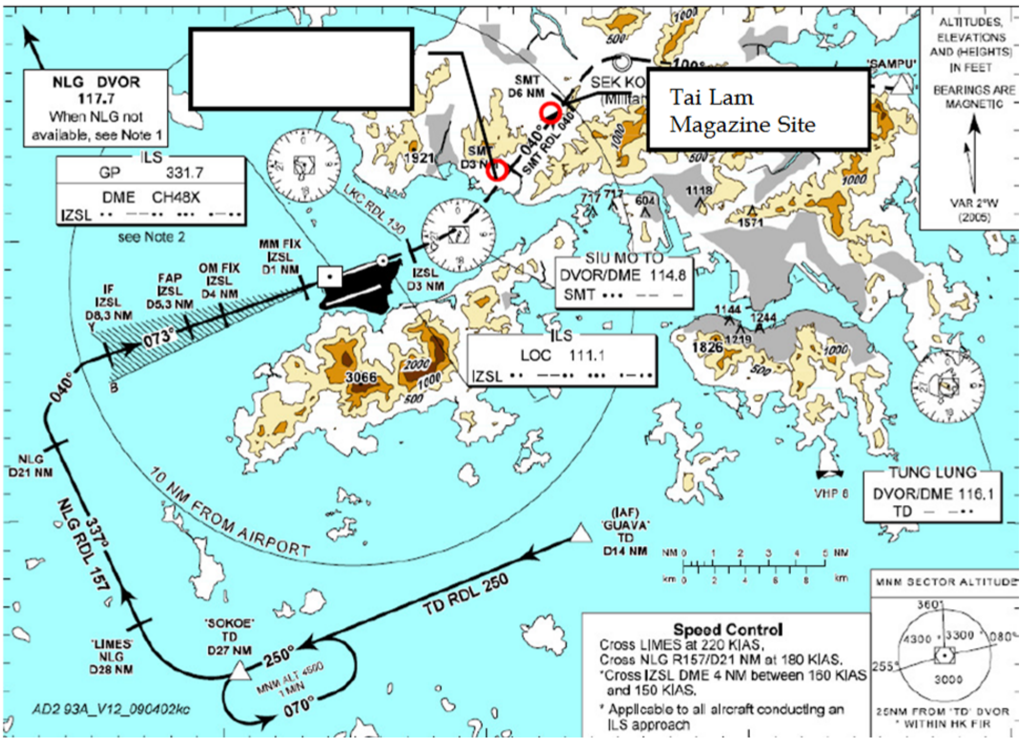
6.1.3 *Impact on Air Traffic near the Tai Lam Site*

The proposed Tai Lam Explosives Magazine site will be located about 5 km away respectively from the regular arrival paths 25L/25R, departure paths 07L/07R (North), 07L/07R (South) and 25L/25R at Hong Kong International Airport (*Figure 6.2* and *Figure 6.3*). These distances are far beyond the maximum impact area of fragments generated in an explosion.

Figure 6.2 Arrival Flight Paths of Hong Kong International Airport

Figure 6.3 Departure Flight Paths of Hong Kong International Airport

Figure 6.4 Missed Approach Flight Path



Impact on Regular Arrival and Departure Flight Paths

Both the regular arrival and departure flight paths are more than 2 km from Tai Lam Explosives Magazine Site. This distance is far beyond the maximum impact zone of fragments generated in the event of an explosion. Any incident at the Magazine site, therefore, will not have any impact on normal flights at Chep Lap Kok.

Impact on Missed Approach Flight Paths

Based on information provided by the Civil Aviation Department (CAD), planes that miss the approach to runway 07L will climb to 5000 ft on a heading that passes over the Tai Lam Explosives Magazine Site (*Figure 6.4*). The altitudes of planes are expected to be about 600m above the Tai Lam Explosives Magazine Site. This is regarded as a lower limit given the distance from the airport and climb gradients of 2.5% to 3.7% (152 – 225 ft/nm). Also, some planes would not be at runway level when they abort a landing but may begin the climb out earlier in the approach so would already have some altitude.

To estimate the risk of fragments affecting an aircraft, it is necessary to assess the magazine explosion frequency, the airplane presence factor and the probability of significant damage leading to a crash.

The explosion frequency is $1x10^{-4}$ per year for the Tai Lam Explosives Magazine Site. During the 12 month period from January 2014 to December 2014, based on information provided by the CAD, there were a total of 291 missed approaches recorded at the airport and about 61% of landings take place on runway 07L. This gives about 177 missed approaches per year for runway 07L that may pass over the Magazine site. The maximum fragment range for an explosion from a magazine is reported to be less than 600m (Moreton 2002). The effects diameter for affecting an aircraft is therefore taken to be 1.2km. This is a little conservative since it assumes the hazard range at >200m altitude will be the same as that as ground level. Assuming an aircraft flies at a speed of about 300km/h, the transit time for crossing this distance is 14 seconds. The presence factor for 270 missed approaches per year may therefore be calculated as 177 x 14 / (365 x 24 x 3600) = $7.9x10^{-5}$. Although the missed approach flight path is close to the Magazine site, there will be some variation in horizontal and vertical position of planes. It is assumed that 50% of aircraft will be out of range horizontally, and 50% will be out of range vertically. If a plane is within range, it is conservatively assumed that it will be struck by a fragment with probability of 1. This gives a probability of impact by fragments from an explosion at the magazine of $10^{-4} \times 7.9x10^{-5} \times 0.25 = 2.0 \times 10^{-9}$ per year.

In the event that an aircraft were hit by a fragment, the crash of the aircraft is not inevitable. The fragment would need to have sufficient energy to penetrate the skin of the aircraft and cause damage to critical components. The target area of these critical components such as engines, hydraulic lines, control surfaces etc. will likely constitute a small fraction of an aircraft's total projected cross-sectional area. Also, given the redundancy in aircraft equipment such as the presence of multiple engines, the probability that fragment damage would be severe enough to lead to a crash before the plane could return safely to the airport is considered to be small. A value of 10% is assumed. This gives a crash frequency for aircraft, caused by an explosion at a magazine, to be 2.0×10^{-10} per year.

The probability for Tai Lam Explosives Magazine will be even lower given its great distance from the airport. It is concluded that the risk of magazine explosions impacting on aircraft is negligible, i.e. $< 10^{-9}$ per year.

6.2 *TRANSPORT OF EXPLOSIVES*

A deflagration or detonation explosion is a possible accidental outcome which may occur during the transportation of explosives from the magazine to the worksites. The causes of potential accidental explosion during transportation have been identified in the WIL QRA study (ERM, 2008), which was based on the DNV study (DNV, 1997) and to a great extent on the ACDS study (ACDS, 1995) and its associated frequency assessment reported by Moreton (Moreton, 1993).

Accidental explosion can be caused by spontaneous fire (non-crash fire), fire after a vehicle crash (crash fire) and impact initiation in crash (crash impact) or spontaneous explosion during the normal condition of transport which may occur if the cargo load contains 'unsafe explosives'.

- Non-crash fire:
  This cause category includes any explosion instance where the explosive load has been subject to thermal stimulus which was not the result of a vehicle collision. Events in this category, not only include instances where the explosive load is directly engulfed in the fire but also events where thermal stimulus occurs by ways of heat conduction and convection;

- Crash fire:
  This cause category is similar to the non-crash fire category but only concerns fires resulting from a vehicle collision;

- Crash impact:
  This cause category includes all instances of vehicle collisions with a sufficient energy to significantly affect the stability of the explosive and which could have the potential to cause an accidental explosion; and

- Spontaneous explosion ('unsafe explosive'):
  The term 'unsafe explosive' originates from the ACDS study (ACDS, 1995). It includes explosions, during conditions of normal transport, resulting from breach of regulations caused by badly packaged, manufactured, and/or 'out-of-specification' explosives.

For crash and non-crash fires, explosive initiation requires a fire to start, the fire to spread to the explosives load and initiation to occur once the load is engulfed by the fire for a period of time.

Based on the Hazard Identification section of this report, explosive initiation due to impact is considered possible but unlikely. It would first require, as demonstrated by bullet impact tests (Holmberg), a significant mechanical (impact) energy which is unlikely to be encountered in a transport accident scenario. Even in the case of a significant mechanical (impact) energy, as demonstrated by the accident records and drop test data (ACDS, 1995), an explosion would be unlikely. Scenarios in this report include direct initiation events of the explosive load due to impact or secondary events resulting in explosives being spilt onto the road which could subsequently initiate due to indirect impact. For both scenarios, the initiating event requires, as mentioned above, a significant crash impact leading to the loss of integrity of the load compartment and/or a significant mechanical energy affecting the explosive load.

6.2.1 *Explosive Initiation Frequency During Transport as Used in Previous Hong Kong Studies*

The basic event frequencies derived in previous Hong Kong studies for road accidents were based on those derived in the ACDS study (ACDS, 1995) for assessing the risks related to the transport of explosives (commercial and non-commercial) in ports. The basic event frequencies were subsequently adjusted in the DNV study (DNV, 1997) to address the risk associated with the transport of commercial explosives by Mines Division Medium/Heavy Goods Vehicle (M/HGV) trucks. Subsequent studies undertaken in Hong Kong including the WIL study (ERM, 2008), Ocean Park Development study (Maunsell, 2006) and Penny's Bay Rail Link study (ERM, 2001) studies adopted the frequencies derived for the M/HGV Mines Division trucks based on the DNV study (DNV, 1997) and applied them to the transport of explosives in pick-up truck type Light Goods Vehicles (LGV) operated by contractors from the relevant magazine to the worksites.

Accounting for the safer nature of the explosives to be transported nowadays in Hong Kong and the existing regulations in place, the WIL study (ERM, 2008) proposed a refined approach for the assessment of the explosion frequency associated with the transport of 'unsafe explosives'. Although such events are considered extremely unlikely for the types of explosives used in Hong Kong, it has not been possible to completely rule out their occurrence. As such, the assumption that the assessed frequency of explosion will be doubled as used in the ACDS study (ACDS, 1995) has been dismissed for the particular types of explosives transported in Hong Kong and replaced, instead, by an overall frequency increase by 1% (i.e. a factor of 1.01 was applied to the overall frequency). The details of the approach are presented in the WIL study report (ERM 2008).

The frequency components for transport of explosives has been re-assessed in detail as part of the XRL study (ERM, 2009) given the current knowledge on the explosives' properties, vehicle incident frequencies provided by the Transport Department and Fire Services Department and specific design features applicable for the project such as:

- Light Goods Vehicle (LGV) pick-up type truck for explosive delivery;

- Recent Hong Kong Transport Department statistics;
- Hong Kong specific vehicle fire data;
- Specific Hong Kong explosive delivery truck design feature;
- Specific Hong Kong explosive delivery truck operation; and
- Revised knowledge of explosives properties.

The revised frequency parameters for transport of explosives are summarised in the following sections. The historical background for the derivation of each frequency component are presented in the XRL study (ERM, 2009) report.

Initiation Probability on Significant Impact

Based on the review with explosives experts, the energy required to detonate PETN or emulsion based explosives is one order of magnitude higher (based on bullet tests) than nitroglycerin (NG) based explosives. Since NG was considered as the basis for determining the probability of initiation under impact conditions in the ACDS study (ACDS, 1995) (assessed at 0.001), a reduction factor of 0.1 was applied based on impact energy consideration (ERP, 2009), giving the overall initiation on impact probability taken as 0.0001.

Probability of Explosive Response to Fire

The initiation of explosives in the DNV study (DNV, 1997) was assessed as 0.1 for any fire involvement. This value was based on the ACDS study (ACDS, 1995), which was derived from an expert judgement for heat insensitive explosive group which included a variety of explosives. In the XRL study (ERM, 2009), the proportion of detonating cord and cartridged emulsion differs from the previous projects. The sensitivity of the explosive load to fire and impact has therefore been reviewed. Based on the experts' knowledge (ERP, 2009) and experience on PETN and sensitised emulsion, the probability that the explosive melts and detonates once the fire impacts on the load is more likely than what was initially assumed in the ACDS study (ACDS, 1995) given the recent transport accident experience and the known properties of mixed explosives used. In the absence of further test data on transported explosives, a probability of 0.5 has been taken in the XRL study (ERM, 2009) to more appropriately represent the mix of explosive loads as applicable in the study. The same 0.5 is used in the current study.

Frequency of Non-crash Fire – Explosives Subject to Thermal Stimulus

Referring to the expert panel review (ERP, 2009) a thermal stimulus is sufficient to cause an explosion of the explosive load based on updated knowledge on explosive properties. The non-crash fire frequency (i.e. 1.30×10^{-9} /km) was then derived specifically for Hong Kong conditions based on goods vehicle data provided by the Transport Department in 2007 and Fire Services Department data on causes of fire call incidents in Hong Kong between 2004 and 2008. This update in the XRL study (ERM, 2009) reflects the most common causes of fires occurring on motor vehicles in Hong Kong, giving a lower fire incident rate compared to UK data (1.4 x 10^{-9}/km).

Vehicle Involvement Rate

In previous studies undertaken in Hong Kong including the WIL EIA (ERM, 2008), Ocean Park Develop (Maunsell, 2006) and DNV QRA (DNV, 1997) studies, they adopted the frequencies derived for the M/HGV to account for Hong Kong situation based on the relevant HK HGV to UK HGV reportable vehicle collision involvement. Since specific LGV pick-up type trucks will be used in the project, a review of the Hong Kong accident data and vehicle involvement rate for LGVs was carried out based on the data published by the Transport Department between 2003 and 2007.

Explosive Initiation Frequency for Different Types of Road

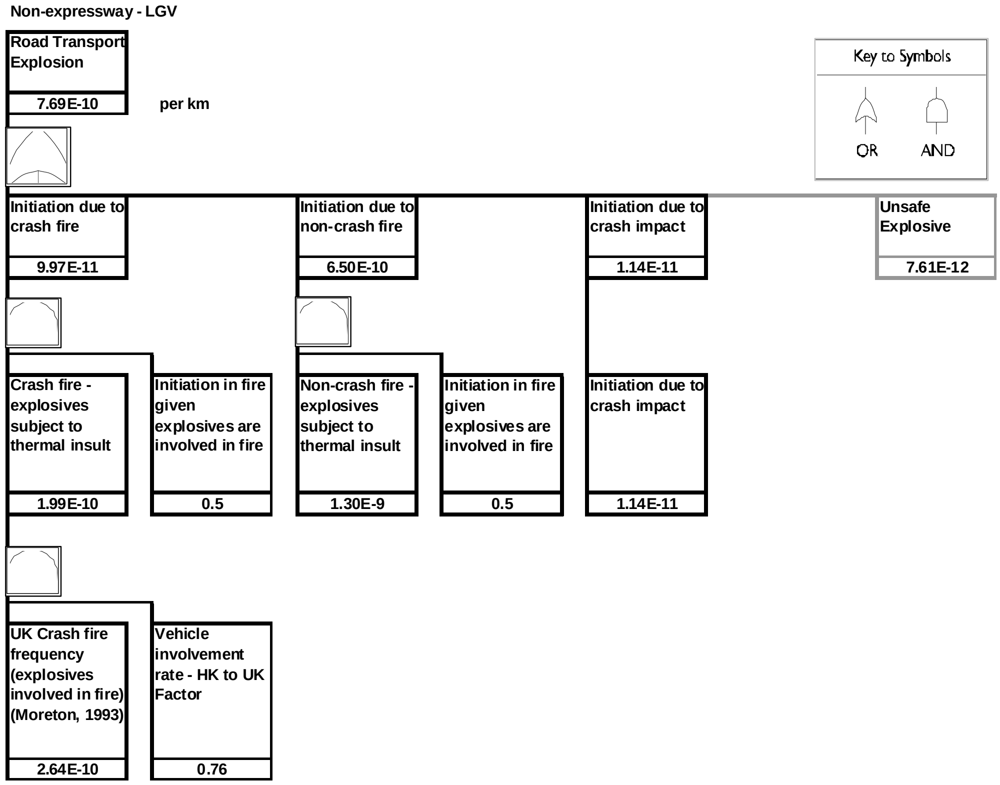
Since the vehicle impact speed and the accident involvement rate on highway/ major roads and non-highway are significantly different, different sets of explosive initiation frequencies for Expressway and Non-expressway have been derived during explosive transport to reflect the road conditions along the transport routes.

The components of the explosive initiation fault tree adopted in the XRL QRA (ERM, 2009) as well as their individual probabilities are shown in *Table 6.5* and the fault tree models for the road transport explosion are shown in *Figure 6.5* and *Figure 6.6*. The frequencies of explosives initiation during road transport were therefore estimated at 6.87 x10^{-10}/km on expressway and 7.69 x10^{-10}/km on other road sections considering an additional 1% increase for "unsafe explosives" (i.e. a factor of 1.01), as justified in the WIL QRA (ERM, 2008).

Table 6.5 Explosives Initiation Fault Tree Inputs from the XRL QRA (ERM, 2009)

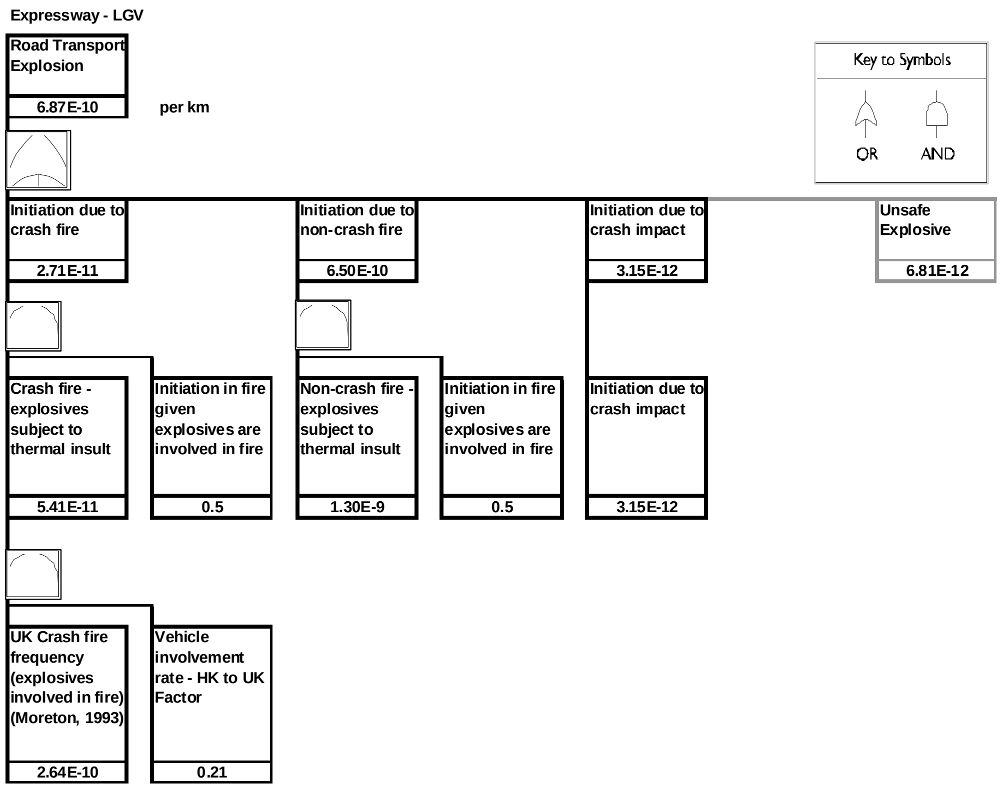
Event	Event type	Value
Vehicle crash (on expressway)	Frequency	1.27 x10^{-7} /km
Vehicle crash (on non-expressway)	Frequency	4.68 x10^{-7} /km
Crash fire (on expressway)	Frequency	5.41 x10^{-11} /km
Crash fire (on non-expressway)	Frequency	1.99 x10^{-10} /km
Non-crash fire	Frequency	1.30 x10^{-9} /km
Explosives initiation in fire	Probability	0.5
Explosives initiation in impact	Probability	0.0001

Figure 6.5 Explosives Initiation Fault Tree for Non-Expressway – Road Transport Events from the XRL QRA (ERM, 2009)



Note: Vehicle involvement rate – HK to UK factor was calculated by dividing the crash frequency of 4.7E-7 per year by the UK frequency of 6.2E-7 per year (see discussion of *Section 6.2.2* in the XRL QRA (ERM, 2009).

Figure 6.6 Explosives Initiation Fault Tree for Expressway – Road Transport Events after the XRL QRA (ERM, 2009)



Note: Vehicle involvement rate – HK to UK factor was calculated by dividing the crash frequency of 1.3E-7 per year by the UK frequency of 6.2E-7 per year (see discussion of *Section 6.2.2* in the XRL QRA (ERM, 2009).

6.2.2 *Transport Explosion Frequency for the Project*

The Hazard to Life Assessment study for Project has been performed based on the explosive initiation frequencies derived in the XRL study (ERM, 2009) for the transport of explosives and the specific explosive transport vehicle design and operation to be used as part of the Project. This approach is consistent with previous studies. The explosives initiation fault tree models for the road transport events for non-expressway and expressway are presented in *Figure 6.5* and *Figure 6.6* respectively. The expressway explosion rate of 6.87×10^{-10} per km has been applied to the Yuen Long Highway, San Tin Highway, and Fanling Highway sections while the non-expressway explosion rate of 7.69×10^{-10} per km has been applied to other road sections.

7 CONSEQUENCE ASSESSMENT

7.1 GENERAL

Explosives present a hazard to both property and people. This hazard manifests itself in the following ways:

- blast and pressure wave;
- flying fragments or missiles;
- thermal radiation; and
- ground shock.

In the case of bulk explosions, the most damage is usually caused by the blast effects. However, for small detonations, fragmentation is the most significant effect and thermal radiation is only of interest in low speed deflagrations.

Three modes of injury can result to people when exposed to blast effects:

- Primary;
- Secondary; and
- Tertiary effects.

Primary effects involve the direct effects of the blast upon sensitive human organs such as the ears and lungs. Compared with secondary and tertiary effects, considerable overpressures are required for fatalities to occur, and consequently people need to be fairly close to the scene of the explosion for primary effects to be significant.

Secondary effects are associated with building collapse or the impact of debris and fragments from damaged building structures and the vehicle or container in which the explosives are held. Predicting injury and fatality levels due to fragments/debris from high explosives is particularly difficult.

Tertiary blast injuries may occur with whole body impacts, when people are displaced or swept away, or due to the violent movement of internal organs within the body. For people outdoors, tertiary effects are dominant.

Thus, for the cartridged emulsion to be transported and stored for this project, the blast effects will be of most concern. Also of interest are the detonators used to initiate these explosives. However, provided these are kept within their original packaging they will only explode 'one-at-a time', and will not present a mass explosion hazard. Packaged in this way, the detonators may be classified as UN Class 1.4 S.

7.2 *PHYSICAL EFFECT MODELLING*

7.2.1 *Blast and Pressure Wave for Explosion*

The consequence models used for the assessment of the probability of fatality due to blast and pressure waves, are based on the most recent UK Explosive Storage and Transport Committee (ESTC) model defined in the HSC publication (ESTC, 2000). This model has been previously used in the SCL study (ERM, 2011) and XRL study (ERM, 2009) and considers all the effects associated with an above ground explosion including fireball, overpressure, flying debris, broken glass, structural damage etc.

People Indoors

The ESTC indoor model is based on the analysis of casualty data collated from records of a number of major incidents involving accidental explosion. The data on which the model is constructed does not distinguish between those killed by the blast and those killed by fragments. It is assumed that blast effects were the cause of most of the fatalities recorded in these incidents but the model implicitly makes some allowance for fragment effects. The probability of fatality for persons located inside conventional buildings for various quantities of explosives can be estimated by:

$$\log_{10} P = 1.827 - 3.433\log_{10} S - 0.853(\log_{10} S)^2 + 0.356(\log_{10} S)^3 \qquad \text{for } 3 < S < 55$$

Where $S = R / Q^{1/3}$

P is the probability of death, R is the range in metres, and Q is the explosive charge mass in kg (TNT equivalent mass).

In this study, the indoor consequence model has been assumed to be also applicable to the population present in vehicles.

People Outdoors

The outdoor model is based on a review of the available literature on primary and tertiary blast effects:

$$P = \frac{e^{(-5.785S + 19.047)}}{100} \qquad \text{for } 2.5 < S < 5.3$$

The distance to 1%, 3%, 10%, 50% and 90% fatality contours were used in the modelling.

7.2.2 *Flying fragments or missiles*

Fatality due to flying fragments or missiles due to explosion is considered in the ESTC model; therefore, no separate model for debris is considered.

7.2.3 *Thermal Radiation*

The initiation of an explosion will result in thermal radiation from a fireball as the explosives initiate. There are relatively few published models in the literature for high explosive fireballs, or those that may result from a cartridged emulsion detonation. Models that are available describe the fireball duration and diameter based on TNT or similar explosives e.g. nitroglycerine, PETN, etc. Radiation effects are generally considered to be a concern for explosives classified as HD 1.3. For the purpose of this study, it is assumed that the fireball correlations are applicable to cartridged emulsion containing ammonium nitrate, fuel oil and aluminium powder.

The diameter and duration of a fireball from a high explosive are given in Lees (1996):

$$D = 3.5\,M^{0.333}$$

$$t_d = 0.3\,M^{0.333}$$

where D is the fireball diameter (m)
M is the mass of the explosive (kg), TNT equivalent
t_d is the duration of the fireball (seconds).

For the largest explosive mass of 467 kg (initiation of an entire store contents), a fireball radius of 13.5 m is predicted with a duration of 2.3 seconds.

The surface emissive power (E_f) can then be calculated from the equation:

$$E_f = \frac{f_s M \Delta H_r}{4\pi r_{fireball}^2 t_d}$$

Where ΔH_r is the heat released from the explosive (kJ/kg), which is approximately 4.01 MJ/kg for cartridged emulsion. M is the mass of explosive (kg) and f_s is the fraction of the heat that is radiated, a conservative value of 0.4 is taken. This gives a surface emissive power of the fireball of 141 kW/m^2.

The heat flux received by a receptor at some distance from the fireball is estimated from:

$$q'' = E_f . F_{view} \tau_a$$

Where E_f is the surface emissive power of the fireball, which is either estimated using the previous equation or is an assumed maximum value. F_{view} is the view factor, and τ_a is the atmospheric transmissivity.

For a vertical surface the view factor can be calculated from:

$$F_{view} = \frac{X (r_{fb})^2}{\left(X^2 + r_{fb}^2\right)^{3/2}}$$

Where X is the distance measured along the ground from the object to a point directly below the centre of the fireball. This distance must be greater than the radius of the fireball, because actual development of the fireball often involves an initial hemispherical shape, which would engulf nearby receptors. Additionally, as the fireball lifts off the ground, the distance to near field receptors changes significantly. This means that the radiation estimates in the near field are of questionable accuracy.

At very large distances, the above equation for the view factor reduces to:

$$F_{view} = \left(\frac{r}{X} \right)^2$$

The atmospheric transmissivity, τ_a, reflects the proportion of radiation that is adsorbed by the water vapour and the carbon dioxide present in the atmosphere. A correlation for the estimation of transmissivity was published by F.D. Wayne (1991):

$$\tau_a = 1.006 - 0.01171 \log_{10}\left(X_{H_2O}\right) - 0.02368\left[\log_{10}\left(X_{H_2O}\right)\right]^2 - 0.03188 \log_{10}\left(X_{CO_2}\right) + 0.001164\left[\log_{10}\left(X_{CO_2}\right)\right]^2$$

where

$$X_{H_2O} = \frac{2.165 P_w^o RHd}{T}$$

$$X_{CO_2} = \frac{273d}{T}$$

RH is the relative humidity and is assumed to be 85% for Hong Kong. P_w^o is the vapour pressure of water at atmospheric temperature T, and d is the distance to the fireball surface, or path length.

The probit equation for fatalities due to thermal radiation is proposed by Eisenberg (Lees, 1996):

$$\Pr = -14.9 + 2.56 \ln L$$

Where L is the thermal dose or load defined as $L = t\, I^{4/3}$, I is the thermal radiation flux (kW/m^2), t is the exposure duration and Pr is the probit that is related to probability of fatality.

The thermal dose units corresponding to 1%, 50%, and 90% fatality levels are 956, 2377, and 3920 s.(kW/m^2)$^{4/3}$ respectively. These broadly match with the 1000, 1800 and 3200 TDU levels reported by the UK HSE Safety Report Assessment Guides (HSE HFLs) for the same fatality levels. Applying the HSE thermal dose criteria limits for a fireball of duration 2.3 s, indicates that the incident radiation fluxes to cause these fatality levels are estimated as 95, 148, and 228 kW/m^2.

Comparing these with the fireball surface emissive power of 140 kW/m^2, shows that these levels of thermal flux will only be realised when in very close proximity to the fireball. Therefore, it can be concluded that a fireball from the initiation of cartridged emulsion within the storage magazine will not pose an off-site hazard. It is generally the case that the thermal hazards from an explosives detonation event are of less concern than the blast and fragment hazards. Therefore, the hazards from a fireball are not considered further in this assessment.

7.2.4 *Ground Shock*

The detonation of solid phase materials liberates energy by a rapid chemical reaction process, which produces and sustains a shock wave in the material. The high temperatures and pressure associated with the shock wave causes almost instantaneous reaction in the material. This reaction produces high pressures and temperatures in the expanding gas. In the case of rock excavation, it is this pressure that crushes surrounding rock when the explosive material is placed in a drill hole for blasting.

In areas where the explosive material is less confined, the pressure will be reduced due to the increased volume into which the gases can expand. If the degree of confinement is reduced, eventually the pressure will cease to crush the rock, but instead will cause rock fractures or cracking. If the level of confinement is reduced further, the pressure will cease to fracture the rock and the energy will propagate through the rock as an elastic wave causing the rock particles to vibrate. The degree of vibration of the rock particles decreases with increasing distance from the blast. However, the vibration of the rock particles can cause damage and structural failure to buildings if sufficiently strong (USBM 656).

Considering the fact that in this project explosive transport and storage will be carried out aboveground with much less confinement than that of rock excavation, this aspect of consequence should not be of much concern compared to the hazards posed by the overpressure wave and debris generated (modelled by the ESTC model). A comparison of 1% fatality impact distance calculated by ground vibration model and ESTC model are provided in *Table 7.1* and the results show the effect of ground vibration are less significant than that of air shockwave and debris.

Table 7.1 Blast Effect Distances for 1% Fatality Probability from Detonation of 467 kg TNT Equivalence of Explosive

Consequence	Receiver's Location	Effect Radius (m)
Shockwave and debris - ESTC model	Indoor	70.8
	Outdoor	25.0
Ground shock – Object falling threshold (PPV = 100 mm/s)	Indoor / outdoor close by a structure	23.0

In addition, excessive ground vibration may lead to slope failure and create a secondary hazards. Based on the effect thresholds defined in the previous assessment, the weakest slope with factor of safety (FOS) of 1.1 can be damaged in 0.01% chance with a peak particle velocity (PPV) of 90 mm/s.

The effect radius of 90mm/s was calculated as 25.1 m for detonation of 467 kg TNT equivalence of explosives, which correspond to the maximum quantity of explosive (TNT equivalent) to be stored in each magazine store. From *Table 4.9,* all the slopes are too far away to be affected or too far away to affect any population or roads. Therefore, the hazards from a ground shock are not considered further in this assessment.

7.3 *RESULTS OF CONSEQUENCE ASSESSMENT*

The consequence results for each transport and storage scenario are summarised in *Table 7.2* and *Table 7.3*. Consequence distances for the storage scenarios (no. 1 -2) may be compared to the separation distances specified in the magazine designs, as follows: public footpaths must be at least 54 m away (vehicle routes must be further); buildings must be at least 183m away. Thus, the design separation distances substantially exceed the 1% fatality distance and hence no significant risk of fatality due to explosive storage is expected.

Table 7.2 Summary of Results for Base Case Consequence Scenarios

No.	Scenario	TNT eqv. kg	Fatality Prob.	*Indoor*	*Outdoor*
				Impact Distance (m)	**Impact Distance (m)**
Storage of Explosives					
01	Detonation of full load of explosives in one store in Tai Lam Explosives Magazine site	467	90%	23.9	19.1
			50%	27.6	19.9
			10%	40.9	22.0
			3%	54.7	23.6
			1%	70.8	25.0
02	Detonation of full load of explosives in one contractor truck on the access road within the Tai Lam Explosives Magazine site boundary	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1
Transport of Explosives					
03	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to Mid-Ventilation Adit delivery point	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1
04	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to North Portal delivery point	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1
05	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam site to South Portal delivery point	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1

Table 7.3 Summary of Results for Worst Case Consequence Scenarios

No.	Scenario	TNT eqv. kg)	Fatality Prob.	*Indoor* Impact Distance (m)	*Outdoor* Impact Distance (m)
Storage of Explosives					
01	Detonation of full load of explosives in one store in Tai Lam Explosives Magazine site	467	90%	23.9	19.1
			50%	27.6	19.9
			10%	40.9	22.0
			3%	54.7	23.6
			1%	70.8	25.0
02	Detonation of full load of explosives in one contractor truck on the access road within the Tai Lam Explosives Magazine site boundary	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1
Transport of Explosives					
03	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to Mid-Ventilation Adit delivery point	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1
04	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam Explosives Magazine site to North Portal delivery point	206	90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1
		206			
05	Detonation of full load of explosives in one contractor truck on public roads – from Tai Lam site to South Portal delivery point		90%	18.2	14.6
			50%	21.1	15.2
			10%	31.2	16.8
			3%	41.6	18.0
			1%	53.6	19.1

7.4 SECONDARY HAZARDS

7.4.1 *Property Damage*

As mentioned previously the Hong Kong Model Engineering Club periodically flies model aircrafts at a site about 300 m from the Magazine. The distance of the entrance of the club to the magazine is about 200 m, which is outside the 183 m specified in the requirements. The 200 m also substantially exceeds the 1% fatality distance.

7.4.2 *Impacts on Slopes and Boulders*

Along the transport route, there are some slopes close to the road, in particular along some sections of Fan Kam Road. There is a possibility that an explosion on a road vehicle may trigger a landslide or a boulder fall. This is regarded as a secondary hazard. The impact of this hazard in terms of potential consequences was evaluated using the approach adopted in the XRL study (ERM, 2009). It was found that any landslide and boulder fall event will impact the same area along the road that is already affected by the primary explosion consequences. Hence, no significant additional fatality will occur.

7.4.3 *Potential Impact to Sensitive Facilities along the Explosives Delivery Routes*

Two sensitive facilities, WSD Au Tau Water Treatment Works (ATWTW) and Tai Po Tau Water Treatment Works (TPTWTW), which are Potentially Hazardous Installations (PHIs), are located more than 450 m and 650 m respectively away from the nearest transport routes (Route Option R1). This is well outside the 100 m impact zone of the explosives truck and hence not considered further.

8 RISK SUMMATION

8.1 OVERVIEW

The Consultants' in-house software has been used for risk calculation and summation. This integrates the risks associated with the Magazine site with those from the transport of explosives to the worksites, including the risks to other road users, nearby buildings and outdoor population.

The base case considered a realistic construction scenario. The individual risk and societal risk results are shown below.

A Worst Case was also considered to address potential changes in the construction programme due to construction uncertainties. The societal risk results for this worst case scenario are also shown for comparison purposes.

8.2 RISK MEASURES

The two types of risk measures considered are societal and individual risks.

8.2.1 *Societal Risk*

Societal risk is defined as the risk to a group of people due to all hazards arising from a hazardous installation or activity. The simplest measure of societal risk is the Rate of Death or Potential Loss of Life (PLL), which represents the predicted equivalent fatalities per year:

$$\text{PLL} = f_1N_1 + f_2N_2 + f_3N_3 + \ldots + f_nN_n$$

where f_i is the frequency and N_i the number of fatalities for each hazardous outcome event.

Societal risk can also be expressed in the form of an F-N curve, which represents the cumulative frequency (F) of all event outcomes leading to N or more fatalities. This representation of societal risk highlights the potential for accidents involving large numbers of fatalities.

8.2.2 *Individual Risk*

Individual risk may be defined as the frequency of fatality per individual per year due to the realisation of specified hazards. Individual Risk may be derived for a hypothetical individual present at a location 100% of the time or a named individual considering the probability of his presence etc. (the latter case being known as Personal Individual Risk).

8.3 *SOCIETAL RISK*

8.3.1 *Potential Loss of Life*

Table 8.1 and *Table 8.6* below show the PLL values for the storage of explosives at the Magazine site and the transport of explosives to the blasting sites. As expected, the Worst Case (PLL = 8.10×10^{-4}/year, 1.56×10^{-3}/year, 9.40×10^{-4}/year) imposes a higher risk than the Base Case (PLL = 6.75×10^{-4}/year, 1.30×10^{-3}/year, 7.83×10^{-4}/year).

The proposed magazine storage site (Tai Lam Explosives Magazine Site) has negligible contribution (i.e. in a magnitude of 1×10^{-9}) to the overall risks since it is located in a remote area with no permanent population nearby.

The variation in contributions to the overall risk due to the different routes can be explained by

- the different route lengths;
- the differences in road traffic and pavement population density;
- the differences in nearby building population density and proximity;
- the differences in explosive loads to the different worksites; and
- the number of trips according to the blasting programme.

Therefore, in the case of minor modifications to the delivery routes, as long as the routes maintain similar characteristics in terms of length and its surroundings (e.g. population density, proximity, etc.), the overall risk will not be significantly impacted.

Table 8.1 PLL for Base Case Route Option R1

Case: Base Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	1.68E-04	24.90%
Tai Lam Explosives Magazine Site to North Portal	2.13E-04	31.55%
Tai Lam Explosives Magazine Site to South Portal	2.94E-04	43.55%
Total	**6.75E-04**	**100.00%**

Table 8.2 PLL for Base Case Route Option R2

Case: Base Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	2.83E-04	21.83%
Tai Lam Explosives Magazine Site to North Portal	3.58E-04	27.61%
Tai Lam Explosives Magazine Site to South Portal	6.56E-04	50.55%
Total	**1.30E-03**	**100.00%**

Table 8.3 PLL for Base Case Route Option R3

Case: Base Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	1.73E-04	22.04%
Tai Lam Explosives Magazine Site to North Portal	2.18E-04	27.84%
Tai Lam Explosives Magazine Site to South Portal	3.93E-04	50.12%
Total	**7.83E-04**	**100.00%**

Table 8.4 PLL for Worst Case Route Option R1

Case: Worst Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	2.02E-04	24.90%
Tai Lam Explosives Magazine Site to North Portal	2.56E-04	31.55%
Tai Lam Explosives Magazine Site to South Portal	3.53E-04	43.55%
Total	**8.10E-04**	**100.00%**

Table 8.5 PLL for Worst Case Route Option R2

Case: Worst Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	3.40E-04	21.83%
Tai Lam Explosives Magazine Site to North Portal	4.30E-04	27.61%
Tai Lam Explosives Magazine Site to South Portal	7.87E-04	50.55%
Total	**1.56E-03**	**100.00%**

Table 8.6 PLL for Worst Case Route Option R3

Case: Worst Case	PLL (per year)	Contribution (%)
Storage of Explosives		
Tai Lam Explosives Magazine Site	9.03E-09	0.001%
Transport of Explosives		
Tai Lam Explosives Magazine Site to Mid-Ventilation Adit	2.07E-04	22.04%
Tai Lam Explosives Magazine Site to North Portal	2.62E-04	27.84%
Tai Lam Explosives Magazine Site to South Portal	4.71E-04	50.12%
Total	**9.40E-04**	**100.00%**

8.3.2 *F-N Curves*

Figure 8.1, *Figure 8.2* and *Figure 8.3* show the overall F-N curves for explosives storage and transport combined. These include the Tai Lam Explosives Magazine Site and the associated transport routes to the 3 worksites.

The Base Case represents the risks associated with the expected blasting programme, whereas the Worst Case has considered a 20% increase in the number of deliveries for the three worksites. It can be seen that for both cases the risks lie in the ALARP region.

Figure 8.1 F-N Curve for Storage and Transport of Explosives (Route Option R1)

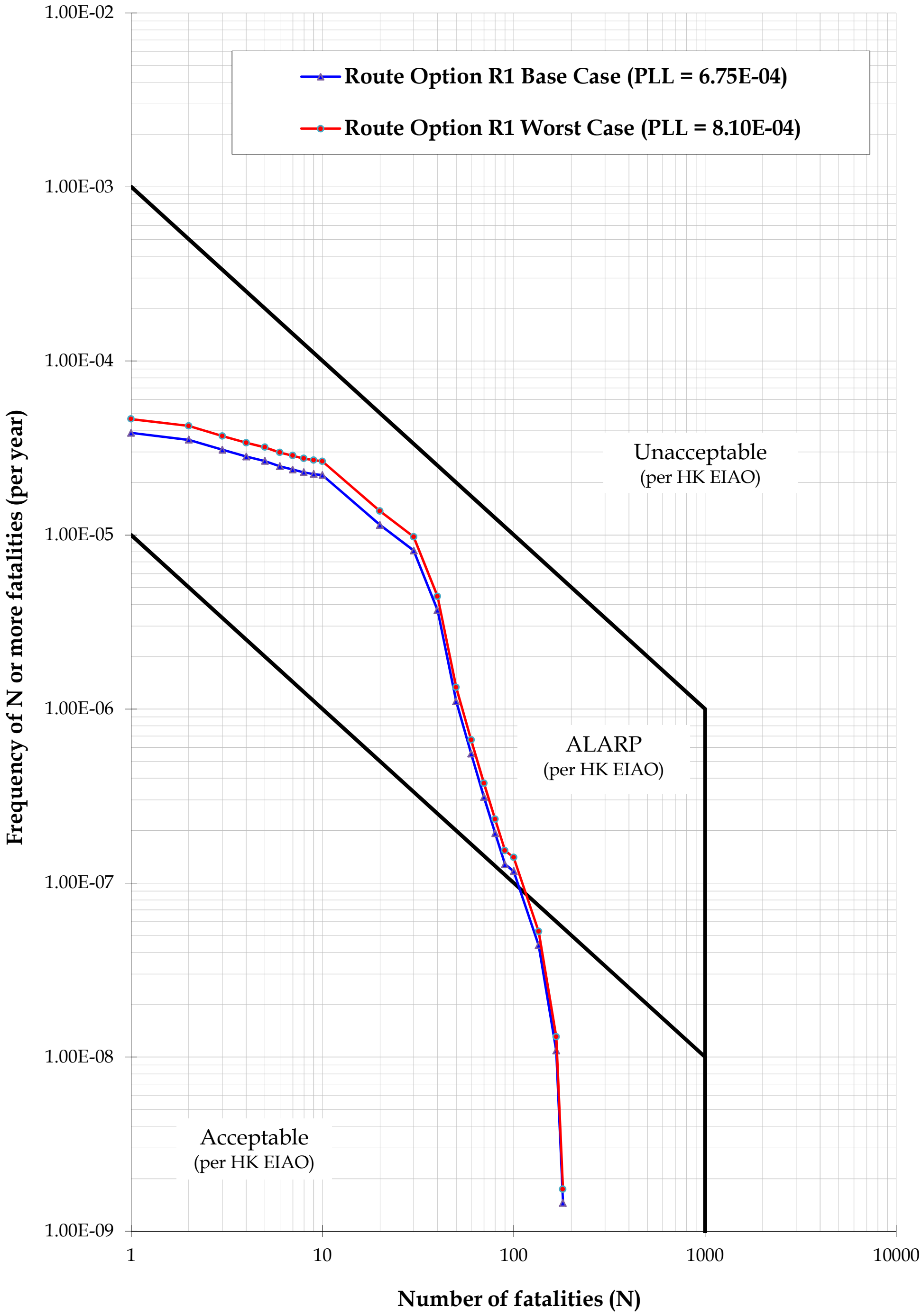


Figure 8.2 F-N Curve for Storage and Transport of Explosives (Route Option R2)

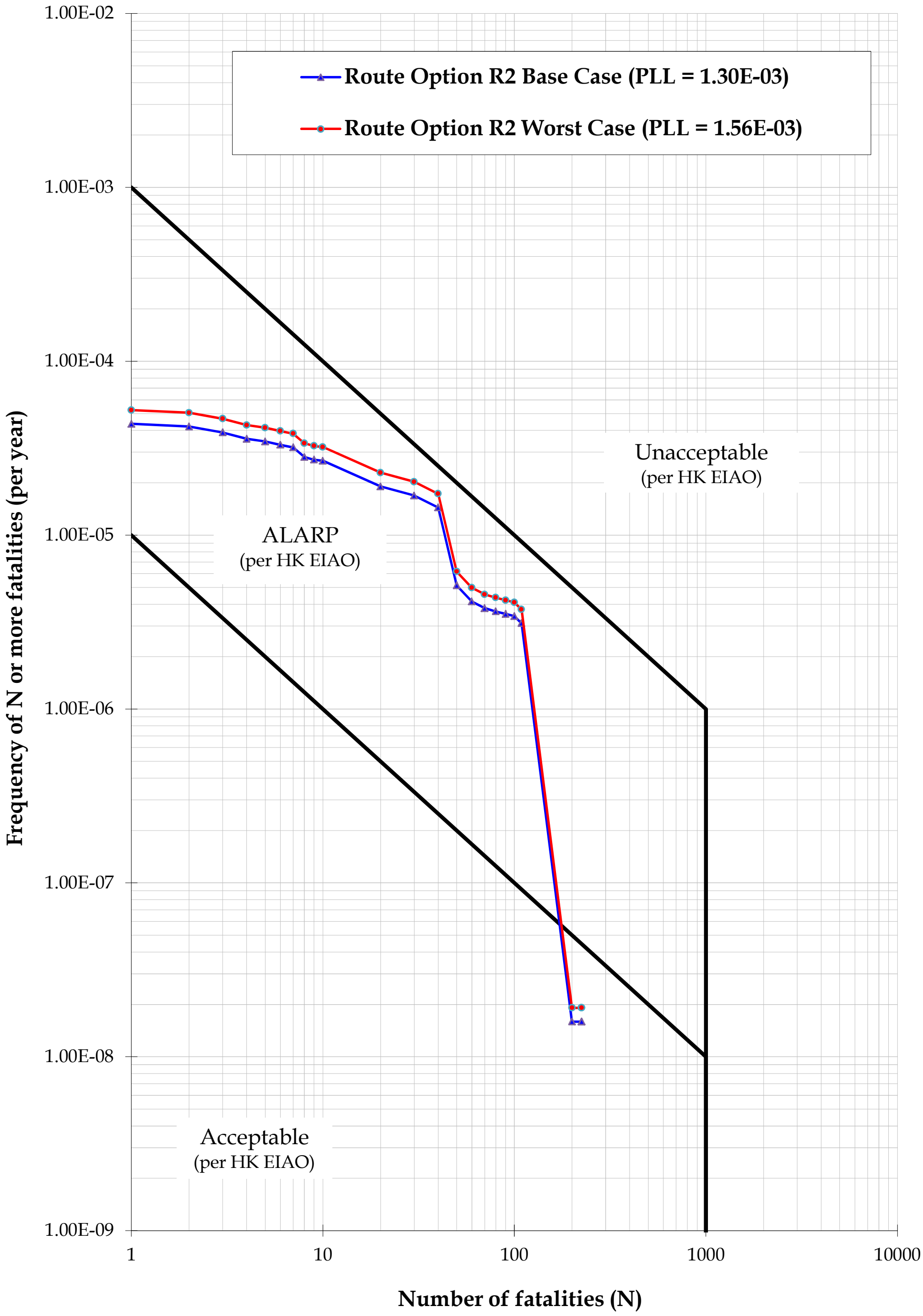


Figure 8.3 F-N Curve for Storage and Transport of Explosives (Route Option R3)

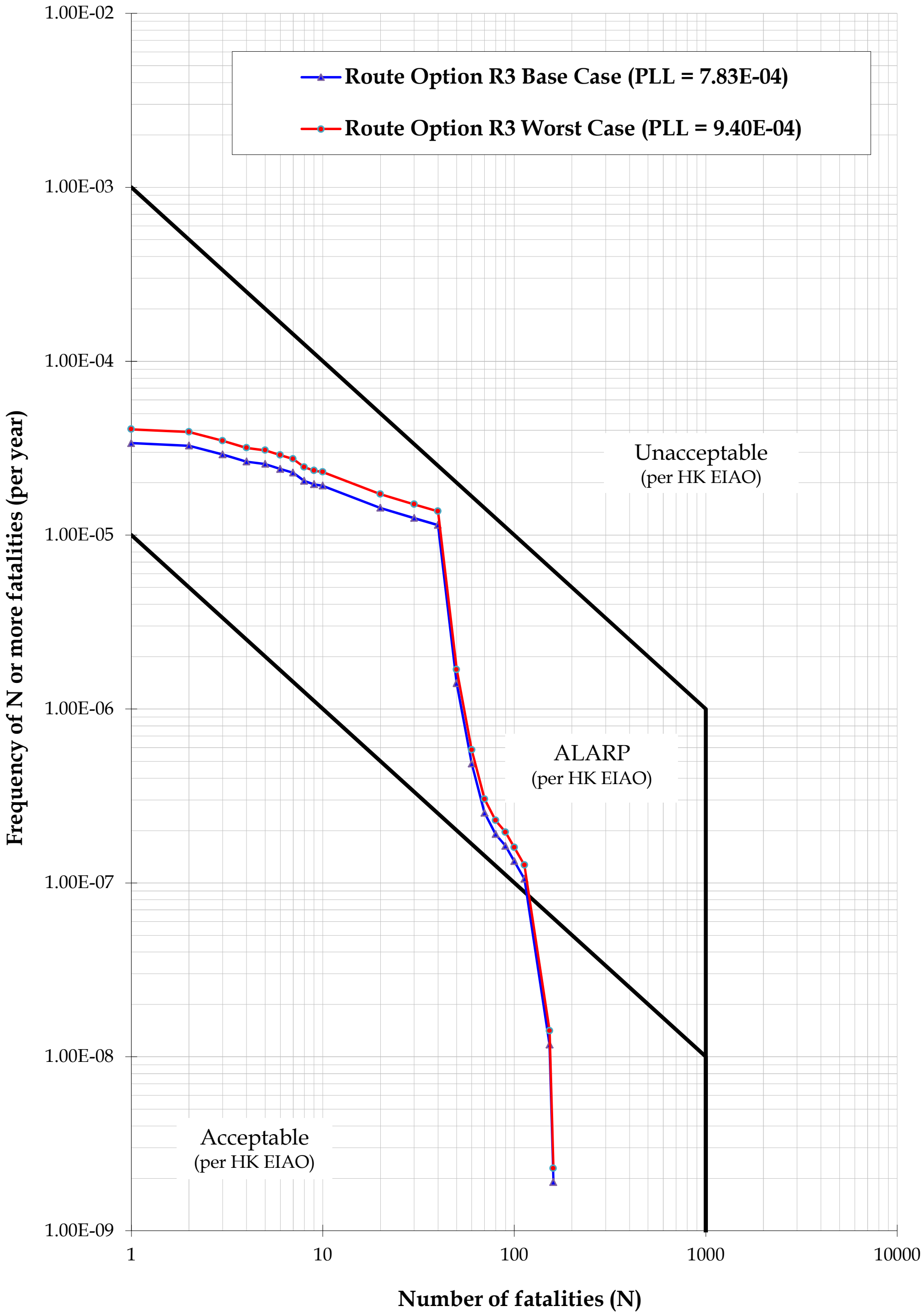


Figure 8.4, Figure 8.5 and *Figure 8.6* show the F-N curves for the Base Case with a breakdown by storage and transport. It can be seen that risks from the Magazine are negligible compared to transport risks. This is consistent with the comments made in relation to the PLL. Population in the vicinity of the Magazine site is very low and hence the societal risks are small.

Figure 8.7, Figure 8.8 and *Figure 8.9* provide a breakdown by population types for the Base Case scenario. As expected, the highest risks are associated with other road users and this dominates the overall F-N curve, high percentages of the PLL is related to population in vehicles. Scenarios involving high numbers of fatalities are also related to fatalities in buildings close to the road. This is particularly noticeable towards the end of the delivery route to Mid-Ventilation Adit and North Portal that passes through non-expressway roads close to residential and commercial buildings with high population densities.

The F-N curves show risks in the ALARP region and therefore mitigation measures need to be considered to reduce the risks. This is assessed in *Section 9*.

It is important to note that conservative measures have been taken into account when calculating the total risk:

- The 200 kg load assumed for each delivery trip in the calculation represents the maximum load – in reality the load is significantly less; and
- The number of delivery trips used in the calculations represents the maximum amount of delivery trips.

Figure 8.4 F-N Curve for the Base Case with Breakdown by Storage and Transport (Route Option R1)

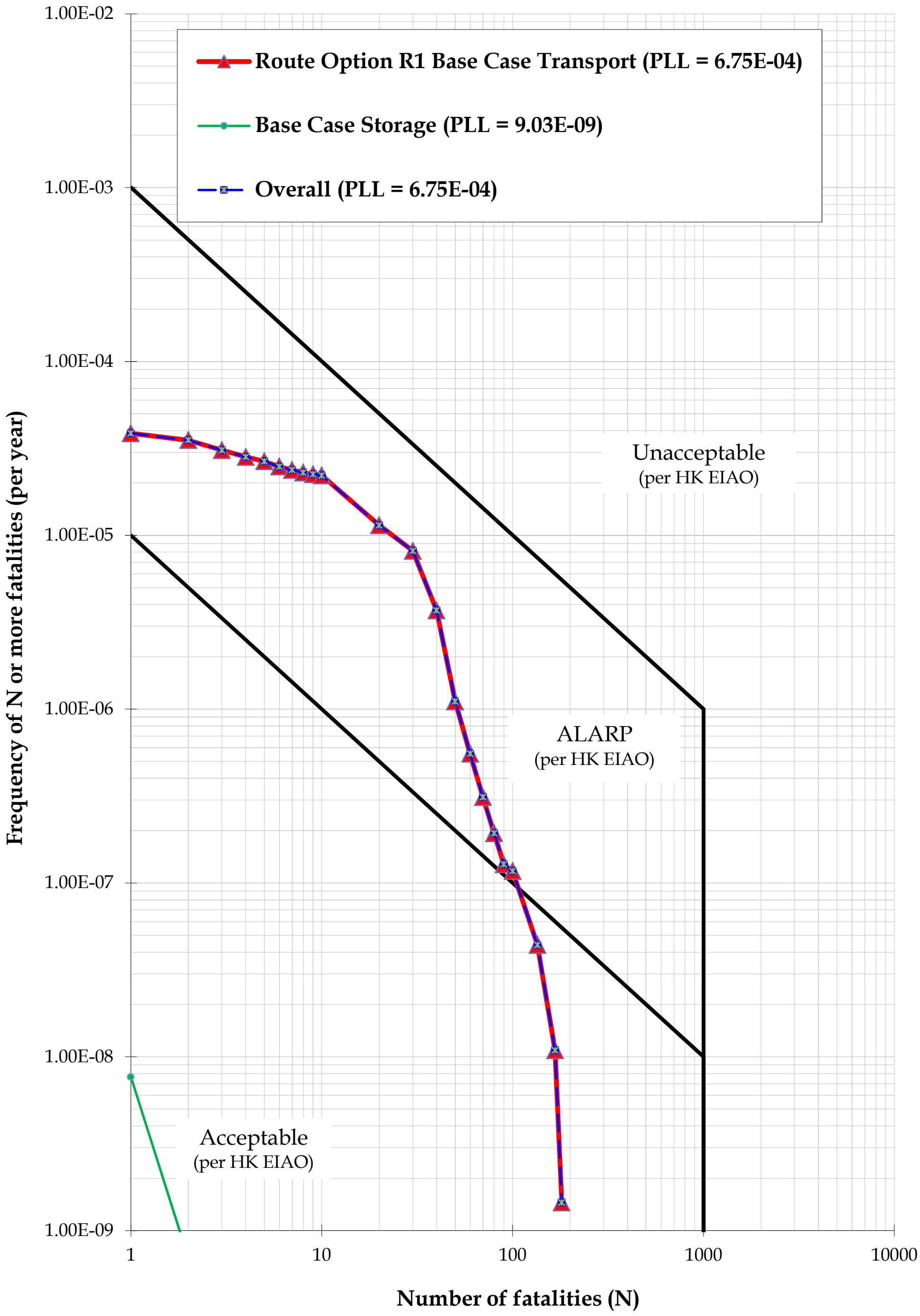


Figure 8.5 *F-N Curve for the Base Case with Breakdown by Storage and Transport (Route Option R2)*

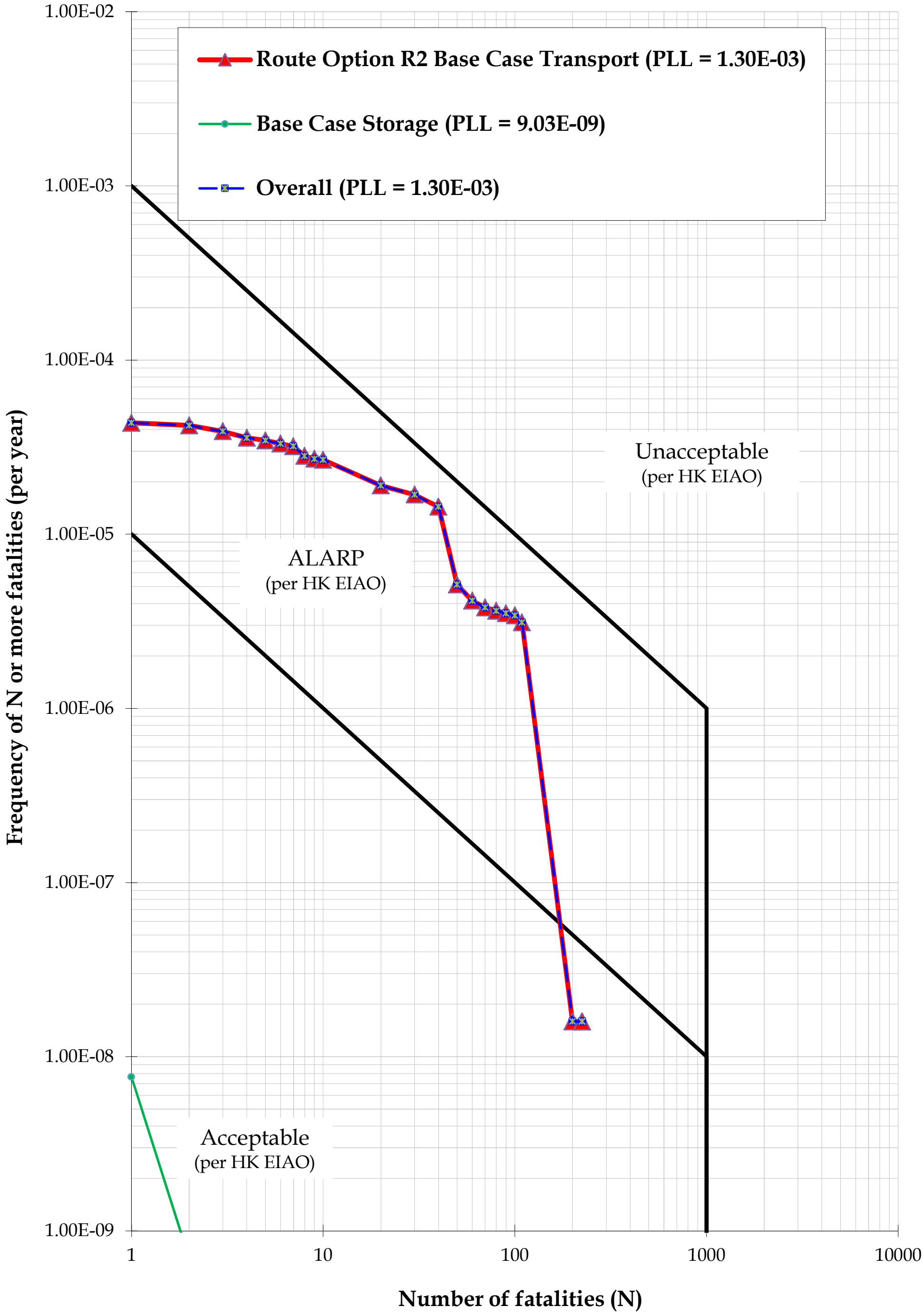


Figure 8.6 *F-N Curve for the Base Case with Breakdown by Storage and Transport (Route Option R3)*

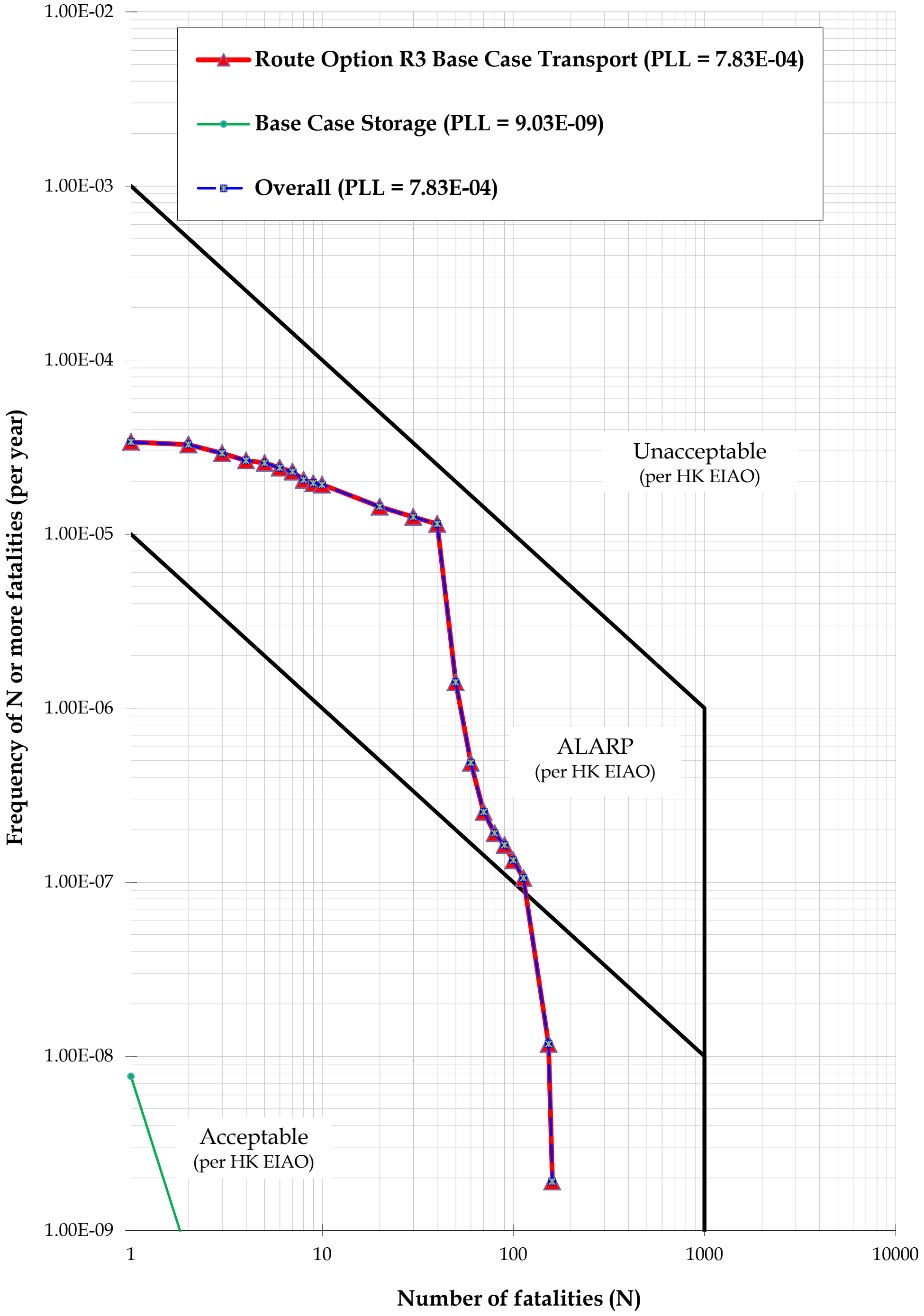
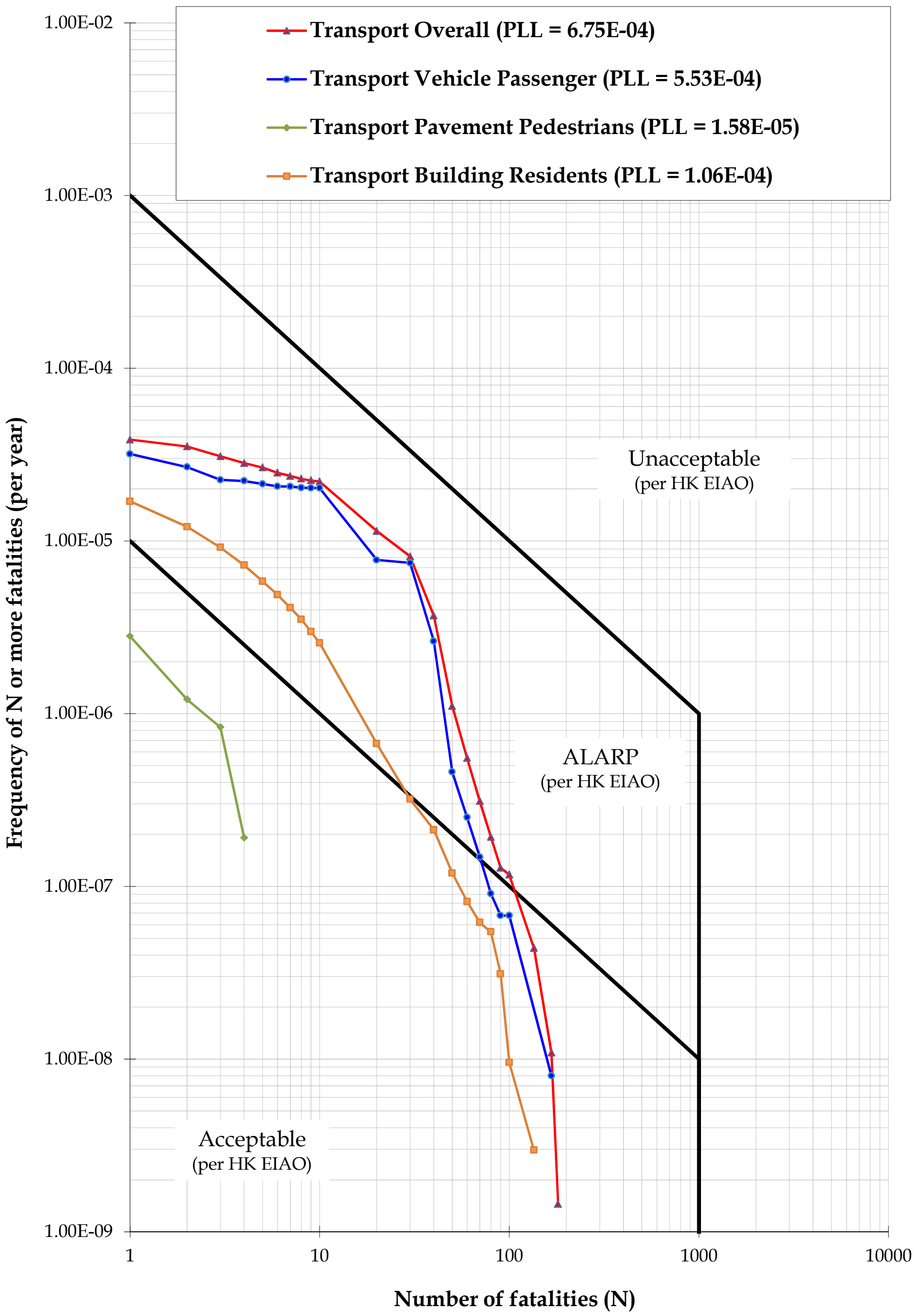
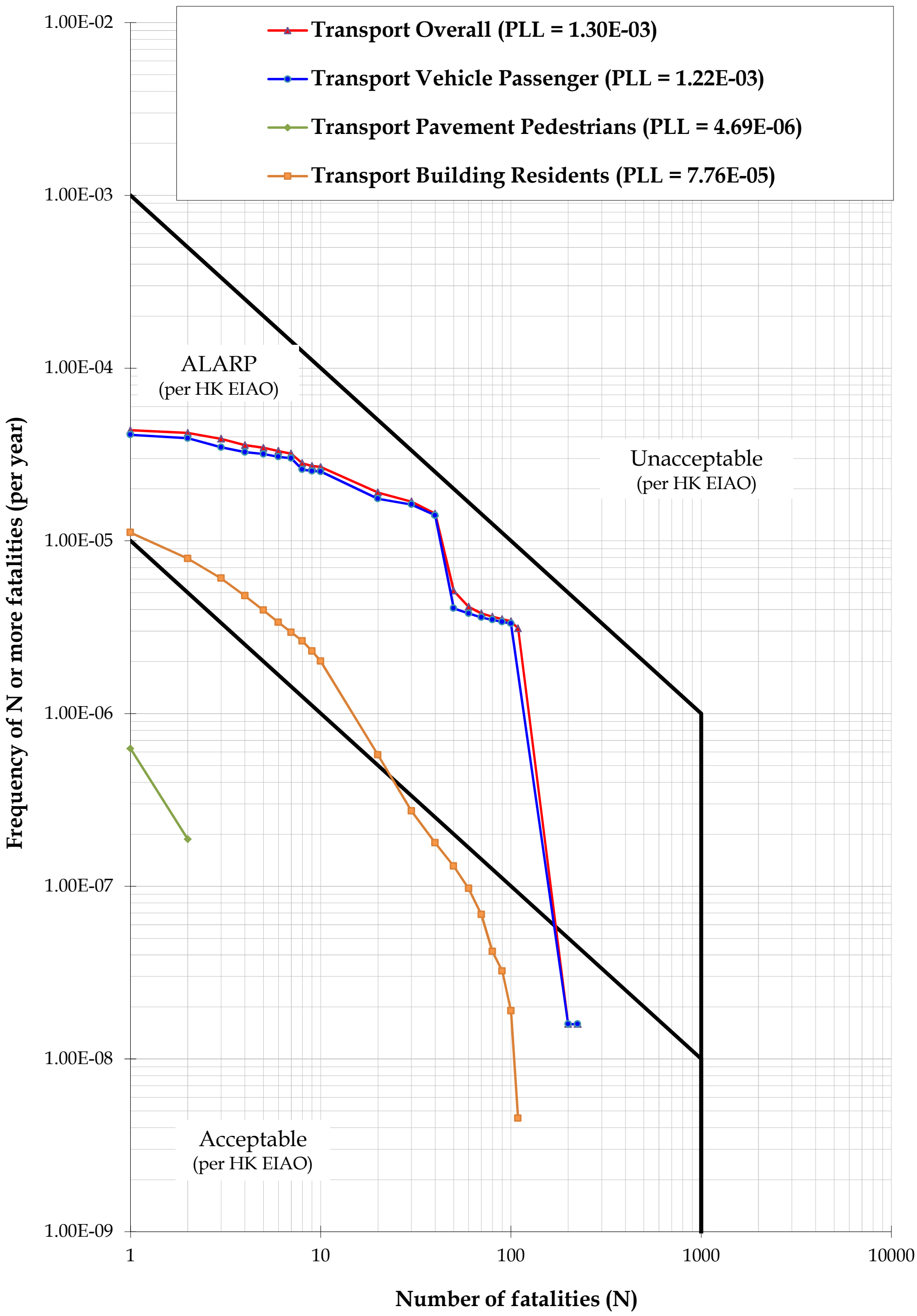


Figure 8.7 F-N Curve for the Base Case with Breakdown by Population Type (Route Option R1)



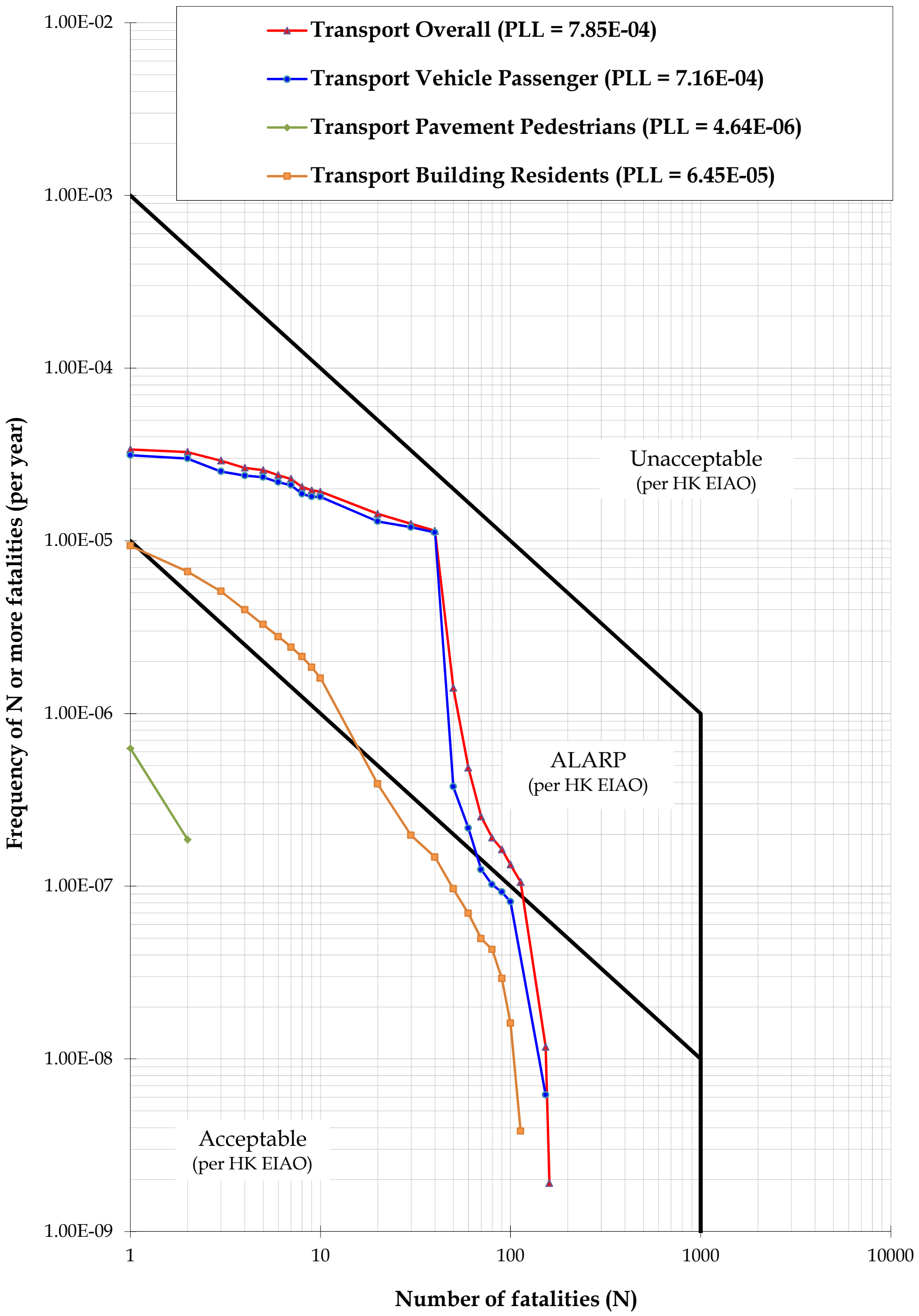
Note: The frequency of N= 1 of more fatalities per year is lower for pavement and building population groups since such population groups are outside the hazard range of the explosion for a large portion of the route. Vehicle passengers above refer to general members of the public on the roads but not the explosives truck crew.

Figure 8.8 F-N Curve for the Base Case with Breakdown by Population Type (Route Option R2)



Note: The frequency of N= 1 of more fatalities per year is lower for pavement and building population groups since such population groups are outside the hazard range of the explosion for a large portion of the route. Vehicle passengers above refer to general members of the public on the roads but not the explosives truck crew.

Figure 8.9 *F-N Curve for the Base Case with Breakdown by Population Type (Route Option R3)*



Note: The frequency of N= 1 of more fatalities per year is lower for pavement and building population groups since such population groups are outside the hazard range of the explosion for a large portion of the route. Vehicle passengers above refer to general members of the public on the roads but not the explosives truck crew.

8.4 INDIVIDUAL RISK

The individual risk (IR) for each section of the transport routes are listed in *Table 8.7*. The same data are shown graphically in *Figure 8.10, Figure 8.11* and *Figure 8.12*. The IR summation takes into account that some road sections are common to several transport routes; the IR is roughly proportional to the frequency of explosives trucks travelling along the road. The IR results presented below represent the maximum individual risk occurring on the road in the same lane as the explosives delivery truck. It can be seen that the maximum IR is about 1.8×10^{-7} per year. This is a low risk when compared to Hong Kong Risk Guidelines which require the offsite IR from a fixed installation to be below 10^{-5} per year. The low values of IR are due to the fact that the risk at any given fixed location along the route is transitory.

Table 8.7 ***Maximum Individual Risk for Each Section of the Transport Routes from Tai Lam Explosives Magazine Site (Base Case)***

Section ID	Description	Maximum IR (per year)
Route R1a (Route Option R1: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)		
Road R1a1	Access road towards Tai Shu Ha Rd West	8.98E-08
Road R1a2	Tai Shu Ha Road West 1	8.78E-08
Road R1a3	Tai Shu Ha Road West 2	1.08E-07
Road R1a4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.13E-07
Road R1a5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	8.63E-08
Road R1a6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	7.30E-08
Road R1a7	Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)	7.90E-08
Road R1a8	Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)	7.82E-08
Road R1a9	Kam Tin Bypass	7.82E-08
Road R1a10	Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)	8.04E-08
Road R1a11	Fan Kam Rd (Kam Tin Rd - Castle Peak Rd)	7.53E-08
Road R1a12	Po Kin Rd (Fan Kam Rd - Pak Wo Rd)	4.87E-08
Road R1a13	Pak Wo Rd (Po Kin Rd - Slip rd to So Kwun Po Int)	4.05E-08
Road R1a14	Pak Wo Rd (Slip rd to So Kwun Po Int - Yu Tai Rd)	3.73E-08
Road R1a15	Pak Wo Rd (Yu Tai Rd - Pak Wo Rd RA)	3.84E-08
Road R1a16	Pak Wo Rd (Pak Wo Rd RA - Wah Ming Rd)	3.81E-08
Road R1a17	Pak Wo Rd (Wah Ming Rd - Wai Ming St)	3.80E-08
Road R1a18	Pak Wo Rd (Wai Ming St - Yat Ming Rd)	3.80E-08
Road R1a19	Pak Wo Rd (Yat Ming Rd - Wo Hop Shek Int)	6.90E-08
Road R1a20	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)	1.09E-07
Road R1a21	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 2	7.15E-08
Road R1a22	Jockey Club Rd (Lok Yip Rd - Sha Tau Kok Rd)	3.94E-08
Road R1a23	Sha Tau Kok Rd (Lung Yeuk Tau) (Jockey Club Rd - Lok Yip Rd)	3.78E-08
Road R1a24	Sha Tau Kok Rd (Lung Yeuk Tau) (Lok Yip Rd - Luen Shing St)	3.77E-08
Road R1a25	Sha Tau Kok Rd (Lung Yeuk Tau) (Luen Shing St - On Kui St)	3.74E-08
Road R1a26	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)	3.90E-08
Road R1a27	Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)	3.84E-08
Road R1a28	Po Kat Tsai Road (Lau Shui Heung Rd - Site)	1.97E-08

Section ID	Description	Maximum IR (per year)
Route R1b (Route Option R1: Tai Lam Explosives Magazine Site – North Portal)		
Road R1b1	Access road towards Tai Shu Ha Rd West	8.98E-08
Road R1b2	Tai Shu Ha Road West 1	8.78E-08
Road R1b3	Tai Shu Ha Road West 2	1.08E-07
Road R1b4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.13E-07
Road R1b5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	8.63E-08
Road R1b6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	7.30E-08
Road R1b7	Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)	7.90E-08
Road R1b8	Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)	7.82E-08
Road R1b9	Kam Tin Bypass	7.82E-08
Road R1b10	Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)	8.04E-08
Road R1b11	Fan Kam Rd (Kam Tin Rd - Castle Peak Rd)	7.53E-08
Road R1b12	Po Kin Rd (Fan Kam Rd - Pak Wo Rd)	4.87E-08
Road R1b13	Pak Wo Rd (Po Kin Rd - Slip rd to So Kwun Po Int)	4.05E-08
Road R1b14	Pak Wo Rd (Slip rd to So Kwun Po Int - Yu Tai Rd)	3.73E-08
Road R1b15	Pak Wo Rd (Yu Tai Rd - Pak Wo Rd RA)	3.84E-08
Road R1b16	Pak Wo Rd (Pak Wo Rd RA - Wah Ming Rd)	3.81E-08
Road R1b17	Pak Wo Rd (Wah Ming Rd - Wai Ming St)	3.80E-08
Road R1b18	Pak Wo Rd (Wai Ming St - Yat Ming Rd)	3.80E-08
Road R1b19	Pak Wo Rd (Yat Ming Rd - Wo Hop Shek Int)	6.90E-08
Road R1b20	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)	1.09E-07
Road R1b21	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd) 2	7.15E-08
Road R1b22	Jockey Club Rd (Lok Yip Rd - Sha Tau Kok Rd)	3.94E-08
Road R1b23	Sha Tau Kok Rd (Lung Yeuk Tau) (Jockey Club Rd - Lok Yip Rd)	3.78E-08
Road R1b24	Sha Tau Kok Rd (Lung Yeuk Tau) (Lok Yip Rd - Luen Shing St)	3.77E-08
Road R1b25	Sha Tau Kok Rd (Lung Yeuk Tau) (Luen Shing St - On Kui St)	3.74E-08
Road R1b26	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1	3.90E-08
Road R1b27	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2	3.63E-08
Route R1c (Route Option R1: Tai Lam Explosives Magazine Site – South Portal)		
Road R1c1	Access road towards Tai Shu Ha Rd West	8.98E-08
Road R1c2	Tai Shu Ha Road West 1	8.78E-08
Road R1c3	Tai Shu Ha Road West 2	1.08E-07
Road R1c4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.13E-07
Road R1c5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	8.63E-08
Road R1c6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	7.30E-08
Road R1c7	Castle Peak Road (Yuen Long) (Pok Oi Int - Kam Tin Rd)	7.90E-08
Road R1c8	Kam Tin Rd (Castle Peak Rd (Yuen Long) - Kam Sheung Rd western junction)	7.82E-08
Road R1c9	Kam Tin Bypass	7.82E-08
Road R1c10	Kam Tin Rd (Kam Sheung Rd western junction - Fan Kam Rd)	8.04E-08
Road R1c11	Kam Tin Rd (Fan Kam Rd - Kam Sheung Rd eastern junction)	7.48E-08
Road R1c12	Lam Kam Rd (Kam Sheung Rd - Lam Kam Rd Int)	4.09E-08
Road R1c13	Lam Kam Rd (Lam Kam Rd Int - Tai Wo Service Rd W)	4.04E-08
Road R1c14	Tai Wo Service Rd W (Lam Kam Rd Int - Kau Lung Hang	4.14E-08

Section ID	Description	Maximum IR (per year)
	FO)	
Road R1c15	Tai Wo Service Rd W (Kau Lung Hang FO - Wo Hing Rd)	4.42E-08
Road R1c16	Unnamed road (Wo Hing Rd - Pak Wo Rd)	7.59E-08
Road R1c17	Jockey Club Rd (Wo Hop Shek Int - Lok Yip Rd)	1.09E-07
Road R1c18	Slip Rd (Jockey Club Rd - Fanling Highway)	7.60E-08
Road R1c19	Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)	1.09E-07
Road R1c20	Tai Wo Service Rd East (Slip rd from Fanling Highway - Road to Site 1)	4.84E-08
Road R1c21	Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)	4.98E-08
Road R1c22	Road to Site 2 (Road to Site 1 - Site)	4.31E-08
Route R2a (Route Option R2: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)		
Road R2a1	Access road towards Tai Shu Ha Rd West	9.09E-08
Road R2a2	Tai Shu Ha Road West 1	8.80E-08
Road R2a3	Tai Shu Ha Road West 2	1.83E-07
Road R2a4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.12E-07
Road R2a5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	8.74E-08
Road R2a6	Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)	1.40E-07
Road R2a7	Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)	1.58E-07
Road R2a8	Connecting road from Tong Yan San Tsuen Int to Long Tin Road	1.25E-07
Road R2a9	Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))	1.30E-07
Road R2a10	Connecting road from Long Tin Road North Bound to South Bound	8.06E-08
Road R2a11	Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)	1.25E-07
Road R2a12	Connecting road from Long Tin Rd to Tong Yan San Tsuen Int	1.16E-07
Road R2a13	Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)	1.63E-07
Road R2a14	Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)	1.50E-07
Road R2a15	Yuen Long Highway (to San Tin Highway 1)	7.10E-08
Road R2a16	Yuen Long Highway (to San Tin Highway 2)	7.02E-08
Road R2a17	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	7.12E-08
Road R2a18	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	7.06E-08
Road R2a19	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	7.52E-08
Road R2a20	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	7.42E-08
Road R2a21	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	7.45E-08
Road R2a22	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	3.84E-08
Road R2a23	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	3.80E-08
Road R2a24	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	3.83E-08
Road R2a25	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	3.81E-08
Road R2a26	Ma Sik Rd (Luen Chit St - Wo Tai St)	3.73E-08
Road R2a27	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	4.11E-08
Road R2a28	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)	3.90E-08
Road R2a29	Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)	3.82E-08
Road R2a30	Po Kat Tsai Road (Lau Shui Heung Rd - Site)	2.00E-08
Route R2b (Route Option R2: Tai Lam Explosives Magazine Site – North Portal)		
Road R2b1	Access road towards Tai Shu Ha Rd West	9.09E-08

Section ID	Description	Maximum IR (per year)
Road R2b2	Tai Shu Ha Road West 1	8.80E-08
Road R2b3	Tai Shu Ha Road West 2	1.83E-07
Road R2b4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.12E-07
Road R2b5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	8.74E-08
Road R2b6	Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)	1.40E-07
Road R2b7	Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)	1.58E-07
Road R2b8	Connecting road from Tong Yan San Tsuen Int to Long Tin Road	1.25E-07
Road R2b9	Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))	1.30E-07
Road R2b10	Connecting road from Long Tin Road North Bound to South Bound	8.06E-08
Road R2b11	Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)	1.25E-07
Road R2b12	Connecting road from Long Tin Rd to Tong Yan San Tsuen Int	1.16E-07
Road R2b13	Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)	1.63E-07
Road R2b14	Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)	1.50E-07
Road R2b15	Yuen Long Highway (to San Tin Highway 1)	7.10E-08
Road R2b16	Yuen Long Highway (to San Tin Highway 2)	7.02E-08
Road R2b17	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	7.12E-08
Road R2b18	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	7.06E-08
Road R2b19	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	7.52E-08
Road R2b20	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	7.42E-08
Road R2b21	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	7.45E-08
Road R2b22	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	3.84E-08
Road R2b23	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	3.80E-08
Road R2b24	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	3.83E-08
Road R2b25	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	3.81E-08
Road R2b26	Ma Sik Rd (Luen Chit St - Wo Tai St)	3.73E-08
Road R2b27	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	4.11E-08
Road R2b28	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1	3.90E-08
Road R2b29	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2	3.59E-08
Route R2c (Route Option R2: Tai Lam Explosives Magazine Site – South Portal)		
Road R2c1	Access road towards Tai Shu Ha Rd West	9.09E-08
Road R2c2	Tai Shu Ha Road West 1	8.80E-08
Road R2c3	Tai Shu Ha Road West 2	1.83E-07
Road R2c4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.12E-07
Road R2c5	Shap Pat Heung Road (Tai Shu Ha Road West 2 - Shap Pat Heung Interchange)	8.74E-08
Road R2c6	Shap Pat Heung Interchange (Shap Pat Heung Road - Yuen Long Highway)	1.40E-07
Road R2c7	Yuen Long Highway (Shap Pat Heung Int - Tong Yan San Tsuen Int)	1.58E-07
Road R2c8	Connecting road from Tong Yan San Tsuen Int to Long Tin Road	1.25E-07
Road R2c9	Long Tin Road (Tong Yan San Tsuen Int - Castle Peak Rd (Ping Shan))	1.30E-07
Road R2c10	Connecting road from Long Tin Road North Bound to South Bound	8.06E-08
Road R2c11	Long Tin Road (Castle Peak Rd (Ping Shan) - Tong Yan San Tsuen Int)	1.25E-07

Section ID	Description	Maximum IR (per year)
Road R2c12	Connecting road from Long Tin Rd to Tong Yan San Tsuen Int	1.16E-07
Road R2c13	Yuen Long Highway (Tong Yan San Tsuen Int - Shap Pat Heung Int)	1.63E-07
Road R2c14	Yuen Long Highway (Shap pat Heung Int - Nr Tsing Long Highway)	1.50E-07
Road R2c15	Yuen Long Highway (to San Tin Highway 1)	7.10E-08
Road R2c16	Yuen Long Highway (to San Tin Highway 2)	7.02E-08
Road R2c17	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	7.12E-08
Road R2c18	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	7.06E-08
Road R2c19	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	7.52E-08
Road R2c20	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	7.42E-08
Road R2c21	Fanling Highway (So Kwun Po Int - Wo Hop Shek Int)	7.30E-08
Road R2c22	Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)	4.04E-08
Road R2c23	Tai Wo Service Rd East (Slip rd from Fanling Highway - Kau Lung Hang FO)	4.43E-08
Road R2c24	Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)	4.69E-08
Road R2c25	Road to Site 2 (Road to Site 1 - Site)	4.32E-08
Route R3a (Route Option R3: Tai Lam Explosives Magazine Site – Mid-Ventilation Adit)		
Road R3a1	Access road towards Tai Shu Ha Rd West	8.62E-08
Road R3a2	Tai Shu Ha Road West 1	8.83E-08
Road R3a3	Tai Shu Ha Road West 2	1.10E-07
Road R3a4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.14E-07
Road R3a5	Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)	8.72E-08
Road R3a6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	7.14E-08
Road R3a7	Yuen Long Highway	6.99E-08
Road R3a8	Yuen Long Highway (to San Tin Highway 1)	6.99E-08
Road R3a9	Yuen Long Highway (to San Tin Highway 2)	7.05E-08
Road R3a10	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	6.88E-08
Road R3a11	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	7.02E-08
Road R3a12	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	7.00E-08
Road R3a13	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	7.04E-08
Road R3a14	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	6.95E-08
Road R3a15	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	3.78E-08
Road R3a16	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	3.73E-08
Road R3a17	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	3.79E-08
Road R3a18	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	3.78E-08
Road R3a19	Ma Sik Rd (Luen Chit St - Wo Tai St)	3.69E-08
Road R3a20	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	4.07E-08
Road R3a21	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Lau Shui Heung Rd)	4.13E-08
Road R3a22	Lau Shui Heung Rd (Sha Tau Kok Rd - Po Kat Tsai Rd)	3.63E-08
Road R3a23	Po Kat Tsai Road (Lau Shui Heung Rd - Site)	2.02E-08
Route R3b (Route Option R3: Tai Lam Explosives Magazine Site – North Portal)		
Road R3b1	Access road towards Tai Shu Ha Rd West	8.62E-08
Road R3b2	Tai Shu Ha Road West 1	8.83E-08
Road R3b3	Tai Shu Ha Road West 2	1.10E-07
Road R3b4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.14E-07
Road R3b5	Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung	8.72E-08

Section ID	Description	Maximum IR (per year)
	Interchange)	
Road R3b6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	7.14E-08
Road R3b7	Yuen Long Highway	6.99E-08
Road R3b8	Yuen Long Highway (to San Tin Highway 1)	6.99E-08
Road R3b9	Yuen Long Highway (to San Tin Highway 2)	7.05E-08
Road R3b10	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	6.88E-08
Road R3b11	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	7.02E-08
Road R3b12	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	7.00E-08
Road R3b13	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	7.04E-08
Road R3b14	So Kwun Po Rd (Fanling Highway - So Kwun Po Rd Int)	6.95E-08
Road R3b15	So Kwun Po Rd (So Kwun Po Rd Int - Jockey Club Rd)	3.78E-08
Road R3b16	Ma Sik Rd (Jockey Club Rd - Tin Ping Rd)	3.73E-08
Road R3b17	Ma Sik Rd (Tin Ping Rd - Fan Leng Lau Rd)	3.79E-08
Road R3b18	Ma Sik Rd (Fan Leng Lau Rd - Luen Chit St)	3.78E-08
Road R3b19	Ma Sik Rd (Luen Chit St - Wo Tai St)	3.69E-08
Road R3b20	Ma Sik Rd (Wo Tai St - Sha Tau Kok Rd (Lung Yeuk Tau))	4.07E-08
Road R3b21	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 1	4.13E-08
Road R3b22	Sha Tau Kok Rd (Lung Yeuk Tau) (Ma Sik Rd - Site) 2	3.64E-08
Route R3c (Route Option R3: Tai Lam Explosives Magazine Site – South Portal)		
Road R3c1	Access road towards Tai Shu Ha Rd West	8.62E-08
Road R3c2	Tai Shu Ha Road West 1	8.83E-08
Road R3c3	Tai Shu Ha Road West 2	1.10E-07
Road R3c4	Tai Kei Leng Road (Tai Shu Ha Road West 2 - Shap Pat Heung Rd)	1.14E-07
Road R3c5	Shap Pat Heung Road (Tai Tong Rd - Shap Pat Heung Interchange)	8.72E-08
Road R3c6	Yuen Long Highway (Shap Pat Heung Int - Pok Oi Int)	7.14E-08
Road R3c7	Yuen Long Highway	6.99E-08
Road R3c8	Yuen Long Highway (to San Tin Highway 1)	6.99E-08
Road R3c9	Yuen Long Highway (to San Tin Highway 2)	7.05E-08
Road R3c10	San Tin Highway (Tsing Long Highway - Fairview Park Boulevard)	6.88E-08
Road R3c11	San Tin Highway (Fairview Park Boulevard - Lok Ma Chau Rd)	7.02E-08
Road R3c12	Fanling Highway (Lok Ma Chau Rd - Fan Kam Rd)	7.00E-08
Road R3c13	Fanling Highway (Slip rds to & from Fan Kam Rd Int - Slip rds to & from So Kwun Po Int)	7.04E-08
Road R3c14	Fanling Highway (So Kwun Po Int - Wo Hop Shek Int)	6.78E-08
Road R3c15	Fanling Highway (Wo Hop Shek Int - Kau Lung Hang Lo Wai)	3.71E-08
Road R3c16	Tai Wo Service Rd East (Slip rd from Fanling Highway - Kau Lung Hang FO)	4.74E-08
Road R3c17	Road to Site 1 (Tai Wo Service Rd East - Road to Site 2)	4.98E-08
Road R3c18	Road to Site 2 (Road to Site 1 - Site)	4.39E-08

Figure 8.10 Maximum IR for the Delivery Routes from Tai Lam Explosives Magazine Site (Base Case Route Option R1)

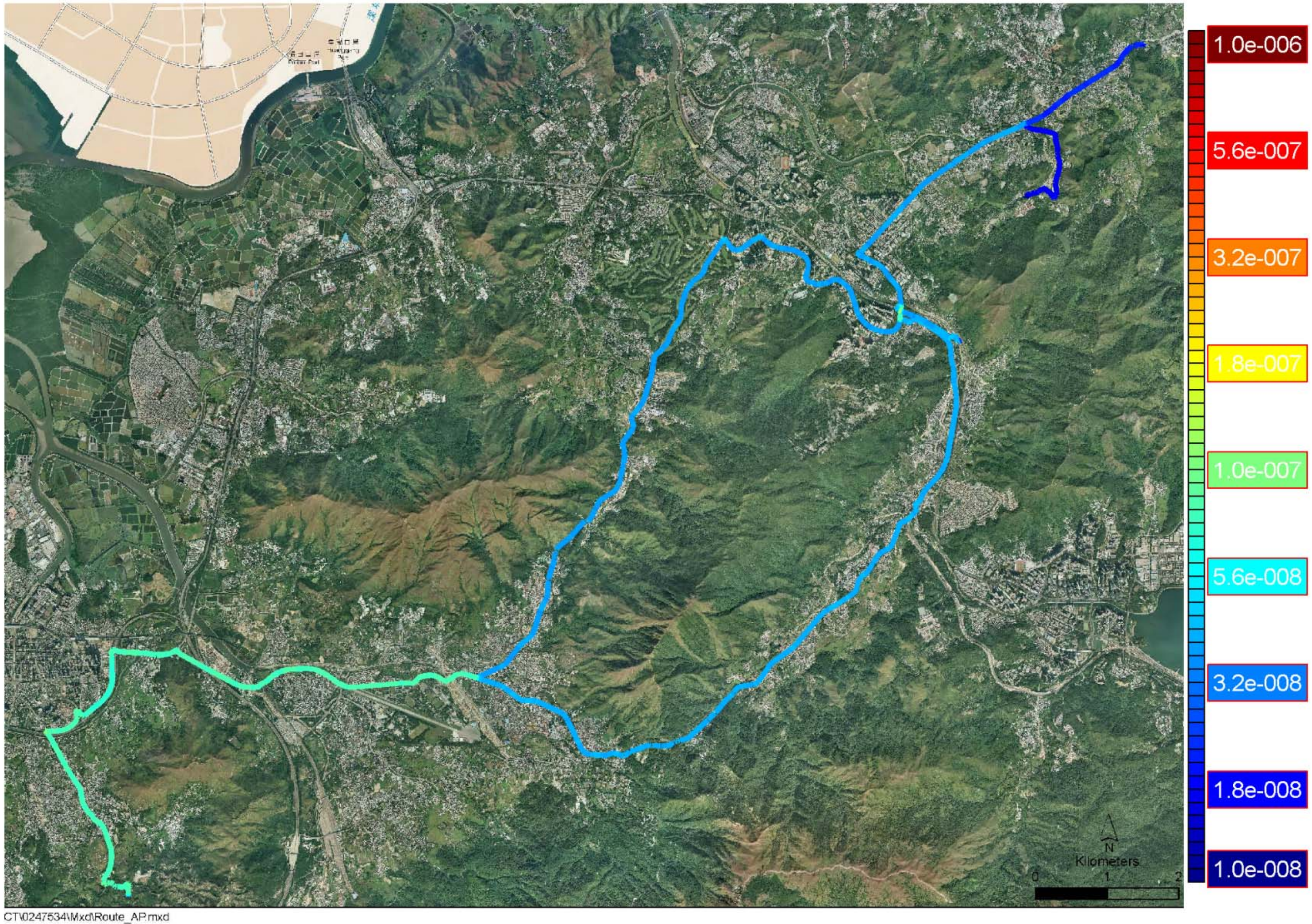
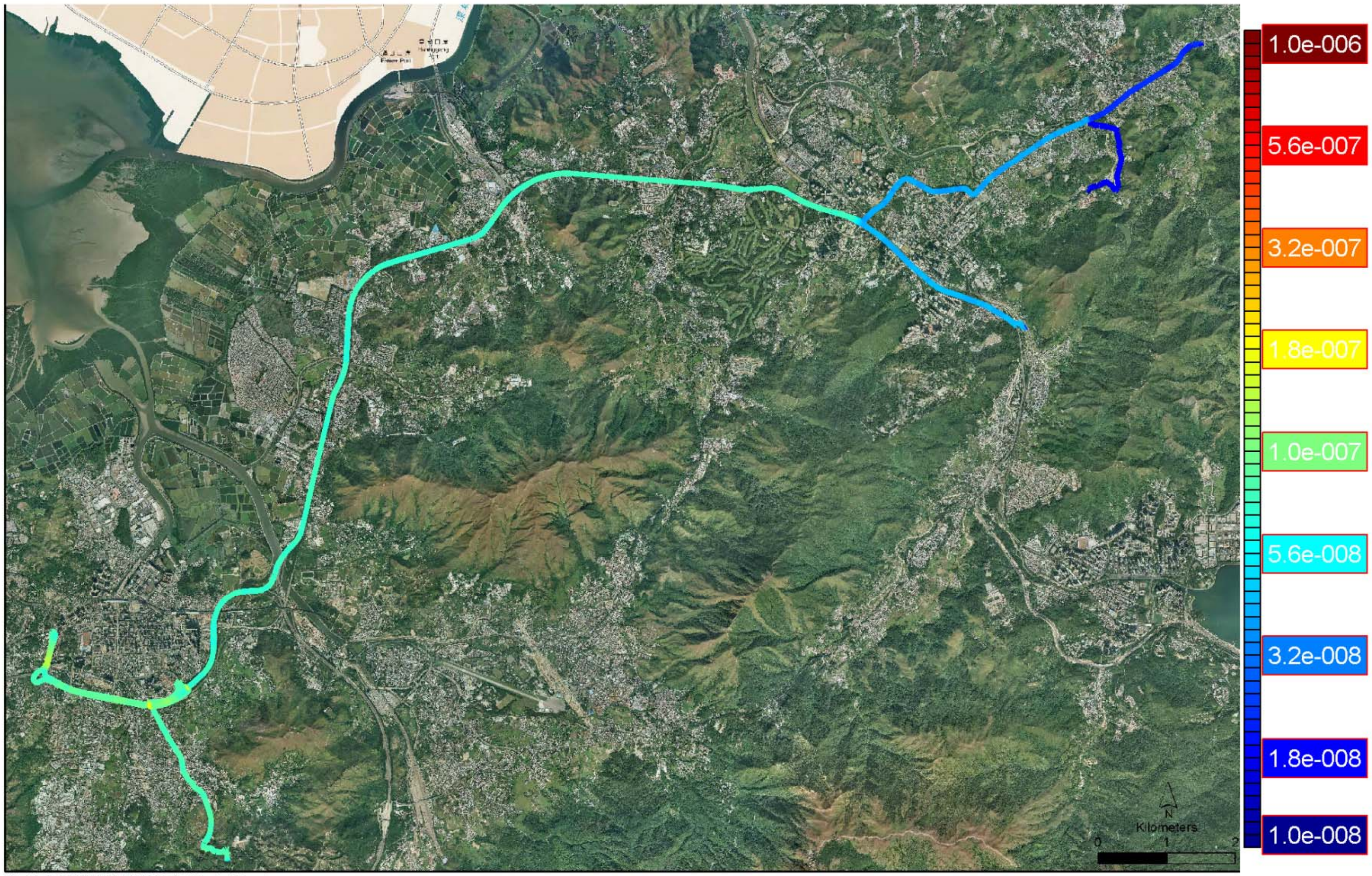
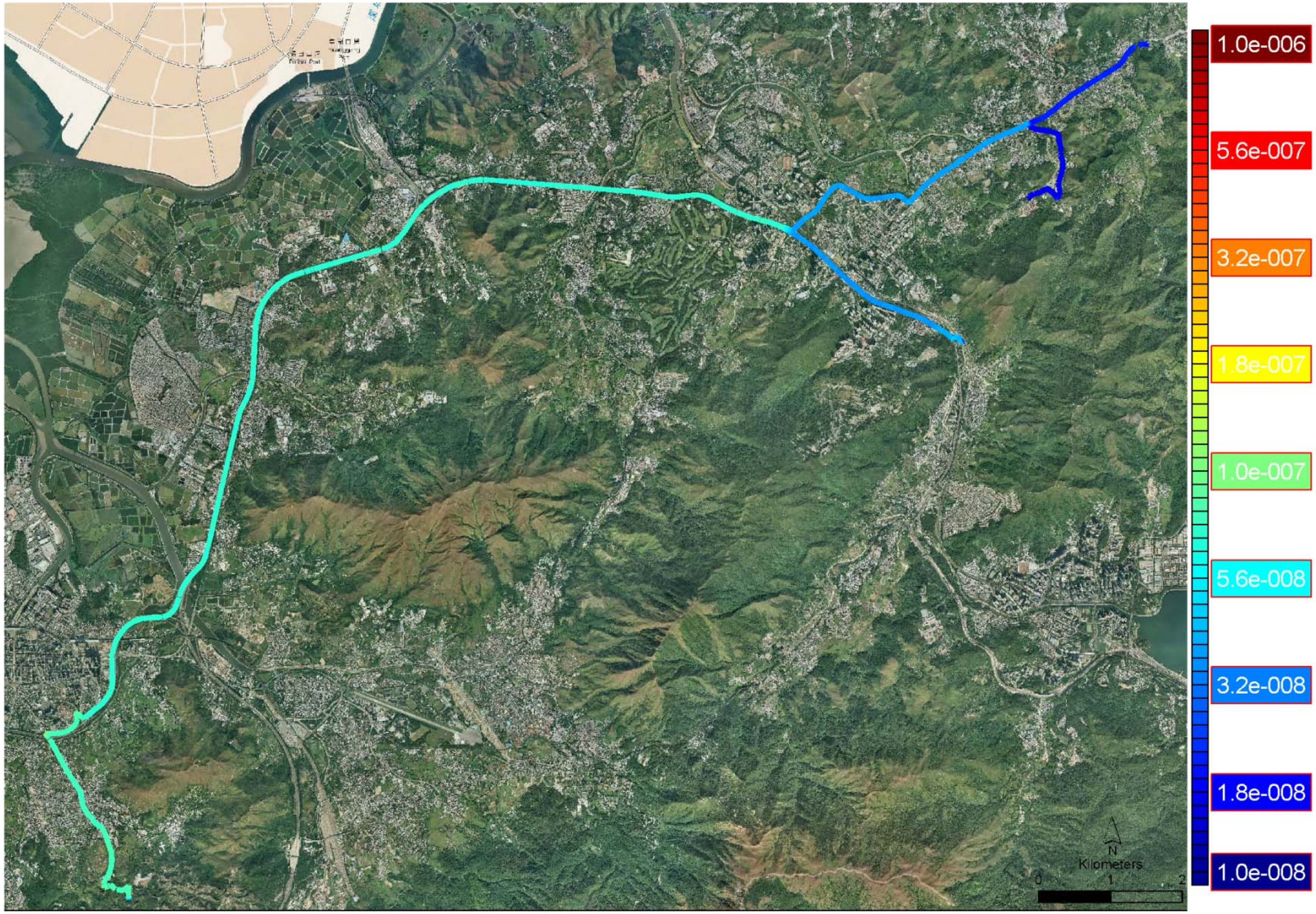


Figure 8.11 Maximum IR for the Delivery Routes from Tai Lam Explosives Magazine Site (Base Case Route Option R2)



File: T:\GIS\CONTRACT\0247534\Mxd\Route_AP.mxd

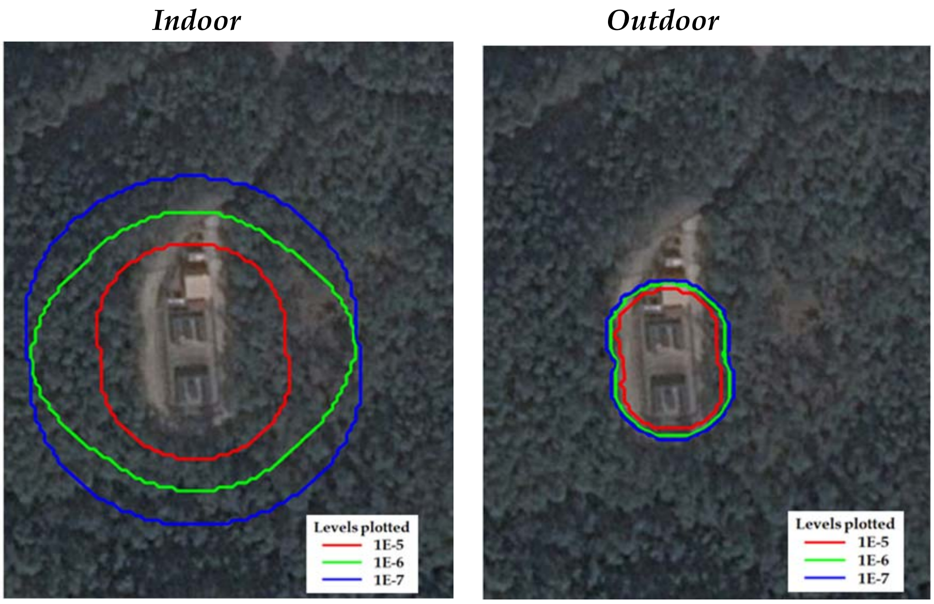
Figure 8.12 Maximum IR for the Delivery Routes from Tai Lam Explosives Magazine Site (Base Case Route Option R3)



CT\0247534\Mxd\Route_AP.mxd

For the storage magazine, individual risk contours have been plotted and overlaid on plot layouts for Tai Lam Explosives Magazine site (*Figure 8.13*). IR contours (assuming a risk exposure factor of 100%) have been presented for both outdoor and indoor populations, with the 10^{-5} per year contour extending offsite in both cases. Persons indoors experience higher risks due to breaking windows and risk of building collapse. However, there are no buildings or structures nearby that lie within these contours and hence the outdoor contours are more appropriate. The maximum IR is about 1×10^{-4} per year considering the base frequency used in the analysis for explosion. This however, neglects to take into account presence factors. The Magazine site is in a remote area and the 10^{-5} per year contours impact only on woodland areas where there is no continuous presence of people. The presence of people in these areas will be rare and only temporary leading to a very small presence factor. The most exposed population group will be people potentially present adjacent to the Magazine site fence. Such persons are not expected to be present more than 1% of the time. Therefore, no member of the public will be exposed to an IR of 10^{-5} per year. The actual risk to any individual will be much less than 10^{-5} per year and is deemed to be acceptable.

Figure 8.13 ***IR of the Tai Lam Explosives Magazine Site***



8.5 UNCERTAINTY ANALYSIS AND SENSITIVITY TESTS

The study is based on a number of assumptions as previously highlighted in various sections of this report.

A discussion on the uncertainties and sensitivity of the results is given below.

Explosion Consequence Model

The employed ESTC model, or any other established TNT explosion model, tends to overpredict the number of fatalities (or, probability of fatality for an individual) when compared to the actual fatalities in past incidents related to explosives. It can be seen that no recorded incident involving road transport had resulted in more than 12 fatalities even in urban locations, while from the assessment, the maximum fatalities due to road transport is estimated as about 100 - 300. There is some conservatism in the model although it is acknowledged that given the dense urban environment in Hong Kong, the fatalities estimated during transport of explosives may not be too conservative.

On the other hand, a number of recent research studies performed by the HSE in the UK, indicates that the ESTC models may underpredict the fatalities caused by flying glass in highly built-up areas. Despite this recent research, the ESTC models are still recommended as the best currently available.

Intervention of the Explosive Truck Crew

In certain circumstances it may be possible for the crew to control a fire developing on the vehicle by using onboard safety devices. Given the quantity and type of fire extinguishers, credit has been given in combination with the fire screen protection. The two events have been assumed to be dependent.

Similarly, if it is possible and safe to do so, given the low amount of explosives to be transported on the truck, it may be possible for the crew to secure the explosive load before the fire fully develops. However, given that a fire could fully develop and critical explosive temperature can be reached within a couple of minutes, no credit was given for people to escape as a conservative assumption.

Intervention of the Fire Service Department

Most likely, a fire would have already fully developed by the time the fire brigade arrives at the scene, in case of a fire incident involving an explosive vehicle. The intervention of the fire brigade would be limited to fight the fire from a safe distance, given the risk posed by the scenario, and to evacuate the area.

Regarding the evacuation, it may be possible to evacuate the accident zone surrounding the vehicle which would include vehicle occupants and people located on the pavement but evacuation of the buildings would be difficult.

For the purpose of this assessment, no or little credit has been given for the intervention of the fire brigade.

Escape and Evacuation

In certain circumstance it may be possible for people to escape from the scene of an accident by themselves before the occurrence of an explosion event. This is particularly true in the case of a fire accident, for example fire on a truck in which explosives cargo is not initially involved but is only affected after a period of gradual escalation. However, modelling such escape scenario would only reduce slightly the consequences and have minimum impact on the conclusion of this report. For the purpose of this study, no credit was given for people to escape as a conservative assumption.

Explosive Initiation under Thermal Stimulus

Although the potential consequences are known, there are still some uncertainties associated with the probability of explosion for an explosive load composed of a mix of cartridged emulsion, cast boosters and detonating cord when involved in a fire during transportation. The probability used in this report has been based on accident statistics applicable to ANFO which is seen as being more sensitive than emulsion and transported in a different manner. In absence of test data, this assumption may be conservative.

It is concluded that the risk assessment approach adopted in this study are on the conservative side, with the best available conservative consequence assessment ESTC model and omitting credits for risk reduction factors in accident failure scenarios and "good practice" mitigation measures.

9 ALARP ASSESSMENT

9.1 RISK RESULTS AND APPROACH TO ALARP

The Hazard to Life Assessment of the Project has assessed the risks arising from the proposed Magazine site in Tai Lam as well as the risks associated with the road transport from this site to the work areas. From *Section 8*, the risks posed by the storage and transport of explosives, for both base case and worst case, are in the ALARP region specified in EIAO-TM Annex 4.

The risk, in terms of PLL, associated with the Worst Case, estimated at 1.56×10^{-3} per year (Route Option R2) has been used for the purpose of the ALARP assessment. This approach is conservative.

The results imply that achievable risk reduction measures and / or any alternate practicable option should be explored for the project. From *Section 8* it was also found that the risk arising from explosive transport is much more significant than that of explosives storage; hence, the following assessment focuses on the transportation aspect of the explosives.

Where the risk falls into the ALARP region, the risks associated with each probable hazardous event should be reduced to a level 'as low as reasonably practicable'. This firstly requires the identification of 'practicable' risk reduction options regardless of their cost. A risk reduction option is considered 'practicable' if an engineering solution exists and can be implemented for the Project regardless of the cost without affecting the project construction programme. Secondly, the extent to which the risk should be reduced is usually measured as a trade-off between the risk reduction, i.e. the safety benefits, and the cost of the risk reduction measure. A mitigation option is considered 'reasonable' if the cost of implementing the option is not grossly disproportionate to the achieved safety benefits.

Risk mitigation measures may take the form of engineered measures, controls in the zones most impacted by the hazardous scenarios presented by this project, or operation and procedural controls.

The following section presents the approach and the outcome of the ALARP assessment.

9.2 APPROACH TO ALARP ASSESSMENT

The approach consists of identifying potential justifiable mitigation measures, assessing their practicability for this project and evaluating their cost and comparing with the safety benefits of implementing the measures. Combinations of mitigation measures are also considered.

Cost benefit analysis (CBA) is widely used in QRA studies to evaluate the cost-effectiveness of alternative measures and provide a demonstration that all reasonably practicable measures have been taken to reduce risks.

The safety benefits are evaluated as follows:

Safety Benefits = Value of Preventing a Fatality x Aversion Factor x Reduction in PLL value x Design life of mitigation measure

The Value of Preventing a Fatality (VPF) reflects the tolerability of risk by the society and therefore the monetary value that the society is ready to invest to prevent a fatality. For the purpose of this assessment and for consistency with previous studies, the Value of Preventing a Fatality is taken as HK$33M per person, which is the same figure as used in previous Hazard Assessment studies (derived from the UK ACDS (ACDS, 1995)) but updated to current prices.

Depending on the level of risk, the value of preventing a fatality may be adjusted to reflect people's aversion to high risks or scenarios with potential for multiple fatalities. The methodology for application of the 'aversion factor' follows that developed in the EPD's Technical Note on Cost Benefit Analysis (EPD, 1996), in which the aversion factor is calculated on a sliding scale from 1 (risks at the lower boundary of the ALARP region of the Risk Guidelines) up to a maximum of 20 (risks at the upper boundary of the ALARP region). The adjusted VPF using the aversion factor of 20 is HK$660M. This value is a measure of how much the society is willing to invest to prevent a fatality, where there is potential for an event to cause multiple fatalities.

The cost of implementing potential justifiable mitigation measures will be first of all checked against the Maximum Justifiable Expenditure. The Maximum Justifiable Expenditure will be estimated on the assumption that risk is reduced to zero. Mitigation measures considered justifiable will be further analysed considering the actual risk (PLL) reduction offered by the measure.

If the safety benefits are greater than the cost of implementation of a particular mitigation measure, the mitigation measure will be considered for implementation in this project; otherwise its cost would not be considered justifiable.

The cost of implementing the mitigation measures should include capital and operational expenditures but exclude any cost associated with design or design change.

It is recognised that it may not always be possible to quantify the cost-benefits of a particular measure. In some cases, a qualitative approach was adopted.

9.3 *MAXIMUM JUSTIFIABLE EXPENDITURE*

The maximum justifiable expenditure for this project is calculated as follows assuming a conservative aversion factor of 20:

Maximum Justifiable Expenditure

= Value of Preventing a Fatality x Aversion Factor x Maximum PLL value x Design life of mitigation measure

Maximum Justifiable Expenditure = HK$ 33M x 20 x 1.56E-3x (24/12)
= HK$ 2.1M

The design life of a mitigation measure is assumed as 2 years (Jan 2016 to Dec 2017, 24 months) based on the Project duration during which storage and transport of explosives will be involved.

For an 'achievable' mitigation measure to be potentially justifiable, its cost should be less than the Maximum Justifiable Expenditure.

9.4 *POTENTIAL JUSTIFIABLE MITIGATION MEASURES*

The approach considered the identification of options pertaining to the following broad categories:

- Options eliminating the need for a magazine or eliminating the risk;
- Options reducing significantly the quantities of explosives to be used such as the use of hard rock TBM or alternatives to cartridged emulsion;
- Options reducing significantly the distance run by contractors' explosives trucks such as closer Magazine site and alternative routes;
- Options reducing significantly the number of trips to be carried out by contractors' explosives trucks;
- Options considering improved explosives truck design; and
- Options considering better risk management systems and procedures.

Based on the review of the risk results and a series of brainstorming sessions with DHK and explosives specialists operating in this industry, the following options were selected as potential candidates for risk mitigation.

9.4.1 *Need for a Tunnel and Proposed Alignment*

This Explosive Storage and Transport Project serves the Liantang / Heung Yuen Wai Boundary Control Point Work in the north-eastern New Territories is a crucial development project to serve the cross-boundary goods vehicles and passengers travelling between Hong Kong (HK) and Shenzhen (SZ) East. The new BCP will connect with the Shenzhen Eastern Corridor and provide an efficient access across the border to the eastern part of Guangdong, including Shantou, Shanwei, Chaozhou, etc. and the adjacent provinces such as Fujian and Jiangxi. The Project will:

- reduce travelling time between HK and SZ East, facilitating future development in these areas and extending the economic hinterland of HK and SZ;

- re-distribute cross-boundary traffic in New Territories East and alleviate the frequent congestion at Man Kam To BCP, resulting in enhancement of the overall operational efficiency, handling capacity and quality of service for BCPs in New Territories East; and

- improve and enhance the overall transport network in New Territories East and provide a convenient access to the proposed Ping Che/Ta Kwu Ling New Development Area by the proposed connecting road linking up the new BCP with Fanling Highway.

The Liantang/Heung Yuen Wai Boundary Control Point Work is an approved project. Opting for any alternative alignment option will cost significantly more than the Maximum Justifiable Expenditure.

9.4.2 *Magazine Requirement and Selection*

Due to the 24 hour blasting requirements as described in *Section 2* and summarised in *Section 2.5.2*, it is not possible for Mines Division to deliver the required explosives quantities directly to all the works areas as this would limit the blasting to one blast per day. An explosives magazine is therefore required.

The alternative Magazine sites to Tai Lam have been considered by Dragages Hong Kong Limited but they are not available for the Project (*Table 9.1*). The existing Tai Lam Explosives Magazine (TLEM) is the best option considering the shortest transportation distance, stakeholders' acceptance situation and its availability with the blasting schedule of the project.

On-site magazines were also considered (at the Mid Ventilation Portal and North Portal). Dragages Hong Kong Limited had preliminary consultation with CEDD Mines Division. After review with the necessary site setups and subsequent application process, Mines Divisions advised that it would not be feasible in managing interfaces with adjacent construction activities, safety of the site could be compromised and match with the program of project.

The only practicable location for the Magazine site is therefore Tai Lam Explosives Magazine site. This site has been used as the basis for this Hazard to Life assessment.

Table 9.1 Potential Explosive Magazine sites Selection

Magazine Location	District Council	Work Project	Contractor	Storage Capacity	Shortest Distance from Nearby Facilities	Status in June 2014	Distance to Liantang 2 Site	Availability for Liantang 2 Site
Tai Shu Ha, Tai Lam (New Territories)	Yuen Long	Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL)	Leighton (C822) and Kier/Kaden/ Ossa (C824)	0.8 tonnes	About 210m	In use by C824 until end of 2014	About 25km	Available. Closest Magazine to the construction site.
So Kwun Wat, Siu Lam (New Territories)	Tuen Mun	Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL)	Leighton (C822) and Dragages (C821)	1.2 tonnes	About 230m	Under demolish stage and reinstate-ment	About 35km	Not Feasible. Longer routes and more district involved.
Chung Hom Shan (Hong Kong Island)	Southern	MTR South Island Line (East)	Leighton (C904) and Nishimatsu (C902)	0.8 tonnes	About 200m	In use by both contractor	N/A	Not Feasible due to transport constraint (transport of explosive through tunnel is prohibited)

Magazine Location	District Council	Work Project	Contractor	Storage Capacity	Shortest Distance from Nearby Facilities	Status in June 2014	Distance to Liantang 2 Site	Availability for Liantang 2 Site
Victoria Road (Hong Kong Island)	Central and Western	MTR West Island Line	Nishimatsu/ Gammon (C704)	2.4 tonnes	About 64m	Not in use	N/A	Not Feasible due to transport constraint (transport of explosive through tunnel is prohibited)
Tseung Kwan O - Area137 (New Territories)	Sai Kung	MTR Kwun Tong Line Extension and Shatin to Central Link	KTE 1001	2.5 tonnes	About 160m	In use by both contractor	About 50km	In use at least until 2018.

9.4.3 *Use of alternative methods of construction*

It is possible to construct hard rock tunnels with hard rock tunnel boring machines (TBMs). The TBMs used in this project are dedicated to soft rock soils applications. For constructing the tunnels solely based on TBMs, TBMs dedicated to hard rock soils should be procured. The cost of such machines will be in the order of several hundred millions of Hong Kong Dollars each which would be much higher than the Maximum Justifiable Expenditure.

In addition, different tunnel profiles will be required leading to the need to use explosives to enlarge the circular TBM driven tunnels. Such costs and programme are not included.

Finally, immediate availability of such TBMs for Hong Kong plus the additional blasting required for non-circular sectors renders the option not practicable since it could lead to several months of project delay.

This option is therefore neither practicable nor justifiable on a cost basis.

9.4.4 *Use of Alternative Routes*

Several route options have been analysed in this assessment. As described in Section 2.6.5, current road improvement work at Pok Oi Interchange imposes limitations to explosives delivery routes selection as identified at the Fourth Meeting of Traffic and Transport Committee under Yuen Long District Council on 24 July 2014 (Thursday). Based on the risk assessment results presented in Section 8, the following routes will be selected for this project:

- At early stage of this project with road improvement work at Pok Oi Interchange (expected to be completed in 2015 but may be delayed), Route Option R2 will be used. Route Options R1 and R3 are not feasible.
- After road improvement work at Pok Oi Interchange is completed, all three routes will be available for use. The Route Option with minimum transport risk, i.e. Route Option R1, will be used. Route Option R3 can only be used as a contingency alternative route in the event that Route Option R1 is infeasible due to road blockage by traffic accidents.

9.4.5 *Use of Different Explosive Types*

The emulsion family of explosives is considered as the safest type of explosive for blasting applications. No safety benefits will be obtained by selecting a different type of explosive.

The detonating cord in this project uses a PETN core with a melting point of around 140 degC. Different detonating cord technologies are available such as those using a RDX or HMX core with a slightly higher melting point

(210 degC and 276 degC). This may offer more time before an explosion occurs following a fire event. The time gained and risk reduction achieved by implementing these technologies would however be negligible for the purpose of this assessment. In addition, current Mines Division's Explosives approval register shows both RDX and HMX core Detonating Cords are not registered and commercially available in HK. This option is therefore not considered further.

9.4.6 *Use of Smaller Quantities of Explosives*

This project has already considered the minimum amount of explosives for transportation as it will transport, as far as possible, initiating explosives only. Bulk blasting explosives will be manufactured on site. This option is therefore not considered further.

9.4.7 *Safer Explosives Truck Design*

The design of the truck has been reviewed to identify potential improvements which could reduce the risk particularly of fire escalating to the load. The analysis has already assumed that the current specification followed for Mines trucks such as use of fire screen between cabin and the load will also be followed for the Contractor's trucks. The use of fire screen is adopted overseas, although mainly for trucks carrying much larger quantities of explosives, i.e. more than 200 kg. However, this measure has been recommended for the Contractor's trucks in this project, as an improvement measure.

Further improvements to the fire and crash protection features for the explosives trucks were reviewed but no account of such practices was found worldwide and the effectiveness of such risk reduction measures is also not known.

It is however possible to implement simple measures such as reducing the combustible load on the vehicle by using fire retardant materials wherever possible and limiting the fuel tank capacity. Since the safety benefits of such measures are difficult to evaluate quantitatively such measures have been included in the recommendation section of this report, but no credit taken in the analysis.

9.4.8 *Lower Frequency of Explosives Transport*

The frequency of explosives transport has been minimized, as far as possible, with the use of alternative methods of construction, such as soft ground TBMs, etc. It has also been minimized with the use of bulk emulsion. No further options have been identified. The possibility of reducing the frequency of explosive transport has not been evaluated further.

9.4.9 *Reduction of Accident Involvement Frequency*

It is possible to reduce the explosive accident probability through the implementation of a training programme for both the driver and his attendants, regular 'toolbox' briefing sessions, implementation of a defensive driving attitude, appropriate driver selection based on good safety record, and medical checks. Such measures are to some degree mandatory and therefore considered in the base case assessment. The actual recommended implementation of this option is given in the recommendations section of this report.

9.4.10 *Reduction of Fire Involvement Frequency*

It is possible to carry better types of fire extinguishers onboard the explosives trucks and with bigger capacities e.g. AFFF-type extinguishers.

Adequate emergency plans and training could also be provided to make sure the adequate fire extinguishers are used and attempts are made to evacuate the area of the incident or securing the explosive load if possible.

The actual recommended implementation of this option is given in the recommendations section of this report.

9.4.11 *Summary*

In summary, various options have been either recommended for implementation or assessed comparing the implementation cost with the maximum justifiable expenditure for the safety benefit gained.

By adopting the feasible explosives delivery routes with the lowest risk, the risk has been reduced as low as practicable considering the impact of road improvement work at Pok Oi Interchange. The risk will be further reduced by implementation of the other selected mitigation measures.

9.5 ALARP ASSESSMENT RESULTS

The evaluation of each option considered is summarised in *Table 9.2*.

Table 9.2 ALARP Assessment Results

Option Description	Practicability	Implementation Cost	Safety Benefits or Justifiable Expenditure	ALARP Assessment Result
Use of alternative methods of construction (TBMs)	Not Practicable	> HK$ 100M	HK$ 2.1M	Neither practicable nor justified.
Use of Magazines Closer to the Worksites	Not Practicable	-	-	Closest practicable Magazine site to the worksites has been selected.
Use of different explosive types (different types of detonating cord)	Pose some limitations.	HK$ 2.4M	No safety benefit	Not justified

Option Description	Practicability	Implementation Cost	Safety Benefits or Justifiable Expenditure	ALARP Assessment Result
Alternative Routes (at early stage of this project, during road improvement work at Pok Oi Interchange)	Not Practicable	-	-	Neither practicable nor justified.
Alternative Routes (after road improvement work at Pok Oi Interchange is completed)	Practicable	< HK$ 10k	Negative	Route Option R1 is the preferred option. Route Option R3 can only be used as a contingency alternative route.
Use of Smaller Explosives Quantities	Not Practicable	-	-	Neither practicable nor justified.
Safer explosive truck (reduced fire load)	Practicable	-	-	This option has been directly incorporated in recommendations.
Reduction of Accident Involvement Frequency (training programme etc.)	Practicable	-	-	This option has been directly incorporated in recommendations.
Reduction of Fire Involvement Frequency (better emergency response, extinguisher types etc.)	Practicable	-	-	This option has been directly incorporated in recommendations.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

A QRA has been carried out to assess the hazard to life issues arising from the storage and transport of explosives from Tai Lam Explosives Magazine site to the three blasting worksites.

The criterion of Annex 4 of the EIAO-TM for Individual Risk is met. The assessment results show that the societal risk lies within the ALARP region when compared to the criteria stipulated in the EIAO-TM. A detailed ALARP assessment has been undertaken considering a wide range of mitigation measures and the results show compliance with the ALARP principles provided that the following recommendations are followed.

A number of recommendations have been made to ensure that the requirements (including ALARP requirements) of the EIAO-TM will be met during the construction period (see *Section 10.2.1*). In additional some general recommendations have been made to minimise the risks further and in accordance with best practices (see *Section 10.2.2*).

10.2 RECOMMENDATIONS

10.2.1 Recommendations for Meeting the ALARP Requirements

Following the ALARP principles, the following recommendations are justified and should be implemented to meet the EIAO-TM requirements:

- The truck design should comply with the Requirements for Approval of an Explosives Delivery Vehicle (CEDD 2) and limit the amount of combustibles in the cabin. The fuel carried in the fuel tank should also be minimised to reduce the duration of any fire;
- The explosive truck accident frequency should be minimised by implementing a dedicated training programme for both the driver and his attendants, including regular briefing sessions and implementation of a defensive driving attitude. In addition, drivers should be selected based on good safety records and medical checks;
- The Contractor should as far as practicable combine the explosive deliveries for a given work area;
- Only the required quantity of explosives for a particular blast should be transported to avoid the return of unused explosives to the Magazine;
- Whenever practicable, a minimum headway between two consecutive truck convoys of 10 min is recommended;

- The explosive truck fire involvement frequency should be minimised by ensuring the implementation of a robust emergency response and training to make sure the adequate fire extinguishers are used correctly and attempts are made to evacuate the area of the incident or securing the explosive load if possible. All explosive vehicles should be equipped with the required amount and type of fire extinguishers and shall be agreed with Mines Division.

10.2.2 *General Recommendations*

The following general recommendations should also be considered for the storage and transport of explosives:

1. The security plan should address different alert security levels to reduce opportunity for arson / deliberate initiation of explosives. The corresponding security procedure should be implemented with respect to prevailing security alert status announced by the Government.

2. Emergency plans (i.e. magazine operational manual) should be followed and amended if necessary to address uncontrolled fire in the Magazine area and for transport. The case of fire near an explosives truck in jammed traffic should also be covered. Drills of the emergency plans should be carried out at regular intervals.

3. Adverse weather working guideline should be followed and amended if necessary to clearly define procedures for explosives transport during thunderstorms.

4. The Magazine storage quantities need to be reported on a monthly basis to ensure that the two day storage capacity is not exceeded.

Specific recommendations for storage and transport of explosives are given below.

10.2.3 *Storage of Explosives in Magazine Store*

The Magazine should be operated and maintained in accordance with Mines Division guidelines and appropriate industry best practice. In addition, the following recommendations should be implemented.

1. A suitable work control system should be followed and amended if necessary, such as an operational manual including Permit-to-Work system, to ensure that work activities undertaken during the operation of the Magazine are properly controlled.

2. There should be good house-keeping within the Magazine to ensure that combustible materials are not allowed to accumulate.

3. The Magazine shall be without open drains, traps, pits or pockets into which any molten ammonium nitrate could flow and be confined in the event of a fire.

4. The Magazine building shall be regularly checked for water seepage through the roof, walls or floor.

5. Caked explosives shall be disposed of in an appropriate manner.

6. Delivery vehicles shall not be permitted to remain within the secured fenced off Magazine store area.

7. Good housekeeping outside the Magazine stores to be followed to ensure combustibles (including vegetation) are removed.

8. A speed limit within the Magazine area should be enforced to reduce the risk of a vehicle impact or incident within the Magazine area.

9. Traffic Management should be implemented within the Magazine site, to ensure that no more than 1 vehicle will be loading/loaded at any time, in order to avoid accidents involving multiple vehicles within the site boundary.

10.2.4 *Transport of Explosives*

General Recommendations:

The following measures should also be considered for safe transport of explosives:

1. Detonators shall not be transported in the same vehicle with other Class 1 explosives. Separation of vehicles should be maintained during the whole trip.

2. Location for stopping and unloading from truck to be provided as close as possible to shaft, free from dropped loads, hot work, etc. during time of unloading.

3. Develop procedure to ensure that parking space on the site is available for the explosives truck. Confirmation of parking space should be communicated to truck drivers before delivery. If parking space on site cannot be secure, delivery should not commence.

4. Ensure lining is provided within the transportation box on the vehicle and in good condition before transportation.

5. Ensure that packaging of detonators remains intact until handed over at blasting site.

6. Emergency plan to include activation of fuel and battery isolation switches on vehicle when fire breaks out to prevent fire spreading and reducing likelihood of prolonged fire leading to explosion.

7. Use only experienced driver(s) with good safety records.

8. Ensure that cartridged emulsion packages are damage free before every trip.

9. Ensure that explosives will be offloaded and stored away from the railway protection area according to the MTRCL railway protection area plan.

Contractors Licenced Vehicle Recommended Safety Requirements:

- Battery isolation switch;
- Front mounted exhaust with spark arrestor;
- Fuel level should be kept as far as possible to the minimum level required for the transport of explosives;
- Minimum 1 x 9 kg water based AFFF fire extinguisher to be provided;
- Minimum 1 x 9 kg dry chemical powder fire extinguisher to be provided;
- Horizontal fire screen on cargo deck and vertical fire screen mounted at least 150 mm behind the drivers cab and 100 mm from the steel cargo compartment, the vertical screen shall protrude 150 mm in excess of all three (3) sides of the steel cargo compartment;
- Cigarette lighter removed;
- Two (2) battery powered torches for night deliveries;
- Vehicles shall be dedicated explosive transport vehicles and should be maintained in good operating condition;
- Daily checks on tires and vehicle integrity;
- Regular monthly vehicle inspections;
  - Fuel system
  - Exhaust system
  - Brakes
  - Electrics
  - Battery
  - Cooling system
  - Engine oil leaks
- Vehicle log book in which monthly inspections and maintenance requirements are recorded; and
- Mobile telephone equipped.

Recommended Requirements for the Driver of the Explosives Vehicle:

The driver shall:

- be registered by the Commissioner of Mines and must be over the age of 25 years with proven accident free records and more than 7 year driving experience without suspension;
- hold a Driving Licence for the class of vehicle for at least one (1) year;
- adopt a safe driving practice including having attended a defensive driving course;
- pass a medical check and be assessed as fit to drive explosives vehicles; and
- not be dependent on banned substances.

Some of the following requirements may also apply to the vehicle attendant(s).

The driver is required to attend relevant training courses recognised by the Commissioner of Mines. The training courses should include the following major subjects, but not limited to:

- the laws and Regulations relating to the transport of explosives;
- security and safe handling during the transport of explosives;
- training courses provided by the explosives manufacturer or distributor, covering the following:
  - explosives identification;
  - explosion hazards; and
  - explosives sensitivity.
  - the dangers which could be caused by the types of explosives;
  - the packaging, labeling and characteristics of the types of explosives;
  - the use of fire extinguishers and fire fighting procedures; and
  - emergency response procedures in case of accidents.

The driver should additionally be responsible for the following:

- The driver shall have a full set of Material Safety Data Sheets (MSDS) for each individual explosive onboard the vehicle for the particular journey;
- The MSDS and Removal Permit (where applicable) shall be produced to any officer of the Mines Division of CEDD upon request;

- A card detailing emergency procedures shall be kept on board and displayed in a prominent place on the drivers door;
- Before leaving the Magazine the driver together with and / or assisted by the shotfirer shall check the following:
    - Packaging integrity and labeling;
    - Check that the types and quantities of explosives loaded onto the vehicle are as stipulated in the Removal Permit(s);
    - Check that the explosive load does not exceed the quantities stated in the removal permit;
    - Check the condition and integrity of the cargo compartment or box;
    - Check that detonators are not loaded in the explosives cargo compartment and vice versa;
    - Check that the cargo is secured and cannot be damaged during the delivery;
    - Ensure that the appropriate placards and a red flag are displayed before leaving the Magazine;
    - Be competent to operate all equipment onboard the vehicle including fire extinguishers and the vehicle emergency cut-off switches;
    - Prohibit smoking when the vehicle is loaded with explosives;
    - When explosives are loaded, ensure the vehicle is not left unattended;
    - Be conversant with emergency response procedures.

Specific Recommended Requirements for the Explosives Vehicle Attendants:

- When the vehicle is loaded with explosives, it shall be attended by the driver and at least one (1) other person authorized by the Commissioner of Mines. The vehicle attendant shall:
    - Be the assistant to the driver in normal working conditions and in case of any emergency;
    - Be conversant with the emergency response procedures; and
    - Be competent to use the fire extinguishers and the vehicle emergency cut-off switches.
- One of the vehicle attendant(s) should be equipped with mobile phones and the relevant MSDS and emergency response plan.

10.2.5 *Type of Explosives & their Disposal*

- Explosive Selection:
    - Cartridged Emulsions with perchlorate formulation should be avoided; and
    - Cartridged Emulsions with high water content should be preferred.

Disposal Recommendations:

If disposal is required for small quantities, disposal should be made in a controlled and safe manner by a Registered Shotfirer.

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Annex 9A

Implementation Schedule of Recommended Mitigation Measures

Implementation Schedule of Recommended Mitigation Measures

Note: Chapters 1 to 2 of the EIA report present the background information of the Project and Project Description. Chapters 3 to 8 of the EIA report present the EIA findings and mitigation measures, as described below with cross-reference to the EIA report. Chapters 9 & 10 summarize the environmental monitoring and audit requirements and provide a conclusion along with a summary of the environmental outcomes of the EIA.

*** O = Operation; D = Decommissioning of the TLEM; CoP = Completion of Project**

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
		Ecological Impact (Operation & Completion of Project)					
S3.5		• Reinstatement planting should be carried out at the site according to the *XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* and the *Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha) (hereafter TLP)*.	To restore the habitat back to borrow area reinstatement plantation, as it was prior to the construction of the TLEM for the MTRC's use. To ensure the proposed mitigation recommended in the approved XRL EIA for loss of green areas affected by the XRL Project, is implemented.	The reinstatement planting will be implemented by DHK. The maintenance agent will be DLO as confirmed in the TLP.	Tai Lam Explosives Magazine (TLEM) site/ During - site restoration prior to mitigation planting, Planting & Establishment period of at least 12 months.	CoP	*XRL EIA Vegetation Survey Report for Tai Shu Ha Road West* *Tree Planting and Landscape Plan TLP-10: Works in Yuen Long District (Tai Shu Ha)* *DEVB TCW No. 10/2013 – Tree Preservation* (supersedes *ETWB TC(W) No. 3/2006*)
		Noise Impact (Operation and Decommissioning)					
S4.4.1		No adverse impacts anticipated. • For good practice, adopt general noise control measures, as listed in *Recommended Clauses for Construction Contracts – Section 3 - Noise Control* during decommissioning	To ensure good site practices are adopted and noise generation minimized during decommissioning	Contractor for DHK	Approximately one month during decommissioning of the TLEM	D	*Recommended Clauses for Construction Contracts – Section 3 - Noise Control*
		Air Quality (Operation and Decommissioning)					
S5		• Not applicable (n/a) – no adverse impacts anticipated.	n/a	n/a	n/a	n/a	n/a

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EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
		Waste Management (Operation and Decommissioning)					
S6.5		• Good site management practice will be adopted by the contractors of the Project and waste on-site will be properly segregated to increase the potential for reuse and recycling. • General refuse is removed from the Project Site regularly (i.e. once per day).	Avoid adverse environmental impacts related to handling and disposal of waste.	DHK	Tai Lam Explosives Magazine (TLEM) site/ During operation of TLEM & approximately one month during decommissioning of the TLEM	O, D	*Waste Disposal Ordinance (WDO) (Cap 354);* *Waste Disposal (Charges for Disposal of Construction Waste) Regulation (Cap 354N);* *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C);* *Land (Miscellaneous Provisions) Ordinance (Cap 28); and* *Public Health and Municipal Services Ordinance (Cap 132) - Public Cleansing and Prevention of Nuisances Regulation.*
S6.5		• Chemical refuse will be properly stored and disposed of separately to general waste.	Avoid contamination by chemical waste.	Licensed Chemical Waste Collector for DHK	Tai Lam Explosives Magazine (TLEM) site/ During operation of TLEM & approximately one month during decommissioning of the TLEM	O, D	*Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* (1992), EPD, Hong Kong Government

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
		Other (Operation and Decommissioning)					
S7.1		No adverse impacts anticipated. For good measure adopt the following good practice measures: • Surface run-off from construction site should be discharged into storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels or earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities. Perimeter channels at site boundaries should be provided where necessary to intercept storm run-off from outside the site so that it will not wash across the site. Catchpits and perimeter channels should be constructed in advance of site formation works and earthworks.	Minimize construction site runoff during decommissioning	Contractor for DHK	TLEM site /Approximately one month during decommissioning of the TLEM	D	*Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)*
S7.1		• Silt removal facilities, channels and manholes should be maintained and the deposited silt and grit should be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times.	Minimize construction site runoff during decommissioning	Contractor for DHK	TLEM site /Approximately one month during decommissioning of the TLEM	D	*Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)*
S7.1		• Earthworks final surfaces should be well compacted and the subsequent permanent work or surface protection should be carried out immediately after the final surfaces are formed to prevent erosion caused by rainstorms. Appropriate drainage like intercepting channels should be provided where necessary.	Minimize construction site runoff during decommissioning	Contractor for DHK	TLEM site /Approximately one month during Decommissioning of the TLEM	D	*Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)*

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S7.1		• Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system, and to prevent storm run-off from getting into foul sewers. Discharge of surface run-off into foul sewers must always be prevented in order not to unduly overload the foul sewerage system.	Minimize construction site runoff during decommissioning	Contractor for DHK	TLEM site /Approximately one month during decommissioning of the TLEM	D	*Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)*
S7.1		• Precautions and actions, as stipulated in Appendix A2 of *ProPECC PN1/94*, should be taken at any time of year when rainstorms are likely, when a rainstorm is imminent or forecast, or during and after rainstorms.	Minimize construction site runoff during decommissioning	Contractor for DHK	TLEM site /Approximately one month during Decommissioning of the TLEM	D	*Practice Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)*
S7.1		• To minimize erosion of exposed soil in between the removal of paved area and the re-vegetation / plantation, exposed soil should be covered with geotextile promptly after the removal works.	Minimize construction site runoff and soil erosion during decommissioning	Contractor for DHK	TLEM site /Approximately one month during Decommissioning of the TLEM	D	-
		Hazard to Life (Operation - Storage)					
S8.9.1		• Ensure the security plan addresses different alert security levels. The corresponding security procedure should be implemented with respect to prevailing security alert status announced by the Government.	Reduce opportunity for arson/ deliberate initiation of explosives.	DHK	TLEM site / Throughout operation of the Project	O	-
S8.9.1 & S8.9.2 & S8.9.3		• Emergency plan (i.e. magazine operational manual) shall be followed and amended if necessary to address uncontrolled fire in magazine area and transport. The case of fire near an explosive carrying truck in jammed traffic should also be covered. Drill of the emergency plan should be carried out at regular intervals.	Minimize risk of uncontrolled fire in TLEM and along transport route	DHK	For TLEM site and Transport route / Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.1		• Adverse weather working guideline should be followed and amended if necessary to clearly define procedure for transport explosives during thunderstorm.	Minimize explosive truck accident frequency.	DHK	TLEM site / Throughout operation of the Project	O	-
S8.9.1		• The Magazine storage quantities need to be reported on a monthly basis	Ensure that the two day storage capacity is not exceeded	Contractor for DHK	TLEM site / Throughout operation of the Project	O	Dangerous Goods Ordinance
S8.9.2		• A suitable work control system should be followed and amended if necessary, such as an operational manual including Permit-to-Work system	Ensure work activities undertaken during the operation of the Magazine are properly controlled.	DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• Good house-keeping within the Magazine	Ensure combustible materials are not allowed to accumulate.	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• Good housekeeping outside the Magazine stores to be followed.	To ensure combustibles (including vegetation) are removed and reduce risk and severity of any accidental fire onsite.	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• The Magazine shall be without open drains, traps, pits or pockets into which any molten ammonium nitrate could flow and be confined in the event of a fire.	Reduce risk of severity of accidental fire and contamination of site.	DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• The Magazine building shall be regularly checked for water seepage through the roof, walls or floor.	Ensure explosives being stored remain dry.	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• Caked explosives shall be disposed of in an appropriate manner.	Ensure general safe practice	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.3		• If disposal is required for small quantities, it should be made in a controlled and safe manner by a Registered Shotfirer.	To reduce the risk during explosives transport	Registered Shotfirer for DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• Delivery vehicles shall not be permitted to remain within the secured fenced off magazine store area	Avoid accidents involving vehicles within the site boundary.	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• A speed limit within the magazine area should be enforced	Reduce the risk of a vehicle impact or incident within the Magazine area.	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-
S8.9.2		• Traffic Management should be implemented within the Magazine site, to ensure that no more than one (1) vehicle will be loaded at any time.	Avoid accidents involving multiple vehicles within the site boundary.	Contractor for DHK	For TLEM site / Throughout operation of the Project	O	-
		Hazard to Life (Operation - Transport)					
S8.9.1		• Truck design should comply with the Requirements for Approval of an Explosives Delivery Vehicle (CEDD 2) and limit the amount of combustibles in the cabin. The fuel carried in the fuel tank should also be minimised to reduce the duration of any fire.	Ensure delivery vehicle is as safe as possible.	Contractor for DHK	Transport vehicle/ Throughout operation of the Project	O	-
S8.9.1		• Implement a dedicated training programme for both the driver and his attendants, including regular briefing sessions, implementation of a defensive driving attitude.	Minimize explosive truck accident frequency.	DHK	Vehicle driver & attendants for Transport route/ Throughout operation of the Project	O	-
S8.9.1		• As far as practicable combine explosive deliveries for a given work area	Reduce number of journeys required	Contractor for DHK	Transport route/ Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.1		• Only the required quantity of explosives for a particular blast should be transported.	Avoid the return of unused explosives to the Magazine.	Contractor for DHK	Transport route/ Throughout operation of the Project	O	-
S8.9.1		• Whenever practicable, a minimum headway between two consecutive truck convoys of 10 minutes is recommended and separation of vehicles should be maintained during the whole trip.	Minimize explosive truck accident severity.	Contractor for DHK	Transport route/ Throughout operation of the Project	O	-
S8.9.1		• Implement a better emergency response and training to make sure the adequate fire extinguishers are used and attempt is made to evacuate the area of the incident or securing the explosive load if possible. • All explosive vehicles should be equipped with the required amount and type of fire extinguishers and shall be agreed with Mines Division.	Minimize explosive truck fire involvement frequency.	Contractor for DHK	Transport route/ Throughout operation of the Project	O	-
S8.9.3		• Detonators shall not be transported in the same vehicle with other Class 1 explosives and separation of vehicles should be maintained during the trip.	Minimize explosive truck accident frequency.	Contractor for DHK	Transport vehicle/ Throughout operation of the Project		-
S8.9.3		• Location for stopping and unloading from truck to be provided as close as possible to shaft, free from dropped loads, hot work, etc. during time of unloading.	To ensure that the risks from the proposed explosives storage and transport would not be unacceptable	Contractor for DHK	End of Transport route/ Throughout operation of the Project	O	-
S8.9.3		• Develop procedure to ensure that parking space on the site is available for the explosive truck. Confirmation of parking space should be communicated to truck drivers before delivery. If parking space on site cannot be secure, delivery should not commence.	To ensure that the risks from the proposed explosives storage and transport would not be unacceptable	Contractor for DHK	End of Transport route/ Throughout operation of the Project	O	-
S8.9.3		• Ensure lining is provided within the transportation box on the vehicle and in good condition before transportation.		Contractor for DHK	Transport vehicle/ Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.3		• Ensure that packaging of detonators remains intact until handed over at blasting site.	To meet the ALARP requirement.	Contractor for DHK	End of Transport route/ Throughout operation of the Project	O	-
S8.9.3		• Emergency plan to include activation of fuel and battery isolation switches on vehicle when fire breaks out.	Prevent fire spreading and reducing likelihood of prolonged fire leading to explosion.	Contractor for DHK	Transport vehicle/ Throughout operation of the Project	O	-
S8.9.3		• Ensure that cartridged emulsion packages are damage free before every trip.	To meet the ALARP requirement.	Contractor for DHK	Transport route/ Throughout operation of the Project	O	-
S8.9.3		• Ensure that explosives will be offloaded and stored away from the railway protection area according to the MTRCL railway protection area plan.	To meet the ALARP requirement.	Contractor for DHK	The three worksites (i.e. Mid-Ventilation Adit, North Portal and South Portal)/ Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.3		Vehicles should meet Licenced Vehicle Safety Requirements including: • Mobile telephone equipment; • Battery isolation switch; • Front mounted exhaust with spark arrestor; • Fuel level should be kept as far as possible to the minimum level required for the transport of explosives; • Minimum 1 × 9 kg water based AFFF fire extinguisher to be provided; • Minimum 1 × 9 kg dry chemical powder fire extinguisher to be provided; • Horizontal fire screen on cargo deck and vertical fire screen mounted at least 150mm behind the drivers cab and 100mm from the steel cargo compartment, the vertical screen shall protrude 150mm in excess of all three (3) sides of the steel cargo compartment; • Cigarette lighter removed; • Two (2) battery powered torches for night deliveries.	Prevent fire spreading and reducing likelihood of prolonged fire leading to explosion.	Contractor for DHK	Transport vehicle/ Throughout operation of the Project	O	CEDD's *Guidance Note on Requirements for Approval of an Explosive Delivery Vehicle*
S8.9.3		Vehicles shall be dedicated explosive transport vehicles and should be maintained in good operating condition; • Daily checks on tyres and vehicle integrity. • Regular monthly vehicle inspections for fuel system, exhaust system, brakes, electrics, battery, cooling system and engine oil leaks. • Vehicle log book in which monthly inspections and maintenance requirements are recorded	Ensure vehicle remains as safe as possible	Contractor for DHK	Transport vehicle/ Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.3		• Drivers should be selected based on good safety record, and medical checks. Use only experienced driver(s) with good safety record. • It is recommended that drivers be registered by the Commissioner of Mines; over the age of 25 years with proven accident free record; have more than seven (7) year driving experience without suspension; .hold a Driving License for the class of vehicle for at least one (1) year; adopt a safe driving practice including having attended a defensive driving course; pass a medical check and are assessed as fit to drive explosives vehicles; and are not dependent on banned substances. • Drivers should attend relevant training courses recognized by the Commissioner of Mines, including but not limited to: the laws and Regulations relating to the transport of explosives: and Security and safe handling during the transport of explosives. • Drivers should attend training courses provided by the explosives manufacturer or distributor, covering: - explosives identification; - explosion hazards; and - explosives sensitivity; - dangers which could be caused by the types of explosives; - packaging, labelling and characteristics of the types of explosives; - the use of fire extinguishers and firefighting procedures; and - emergency response procedures in case of accidents.	Minimize explosive truck accident frequency and/ or severity.	Contractor for DHK	Vehicle driver for Transport route / Throughout operation of the Project	O	-

Implementation Schedule of Recommended Mitigation Measures

EIA Ref	EM&A Ref	Recommended Mitigation Measures	Objectives of the Recommended Measures & Main Concerns to address	Implementation Agent	Location/ Duration of the measure	Implementation Stage (O, D, CoP*)?	Relevant Legislation & Guidelines
S8.9.3		• The Driver will also be responsible for various matters as listed in the EIA, including having a full set of Material Safety Data Sheets (MSDS) for each individual explosive aboard the vehicle and for the particular journey, etc. • The MSDS and Removal Permit (where applicable) shall be produced to any officer of the Minds Division of CEDD upon request.	Minimize explosive truck accident frequency and/ or severity.	Contractor for DHK	Vehicle driver for Transport route/ Throughout operation of the Project	O	-
S8.9.3		• Explosive Vehicle Attendants shall: - Be the assistant to the driver in normal working conditions and in case of any emergency - Be conversant with the emergency response procedures - Be competent to use the fire extinguishers and the vehicle emergency cut-off switches - At least one of the vehicle attendant(s) should be equipped with a mobile phone and the relevant MSDS and emergency response plan	Reduce number of journeys required	Contractor for DHK	Vehicle driver attendants for Transport route/ Throughout operation of the Project	O	-
S8.9.3		For explosive selection, the following should be considered: • Cartridged Emulsions with perchlorate formulation should be avoided • Cartridged Emulsions with high water content should be preferred.	To meet the ALARP requirement.	Contractor for DHK	For TLEM site and Transport route / Throughout operation of the Project	O	-

*** O = Operation; D = Decommissioning of the TLEM; CoP = Completion of Project**

Annex 10A

Compliance Checklist for EIA Study Brief No. ESB-280/2014

Ref.	Section of the EIA Study Brief	Specific Requirements	EIA Report Compliance Check (August 2015)
1.	1.1	An application (No. ESB-280/2014) for an Environmental Impact Assessment (EIA) Study Brief under section 5(1)(a) of the Environmental Impact Assessment Ordinance (EIAO) was submitted by the Applicant on 11 September 2014 with a project profile (No. PP-516/2014) (the Project Profile).	Not applicable (N/A)
2.	1.2	The Project is to continue using the existing Tai Lam Explosive Magazine at Yuen Long for the tunnel construction works under the Liantang/Heung Yuen Wai Boundary Control Point (BCP) project. The magazine is currently use by the MTR Corporation Limited (MTRC) for the construction of the Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) until end of 2014 (Environmental Permit No. EP-349/2009/L). The Applicant intends to take over the explosive magazine after the XRL project finishes using this facility.	N/A
3.	1.3	No construction activity will be carried out at the explosive magazine site. Mines Division of the Civil Engineering and Development Department will deliver a maximum of 800 kg explosives daily to the Tai Lam Explosive Magazine. The Applicant will deliver the explosives from the magazine to three BCP worksites (North Portal, Mid-ventilation Portal and South Portal) by trucks approved by the Mines Division of the Civil Engineering and Development Department.	N/A
4.	1.4	The existing Tai Lam Explosive Magazine is composed of: (i) Two stores; (ii) Secure fence; (iii) CCTV system; (iv) Guard house; and (v) Street fire hydrant water tank (245m3) and 2 pumps. Location of the Project and the proposed delivery routes as given in the Project Profile is reproduced in Appendix A of this study brief.	Noted in **Section 2.4** of the EIA report and further details of these delivery routes and scheduling can be found in **Section 8 Hazard to Life.**
5.	1.5	The Project is a designated project by virtue of Item K.10 "*An explosives depot or explosives manufacturing plant in a stand-alone, purpose built building*" in Part I of Schedule 2 of the EIAO	Noted in **Section 1.2** of the EIA report.
6.	1.6	Pursuant to section 5(7)(a) of the EIAO, the Director of Environmental Protection (the Director) issues this EIA study brief to the Applicant to carry out an EIA study.	N/A
7.	1.7	The purpose of this EIA study is to provide information on the nature and extent of environmental impacts arising from the operation of the Project and related activities that take place concurrently. This information will contribute to decisions by the Director on : (i) the acceptability of any adverse environmental consequences that are likely to arise as a result of the Project; (ii) the conditions and requirements for the operation of the Project to mitigate against adverse environmental consequences; and (iii) the acceptability of residual impacts after the proposed mitigation measures is implemented.	Purpose of the EIA study noted in **Section 1.2** of the EIA report. Also note there are no known existing, committed and/or planned projects in the vicinity of the Project that could potentially cause cumulative environmental impacts through their interaction with the Project.

Ref.	Section of the EIA Study Brief	Specific Requirements	EIA Report Compliance Check (August 2015)
8.	2.1	The objectives of the EIA study are as follows : (i) to describe the Project and associated works together with the requirements and environmental benefits for carrying out the Project; (ii) to identify and describe elements of community and environment likely to be affected by the Project and/or likely to cause adverse impacts to the Project, including natural and man-made environment and the associated environmental constraints; (iii) to identify and quantify emission sources (including air quality, noise, water quality, waste, etc. as appropriate) and determine the significance of impacts on sensitive receivers and potential affected uses; (iv) to propose the provision of mitigation measures to minimize pollution, environmental disturbance and nuisance during operation of Project; (v) to investigate the feasibility, practicability, effectiveness and implications of the proposed mitigation measures; (vi) to identify, predict and evaluate the residual environmental impacts (i.e after practicable mitigation) and the cumulative effects expected to arise during the operation phases of the Project in relation to the sensitive receivers and potential affected uses; (vii) to identify, assess and specify methods, measures and standards, to be included in the operation of the Project which are necessary to mitigate these residual environmental impacts and cumulative effects and reduce them to acceptable levels; (viii) to investigate the extent of the secondary environmental impacts that may arise from the proposed mitigation measures and to identify constraints associated with the mitigation measures recommended in the EIA study, as well as the provision of any necessary modification; (ix) to design and specify environmental monitoring and audit requirements for the effective implementation of the recommended environmental protection and pollution control measures; and (x) to identify any additional studies necessary to implement the mitigation measures or monitoring and proposals recommended in the EIA report.	Noted and addressed according to specific SB requirements as set out below.
9.	3.1.1	The purpose of this study brief is to scope the key issues of the EIA study and to specify the environmental issues that are required to be reviewed and assessed in the EIA report. The Applicant has to demonstrate in the EIA report that the criteria in the relevant sections of the Technical Memorandum on the Environmental Impact Assessment Process of the Environmental Impact Assessment Ordinance (hereinafter referred to as "the TM") are complied with.	The purpose and scope of the EIA study are noted in **Sections 1.2 and 1.3** of the EIA report. Each relevant section demonstrates the relevant criteria (e.g. for Air, Noise, etc.) have been met according to the TM.
10.	3.2.1	The scope of this EIA study shall cover the Project and associated works proposed in the Project Profile and mentioned in Section 1.2 and 1.3 above. The EIA study shall address the likely key issues described below, together with any other key issues identified during the course of the EIA study:	The scope of the EIA study noted in **Section 1.3** of the EIA report.
11.	3.2.1 (i)	review and, if necessary, update the relevant sections of the approved Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA report (No. AEIAR-143/2009) for the environmental impacts arising from operation of the Tai Lam Explosive Magazine;	The fact that this has been done is noted in **Section 1.3** of the EIA report.
12.	3.2.1 (ii)	potential hazard to life including explosive storage and transport during operation of the Project; and	**Section 8 and Annex 8A** address potential Hazard to Life risks
13.	3.2.1 (iii)	potential cumulative impacts of the Project, through interaction or in combination with other existing, committed and planned projects in the vicinity of the Project.	As stated in **Section 2**, there are no known existing, committed and/or planned projects in the vicinity of the Project that could potentially cause cumulative environmental impacts through their interaction with the Project.
14.	3.3.1	The Applicant shall provide information on the background and history of the Project, including consideration given to different options as described in Sections 3.3.2 and 3.3.3 below. The Applicant shall describe and compare the environmental benefits and disbenefits of the scenarios with or without the Project.	Background and history of the Project is provided in **Section 2** including consideration of the benefits/ disbenefits of project alternatives. **Section 8** and **Annex 8A** also provide detailed analysis of the benefits/ disbenefits of different scenarios.
15.	3.3.2	<u>Consideration of Alternative Explosive Transport Routes</u> The Applicant shall present in the EIA report the consideration of alternatives of the Project, including alternative transport routes, with a view to avoiding adverse environmental impacts during operation of the Project.	**Section 2.1** addresses Project alternatives, including alternative explosive magazine sites and alternative transport routes.
16.	3.3.3	<u>Selection of Preferred Scenario</u> The Applicant shall, taking into consideration of the findings in Sections 3.3.2 above, describe the reasons for selecting the proposed routings and the part that environmental factors played in the selection.	Section 2.1 addresses Project alternatives, including alternative explosive magazine sites and alternative transport routes.

Ref.	Section of the EIA Study Brief	Specific Requirements	EIA Report Compliance Check (August 2015)
17.	3.4.1	The Applicant shall conduct the EIA study to address the environmental aspects described in Sections 3.1, 3.2 and 3.3 above. The assessment shall be based on the best and latest information available during the course of the EIA study. The Applicant shall assess the cumulative environmental impacts from the Project and interacting projects as identified in the EIA study.	See compliance check notes for 3.1.x to 3.3.x above (ref. 9-16). The best and latest information available has been used. There are no known existing, committed and/or planned projects in the vicinity of the Project that could potentially cause cumulative environmental impacts through their interaction with the Project.
		THE EIA STUDY SHALL INCLUDE THE FOLLOWING TECHNICAL REQUIREMENTS ON SPECIFIC IMPACTS.	
	3.4.2	**Review and Update of the previously approved EIA**	
18.	3.4.2.1	To review the approved Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA report (No. AEIAR-143/2009) XRL) for relevant environmental impacts apart from hazard to life on sensitive receivers arising from operation of the Tai Lam Explosive Magazine. Should the review concluded that there are changes in circumstances that warrant a revised environmental impact assessment for any media, the revised assessment(s) shall follow the relevant criteria and guidelines as stated in the respective Annexes of the TM. The Applicant shall submit the detailed technical requirements for the Director's approval prior to commencement of the revised assessment(s).	The EIA report has reviewed the approved XRL EIA report (No. AEIAR-143/2009) XRL) as outlined in **Section 1.3** and detailed in the following sections for relevant elements (**Section** 3 re. Ecology, **Section** 4 re. Noise, **Section** 5 re. Air, **Section** 6 re. Waste Management, **Section** 7 re. 'Other' including water quality and LVIA) and concluded that
	3.4.3	**Impact to Hazard to Life**	
19.	3.4.3.1	The Applicant shall follow the criteria for evaluating hazard to life as stated in Annex 4 of the TM.	Noted these have been followed in **Section 8.2.1**
20.	3.4.3.2	The hazard assessment for the operation of the Project shall follow the detailed technical requirements given in Appendix B of this EIA Study Brief.	See notes under 'Appendix B' below (ref. 31 to 35)
	3.4.4	**Presentation of Summary Information of Environmental Outcomes**	
21.	3.4.4.1	Summary of Environmental Outcomes The EIA report shall contain a summary of key environmental outcomes arising from the EIA study, including environmental benefits of the Project and the environmental protection measures recommended, population and environmentally sensitive areas protected, recommended environmentally friendly designs, key environmental problems avoided and any compensation areas included.	A summary of environmental outcomes is provided in **Section 10**.
22.	3.4.4.2	Summary of Environmental Impacts To facilitate effective retrieval of pertinent key information, the EIA report shall contain a summary table of environmental impacts showing the assessment points, results of impact predictions, relevant standards or criteria, extents of exceedances predicted, impact avoidance measures considered, mitigation measures proposed and residual impacts (after mitigation).This summary shall cover each individual impact and shall form an essential part of the executive summary of the EIA report.	A summary of environmental impacts is provided in **Section 10**, and **Table 10.1**
	3.4.5	**Environmental Monitoring and Audit (EM&A) Requirements**	
23.	3.4.5.1	The Applicant shall identify and justify in the EIA study whether there is any need for EM&A activities during the operation phase of the Project and, if affirmative, define the scope of EM&A requirements for the Project in the EIA study.	Each **Section** that deals with an environmental media (i.e. **Section** 3 re. Ecology, **Section** 4 re. Noise, **Section** 5 re. Air, **Section** 6 re. Waste Management, **Section** 7 re. 'Other' including water quality and LVIA) includes sections detailing whether any mitigation measures are considered necessary for that media and if so, provides details of the recommended mitigation. **Section** 8 for Hazard to Life Assessment similarly provided details of recommended mitigation measures. **Section 9** details the EM&A requirements of the whole Project
24.	3.4.5.2	Subject to the confirmation of the EIA study findings, the Applicant shall follow the guidelines for an EM&A programme as stated in Annex 21 of the TM.	An EM&A Manual is provided separately.
25.	3.4.5.3	The Applicant shall prepare a Project Implementation Schedule in the form of a checklist as shown in Appendix C of this EIA study brief. It shall contain the EIA study recommendations and mitigation measures with reference to the implementation programme.	The Project Implementation Schedule is included as **Annex 9A**
26.	4.1	The Applicant shall notify the Director of the commencement of the EIA study. If the EIA study does not commence within 36 months after the date of issue of this EIA study brief, the Applicant shall apply to the Director for a fresh EIA study brief before commencement of the EIA study.	N/A to EIA report.

Ref.	Section of the EIA Study Brief	Specific Requirements	EIA Report Compliance Check (August 2015)
27.	5.1	In preparing the EIA report, the Applicant shall refer to Annex 11 of the TM for the contents of an EIA report. The Applicant shall also refer to Annex 20 of the TM, which stipulates the guidelines for the review of an EIA report. The Applicant shall accompany with the submission of the EIA report a summary, pointing out where in the EIA report the respective requirements of this EIA Study have been addressed and fulfilled.	This document presents the summary pointing out where in the EIA report the respective requirements of this EIA Study have been addressed and fulfilled. With reference to Annex 11 of the TM for the contents of an EIA report, this EIA report contains: EXECUTIVE SUMMARY IN ENGLISH AND CHINESE presented separately to the EIA Report INTRODUCTION in **Section 1** DESCRIPTION OF THE PROJECT in **Section 2** **Section 3** (Ecology), **4** (Noise), **5** (Air), **6** (Waste Management), **7** (Other including water quality and LVIA) all include text, as applicable, describing stipulated titles below. Note for **Section 8** (Hazard to Life) nomenclature may differ slightly: - ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA - DESCRIPTION OF THE ENVIRONMENT (in **Section 8** included in 'Facility Details') - DESCRIPTION OF ASSESSMENT METHODOLOGIES in **Section 8** included in 'Base Case and Worst Case for Quantitative Risk Assessment', 'Population Data', 'Hazard Identification' and 'Summary of Risks') - IDENTIFICATION OF ENVIRONMENTAL IMPACTS (in **Ch8** included in 'Hazard identification') - PREDICTION AND EVALUATION OF ENVIRONMENTAL IMPACTS (in **Section 8** included in 'Summary of Risks') - MITIGATION OF ADVERSE ENVIRONMENTAL IMPACTS (in **Ch8** included in 'Conclusion and Recommendations') - DEFINITION AND EVALUATION OF RESIDUAL ENVIRONMENTAL IMPACTS (in **Section 8** included in 'Summary of Risks') ENVIRONMENTAL MONITORING AND AUDIT (and overall summary in **Section 9**) - CONCLUSIONS AND RECOMMENDATIONS (and overall summary in **Section 10**) SCHEDULE OF RECOMMENDED MITIGATION MEASURES as **Annex 9A** APPENDIX Annexes provide supporting information for the main EIA report, as detailed in the EIA Table of Contents.
28.	5.2	The Applicant shall supply the Director with hard and electronic copies of the EIA report and the executive summary in accordance with the requirements given in Appendix D. The Applicant shall, upon request, make additional copies of EIA report/documents available to the public, subject to payment by the interested parties of full costs of printing.	See notes under 'Appendix D' below (ref. 36 to 42)
29.	6.1	If there is any change in the name of Applicant for this EIA study brief during the course of the EIA study, the Applicant must notify the Director immediately.	N/A
30.	6.2	If there is any key change in the scope of the Project mentioned in Section 1.2 of this EIA study brief and in Project Profile (No. PP-516/2014), the Applicant must seek confirmation from the Director in writing on whether or not the scope of issues covered by this EIA study brief can still cover the key changes, and the additional issues, if any, that the EIA study must also address. If the changes to the Project fundamentally alter the key scope of the EIA study brief, the Applicant shall apply to the Director for a fresh EIA study brief.	N/A
	Appendix B 1	**Requirements for Hazard to Life Assessment** The Applicant shall carry out hazard assessment as follows:	
31.	1 (i)	Identify hazardous scenarios associated with the storage and transport of explosives and then determine a set of relevant scenarios to be included in a Quantitative Risk Assessment (QRA);	EIA Report also includes key details in Section 8. Detail provided in Annex 8A Section 2, Section 3, Section 4, Section 5, Section 6, Section 7.
32.	1 (ii)	Execute a QRA of the set of hazardous scenarios determined in (i), expressing population risks in both individual and societal terms;	EIA Report also includes key details in Section 8. Detail provided in Annex 8A Section 8
33.	1 (iii)	Compare individual and societal risks with the criteria for evaluating hazard to life stipulated in Annex 4 of the TM; and	EIA Report also includes key details in Section 8. Detail provided in Annex 8A Section 8

Ref.	Section of the EIA Study Brief	Specific Requirements	EIA Report Compliance Check (August 2015)
34.	1 (iv)	Identify and assess practicable and cost-effective risk mitigation measures.	EIA Report also includes key details in Section 8. Detail provided in Annex 8A Section 9
35.	2	The methodology to be used in the hazard assessment should be consistent with previous studies having similar issues (e.g. Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA report (Register No. AEIAR-143/2009)).	EIA Report also includes key details in Section 8. Detail provided in Annex 8A Section 3
	Appendix D	**Requirements for EIA Report Documents**	
	1	The Applicant shall supply the Director with the following number of copies of the EIA report and the executive summary:	
36.	1 (i)	30 copies of the EIA report and 30 copies of the bilingual (in both English and Chinese) executive summary as required under section 6(2) of the EIAO to be supplied at the time of application for approval of the EIA report.	N/A to EIA Report itself. 30 copies, or the number stipulated by the subject officer, of the EIA report and 30 copies, or the number stipulated by the subject officer, of the bilingual (in both English and Chinese) executive summary will be supplied at the time of application for approval of the EIA report.
37.	1 (ii)	When necessary, addendum to the EIA report and the executive summary submitted in item (i) above as required under section 7(1) of the EIAO, to be supplied upon advice by the Director for public inspection.	N/A to the current submission. Will be provided if required at a later date.
38.	1 (iii)	20 copies of the EIA report and 50 copies of the bilingual (in both English and Chinese) executive summary with or without Addendum as required under section 7(5) of the EIAO, to be supplied upon advice by the Director for consultation with the Advisory Council on the Environment.	N/A to EIA Report itself. 20 copies, or the number stipulated by the Director, of the EIA report and 50 copies, or the number stipulated by the Director, of the bilingual (in both English and Chinese) executive summary with or without addendum, will be supplied upon advice by the Director for consultation with the Advisory Council on the Environment.
39.	2	To facilitate public inspection of EIA report via EIAO Internet Website, the Applicant shall provide electronic copies of both the EIA report and the executive summary prepared in HyperText Markup Language (HTML) (version 4.0 or later) and/or in Portable Document Format (PDF version 1.3 or later). A content page capable of providing hyperlink to each section and sub-section of the EIA report and the executive summary shall be included in the beginning of the document. Hyperlinks to figures, drawings and tables in the EIA report and the executive summary shall be provided in the main text from where respective references are made. Graphics in the report shall be in interlaced GIF format or in suitable formats accepted by the Director.	Noted. Once a date for public inspection has been agreed, such electronic copies as stipulated will be provided.
40.	3	The electronic copies of the EIA report and the executive summary shall be submitted to the Director at the time of application for approval of the EIA report.	N/A to EIA Report itself. Noted that a CD containing electronic copies of the EIA report and executive summary will be submitted at the time of application for approval of the EIA report.
41.	4	When the EIA report and the executive summary are made available for public inspection under section 7(1) of the EIAO, the content of the electronic copies of the EIA report and the executive summary must be the same as the hard copies and the Director shall be provided with the most updated electronic copies.	N/A to EIA Report itself. Noted.
42.	5	To promote environmentally friendly and efficient dissemination of information, both hardcopies and electronic copies of future EM&A reports recommended by the EIA study shall be required.	N/A to EIA Report itself. Noted.

Annex 10B

Compliance Checklist for EIA Report (Brief No. ESB-280/2014) against *Technical Memorandum Annex 11: Contents of an Environmental Impact Assessment (EIA) Report*

COMPLIANCE CHECKLIST FOR EIA REPORT (BRIEF NO. ESB-280/2014) AGAINST TECHNICAL MEMORANDUM ANNEX 11: CONTENTS OF AN ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT

Ref.	TM Annex 11 Title	Specific Requirements	EIA Report Compliance Check (July 2015)
1.	EXECUTIVE SUMMARY IN ENGLISH AND CHINESE	• Summary of main issues, findings, conclusions and recommendations	Presented separately to the EIA Report in English and Chinese, with Section 1.2 describing the Project and its purpose and benefits as well as key facilities, Section 1.3 describing the key impact assessment findings for each environmental medium (e.g. ecology, noise, AQ, etc) and with regard to hazard to life, Section 1.4 detailing the key recommended mitigation measures and monitoring required and Section 1.5 providing the conclusion.
2.	INTRODUCTION	• Background of the project • Purpose of the EIA study • The approach	• Section 1.1 provides background of the Project • Section 1.2 provides purpose of the IEA Study • Section 1.3 (Scope of the EIA) and Section 1.4 (Report Structure) provide the approach
3.	DESCRIPTION OF THE PROJECT	• Key project requirements • Site location and site history • Nature, scope and benefits of the project • Size or scale, shape and design of the project • Project timetable and phasing of the project • Means by which the project will be implemented • Any related projects • Type, scope, scale, frequency and duration of the construction, operational or decommissioning (if relevant) activities • Background and history of the project, including considerations given to different options, and the project's different siting or alignment • Description of scenarios with or without the project	• Section 2.4 provides the key project requirements • Section 2.2 provides the site location and site history. History of the site is also provided in Section 3.3 • Section 2.4 describes the nature and scope of the Project while Section 2.1 describes the benefits of the selected site location and selected explosive transport route. • Section 2.3 provides the project schedule • Section 1.1 paragraph 2 provides the contractual arrangements and 2.4 includes the means by which the Project will be implemented • Regarding related projects, the EIA Report is largely drawn from a review of the XRL EIA which was used to obtain the current EP for the magazine site. This is reported in Section 1.3 • Section 2.3 provides the project schedule reporting on operation and decommissioning. There is no construction phase • Section 1.1 provides background of the Project. Section 2.2 provides the site location and site history. History of the site is also provided in Section 3.3. Section 2.1.1 and 2.1.2 describe alternative Site locations and proposed explosive transport routes. Further details of the magazine requirement and selection are presented in Section 9.4.2 of Annex 8A. • Section 2.1 which talks of Project Alternatives discussed the scenario should the TLEM not continue to operate as a magazine and an alternative site have to be found
4.	ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA	• Applicable environmental ordinances and regulations • Applicable government environmental policies and plans • Applicable environmental standards and criteria • Other references	Provided separately as necessary for each medium ie in Section 3.2 (Ecology), 4.2 (Noise), 5.2 (Air), 6.2 (Waste Management), 7.1.1 (Other including water quality and LVIA), 8.2 (Hazard to Life).
5.	DESCRIPTION OF THE ENVIRONMENT	• Baseline environmental conditions • Environmental trends	Provided separately as necessary, for each medium in Section 3.3 (Ecology), 4.3 (Noise), 5.3 (Air), 6 (not applicable - Waste Management), 7.1.2 (Other including water quality and LVIA). In Ch8 included in 'Facility Details'.
6.	DESCRIPTION OF ASSESSMENT METHODOLOGIES	• Assessment methodologies, assumptions and criteria, including sample calculations and input and output files of a typical model run for all mathematical modelling	Section 1.3 describes the scope of the EIA report and how, as per the Study Brief, reference has been made to the approved Hong Kong Section of *Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA Report* (No. AEIAR-143/2009) (hereafter 'XRL EIA') according to which the EP under which the magazine site currently operates was issued. Noting there is no construction phase to the current Project, assessment methodologies have been provided separately to the legislation, policies, plans, standards and criteria, where as necessary for a medium. Section 4.5 describes the assessment methodology for Noise. For Air, Section 5.2 lists the relevant Air Quality Objectives and Section 5.3 explains the rationale for model adopted to predict baseline conditions. In Ch8 descriptions of the methodologies and relevant assumption are included in Section 8.3 'Study Objectives and Methodology', Section 8.5 'Base Case and Worst Case for Quantitative Risk Assessment', Section 8.6 'Population Data', Section 8.7 'Hazard Identification' and Section 8.8 'Summary of Risks'.

Ref.	TM Annex 11 Title	Specific Requirements	EIA Report Compliance Check (July 2015)
7.	IDENTIFICATION OF ENVIRONMENTAL IMPACTS	• Potential environmental impacts including the types, characteristics and estimated quantities of emissions, discharges, wastes, potential risks, disturbances or displacement associated with the activities relating to the project during construction, operation and decommissioning phases • Description of resources or receivers which are vulnerable to change or environmental impacts	Provided separately as necessary, for each medium. Impact identification is provided in Section 3.4 (Ecology), 4.4 and 4.6 (Noise), 5.5 (Air), 6.3 (Waste Management), 7.1.3 (Other including water quality and LVIA). In Ch8 impact identification is included in Section 8.7 'Hazard identification'.
8.	PREDICTION AND EVALUATION OF ENVIRONMENTAL IMPACTS	• Prediction of environmental impacts (including beneficial or adverse; direct or indirect; short term or long term; reversible or irreversible; trans-boundary; cumulative) • Evaluation of predicted environmental impacts against applicable environmental legislation, policies, plans, standards and criteria	Provided separately as necessary, for each medium. Impact identification and evaluation of impacts are provided in Section 3.4 (Ecology), 4.6 (Noise), 5.6 (Air), 6.4 (Waste Management), 7.1.3 (Other including water quality and LVIA). In Ch8 prediction of evaluation of impact is included in Section 8.8 'Summary of Risks'. Table 10.1 also provides a summary of environmental impacts
9.	MITIGATION OF ADVERSE ENVIRONMENTAL IMPACTS	• Measures to eliminate, reduce or remedy adverse environmental impacts	Provided separately as necessary, for each medium. Mitigation measures are proposed in Section 3.5 (Ecology) and Section 6.5 (Waste Management), and deemed not necessary in Section 4 (Noise), Section5 (Air), and Section 7 (Other including water quality and LVIA). In Ch8 mitigation measures are included in Section 8.8.3 'ALARP Assessment' and Section 8.9 'Conclusion and Recommendations'.
10.	DEFINITION AND EVALUATION OF RESIDUAL ENVIRONMENTAL IMPACTS	• Definition and evaluation of net environmental impacts with mitigation measures in place	Provided separately as necessary, for each medium. Impact identification and evaluation of residual impacts are provided in Section 3.4 (Ecology), 4.6 (Noise), 5.6 (Air), 6.4 (Waste Management), 7.1.3 (Other including water quality and LVIA). In Ch8 evaluation of residual impact is included in Section 8.8 'Summary of Risks'. Table 10.1 also provides a summary of residual environmental impacts
11.	ENVIRONMENTAL MONITORING AND AUDIT	• Need for and scope of monitoring and audit • Environmental monitoring and audit requirements, if found to be necessary, and the related environmental monitoring and audit programme	Section 9 details the environmental monitoring and audit requirements of the Project. No adverse impacts are expected prior to mitigation for airborne noise, air quality and water quality, and therefore there are no monitoring or audit requirements for these environmental media. Therefore Section 9 details EM&A for waste management, hazard to life and ecology with Annex 9A providing an implementation schedule
12.	CONCLUSIONS AND RECOMMENDATIONS		Provided separately for each medium. Conclusion and recommendations are provided in Section 3.6 (Ecology), 4.7 (Noise), 5.7 (Air), 6.6 (Waste Management), 7.4 (Other including water quality and LVIA) and 8.9 (Hazard to Life) Section 10 provides and overall summary of conclusions and a final conclusion for the whole report.
13.	SCHEDULE OF RECOMMENDED MITIGATION MEASURES	• A schedule of all mitigation measures recommended in the EIA report, listing out what the mitigation measures are, by whom, when, where and to what requirements, and including the key environmental monitoring and audit requirements	Annex 9A provides the Implementation Schedule
14.	APPENDIX	• Responses to comments received	Annex 10RtC provides the responses to comments received.

Annex 10C

Compliance Checklist for EIA Report (Brief No. ESB-280/2014) against *Technical Memorandum Annex 20*: *Guidelines for the Review of an EIA Report*

COMPLIANCE CHECKLIST FOR EIA REPORT (BRIEF NO. ESB-280/2014) AGAINST TECHNICAL MEMORANDUM ANNEX 20: GUIDELINES FOR THE REVIEW OF AN EIA REPORT

Ref.	TM Annex 20 Title	EIA Report Compliance Check (July 2015)
1	GENERAL APPROACH	
	Organisation of the Information	
1.1	Is the Information logically arranged in sections	Yes. The EIA has been divided in to 10 sections to cover the key environmental media and hazard to life components off the Project. Figures, Tables and Annexes are numbered in accordance the Section number they relate to. In addition page numbers are numbered according to the Section they are in.
1.2	Is the location of information identified in an index or table of contents?	Yes, Table of Contents is provided at the start.
1.3	When information from external sources has been introduced, has a full reference to the source been included?	Yes. e.g. Section 3 provides links to publically available sites for two referenced documents. e.g. Section 8, Section 8.10 lists full details of all references.
	Presentation of Information	
1.4	Has information and analysis been offered to support all conclusions drawn?	Yes, each Section covering a particular medium [Sections 3 (Ecology), 4 (Noise), 5 (Air), 6 (Waste Management), 7 (Other including water quality and LVIA), 8 (Hazard to Life)] has provided information to support the conclusion drawn at the end of the Section. Section 10 then provides an overall conclusion to the EIA report and a summary of the environmental outcomes of the EIA.
1.5	Has information and analysis been presented so as to be comprehensive to the non-specialist using maps, tables and graphical material as appropriate?	Yes.
1.6	Are all the important data and results discussed in an integrated fashion within the information?	Yes.
1.7	Has superfluous information (i.e. information not needed for the decision) been avoided?	Yes. e.g. For Annexes 3A and 3B to Section 3, information repeated in both documents has been removed from one, making reference to the other.
1.8	Has the information been presented in a concise form with a consistent terminology and are there logical links between different sections?	Yes.
1.9	Have prominence and emphasis been given to severe adverse impacts, to substantial environmental benefits, and to controversial issues?	Yes, Section 10 provides a summary of the environmental outcomes of the EIA including Section 10.4 detailing the key environmental problems avoided.
1.10	Is the information objective?	Yes.
	Public Concerns	
1.11	Does the information identify and address the main concerns of the general public and special interest groups (clubs, societies etc.) who may be affected by the project?	Yes. e.g. For Section 8 (Hazard to Life), concerns of the Yuen Long District Council regarding traffic conditions of Pok Oi Interchange during road improvement works that are being carried out and how transport of explosives may be of concern, have been addressed.
1.12	Does the information take account of the main concerns of the relevant statutory or advisory bodies?	Yes. e.g. The draft EIA Report has been reviewed by EPD and specialist departments (e.g. AFCD, etc.) and any informal concerns addressed.
2	DESCRIPTION OF THE PROJECT	
	Features of the Project	
2.1	Are the purpose(s) and objectives of the project explained?	Yes, in Section 1 (Introduction) and Section 2 (Project Description).
2.2	Are the nature and status of project decision(s), for which the EIA study is undertaken, clearly indicated?	Yes, in Section 1 (Introduction) and Section 2 (Project Description).
2.3	Is the estimated duration of the construction phase, operational phase and, where appropriate, decommissioning phase given, together with the programme within these phases?	Yes. There is no construction phase, as detailed in the report. Section 2.3 details the Project Schedule.
2.4	Is the design and size of the project described, using diagrams, plans and/or maps as necessary?	Yes, in Section 2 (Project Description).
2.5	Are the methods of construction described?	n/a as not construction phase.
2.6	Are the nature and methods of production or other types of activity involved in operation of the project described?	Yes, in Section 2 (Project Description).
2.7	Has the land taken up by the project site(s), construction sites, and any associated access arrangements, auxiliary facilities and landscaping areas, been clearly shown on a scaled map?	Yes, in Section 2 (Project Description).
2.8	For a linear project, has the land corridor, vertical and horizontal alignment and need for tunnelling, and earthworks been described?	Yes, Section 2.1.2 describes the proposed transport routes considered for this Project.

Ref.	TM Annex 20 Title	EIA Report Compliance Check (July 2015)
2.9	Have the uses to which the project will be put been described and the different land use areas demarcated?	n/a (no change in land use). Section 2 provides all necessary details of the Project.
	Residues and Emissions	
2.10	Have the types and quantities of waste matter, energy (noise, vibration, light, heat, radiation etc.) and residual materials generated during construction and operation of the project, and the rate at which these will be produced, been estimated ?	Construction n/a for this Project as explained in Section 2 and Section 2.4. Yes, relevant aspects are covered in Section 6 (Waste Management) and Section 4 (Noise).
2.11	Have the ways in which it is proposed to handle and/or treat these wastes and residual materials prior to release/disposal been indicated, together with the routes by which they will eventually be disposed of to the environment?	Yes, relevant aspects are covered in Section 6 (Waste Management).
2.12	Have any special or hazardous wastes which will be produced been identified as such and the methods for their disposal been described, as regards their likely main environmental impacts?	Yes, special or hazardous wastes are not identified as an issue but relevant aspects are covered in Section 6 (Waste Management).
2.13	Have the means by which the quantities of residuals and wastes were estimated been indicated and has uncertainty been acknowledged and ranges provided where appropriate?	Yes, waste is not identified as a key issue but relevant aspects are covered in Section 6 (Waste Management).
3	**BACKGROUND AND HISTORY OF THE PROJECT**	
3.1	Where appropriate does the information include reference to the consideration of the project's siting or alignment by the project proponent?	Yes, Section 2 (Project Description) includes Section 2.2 regarding Project Location and Section 2.1 regarding Project Alternatives.
3.2	Are the reasons for selecting the proposed project or its siting and alignment, and the part environmental factors played in the selection, adequately described?	Yes, in Section 2.1 Project Alternatives.
3.3	Have the main environmental impacts of different siting or alignment options been compared clearly and objectively with those of the proposed project and with the likely future environmental conditions in the absence of the project?	Yes, in Section 2.1 Project Alternatives and Section 9.4.2 of *Annex 8A*.
4	**DESCRIPTION OF THE ENVIRONMENT**	
	Description of the Area Occupied by and Surrounding the Project	
4.1	Have the areas expected to be significantly affected by the various aspects of the project been indicated with the aid of suitable maps?	Yes, Section 2 (Project Description) provides clear information on the area of the Project site and proposed transport route options. In addition relevant Sections regarding different media [e.g. Sections 3 (Ecology), 4 (Noise), 5 (Air)] detail their particular study areas with the aid of figures e.g. Figures 3.1, 4.1, 5.1, etc.
4.2	Have the land uses on the site(s) and in the surrounding areas been described?	Land use will remain the same as existing conditions, as described in Sections 1 (Introduction) and 2 (Project Description). In addition Section 3.3 and Section 7.2 describe the existing conditions.
4.3	Has the affected environment been defined broadly enough to include any potentially significant effects occurring away from the immediate areas of construction and operation?	Construction n/a as noted previously. Yes, affected environment has been defined broadly enough.
	Baseline Conditions	
4.4	Have the components of the environment potentially affected by the project been identified and described sufficiently for the prediction of impacts?	Yes, each Section covering a particular medium [Sections 3 (Ecology), 4 (Noise), 5 (Air), 6 (Waste Management), 7 (Other including water quality and LVIA), 8 (Hazard to Life)] has provided sufficient information on relevant baseline conditions.
4.5	Were the methods used to investigate the affected environment appropriate to the size and complexity of the assessment task?	Yes.
4.6	Has a prediction of the likely future environmental conditions in the absence of the project been developed?	Yes, Section 3 in particular considers this.
4.7	Have existing technical data sources, including local records and studies carried out for environmental agencies and/or interest groups been searched?	Yes, reference in particular is made the XRL EIA Report.
4.8	Have local, regional and national plans and policies been reviewed and other data collected as necessary to predict future environmental conditions?	Yes. e.g. Section 5.3. "Since the continued operation of the magazine site for the HKLTH will commence in 2015, the hourly ambient pollutant concentration data predicted by the **PATH (Pollutants in the Atmosphere and their Transport over Hong Kong) model for Year 2015** has been adopted to reflect the future background air quality in the Project Site area during the operation of the Project".
4.9	Have relevant departments and agencies holding information on baseline environmental conditions been approached?	Yes, draft report circulated to EPD and relevant government departments e.g. AFCD & Risk Officers.

Ref.	TM Annex 20 Title	EIA Report Compliance Check (July 2015)
5	DESCRIPTION OF IMPACTS	
5.1	Have the direct and indirect/secondary effects of constructing, operating and, where relevant, after use or decommissioning of the project been considered (including both positive and negative effects)?	Yes, each Section covering a particular medium [Sections 3 (Ecology), 4 (Noise), 5 (Air), 6 (Waste Management), 7 (Other including water quality and LVIA), 8 (Hazard to Life)] has provided relevant information regarding potential impacts.
5.2	Does the information include consideration of whether effects will arise as a result of "consequential" development i.e. whether additional development, which it would be difficult to resist, will be included in the area, leading to further environmental effects? For a project with multiple stages, are the impacts caused by overlapping of different stages considered and determined?	n/a.
5.3	Have the above types of impacts been investigated in so far as they affect the following:	
	air and climate;	Yes, Section 5.
	water and soils;	Yes, Section 7.
	noise;	Yes, Section 4.
	landscape;	Yes, Section 7.
	ecology;	Yes, Section 3.
	historic and cultural heritage;	Not relevant to this Project.
	land use;	Not relevant to this Project.
	impacts on people and communities;	Not relevant to this Project.
	impacts on agriculture and fisheries activities.	Not relevant to this Project.
5.4	If any of the above are not of concern in relation to the specific project and its location is this clearly stated in the information?	Yes, Section 1.3 clearly defines the scope of the report.
5.5	Is the investigation of each type of impact appropriate to its importance for the decision, avoiding unnecessary information and concentrating on the key issues?	Yes, information is succinct with Annexes provided for more detail where required.
5.6	Are impacts which may not be themselves significant, but which may contribute incrementally to a significant effect considered?	As stated in Section 2, there are no known existing, committed and/or planned projects in the vicinity of the Project that could potentially cause cumulative environmental impacts through their interaction with the Project. Any impacts that may have incremental significance have been duly considered.
5.7	Does the information include a description of the methods/approaches used to identify impacts and the rationale for using them?	Yes, each Section covering a particular medium [Sections 3 (Ecology), 4 (Noise), 5 (Air), 6 (Waste Management), 7 (Other including water quality and LVIA), 8 (Hazard to Life)] includes details of the methods/ approaches used.
5.7	If the nature of the project is such that accidents are possible which might cause severe damage within the surrounding environment, has an assessment of the probability and likely consequences of such events been carried out and the main findings reported?	Yes, Section 8 (Hazard to Life) covers this.
	Magnitude of Impacts	
5.9	Are impacts described in terms of the nature and magnitude of the change occurring and the nature (location, number, value, sensitivity) of the affected receiver?	Yes, magnitude of any potential impacts identified have been suitably described in each Section covering a particular medium [Sections 3 (Ecology), 4 (Noise), 5 (Air), 6 (Waste Management), 7 (Other including water quality and LVIA), 8 (Hazard to Life)].
5.10	Has the timescale over which the effects will occur been predicted such that it is clear whether impacts are short, medium or long term, temporary or permanent, reversible or irreversible?	Yes. Section 2.3 provides an overall schedule for the Project and duration of impacts is noted where necessary for particular media [Sections 3 (Ecology), 4 (Noise), 5 (Air), 6 (Waste Management), 7 (Other including water quality and LVIA), 8 (Hazard to Life)]
5.11	Where possible, have predictions of impacts been expressed in quantitative terms? Otherwise, have qualitative descriptions been defined?	Yes. In particular quantitative terms have been used in Section 8 (Hazard to Life), and Sections 4 (Noise), 5 (Air) and 7.1 (Water Quality). More qualitative descriptions are given in Section 3 (Ecology), 6 (Waste) and
5.12	Where quantitative predictions have been provided is the level of uncertainty attached to the results described?	Yes. e.g. for Section 8 (Hazard to Life), 8.5 discusses the base case and worst case quantitative risk assessment
	Data and Methods	

Ref.	TM Annex 20 Title	EIA Report Compliance Check (July 2015)
5.13	Have the methods used to predict the nature, size and scale of impacts been described and are they appropriate to the importance of each projected impact?	Yes. Section 1.3 describes the scope of the EIA report and how, as per the Study Brief, reference has been made to the approved Hong Kong Section of *Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL) EIA Report* (No. AEIAR-143/2009) (hereafter 'XRL EIA') according to which the EP under which the magazine site currently operates was issued. Noting there is no construction phase to the current Project, assessment methodologies have been provided separately to the legislation, policies, plans, standards and criteria, where as necessary for a medium. Section 4.5 describes the assessment methodology for Noise. For Air, Section 5.2 lists the relevant Air Quality Objectives and Section 5.3 explains the rationale for model adopted to predict baseline conditions. In Ch8 descriptions of the methodologies and relevant assumption are included in Section 8.3 'Study Objectives and Methodology', Section 8.5 'Base Case and Worst Case for Quantitative Risk Assessment', Section 8.6 'Population Data', Section 8.7 'Hazard Identification' and Section 8.8 'Summary of Risks'.
5.14	Are the data used to estimate the size and scale of the main impacts sufficient for the task, are they clearly described and have their sources been clearly identified?	Yes. e.g. for Section 8, Section 8.10 lists full details of all references.
6	**MITIGATION**	
	Description of Mitigating Measures	
6.1	Has the mitigation of significant negative impacts been considered and, where feasible, have specific measures been proposed to address each impact?	Yes. Impact identification and evaluation of impacts are provided in Section 3.4 (Ecology), 4.6 (Noise), 5.6 (Air), 6.4 (Waste Management), 7.1.3 (Other including water quality and LVIA). In Ch8 evaluation of residual impact is included in Section 8.8 'Summary of Risks'. Overall, specific measures have been proposed to address each impact identified to be of significance, as summarised for all media in Section 9 (Environmental Monitoring and Audit Requirements) and the Implementation Schedule of Recommended Mitigation measures in *Annex 9A*. Table 10.1 also provides a summary of environmental impacts
6.2	Have the reasons for choosing the particular type of mitigation, and the other options available, been described?	No adverse impacts are expected prior to mitigation for airborne noise, air quality and water quality although standard good practise measures are advised for good measure relating to noise and water quality during decommissioning, as described in Section 4 and 7.1 respectively. Mitigation for waste management, hazard to life and ecology are described in Sections 6, 8 and 3 respectively with Section 9 summarising the EM&A requirements and Annex 9A providing an implementation schedule
6.3	Where mitigating measures are proposed, has the significance of any impact remaining after mitigation been described?	Yes. Impact identification and evaluation of residual impacts are provided in Section 3.4 (Ecology), 4.6 (Noise), 5.6 (Air), 6.4 (Waste Management), 7.1.3 (Other including water quality and LVIA). In Ch8 evaluation of residual impact is included in Section 8.8 'Summary of Risks'. Table 10.1 also provides a summary of residual environmental impacts
6.4	Where appropriate, do mitigation methods considered include modification of project design, construction and operation, the replacement of facilities/resources, and the creation of new resources, as well as "end-of-pipe" technologies for pollution control?	Appropriate mitigation measures have been suggested. Since there is no construction phase to the Project, there are limited possibilities to modify the project design.
6.5	Is it clear to what extent the mitigation methods will be effective?	Yes.
6.6	Where the effectiveness is uncertain or depends on assumptions about operating procedures, climatic conditions, etc., or where there is a risk that mitigation will not work, is this made clear and has data been introduced to justify the acceptance of the assumptions?	The effectiveness of mitigation measures is not uncertain in this respect, therefore not applicable.
	Implementation of Mitigation Measures	
6.7	Have details of how the mitigation measures will be implemented and function over the time span for which they are necessary been presented? Does the report list out clearly what mitigation measures would be implemented, by whom, when, where and to what requirements? Is the responsibility for implementing the recommended mitigation measures clearly defined?	Yes, the Implementation Schedule of Recommended Mitigation Measures in *Annex 9A* provides these details.
	Environmental Effects of Mitigation	
6.8	Have any adverse environmental effects of mitigation measures been investigated and described?	None of the mitigation measures suggested are considered to have adverse environmental effects therefore this is not applicable.
6.9	Has the potential for conflict between the benefits of mitigating measures and their adverse impacts been considered?	Yes, but no conflict has been identified.
7	**Evaluation of Residual Impacts**	
7.1	Have the available standards, assumptions and criteria which can be used to evaluate the impacts been discussed?	Yes. Provided separately as necessary for each medium i.e. in Section 3.2 (Ecology), 4.2 (Noise), 5.2 (Air), 6.2 (Waste Management), 7.1.1 (Other including water quality and LVIA), 8.2 (Hazard to Life).

Ref.	TM Annex 20 Title	EIA Report Compliance Check (July 2015)
7.2	Have the predicted impacts been compared to the available standards and criteria?	Yes. Impact identification and evaluation of impacts are provided in Section 3.4 (Ecology), 4.6 (Noise), 5.6 (Air), 6.4 (Waste Management), 7.1.3 (Other including water quality and LVIA). In Ch8 prediction of evaluation of impact is included in Section 8.8 'Summary of Risks'.
7.3	Have the residual impacts, which are the net impacts with the mitigation measures in place, been described and evaluated against the available Government policies, standards and criteria?	Yes. No adverse residual impacts are predicted for environmental media. For hazard to life, adverse residual impact is not predicted for risk due to storage of explosives and for risk due to transport, Individual Risk level is below 1×10^{-5} per year; and Societal Risk level is in ALARP region as summarised in Section 8.8.
7.4	Have the residual impacts been discussed and evaluated in terms of the impact on the health and welfare of the local community and on the protection of environmental resources?	Yes. e.g. Section 8.8.1 discussed Individual Risk results, 8.8.2 discusses Societal Risk results and 8.8.3 discusses the ALARP assessment.
7.5	Have the magnitude, location and duration of the residual impacts been discussed in conjunction with the value, sensitivity and rarity of the resource?	Yes.
7.6	Where there are no generally accepted standards or criteria for the evaluation of residual impacts, have alternative approaches been discussed and, if so, is a clear distinction made between fact, assumption and professional judgment?	There are generally accepted standards or criteria for all evaluated impacts and risks.
7.7	Have the residual impacts, if any, arising from the implementation of the proposed mitigation measures, been considered?	As no adverse impacts from implementing the proposed mitigation measures have been identified this is not applicable.
8	**Environmental Monitoring and Audit Proposals**	
8.1	If impacts are uncertain, have monitoring arrangements been proposed to check the environmental impacts resulting from the implementation of the project and their conformity with the predictions made?	Yes, Section 9 details the environmental monitoring and audit programme and a separate EM&A Manual has been developed for the Project.
8.2	Does the scale of any proposed monitoring arrangements correspond to the potential scale and significance of deviations from expected impacts?	Yes.
8.3	Is the need for and the scope of the monitoring and audit requirements defined in the report?	Yes. Section 9 details the environmental monitoring and audit programme and a separate EM&A Manual has been developed for the Project.
8.4	Does the report contain an Environmental Monitoring and Audit programme, as prescribed in Annex 21, if it is found to be needed?	Yes.
9	**Difficulties Compiling the Information**	
9.1	Have any gaps in the required data been indicated and the means used to deal with them in the assessment been explained?	No significant gaps in data identified.
9.2	Have any difficulties in assembling or analysing the data needed to predict impacts been acknowledged and explained?	No difficulties in assembling or analysing data were encountered.
10	**Executive Summary**	
10.1	Does the executive summary contain at least a brief description of the project and the environment, an account of the main mitigation measures to be implemented by the developer, and a description of any remaining or residual impacts?	Yes. The ES is ordered as such to summarise the key details of the EIA report: 1.1 Background 1.2 Project Description including nature and scope; purpose and benefit; and key facility of the Project 1.3 Environmental impact assessment, split into 1.3.1 covering all the environmental media (ecology, noise, air quality, waste management, and other environmental consideration', as well as 1.3.2 hazard to life 1.4 Environmental monitoring and audit 1.5 Conclusion
10.2	Have technical jargons been avoided as far as possible in the executive summary?	Yes.
10.3	Does the executive summary present the main findings of the assessment and cover all the main issues?	Yes. See check against 10.1
10.4	Does the executive summary include a brief explanation of the overall approach to the assessment?	Yes. See check against 10.1
10.5	Does the executive summary provide an indication of the confidence which can be placed in the results?	Yes. See check against 10.1
10.6	Is the executive summary presented in both English and Chinese?	Yes.

Annex 10RtC

Responses to Comments Received

Minutes of Relevant District Council Meetings

會議記錄於 25.9.2014 獲得通過，無須修訂。

元朗區議會交通及運輸委員會
二零一四年度第四次會議記錄

日　期：二零一四年七月二十四日(星期四)

時　間：上午九時三十分至下午四時二十分

地　點：元朗橋樂坊二號元朗政府合署十三樓 元朗區議會會議廳

出席者		出席時間	離席時間
副主席：	黃卓健議員	會議開始	會議結束
委　員：	湛家雄議員, BBS, MH, JP	會議開始	會議結束
	陳美蓮議員	會議開始	會議結束
	陳思靜議員	上午 09:45	會議結束
	張木林議員	會議開始	會議結束
	趙秀嫻議員	上午 09:45	會議結束
	周永勤議員	上午 10:05	下午 03:40
	徐君紹議員	會議開始	下午 03:40
	郭慶平議員	上午 09:50	下午 02:20
	郭　強議員, MH	會議開始	會議結束
	鄺俊宇議員	會議開始	會議結束
	黎偉雄議員	會議開始	下午 03:20
	劉桂容議員	會議開始	會議結束
	李月民議員, MH	會議開始	會議結束
	梁福元議員	會議開始	會議結束
	呂　堅議員	上午 10:15	下午 03:50
	麥業成議員	上午 09:45	下午 01:20
	文志雙議員	會議開始	上午 10:45
	文光明議員	會議開始	會議結束
	沈豪傑議員	會議開始	下午 03:40
	蕭浪鳴議員	上午 09:50	會議結束
	鄧焯謙議員	上午 09:50	下午 03:40
	鄧卓然議員	會議開始	下午 03:45
	鄧家良議員	會議開始	會議結束
	鄧貴有議員	會議開始	下午 03:45
	黃煒鈴議員	會議開始	下午 03:55
	王威信議員	會議開始	下午 03:45
	姚國威議員	會議開始	上午 11:50
	袁敏兒議員	會議開始	會議結束

增選委員	：	朱錦輝先生	會議開始	下午 12:05
		高俊傑先生	上午 09:45	會議結束
		鄺智揚先生	會議開始	會議結束
		梁明堅先生	會議開始	會議結束
		梁業鵬先生	會議開始	下午 03:40
		馬淑燕女士	上午 10:00	會議結束
		鄧川雲先生	會議開始	會議結束

秘　　書 ： 蔡鴻敏小姐　　元朗民政事務處行政助理(區議會)二

<u>列 席 者</u>

蔡松霖先生	元朗民政事務助理專員(二)
黎聲泉先生	運輸署高級運輸主任/元朗
張飛傑先生	運輸署工程師/元朗東
陳建峰先生	運輸署工程師/行人區改善計劃
馮靖翔先生	運輸署工程師/天水圍
鄭偉豪先生	路政署區域工程師/元朗(西)
葉偉倫先生	土木工程拓展署工程師/16 (新界西)
吳良知先生	香港警務處元朗區交通隊主管
徐雲龍先生	房屋署房屋事務經理(元朗五)
莫慧詩女士	元朗地政處行政助理/地政
鄧慶業議員	
梁志祥議員	
邱帶娣議員	
黃偉賢議員	

<u>議程第二項</u>

黃劍波先生	土木工程拓展署總工程師/口岸工程
鄒炳基先生	土木工程拓展署高級工程師/4，口岸工程
柯重銘先生	土木工程拓展署工程師/7，口岸工程
黃仲達先生	艾奕康有限公司駐地盤總工程師
魯錦明先生	艾奕康有限公司駐地盤高級工程師
黃永健先生	艾奕康有限公司駐地盤高級工程師
鄭威文先生	香港寶嘉建築有限公司副項目董事
歐陽順先生	香港寶嘉建築有限公司建造經理

<u>議程第三項</u>

王建生先生	水務署工程師/顧問工程管理(12)
呂素賢女士	博威工程顧問有限公司駐地盤高級工程師
張志成先生	博威工程顧問有限公司駐地盤工程師
陳廣生先生	博威工程顧問有限公司駐地盤高級工程督察

<u>議程第四項</u>

李德興先生	香港鐵路有限公司高級建造工程師

<u>議程第四及五項</u>

王謙佑先生	運輸署高級工程師/西北

<u>議程第四、六(1)、七(3)及(4)項</u>

林　圓女士	香港鐵路有限公司助理公共關係經理—對外事務

<u>議程第五項</u>

陳派明先生	路政署主要工程管理處處長
黃鎮健先生	路政署主要工程管理處高級工程師 4/屯門路(候任)
陸偉雄先生	渠務署設計拓展科總工程師/排水工程
吳永順先生	香港城市設計學會副會長(公共政策)
岑延威先生	香港建築師學會本地事務部主席

<u>議程第六(2)項</u>

梁佩賢女士	運輸署總運輸主任/新界西北
張蓮用女士	運輸署總運輸主任/巴士及鐵路 1
黃培中先生	運輸署運輸主任/巴士發展(九龍)
陳碧君女士	九龍巴士(一九三三)有限公司企業事務總監
尹彥超先生	九龍巴士(一九三三)有限公司社區事務高級經理
蔡麗芬女士	九龍巴士(一九三三)有限公司高級經理(策劃及發展)
溫惠炎先生	九龍巴士(一九三三)有限公司襄理(車務)
黃綺玲女士	九龍巴士(一九三三)有限公司高級車務主任
潘振剛先生	龍運巴士有限公司襄理(車務)
羅耀華先生	龍運巴士有限公司一級策劃及支援主任

<u>缺 席 者</u>

陸頌雄議員	(因事請假)
莊健成議員	(因事請假)
鍾啟生先生	(因事請假)
余仲良先生	(因事請假)

*　　*　　*　　*　　*

歡迎詞

交通及運輸委員會(交委會)主席因公離港，未能出席會議。根據元朗區議會常規第 6 條(2)的規定，副主席須履行主席的職責(包括主持會議)，因此是次會議將由副主席主持。

2． 副主席歡迎各委員及政府部門代表出席元朗區議會交委會二零一四年度第四次會議，並特別歡迎首次出席會議的土木工程拓展署工程師/16(新界西)葉偉倫先生。同時，副主席表示議程第六項(2)的 2014–2015 年度元朗區巴士路線發展計劃將留待本年八月六日舉行的交委會第二次特別會議上討論。另外，副主席批准加入「關注西鐵綫在本月 22 日發生信號系統故障，令全線服務延誤超過六小時情況」的議程項目。

第一項：通過二零一四年度第三次會議記錄

3． 委員一致通過上述會議記錄。

第二項：蓮塘／香園圍口岸與相關工程
(交委會文件 2014／第 56 號)

4． 副主席歡迎下列人士出席會議：

土木工程拓展署	
總工程師/口岸工程	黃劍波先生
高級工程師/4, 口岸工程	鄒炳基先生
工程師/7, 口岸工程	柯重銘先生
艾奕康有限公司	
駐地盤總工程師	黃仲達先生
駐地盤高級工程師	魯錦明先生
駐地盤高級工程師	黃永健先生
香港寶嘉建築有限公司	
副項目董事	鄭威文先生
建造經理	歐陽順先生

5． 黃永健先生簡介上述文件。

6． 委員就議題發表的意見摘錄如下：

(1) 指出香港鐵路有限公司(港鐵公司)現正使用元朗大樹下火藥貯存庫以配合廣深港高速鐵路工程，而土木工程拓展署(土拓署)將於二零一五年至二零一八年間，使用同一貯存庫存取爆炸品以配合題述工程，擔心有關貯存庫將成為恆常甚至永久的火藥貯存庫，為區內居民帶來隱憂；

(2) 反映博愛交匯處的交通擠塞問題嚴重，由於現正進行改善工程，改道的安排令有關路段更加迂迴，加上改善工程的進度有機會受新建行車天橋地基影響而延誤，短期內未必能紓緩博愛交匯處的交通壓力，增加運送爆炸品的潛在風險，故建議修改運送路線至唐人新村交匯處及元朗公路，盡量避免經過十八鄉交匯處及博愛交匯處，以減低發生意外的風險；

(3) 查詢導致爆炸品爆炸的可能性，包括發生交通意外、車輛起火、車輛被騎劫、雷擊，甚至與模型飛機場的模型飛機產生碰撞等；

(4) 查詢運送爆炸品至工地的詳細程序，例如有否安全人員陪同運送爆炸品及運送車輛的前後有否其他車輛開路和殿後，以確保運送過程安全無誤；

(5) 查詢運送爆炸品至工地的次數、頻率及數量，並反映十八鄉一帶有路段需單線雙程行車，路面比較狹窄，建議有關部門於非繁忙時段或凌晨時段運送爆炸品，以將風險降至最低，同時減少對區內居民的影響；

(6) 反映除了對運送爆炸品至工地的過程有疑慮外，亦非常關注將爆炸品運入至元朗大樹下火藥貯存庫的路線及程序；

(7) 指出內地曾發生因運送爆炸品而造成傷亡的意外，湖北及黑龍江分別於二零零九年及二零一三年發生類似事件，強調有關部門必須採取足夠的安全措施，以釋除委員及區內居民的疑慮；

(8) 有委員指出題述工程的工地為北區範圍，對有關部門使用元朗大樹下火藥貯存庫以存取爆炸品表示無法理解，查詢招標期間預計使用的火藥貯存庫地點，並指出貯存庫地點的位置差異會直接影響招標的價格，必須釐清，同時建議於工地附近申請興建新火藥貯存庫，以減少運輸時間，從而降低發生交通意外的風險；

(9) 另有委員表示明白另覓地點或興建新火藥貯存庫需時數年，並理解運送期間將爆炸品及雷管以不同車輛運送至目的地的做法

安全，故大致同意運送爆炸品的安排，但強調有關部門必須與十八鄉鄉事委員會及當區議員保持緊密聯繫，定期匯報工程事宜，以確保區內居民知悉；及

(10) 有委員要求將議題中涉及存放爆炸品於火藥貯存庫的部分轉交城鄉規劃及發展委員會討論。

7. <u>黃永健先生</u>綜合回應如下：

(1) 強調承建商將根據香港法例第 295 章《危險品條例》運送、貯存及使用爆炸品，運送車輛設有全球定位系統，而運送車輛的司機亦會由礦務部審批，具備專業的操守；

(2) 有關運送爆炸品至工地的次數及頻率，承建商每天將運送三至四次爆炸品，運送時間均為非繁忙時段，包括早上七時三十分前、約下午一時後及晚上八時後，如有需要，會另於凌晨時分運送爆炸品；

(3) 有關運送爆炸品至工地的程序，承建商每次均會以兩輛車分別運載爆炸品及雷管，並於車內設置木箱妥善封存爆炸品及雷管，確保運送過程安全妥善；

(4) 指出礦務部會根據貯存庫的火藥存量定期指派人員巡查，以確保貯存庫的運作正常；

(5) 指出於香港運送爆炸品並非先例，有關題述工程的運送安排與西港島綫、南港島綫、觀塘延綫及廣深港高速鐵路等工程的爆炸品運送程序大致相同；

(6) 重申承建商是根據實際情況使用元朗大樹下火藥貯存庫存取爆炸品，並指出港鐵公司之承建商另有掃管笏火藥貯存庫及將軍澳火藥貯存庫，惟與上述兩者相比，元朗大樹下火藥貯存庫與工地相距最近，能有效縮短運送路線；

(7) 解釋沒有接駁雷管的爆炸品無法引爆，因此大部分特殊情況如發生交通意外及車輛起火，均不會導致爆炸品爆炸；及

(8) 強調土拓署及顧問公司將於會後繼續與當區議員及十八鄉鄉事委員會商討有關事宜，而專責工作小組亦會繼續收集意見，以期優化方案。

8． 鄭威文先生補充，內地因運送爆炸品而造成傷亡意外的主要原因是當時內地所使用的爆炸品為粉末狀的黑火藥，而題述工程所使用的爆炸品為傳統的「豬腸形」火藥，必須有雷管才能引爆，質素較高。

9． 魯錦明先生補充，根據承建商於招標時提供的時間表，原本計劃毋須使用火藥貯存庫，惟因時間緊迫，加上面臨各種不明確因素，包括天氣變化及地質問題，因此承建商提出使用火藥貯存庫，以確保工程能如期竣工。

10． 副主席總結，大部分委員同意元朗大樹下火藥貯存庫比其他貯存庫的位置方便運送，惟委員均非常關注運送爆炸品期間的安全問題，尤其重視運送的時間及路線，期望土拓署能與當區議員及有意見的委員積極商討有關安排。

第三項：為配合水務工程而需臨時封閉近凹頭交匯處的行車天橋計劃(交委會文件 2014／第 57 號)

11． 副主席歡迎下列人士出席會議：

水務署	
工程師/顧問工程管理(12)	王建生先生
博威工程顧問有限公司	
駐地盤高級工程師	呂素賢女士
駐地盤工程師	張志成先生
駐地盤高級工程督察	陳廣生先生

12． 張志成先生簡介上述文件。

13． 委員就議題發表的意見摘錄如下：

(1) 支持水務署更換及修復水管的工程，惟不贊同臨時封閉連接青山公路 – 元朗段和潭尾段的行車天橋的安排；

(2) 指出有關行車天橋於九十年代興建至今，一直有效紓緩博愛交匯處的交通壓力，對交通流量報告的數據並不認同，認為連接青山公路 – 元朗段和潭尾段的行車天橋並不只應付三成的交通流量，尤其當博愛交匯處出現交通擠塞的情況下，有關行車天橋具有後備作用，有助疏導交通；

(3) 反映區內陸續有新屋苑入伙，人口不斷增加，車輛流量隨之上升，臨時封橋會令博愛交匯處及凹頭交匯處的交通擠塞問題惡化，對錦田、新田、八鄉及錦綉花園一帶居民造成深遠的影響；

(4) 明白水務署因關注交通安全問題而臨時封橋，惟認為署方應平衡交通安全及交通擠塞問題，慎重考慮臨時封橋的必要性，並要求署方解釋封橋與否對工程進度的影響有何差異；

(5) 反映連接青山公路 – 元朗段和潭尾段的行車天橋與友善街距離甚遠，並指出屯門公路曾進行路面重建工程，惟當時屯門公路荃灣至汀九路段只實施臨時收緊車速限制的措施，並無封路或封橋的安排，故認為臨時封橋並非唯一的解決方法，建議以其他臨時交通管制措施取代有關安排，例如收緊車速限制至時速五十公里以下、於落橋位及道路匯合點加設黃色減速帶、於工程位置附近加設警告標誌或指示牌、於橋頂設置閉路電視等；

(6) 對署方設有後備方案表示不理解，認為顧問公司根據圖則進行評估及研究，應能確定水管位於青山公路 – 元朗段西行方向的中線或快線，而非於挖掘後才確定水管的位置；

(7) 查詢假如落實臨時封橋的安排，當發生交通意外而造成凹頭交匯處出現擠塞時，即時開通有關行車天橋以疏導車輛的可能性；

(8) 假如落實臨時封橋的安排，建議縮短封橋的長度，盡量預留更多空間予車輛由中線切入快線，並將施工時期縮短，以減少對居民及駕駛者造成的影響，另建議於工程期間翻新有關行車天橋，以確保其結構安全鞏固；

(9) 由於石棉對人體有害，查詢工程進行期間會否密封施工位置以確保駕駛者的安全，並查詢區內尚餘石棉喉管的數量；及

(10) 指出署方必須與當區議員及各鄉事委員會詳細商討有關安排，建議署方於會後繼續聽取各方意見，以期優化並完善方案。

14． <u>張志成先生</u>綜合回應如下：

(1) 表示會與運輸署及警務處共同商討有關於行車天橋落橋位實施臨時交通管制措施的意見，改善行車安全問題；

(2) 重申於本年六月至七月進行交通流量評估，結果顯示經連接青山公路 － 元朗段和潭尾段的行車天橋至元朗方向的交通流量佔三成，而經交匯處至元朗方向則佔七成；及

(3) 解釋署方曾於六月中與運輸署及警務處開會商討施工安排，最後基於交通流量及安全考慮才建議臨時封橋。

15． 副主席總結，水務署更換及修復水管的工程能確保食水水質，因此委員不反對進行有關工程，惟臨時封橋將對區內居民造成一定的影響，故委員一致不贊成臨時封橋的安排。副主席建議署方於會後繼續與各鄉事委員會及有意見的委員溝通，考慮其他替代方案，而日後有相關的施工安排亦務必事先與各委員溝通，以期達成共識。

第四項：輕鐵大棠路站二號月台提升工程 － 相關之臨時交通管理計劃 (交委會文件 2014／第 58 號)

16． 副主席歡迎下列人士出席會議：

運輸署	
高級工程師/西北	王謙佑先生
香港鐵路有限公司	
高級建造工程師	李德興先生
助理公共關係經理—對外事務	林　圓女士

17． 林圓女士及李德興先生簡介上述文件。

18． 委員就議題發表的意見摘錄如下：

(1) 對香港鐵路有限公司(港鐵公司)未有事先與委員共同商討有關的臨時交通管理計劃表示不認同，並指出各委員對區內的交通網絡較為熟悉，能提供有建設性的意見；

(2) 指出港鐵公司提供的資料欠詳盡且缺乏數據支持，要求港鐵公司提供工程完成後月台候車空間增加的數據，另指出港鐵公司應對臨時封閉快線所造成的交通影響及施工期間對候車乘客造成的影響作出評估，例如施工期間所佔用的月台候車範圍及疏導候車乘客的措施；

(3) 大部分委員對港鐵公司臨時封閉部分青山公路 – 元朗段西行方向的快線以及港鐵公司建議的替代路線有保留，當中替代路線一經過的谷亭街一直面對交通擁擠的問題，而替代路線二經過的日新街、阜財街、又新街、合益路及合財街的車輛違泊問題亦非常嚴重，加上兩條替代路線均較迂迴，擔心有關方案會增加區內交通負荷；

(4) 建議將替代路線一由谷亭街直入至內街的路線改為右轉至青山公路 – 元朗段；

(5) 建議將替代路線二由日新街左轉入阜財街的路線改為右轉入阜財街，並直出大棠路；

(6) 建議將替代路線二由朗日路轉入大棠道的路線作為臨時巴士專線，而由朗日路轉入鳳翔路的路線則供其他車輛使用，其他車輛可經合益路、馬棠路或十八鄉路向西行；

(7) 建議臨時封閉輕鐵大棠路站二號月台末段近新基大廈的交通燈，以助疏導青山公路 – 元朗段的車輛流量；

(8) 反映週末常有非本區居民及遊客駕駛至元朗，有關人士對元朗區內的道路並不熟悉，臨時封路的安排容易造成混亂，因此，於臨時封閉快線期間，必須加強道路交通指示，尤其於車輛進入元朗區內範圍前，需正確指導駕駛者；

(9) 指出實施臨時封路措施的時期過長，認為有關措施毋須分兩個階段進行，建議一次性進行工程，並縮短封路的時期至三個月，減少對附近居民及駕駛者的影響；

(10) 有關提升工程的計劃詳情，委員普遍贊成將附近的行人過路處由五米擴闊至九米，並同意伸延簷蓬至月台旁的斜道，惟大部分委員不認同將現有月台上蓋簷蓬支柱往後移的工程，認為有關工程對增加月台候車空間的作用不大，而省去有關工程便毋須封閉快線，能減少對區內居民的影響，亦有委員對月台上蓋採用半透明的設計表示保留，指出半透明上蓋容易積聚灰塵，而且未能完全隔光，遮蔭效果有限，另有委員建議於月台加裝通風扇，降低月台的溫度，以改善候車環境；及

(11) 促請港鐵公司加強與運輸署及警務處的溝通及合作，互相配合，將對附近居民及道路使用者的影響減至最低。

19． 李德興先生綜合回應如下：

(1) 指出九廣鐵路公司(九鐵)十年前已於輕鐵大棠路站進行擴闊月台的工程，當時九鐵未有將月台上蓋簷蓬支柱往後移，但由於輕鐵大棠路站的候車乘客數量日漸增加，為了騰出更多候車空間，港鐵公司計劃移後月台上蓋簷蓬支柱，預計有關工程完成後，月台的人流量將增加約兩成；

(2) 解釋有關工程的施工技術及難度較高，港鐵公司需鑽挖並種入多條鐵支作為月台地基的結構物，以確保月台地基及支柱有足夠的承受力支撐新建之月台上蓋簷蓬，並能承受猛烈的風力，由於月台旁已是青山公路 – 元朗段西行方向快線，工程難免需佔用部份快綫範圍，故須臨時封閉有關路段；

(3) 由於進行鑽挖地基的工程會發出一定的聲響，故必須於日間進行，而夜間則進行吊運及安裝的工序，以減少對附近居民造成的滋擾；

(4) 指出港鐵公司曾考慮三個方案進行臨時封路的措施，包括單一階段、分兩個階段或三個階段進行，如一次過不分階段進行有關措施，能將封路期縮短至三個月，惟該三個月每天需長時間佔用候車空間，對候車乘客造成較大的影響，而分三個階段進行，每天的封路時間會減少，但整個工期包括封路日子則會延長至九個月，對駕駛者造成較長時間的影響，因此港鐵公司取其平衡，分兩個階段進行，預計於星期一至六早上十時至下午四時進行封路，以盡量減少對候車乘客及駕駛者的影響；

(5) 重申港鐵公司已委託顧問公司於平日、週末及假日就輕鐵大棠路站一帶的交通流量作詳細的評估，其結果顯示，假如青山公路 - 元朗段減少兩成車輛流量，一條行車線亦足以應付餘下的車輛流量，而港鐵公司建議的替代路線正正能應付額外增加的兩成車輛流量；

(6) 備悉委員對替代路線的意見，港鐵公司會積極考慮各方案；及

(7) 強調港鐵公司將繼續與運輸署及警務處保持緊密聯繫，盡快實施交通試行的安排，及早檢視臨時封路及替代路線的可行性。

20． 林圓女士補充，將輕鐵大棠路站月台上蓋簷蓬支柱往後移能有效騰出更多月台候車空間，以應付日益增長的乘客量。就委員提出有關其他月台措施提升的建議，港鐵公司進行月台提升工程前，需對有關月台作出適當的評估，包括考慮人流、地理環境、技術可行性等因素。另外，港鐵公司一直有定期檢討月台措施的管理，例如早前於輕鐵大棠路站、康樂路站及豐年路站調動出入閘機，更有效疏導人流。

(港鐵公司會後補註：港鐵公司於二零一四年八月八日邀請了相關委員，並聯同運輸署及警方，視察臨時交通管理措施的試行情況，經詳細考慮後，適切採納了議員及相關政府部門的意見，將實施時間由早上十時至下午四時，改為早上九時至下午三時，並將實施時間改為星期一至五而非星期一至六，以避免在平日下午及週末等較繁忙的時段實施臨時交通管理安排。港鐵公司亦於八月二十八日透過秘書處向委員提交有關試行結果及工程開展日期的進展報告。)

21． 王謙佑先生補充並讚揚港鐵公司積極改善輕鐵月台的不足之處，另重申雖然臨時封路容易造成交通擠塞的問題，但輕鐵大棠路站二號月台的提升工程對整個社區有正面的影響，而港鐵公司亦將安排交通試行，預先審視臨時封路及替代路線的成效，期望各委員支持及理解。

22． 副主席總結，大部分委員均認為臨時封路的措施會引致區內交通嚴重擠塞，惟明白有關提升工程對社區有長遠的裨益。至於有關交通試行的日期及詳情，希望港鐵公司事先諮詢各委員及區內居民的意見，並於試行期間設置清晰的道路交通指示牌，而於試行後亦需向委員解釋結果。

第五項：擬議元朗市行人通道
(交委會文件 2014／第 69 號)

23． 副主席歡迎下列人士出席會議：

路政署

主要工程管理處處長	陳派明先生
主要工程管理處高級工程師 4/屯門路(候任)	黃鎮健先生

運輸署

高級工程師／西北	王謙佑先生

渠務署
設計拓展科總工程師/排水工程　　陸偉雄先生

香港城市設計學會
副會長(公共政策)　　吳永順先生

香港建築師學會
本地事務部主席　　岑延威先生

24· 陳派明先生、岑延威先生及吳永順先生以投影片(見本會議記錄附件一)簡介上述文件。

25· 委員就議題發表的意見摘錄如下：

(1) 大部分委員指出原方案能有效紓緩區內行人路擠迫的情況，故普遍支持原方案，同時要求將高架行人通道延伸至馬棠路，以配合元朗市南的發展，疏導日益增加的人流，另有委員指出橋樑及有關建築物外觀諮詢委員會於過去十年從未接納任何有關延長天橋的建議，因此認為假如署方的原方案未有延伸高架行人通道至馬棠路，相信日後亦難以實現有關訴求；

(2) 對專業團體於原方案接近達成共識時才提出另議方案表示不理解，關注興建行人通道的時間表會因此而受到拖延；

(3) 不認同署方只注重專業團體提出的意見，認為應同時積極聽取委員的意見；

(4) 指出根據另議方案的建議詳情，行人需多次上落行人天橋，其疏導人流的成效有限，而且不便長者及傷健人士使用，未能切合區內居民的需要及生活習性；

(5) 反映區內有大部分居民以單車代步，而另議方案的設計過於四通八達，因此居民能輕易駕駛單車進入行人通道，甚至有機會停泊單車於通道，縮窄有關通道的範圍，構成安全問題；

(6) 專業團體於另議方案提出擴闊明渠兩旁的行人通道以取代部分高架行人通道，有委員指出有關建議涉及收地或收窄明渠，其可行性有限，另有委員擔心擴闊明渠兩旁的行人路會加劇店鋪伸延的問題；

(7) 有委員指出專業團體強調需考慮天橋附近的街道經濟，故向專業團體查詢是否持有天橋附近商鋪的業權，並應作出利益申報；

(8) 另有委員認同興建行人天橋需考慮街道經濟問題，兩者應保持平衡發展，以將軍澳、天水圍及旺角為例，興建行人天橋後，街道經濟受到一定的影響，因此查詢以原方案作基礎的情況下是否有其他方法能保留街道經濟；

(9) 有委員反映行人天橋附近只有小量商鋪，現時元朗大部分的商鋪主要集中於青山公路 – 元朗段、教育路及安寧路，其分佈為東西走向，而行人通道則為南北走向，因此興建有關行人通道能將遊逛商鋪及乘搭西鐵的行人分流；

(10) 反映區內多個大型屋苑相繼落成，人口將相應增加，有關行人天橋容易出現擠擁情況，故建議於行人天橋加設自動行人輸送帶，以加快疏導人流；

(11) 要求署方提供現時擬議元朗市行人通道的工程進度，並查詢是否已委託顧問公司作進一步研究；

(12) 另有委員表示支持另議方案，認為其於青山公路 – 元朗段及西鐵朗屏站和元朗安寧路的一段明渠上空興建高架行人通道已能達到加強區內南北走向的作用，並減少對附近景觀造成的影響，另指出另議方案的施工期將較原方案短，居民能於較短時間內使用有關天橋；及

(13) 有委員指出原方案及另議方案並無衝突，建議同時採納兩個方案的建議詳情。

26． 陳派明先生綜合回應如下：

(1) 路政署曾於去年三月就元朗市行人環境改善計劃進行公眾參與活動，以收集各方意見，並曾與委員討論有關議題。香港建築師學會、香港園境師學會、香港規劃師學會及香港城市設計學會共同提出高架行人通道計劃(原方案)以外的另議方案，署方認為應就有關專業團體的意見給予慎重考慮，因此署方就原方案及另議方案的建議詳情作適當的比較，並再次諮詢委員的意見；

(2) 有關專業團體是以義務性質提供意見及方案予委員參考，以完善及優化擬議元朗市高架行人通道的計劃；

(3) 根據行人流量分析，原方案和另議方案均能改善現時元朗市行人通道的擠迫情況；

(4) 於行人天橋加設自動行人輸送帶將令天橋的重量增加，因而需要更龐大及複雜的結構；

(5) 有關將高架行人通道延伸至馬棠路的建議，署方將在擬議行人通道的南端預留接駁口，並將密切關注元朗市南的發展，如有需要會研究將其延伸；

(6) 有關委員提出同時採納兩個方案的建議，路政署認為可行性較低。於技術層面而言，為緩解同時建造兩個方案對元朗明渠的排洪能力的影響，渠務署評估須沿明渠兩旁的行人路，增設約一點九米高的防洪牆，此舉將對景觀造成影響；於財政層面而言，同時進行兩個方案需要更龐大的工程費用，加上兩個方案各自均已能紓緩區內行人通道擠迫的情況，因此並無必要同時進行兩個方案；

(7) 擬議高架行人通道的可行性研究經已完成，待委員會對原方案及另議方案作出選擇及決定後，署方將隨即進行遴選顧問的工作，期望於二零一四年內可展開項目的勘測和詳細設計的顧問研究。另外，由於有關工程屬《環境影響評估條例》下的指定工程項目，故有關工程需完成環境影響評估研究，之後再進行刊憲；及

(8) 署方將繼續聽取委員的意見，並考慮作出適當的調整，以盡快開展有關工程。

27． <u>吳永順先生</u>綜合回應如下：

(1) 通過署方舉辦的公眾參與活動，專業團體根據其專業知識提出意見，並建議可行的方案，雖然是在較後期提出，他強調當中並不涉及任何商業目的；

(2) 解決行人擠迫情況並非只考慮人流，其他因素包括城市設計、規劃、綠化、景觀、通風、商業活動等，均不可忽視。專業團體提出了一個顧及各個因素的另議方案，供委員考慮；及

(3) 專業團體將尊重委員的意見及委員會的最後決定。

28· 副主席總結，由於絕大部分委員表示支持高架行人通道的原方案，因此委員會亦對原方案表示支持，並要求路政署盡早落實有關工程，同時建議署方參照去年於交委會通過的動議，將高架行人通道延至馬棠路。副主席續指，署方可參考灣仔區的天橋，於高架行人通道加入藝術元素。

第六項：前議事項：

(1) 港鐵元朗站隔音屏障工程最新進度

(交委會文件 2014／第 59 號)

29· 委員向港鐵公司查詢日後於其他西鐵站加設隔音屏障的可能性。

30· 林圓女士回應，西鐵綫鐵路運作須符合《環境影響評估條例》內所載的規定和法定標準聲響，港鐵公司已按環境許可證的要求實施相關的音量緩解措施，並將繼續密切留意有關西鐵綫的鐵路運作聲響，盡量減少對居民造成的影響。

31· 副主席總結，希望港鐵公司留意有關西鐵綫的鐵路運作聲響。

第七項：委員提問：

關注西鐵綫在本月 22 日發生信號系統故障，令全線服務延誤超過六小時情況

32· 副主席提出先討論於會議開始前批准加入「關注西鐵綫在本月 22 日發生信號系統故障，令全線服務延誤超過六小時情況」的議程項目。

33· 委員就議題發表的意見摘錄如下：

(1) 反映港鐵發生故障的情況時有發生，對乘客造成不便；

(2) 反映港鐵露天的鐵路路軌主要集中於屯門及元朗區，加上風季及雨季將至，為免同類事件再次發生，建議港鐵公司盡快提升其避雷裝置系統；

(3) 建議港鐵公司提升其緊急應變措施，假如再有同類事件發生，應即時透過各媒體向公眾發放有關資訊，並需調派接駁巴士以疏導人流，同時應加強月台及車廂的指示及廣播；及

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