S.16 PLANNING APPLICATION
APPROVED KAI TAK OUTLINE ZONING PLAN NO. S/K22/8

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

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ANNEX 9

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

VISUAL IMPACT ASSESSMENT

January 2025

Project Proponent:
International Trademart Co. Limited

Visual Impact Specialist:
KTA Planning Limited

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Visual Impact Assessment

1. INTRODUCTION

1.1 Purpose

1.1.1 This Visual Impact Assessment ("VIA") report is prepared on behalf of International Trademart Co. Limited (the "Project Proponent") in support of S16 Planning Application for Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon ("the Site").

1.1.2 The proposed redevelopment is divided into two portions: eastern and western portions. The eastern portion comprises one 28 storeys Mixed Block (with hotel/ commercial/ showroom) and one 27 storeys Office Tower atop 3 levels podium (with exhibition/showroom/commercial). While, the western portion comprises four 34 to 36 storeys residential towers atop a 4-storey podium with a commercial arcade (including a mezzanine floor underneath the portion below Towers 1 and 2) with social welfare facilities, podium garden and recreational facilities. The building height (BH) for the proposed residential scheme has a BH profile generally descending from 140mPD (hinterland) to 133.7mPD (towards Kai Tak Waterfront), while, both the proposed office tower and mixed block with BH of 140mPD, respectively are proposed along the eastern side of the Site facing Trademart Drive. All carparking spaces/ loading and unloading bays and part of the E&M facilities will be provided at the two levels of basement.

1.1.3 The Site is currently zoned "Other Specified Uses" annotated "Trade Mart and Commercial Development" with a tiny portion of it shown as "Road" under the Approved Kai Tak Outline Zoning Plan No. S/K22/8 (the "Approved OZP") (**Figure 1.1** refers). Uses include 'Exhibition or Convention Hall', 'Office', 'Eating Place', 'Shop and Services', 'Place of Entertainment', 'School', 'Social Welfare Facility' (including Day Care Centre for the Elderly and Office Base of Social Work Service for Pre-primary Institutions) are all column 1

uses (uses that are always permitted). While 'Flat' and 'Social Welfare Facility' (including Residential Care Home for the Elderly) are column 2 uses (where planning permission is required). Nevertheless, a Visual Impact Assessment ("VIA") shall be submitted at the S16 Planning Application stage to demonstrate that the Proposed Redevelopment at the Site is visually acceptable with minor relaxation of building height restriction from 100mPD to 140mPD.

1.1.4 This VIA evaluates, in accordance with the Town Planning Board Guidelines on Submission of Visual Impact Assessment for Planning Applications to TPB ("TPB PG-NO.41"), the anticipated visual impacts of the Proposed Development on the Visually Sensitive Receivers ("VSRs") relevant to the Site and concludes with recommendation on mitigation measures if necessary.

1.2 Report Structure

1.2.1 Following this introductory section, the methodology adopted in this assessment will be set out in Section 2. The baseline review of the site and the surrounding area is included in Section 3. Section 4 includes the proposed development scheme and discussion on the design merits. Visual envelops, visual sensitive receivers and their representative viewpoints will be identified in Section 5, followed by assessment of the visual impact in Section 6. Section 7 concludes and summarises this Visual Impact Assessment.

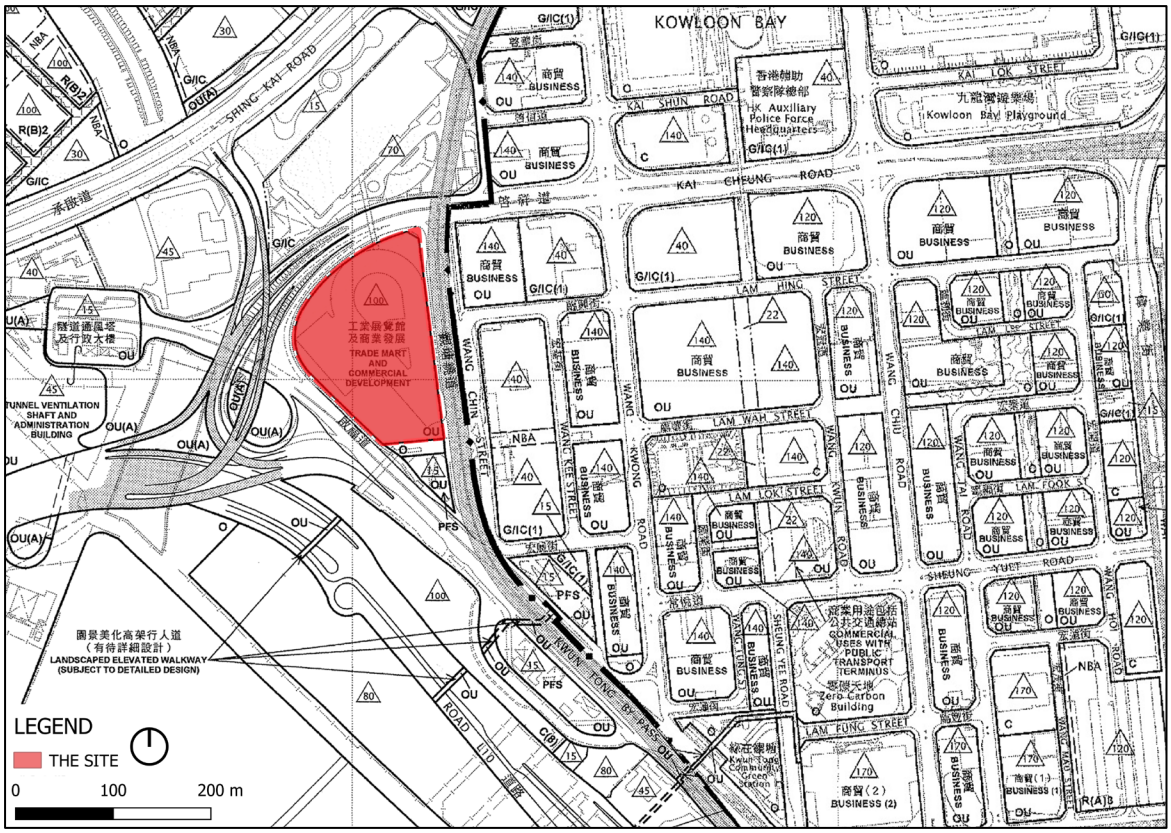


Figure 1.1 Location and Statutory Zoning Plan
(Extracts from Approved Kai Tak OZP No. S/K22/8 and Approved Ngau Tau Kok and Kowloon Bay OZP No. S/K13/32)

2. METHODOLOGY

2.1 Visual Impact Assessment Approach

2.1.1 This Visual Impact Assessment aims to evaluate the visual impact of the Proposed development by comparing the visual effect of the existing to the Proposed development with maximum building height at 140mPD (main roof level) on public visual sensitive receivers ("VSRs").

2.1.2 According to TPB PG-No. 41, Visual Impacts shall be assessed based on i) the sensitivity of the key public viewers; ii) visual resources and visual amenities likely to be affected iii) the magnitude, extent and duration of impact and any resultant improvement or degradation in the visual quality and character of the surrounding area; and iv) the planning intention and known planned developments of the area. Visual Impacts could be either beneficial or adverse. Visual sensitivity of public viewers/VSRs is determined taking into account the activity of the VSR, the duration and distance over which the proposed development would remain visual, and the public perception of the value attached to the view being assessed. It typically qualitatively graded from high to low.

2.1.3 Visual changes could be positive or negative and they are not necessarily mutually exclusive. In considering the effect of visual changes, it covers the following four aspects:

- the total effect on the **Visual Composition** of the surrounding context;
- the degree of **Visual Obstruction** to key public viewing points;
- the visual **Effect on Public Viewer**/VSRs; and
- the **Effect on Visual Resources**.

The magnitude of visual changes will be qualitative graded as Substantial, Moderate, Slight or Negligible.

2.1.4 The VIA will be undertaken in the following steps:

- A baseline review will be conducted to capture the existing visual elements in the surroundings and the planning context of the Site.
- The development scheme for the Proposed Development at the Site will be briefly presented.
- The Visual Envelope ("VE") will be determined and appropriate public viewpoints ("VPs") to represent the view from public VSRs will be identified.
- Each VP and potential visual impacts of the Proposed Development on the VSRs will be analyzed based on the photomontages prepared from the selected VPs.
- The overall visual impact will be assessed and conclusion on the visual acceptability of the Proposed Development will then be drawn.

3. BASELINE REVIEW

3.1 Existing Site Condition

3.1.1 The Site has an area of about 22,280m^2, where it sits on a privately owned land zoned "Other Specified Uses" annotated "Trade Mart and Commercial Development". It is bounded by the Trademart Drive to the east (with the Kwun Tong Bypass - an elevated expressway abutting the Site's eastern periphery running in a north to south direction), a strip of open space and a petrol filling station to the south, Kai Fuk Road to southwest and Kai Cheung Road along the northwestern and northern sides of the Site.

3.1.2 Currently the Site is occupied by an existing building with about 58mPD namely Kowloon Bay Trade and Exhibition Centre (KITEC), completed in 1996 (**Photos 3.1 & 3.2** refer). The Site has an existing site formation level of about 4.3mPD.

Photo 3.1 Site Photo (facing the eastern side of the Site)

Photo 3.2 Site Photo (facing the eastern side of the Site)

3.2 Existing Visual Elements in the Surrounding Context

3.2.1 The visual outlook of an area is shaped by a combined composition of all the visual elements which come into sight of the viewers. Kai Fuk Road and Kai Cheung Road are the main road access to the area and they both act as an east-west and north-south defining element for the visual character of the local context (**Figure 3.1** refers).

3.2.2 The area to the east of Trademart Drive is the Kowloon Bay Business Area ("KBBA") with predominantly low-rise industrial/commercial development zoned "Other Specified Uses" annotated "Business" and "Commercial" zone. However, it should be noted that the KBBA is under transformation to the second central business district (CBD). Some of the newly constructed mid-high rise office developments (i.e. Billion Centre, Megabox) entail a building height(constructed in accordance to the permitted BHR under OZP). The BHR ranges from 120mPD to 173mPD within the KBBA. The area to the west of Kai Fuk Road is the South Apron area of Kai Tak development with areas zoned "Commercial" with planned commercial developments at the South Apron Corner of Kai Tak Development.

The newly constructed mid-high rise office developments with the BHR of OZP (ranging 120mPD to 173mPD) in KBBA (comprise

a. Billion Centre with 140mPD
b. YHC Tower with 140mPD
c. Enterprise Square II with 133mPD
d. Enterprise Square V with 170mPD
e. Enterprise Square III with 164mPD
f. Manhattan Place with 173mPD
g. Capital Tower with 120mPD
h. One Kowloon with 161mPD
i. Exchange Tower with 126mPD
j. FTLife Tower with 120mPD
k. Kingston International Centre with 120mPD
l. CCB Centre with 134mPD
m. The Bay Hub (also known as Goldin Financial Global Centre with 140mPD)

3.2.3 While the area to the north across the Kai Cheung Road is the Electrical and Mechanical Services Department Headquarters and the cluster of residential developments (i.e. One Kai Tak, K. City, Tak Long Estate, K. Summit, The Henley) ranging from 100 to 130mPD in the Kai Tak City Centre. The area to the south of the Site consists of three liquid petroleum gas cum gasoline stations and to the southeast of the Site is the planned development node with compressive commercial developments in the Kowloon Bay Action Area (KBAA).

Newly constructed mid-high rise residential developments (ranging 100mPD to 130mPD) in Kai Tak City Centre comprise

1. The Henley with 130mPD
2. K. Summit with 130mPD
3. Upper Riverbank with 130mPD
4. Monaco with 120mPD
5. Vibe Centro with 120mPD
6. K City with 120mPD
7. Victoria Skye with 120mPD
8. One Kai Tak with 110mPD
9. Tak Long Estate with 120mPD

3.3 Statutory Zoning

3.3.1 The Site falls primarily within an area zoned "Other Specified Uses" annotated "Trade Mart and Commercial Development", with a tiny portion of it shown as "Road"[1] zone on the Approved Kai Tak Outline Zoning Plan No. S/K22/8 ("Approved OZP") (**Figure 1.1** refers).

3.3.2 According to the Statutory Notes of the Approved OZP, the planning intention of "Other Specified Uses" annotated "Trade Mart and Commercial Development" is *"primarily for exhibition and ancillary commercial uses."* Any developments are subject to a maximum plot ratio (PR) of 12.0 and a maximum building height of 100mPD. Uses include 'Exhibition or Convention Hall', 'Office', 'Eating Place', 'Shop and Services', 'Place of Entertainment', 'School', 'Social Welfare Facility' (including Day Care Centre for the Elderly and Office Base of Social Work Service for Pre-primary Institutions) are all column 1 uses (uses that are always permitted). While, 'Flat' and 'Social Welfare Facility' (including Residential Care Home for the Elderly) are column 2 uses (where planning permission is required) under the "Other Specified Uses" annotated "Trade Mart and Commercial Development" zone. The remarks also state that the gross floor area of maximum plot ratio of 12.0 or the plot ratio of the existing building shall include not less than 11,285m^2 for exhibition/trade-related uses. Based on the individual merits of a redevelopment proposal, minor relaxation of the building restrictions, may be considered by the Town Planning Board on application under section 16 of the Town Planning Ordinance.

[1] *The Site includes a tiny portion (about 0.8% or 188.5m2) fall within an area shown as "Road" on the Approved OZP which can be regarded as minor boundary adjustment.*

4. THE PROPOSED REDEVELOPMENT

4.1 The Proposed Redevelopment

Proposed Use

4.1.1 It is proposed to redevelop the Site for the proposed composite redevelopment with Trade Mart, Exhibition, Hotel, Commercial, Office, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction from 100mPD to 140mPD (**Table 4.1** refers).

4.1.2 The proposed redevelopment is divided into two portions: eastern and western portions. The eastern portion comprises one 28 storeys Mixed Block (with hotel/ commercial/ showroom) and one 27 storeys Office Tower atop 3 levels podium (with exhibition/showroom/commercial). While, the western portion comprises four 34 to 36 storeys residential towers atop a 4-storey podium with a commercial arcade (including a mezzanine floor underneath the portion below Towers 1 and 2) with social welfare facilities, podium garden and recreational facilities. The building height (BH) for the proposed residential scheme has a BH profile generally descending from 140mPD (hinterland) to 133.7mPD (towards Kai Tak Waterfront), while, both the proposed office tower and mixed block with BH of 140mPD, respectively are proposed along the eastern side of the Site facing Trademart Drive. All carparking spaces/ loading and unloading bays and part of the E&M facilities will be provided at the two levels of basement.

4.1.3 Not more than 23,273m^2 of exhibition/showroom (trade mart) will be provided within the proposed redevelopment, of which not less than 11,285m^2 will be provided in accordance with the lease and zoning requirements in respect of the Site, to dedicate for trade mart uses to allow for the display, exhibition of, and wholesale trade in manufactured goods or services. Aiming to enhance vibrancy at the street level, exhibition/commercial/showroom (trade mart) uses are proposed strategically at the lower floors of the redevelopment facing directly to Trademart Drive.

Design Principles

4.1.4 When designing the proposed redevelopment, the Applicant has carefully adopted the following design principles and merits into the proposal. The design principles include building design and building disposition, stepped podium, building separation, building setback and open plaza for enhancing air permeability.

Building Design and Building Disposition

4.1.5 The proposed development is located at a visually prominent and strategic location sandwiching between Kai Tak New Development Area and Kowloon Bay Business area. Upon completion, the proposed development will not only aim at being gateway and iconic development to the areas, it will also

help in bridging the gap between the under-construction Kai Tak and the changing development context Kowloon Bay Business Area.

4.1.6 In view of that, the proposed development intends to transform the existing development into a modern "signature" development. It will be visually of interest to the public viewers along Lam Hing Street (from the hinterland) and across Victoria Harbour due to its strategic location.

Building Separation

4.1.7 The proposed building mass and disposition above the podium have been carefully designed with building separation. The residential towers are divided into 2 groups: northern and southern sides, and are separated with a width of not less than 15m between Tower 2 in the south and Tower 3 in the north. This central building separation together with about 6m high permeable podium garden could allow prevailing ENE, E, ESE, and WSW wind to penetrate through the Site. It could also benefit its downstream area at the Site. Aside from that, there will also be a not less than 15m building separation between the residential tower 1 and the office tower.

4.1.8 Apart from enhancing wind permeability, the building separation between the two groups of residential towers would also establish a physical and visual connection for pedestrians to view through the Site from the inner area of Telford Gardens (East) and outer area of Kai Tak Waterfront area (West), especially through Lam Hing Street. Spatial relief of the proposed development is also offered to pedestrians at street level due to the adoption of a relatively small podium footprint.

Building Setback

4.1.9 The podium of the proposed redevelopment will have a voluntary setback of 3m from Trademart Drive to allow for landscape treatment and a wider footpath for pedestrians to walk comfortably along Trademart Drive. Aside from the podium setback, the residential towers at the upper level will also be setback from Kai Cheung Road and Kai Fuk Road (with at least 15m) to minimise the traffic noise and air quality impacts to the residents. The office tower atop the podium is also setback from the open space at the adjoining government land by about 15m. The building setback would minimise obstruction to wind flow around the buildings under the annual and summer prevailing wind.

Enhance air permeability

4.1.10 Besides the building separations between towers, the proposed development also adopts the 6m high podium garden on the 2/F of the western portion to allow users and visitors with air-breathing spaces and also enhance the penetration of prevailing winds through the development at lower levels with

the direct downward airflow to the pedestrian level. Besides that, the stepped podium design is adopted to facilitate wind flow from the podium to pedestrian level (i.e. east wind can flow over podium on west side between Towers 2 and 3 to pedestrian level).

Open Plaza

4.1.11 Open plaza is provided at ground level at the centre of the Site. The urban window (with about 6.5m tall and not less than 15m wide) created through the centre of the Site on the east side underneath the main exhibition/multi-purpose hall will allow the prevailing wind to reach the open plaza and enhance wind availability among the open plaza.

Table 4.1 Key Development Parameters of Proposed Redevelopment

1.	**Site Area (m^2)**	**22,280m^2**
2.	**Total GFA (m^2)**	**166,032m^2**
	• **Domestic**	Max. 65,949m^2
	• **Non-Domestic**	Max. 100,083m^2
	a) Showroom/Exhibition-related Uses/Spaces	About 23,273m^2 (including 11,285 for Showroom (Trade Mart))
	b) Office	About 35,600m^2
	- **Hotel**	About 24,000m^2
	- **Commercial**	About 13,960m^2
	- **Commercial (including Eating Place/Shop and Service/Cinema)**	About 13,403m^2
	- **Kindergarten**	About 557m^2
	c) G/IC Facilities	Min. 2,090m^2
	- **RCHE/DCCE/SWSPPI**	2,090m^2
	• **Footbridge ****	About 1,160m^2
3.	**Total PR**	**7.4521**
4.	• **Domestic**	2.96
	• **Non-Domestic****	4.4921
	• **Site Coverage**	
4.	**Podium (Below 15m)****	80%
5.	• **Tower (Above 15m)**	48%
	• **Domestic**	19%
	• **Non-Domestic**	29%
	• **No. Hotel Rooms**	720
6.	**No. of Flats**	1,470
7.	**Average Flat Size**	45m^2
8.	**Design Population**	3,969
9.	**No. of Blocks**	6
10.	**Max. Building Height (main roof level)**	Maximum 140mPD
10.1.	**Eastern Portion:**	Mixed Block: 28 Storeys (140mPD) Office Tower: 27 storeys (140mPD) All atop a 3-storey podium and 2 basement levels
	Western Portion:	Residential Towers 3 & 5: 36 storeys (140mPD) Residential Towers 1 & 2: 34 storeys

		(133.7mPD) All atop a 4-storey podium with a commercial arcade (including a mezzanine floor underneath the portion Towers 1 and 2) and 2 basement levels
	Site Area (m^2)	**22,280m^2**

Footnote ** - *It should be noted that the proposed development parameters in Table 4.1 has included the GFA of 1,160m^2 for the proposed southern footbridge link and the proposed opening to the existing Kai Cheung Road footbridge which may not be exempted by the Buildings Authority (BA). If this footbridge GFA is included and cannot be exempted from BA, the footbridge GFA will not be used and account for any domestic and non-domestic uses within the redevelopment.*

4.2 Sensitive Design Measures

4.2.1 The Proposed Development has adopted the following sensitive design measures ("DM") features, so as to alleviate the visual impact if any, due to the Proposed Development to an acceptable level:

- DM1: The BH of the proposed redevelopment gradually descends from hinterland to waterfront area;
- DM2: The podium and towers being setbacks from the site boundary and major arterial routes to create a focal point at the lower level
- DM3: Stepped podium is adopted to facilitate wind flow from the podium to pedestrian level, as well as creating dynamic architecture design at lower levels for pedestrians;
- DM4: A 15m building separation between the two groups of residential towers to establish a physical and visual connection for pedestrians to view through the Site from the hinterland and other areas of Kai Tak waterfront;
- DM5: Not less than 15m building separation between residential tower 1 and office tower to establish a physical and visual connection for pedestrians to view from the Site to the South Apron Corner of Kai Tak;
- DM6: Adopt 6m high podium garden to allow users and visitors with air-breathing spaces and enhance the penetration of prevailing winds at lower levels;
- DM7: Adopt architectural articulation to break down the perceived bulk and visual massing of the building and to create visual interest and
- DM8: The proposed development does not encroach onto the "20% Building Free Zone" of the Kowloon Ridgeline.

5 IDENTIFICATION OF VISUAL SENSITIVE RECEIVERS AND SELECTION OF VIEWPOINTS

5.1 Identifying Visual Envelope and Visual Sensitive Receivers

5.1.1 The Visual Envelope ("VE") within which the Proposed Development is pronouncedly visible from key sensitive viewers is shown in **Figure 5.1**. In the interest of the public, the VIA will focus primarily on public Visual Sensitive Receivers ("VSRs") only and no private VSR, such as residents of private developments and users of developments with restricted / exclusive accesses (e.g. school and office, etc.) will be included.

5.1.2 In the urban context around the Site, when viewing from street level, existing developments and trees may screen off most of the view from close-by VSRs while buildings of similar height may hide the development even from distant. Therefore, locally the identification of VSRs is largely constrained by the existing built environment and trees. The VE covers the area where direct sight towards the proposed development is available as presented in **Figure 5.1**.

5.2 Selection of Representative Viewpoints

5.2.1 Based on the identified VSRs, representative viewpoints ("VPs") were selected for further assessment. Selected VPs shall cover public views from easily accessible and popular area from different directions. When selecting VPs, priority shall be given to public open space (or planned public open spaces), public focal points, open spaces, existing/future pedestrian node, key pedestrian/vehicular corridor, and existing major vistas key transient corridor will be considered as major visually sensitive viewpoints. In this VIA, 5 nos. of local VPs are selected within the visual envelope and 3 distant VPs are selected based on their strategic importance to the vicinity or to the territory. The selected VPs are presented in **Table 5.1** and shown on **Figure 5.2** or **Figure 5.3**.

<u>VP1 – Footbridge near Telford Gardens to the East</u>

5.2.2 VP1 is taken from the footbridge connecting the podium level of Telford Gardens to Lam Hing Street across Wai Yip Street. Pedestrians are able to walk to the Kowloon Bay Business Area ("KBBA") from Kowloon Bay MTR station via the podium of Telford Gardens. Lam Hing Street acts as a direct viewing corridor for pedestrians to view towards the Site despite the surrounding buildings at the side screened off most of the Site. Whilst, the Site sits and sandwiches in the middle between existing industrial/ commercial development along Lam Hing Street. The existing view towards the Site comprises (from left to right) the The University of Hong Kong- Lee Shiu Building, Metro Centre I, the Site and Metro Centre II.

5.2.3 The footbridge is frequently used by the public. The quality of view is fair but the view is transient and short-lived. The public viewers at the footbridge are considered to have a medium sensitivity to visual change.

VP2 – Football Field of Kowloon Bay Playground to the Northeast

5.2.4 VP2 is taken from the football field of Kowloon Bay Playground along Kai Cheung Road. It is selected as a viewpoint, as the public users can enjoy and play different sport activities like football and basketball at the Kowloon Bay Playground. It is thus considered as public gathering point for the public users to exercise. Currently, the public from the Kowloon Bay Playground would merely view the existing development by screening off with street trees along Kai Cheung Road. The existing view towards the Site consists (from left to right) Kai Cheung Road, Hong Kong Auxiliary Police Headquarters, Bay Hub and Skyline Tower.

5.2.5 The current viewpoint is frequently used by public. The quality of view is Good and the view is static. The public viewers at the footbridge are considered to have a medium sensitivity to visual change.

VP3 – EMSD Headquarters; Shing Kai Road Bus Stop to the North

5.2.6 VP3 is selected as one of the viewpoints, as the current standing point is at the EMSD Headquarters bus stop along Shing Kai Road, which have a partial view of the Site. This bus stop also represents the viewpoint from the public awaiting for buses. The Bus Stop is selected as a viewpoint, as it serves the general public from the residential developments in the Kai Tak development area. The existing view towards the Site comprises (from the left to the right) the Skyline Tower, Electrical and Mechanical Services Department Headquarters and the Site.

5.2.7 The current viewpoint is occasionally used by public and the quality of view is fair for the public to capture the views of the open sky as it is partly dominated by the existing EMSD building in the foreground. The public viewers from the Bus Stop are considered to have a medium sensitivity to visual change.

VP4 – Junction at Shing Kai Road/Shing Fung Road to the Northwest

5.2.8 VP4 is selected as one of the viewpoints, as the current standing point is next to Kai Tak Sports Park. Kai Tak Sports Park is designed to be the world's leading sports, leisure and entertainment destination in Kai Tak Development to host major international events in any weather. It will be a major public gathering point, once the construction of the Kai Tak Sports Park is completed. The existing view towards the Site comprises the Electrical and Mechanical Services Department and Sky Tower behind the newly constructed District Cooling System, Site, Billion Centre and Megabox.

5.2.9 Although the current viewpoint is occasionally used by public, it is noted that the Kai Tak Sports Park will be frequently used by the public once the construction of the Kai Tak Sports Park is completed. The quality of view is good for the public to capture the views of the open sky. The public viewers from the Kai Tak Sports Park are considered to have a medium sensitivity to visual change.

VP5 – Kai Fuk Road Footbridge to the Southwest

5.2.10 This VP is taken from the southwest of the Site, which is adjacent to the site (with less than 1 minute walking distance). It is selected as one of the viewpoints, as this footbridge is to connect the pedestrians from the future South Apron Corner of Kai Tak Development to Kai Tak City Centre across Kai Fuk Road via the Site. It also lands at the open space of government land to KBBA. The public would directly view towards the Site and the residential clusters of the Kai Tak City Centre while walking through the footbridge. The existing view towards the Site consists (from left to right) Kai Fuk Road, a cluster of residential developments at Kai Tak City Centre and the Site.

5.2.11 The footbridge is frequently used by the public. The quality of view is fair but the view is transient and short-lived. The public viewers at the footbridge are considered to have a high sensitivity to visual change.

VP6 – Kai Tak Promenade to the South

5.2.12 This VP is taken from the south of the Site. Kai Tak Promenade is selected as a viewpoint, as the local residents and visitors would be able to walk along the Kai Tak Promenade from Kai Tak Cruise Terminal to Kai Tak Sports Park when the residential developments along the Runway Precinct are completed. The public viewers could enjoy the view towards Kwun Tong Typhoon Shelter and Kowloon East (including Kwun Tong and Kowloon Bay and Ngau Tau Kok area). The existing view toward the Site includes (from the left to right) the Kai Tak Sports Park, some planned and under construction residential development in Kai Tak City Centre, the Site and the under construction new acute hospital.

5.2.13 The Kai Tak Promenade is frequently used by the public, mainly the visitors to and from Kai Tak Cruise Terminal or the nearby residents. The quality of view is good for the public, as the public can view the transition of Kowloon East and waterbody of Kwun Tong yphoon shelter. The view is considered to be static as people may stay here for a while to enjoy the view. The public viewers from this point are considered to have a high sensitivity to visual change.

VP7 – King Wan Street Leisure Path (Seafront) to the Southwest

5.2.14 This VP is taken from the southwest of the site. King Wan Street Leisure Path (Seafront) is selected as a viewpoint as it is located within the Ma Tau Kok Waterfront. It also overlooks the Site and the surrounding areas including the existing developments or planned developments in the South Apron Corner of Kai Tak Development and KBBA. Public viewers are also able to view the open sky and mountain backdrop of the Site, especially the ridgeline of the mountain.

5.2.15 The King Wan Street Lesiure Path (Seafront) is a public leisure path and it is occasionally used by the public. The view is static where the public can view the entire Kowloon east, the open sky and the mountain backdrop of the Site. The quality of the view is good. The public viewers at this point are considered to have a high sensitivity to visual change.

VP8 – Quarry Bay Park to the Southeast

5.2.16 This VP is taken from the southeast of the Site. Quarry Bay Park is one of the strategic viewpoints, where is an urban park and lies between the waterfront promenade area and the Tai Koo Shing Estate. It is the viewpoint, which captures the entire Kowloon East, including the Kai Tak Development, Kwun Tong Business Area and Kowloon Bay Business Area. The public viewers also able to capture the view of Victoria Harbour and open sky.

5.2.17 This VP is frequently visited by the public. It is considered to be static where the public can stay long to enjoy the view of Victoria Harbour and open sky view to the north. The quality of the view is very good. The public viewers from this VP are considered to have a high sensitivity to visual change.

Potential Viewpoint:

PVP- Viewing Platform Near Goldin Bauhinia Square and Hong Kong Convention and Exhibition Centre to Southwest

5.2.16 This potential viewpoint (**Figure 5.4** refers) has been given with due consideration throughout the viewpoint selection stage. Given with the topography and distance to the Subject Site, as well as the proposed development being screened off by a group of buildings at the Kowloon Peninsula, this potential viewpoint in the Southwest is not selected for preparation of the VIA.

Table 5.1 Summary of Selected Viewpoints

Viewpoints (VPs)	Distance/ Direction	Level of the VP	Nature of VP	Popularity by Public	Visual Quality	Visual Sensitivity
VP1: Footbridge near Telford Gardens	Approx. 719m/ East	Approx. 13.4mPD	Transient	Frequent	Fair	Medium
VP2: Football Field of Kowloon Bay Playground	Approx. 552m/ Northeast	Approx. 6.4mPD	Static	Frequent	Good	Medium
VP3: EMSD Headquarters; Shing Kai Road Bus Stop	Approx. 217m/ North	Approx. 5.3mPD	Transient	Occasional	Fair	Medium
VP4: Junction at Shing Kai Road and Shing Fung Road	Approx. 366m/ Northwest	Approx. 5.1mPD	Static	Occasional	Good	Medium
VP5: Kai Fuk Road Footbridge	Approx. 33.8m/ Southwest	Approx. 13.3mPD	Transient	Frequent	Fair	High
VP6: Kai Tak Promenade	Approx. 1034m / South	Approx. 11.3mPD	Static	Frequent	Good	High
VP7: King Wan Street Leisure Path (Seafront)	Approx. 1381m / Southwest	Approx. 3.4mPD	Static	Occasional	Good	High
VP8: Quarry Bay Park	Approx. 3752m / Southeast	Approx. 4mPD	Static	Frequent	Very Good	High

6 ASSESSMENT OF VISUAL IMPACTS

6.1 General

6.1.1 The primary objective of this VIA is for evaluating the building height and visual impact of the Proposed Development. The assessment will focus on the visual impact of the overall bulk to the identified VSRs. The visual impact rating is also assessed based on the comparison between existing and proposed development, taking into account the planned/committed developments in the surroundings. A comparison of the visual impact with the OZP-compliant scheme will also be discussed for reference only.

6.2 VP1 – Footbridge near Telford Gardens to the East *(**Figure 6.1** refers)*

Visual Composition

6.2.1 VP1 is located to the east of the Site. This VP captures the building separation of not less than15m between T2 and T3. Under the scenario with proposed development, it captures the building edge of residential tower 2 and 3, as well as the majority portion of the mixed block. The mixed block in the foreground has screened off the residential tower 5. However, the majority portion of the redevelopment including the residential tower (i.e. T1) and office tower would be screened off by the surrounding industrial/commercial developments zoned “OU” annotated “Business” at the right and left-hand side of the photomontages.

6.2.2 Under the Planned/Committed development scenario, the planned/committed development would block the majority of the redevelopment including residential towers (i.e. T1, T2, T3 and T5), as well as the office tower and mixed block. Only the building edge of the residential towers 2 and 3 and the mixed block would be partly seen.

Visual Obstruction

6.2.3 From this VP, the existing industrial/ commercial developments along Lam Hing Street have already limited the openness of the existing view. The overall visual change before and after is limited provided that existing industrial/ commercial developments to the east and west of Lam Hing Street would screen off the majority portion of the proposed redevelopment. Under the Planned/Committed development scenario, the overall visual change before and after is also limited, as the majority portion of the proposed redevelopment would be behind and covered by the planned/committed developments. Only the building edge of the residential towers 2 and 3 and the mixed block would be partly seen.

Effect on Public Viewers

6.2.4 This VP represents the view of pedestrians from the footbridge, connecting the Telford Gardens to Kowloon Bay Business Area ("KBBA"). **Figure 6.1** shows that the difference between the existing view and the scenario of the proposed redevelopment is minor. The proposed redevelopment in fact blends in well with the existing industrial/ commercial developments setting along Lam Hing Street with the building separation of not less than 15m. It continues to maintain and open up a viewing corridor along Lam Hing Street when viewing from the footbridge. The architectural articulation of the mixed block and greenery at the refuge floor of the mixed block would also help to break down the building mass of the building. It also provides visual relief to the pedestrians when viewing from the footbridge. Under the scenario with planned/committed development, the residential towers 2 and 3 and mixed block would be partly seen. Indeed, the planned/ committed developments along Lam Hing Road are intended to be redeveloped with 120mPD to 140mPD as stipulated in the Approved OZP, including the approved planning application No. A/K13/318 would become dominant views and inevitably reduce the openness of the sky yet, leaving the pedestrians in the viewing corridor of Kai Tak area via the building gap of the proposed development would enable the views to the open sky of Kai Tak area. In light of that, there will only be a slight visual change to the public viewers with **slightly adverse** impact.

Effect on Visual Resources

6.2.5 The sky view is currently blocked by the existing industrial/commercial development, while the sky view would continue to be blocked by the planned/committed developments, despite whether the proposed development is redeveloped or not. Under the existing and planned/committed development scenario, the proposed redevelopment would only be seen behind the existing industrial/commercial developments and planning/committed developments, as well as in the same street line of Lam Hing Street. The proposed redevelopment would continue to maintain a not less than 15m wide building separation to maintain the sky view in between the towers. Thus, the proposed redevelopment would only create limited effect on the visual resources (i.e. the sky view at the back).

Comparison between 100mPD (with PR 12) and Proposed Development

6.2.6 By comparing the development with 100mPD and proposed development with 140mPD, it is evident that the development with 100mPD would completely screen off the viewing corridor to Kai Tak area when viewing from the footbridge near Telford Gardens (**Figure 6.1** refers). The development with 100mPD would not provide any sensitive design measures (i.e. building separation) in providing visual and spatial relief when viewing from the footbridge to Kai Tak development. Once the planned/ committed developments are redeveloped into development with 120mPD-140mPD

along Lam Hing Road, the sky view would also be screened off by the future developments.

6.3 VP2 – Football Field of Kowloon Bay Playground to the Northeast ***(Figure 6.2** refers)*

Visual Composition

6.3.1 VP2 is located to the northeast of the Site. At present, this VP captures (from left to right) some industrial buildings, Hong Kong Auxiliary Police Headquarters, The Bay Hub (formerly known as Goldin Financial Global Centre) with 140mPD and Skyline Tower with 152mPD. Meanwhile, the proposed development would be at the backdrop of the industrial developments i.e. Po Lung Centre, DCH Building.

Visual Obstruction

6.3.2 From this VP, residential towers T1, T2, T3 and T5 and office tower would be completely screened off by the DCH building, whilst, the lower portion of mixed block would be shielded off by roadside plantings along Kai Cheung Street. The upper portion of the mixed block would change the open view of the sky between the industrial buildings and commercial developments. Majority of sky openness and the skyline of Kowloon Bay and Ngau Tau Kok area remain unchanged.

6.3.3 Under the planned/committed development scenario, the planned/committed developments that are redeveloped along Kai Cheung Road will be about 140mPD permissible under the OZP, and the proposed redevelopment would be completely screened off by the future developments.

Effect on Public Viewers

6.3.4 As shown in the photomontage in **Figure 6.2**, this viewpoint represents users enjoying and playing sport activities i.e. playing soccer and basketball within the playground. It is noted that the majority of the proposed redevelopment would either screened off by roadside planting along Kai Cheung Road and existing developments. Only the upper portion of mixed block would be seen and has adopted architectural articulation to break down of perceived bulk and visual massing of the mixed block when users viewing from the VP. It also creates visual interest of the mixed block. The VSRs could continue to enjoy a good quality open view. With the planned/ committed developments, the planned/ committed developments along Kai Cheung Road (left side) with 120mPD to 140mPD would block the proposed development entirely, while the open sky will be maintained.

Effect on Visual Resources

6.3.5 The Residential Towers T1, T2, T3 and T5 and office tower would be screened off by the existing development DCH Building. Meanwhile, the upper portion of mixed block would partially change the sky openness

between the industrial buildings to the left and commercial developments to the right. Although the mixed block would affect the sky openness, the mixed block has adopted architectural articulation to break down of perceived bulk and visual massing of the mixed block when users viewing from the VP. It also creates visual interest in the mixed block. This would minimise the visual impact when viewing from the playground. The skyline and the majority of the sky will remain unchanged. Under the planned/ committed development scenario, the entire proposed development would be screened off by future planned development with 120mPD to 140mPD. In this regard, the visual impact brought about by the proposed development would be **Negligible**.

Comparison between 100mPD (with PR 12) and Proposed Development

6.3.6 By comparing the development with 100mPD and the proposed development, it is apparent that development with 100mPD would likely have a bulky building form without a building gap (**Figure 6.2** refers). Although the proposed development would slightly extend higher than the development with 100mPD and affect the sky openness, the mixed block would provide visual interest in terms of the architectural form and architectural articulation to break down the bulk of the mixed block. With such careful design of the mixed block, the mixed block could minimise the visual impact of the sky openness and the visual impact towards the mixed block. However, with the future changing planning and development context, both development with 100mPD and 140mPD would be hidden behind and screened off by the planned/committed development in the front.

6.4 VP3 – EMSD Headquarters; Shing Kai Road Bus Stop to the North *(**Figure 6.3** refers)*

Visual Composition

6.4.1 VP3 is located to the north of the Site. At present (viewing from east to west), there is a Skyline Tower with 152mPD, Electrical and Mechanical Services Department (EMSD) with 59.4mPD and the Site.

Visual Obstruction

6.4.2 From this VP, the EMSD with 59.4mPD has blocked the majority portion of the mixed block, residential tower T5 with the upper roof to be seen. Meanwhile, the majority portion of the residential towers T3 and T2 would be come into sight, despite some portion of the sites would be screened off by either the EMSD or the existing vegetations along Shing Kai Road. The residential towers T3 and T2 would change the skyview and openness to a certain extent. Despite that, the proposed redevelopment would however continue to be compatible with the building height bands of the development (i.e. Skyline Tower with 152mPD) in the background of the Kowloon Bay

area. Under the planned/committed development, there will also be planned developments with 100mPD and 80mPD in the South Apron Corner of Kai Tak Development to the right of the proposed development.

Effect on Public Viewers

6.4.3 This VP represents the viewpoint from the public awaiting for buses, as the bus stop serves the general public from the residential developments in the Kai Tak development area. **Figure 6.3** shows that the existing view and the scenario with the proposed redevelopment though the latter (Residential tower T3 and T2) will change the sky view and openness to a certain extent. Under the Planned/Committed Development, there will be planned/committed developments (to the right) with 100mPD and 80mPD in the South Apron Corner of Kai Tak Development. The proposed redevelopment will maintain a compatible building height profile with the surrounding development. In this regard, visual impact to the public viewers is considered to be **slightly to moderately adverse**.

Effect on Visual Resources

6.4.4 The residential towers T2 and T3 will change the skyview openness of Kai Tak Development to a certain extent. However, the sky openness and view to the left and right will remain unchanged. Meanwhile, the majority portion of the proposed development will be screened off by the EMSD building in the foreground. It should be noted that the proposed redevelopment would align with the building height of the commercial developments (i.e. Skyline Tower with 152mPD) in the Kowloon Bay and Ngau Tau Kok planning area. Under the planned/committed development, there will be developments (to the right) with 100mPD and 80mPD in the South Apron Corner of Kai Tak Development, which will also eventually change the sky view of the area.

Comparison between 100mPD (with PR 12) and Proposed Development

6.4.5 When compare the development with 100mPD and proposed development, though the development with 100mPD would have a lower building height which would minimise the impact to the sky view, it is expected that the development would have been more massive in terms of bulk and even sensitive design mitigation measures like building separation could hardly be bared. However, with a relaxation in building height, the Proposed Development would be able to provide slender building design with a gradual drop of building height towards Kai Tak waterfront.

6.5 VP4 – Junction at Shing Kai Road/ Shing Fung Road to the Northwest *(**Figure 6.4** refers)*

Visual Composition

6.5.1 VP4 is located to the northwest of the Site. At present (view from east to west), there is a newly built District Cooling System (DCS) at 45mPD with Electrical and Mechanical Services Department (EMSD) at 59.4mPD and Skyline Tower at 152mPD behind, the Site, the Planned Development at 140mPD (Existing Development: Kinetic Industrial Centre), the Billion Centre with 140mPD and South Apron Corner Development at 100mPD.

Visual Obstruction

6.5.2 From this VP, the podium of the proposed redevelopment would be partially screened off by the construction containers and vegetation in the foreground. The office and mixed block will be behind the residential towers. The sky openness will thus be affected by the 4 nos. of residential towers and the building edge of the mixed block to a certain extent. Despite that, the building height of proposed redevelopment has a gradual decrease of BH from 140mPD (from the hinterland) to 133.7mPD (towards the waterfront area) to minimise the overall impact on the skyline of the Kai Tak and Kowloon Bay and Ngau Tau Kok area. A not less than 15m building separation between the 2 groups of residential towers is also adopted to provide visual relief with the Skyview at the street level. Under the Planned/Committed Development Scenario, it should be noted that the portion of the proposed development (including mixed block, residential towers T5 and T3) will be screened off by the planned electric substation with 40mPD zoned “G/IC” in the foreground. Only residential towers T1 and partially of the T2 would be seen. A planned development at 140mPD (existing development: Kinetic Industrial Centre) and the planned development at 100mPD at South Apron Corner will also be located to the right of the proposed development.

Effect on Public Viewers

6.5.3 This VP represents the view of passengers on vehicles along the Shing Kai Road and Shing Fung Road. It also represents the view of public users from newly constructed Kai Tak Sports Park. **Figure 6.4** shows that the existing view and the scenario with the proposed redevelopment through the latter will change the sky openness to a certain extent. However, it should be noted that proposed redevelopment adopts a building separation of not less than 15m between the two groups of residential towers which enables the public viewers to view the skyview through central building gap. It is also to allow the wind penetration along Lam Hing Road and avoid the “wall” effect. Under the Planned/Committed Development Scenario, it should be noted that the portion of the proposed development will be screened off by the planned electric substation with 40mPD zoned “G/IC” in the foreground.

Only the upper portion of residential towers T1 and T2 would be seen. The building height of the proposed development would however be congruous with the existing/planned developments (i.e. Billion Centre and redevelopment of Kinetic Industrial Development) with a general building of 120mPD to 140mPD in the background. The building height of the proposed development would also be compatible with planned development in the South Apron area (with 100mPD). In this regard, visual impact on the public viewers is considered to be **slightly adverse**.

Effect on Visual Resources

6.5.4 The 4 nos. of residential towers and mixed block will change the sky openness and the skyline of the Kowloon Bay and Ngau Tau Kok area to a certain extent. However, the sky openness to the left and right will remain unchanged. It should be noted that the 4 nos. of residential towers will comprise a building gap of not less than 15m, which would allow the pedestrians to view the sky through the central building gap. it should be noted that the portion of the proposed development will be screened off by the planned electric substation with 40mPD zoned "G/IC". Only the residential towers T1 and T2 would be seen at a slightly farthest distance.

Comparison between 100mPD (with PR 12) and Proposed Development

6.5.5 When compare the development with 100mPD and the proposed redevelopment, the development with 100mPD would have a bulky building form extending a wider coverage. Although the development with 100mPD has a lower building height and would minimise the impact on the sky view, the development with 100mPD would unlikely be able to provide sensitive design mitigation measures (such as wide building gap) to view the hinterland of Kowloon Bay and Ngau Tau Kok area. The Proposed Development however provides a building separation of not less than 15m for visual relief.

6.6 VP5 – Kai Fuk Road Footbridge to the Southwest *(**Figure 6.5** refers)*

Visual Composition

6.6.1 This VP represents the public viewers crossing Kai Fuk Road through the newly constructed footbridge from South Apron Corner of Kai Tak Development to KBBA. At present, this VP captures the major arterial route Kai Fuk Road, the stepped podium with the greenery and canopy of the proposed redevelopment and the lower portion of the residential towers T1, T2, office tower and mixed block. The skyline of the newly developed residential cluster at the Kai Tak City Centre and open sky view are captured at the backdrop of the proposed development.

Visual Obstruction

6.6.2 From this VP, the overall visual change before and after is limited, as the proposed redevelopment would block the upper portion of the sky-open view after redevelopment. Although the podium and lower portion of the residential towers T1 and T2, office tower and mixed block would cover the skyline at the right-hand side of the photomontage, the overall skyline at the Kai Tak City Centre would not be changed and the extent of view would even be widened with the removal of the existing Star Hall complex. In fact, the proposed development would complement with the residential cluster with 130mPD to 110mPD in the Kai Tak Centre (on the left side of the photomontages).

Effect on Public Viewers

6.6.3 As shown in the photomontage in **Figure 6.5**, a portion of the open sky view will be blocked, while the open sky view in the residential cluster of Kai Tak Development will remain unchanged. However, the podium with greenery (i.e. extensive vertical green walls and tree planting) at the the façade of the proposed redevelopment would help to soften the podium edge and provide visual relief of the area to the pedestrians at street level. It also creates a dynamic architectural design. Besides that, the proposed redevelopment will also provide a canopy for weather protection along the building edge facing Kai Fuk Road to create a pedestrian-friendly walking environment. The mixed block and office tower also adopted architectural articulation to break the visual mass of the building. In this regard, the visual change brought about by the proposed development would be moderate and thus the visual impact is considered **moderately adverse**.

Effect on Visual Resources

6.6.4 The proposed redevelopment would block the upper portion of the sky-open view after redevelopment. Although the podium and the lower portion of the proposed redevelopment would cover the sky at the right-hand side of the photomontage, the overall skyline at the Kai Tak City Centre on the left of the photomontage would not be changed and the extent of view would even be wider with the removal of the existing Star Hall complex at the foreground. Sensitive design measures (i.e. vertical green wall at the façade of the proposed development and podium with plantings) are in place to soften the building edge when public views from the footbridge.

Comparison between 100mPD (with PR 12) and Proposed Development

6.6.5 It is evident that development with 100mPD would also cover the open sky view as the proposed development when viewing from the footbridge (on the right of the photomontage) (**Figure 6.5** refers).

6.7 VP6 – Kai Tak Promenade to the South *(Figure 6.6 refers)*

Visual Composition

6.7.1 This VP is taken from the south of the Site. Kai Tak Promenade is selected as a viewpoint, as the local residents and visitors would be able to walk along the Kai Tak Promenade from Kai Tak Cruise Terminal to Kai Tak Sports Park when the residential developments along the Runway Precinct are completed. This VP captures toward the Site includes (from the left to right) the Kai Tak Sports Park, the residential cluster (with 110mPD to 130mPD) in Kai Tak City Centre, the Site and the under-construction new acute hospital.

Visual Obstruction

6.7.2 From this VP, the proposed redevelopment is sandwiched between Kai Tak Development and the under-construction new acute hospital (in the middle of the photomontage). The proposed redevelopment will potentially change the overall skyline of the Kai Tak Development area and the openness of the sky to a certain extent. The proposed redevelopment would also screen off some of the residential estates in Kai Tak City Centre. However, the proposed redevelopment would not affect or have any visual change to the Kowloon Bay area, as the under-construction New Acute Hospital with 60mPD will already have screened off the entire Kowloon Bay and Ngau Tau Kok area. Under the planned/committed development scenario, the proposed development will be entirely screened off by the planned commercial developments ranging from 80mPD to 100mPD in the South Apron Corner of Kai Tak Development.

Effect on Public Viewers

6.7.3 This VP represents the view of users which walking along and enjoying at the Kai Tak Promenade. **Figure 6.6** shows that the difference between the existing view and the scenario with proposed redevelopment and the scenario with proposed redevelopment and planned/committed development. Under the scenario with proposed redevelopment, the office tower with 140mPD and residential towers (i.e. T1, T2 and T5) of the proposed redevelopment would only be seen. The mixed block would be entirely screened off by the office tower in the front. The proposed redevelopment has adopted sensitive design measures including a building separation of not less than 15m between the residential tower T1 and the office tower, which allows pedestrians to view from Kai Tak promenade to the Site. The building separation also helps to break down the visual mass of the proposed redevelopment and avoid the wall effect. The architectural articulation of the office tower creates dynamic and interesting architectural forms for the area and the public viewers. Under planned/committed development scenario, the entire proposed redevelopment will be screened off by the commercial

development in the foreground with the building height ranging from 80-100mPD in the South Apron corner.

Effect on Visual Resources

6.7.4 The overall skyline and openness of sky of the surrounding area would not be affected and have any visual change brought by the proposed redevelopment, especially to Kai Tak Development. Some of the existing residential estates, skyview and the mountain backdrop would however be screened off by the proposed redevelopment. The proposed redevelopment has adopted a building separation of not less than 15m between residential tower T1 and office tower to break down the building mass when viewing from Kai Tak promenade. Under the planned/committed development scenario, the proposed development would also be largely blocked by future planned commercial developments ranging from 80mPD to 100mPD at the South Apron Corner in the front. In this regard, the visual impact will be **Negligible**.

Comparison between 100mPD (with PR 12) and Proposed Development

6.7.5 It is evident that development with 100mPD would most likely have a bulky building form with limited sensitive design measures (**Figure 6.6** refers). With a minor relaxation in building height, the proposed development would entail a taller and slender building forms. Under the planned/committed scenario, both development with 100mPD and 140mPD would be completely covered by the developments with 80mPD and 100mPD in the South Apron corner in the foreground.

6.8 VP7 – King Wan Street Leisure Path (Seafront) to the Southwest *(Figure 6.7 refers)*

Visual Composition

6.8.1 VP7 is located to the southwest of the Site. It is taken from King Wan Street Leisure Path, which is part of the Ma Tau Kok waterfront of Kai Tak Development. This VP captures the Proposed Development and surrounding residential and commercial developments within KBBA and Kai Tak Development.

Visual Obstruction

6.8.2 From this VP, the proposed redevelopment is located near the waterfront area. The existing industrial/commercial developments in KBBA and Kowloon Peak (with +602mPD) are in the background. The proposed redevelopment (including mixed block, residential towers T3, T2 and T1 and office tower) would screen off some of the planned or existing industrial/commercial developments within the KBBA. The residential tower T5 and the mixed block would be screened off by the residential towers (T1-T3) in the front. The upper roof of office tower will slightly intercept the

ridgeline. Under the Planned/Committed development scenario, the proposed development at the South Apron corner with 80mPD- 100mPD will be in the front row of the waterfront. The proposed development will be at the backdrop of those buildings, along with the planned/committed development with 120mPD- 140mPD, which have a similar building height as the proposed development, especially with Billion Centre at 140mPD.

Effect on Public Viewers

6.8.3 This VP represents the public viewers in enjoying public space with the seafront view. As shown in the photomontage in **Figure 6.7**, the VSRs could continue to enjoy a good quality open view and the overall landscape context. There will be some visual change when public viewers view towards the Site and the KBBA. With the planned/ committed development, a group of 80mPD- 140mPD buildings will be aligning along the edge of the waterfront area. The planned/committed development would completely cover the existing developments in the background. The visual impact is considered to be **Slightly to moderately adverse.**

Effect on Visual Resources

6.8.4 Only some of the existing industrial/ commercial developments would be screened off by the proposed redevelopment. A portion of the mountain backdrop and a tiny minor portion of the sky view would be intercepted by the proposed redevelopment (i.e. office tower). The planned/committed development will also be developed along the edge of waterfront area and the future development with 80mPD-100mPD, which will completely cover the existing developments and the sky open view. The future planned development at the KBBA (with the indicated building height) at the back of the proposed development would also have a similar building height as the proposed development.

Comparison between 100mPD (with PR 12) and Proposed Development

6.8.5 The development with 100mPD would cover existing developments at the back of the proposed development as the proposed development (**Figure 6.7** refers). Despite that, the development with 100mPD would create a continuous building bulk form, as it would unlikely be able to provide a wide building gap with building separation. Whilst, the proposed development has a 15m building gap in the middle of the development. Under the planned/committed development scenario, the development with 100mPD and proposed development would be developed along the edge of the waterfront area and be compatible with surrounding developments with similar building height.

6.9 VP8 – Quarry Bay Park to the Southeast *(Figure 6.8 refers)*

Visual Composition

6.9.1 This VP represents the public viewers at the urban park enjoying the view of Victoria Harbour and Kowloon East. The existing view comprises the overall context of the Kowloon East (with Kai Tak Development, KBBA and KBAA) and the Lion Rock (Kowloon Ridgeline) as the backdrop. It overlooks the mid-high rise residential developments at 95mPD to 120mPD at the Kai Tak Runway Precinct with the backdrop of commercial developments at 120mPD to 140mPD in KBBA and residential developments at 110mPD to 130mPD at Kai Tak City Centre. It also overlooks the Kai Tak Cruise Terminal within the Kowloon East, as well as the water body of Victoria Harbour. As shown in the photomontage in **Figure 6.8**, the proposed redevelopment would stand amid the mid-high rise residential/ commercial developments with height and scale comparable to the existing developments.

Visual Obstruction

6.9.2 The proposed redevelopment only forms a tiny extension of the mid-rise commercial development profile. The ridgeline at backdrop continues to maintain and it should be noted that the proposed redevelopment including rooftop structures would not have any encroachment of the "20% building free zone" of the Kowloon Ridgelines. In general, the visual obstruction is considered limited. Under the planned/committed scenario, the proposed development would be completely screened off by the future developments in the front and hidden from the future developments

Effect on Public Viewers

6.9.3 Public viewers at the Quarry Bay Park would be able to continue to enjoy the open and city views towards Kowloon East area. The VSRs at this VP would continue to have the Kowloon ridgelines, in which the proposed development including rooftop structures would not encroach into the "20% Building Free Zone" of the Kowloon ridgelines. Meanwhile, the proposed redevelopment is at similar height with the existing residential and commercial developments, forming a compatible building profile with the surrounding developments. In addition, the proposed development would be completely screened off by the future development in the front. The visual impact to the Public brought by the proposed development is considered to be **Negligible** only.

Effect on Visual Resources

6.9.4 At this VP, the waterbody of Victoria Harbour, the openness of sky, the Kowloon Ridgelines and the views toward Kowloon East as the key visual resources are not affected. Under the planned/committed development scenario, the proposed development would be completely covered by future developments.

Comparison between 100mPD (with PR 12) and Proposed Development

6.9.5 The development with 100mPD will create a “wall” effect (**Figure 6.7** refers). Under the planned/committed development scenario, both of the developments would be completely screened by the future developments and will be hidden from the future developments in the foreground.

7 CONCLUSION

7.1 The proposed redevelopment is divided into two portions: eastern and western portions. The eastern portion comprises one 28 storeys Mixed Block (with hotel/ commercial/ showroom) and one 27 storeys Office Tower atop 3 levels podium (with exhibition/showroom/commercial). While, the western portion comprises four 34 to 36 storeys residential towers atopatop a 4-storey podium with a commercial arcade (including a mezzanine floor underneath the portion below Towers 1 and 2) with social welfare facilities, podium garden and recreational facilities. The building height (BH) for the proposed residential scheme has adopted a BH profile generally descending from 140mPD (hinterland) to 133.7mPD (towards Kai Tak Waterfront), while, both the proposed office tower and mixed block with BH of 140mPD, respectively are proposed along the eastern side of the Site facing Trademart Drive. All carparking spaces/ loading and unloading bays and part of the E&M facilities will be provided at the two levels of basement.

7.2 Based on the analysis of the visual impact appraisal on Visual Composition, Visual Obstruction, Effect on Public Views and Effect on Visual Resources, **Table 7.1** below presents the overall visual impact posed by the proposed development to the VSRs represented in each VP.

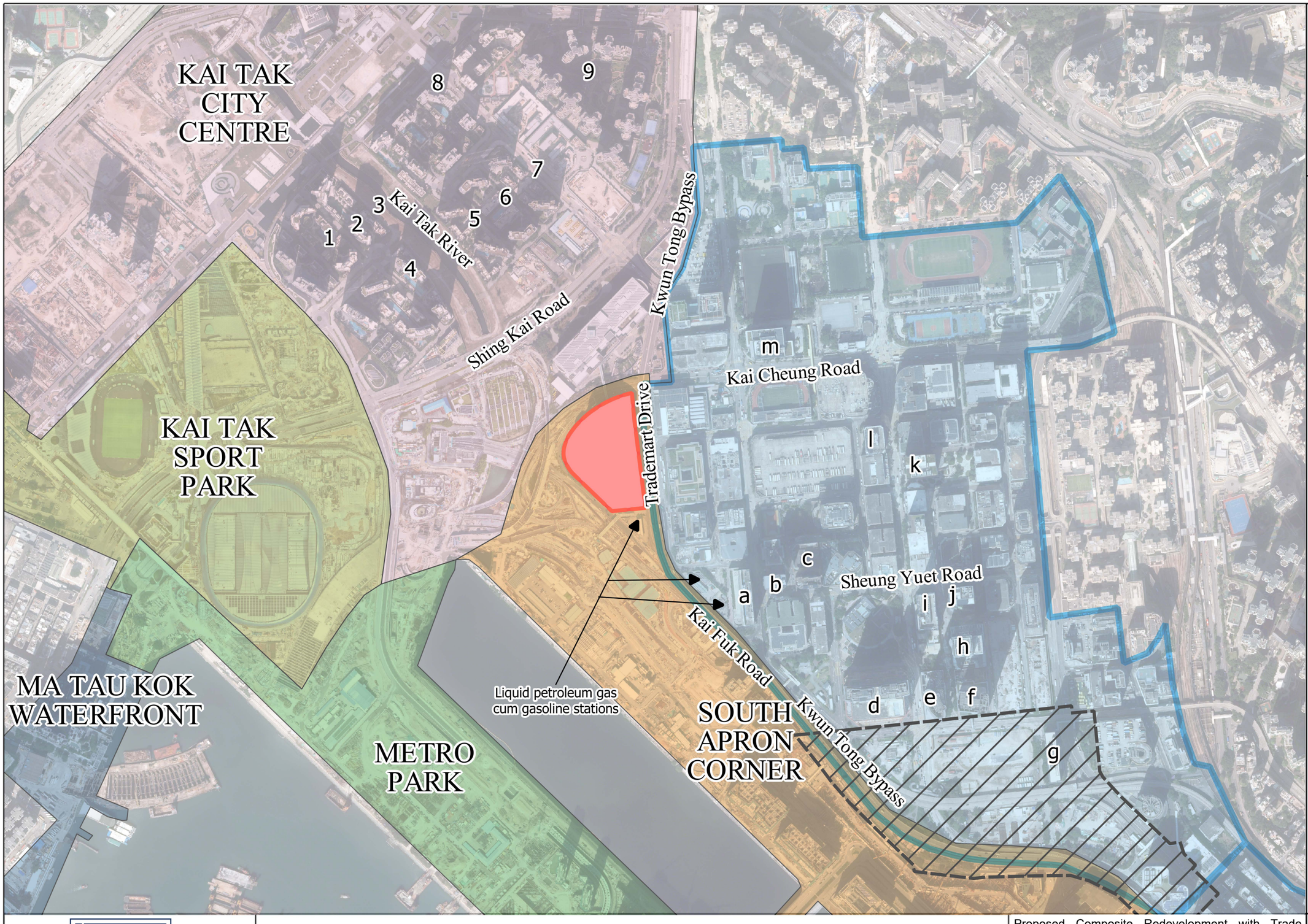
Table 7.1 Summary of Assessment of Visual Impact at the Viewpoints

Viewpoint	Location	Visual Impact due to Proposed Development
Local Viewpoint		
VP1	Footbridge near Telford Gardens to the East	Slightly Adverse
VP2	Football Field of Kowloon Bay Playground to the Northeast	Negligible
VP3	EMSD Headquarters; Shing Kai Road Bus Stop	Slightly to moderately Adverse
VP4	Junction at Shing Kai Road/ Shing Fung Road to the Northwest	Slightly Adverse
VP5	Kai Fuk Road Footbridge to the Southwest	Moderately Adverse
Distant Viewpoint		
VP6	Kai Tak Promenade to the South	Negligible
VP7	King Wan Street Leisure Path (Seafront) to the Southwest	Slightly to Moderately Adverse
VP8	Quarry Bay Park to the Southeast	Negligible

7.3 Overall, the proposed development would blend in well with the surrounding mid to high rise industrial/ commercial developments, as the sensitive design measures (i.e. building separation, stepped podium) are in place. The above

visual impact rating is assessed based on the comparison between existing and proposed development, taking into account the planning/committed developments in the surroundings. For reference, a comparison of the visual impact based on the OZP-compliant scheme is also discussed in this report.

7.4 Taken into consideration that the proposed development will be an iconic development with the proposed design mitigation measures in place, the resultant visual change due to the Proposed Development is considered **acceptable** to the identified visual sensitive receivers and will not be visually incompatible with the surrounding context.



LEGEND

- Emax Lot copy
- Kowloon Bay Business Area
- Kowloon Bay Action Area

Newly constructed mid-high rise office developments (ranging 115mPD to 173mPD) in KBBA comprise

a. Billion Centre with 140mPD
b. YHC Tower with 140mPD
c. Enterprise Square II with 133mPD
d. Enterprise Square V with 170mPD
e. Enterprise Square III with 164mPD
f. Manhattan Place with 173mPD
g. Capital Tower with 120mPD
h. One Kowloon with 161mPD
i. Exchange Tower with 126mPD
j. FTLife Tower with 120mPD
k. Kingston International Centre with 120mPD
l. CCB Centre with 134mPD
m. The BayHub with 140mPD

Newly constructed mid-high rise residential developments (ranging 100mPD to 130mPD) in Kai Tak City Centre comprise

1. The Henley with 130mPD
2. K. Summit with 130mPD
3. Upper Riverbank with 130mPD
4. Monaco One with 120mPD
5. Vibe Centro with 120mPD
6. K City with 120mPD
7. Victoria Skye with 120mPD
8. One Kai Tak with 110mPD
9. Tak Long Estate with 120mPD

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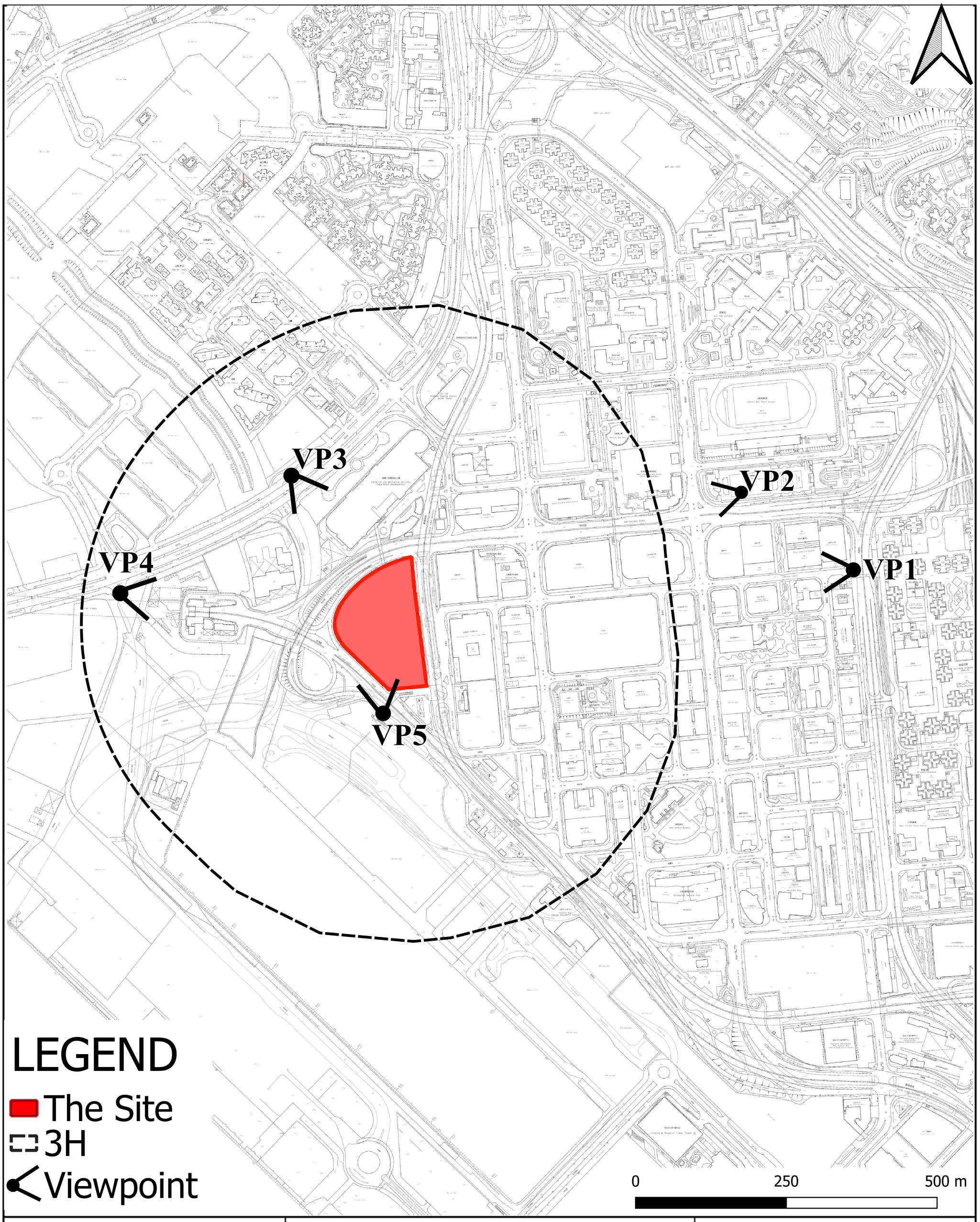
VISUAL ELEMENTS IN THE SURROUNDING AREA

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Visual Impact Assessment

Figure 3.1

Date: 13/6/2024



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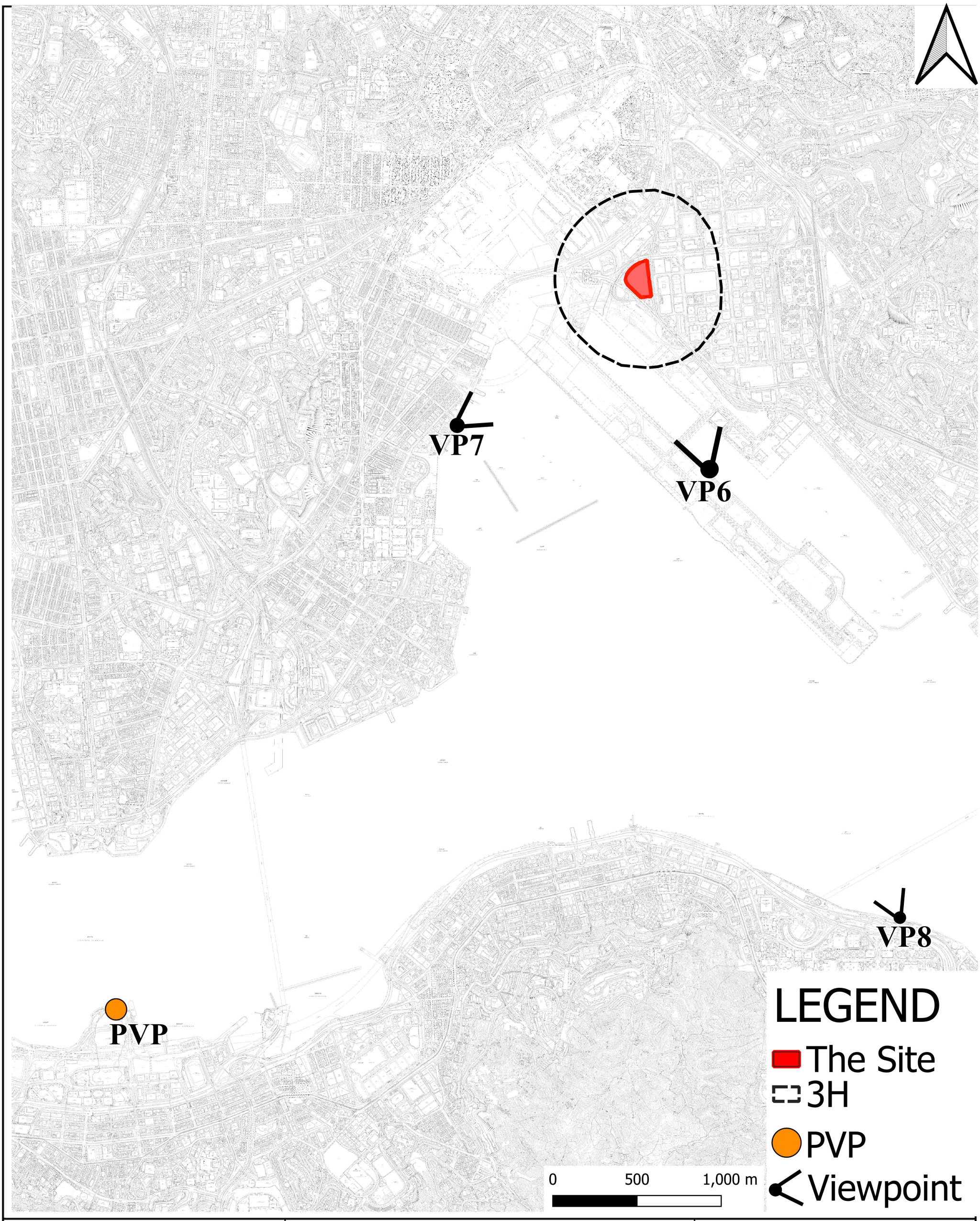
Visual Impact Assessment

LOCAL VISUAL CONTEXT (LOCATIONS OF VPs 1-5)

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Figure 5.1



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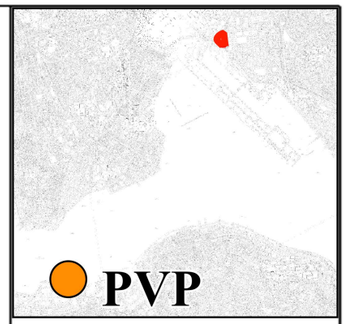
Visual Impact Assessment

DISTANT VISUAL CONTEXT (LOCATIONS OF VPs 6-8 AND PVP)

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Figure 5.2



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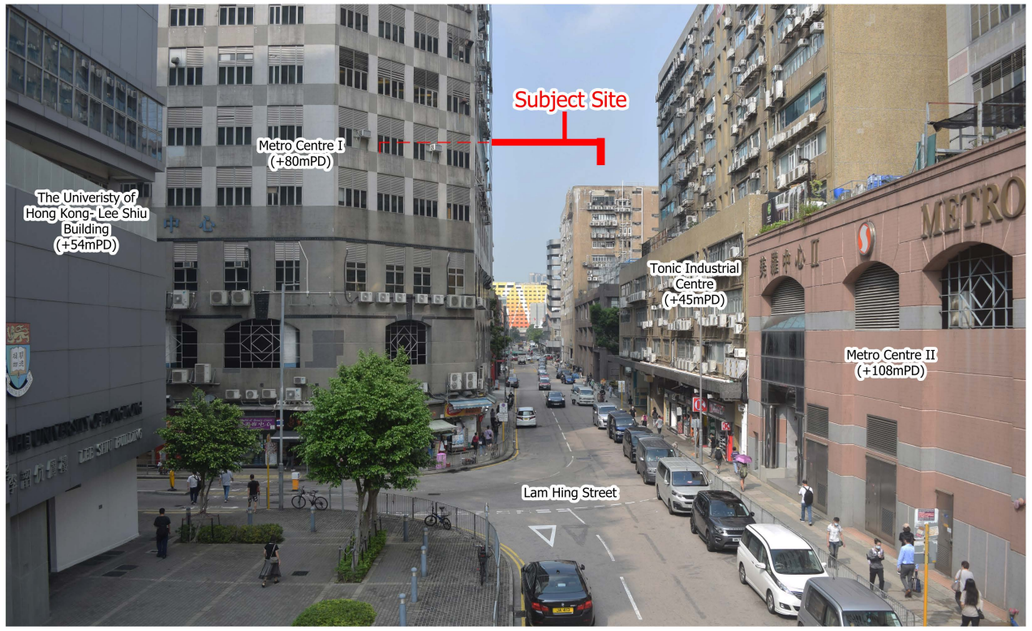
PVP- Viewing Platform Near Golden Bauhinia Square and Hong Kong Convention and Exhibition Centre To The Southwest

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

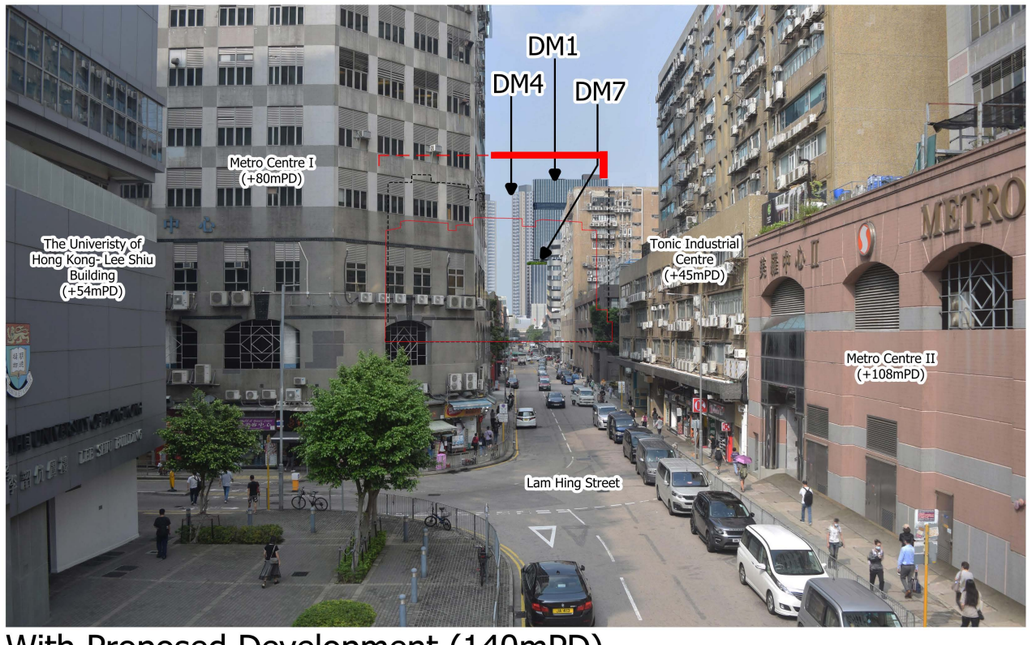
Visual Impact Assessment

Figure 5.3

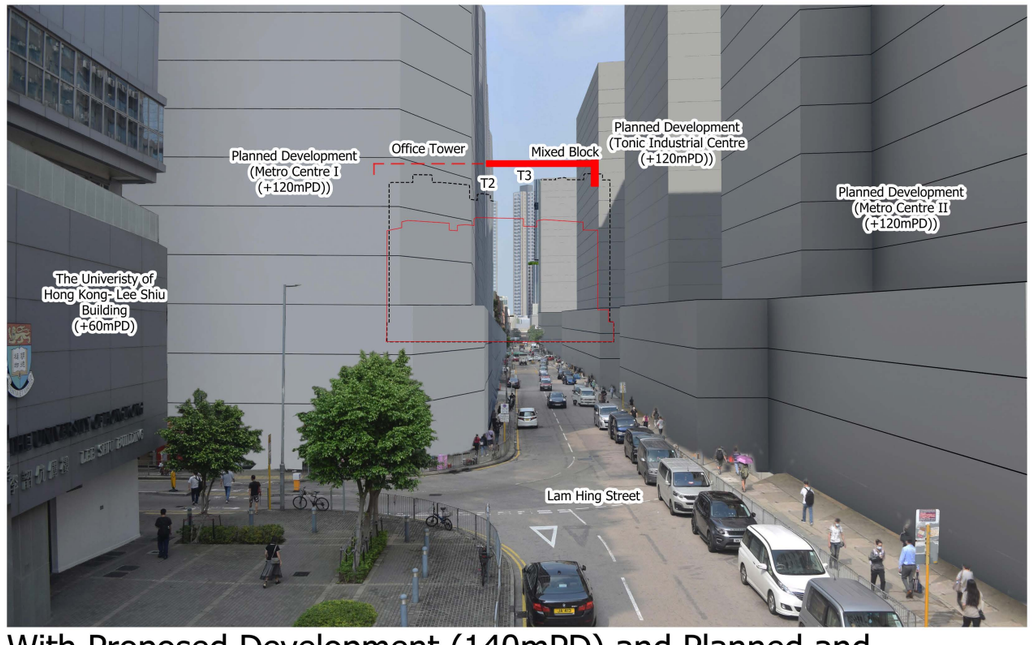
Date: 12/12/2024



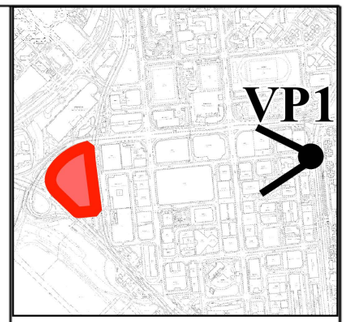
Existing Condition



With Proposed Development (140mPD)



With Proposed Development (140mPD) and Planned and Committed Development



Design Measures:

DM1: The BH of the proposed redevelopment gradually descends from hinterland to waterfront area

DM4: A 15m building separation between the two groups of residential towers to establish a physical and visual connection for pedestrians to view through the Site from hinterland and other area of Kai Tak waterfront

DM7: Adopt architectural articulation to break down the perceived bulk and visual massing of the building and to create visual interes

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR12

PLANNING LIMITED
規劃顧問有限公司

VP1- Footbridge Near Telford Gardens To The East

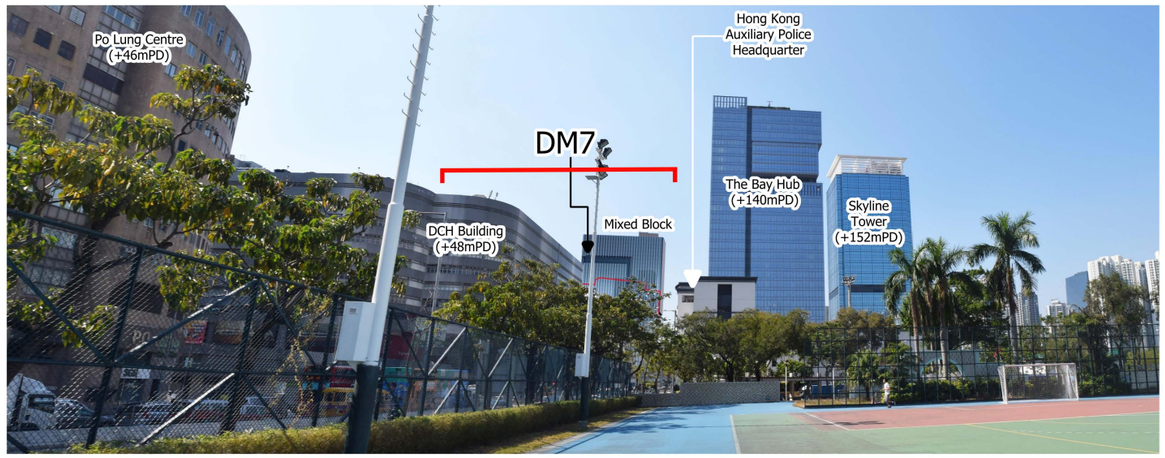
Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Visual Impact Assessment

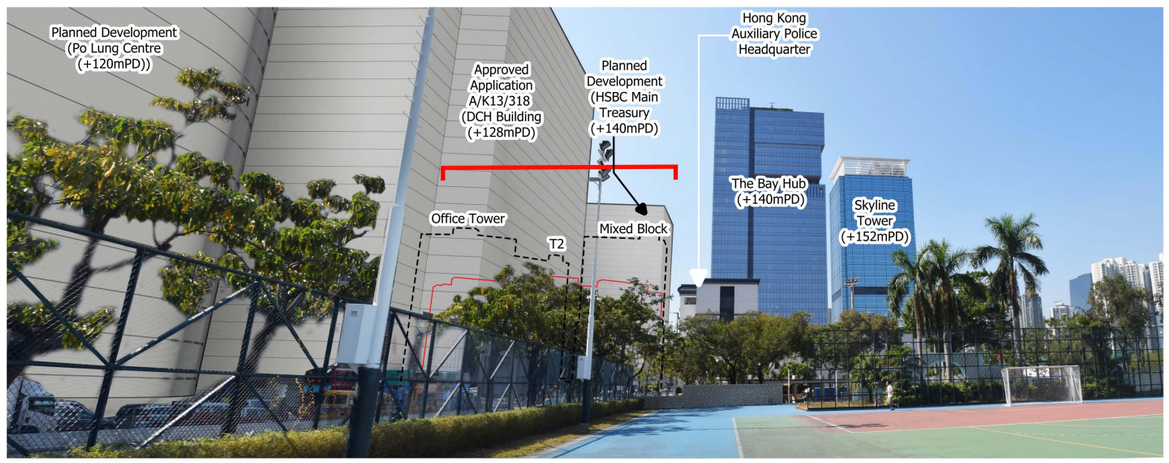
Figure 6.1

Date: 29/4/2025

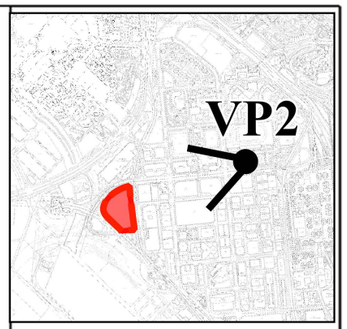
Existing Condition



With Proposed Development



With Proposed Development and
Planned/Committed Development



Design Measures:

DM7: Adopt architectural articulation to break down the perceived bulk and visual massing of the building and to create visual interest

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

PLANNING LIMITED
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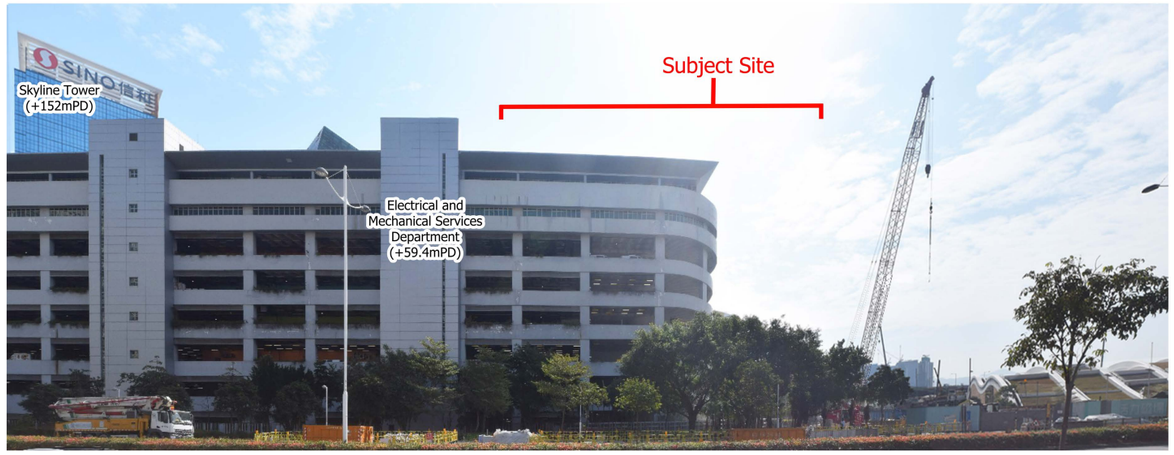
VP2- Football Field Of Kowloon Bay Playground To The Northeast

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

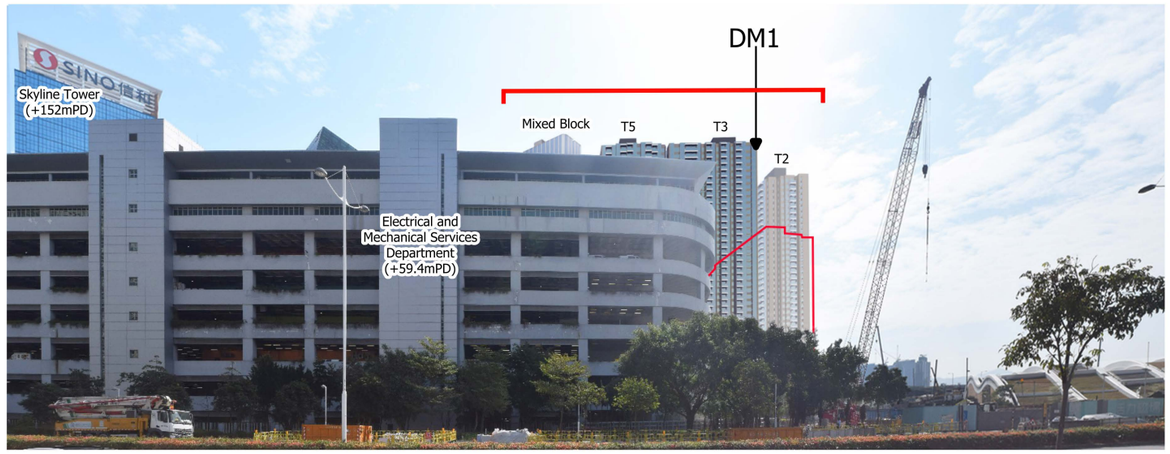
Visual Impact Assessment

Figure 6.2

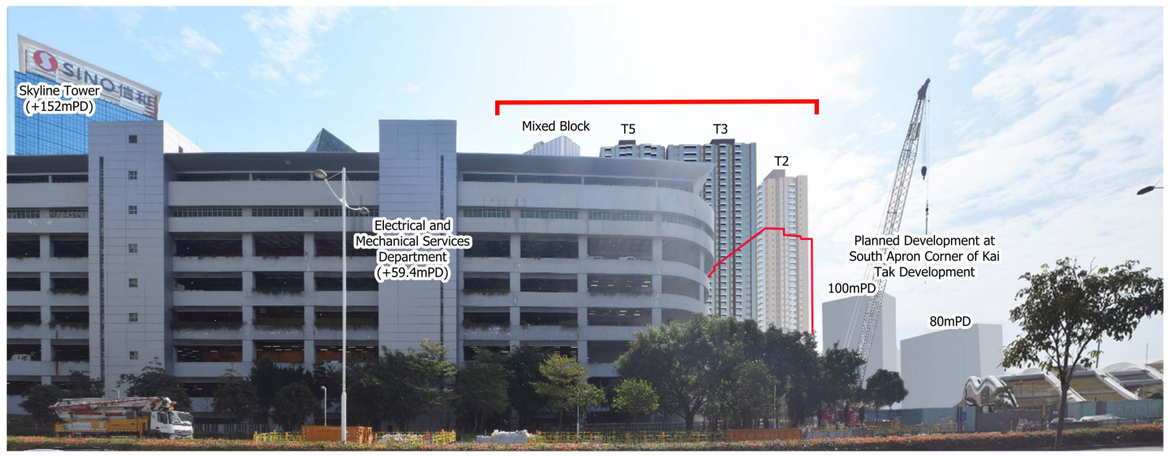
Date: 12/12/2024



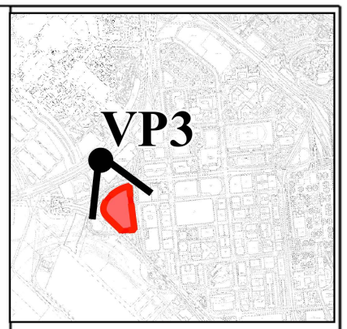
Existing Condition



With Proposed Development



With Proposed Development and Planned/Committed Development



Design Measures:

DM1: The BH of the proposed redevelopment gradually descends from hinterland to waterfront area

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

PLANNING LIMITED
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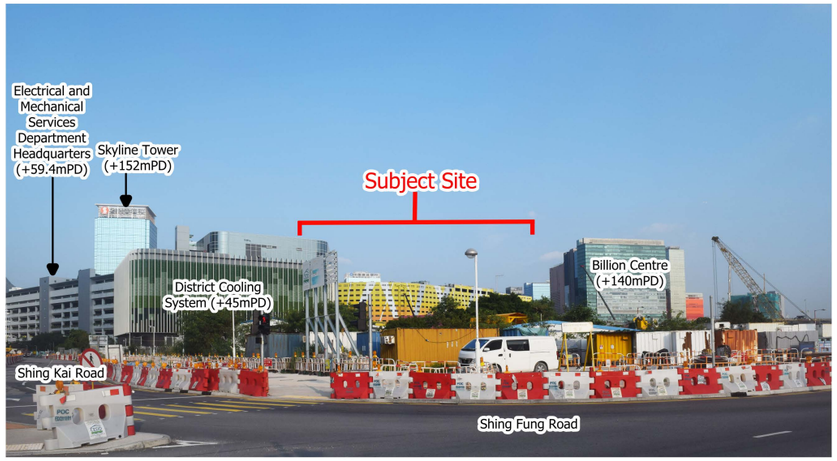
VP3- EMSD Headquarters; Shing Kai Road Bus Stop to the North

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

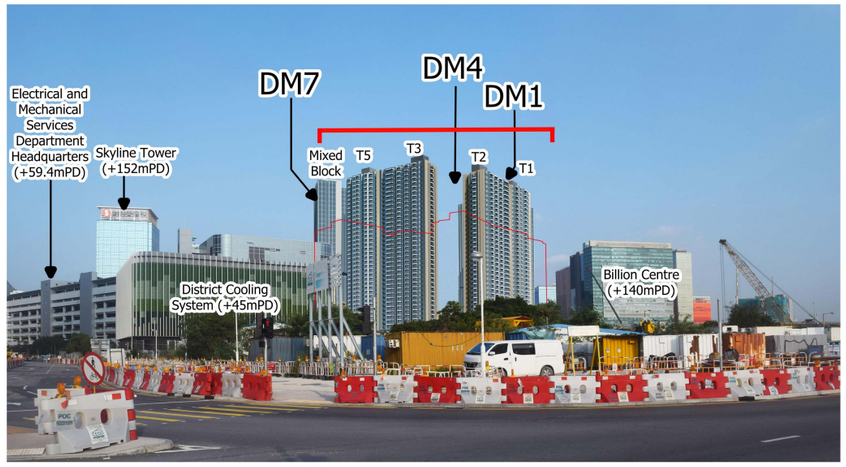
Visual Impact Assessment

Figure 6.3

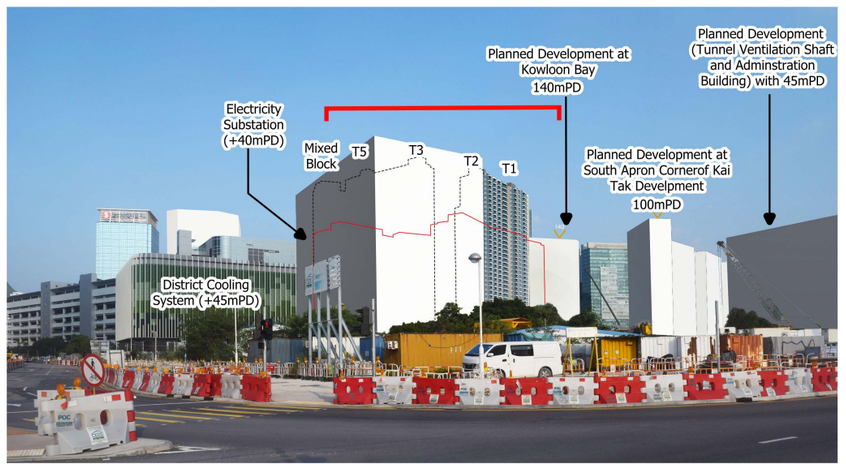
Date: 22/1/2024



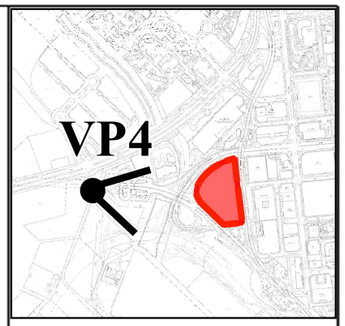
Existing Condition



With Proposed Development



With Proposed Development and Planned/Committed Development



Design Measures:

DM1: The BH of the proposed redevelopment gradually descends from hinterland to waterfront area

DM4: A 15m building separation between the two groups of residential towers to establish a physical and visual connection for pedestrians to view through the Site from the hinterland and other areas of Kai Tak waterfront

DM7: Adopt architectural articulation to break down the perceived bulk and visual massing of the building and to create visual interest

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

PLANNING LIMITED
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VP4- Junction at Shing Fung Road and Shing Kai Road

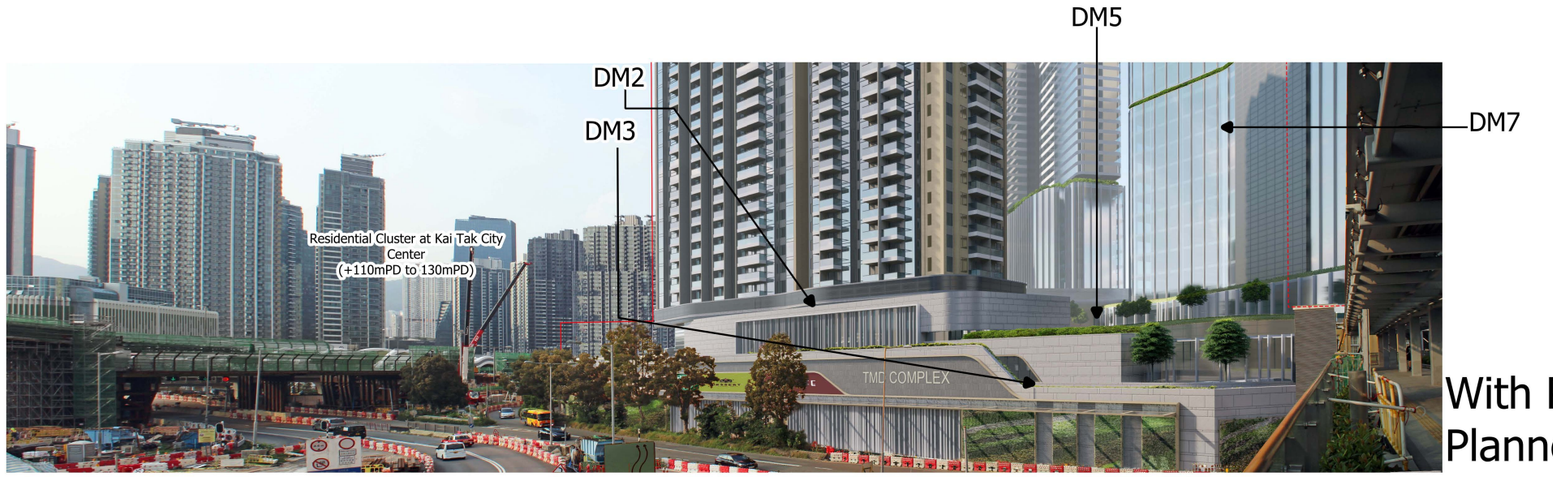
Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Visual Impact Assessment

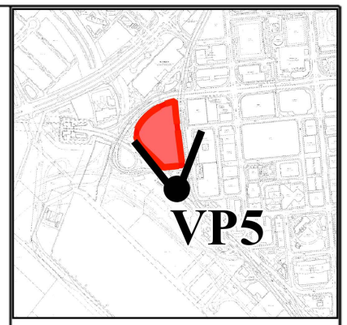
Figure 6.4

Date: 3/4/2024

Existing Condition



With Proposed Development and Planned/Committed Development



Design Measures:

DM2: The podium and towers being setbacks from the site boundary and major arterial routes to create a focal point at the lower level

DM3: Stepped podium is adopted to facilitate wind flow from the podium to pedestrian level, as well as creating dynamic architecture design at lower levels for pedestrians

DM5: Not less than 15m building separation between residential tower 1 and office tower to establish a physical and visual connection for pedestrians to view from the Site to the South Apron Corner of Kai Tak

DM7: Adopt architectural articulation to break down the perceived bulk and visual massing of the building and to create visual interest

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

PLANNING LIMITED
規劃顧問有限公司

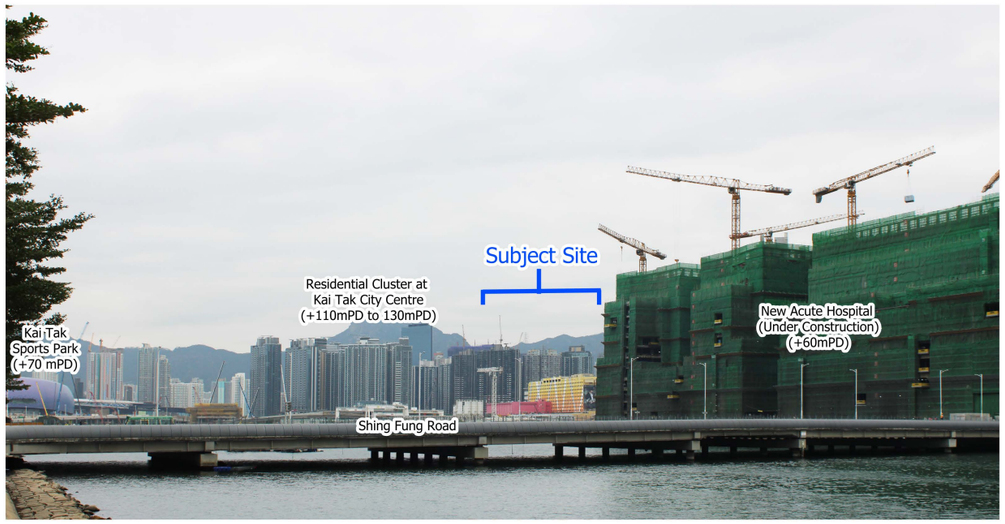
VP5- Kai Fuk Road Footbridge To The Southwest

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

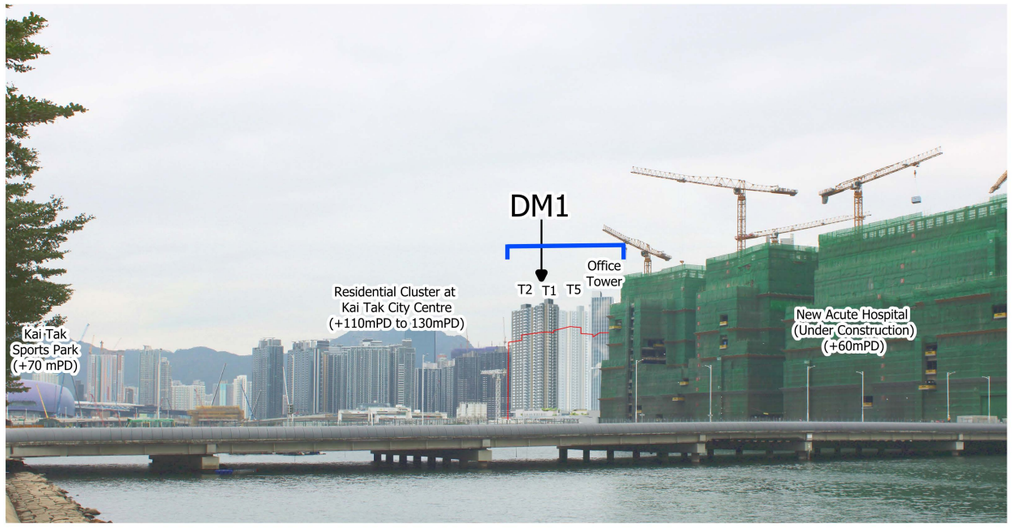
Visual Impact Assessment

Figure 6.5

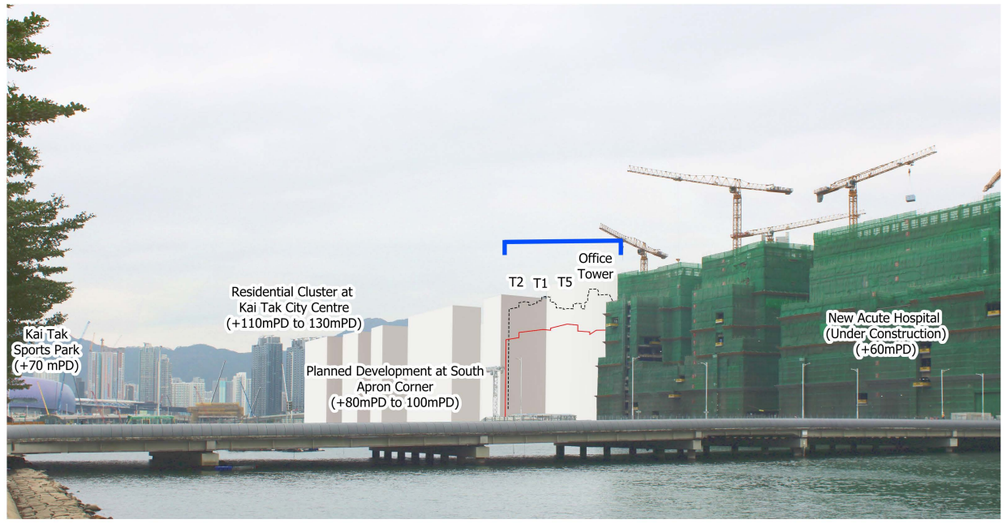
Date: 24/1/2025



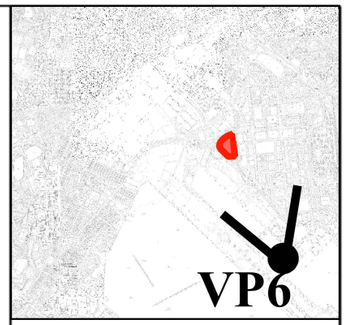
Existing Condition



With Proposed Development



With Proposed Development and Planned/Committed Development



Design Measures:

DM1: The BH of the proposed redevelopment gradually descends from hinterland to waterfront area

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

PLANNING LIMITED
規劃顧問有限公司

VP6- Kai Tak Promenade To The South

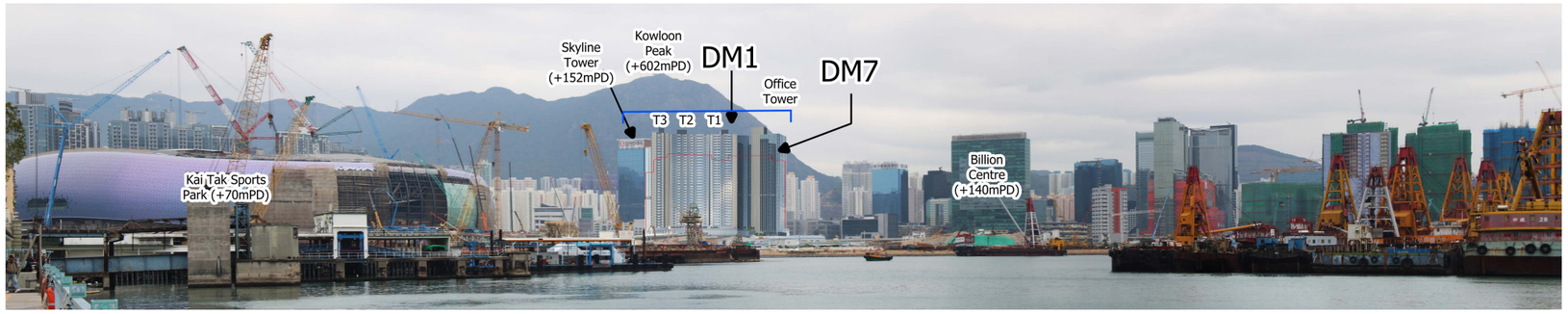
Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Visual Impact Assessment

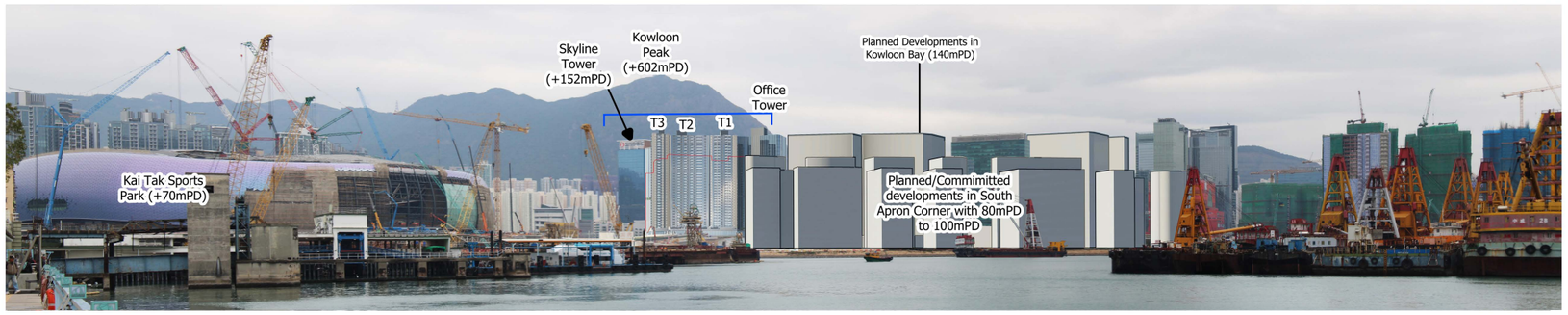
Figure 6.6

Date: 3/4/2024

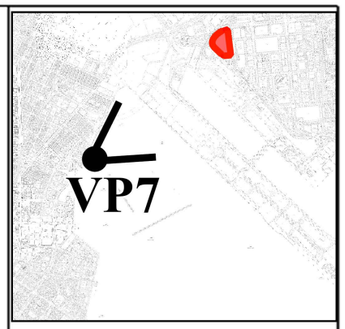
Existing Condition



With Proposed Development



With Proposed Development and Planned/Committed Development



Design Measures:

DM1: The BH of the proposed redevelopment gradually descends from hinterland to waterfront area

DM7: Adopt architectural articulation to break down the perceived bulk and visual massing of the building and to create visual interest

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

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VP7- King Wan Street Leisure Path (Seafront) To The Southwest with Proposed Development

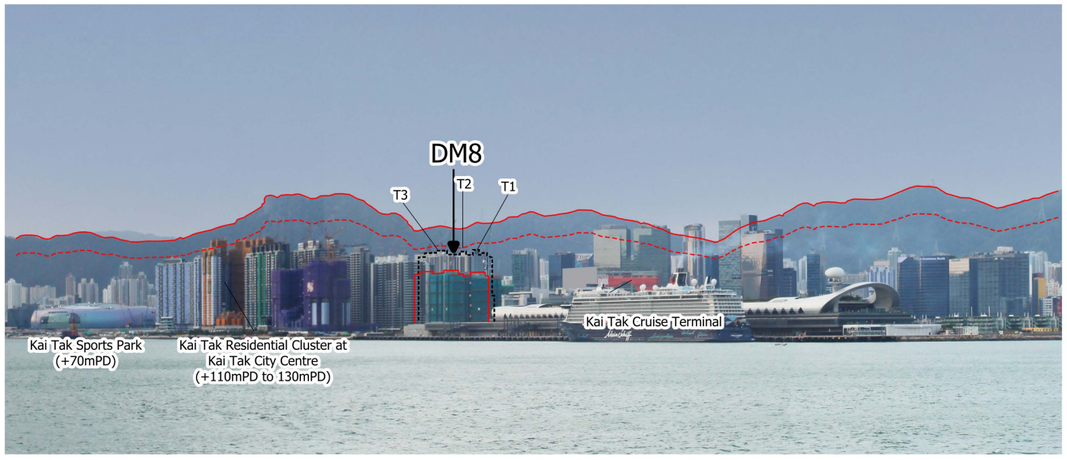
Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Visual Impact Assessment

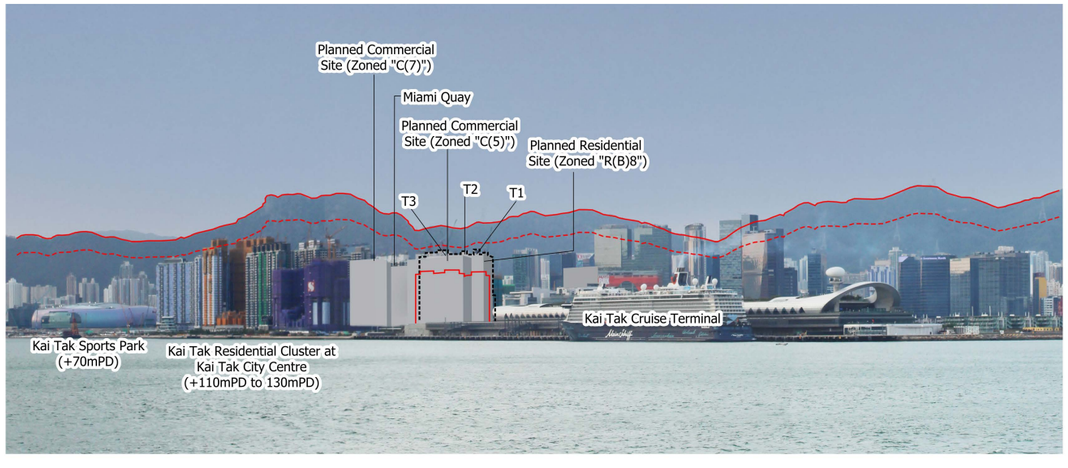
Figure 6.7

Date: 3/4/2024

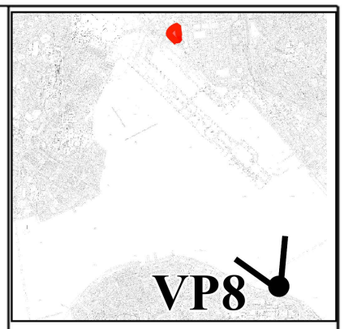
Existing Condition



With Proposed Development



With Proposed Development and Planned/Committed Development



Design Measures:

DM8: The proposed development does not encroach onto the “20% Building Free Zone” of the Kowloon Ridgeline

Proposed Development with 140mPD

OZP-Compliant Scheme with 100mPD with PR 12

PLANNING LIMITED
規劃顧問有限公司

VP8- Quarry Bay Park To The Southeast

Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilties and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

Visual Impact Assessment

Figure 6.8

Date: 24/1/2025

ANNEX 10

Prepared by

Ramboll Hong Kong Limited

PROPOSED COMPOSITE REDEVELOPMENT WITH TRADE MART/EXHIBITION AND COMMERCIAL, RESIDENTIAL, SOCIAL WELFARE FACILITIES AND SCHOOL USES AND MINOR RELAXATION OF BUILDING HEIGHT RESTRICTION, NEW KOWLOON INLAND LOT NO. 6032, 1 TRADEMART DRIVE, KOWLOON BAY, KOWLOON

AIR VENTILATION ASSESSMENT (EXPERT EVALUATION)

Date	**April 2025**
Prepared by	**Mike Kwan** **Assistant Environmental Consultant**
Signed	
Approved by	**Calvin Chiu** **Technical Director**
Signed	
Project Reference	**HQIKITECEI00**
Document No.	**R9126_V2.1**

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CHAPTERS

TABLES

FIGURES

APPENDIX

1. INTRODUCTION

1.1 Project Background

1.1.1 The background in relation to the project and this Section 16 planning application is included in the planning statement.

1.1.2 Ramboll Hong Kong Limited has been commissioned by the Applicant to prepare the Air Ventilation Assessment – Expert Evaluation (AVA-EE report) for Proposed Development. The AVA-EE report will assess the air ventilation issues of the Application Site and the surrounding area.

1.2 Objective

1.2.1 This AVA-EE report has been prepared to identify opportunity and good design features that can be practicably adopted in the Proposed Scheme from air ventilation standpoint and evaluate if there would be any impact on the overall air ventilation performance of the assessment area by comparing the Proposed Scheme with the OZP Compliant Scheme.

1.3 Application Site and its Environs

1.3.1 The Application Site is located in Kowloon Bay area with surrounding context described under Section 2.1.1 of the planning statement. Kai Fuk Road is connected to the existing Kai Tak Tunnel with tunnel portal located on west side of the Application Site. The planned Central Kowloon Route would have the future alignment running along and to the further southwest.

1.3.2 The Application Site is currently occupied by KITEC. The building of KITEC is 14 storeys high and has building height of about +52.4mPD.

1.3.3 The Application Site is located in a well-established area with commercial and industrial development, Government, Institution or Community ("G/IC") facilitates. The Application Site is at the western periphery of Kowloon Bay Business Area ("KBBA") and separated by Trademart Drive. The KBBA is consist of medium to high-rise commercial and industrial buildings ranging from +120mPD to +170mPD. Kai Tak Residential Cluster is on the opposite side of Shing Kai Road to the north and northwest of the Application Site consist of high-rise residential buildings ranging from +100mPD to +130mPD.

1.3.4 The Application Site also falls within the "South Apron Corner" of Kai Tak Development ("KTD") area which mainly consist of mid- and high-rise commercial developments and government uses.

1.3.5 **Figure 1** shows the location of the Application Site and its environs. **Figure 1** indicates either the building height of the existing development, the proposed building height of planned developments (referring to approved planning applications), or building height restriction of lot area not occupied yet as stipulated in the latest Approved OZP.

1.4 OZP Compliant Scheme

1.4.1 The OZP Compliant Scheme consist of a large podium (+20mPD) covering the entire Application Site and 4 nos. of office towers with 23-storeys atop it. The plot ratio of the OZP Compliant Scheme is about 12 and the building height of all office towers are +100mPD. The disposition of the office towers would be closely positioned to each other with narrow/small building gap between towers. It would create a continuous

façade facing east/west and pose unfavourable impacts to the surrounding area in the air ventilation standpoint.

1.4.2 The Indicative Block Plan of the OZP Compliant Scheme is shown in **Appendix 1**.

1.5 Proposed Scheme

1.5.1 The Proposed Scheme is divided into two portions for residential use at the western half and commercial use at the eastern half of the Application Site. It comprises four 34-36 storeys residential towers (Tower 1 to Tower 5, Tower 4 omitted) elevated at 133.7mPD or 140mPD (measured at main roof), one office tower elevated at 140mPD and one mixed block (with commercial use at G/F to 10/F and hotel use at 11/F and above) elevated at 140mPD. The office tower and mixed block are atop of a connected 3-level podium elevated at 26.5mPD mainly for exhibition/ commercial/ showrooms uses. The residential towers are atop of a 4-storey podium for Residential Care Home for the Elderly (RCHE)/ Day Care Centre for the Elderly (DCCE)/ office base of social work service for Pre-Primary Institutions (SWSPPI)/ kindergarten/ commercial uses/ residential clubhouse (including a mezzanine floor underneath the portion below Tower 1 and 2). The elevations (including transfer plate) range from 10.9 to 25.9mPD. All carparking spaces/ loading and unloading bays and part of the E&M facilities will be provided at the two levels of basement.

1.5.2 The residential towers are divided into 2 groups on north and south sides, and separated by a gap of not less than 15m (above the transfer plate elevated at 25.9mPD). The building height (BH) for the proposed residential towers has adopted a BH profile descending from 140mPD (north) to 133.7mPD (south), while the proposed office tower and mixed block both with BH of 140mPD are proposed along the eastern half of the Site facing Trademart Drive.

1.5.3 Varying and stepped building height design is adopted for the podium. The podium of residential portion has elevation stepped at 10.9mPD, 15.8/16.8mPD, 22.8mPD and 25.9mPD. Building structure at 2/F of the podium garden has been minimised to allow for a permeable podium garden of about 6m height (especially between Tower 2 and Tower 3).

1.5.4 Both the office tower and mixed block are located on eastern side of the Application Site. The office tower is next to Tower 1 on south side. The mixed block is next to Tower 5 on north side. The podium for commercial portion consists of 3 storeys (+23mPD/+26.5mPD).

1.5.5 Beside the buildings within site, there is an Existing Kai Cheung Road Footbridge Connection provided outside site associated with the proposed development. It will connect the proposed development at the Application Site and northward crossing Kai Cheung Road and Shing Kai Road with proposed northern footbridge extension. The design of the footbridge is subjected to detailed design including to address government's comment. Tentatively, the footbridge is elevated not less than 5.5m aboveground. It is a single storey structure with about 5m width, and with opening and permeable railing on both sides. While there is a proposed southern link bridge, this is to connect with the existing Kai Fuk Road footbridge to the South Apron Corner of Kai Tak Development and will project less than 5m to connect to the existing government footbridge. Tentatively, permeable design (with opening and permeable railing on both sides) will be adopted as well.

1.5.6 Design and measures have been adopted to enhance air ventilation performance of the Proposed Scheme. (1) For the residential portion, there is a building separation with

width of not less than 15m between Tower 2 & Tower 3 (at +25.9mPD and above) promoting wind penetration at high level across the Application Site; (2) There are at least 15m setbacks of residential towers (at +25.9mPD and above) away from site boundaries, and there is at least 15m building setback of building structure of the proposed development (except ramp road and footbridge) away from the southern boundary to promote E/W wind penetration. All building setbacks can enhance the wind flow along the surrounding road bounding the site. (3) Podium garden of about 6m height is provided at podium underneath residential towers. (4) Stepped podium design at the residential podium is provided to facilitate wind flow over the podium and reach pedestrian level easer then. (5) Moreover, there is an urban window that is about 6.5m tall and not less than 15m wide at pedestrian level below the central exhibition multi-purpose hall, which is designed to facilitate E wind entry at pedestrian level into the open plaza at the middle of the project development.

1.5.7 In addition, while the proposed building height of the Proposed Scheme is higher than that of the OZP Compliant Scheme (140mPD vs 100mPD) and would impose more blockage at higher level, it could also generate relatively more downwash wind, which would benefit the air ventilation performance of the area in-between the residential towers and in close vicinity.

1.5.8 The Indicative Block Plan and the section drawings of the Proposed Scheme are shown in **Appendix 2**. The key development parameters of the OZP Compliant Scheme and Proposed Scheme are summarized in **Table 1.1**.

Table 1.1 Key Development Parameters

Development Parameters	OZP Compliant Scheme	Proposed Scheme
Total Site Area (approx.)	22,280 m^2	
Total Plot Ratio (Max.) • Domestic (Max.) • Non-domestic (Max.) #	12 - 12	7.4 2.96 4.44
Total GFA (approx.) • Domestic (approx.) • Non-domestic (approx.)*	267,360 m^2 0 m^2 267,360 m^2	164,872 m^2 65,949 m^2 98,923 m^2
No. of Blocks	4 Office Towers	4 Residential Towers + 2 non-Domestic blocks for Office, Hotel, Retail and GIC
Site Coverage - Podium (Below 15m) # - Tower (Above 15m) • Domestic • Non-domestic	 100% Not more than 65% - Not more than 65%	 80% 48% 19% 29%
Maximum No. Storeys (excluding basement carpark) • Residential • Office • Mixed	 - 23 storeys -	 36 storeys 27 storeys 28 storeys
Maximum Building Height (at main roof level) • Residential • Office • Mixed	 - 100mPD -	 140 mPD 140 mPD 140 mPD

Note:

* Including GFA of office 35,600m^2; Showroom/Exhibition 11,285m^2; Shops and Eating Place: 13,403m^2 (i.e. excluding GFA of proposed southern of footbridge link and the proposed opening with associated bridge linkage).

\# Excluded proposed southern footbridge link and the proposed opening with associated bridge linkage.

1.5.9 The proposed development with a site area of over 2 hectares, an overall PR of 5 or above as well as a total GFA exceeding 100,000m^2 has fallen under the criteria set out in the Joint HPLB-ETWB Technical Circular on AVA No. 1/06.

2. SITE WIND AVAILABILITY DATA

2.1 Site Wind Availability Data From RAMS

2.1.1 According to the Planning Department's website, a meso-scale Regional Atmospheric Modelling System (RAMS) was used to produce a simulated 10-year wind climate at the horizontal resolution of 0.5 km x 0.5 km covering the whole territory of Hong Kong. The simulated wind data represents the annual, winter and summer wind condition at various levels, i.e. 200 m, 300 m, and 500 m above terrain.

2.1.2 The RAMS data of the grid (X: 086, Y:043) and (X: 086, Y:044) have been extracted from the Site Wind Availability Data of Planning Department's website as the Application Site falls into both grids.

2.1.3 Among the wind roses with respect to different heights (200, 300 or 500m) available, the 200 m site wind availability data represents wind data that takes into account the topographical effect around the Application Site. Therefore, a lower level of wind roses at 200 m height is selected to study the prevailing wind condition as it represents the incoming wind to the Application Site and considers the influence on the prevailing winds by the surrounding topography.

2.1.4 According to the wind roses at 200 m altitude, annual prevailing wind directions for the Application Site are ENE, E, ESE whereas summer prevailing wind directions are E, ESE, SE, SSW, SW, and WSW. **Figure 2a** shows the relevant wind roses diagrams representing the frequency and wind speed distribution at 200m height in annual and summer conditions. The wind frequency data is provided in **Table 2.1** below.

Table 2.1 Summary of RAMS Data and Wind Direction at 200m

	(X: 086, Y: 043)		(X: 086, Y: 044)	
Wind Direction	**Probability for Annual Condition (%)**	**Probability for Summer Condition (%)**	**Probability for Annual Condition (%)**	**Probability for Summer Condition (%)**
N	3.9%	1.1%	4.0%	1.2%
NNE	7.3%	1.1%	8.3%	1.2%
NE	6.2%	1.1%	5.9%	1.1%
ENE	**13.1%**	3.5%	**12.3%**	3.2%
E	**28.3%**	**11.7%**	**28.5%**	**12.0%**
ESE	**9.3%**	**10.3%**	**9.5%**	**10.5%**
SE	4.6%	**8.6%**	5.0%	**9.5%**
SSE	2.5%	5.4%	2.6%	5.6%
S	3.0%	7.0%	2.9%	6.8%
SSW	4.4%	**10.3%**	4.7%	**11.0%**
SW	5.8%	**15.4%**	5.2%	**14.1%**
WSW	4.1%	**11.1%**	4.0%	**10.9%**
W	3.0%	7.1%	2.9%	6.8%
WNW	1.6%	2.9%	1.6%	2.8%
NW	1.2%	1.8%	1.2%	1.9%
NNW	1.6%	1.4%	1.5%	1.4%

Note: Bolded characters highlighted in grey represent the selected prevailing wind directions for evaluation.

2.2 Wind Data from HKO Station

2.2.1 According to wind data of Kai Tak Hong Kong Observatory Wind Station which is nearest weather station to the Application Sites. The annual prevailing winds are mainly from E, ESE, SSE and the annual wind rose for Kai Tak Wind Station (1999 – 2019) is shown in **Figure 2b**. The summer (Jun-August) prevailing wind direction is extracted from the monthly data of Kai Tak Wind Station, and they are generally from ESE and SW. **Table 2.2** shows the monthly prevailing wind direction in degrees extract from the Monthly Data of the Kai Tak Wind Station.

Table 2.2 Prevailing Wind Direction in degrees Extracted from Monthly Data of the Kai Tak Wind Station

Month	Prevailing Wind Direction (degrees)
01	100
02	100
03	110
04	130
05	110
06	**230**
07	**120**
08	**120**
09	100
10	100
11	130
12	320

Note: Bolded characters highlighted in grey represent the summer prevailing wind directions for evaluation.

2.3 Wind Data from Previous Studies

2.3.1 There are several air ventilation assessments in Kowloon East area, and some of them can be considered as reference. The Application Site falls into the Study Area B of "Agreement No. CE35/2006 (CE) Kai Tak Development Engineering Study cum Design and Construction of Advance Works – Investigation, Design and Construction" (ref. AVA/G/76). The Application Site also located to the west of the concerned area in "Term Consultancy for Expert Evaluation on Air Ventilation Assessment for an Instructed Project for Ngau Tau Kok and Kowloon Bay – Expert Evaluation Report" (ref. AVA/G/133).

2.3.2 According to ref. AVA/G/76, the wind availability at 150mPD was adopted. ESE (19.2%), E (17.5%), and SE (13.9%) prevailing wind were selected for annual prevailing wind direction, while the summer prevailing wind were SE (19.0%), WSW (12.7%), and ESE (11.4%).

2.3.3 According to ref. AVA/G/133, various wind data were referenced for the Ngau Tau Kok and Kowloon Bay Study Area. It is concluded that wind data provided by PlanD is likely to be more representative to reflect the wind availability of the concern area. The annual prevailing wind direction adopted in the study were N, NNE, NE, ENE, E, ESE

and SE, while the summer prevailing wind direction were E, ESE, SE, S, SSW, SW and WSW.

2.3.4 Based on all sets of wind data, it is considered that RAMS data and the wind data from previous AVA study ref. AVA/G/76 are the most relevant reference for this study (Kai Tak Hong Kong Observatory Wind Station, which is located at the apron area of old Kai Tak Airport and it is about 1.9 km away from the Application Site to the southeast. The HKO wind data is considered least relevant due to its localities and the impacts on the topography. On the other hand, the Application Site does not fall into the concern area of AVA study ref. AVA/G/133 so that it is less relevant as well.). Thus, the annual prevailing winds come from ENE, E, ESE and SE directions. While in summer condition, the prevailing winds mainly come from E, ESE, SE, SSW, SW, and WSW directions.

2.4 Topography

2.4.1 The Application Site is located in the west of KBBA. The topography of the Application Site and surrounding is mainly flat. It is expected that wind availability is more influenced by building morphology rather than topography.

2.5 Building Morphology

2.5.1 All major noise barriers, elevated structures, planned and committed development, if any in the surrounding, are considered in this report. After checking by the site visit for existing developments and the published information in Statutory Planning Portal under the Town Planning Board regarding planned / committed developments in the model area, the Application Site is mainly surrounded by medium-rise development in the immediate vicinity, e.g. HSBC Building Kowloon Bay Main Treasury (+36mPD) to the east, Central Mail Centre (+40mPD) to the southeast, EMSD Headquarters (+59mPD) to the north. There is an existing footbridge across Kai Cheung Road that connects the Application Site with the EMSD Headquarters in its north.

2.5.2 The building density of the surrounding is considered medium. The surrounding area covers an area of at least by the height of the highest building within the assessment area (+140mPD) from the Application Site boundary. The surrounding areas are mainly development including scatter of industrial development in the KBBA. The surrounding areas also consist of residential development in the Kai Tak Development (KTD) area and some of the government, commercial and mixed-use development in the Kai Tak Promenade Area and to the further east which are of higher building heights.

2.5.3 The east side of the Application Site is KBBA. It consists of development including Wing On Godown Building (+30mPD), Jing Hin Industrial Building (+30mPD), Kinetic Industrial Centre (+33mPD), Megacube (+32mPD), and YHC Tower (+140mPD), etc. Remaining areas are either open area or mixed building uses development. Potential building blockage effect due to the surrounding existing developments (to the east) are considered minor.

2.5.4 Northwest and north of the Application Site is Kai Tak City Centre of KTD Area. It mainly consists of high-rise residential development. According to Approved Kai Tak OZP (S22/K/8), the area is zoned as "Residential (Group B)" and "Residential (Group A)" further north. Private residential development within the area includes Vibe Centro (+119.5mPD), K.City (+120.3mPD), Victoria Skye (+120.2mPD), Oasis Kai Tak (+110mPD), One Kai Tak (+110mPD), Upper Riverbank (+130mPD), K.Summit (+130mPD), The Henley (+130mPD), Tak Long Estate (+119mPD), and Kai Tai Development Site 1L1 to 1L3 (Planning Application No. A/K22/16, +120mPD), etc. Northerly and westerly wind are not the major prevailing wind neither annual nor

summer wind condition. Therefore, the prevailing wind blockage by the residential building in Kai Tak City Centre of KTD area is not a concern.

2.5.5 The southwest of the Application Site is Kai Tak Promenade Area separated by Kai Fuk Road, which belongs to South Apron Corner of KTD area. There is commercial development zoned as "C(8)" and "C(1)" with building height restriction of +100mPD and +80mPD respectively.

2.5.6 The further south of the Application Site is the Kat Tak Runway and mainly consist of residential development, commercial/hotel and the Metro Park for leisure use. The residential development includes One Victoria (+110 mPD), and other planned residential development (S22/K/8), ranging from +95mPD to +120mPD. Wind from southwest will be blocked by the high-rise residential development, however, the Metro Park on southwest side as open space would promote south-westerly wind towards the Application Site. Therefore, SW wind is generally not affected.

2.5.7 Kwun Tong Bypass is the major road within the surrounding area. The road will likely facilitate air flow above it across the Kowloon Bay area. As this is an elevated road, it will likely reduce some wind availability underneath the road.

2.6 Summary of Existing Site Wind Availability

2.6.1 According to the wind availability data from RAMS, HKO weather station, and previous AVA study ref. AVA/G/76, the summarised annual wind directions of the Application Site include ENE, E, ESE and SE directions. While in summer wind condition, the prevailing winds mainly come from E, ESE, SE, SSW, SW and WSW directions.

2.6.2 The wind probability from the E direction is likely the most dominant if both simulated and measurement data are considered. Other than E wind, ENE wind is considered to be important as well. The wind probability from the SW is the most dominant summer winds direction for the area. E wind is also relatively dominant when compared to other summer wind directions.

2.6.3 It is anticipated that the surrounding traffic network would be the main air paths under the annual and summer condition. For instance, Kai Cheung Road is aligned along prevailing ENE and E wind direction under annual wind condition. Even Lam Hing Street and Lam Wah Street are facilitating prevailing ENE and E wind flow in certain extent. Kai Fuk Road is aligned along annual and summer prevailing SE wind direction. On the other hand, Kai Cheung Road is also parallel with summer prevailing SSW and SW wind flow.

2.6.4 **Figure 3** and **Figure 4** show the identified major air paths under the annual and summer wind conditions.

3. EXPERT EVALUATION OF AIR VENTIALTION PERFORMACE OF THE PROPOSED DEVELOPMENT

3.1 Important Pedestrian Areas

3.1.1 Important surrounding areas that the public would often access have been identified as the following:

- Roads surrounding the Application Site (Trademart Drive, Kai Cheung Road and Kai Fuk Road, and roads further away);
- Open space; and
- Nearby residential and commercial developments.

3.2 Evaluation of Merit/Demerit of Design Features of the Proposed Development

3.2.1 Under the Proposed Scheme, various good design features are beneficial to air ventilation such as large building separation advantageous to prevailing wind penetration, separation of building from site boundary and permeable open plaza and podium garden are incorporated.

- A large building separation is provided between Tower 2 and Tower 3 (not less than 15m, at +25.9mPD and above) oriented to east/west direction and allow annual and summer prevailing ENE, E, ESE and WSW wind to penetrate through. This separation facilitates wind penetration to benefit its downstream areas.
- There are setbacks of building mass from site boundaries. All major building structures should have at least 15m setback from southern site boundary; and all residential towers (at +25.9mPD and above) should have at least 15m setback from site boundaries (southwest and northwest). The building setback would minimise obstruction to wind flow around the buildings under annual and summer prevailing wind.
- Residential podium garden with about 6m in height (+16.8mPD to +22.8mPD) is provided at the second floor. The podium garden below Tower 2 & Tower 3 would facilitate prevailing ENE, E, ESE and WSW wind to penetrate through.
- Stepped podium height design is adopted to facilitate wind flow from above podium to pedestrian level. For example, E wind can flow over the podium on east side (26.5mPD) and over podium on west side between Tower 2 and Tower 3 (16.8mPD and then 10.9mPD) to pedestrian level in the surrounding (5mPD).
- Open plaza is provided at ground level at the middle of the Site and surrounded by the podium buildings. The urban window on east side (about 6.5m tall and not less than 15m wide) below the central exhibition multi-purpose hall will welcome prevailing E, ENE, and ESE wind to reach the open plaza and wind availability among the open plaza is enhanced.

3.2.2 Further discussion of the scheme based on the good design features above is included below.

Air paths

3.2.3 **Figure 3** and **Figure 4** illustrate the prevailing winds from annual and summer wind directions for the Baseline Scheme. **Figure 5** and **Figure 6** illustrate the prevailing winds from annual and summer wind directions for the Proposed Scheme.

3.2.4 Major air paths nearby the Application Site are along Kai Cheung Road, Kai Fuk Road, Trademart Drive and Kwun Tong Bypass. Also, there are secondary air paths that could ventilation from KBBA towards the Application Site, for instance, Lam Hing Street, Lam Wah Street, and Sheung Yuet Road all along E/W axis. The open space to the immediate south outside the Application Site can also serve as secondary air path (about 15m wide). These secondary air paths mainly promote easterly wind to flow towards or around the Application Site. These air paths are outside the Application Site so that they would be the same under the OZP Compliant Scheme and Proposed Scheme.

3.2.5 Under the Proposed Scheme, the air paths along Lam Hing Street would be able to connect to the open plaza through the urban window and could enable wind flow to reach the open plaza (+5mPD). Moreover, the annual and summer prevailing E wind could flow atop the central exhibition multi-purpose hall (+26.5mPD) and through the building separation of not less than 15m between Tower 2 & Tower 3 above the podium to its downwind area. There are at least 15m proposed setbacks of residential tower from the southern, southwestern and northwestern boundaries of the Application Site (at +25.9mPD and above). These building setbacks would effectively widen the major or secondary air paths immediate to the Application Site and allow more wind penetration along the air path at Kai Cheung Road and Kai Fuk Road. The development would also enable E wind penetration along the proposed building setback (at least 15m) from southern site boundary.

Building Disposition and Development Permeability

3.2.6 Under the OZP Compliant Scheme, there is a massive podium with full site coverage. The buildings atop the podium have one building gap between (facing NNW/SSE) and create a continuous frontage blocking wind from east/west directions. The long impermeable façade is unfavourable for prevailing wind penetration. Under the annual and summer wind conditions, prevailing wind (e.g. E, ESE, ENE, SW) would likely dissipate at the long façade of the OZP Compliant Scheme and would not reach the downward areas. It is expected that the wind environment at immediate downwind areas would be lower.

3.2.7 Under the Proposed Scheme, the overall building footprint has been reduced. The podium adopts stepping design and would also have at least 15m setback from southern boundary. There is also some building setback at northeast corner. The proposed southern footbridge adopts permeable design with minimum wind blockage. It would not significantly obstruct any concerned prevailing wind (especially E wind) penetration across the Application Site. Four numbers of residential towers have been proposed atop the podium with building separation of not less than 15m between Tower 2 and Tower 3. It is expected the wind blockage by building frontage would decrease. In addition of the proposed building separation, which allow the annual and summer prevailing E, ESE, ENE, WSW wind to penetrate through, the open plaza at ground level under Proposed Scheme in connection with Lam Hing Street would welcome E, ESE, ENE wind penetration through the urban window underneath the central exhibition multi-purpose hall towards the Application Site. Moreover, the podium garden (about 6m in height) at second floor of residential portion under Tower 2 & Tower 3 would facilitate annual and summer prevailing wind penetration.

Building Height

3.2.8 The proposed maximum building height of the Proposed Scheme at +140mPD is higher than the maximum building height permissible under the OZP compliant scheme

(+100mPD) and the existing development. Theoretically, the Proposed Scheme with higher building height would result in more wind blockage impact and it is more difficult for wind to pass over the building and come to the pedestrian level when compared to the OZP Compliant Scheme. Thus, larger wake area due to building height is expected on downwind side. However, the permeable design measure such as building separation and building setback would facilitate wind flow around and through the Application Site. Such building setback is aligned to east/west directions so that most prevailing wind directions (E, ESE, ENE, WSW) can be benefited. The building setback also benefits all annual and summer prevailing wind directions, The podium building footprint under Proposed Scheme is smaller in comparing with that under OZP Compliant Scheme. More wind would be able to flow around the building mass at or near the pedestrian level towards the downwind area.

3.2.9 On the other hand, the high-rise buildings could generate downwash wind from the wind at upper level to the pedestrian level within the Application Site and the adjacent surrounding areas including Trademart Drive, Kai Cheung Road and Kai Fuk Road. Although downwash effect may not be as effective as building separation and setback, it is considered that blockage effect due to higher building height can be further offset in certain extent.

3.2.10 Therefore, it is anticipated that unfavourable impact in terms of wind environment would be offset in certain degree and minimised. The Proposed Scheme is expected to have similar air ventilation performance when compared with the OZP Compliant Scheme.

Northern and Southern Footbridge Extension

3.2.11 The proposed northern footbridge extension connects the proposed development and northward crossing Kai Cheung Road and Shing Kai Road. The tentative design of the footbridge is elevated not less than 5.5m aboveground and with opening and permeable railing on both sides which would enable natural ventilation and minimise obstruction to wind flow. The road carriageways it is crossing include Kai Cheung Road and Shing Kai Road, both are wide and considered as air paths that can facilitate prevailing wind flow (e.g. E, SSW, SW, WSW). Nevertheless, the proposed footbridge is not a substantial structure as discussed above and would not significantly block wind flow. Moreover, it is elevated higher so that there is least impact on wind flow at pedestrian level. The air ventilation impact due to the proposed northern footbridge connection on pedestrian area is not considered significant.

3.2.12 Similarly, the southern link bridge with clear height of 3.5m above ground (connected to the existing government Kai Fuk Road footbridge) is of much small scale (less than 5m outside Site). It will mainly generate some blockage under E, ENE, ESE, WSW wind. Again, the building structure is not substantial and is located at higher level so that there is least impact on wind flow at pedestrian level. The air ventilation impact due to the proposed southern footbridge connection on pedestrian area is not considered significant.

3.3 Directional Analysis of the development

3.3.1 As discussed in **Sections 2.1** to **2.3**, winds from ENE, E, ESE and SE directions are annual prevailing winds whereas winds from E, ESE, SE, SW, SSW, and WSW are dominant in the summer. The following appraises the situation with respect to the Proposed Scheme.

ENE Wind

3.3.2 Under annual prevailing ENE wind condition, the wind flows towards the Application Site through Kai Cheung Road, which is known as the major air path. The ENE wind would penetrate the Application Site through the setback between residential tower and the northwestern site boundary (at +25.9mPD and above). The ENE wind would continue to flow along Kai Cheung Road and increase wind availability at KTD and the Kai Tak Promenade Area on downwind side.

3.3.3 Similarly, building setback from southern boundary will increase the effectiveness of another air path along existing open space (about 15m in width) to the immediate south. ENE wind can flow through Lam Wah Street and the Non-building Area within Hong Kong Post Building then through the abovementioned air path towards the downwind area.

3.3.4 Some portion of ENE wind would travel along Lam Hing Street from the KBBA and penetrate the urban window underneath central exhibition/multi-purpose hall and reach the open plaza at pedestrian level. The high-level ENE wind from Lam Hing Street would flow atop exhibition/multi-purpose hall then penetrate through building separation of not less than 15m between Tower 2 and Tower 3 above the podium (+25.9mPD) and reach downstream area at pedestrian level gradually. The stepped podium design at the residential portion also facilitate wind to reach pedestrian level easier after pass over the podium.

3.3.5 Despite that there is higher building mass, the building setback and more building separations can facilitate wind penetration. The podium garden (about 6m in height) at lower elevation (+16.8mPD to +22.8mPD) combined with setback (at least 15m) of residential tower from northwestern site boundary (at +25.9mPD and above) allow ENE wind from Kai Cheung Road to travel towards its downwind area.

3.3.6 On the other hand, the development under the OZP Compliant Scheme is oriented perpendicularly to the incoming ENE wind flow with a longitudinal façade, it would limit the incoming wind to penetrate through the Application Site. In comparison with the OZP Compliant Scheme, the Proposed Scheme has adopted various permeable design features to maintain the overall air ventilation performance despite it has higher building height.

E and ESE Wind

3.3.7 The annual and summer prevailing E and ESE wind would flow towards the Application Site through Kai Cheung Road, Lam Hing Street and Lam Wah Street, similar to ENE wind. The E and ESE wind along Kai Cheung Road would flow through the building setback from the northwestern site boundary of the Application Site (at +25.9mPD and above) and reach its downwind areas. Besides, Lam Wah Street also facilitate the E and ESE wind to flow across the KBBA and penetrate through the non-building area towards the Application Site. The wind is then penetrating through the building setback area (at least 15m from southern boundary) and the open space to the immediate south of the Proposed Development. Furthermore, high-level prevailing E wind flows along Lam Hing Street would penetrate through the building separation of not less than 15m between Tower 2 & Tower 3 and would reach leeward area, such as KTD, Kai Tak Promenade Area and further west of the Application Site. On the other hand, E wind at pedestrian level would flow through the urban window underneath central exhibition/multi-purpose hall to reach the open plaza.

3.3.8 The proposed maximum building height of the Proposed Scheme would be higher than that of the OZP Compliant Scheme. It is anticipated that the proposed development

would block the incoming easterly wind flow (E and ESE wind) at the higher level. Wake area would be generated at the immediate leeward side of the proposed development including Kai Fuk Road. However, the Proposed Scheme is promoting the easterly wind to penetrate through tower separations and atop the second floor of the proposed podium. The permeable podium garden at this level is expected to improve the permeability of the proposed development while providing comfortable wind environment for the users of the space.

3.3.9 On the other hand, the development under the OZP Compliant Scheme is oriented perpendicularly to the incoming easterly wind flow with a longitudinal façade, it would limit the wind to penetrate through the Application Site.

SE Wind

3.3.10 Kai Fuk Road is well aligned with annual and summer prevailing SE wind direction. Kwun Tong Bypass should be able to facilitate SE wind flow as well.

3.3.11 The annual and summer prevailing SE wind would mainly flow along Kai Fuk Road and facilitate wind breeze. SE wind would continue flow along Kai Fuk Road and towards the downwind areas with no obstruction from the Proposed Development. There is setback of residential towers in the Proposed Scheme (at +25.9mPD and above) to facilitate more SE wind flow at higher level towards the downwind area. The proposed setback would welcome wind circulation within the Application Site and surrounding pedestrian wind environment. Some portion of SE wind would flow through the setback area from southern boundary and the open space at the immediate south of the Application Site then obstructed by the proposed office tower. However, the higher-level SE wind would then downwash to the adjacent pedestrian walkway. Although downwash effect may not be as effective as building separation and setback, it is considered that blockage effect due to higher building effect due to higher building height can still be further offset.

3.3.12 Some portion of SE wind would flow along Trademart Drive and Kwun Tong Bypass. There is no significant difference between Baseline Scheme and Proposed Scheme.

3.3.13 Under SE wind direction, the increased building height in Proposed Scheme has some impact to the overall ventilation performance. SE wind would take advantage of building setback and flow around the Application Site under both Baseline and Proposed Scheme. The Baseline Scheme has building separation in-between oriented to SSE/NNW axis which can let portion of SE wind penetrate through it as well. As the building height of the Proposed Scheme is higher, the air ventilation performance would be slightly worsened when compared to Baseline Scheme under SE wind.

SSW and SW wind

3.3.14 The building separation and setback are not well aligned with SSW and SW wind.

3.3.15 The summer prevailing SSW and SW wind would be more able to penetrate through the northwestern side of Application Site along Kai Cheung Road taking advantage of the building setback of the Proposed Scheme. More building setback from southern boundary can allow more SSW and SW wind to enter Trademart Drive at pedestrian level and higher elevations as well. Apart from the above, the Proposed Scheme cannot allow further wind penetration.

3.3.16 Moreover, the higher building height is expected to induce more wind blockage at higher level. The residential towers on southwest side in the Proposed Scheme oriented perpendicular to the SSW and SW wind direction. Wake area would be induced at the leeward side and affecting the wind environment at the immediate surrounding such

as Kai Cheung Road and Trademart Drive. As discussed before impact along Trademart Drive is partially offset by wind penetrating from building setback area on southern side. The residential tower setback can enable more SSW and SW wind to flow around the western and northwestern side of the development to downwind area such as Kai Cheung Road so that the impact is reduced again.

3.3.17 Since there are surrounding building masses on leeward side, the increased building height would not effect to contribute to any significant additional air ventilation impact to further downwind area such as Wang Kee Street and Kai Shun Road as the existing building masses immediate to these pedestrian areas would already generate the impact.

3.3.18 On the other hand, while there is tower setback above podium along the southern site boundary in the OZP Compliant Scheme, the development under the OZP Compliant Scheme is generally less permeable under SSW and SW wind. In comparison, the overall ventilation impact by the building orientation under the OZP Compliant Scheme would likely be higher than the Proposed Scheme.

WSW Wind

3.3.19 The summer prevailing WSW wind would penetrate the Application Site along Kai Cheung Road taking advantage of residential tower setback of the Proposed Scheme. It can reach Trademart Drive through the setback area from southern boundary of the Proposed Scheme. Some portion of WSW wind is also able to flow through the building separation (not less than 15m) between Tower 2 and Tower 3 towards the downwind areas. The proposed separation has an effective width of not less than 15m, which could promote more wind flow to penetrate through the Proposed Development.

3.3.20 On the other hand, while there is tower setback above podium along the southern site boundary in the OZP Compliant Scheme, the development under the OZP Compliant Scheme is generally less permeable under WSW wind. In comparison, the overall ventilation impact by the building orientation under the OZP Compliant Scheme would likely be higher than the Proposed Scheme.

3.4 Summary of Relative Air Ventilation Performance

3.4.1 The air ventilation performance of the OZP Compliant Scheme and the Proposed Scheme has been appraised. Under the OZP Compliant Scheme, it consists of full-coverage podium (+20mPD) and long and continuous office tower building frontage with height of about +100mPD.

3.4.2 Under the Proposed Scheme, higher maximum building height (+140mPD) is proposed but with air ventilation design measures of building separation at E/W direction, building setbacks along site boundaries, permeable podium garden, stepped podium and urban window design.

3.4.3 Building separation is aligned with most annual and summer prevailing wind direction (ENE, E, ESE and WSW) that will facilitate wind flow across the Proposed Development. Besides, the building setbacks from the site boundary (a minimum 15m building setback of all major building structures from southern boundary, and minimum 15m setback of residential towers at +25.9mPD and above from southwest, west, and northwest boundaries) also facilitate the prevailing wind flows. In addition, podium garden of about 6m height underneath residential towers (mainly Towers 2 to 3) can allow wind penetration with respect to ENE, E, ESE and WSW wind. Stepped podium allows wind to flow over the podium and then reach pedestrian level easier. The open plaza and urban window can improve air ventilation within the Proposed Development.

3.4.4 Moreover, the high-rise buildings of the Proposed Scheme might impose more blockage at higher level on one hand, but it could also generate downwash wind on the other hand, which would benefit the air ventilation performance of the area in close vicinity and offset the impact of higher building mass in some degree.

3.4.5 Combination of various good design measures have been incorporated in the Proposed Scheme wight higher building height so that it would unlikely impose significant adverse overall air ventilation impacts on the surrounding as compared with the OZP Compliant Scheme.

4. CONCLUSION

4.1.1 A qualitative assessment on the air ventilation performance of the Proposed Development has been carried out.

4.1.2 According to the findings of this AVA-EE, the annual prevailing wind comes from ENE, E, ESE and SE directions while the summer prevailing wind comes from E, ESE, SE, SSW, SW and WSW directions. Good design features of the Proposed Development include a building separation of not less than 15m-wide between Towers 2 and 3, a minimum 15m building setback of all major building structures from southern boundary, minimum 15m setback of residential towers at +25.9mPD and above from southwest, west and northwest boundaries, about 6m height podium garden underneath residential Tower 2 and Tower 3, stepped podium design, are provided to maintain air ventilation performance. Urban window is provided to allow annual and summer prevailing wind to reach the proposed development at the open plaza.

4.1.3 After considering the potential air ventilation impacts on the Application Site under all prevailing wind directions, it is considered that the Proposed Scheme with the good design features incorporated would unlikely impose significant adverse overall air ventilation impacts on the surrounding as compared with the OZP Compliant Scheme.

Figures

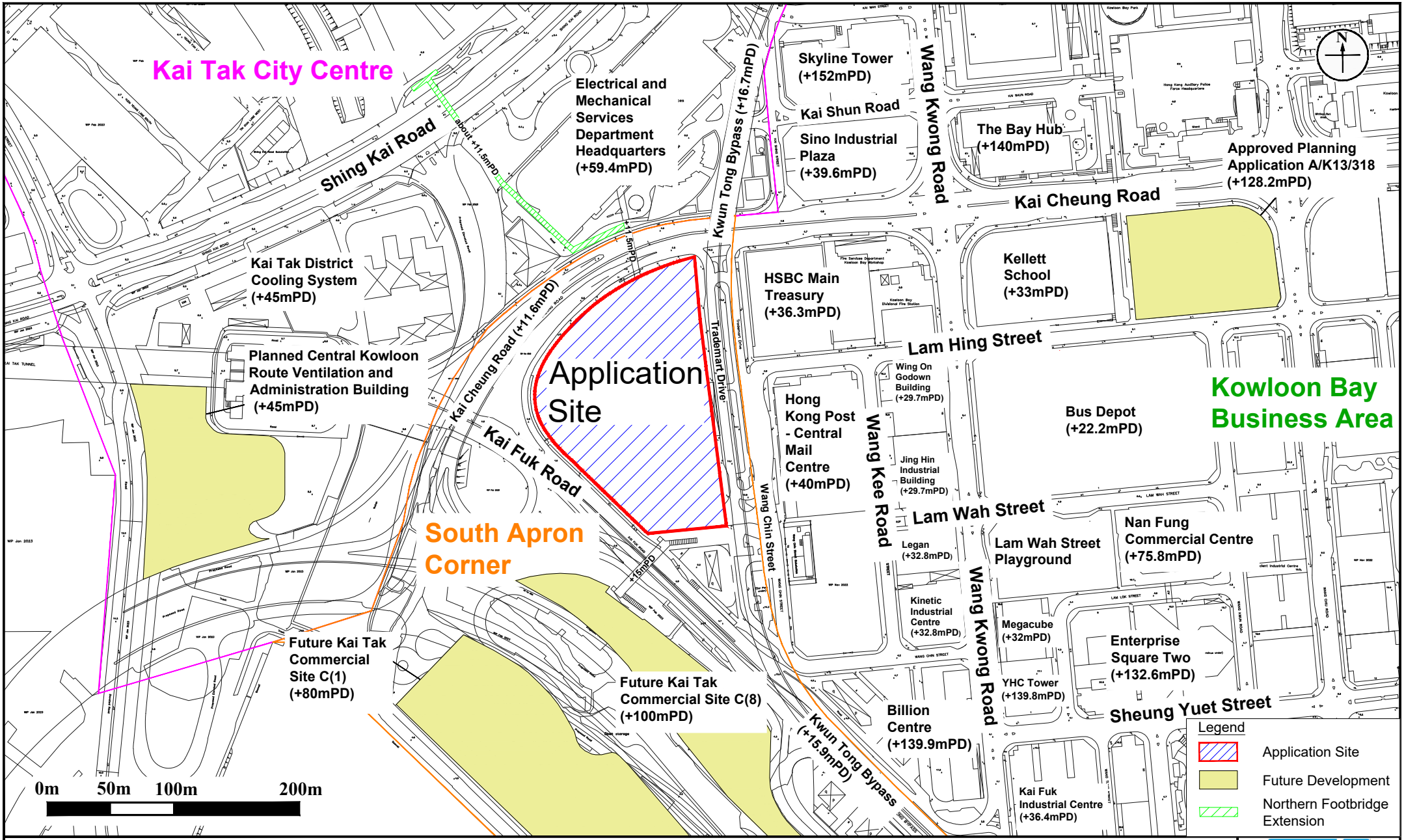

Figure: 1

Title: Location Plan of the Proposed Development

Project: Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

RAMBOLL

Drawn by:	AW
Checked by:	CC
Rev.:	2.1
Date:	Apr 25

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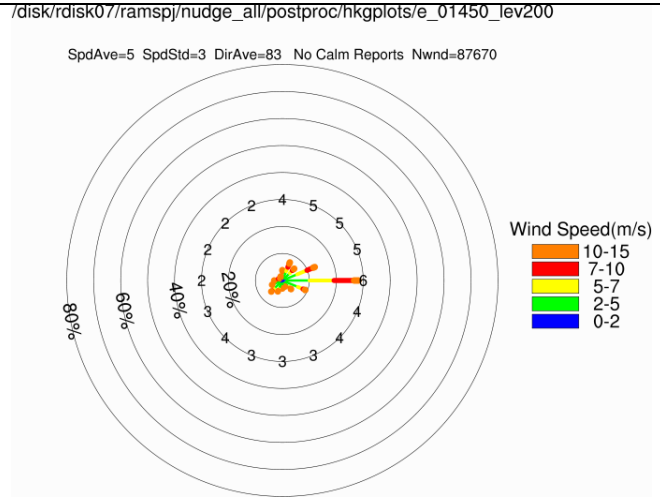

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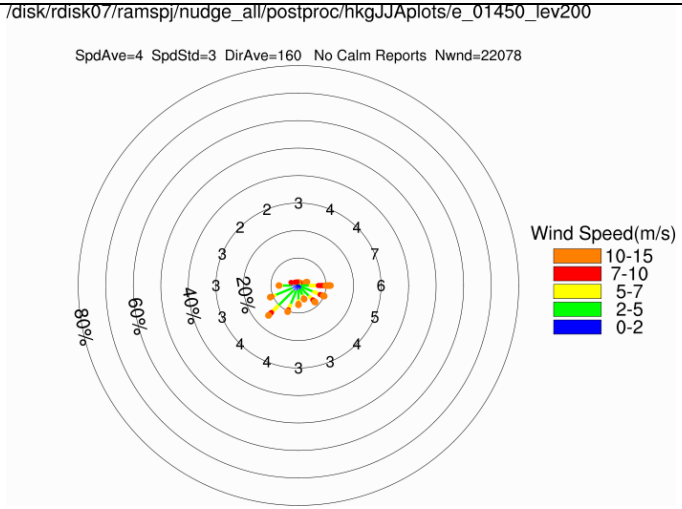

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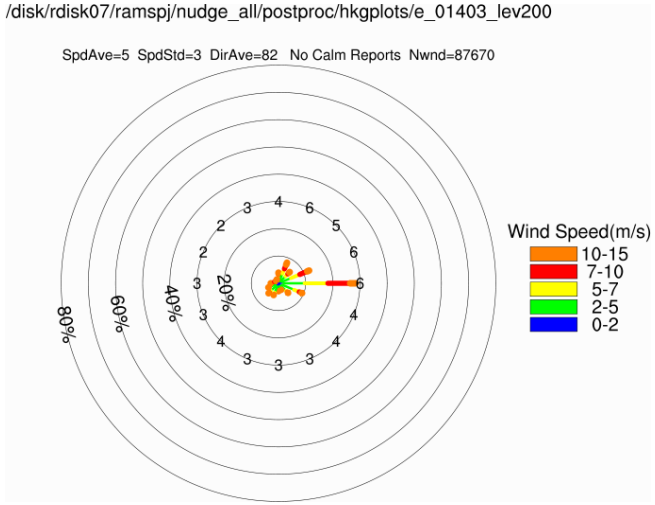

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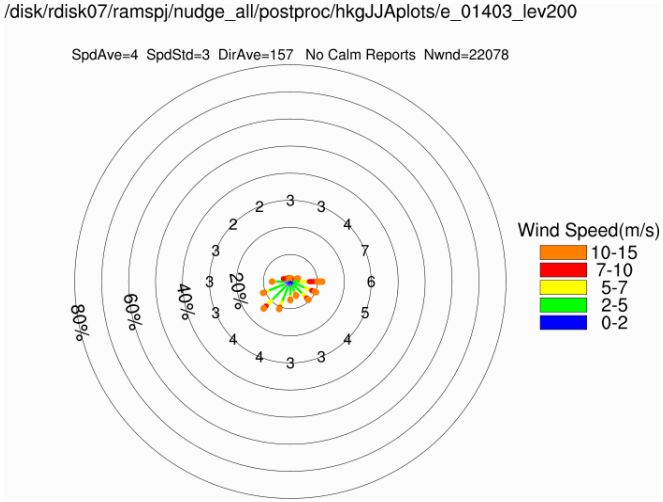

Summer

Figure:	2a	RAMBOLL
Title:	Windrose Diagram representing V∞ of the Area under Concern at 200m above ground (X:086, Y:043; X:086, Y:044)	Drawn by: AW Checked by: CC
Project:	Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 2.0 Date: Jan 2025

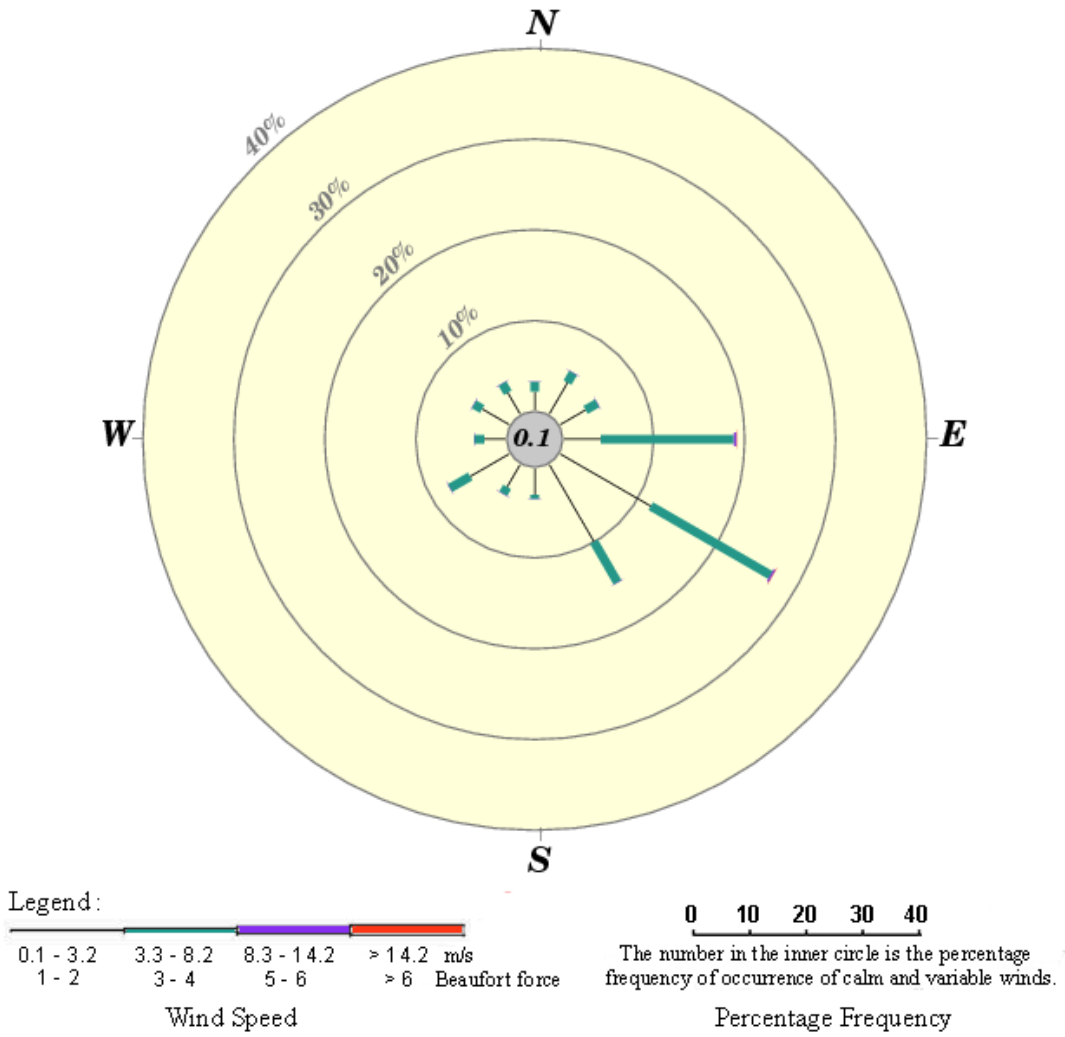

Figure:	2b	RAMBOLL
Title:	Annual Windrose Diagram of Kai Tak Hong Kong Observatory Wind Station (1999-2019)	Drawn by: AW Checked by: CC
Project:	Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 2.0 Date: Jan 2025

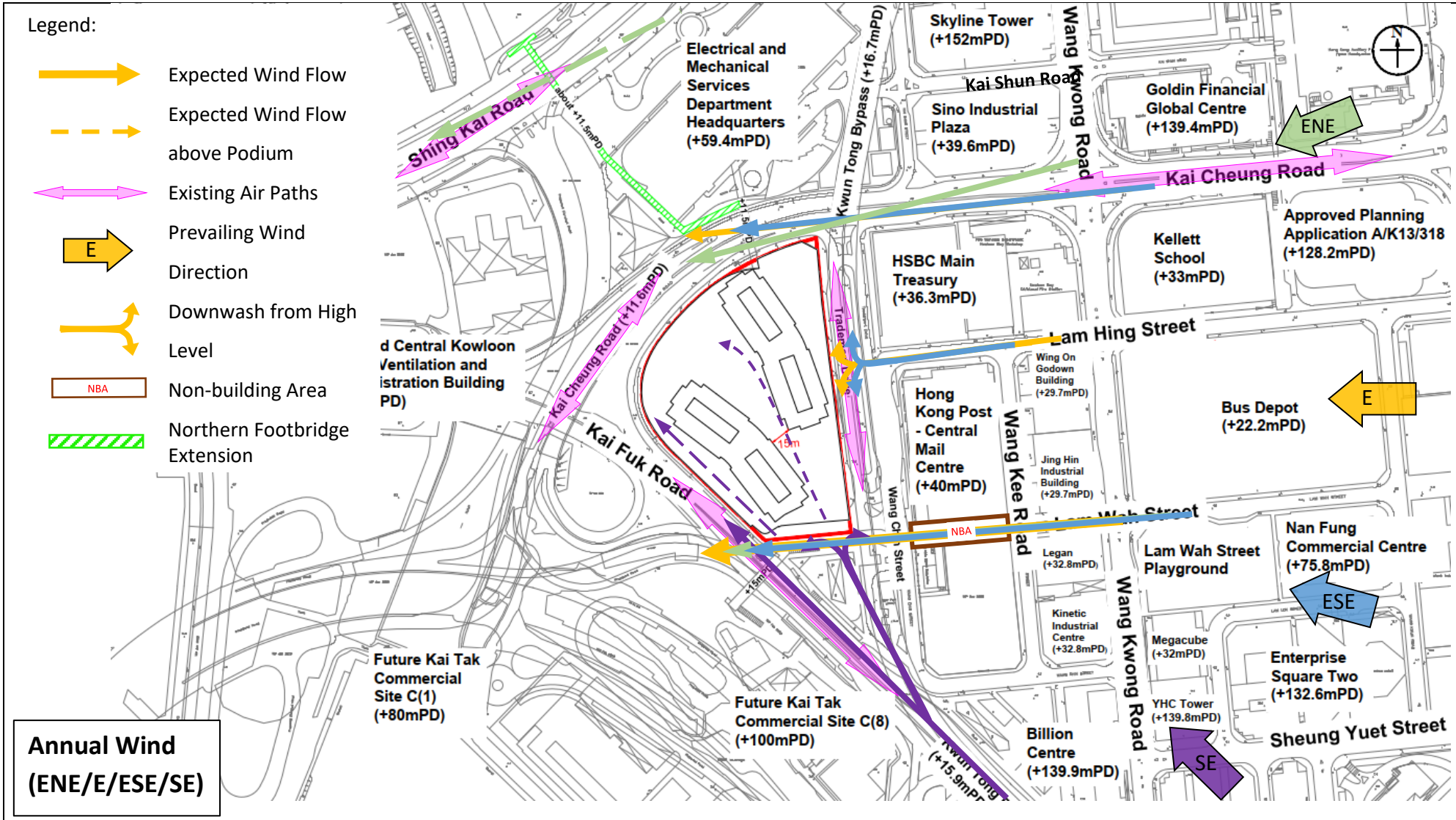

Figure: 3	RAMBOLL
Title: Illustration of Wind Flow from Annual Wind Directions for OZP Compliant Scheme	Drawn by: AW Checked by: CC
Project: Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 2.0 Date: Jan 2025

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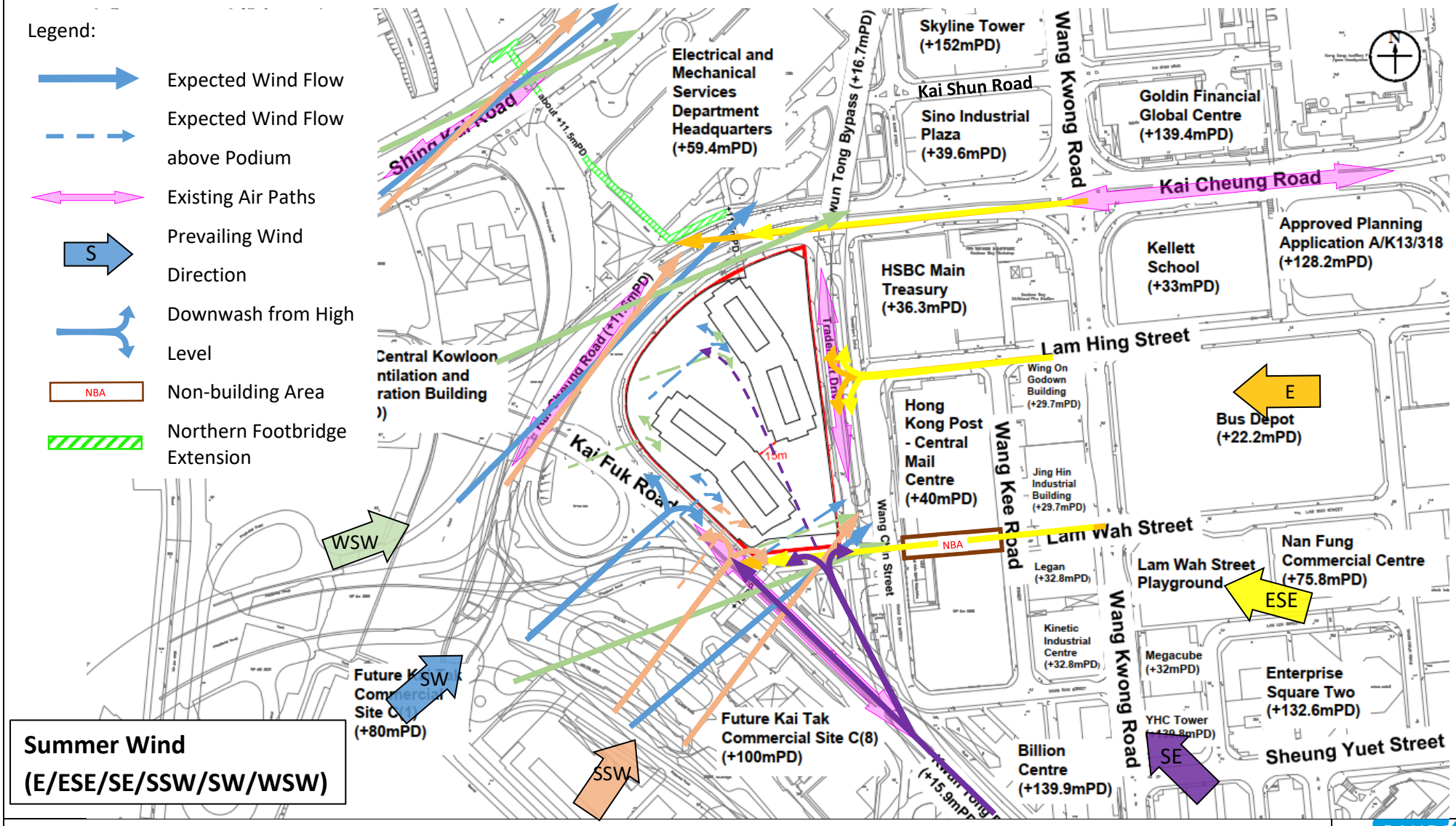

Figure: 4	RAMBOLL
Title: Illustration of Wind Flow from Summer Wind Directions for OZP Compliant Scheme	Drawn by: AW Checked by: CC
Project: Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 2.0 Date: Jan 2025

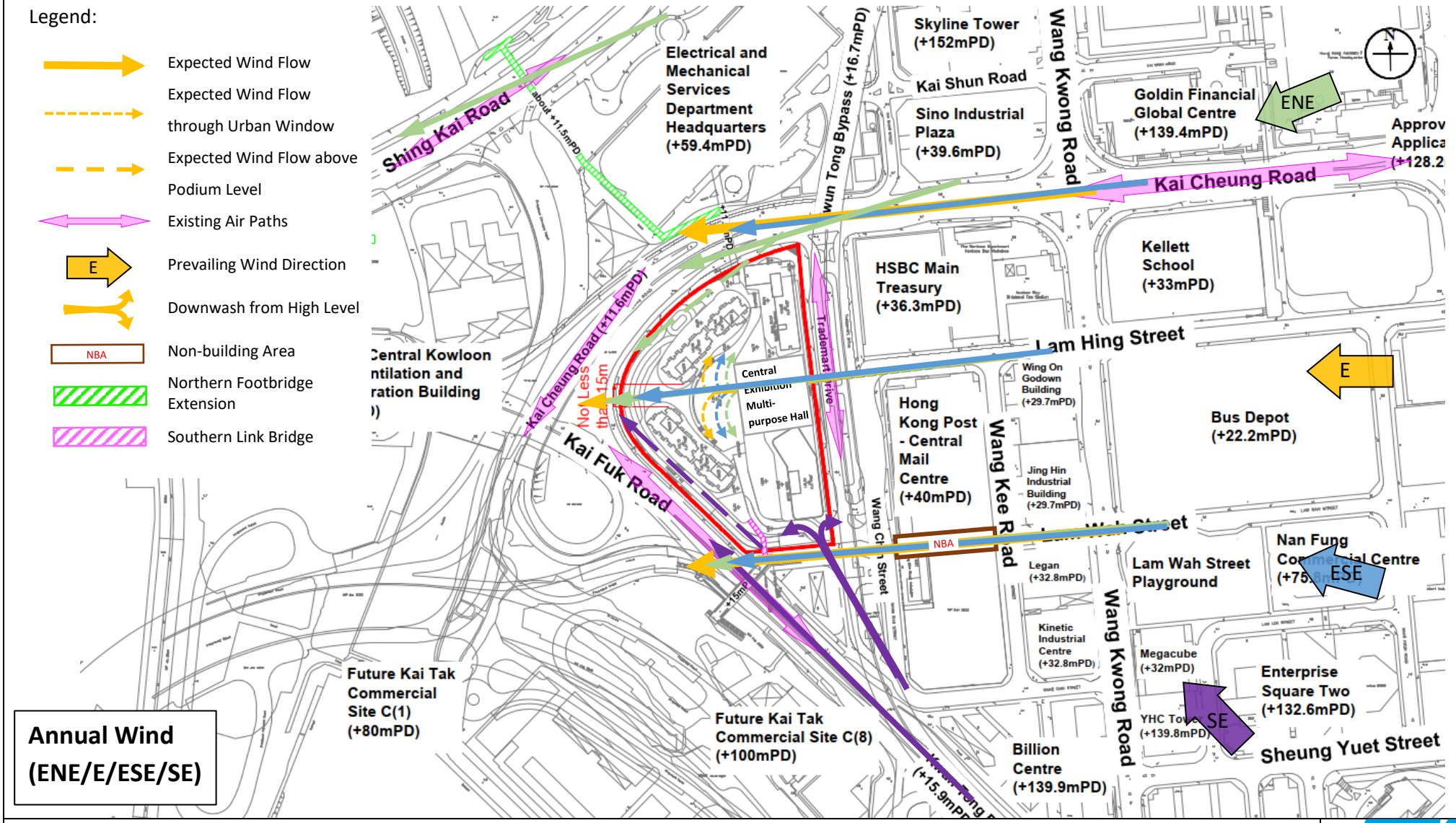

Figure: 5	RAMBOLL
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Project: Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 2.0 Date: Jan 2025

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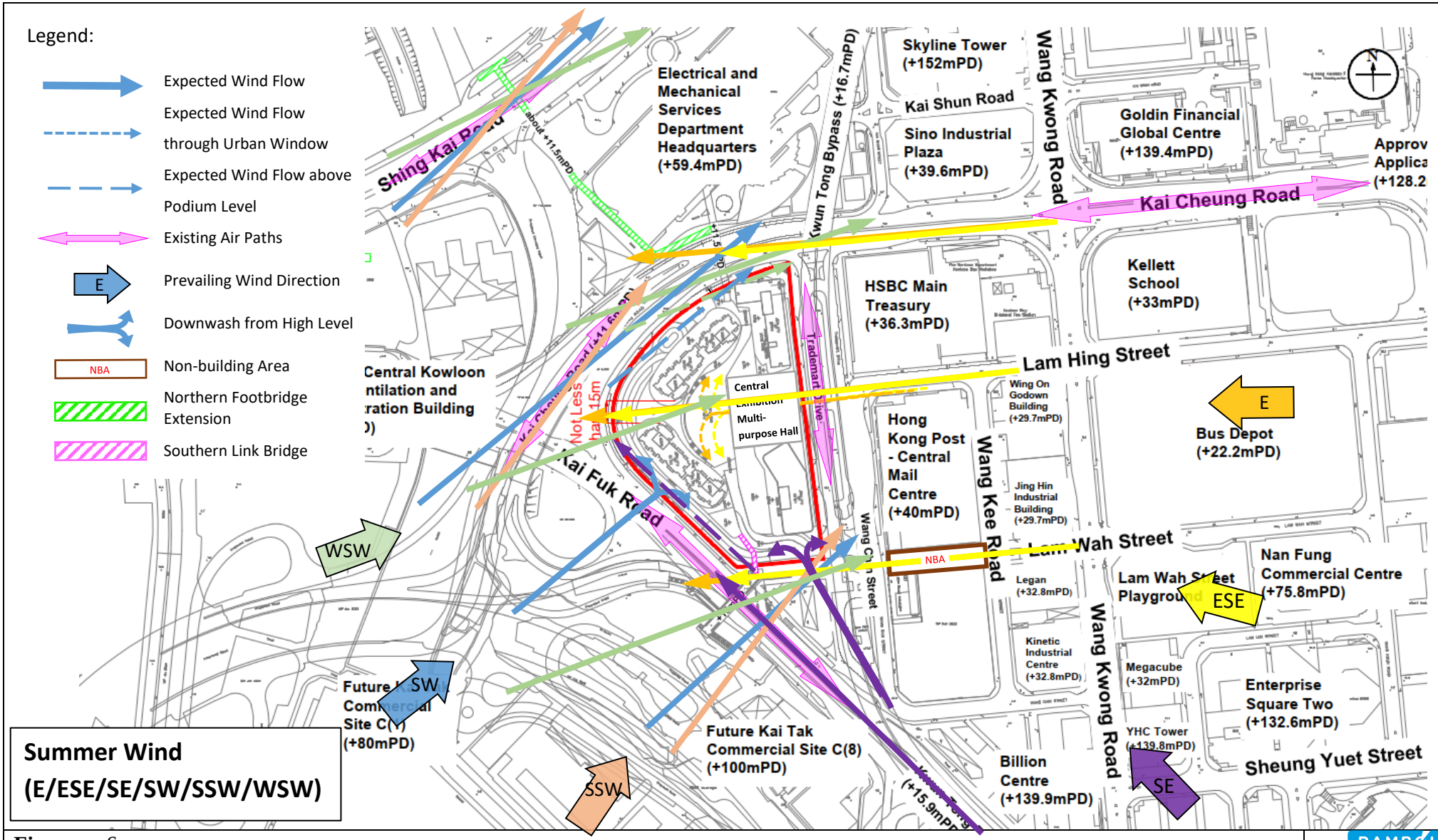
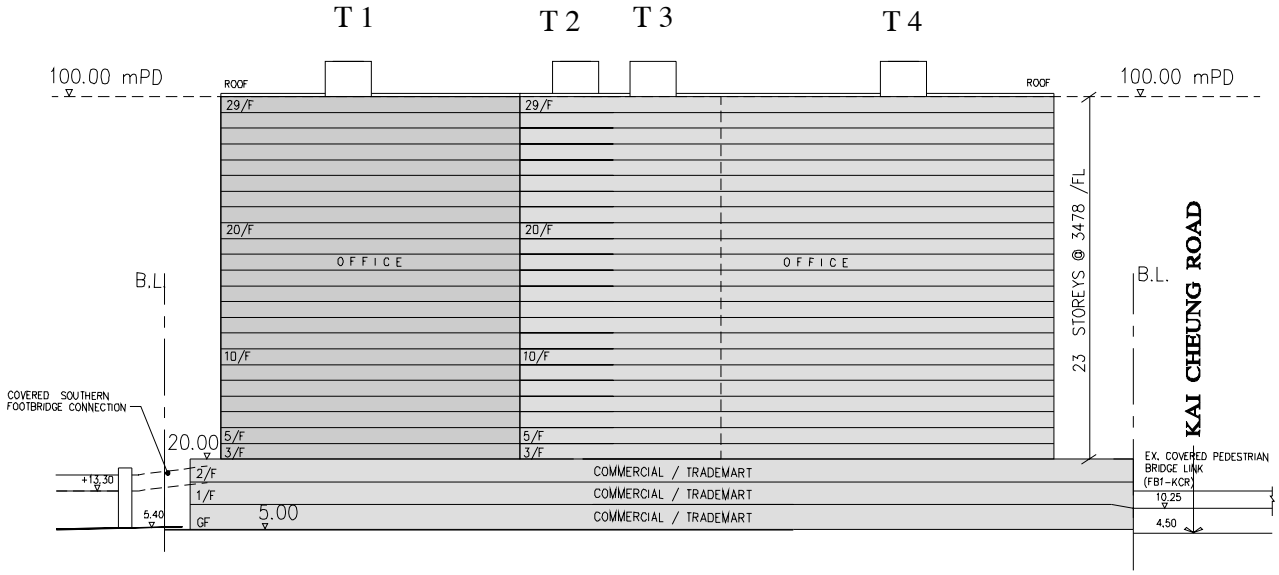


Figure: 6	RAMBOLL
Title: Illustration of Wind Flow from Summer Wind Directions for Proposed Scheme	Drawn by: AW Checked by: CC
Project: Proposed Composite Redevelopment with Trade Mart/Exhibition and Commercial, Residential, Social Welfare Facilities and School Uses and Minor Relaxation of Building Height Restriction, New Kowloon inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 2.0 Date: Jan 2025

Appendix 1

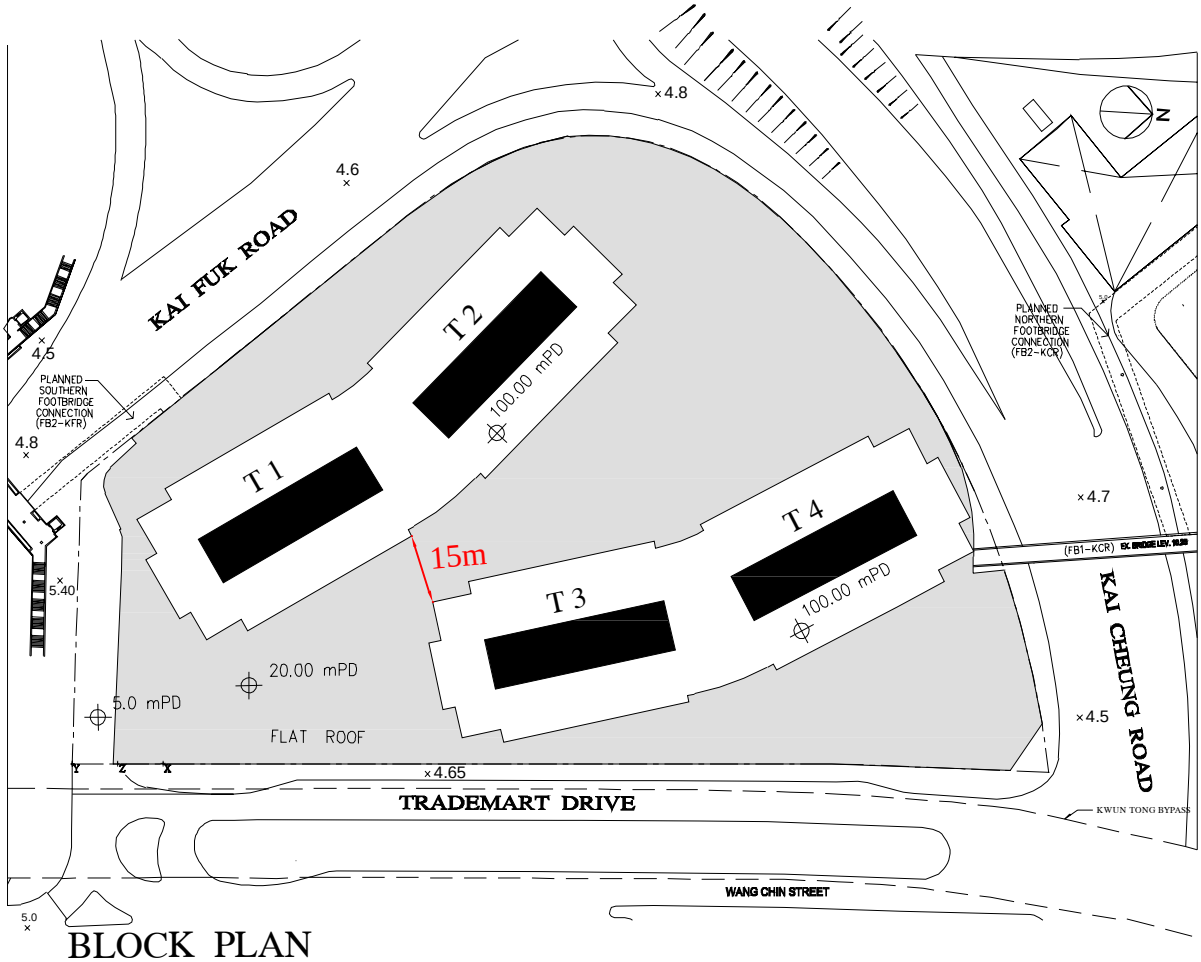
The Indicative Block Plan of the OZP Compliant Scheme

COMPLIANCE SCHEME
BASED ON PR 12 & EXISTING BH 100mPD



DIAGRAMMATIC SECTION

FLOOR NOS. WITHOUT 4,13,& 14



BLOCK PLAN

G/F Building Mass

1/F Building Mass

2/F Building Mass

Transfer Plate above 2/F

KAI FUK ROAD

KAI CHEUNG ROAD

TRADEMART DRIVE

At Least 15m

At Least 15m

At Least 15m

At Least 15m

CANOPY

EVA / DRIVEWAY

PAVEMENT

TOWER 1

TOWER 2

TOWER 3

TOWER 5

133.70
FLAT ROOF

133.70
FLAT ROOF

140.00
FLAT ROOF

140.00
FLAT ROOF

10.90

16.80

15.80

22.80

5.00
OPEN PLAZA

FOOTBRIDGE

10.90

16.80

16.80

PINK CROSS HATCHED BLACK AREA

EXISTING GOVERNMENT NORTHERN FOOTBRIDGE

BRIDGE LEV. 10.25

PROPOSED OPENING TO CONNECT WITH EXISTING GOVERNMENT NORTHERN FOOTBRIDGE

BRIDGE LEV. 13.30

EXISTING GOVERNMENT SOUTHERN FOOTBRIDGE

PLANNED SOUTHERN LINK BRIDGE

5.00

18.00

26.50

OFFICE TOWER

140.00
FLAT ROOF

26.50
ROOF OF EXHIBITION / MULTI-PURPOSE HALL

18.00

FOOTBRIDGE

23.00

63.00

MIXED BLOCK
(INCLUDING HOTEL, COMMERCIAL / SHOWROOMS)

140.00
FLAT ROOF

18.00

63.00

PINK HATCHED BLACK AREA

CANOPY

E M S D HEADQ

N

5.0

5.0

BLOCK PLAN

(SCALE 1:800)

PROPOSED COMPOSITE REDEVELOPMENT WITH TRADE MART / EXHIBITION AND COMMERCIAL, RESIDENTIAL, SOCIAL WELFARE FACILITIES AND SCHOOL USES AND MINOR RELAXATION OF BUILDING HEIGHT RESTRICTION, NEW KOWLOON INLAND LOT NO. 6032, 1 TRADEMART DRIVE, KOWLOON BAY, KOWLOON

MLA ARCHITECTS (HK) LTD
馬梁建築師事務所(香港)有限公司

Drawing No. MLP-01
Dated: 22 JAN 2025

Podium Garden

UPPER SECOND FLOOR PLAN

N

KAI FUK ROAD

KAI CHEUNG ROAD

19.30
RCHE

55000
RCHE / PETROL STATION

BRIDGE LEV. 13.30

15.80
FLAT ROOF

FOOTBRIDGE ROOF

LIFT LOBBY TOWER-1

15.80
RCHE

16.80
RESIDENTIAL CLUBHOUSE

LIFT LOBBY TOWER-2

SWIMMING POOL

16.80
POOL DECK

LIFT LOBBY TOWER-3

16.80
RESIDENTIAL CLUBHOUSE

16.80
PODIUM GARDEN

LIFT LOBBY TOWER-5

UPPER PART OF OPEN PLAZA

PINK CROSS HATCHED BLACK AREA

BRIDGE LEV. 10.25

E M S D HEADQ

18.00
FLAT ROOF

UPPER PART OF EXHIBITION / MULTI-PURPOSE HALL

18.00
FLAT ROOF

FOOTBRIDGE ROOF

18.00
SHOWROOMS

COMMERCIAL

18.00
SHOWROOMS

18.00

COMMERCIAL

PINK HATCHED BLACK AREA

TRADEMART DRIVE

SECOND FLOOR PLAN

(SCALE 1:800)

PROPOSED COMPOSITE REDEVELOPMENT WITH TRADE MART / EXHIBITION AND COMMERCIAL, RESIDENTIAL, SOCIAL WELFARE FACILITIES AND SCHOOL USES AND MINOR RELAXATION OF BUILDING HEIGHT RESTRICTION, NEW KOWLOON INLAND LOT NO. 6032, 1 TRADEMART DRIVE, KOWLOON BAY, KOWLOON

MLA ARCHITECTS (HK) LTD
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Drawing No. MLP-06
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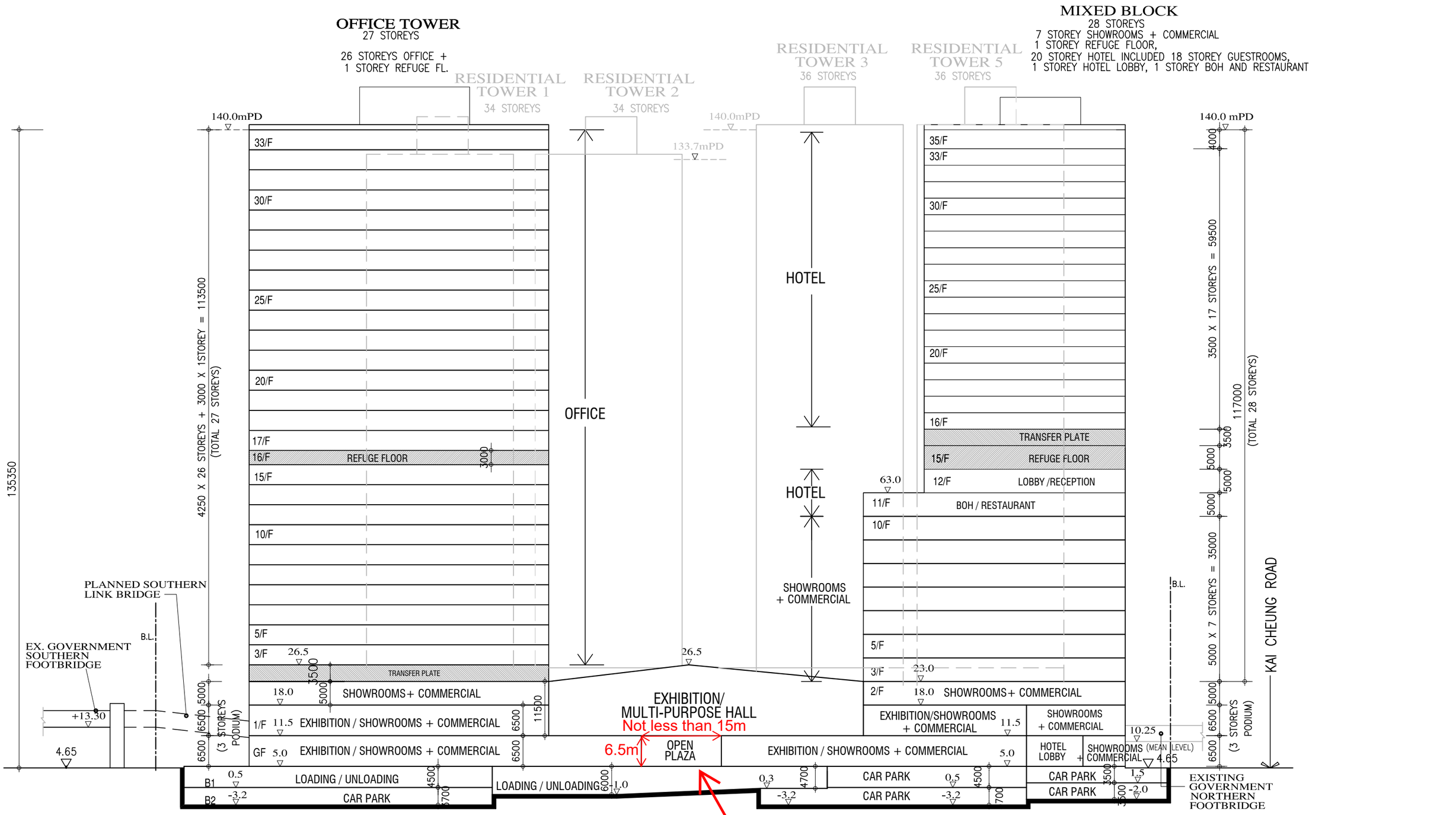

DIAGRAMMATIC SECTION A

* 4/F, 13/F, 14/F, 24/F & 34/F OMITTED
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PROPOSED COMPOSITE REDEVELOPMENT WITH TRADE MART / EXHIBITION AND COMMERCIAL, RESIDENTIAL, SOCIAL WELFARE FACILITIES AND SCHOOL USES AND MINOR RELAXATION OF BUILDING HEIGHT RESTRICTION, NEW KOWLOON INLAND LOT NO. 6032, 1 TRADEMART DRIVE, KOWLOON BAY, KOWLOON

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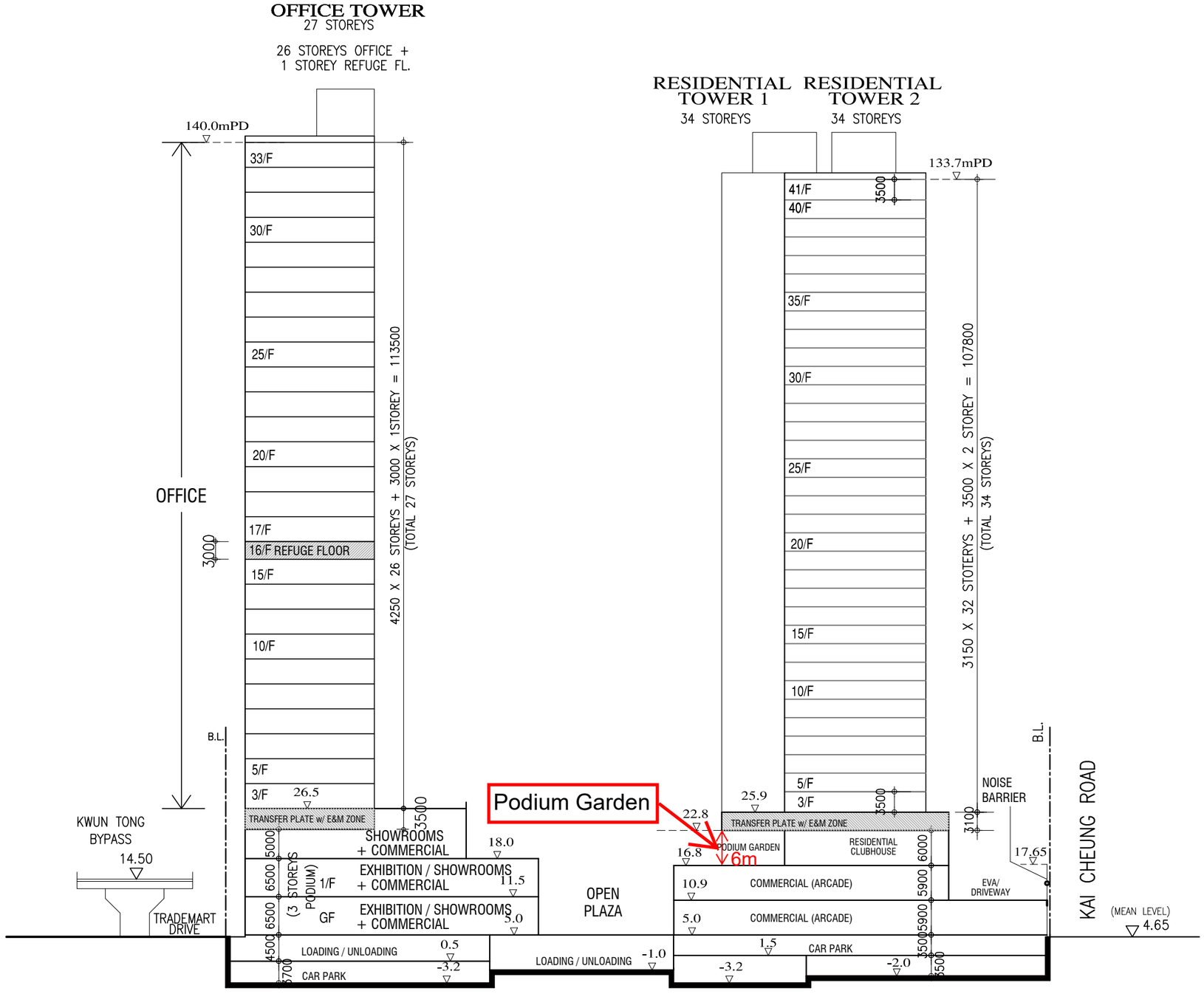
Drawing No. MLP-10
Dated: 26 MAR 2025



DIAGRAMMATIC SECTION B

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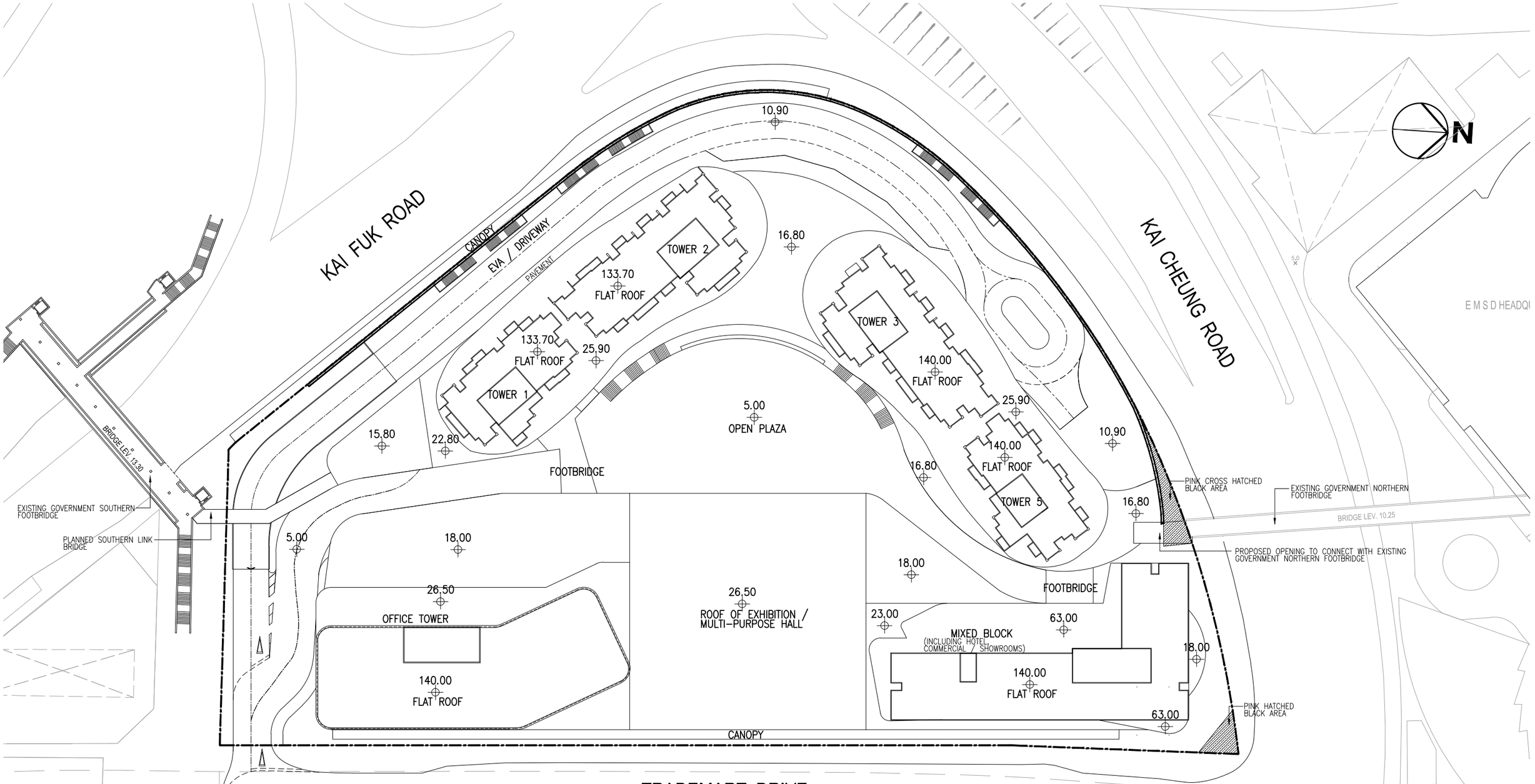
Drawing No. MLP-11
Dated: 22 JAN 2025

Appendix 2

The Indicative Block Plan of the Proposed Scheme



BLOCK PLAN

(SCALE 1:800)

PROPOSED COMPOSITE REDEVELOPMENT WITH TRADE MART / EXHIBITION AND COMMERCIAL, RESIDENTIAL, SOCIAL WELFARE FACILITIES AND SCHOOL USES AND MINOR RELAXATION OF BUILDING HEIGHT RESTRICTION, NEW KOWLOON INLAND LOT NO. 6032, 1 TRADEMART DRIVE, KOWLOON BAY, KOWLOON

MLA ARCHITECTS (HK) LTD
馬梁建築師事務所(香港)有限公司

Drawing No. MLP-01
Dated: 22 JAN 2025

ANNEX 11

Prepared for

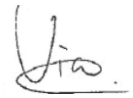
International Trademart Company Limited

Prepared by

Ramboll Hong Kong Limited

PROPOSED COMPOSITE REDEVELOPMENT WITH TRADE MART/EXHIBITION AND COMMERCIAL, RESIDENTIAL, SOCIAL WELFARE FACILITIES AND SCHOOL USES AND MINOR RELAXATION OF BUILDING HEIGHT RESTRICTION, NEW KOWLOON INLAND LOT NO. 6032, 1 TRADEMART DRIVE, KOWLOON BAY, KOWLOON

QUANTITATIVE RISK ASSESSMENT FOR EXISTING LPG FILLING STATIONS

Date	**March 2025**
Prepared by	**Vico Woo** **Consultant**
Signed	
Reviewed by	**Stephen Pang** **Principal consultant**
Signed	
Approved by	**Herve Bonnel** **Partner**
Signed	
Project Reference	**HQIKITECEI00**
Document No.	**R9125_V2.1**

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CHAPTERS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

The Application Site is proposed in the Kowloon Bay area and bounded by roads on east (Kwun Tong Bypass and Trademart Drive), north (Kai Cheung Road) and southwest (Kai Fuk Road) sides.

A Quantitative Risk Assessment (QRA) has been prepared to assess risk posed by the existing LPG Filling Stations in the vicinity of the Subject Site and recommendations for mitigation measures, protection works and other measures and works to be carried out, if necessary, is recommended within the Subject Site to ensure compliance with the risk guidelines as described in Section 4.4, Chapter 12 of the Hong Kong Planning Standards and Guidelines (HKPSG). Key study findings are summarized as below:

Individual Risk

The individual risk contour of 10^{-5} per year does not reach the LPG Filling Station. Therefore, it could be concluded that the individual risk of the LPG Filling Stations are in compliance with the Hong Kong Government Risk Guidelines.

Societal Risk

The societal risks (F-N curves) of the LPG Filling Stations during Operation Phase (2029) are within the "Acceptable" region. Therefore, it could be concluded that the societal risk associated with the LPG Station during Operation Phase (2029) are in compliance with Hong Kong Government Risk Guidelines.

Conclusions

The individual risk and societal risk associated with LPG Filling Stations are in compliance with Hong Kong Risk Guidelines, no further mitigation measures are required.

As a good matter of engineering practice, it is recommended to ensure the effectiveness of fire protection system, fire-fighting system and the associated safety management system for the proposed development in compliance with the engineering standards and codes.

1. INTRODUCTION

1.1 Project Background

The background in relation to the project and this Section 16 planning application is included in the planning statement.

Ramboll Hong Kong Limited is commissioned by the applicant to prepare this Quantitative Risk Assessment with respect to operations of existing LPG filling stations in the vicinity of the Application Site.

1.2 Application Site and its Environment

The Application Site is located in Kowloon Bay area with surrounding context described under Section 2.1.1 of the planning statement. To the immediate south is an area zoned open space and the further Petrol and LPG filling station. It is at the western fringe of Kowloon Bay commercial area. Kai Fuk Road is connecting to the existing Kai Tak Tunnel with tunnel portal located on west side of the Application Site. The planned Central Kowloon Route would have the future alignment running along and to the further southwest.

The surrounding area consists of new office developments, ageing industrial buildings, GIC uses, bus depot, school, hotel, open space/ playground, etc.

The Application Site itself is currently occupied by existing KITEC development with nearly 100% building footprint.

1.3 Proposed Development

Residential, retail, office and GIC developments are proposed at the Application Site.

- There is an exhibition/ multi-purpose hall, office tower, mixed blocks, which includes hotel commercial and showrooms, and 4 residential towers (Tower 1 to 5, with Tower 4 omitted). Ancillary facilities include car park, clubhouse (with 1 outdoor swimming pool) for residential portion, E&M rooms, etc.
- There are altogether 1,470 flat units provided.
- The GFA of exhibition related uses & showroom, retail, office, hotel, Government, Institution or Community facilities and kindergarten are respectively 23,273 m^2, 13,403 m^2, 35,600 m^2, 24,000 m^2, 2,090 m^2 and 557m^2, respectively.
- There will be a kindergarten housed in podium building, day care centre for elderly (DCCE), social work service for pre-primary institutions (SWSPPI) and residential care home for the elderly (RCHE) housed in commercial arcade.
- The tentative completion year is 2029.
- Layout and floor plans of the proposed development are given in **Figure 4-1.**

1.4 Objective and Scope of Work

The objective of this QRA Study is to demonstrate if the risk levels posed by the existing LPG Filling Station, located in vicinity of Proposed Development in Kowloon Bay, are still in compliance with Hong Kong Risk Guidelines in Berms of individual risk and societal risk.

The scope of work for this QRA Study:

- LPG Filling Stations in vicinity of Proposed Development in Kowloon Bay.

The following scenarios were assessed in this QRA Study:

- Operation Phase – to consider the LPG Filling Station and the off-site surrounding population (population outside the subject LPG Filling Station and within the study zone of 200m) in 2029 upon operation of the proposed development

The detailed tasks are summarized as follow:

- To identify all credible hazards associated with the LPG Filling Station and its operation activities to the off-site population;
- To conduct a QRA study to quantify off-site population risk in terms of both individual risk and societal risk;
- To compare the identified risk profiles against with Hong Kong Risk Guidelines; and
- To identify and recommend practical and cost effective risk mitigation measures, if required.

This QRA Study is limited to the risks associated with LPG Filling Station, which have potential risks to cause fatalities to off-site population. The transportation of LPG by LPG road tankers outside the LPG Filling Station is outside the scope of work of this QRA Study.

It is also noted that according to HKSAR Government's climate action plan 2050, zero vehicular emissions and zero carbon emissions in the transport section before 2050 is aimed at. The provision of LPG filling stations may be redundant in future and corresponding risk impact should no longer be an issue afterwards.

2. PROPOSED QUANTITATIVE RISK ASSESSMENT METHODOLOGY

The elements of this QRA Study are depicted in **Figure 2-1**, and each of the elements is depicted as follows:

2.1 Hazard Identification

This QRA Study concerns the fire and explosion hazards associated with the LPG Filling Stations and usage at the LPG Filling Stations. The associated failure may be partial or catastrophic as a result of corrosion, fatigue, etc. These failures are taken into account in this detailed QRA Study.

2.2 Frequency Analysis

This task involves the frequency analysis for each of the identified hazardous scenarios. Frequency analysis includes quantification of the frequency of the initiating events (e.g. pipework failure), and conducting event tree analysis to model the development of an event to its final outcomes (flash fire, jet fire, fire ball, toxicity if not being ignited).

2.3 Consequence Analysis

Consequence analysis involves the modelling of the physical effects, and SAFETI 8.9, was adopted in this QRA Study. Consequence modelling results were used to establish levels of harm to critical equipment at varying distances from the identified hazards. Probit equations are used to relate levels of harm to exposure.

2.4 Risk Summation and Assessment

Risk summation was conducted using SAFETI 8.9 which calculates the risk based on different failure outcomes, failure event location, and weather conditions prevailing proximity to the LPG Filling Stations. This step involves the integration of consequence and frequency data to give the risk results in terms of the required risk measures.

The products of the frequency and consequence for each outcome event above are summed and the total risks are expressed in individual risk and societal risk terms. Individual risk results were presented as iso-risk contours overlaid on the LPG Filling Stations plot plan. The acceptability of the risks for the off-site population was compared with Hong Kong Risk Guidelines.

Examples of recently completed studies with respect to LPG filling stations based on same methodology include: "Quantitative Risk Assessment of Proposed Rezoning of Tung Chung Traction Substation and Adjacent Areas for Residential Use" prepared in June 2023.

2.5 Risk Mitigation

Practical and cost-effective risk mitigation measures based on this QRA Study are recommended, if required, to demonstrate the risks are ALARP.

3. LPG FILLING STATIONS DESCRIPTION

3.1 Proposed Residential Development

The two LPG Filling Stations, located in vicinity of Proposed Development in Kowloon Bay, are depicted at **Figure 3-1**.

3.2 LPG Filling Station Description (Shell)

The LPG Filling Station consists of one (1) 25.4 kL (~14 tonnes) underground LPG storage vessel installed in an individual concrete chamber filled with washed sand. Under normal operations, the LPG storage vessel is filled approximately, ~12-tonne, 85% of the maximum capacity. The storage vessel is covered with corrosion protection coating, 100% radiography tested and fully stress relieved. It is designed, manufactured and tested in accordance with the requirements of Gas Standards Office (GasSO) of Electrical and Mechanical Services Department, the Hong Kong Government.

Based on the layout plan, the underground storage vessel is installed southbound of the LPG Filling Station and it is replenished by 9-tonne LPG road tankers to top up maximum 85% capacity of storage vessel through connection points northbound of the station. A dedicated LPG road tanker unloading bay is provided for parking during unloading operations. Road tankers were estimated to enter the LPG Filling station 700 trips annually and the average residence time is typically around 120 minutes, including 10 minutes for setting-up and parking away the refilling equipment; and 110 minutes for off-loading operation.

Twin nozzles are installed at each of the two (2) LPG dispenser and each nozzle has capacity of 750 kg/ hr for consumers. The dispensers are located westbound of the LPG Filling Station, adjacent to the underground LPG storage vessel.

3.3 LPG Filling Station Description (Sinopec)

The LPG Filling Station consists of two (2) 16 kL (~9 tonnes) underground LPG storage vessel installed in an individual concrete chamber filled with washed sand. Under normal operations, the LPG storage vessel is filled approximately, ~7.65-tonne, 85% of the maximum capacity. The storage vessel is covered with corrosion protection coating, 100% radiography tested and fully stress relieved. It is designed, manufactured and tested in accordance with the requirements of Gas Standards Office (GasSO) of Electrical and Mechanical Services Department, the Hong Kong Government.

Based on the layout plan, the underground storage vessel is installed southbound of the LPG Filling Station and it is replenished by 9-tonne LPG road tankers to top up maximum 85% capacity of storage vessel through connection points northbound of the station. A dedicated LPG road tanker unloading bay is provided for parking during unloading operations. Road tankers were estimated to enter the LPG Filling station 559 trips annually and the average residence time is typically around 120 minutes, including 10 minutes for setting-up and parking away the refilling equipment; and 110 minutes for off-loading operation.

Twin nozzles are installed at each of the two (2) LPG dispenser and each nozzle has capacity of 750 kg/ hr for consumers. The dispensers are located westbound of the LPG Filling Station, adjacent to the underground LPG storage vessel.

4. SURROUNDING POPULATION AND METEOROLOGICAL DATA

4.1 Proposed Development

The tentative completion year of the proposed development is year 2029, and the layout of the proposed development is depicted at **Figure 4-1**. The total population of the proposed development is assumed to be 9,559, and the breakdown of the population is presented in the following table.

Development Parameters	Proposed Development										
	Residential	Clubhouse	Hotel	Retail	F&B	Office	Exhibition related uses & showroom	Kindergarten	Day Care Unit	RCHE	SWSPPI
Number of flats	1,470		720								
Assumed Area (m2)	-		24,000	10,723	2,680	35,600	23,273	557	365	1,560	-
Assumed Population	3,969	87	1,440 Guest 768 Staff Total 2,208	375	137	1,958	512	120 Students 15 Staff Total 135	30 Elderly 12 Staff Total 42	60 Residents 51 Staff Total 111	25

The proposed development maintains separation in compliance with requirement in Ch 12 of the HKPSG (i.e. 15 m from commercial building; 55 m from residential building to LPG filling station).

4.2 Surrounding Population

The surrounding population within the proposed study zone of the LPG Filling Station, including building and traffic population, is summarised in **Appendix 4-2**. The majority of the population is contributed from the nearby commercial and industrial buildings, etc.

Proposed Study Zone

A proposed study zone of 200 m from the LPG storage vessel at the LPG Filling Stations is adopted for this QRA Study based on other previous QRA Studies results. The proposed study zone is depicted at **Figure 3-1**.

The population data within the proposed study zone was estimated based on online available population data (e.g. population census, traffic census, etc.). Detailed approaches to building and traffic population are elaborated below.

Type of Population

Three (3) types of population were considered in this QRA Study:

- Pedestrian population on footpaths and pavements next to hazardous facilities;
- Road traffic population; and
- Building population.

The population estimation methods for each type of population are outlined in the following section. For areas not supported by surveys or where information is not available from other pertinent sources of information, the assumptions were made based on consultant's best judgment.

Pedestrian Population

Pedestrian flow on the pavement was assessed by a site survey conducted in December 2024. The site survey was aimed to collect site specific information such as the width of pavement, surrounding conditions of the public traffic roads etc. The results from the survey were analysed

and used to calculate population densities for all pavements within the proposed study zone. Based on the population data from the site survey, the population density can be calculated from:

$$\text{Pedestrian population (persons m}^{-2}) = P / t / v / W$$

where:

P	is the number of pedestrians passing a given point (person);
t	is the total time the survey is carried out (second);
W	is the pavement width (m); and
v	the average walking velocity of pedestrian (m s^{-1}).

Road Traffic Population

Road traffic population on the public roads was estimated from a combination of the following databases:

- Site survey in December 2024; and
- Annual Traffic Census 2023 (ATC 2023)[5] (latest available census data at the time of preparation of this report)

A population density approach was adopted for estimating the population within vehicles on the road. The traffic density information adopted in this QRA Study was estimated based on the data in ATC 2023 to determine the distribution of vehicle types. The road population density can be calculated:

$$\text{Population Density (persons/m}^2) = AADT * P_{avg} / 1{,}000 / 24 / V * L$$

where:

AADT	is Annual Average Daily Traffic from 2020 Annual Traffic Census;
P_{avg}	is the average number of persons per vehicle;
V	is the vehicle speed in km hr^{-1}; and
L	is the road length in meter, based on actual road length data.

The average number of persons per vehicle can be calculated:

$$P_{avg} = \sum_{i=1}^{N} (f_i \times P_i)$$

where:

f_i	is the fraction of vehicle type i (based on ATC 2023); and
P_i	is the mean occupancy of vehicle type i (based on ATC 2023).

Typically, vehicle speed of 50 km hr^{-1} for non-highway route sections and vehicle occupants were conservatively assumed as outdoor with regards to consequence models (i.e. flash fire/ toxic cloud, etc.).

Land and Building Population

The population within the proposed study zone was based on site survey and the following data:

- 2022 Population By-Census;

- Home Affairs Department (HAD), the Government of the Hong Kong Special Administrative Region;
- Planning Data from Town Planning Board;
- Centamap (2023); and
- Geographic Information System (GIS) database (2023 data).

Based on 2022 Population By-census, the average domestic household size in Kwun Tong District is 2.7.

For population that could not be achieved by above approaches, estimation followed the generic assumption in approved "EIA Study for Operation of the Existing Tai Lam Explosive Magazine at Tai Shu Ha, Yuen Long for Liantang/ Heung Yuen Wai Boundary Control Point Project, Register No.: AEIA-193/2015" for both existing buildings and approved developments.

Buildings within or extended partly into the proposed study zone were also included in this QRA Study. Rather than considering density based averages of population, the analysis was based on individual buildings which led to a more conservative results. The task of assessing population building-by-building is substantial and necessary to accurately model the F-N pairs with high N values.

Building Identification

The Lands Department (LD) of the HKSAR Government maintains a GIS database of buildings in Hong Kong. To identify buildings within the proposed study zone, a recent GIS map layer containing all buildings (LD) is obtained. Additionally, the GIS building height information for most of the buildings (but usually not podiums or other similar structures) are available from the same source.

Building Attributes, Usage and Population Identification

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 is 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 is determined and each building is assigned to one of the following building usage categories:

- Administrative/Commercial Building;
- Car Park;
- College;
- School;
- Industrial Building;
- Leisure;
- MTR station/Bus terminus;
- Residential Building;
- Station such as Petrol Station; and
- Fire Station.

It is noted that unless their usage could be determined from other available sources, the GIS categories OSP, TSP and RU, will be assumed to be unpopulated.

Following this, the same information sources are 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

For some commercial/industrial buildings and most of the high-rise residential buildings (excluding the housing estates), the floor number information, considered more accurate, is available from the owner and property developer websites. When the above information is not available and where it will be possible, the number of floors will be estimated from 3-dimensional aerial photos. In the event of an absence of data from any of the above sources, such buildings are covered by site survey carried out.

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 Study[/22/], and is based on typical Hong Kong building structure, usage, height, and typical capacity of public facilities. The details are presented in Table 4.1 . In the application of typical values from Table 4.1, further refinements will be 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[/24/]).

Table 4.1 Building Population Assumptions (other than the Proposed Development)

Category	**Building Height /Size(1)**	**Assumption**			**Total**
Car Park		Basic assumptions are listed below. In some cases the car park population will be adjusted based on the building area. For car parks located in podiums of residential, commercial or industrial buildings, the podium population will be 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
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
Industrial Building		Floors	Units	People/unit	
	H	25	8	8	1,600
	M	15	6	8	720
	L	8	6	6	288
Administrative/ Commercial		Floors	Units	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

Note:

(1) Legend for Building Height/Size
- H for Tall/Large, 40 storeys;
- M for Medium, 20 storeys;
- L for Low/Small, 3-storey; and
- 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.

Time Period and Occupancy

Since population can vary during day and night time periods, the analysis considered three (3) time categories. These are summarised in **Table 4.2**.

Table 4.2 Population Time Periods

Time Period	Description
Weekday Day	7am to 7pm, Monday – Friday
Weekend Day	7am to 7pm, Saturday – Sunday
Night	7pm to 7am, Monday – Sunday

The occupancy of buildings during each time period was based on assumptions as listed in **Table 4.3**. For vehicle and pavement populations, distribution across various time periods was based on site surveys.

Table 4.3 Population Distribution

Type	Occupancy (%)		
	Weekday Day	**Weekend Day**	**Night**
Leisure (1)	70%	100%	0%
Carpark (1)	70%	70%	10%
Residential Building (1)	50%	80%	100%
Construction Site	100%	50%	0%
Petrol Station (1)	50%	50%	1%
School/Clinic (1)	100%	10%	0%

Notes:

1. Based on site survey observations and ERM project experience.

2. Population occupancy based on Harbour Area Treatment Scheme Stage 2A EIA/2/

3. Population occupancy base on MTRCL SCL EIA/3/

*4. For population time period, refer to **Table 4.2***

5. Based on previously approved QRA Study for Towngas Transmission Network 2012/19/

Sources of Ignition

Flammable gas cloud from an accidental LPG release can be ignited if ignition sources are present in the close vicinity or on the migration path of the cloud, leading to a fire or an explosion. If the gas cloud is diluted outside the flammable concentration range (i.e. below lower flammable limit (LFL)), or the ignition source is not present, it will disperse and disappear with no fire hazards to the surroundings. The energy level, timing, location and ignition effectiveness of ignition sources in the vicinity of the LPG Filling Station affect the extent of gas cloud dispersion and its potential impacts.

Three (3) types of ignition sources are defined in the SAFETI 8.9 risk model.

Population polygons are defined to account for human activities such as smoking, cooking, and using electrical appliances, which are assigned implicitly to all population groups by SAFETI 8.9.

Transportation route segments are defined for the moving vehicles on roads. Its ignition probability is calculated from its traffic density, average vehicle speed, vehicle ignition efficiency and total length of the road.

Protection Factors

Protection factors[4] are used to factor down the population so that only those exposed to hazardous scenarios are considered in the risk summation. Three (3) types of protections were considered in this QRA Study:

Height Protection Factors

Partial or full height of the surrounding buildings (high-rise and low-rise) could be affected by a fireball and a boiling liquid expanding vapour explosion (BLEVE) considering their size and lift-off (90 m).

The maximum height of the vapour cloud could reach almost up to 30 m in its transient state, therefore only the lowest ten (10) floors of the buildings (assume 3 m per floor) would possibly be encompassed.

The vapour cloud dispersed from a horizontal pressurised jet release could extend to up to three (3) m. In this analysis, the affected height is conservatively assumed as five (5) m, i.e. the lowest two (2) floors are affected.

Indoor Protection Factors

Protection for indoor population against thermal radiation and flash fire is considered by assuming that the indoor fatality rate is 10% of the outdoor fatality rate.

For persons within the fireball radius/ criteria zone, it was assumed that 50% of person would be killed and 50% indoor protection factor was applied in this QRA Study.

Shielding Protection Factors

A shielding factor is generally used to take credit for the shielding of buildings by other buildings from fire effects. A shielding factor of 50% is applied only to these buildings located behind the closest buildings for fireball scenario.

4.3 Meteorological Data

The proximity weather station to the LPG Filling Station is Kai Tak Weather Station. Therefore, wind speed, wind stability and direction data between 2019 and 2023 taken from Kai Tak Weather Station were adopted for this QRA Study.

With reference to "Guidelines For Quantitative Risk Assessment, CPR 18E (Purple Book)", at least six (6) representative weather classes are recommended for this QRA Study, covering the stability conditions of stable, neutral and unstable, low and high wind speed. At least the following six (6) weather classes have to be covered in terms of Pasquill classes.

Stability class	Wind speed (1)
B	Medium
D	Low
D	Medium
D	High
E	Medium
F	Low

Note: Low wind speed corresponding to 1 – 2 m s-1
Medium wind speed corresponding to 3 – 5 m s-1
High wind speed corresponding to 8 – 9 m s-1

The details of meteorological data analysis can be referred to Assumption 1.1.1 in **Appendix 4-1 .**

The probability of each weather state for each direction during the day and night are rationalized for analysis based on the requirements presented in "Guidelines For Quantitative Risk Assessment, CPR 18E (Purple Book)". Based on the analysis on raw data, the summary of meteorological data is shown in, which was used for this QRA Study.

The wind speeds are quoted in units of meters per second, (m s−1). The atmospheric stability classes refer to:

A – Turbulent

B – Very Unstable

C – Unstable

D – Neutral

E – Stable

F – Very Stable

Atmospheric stability suppresses or enhances the vertical element of turbulent motion. The vertical element of turbulent motion is a function of the vertical temperature profile in the atmosphere. The greater the rate of decrease in temperature with height, the greater the level of turbulent motion. Category D is neutral and neither enhances nor suppresses turbulence.

Table 4.4 Meteorological Data from Kai Tak Weather Station (Year 2019 – 2023)

		Probability												
		Day						Night						
Wind Speed (m s−1)		3.0	1.7	4.0	6.9	3.1	1.5	1.0	1.6	4.0	7.2	3.0	1.5	
Direction (degree)	Atmospheric Stability	B	D	D	D	E	F	B	D	D	D	E	F	Total (%)
0		0.49	0.23	0.38	0.03	0.06	0.24	0.00	0.05	0.26	0.04	0.35	1.12	3.24
30		0.59	0.25	0.45	0.01	0.12	0.31	0.00	0.09	0.34	0.01	0.55	1.43	4.15
60		0.77	0.19	0.65	0.08	0.07	0.16	0.00	0.05	0.58	0.04	0.37	0.87	3.81
90		2.68	0.29	4.82	1.04	0.37	0.25	0.00	0.08	5.51	0.85	2.47	1.71	20.05
120		5.69	0.83	5.58	0.45	0.74	0.71	0.00	0.13	4.45	0.28	3.18	5.64	27.68
150		3.72	0.80	1.55	0.02	0.23	0.82	0.00	0.06	0.34	0.01	0.76	5.27	13.58
180		1.12	0.43	0.18	0.00	0.01	0.23	0.00	0.04	0.05	0.00	0.11	2.19	4.36
210		1.75	0.39	0.20	0.00	0.02	0.18	0.00	0.03	0.11	0.00	0.19	1.37	4.24
240		2.76	0.42	0.79	0.02	0.05	0.27	0.00	0.04	0.65	0.02	0.44	2.15	7.60
270		0.87	0.23	0.34	0.03	0.04	0.22	0.00	0.08	0.23	0.01	0.22	1.43	3.69
300		0.68	0.33	0.64	0.01	0.10	0.30	0.00	0.12	0.45	0.01	0.36	1.14	4.15
330		0.65	0.21	0.53	0.05	0.09	0.22	0.00	0.07	0.44	0.01	0.37	0.80	3.44
	Total (%)	21.75	4.58	16.10	1.74	1.90	3.92	0.00	0.85	13.40	1.28	9.35	25.12	100.00

5. HAZARD IDENTIFICATION

5.1 Hazards of LPG Facilities

Properties of LPG

LPG supplied in Hong Kong is a pressurised mixture of propane and butane (3:7). Upon a release to the ambient environment it vaporises and mixes with air, forming a dense flammable gas cloud which tends to flow and disperse close to the ground. The gas cloud may extend over a long distance until it gets too diluted or encounters ignition sources.

Events Leading to an Accidental LPG Release

Historical accident records such as Major Hazard Incident Data Service (MHIDAS) database, and previous QRA Study reports were reviewed. The main hazard associated with the LPG Filling Stations is an accidental uncontrolled release of LPG resulting in a fire or an explosion upon an ignition. The initial events leading to an LPG release could be one of the following:

- Spontaneous failure of pressurised LPG equipment due to material / design / construction defect, fatigue, corrosion, erosion, etc.;
- Loading failure, i.e. an LPG release occurs as a direct result of the road tanker unloading operation;
- Refuelling failure, i.e. an LPG release occurs during LPG refuelling operation; and
- External events such as earthquake.

1. Storage Vessel Failure

Failure of the storage vessel may result from:

- Spontaneous cold catastrophic failure leading to an instantaneous release of full inventory;
- Spontaneous partial failure (25 mm hole leak) leading to a continuous release of the full inventory;
- Over-pressurisation due to an accidental overfilling during unloading from the LPG road tanker; and
- External events such as earthquake.

2. Road Tanker Failure

Failure of the LPG road tanker may result from:

- Spontaneous cold catastrophic failure leading to an instantaneous release of full inventory;
- Spontaneous partial failure (25 mm hole leak) leading to a continuous release of the full inventory, and;
- Accidents during unloading caused due to collision by another vehicle in the LPG Filling Stations.

3. Pipework Failure

Spontaneous failure of the LPG pipework is possible due to material defects, corrosion, fatigue and erosion. Most of the LPG pipework is installed aboveground, which includes the liquid-inlet pipework for LPG unloading to the storage vessel, the liquid supply line from the vessel to vaporisers and the vapour pipe from the vessel and vaporisers to the distribution network outside the LPG Filling Stations. Pipework may fail in an earthquake. Part of the liquid-inlet pipework for LPG unloading to the storage vessel is installed above ground, which may subject to failure due to impact of the LPG road tanker.

4. Dispenser Failure

Spontaneous failure of the dispenser is possible due to material defects, corrosion, fatigue and erosion. Failure of the dispenser is also possible due to an impact of the vehicle in the LPG Filling Station for refuelling.

5. Refuelling Flexible Hose Failure

An accidental release from the flexible hose may be caused by spontaneous failure due to material degradation, fatigue, corrosion and erosion. It can also be resulted from the unloading operation:

- Hose misconnection error, an error by the driver/ operator failing to properly connect the loading hose and the hose coming adrift during unloading;
- Hose disconnection error, an error where the driver/ operator inadvertently disconnects the hose while the valve is still open or has failed open; and
- Road tanker drive-away error, an error where the driver inadvertently drives the tanker away during unloading
- Impact to the refuelling vehicle by another vehicle in the LPG Filling Station, which causes movement of the refuelling vehicle leading hose disconnection and hose damage.

6. Submersible Pump Failure

Leak from the submersible pump itself will result in a release of LPG back to the storage vessel and therefore any hazard is not expected. A release is possible from the flange associated with the fitting of the pump on the top of the storage vessel. This will results in a liquid leak from a 25 mm hole, equivalent to the space between two (2) bolt holes on a flanged joint.

7. External Events

An LPG release may occur due to external events and the associated failure could be catastrophic failure or a leak. The related external events are listed as following:

- Earthquake;
- Aircraft crash;
- Car crash;
- Landslide;
- Severe environmental events;
- Lightning strike;
- Dropped object;
- Subsidence; and
- External fire.

Safety Provision

Various safety provisions are installed in the LPG Filling Stations upon the safety guidelines requirements of the Gas Authorities of EMSD, Code of Practice of Hong Kong LPG Industry. These provisions can act in different combinations to prevent or mitigate the hazards due to an accidental LPG release. In this project, the following safety provisions are provided.

a. Non-return Valve

Non-return valve on the liquid filling line can prevent back flow from the LPG storage vessel.

b. Excess Flow Valve

Excess flow valve installed at the tanker, storage vessel is used to stop the liquid flow when a large release occurs (e.g. a guillotine failure of the pipe/ hose).

c. Breakaway Coupling

It is possible that the LPG road tanker or vehicle may be driven away while the hose is still connected, which may cause damage to the LPG facilities and lead to an LPG release. The breakaway coupling is installed to prevent the LPG spillage due to tanker/ vehicle drive-away during unloading/ refuelling operation.

d. Double-check Filler Valve

Double-check filler valve is installed at the LPG filling point to prevent the release back from the storage vessel.

e. Pressure Relief Valve

Pressure relief valve is installed on the LPG road tanker and storage vessel to protect against excessive pressure built-up due to overfilling or over-heating by an external fire. The excessive pressure may cause a leak or catastrophic failure of the LPG road tanker and storage vessels.

f. Manual Isolation Valve

Manual isolation valves are installed on the LPG road tanker, storage vessel and pipework for the operators/ drivers to close the manual valve in case of a failure or for maintenance operation.

g. Chartek Coating

Chartek coating is a safety feature for the LPG road tankers in Hong Kong. It was reported that the coating could give a protection for at least thirty (30) minutes in case of jet fire impingement. The coating can prevent formation of hot spots on the LPG road tanker upon a jet fire impingement, which induces thermal weakening of the tanker wall and leads to a BLEVE scenario.

h. Emergency Shutdown System

The LPG storage, unloading and refilling will be stopped and isolated by the emergency shutdown (ESD) system, which is activated manually by fireman.

i. Leak Detection System with Alarm

Flammable gas detectors are installed near the LPG filling point, LPG storage vessel, LPG dispenser and the office. Alarm will be initiated and activated upon a detection of a flammable vapour cloud.

j. Emergency Shutdown System

The LPG storage, unloading and refilling will be stopped and isolated by the emergency shutdown (ESD) system, which is activated by manually press emergency bush button or automatically if any dispenser malfunction.

k. Water Spray System

Water spray system is provided, which is automatically activated by infra-red detection system as well as the manual push handle.

l. Dry Powder Fire Extinguishers, Sand Buckets and Fire Hydrant

Dry powder fire extinguishers, sand buckets and fire hydrant are provided for general fire-fighting uses.

m. Emergency Response Plans

Emergency response plans are enacted in accordance with the Code of Practice for Hong Kong LPG Industry.

n. Fire Services

Fire brigade is available within a few minutes upon an emergency call in case of a fire. BLEVE scenario could be prevented by effective fire-fighting measures by the well trained fire-fighters

Outcome of an Accidental LPG Release

The following outcomes could result from an accidental LPG release:

- Jet fire;
- Flash fire;
- Vapour Cloud Explosion (VCE);
- Fireball; and
- Boiling Liquid Expanding Vapour Explosion.

Catastrophic failure of the LPG vessel and road tankers may lead to a fireball, a flash fire or an VCE. Vessel/tanker partial failure (leak), pipework / flexible hose failure may cause a jet fire, a flash fire or an VCE. Potential fire escalation to a BLEVE scenario is considered if a jet fire impinges on the road tanker over a period of time, causing the formation of hot spots on the road tanker wall and subsequent a structural failure. The LPG storage vessel in the LPG Filling Stations is underground in a concrete compartment filled with washed sand. Fireball and escalation to a BLEVE scenario are considered unlikely for such tank.

If an ignition source is not present in the vicinity of the LPG vapour cloud or along the migration path of the cloud with the wind, the LPG vapour cloud will dissipate and no hazardous impact is expected.

LPG Hazardous Release Scenarios

Representative LPG accidental release scenarios to be considered in this QRA Study are summarised in Table 5.1

Table 5.1 Accidental LPG Release Scenarios Considered

Equipment	Failure Type	Release Type	Potential Hazardous Outcomes
LPG storage vessel	Catastrophic failure	Instantaneous	Flash fire, VCE
	Partial failure (leak)	Continuous	Flash fire, VCE, Jet fire
LPG road tanker	Catastrophic failure	Instantaneous	Flash fire, VCE, fireball
	Partial failure (leak)	Continuous	Flash fire, VCE, Jet fire
Liquid-inlet pipeline	Guillotine failure	Continuous	Flash fire, VCE, Jet fire, BLEVE
	Leak	Continuous	Flash fire, Jet fire
Liquid supply line to dispenser	Guillotine failure	Continuous	Flash fire, VCE, Jet fire
	Leak	Continuous	Flash fire, Jet fire
Dispenser	Guillotine failure	Continuous	Flash fire, Jet fire, BLEVE
Flexible hose to vessel	Guillotine failure	Continuous	Flash fire, VCE, Jet fire, BLEVE
	Leak	Continuous	Flash fire, Jet fire
Flexible hose to vehicle	Guillotine failure	Continuous	Flash fire, Jet fire, BLEVE
Submersible Pump Flange	Leak	Continuous	Flash fire, VCE, Jet fire, BLEVE

Failure of the underground vapour return line is not further considered in this QRA Study because the LPG vapour release can only impact a few meters from the leak source, thus only imposes risk to the on-site population at the LPG Filling Station.

Failure of LPG vehicle (taxi / minibus) is not further considered in this QRA Study due to the small tank inventory, which is about 95.5 to 103.5 L and 122 L for the LPG taxies and minibuses respectively. Such a small inventory could only sustain a short duration of the LPG release, resulting in insignificant impacts at the LPG Filling Station compared with releases from the pipework/ hose connected to the LPG storage vessel/ road tankers.

6. FREQUENCY ANALYSIS

6.1 Overview

Frequency analysis involved estimation of likelihood of LPG containment failure leading to an accidental LPG release and subsequent outcome probabilities. The initiating failure probabilities were estimated from the historical accident statistics, published failure data report, industrial testing results and professional judgement /4//9//10//11/. Base failure frequencies of LPG facilities (vessels, pipework, etc.) were derived from the initiating failure events by applying failure analysis techniques such as fault tree analysis. Occurrences of subsequent hazardous outcomes in an accident are estimated by event tree analysis, taking into account of severity of the release event and surrounding environment. Frequency analysis in this QRA Study takes into account previous QRA Studies /4/.

6.2 Base Failure Frequencies

Base Initiating Failure Frequencies

Storage Vessel Failure

Storage vessel failure refers to a cold catastrophic failure leading to an instantaneous release of the whole inventory or a cold partial failure causing a continuous leakage. 1.8×10^{-7} per vessel year and 5.0×10^{-6} per vessel year are adopted for cold catastrophic and partial failures, respectively. The vessel is stress relieved and 100% radiograph tested.

It is assumed that the vessel inventories would be nominally full (80% maximum capacity of vessel) in 20% of time and there is nominal 60% vessel inventory in 80% of the time.

Road Tanker Failure

LPG road tanker can be regarded as a mobile LPG storage vessel. The cold spontaneous failure rate for LPG road tankers could be higher than for a fixed storage vessel because of stresses experienced by the road tanker due to vibration during transportation, and cyclic loading associated with unloading of the road tanker. The catastrophic and partial failure probabilities of a LPG road tanker are 2.0×10^{-6} and 5.0×10^{-6} per year, respectively.

LPG road tankers will generally stay in the LPG Filling Stations for 60 minutes per delivery, in which the first and last 5 minutes are used as setting up the equipment. As such, inventories of the road tankers are assumed to be full in 4.2% of time, 50% in 91.6% of time and 0% in 4.2% of time.

Dispenser Failure

LPG from the storage vessel is pumped to the dispenser for the vehicle refuelling operation. The typical dispenser in Hong Kong is a metering device, a hose with self-sealing connector, four (4) ball valves (with two (2) flanges for each valve) and a certain length of a rigid pipework. Failure of the dispenser is estimated as 7.9×10^{-5} per year by "Parts Count" approach as illustrated in Table 6.1. The pipework in the dispenser has a diameter of 20 mm. Only significant leak is considered in this QRA Study.

Table 6.1 Failure Rate of LPG Dispenser

Item	Quantity, no. or m	Base failure rate, per year or per m.year	Fraction of significant leak (>0.2 D)	Failure rate, per year
Pipe (1)	2	2.5×10^{-5}	15%	7.5×10^{-6}
Ball valve (2)	4	8.8×10^{-5}	6%	2.1×10^{-5}
Flange (1)	10	5.0×10^{-6}	100%	5.0×10^{-5}

Pipework Failure

Failure of LPG pipework can be a guillotine failure (full bore rupture) and a partial failure (a leak from pipe cracks). For LPG Filling Stations, a leak from pipework is considered insignificant contributors to the overall risk levels. Nevertheless, a leak from pipework (pipe diameter 50 mm or above) is included in this analysis for the conservatism. The generic guillotine failure rate of LPG pipework is taken as 10^{-6} per meter per year, and the rate of partial failure (equivalent to 10% pipe diameter) is taken as 3.3 times of the guillotine failure rate, i.e. 3.3×10^{-6} per meter per year. It should be noted that failure of pipework cannot result in uncontrolled continuous release of LPG unless isolation fails, i.e. simultaneous failure of safety equipment (non-return valve, excess flow valve and ESD valve) and manual shut-off valves.

Flexible Hose Failure

A cold spontaneous failure of a flexible hose may occur during the road tanker unloading or vehicle refuelling operation. Likelihood of a guillotine failure is taken as 9.0×10^{-8} per hour. Average residence time of the LPG road tanker at the LPG Filling Stations is about 60 minutes, therefore the guillotine failure rate of the unloading flexible hose is estimated to be $9.0 \times 10^{-8} \times 60 / 60 = 9.0 \times 10^{-8}$ per operation. Partial failure of an unloading flexible hose to vessel (hose diameter 38 mm) is also considered in this QRA Study. Similarly, a failure rate of 3.3 times the guillotine failure rate is applied.

Road Tanker Unloading Operation

Hose Misconnection Error

A misconnection error could occur if the hose is improperly connected to the filling point. A failure rate of 3×10^{-5} per operation is adopted in this QRA Study. It is assumed the error causes the hose to come completely apart, leading to a full-bore release.

Hose Disconnection Error

This error is caused by inadvertently disconnecting the filling hose during the unloading operation, which requires a complete disregard of normal operating procedures, as well as the failure to re-tightening the coupling immediately upon loosening it. A gross human error of 2×10^{-6} per operation is adopted in the analysis, assuming it results in a full-bore release.

Road Tanker/ vehicle Drive-away Error

A drive-away error could occur due to an inadvertent drive-away before completion of replenishment. A full-bore release is assumed in this QRA Study. The probability of drive-away error before operation completion is deemed low and a failure rate of 4×10^{-6} per operation is adopted.

Road Tanker Impact onto LPG Facilities

The road tanker may strike the LPG Filling Stations during truck manoeuvring within the LPG Filling Stations, causing damage to the LPG Filling Stations or the road tanker. A likelihood of 1.5×10^{-4} per operation is adopted for this human error. The road tanker moves very slowly during manoeuvring to its unloading bay. A release from the road tanker due to slight impact is considered remote because the road tanker is equipped with side and rear end protection (mechanical barriers and rear protection bumper) for the vessel, fittings, valves and pipework fitted to it. The probability of damaging the filling pipework is considered very low as it is protected by a steel framework and the vehicle bumper, minimising the chance and energy of direct tanker impact on the pipework. A release from the damaged pipework could ensue only if the driver neglects his duty to check the pipework integrity and possible leakage before unloading starts.

Road Tanker Collision during Unloading

The LPG road tanker is parked in a designated unloading bay of the LPG Filling Stations with fencing forming an area with limited access. The collision by other vehicles to an unloading road tanker is considered very unlikely, nevertheless, a frequency of 10^{-8} per operation is used in this QRA Study.

Damage due to Tanker/ Vehicle Impact

Compared with normal road accidents, an inadvertent impact by the road tanker/ vehicle to the LPG facilities is deemed to be a low speed/ momentum collision due to provision of speed limit, sufficient lighting, well-maintained concrete floor, warning signage, and supervision of working staff, etc. at the LPG Filling Station. Mostly it will cause slight damage, which is not potential to result in an uncontrolled LPG release.

Road traffic accident statistics from the Transport Department shows 86% of all road accidents in Hong Kong are slight collision, 13% (take 20% in the aforementioned calculation) are serious collision and 1% is fatal collision. Most of the road accidents are related to speeding, crossing the road, drunk/ drug drive, poor road condition, bad weather, etc. In this QRA Study, it is assumed fatal accidents have the potential to cause a catastrophic rupture of the tanker, a guillotine failure of the LPG pipework/ dispenser/ flexible refuelling hose, and serious accidents have the potential to cause leakage of the tanker/ pipework. To account for the aforementioned provisions at the LPG Filling Station, a modification factor of 0.5 is conservatively applied, i.e. the probability of fatal and serious damage in an impact accident at the LPG Filling Station is taken as 1% x 0.5 = 0.5% and 20% x 0.5 = 10%, respectively. For the liquid-inlet pipework at the LPG filling point, a modification factor of 0.1 is applied considering the extra protection from the crash barrier around the unloading area, i.e., the probability of 0.1% and 2% is adopted for fatal and serious damage in an impact accident.

Table 6.2 Road Traffic Accidents by Severity (2004 – 2024)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Fatal	160	139	135	153	143	126	114	128	116	128	99
Serious	2,519	2,504	2,315	2,376	2,096	1,943	2,052	2,190	2,385	2,476	2,508
Slight	12,347	12,419	12,399	12,786	12,337	12,247	12,777	13,223	13,393	13,485	13,183
Total	**15,026**	**15,062**	**14,849**	**15,315**	**14,576**	**14,316**	**14,943**	**15,541**	**15,894**	**16,089**	**15,790**
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**Total**
Fatal	117	129	104	107	107	96	94	89	96	83	2,463
Serious	2,510	2,379	2,070	1,682	1,831	1,912	1,824	1,046	1,000	751	42,369
Slight	13,543	13,591	13,551	14,146	14,164	13,290	15,913	13,972	16,093	17,521	286,380
Total	**16,170**	**16,099**	**15,725**	**15,935**	**16,102**	**15,298**	**17,831**	**15,107**	**17,189**	**18,355**	**331,212**

Storage Vessel Overfilling/ Overpressurisation

During the unloading operation the driver should stay close to the road tanker while his assistant should monitor the filling in progress at the LPG vessel. The vessel shall not be filled more than 85% of the total volume[/26/]. Each bulk storage vessel is equipped with two (2) gauges for indicating the quantity of content, one (1) is the level indicator and the other is the pressure indicator. In Hong Kong, it is an offence to overfill an LPG storage vessel, and the possibility is considered to be 2×10^{-2} per operation. However, even if overfilling occurs, a release due to overpressurisation will not occur unless all of the following failures take place:

- Failure of truck pump overpressurisation protection system;
- Failure of pressure relief valve on the storage vessel; and
- Failure of the driver and his assistant to activate ESD system and close manual shut-off valves.

Considering the design pressure of the LPG storage vessel is 17.25 barg (around 3.7 times of the normal operating pressure of 4.6 to 4.7 barg in summer), the outcome of storage vessel overfilling/ overpressurisation is mostly probably the leak from the vessel connections. Nevertheless, a catastrophic rupture of the vessel may not be ruled out. Historical records in the MHIDAS database (1950 – 2006) on vessel overfilling show that 3 in 123 incidents led to a catastrophic rupture of the storage vessel which accounts for about 2.4% of all incidents. In this QRA Study, the probability of a catastrophic rupture is assumed as 2.5%.

Human Error

In case of an accidental failure, it is very probable that the on-site staff can rectify the problem before and after any hazard event occurs. Two (2) competent persons (the driver and the assistant) are required to be engaged in the whole unloading process and stay in close vicinity of the road tanker and the filling point during the whole unloading operation. They are suitably trained in the unloading operation, first aid, firefighting and emergency response, and equipped with necessary personal protection equipment (PPE). Nevertheless, they might make errors in a series of operations. The probability is taken as 0.01 for error in a routine operation where care is required from "A Guide to Practical Human Reliability Assessment". Upon an accidental LPG release from the LPG road tanker, the driver and the assistant will immediately terminate the unloading operation by pressing the ESD button on the tanker, and close the shut-off valves on the tanker. If there is an accidental LPG release from the LPG pipework or the LPG dispenser and its associated hoses, alarm will be raised by the leak detection system, the on-site working staff will stop and isolate the LPG filling system by pressing the ESD button in the office or at the dispenser. The failure to start the ESD system of the LPG road tanker/ the LPG Filling Station by pressing the ESD button under an emergency situation is taken as 0.1 for failure to act correctly at a stressful emergency situation.

At the LPG Filling Station, an isolation of LPG unloading/ refuelling pipework and LPG dispensers can be activated by all ESD buttons by staff at the LPG Filling Station. Therefore, the failure probability for two (2) or more staff to activate the ESD system for an isolation is estimated as 0.01 (= 0.1 x 0.1) in an emergency situation. Probability of human error becomes much higher under emergency situations when a hazard event occurs, the operator has to take immediate actions to rectify the problem under extreme stresses, and also possibly puts himself in some danger from the LPG release. This chance of human errors in this case is 0.3 for general rate for errors involving very high stress levels. Nevertheless, a more conservative probability of 0.5 is adopted in this QRA Study considering the operators are facing the dangers from an accidental LPG release.

Failure of Safety Provisions

Hazards from an accidental LPG release can be prevented or mitigated by the safety provisions at the LPG Filling Station. The following failure probabilities in **Table 6.3** are assumed based on "QRA methodology for LPG Installations"[/4/] and "Lees"[/10/].

Table 6.3 Failure of Safety Provisions

Item	Failure probability
Excess Flow Valve (LPG vessel)	1.3×10^{-2} per demand
Excess Flow Valve (LPG road tanker)	1.3×10^{-2} per demand
Non-Return Valve	1.3×10^{-2} per demand
ESD Trip System Fails	10^{-4} per demand
Breakaway Coupling	1.3×10^{-2} per demand
Double-Check Filler Valve	2.6×10^{-3} per demand
Chartek Coating under Jet Fire Attack	10^{-1} per demand
Fire Service to Prevent BLEVE (Jet Fire Impingement on the Road Tanker)	5×10^{-1} per demand
Pressure Relief Valve	10^{-2} per demand
Truck Pump Over-pressure Protection System (LPG Road Tanker)	10^{-4} per demand

External Events

Earthquake

Hong Kong is situated on the southern coast of mainland China and facing the South East China Sea. Hong Kong is not located within the seismic belt and according to Hong Kong Observatory, earthquakes occurring in the circum-Pacific seismic belt which passes through Taiwan and Philippines are too far away to affect Hong Kong significantly. Buildings and infrastructures in Hong Kong are designed to withstand earthquakes up to Modified Mercalli Intensity (MMI) VII.

It is estimated that MMI VIII is of sufficient intensity to cause damage to specially designed structures. In this QRA Study, it is assumed that such earthquake may result in storage vessel leakage and pipework rupture at a probability of 0.01[/13/]. The probability of earthquake occurrence at MMI VIII and higher in Hong Kong is very low comparing with other regions and is estimated to be 10^{-5} per year[/4/].

Aircraft Crash

The LPG Filling Stations are far away from the Hong Kong International Airport. The frequency of aircraft crash was estimated using the Health & Safety Executive methodology[/14/], which was adopted in previous QRA study of an LPG Storage Installation. The number of flights from 1999 to 2017 is extracted from the Civil Aviation Department[/15/], and extrapolated to year 2017 by linear regression. The calculated impact frequency due to aircraft crash is in the order of magnitude lower than 10^{-9} per year. It is therefore not further considered in this QRA Study.

Car Crash

The LPG Filling Stations are surrounded by concrete boundary wall, railings and fence. A buffer area with bollard and railings along road side is provided on the side to the public access road in the vicinity of the LPG Filling Stations. It is considered car crash on the public road impacts negligible threat to the LPG Filling Stations.

Severe Environmental Events

Loss of containment due to severe environmental events such as typhoon or tsunami (large scale tidal wave) is considered unlikely since the LPG vessel is installed underground in a mounted concrete compartment. The LPG Filling Station is designed safe to withstand the wind load for typhoon. The site is not threatened by tsunami since it is far away from the shore. Therefore the risk is deemed unlikely and not further considered in this QRA Study.

Lightning Strike

The frequency of lightning strike on a properly protected building structure is extremely low in Hong Kong. Risk resulting from lightning strike on LPG facilities in the LPG Filling Stations is extremely low as it is next to industrial/residential buildings. It is deemed lighting strike is remote, therefore not further considered in this QRA Study.

Dropped Object

The chain link fence and aboveground facilities of the LPG Filling Stations are sheltered by the roof. Thus, it is considered the threat from dropped objects to the LPG Filling Stations is remote and not further assessed in the analysis.

Subsidence

Excessive subsidence may lead to a failure of the structure and ultimately loss of containment scenario. However, subsidence is usually slow in movement and such movement can be observed and remedial action can be taken in time. Besides, the ground condition of the LPG Filling Stations is stable, risk from subsidence is therefore deemed remote and not further considered.

External Fire

External fire refers to the occurrence of a fire event outside the LPG Filling Stations which may lead to the failure of the LPG facilities. This might be expected from road accidents on the public road, probably involving car crash or engine failures (e.g. overheating during hot summer). The resulting fire is usually small, only affecting a few meters around the car, and could be quickly extinguished using fire extinguishers or by the fire brigade. However, the LPG Filling Stations are separated from the main road by a buffer area, and the key facilities inside are further protected by concrete building structures (e.g. the LPG vessel compartment) and activation of emergency shutdown system for potential external fire threat. The risk of escalation by an external fire to the LPG facilities is deemed remote and not further considered in this QRA Study.

Estimated Base Failure Frequencies

Base failure frequencies of hazardous events are derived by fault tree analysis from the initiating failures and summarised in **Table 6.4** and **Table 6.5**.

Table 6.4 Base Failure of Hazardous Events for Sinopec LPG Refilling Station (LPG A)

Hazardous Event	Failure Frequency (per year)
Cold Catastrophic Failure of LPG Road Tanker (100% Full)	4.58E-08
Cold Catastrophic Failure of LPG Road Tanker (50% Full)	1.83E-07
Cold Partial Failure of LPG Road Tanker (100% Full)	2.08E-07
Cold Partial Failure of LPG Road Tanker (50% Full)	8.30E-07
Failure of Flexible Hose to Vessel (rupture) (100% Full)	2.36E-06
Failure of Flexible Hose to Vessel (rupture) (50% Full)	9.42E-06
Failure of Flexible Hose to Vessel (leak)	2.49E-05
Failure of Liquid-Inlet Pipework (rupture)	1.21E-08
Failure of Liquid-Inlet Pipework (leak)	2.00E-06
Cold Catastrophic Failure of LPG Vessel (100% Full)	7.26E-08
Cold Catastrophic Failure of LPG Vessel (50% Full)	2.90E-07
Cold Partial Failure of LPG Vessel (100% Full)	2.04E-06
Cold Partial Failure of LPG Vessel (50% Full)	8.17E-06
Failure of Liquid Supply Line to Dispenser (rupture)	1.06E-07
Failure of Liquid Supply Line to Dispenser (leak)	1.50E-06
Failure of Dispenser	1.86E-05
Failure of Vapour return pipework from Dispenser to Vessel (rupture)	1.01E-05
Failure of Vapour return pipework from Dispenser to Vessel (leak)	3.30E-05
Failure of Flexible Hose to Vehicle (rupture)	3.71E-04
Failure of Submersible Pump Flange (leak)	1.52E-07

Table 6.5 Base Failure of Hazardous Events for Shell LPG Refilling Station (LPG B)

Hazardous Event	Failure Frequency (per year)
Cold Catastrophic Failure of LPG Road Tanker (100% Full)	5.73E-08
Cold Catastrophic Failure of LPG Road Tanker (50% Full)	2.29E-07
Cold Partial Failure of LPG Road Tanker (100% Full)	2.60E-07
Cold Partial Failure of LPG Road Tanker (50% Full)	1.04E-06
Failure of Flexible Hose to Vessel (rupture) (100% Full)	2.95E-06
Failure of Flexible Hose to Vessel (rupture) (50% Full)	1.18E-05
Failure of Flexible Hose to Vessel (leak)	3.12E-05
Failure of Liquid-Inlet Pipework (rupture)	1.52E-08
Failure of Liquid-Inlet Pipework (leak)	2.50E-06
Cold Catastrophic Failure of LPG Vessel (100% Full)	3.67E-08
Cold Catastrophic Failure of LPG Vessel (50% Full)	1.47E-07
Cold Partial Failure of LPG Vessel (100% Full)	1.05E-06
Cold Partial Failure of LPG Vessel (50% Full)	4.19E-06
Failure of Liquid Supply Line to Dispenser (rupture)	1.06E-07
Failure of Liquid Supply Line to Dispenser (leak)	1.50E-06
Failure of Dispenser	3.52E-05
Failure of Vapour return pipework from Dispenser to Vessel (rupture)	1.01E-05
Failure of Vapour return pipework from Dispenser to Vessel (leak)	3.30E-05
Failure of Flexible Hose to Vehicle (rupture)	4.60E-04
Failure of Submersible Pump Flange (leak)	1.52E-07

6.3 Event Tree Analysis

Event tree analysis (ETA) is used to develop the evolution of a failure event from its initial release to the final outcome scenarios, namely, jet fire, flash fire, fireball, etc. It depends on various factors such as a release type (an instantaneous or a continuous type), ignition sources and ignition probabilities, and degree of congestion to cause a VCE.

SAFETI 8.9's built-in event trees are used to calculate the frequencies of hazardous outcome scenarios.

Catastrophic Failure of LPG Road Tanker and Storage Vessel

For a catastrophic failure (tank catastrophic rupture scenario) of the LPG road tankers and LPG storage vessel and, the associated event trees are depicted in **Figure 6-1**, **Figure 6-2** and **Figure 6-3** respectively. Immediate ignition is assumed a probability of 0.5 for a large releases following Purple Book, as shown in **Table 6.6**.

For road tankers, immediate ignition results in a fireball, as the content would be instantly released to the ambient. For LPG storage vessel installed in a sand-filled concrete compartment, the probability of a fireball is negligible and therefore its effect is not evaluated. Instead flash fire is considered under this circumstance.

A probability of 0.5 is assigned to a delayed ignition, which may produce a flash fire or a VCE. The occurrence of a VCE requires an ignition of a dispersed gas cloud present in a confined or congested space. Given the relatively open nature of the surroundings of the LPG Filling Stations, an explosion probability of 0.2 is conservatively assumed in this QRA Study.

Table 6.6 Ignition Probabilities from Purple Book

Source		Ignition Probability
Continuous	Instantaneous	
< 10 kg s^{-1}	< 1,000 kg	0.2
10 – 100 kg s^{-1}	1,000 – 10,000 kg	0.5
> 100 kg s^{-1}	> 10,000 kg	0.7

Leak from LPG Storage Vessel / Road Tanker

For a partial failure (a leak) of the LPG road tankers and LPG storage vessel, a lower probability of 0.2 is adopted for an immediate ignition from **Table 6.6**. Immediate ignition of a continuous pressurised release results in a jet fire. Similar probabilities are assumed for the delayed ignition, which could also lead to a flash fire or a VCE. The associated event trees are depicted in **Figure 6-4** and **Figure 6-5**.

It is possible a jet flame from an aboveground pipe/ hose/ vaporiser failure may impinge on the road tanker and cause tank failure over a period of time. The probability of flame impingement is assumed as 1/6 for the liquid inlet pipework and flexible hose of the road tanker. For the flexible filling hose to vehicle, a direction probability of 1/12 is assumed based on the LPG Filling Stations layout, and the fraction of residence time of the LPG road tanker is also considered for fire impingement. In Hong Kong the LPG road tankers are protected by a layer of Chartek coating, preventing the formation of hot spots above the liquid level of the tank. The probability of coating failure is assigned as 0.1. Consideration is also given to fire services which may be ineffective in preventing a BLEVE, and the probability is assumed as 0.5. The mounted LPG storage vessel is free from flame impingement. The associated event trees of the aboveground

pipe/ hose/ vaporiser failure leading to a BLEVE are presented from **Figure 6-6** to **Figure 6-8** respectively.

Leak from Underground Pipe

Vertical jet release is considered for an underground release. BLEVE due to a jet fire impingement on the LPG road tanker wall is not considered as the LPG tank is protected by the vehicle chassis. The associated event trees of an underground pipe are presented in **Figure 6-9** and **Figure 6-10,** respectively.

6.4 Knock-on Effect from Surrounding LPG Filling Stations

In additional to the process equipment failures associated with the LPG Filling Stations, the knock-on effect (the additional risk, such as the escalated fireball event from the LPG road tanker) from the surrounding LPG Filling Stations were also considered and included for the QRA Study. The knock-on effect (the additional risk) from the surrounding LPG Filling Stations were identified from the individual risk contours of each surrounding LPG Filling Station.

7. CONSEQUENCE ANALYSIS

The consequence analysis was conducted in two (2) steps:

- Source term modelling to determine the release rate, duration and quantity; and
- Physical effects modelling to determine the gas dispersion, fire and explosion effects zone based on the output of source term modelling.

The impact of the hazardous outcomes on the surrounding population was analysed. In this QRA Study, the simulation software SAFETI 8.9 was employed to calculate the hazardous release and the effects zones.

7.1 Source Term Modelling

LPG is modelled as a mixture of 70% butane and 30% propane. LPG stored in a storage tank is pressurised to medium pressures to reach an equilibrium state between the liquid and vapour phases, depending on ambient temperatures. In the analysis maximum allowable inventory is conservatively assumed at the time of failure, i.e. 11 tonnes for LPG storage vessel and 9 x 85% = 7.65 tonnes for LPG road tankers. Instantaneous release of the whole inventory is assumed for a catastrophic rupture of LPG tanks. For a continuous release, a discharge rate is calculated by SAFETI 8.9 based on the leak size, release temperature, release pressure, and fluid phase. Duration of discharge is determined by discharge rate and total inventory.

7.2 Physical Effects Modelling

Gas Dispersion

The dispersion model in *SAFETI 8.9* was used for the dispersion of unignited vapour cloud following an accidental LPG release. The model takes into account various transition phases, from dense cloud dispersion to buoyant passive gas dispersion, in both an instantaneous release and a continuous release.

LPG vaporises rapidly upon a release. A number of possible outcomes may occur depending on whether the vapour is ignited immediately or ignited after a period of time. The dispersion characteristics are influenced by meteorological conditions and material properties, such as density of the vapour cloud.

Fire scenarios of different kinds may be developed in the presence of ignition sources in the proximity of a LPG release. Flash fire could occur once the cloud encounters ignition sources. It may result in a VCE in a confined space or a congested area. If ignition source is not present, the vapour cloud will disperse downwind, and be diluted to the concentration below its LFL. In this case, the vapour cloud would become too lean to be ignited and have no harmful effect.

Jet Fire

For flammable fluids stored under pressure (pressurised storage or from liquid height above a release point), release from an orifice will become a flame jet (i.e. jet fire) when ignited immediately. The combustion of the jet is influenced by the momentum of the release.

Fireball and BLEVE

Immediate ignition of an instantaneous release of the whole inventory inside a pressurised vessel will result in a fireball. Fireball is characterised by its high thermal radiation intensity and short duration time. The principal hazard of a fireball arises from thermal radiation, which is not significantly influenced by weather, wind direction or sources of ignition. A BLEVE is similar to a fireball except that it is caused by integrity failure from a fire impingement and therefore occurs as fire escalation events. The physical effects are calculated in the same way as fireballs.

Thermal Radiation of Fires

The following Probit equation[/7/] is used to determine lethal doses for various fire scenarios.

$$Pr = -36.38 + 2.56 \ln Q^{4/3} t$$

where

Pr: Probit corresponding to the probability of death;

Q: the thermal radiation intensity in W m^{-2}; and

t: the exposure time in seconds.

A building is assumed to offer protection to its occupants against hazards from fires. The protection factor is assumed to be 90% for the indoor population.

Flash Fire

An LPG release will vaporise and form a vapour cloud around the release source in case not ignited immediately. This cloud will move in the downwind direction, entraining air as it disperses and get diluted. If it gets ignited before it is diluted to below its LFL, a flash fire will result. Major hazards from flash fire are thermal radiation and direct flame contact. Since the flash combustion of a gas cloud normally lasts for a short duration, thermal radiation effect on people near a flash fire is limited. Humans who are encompassed outdoors by the flash fire will be fatally injured. A fatality rate of unity is assumed for outdoor population, and 90% protection factor is assumed for the indoor occupants.

Vapour Cloud Explosion

If the vapour cloud passes through an area of congestion (e.g. cluster of pipe racks, a confined space) and gets ignited, the confinement will limit the degree of expansion of the burning cloud, causing an explosion and damage to the surroundings by the resulting overpressure. In SAFETI 8.9 the hazardous effects are modelled by two (2) concentric circular areas corresponding to heavy and light building damage, respectively. The fatality rates for persons outdoors and indoors are determined from the "Health & Safety Executive" method[/20/] and "Chemical Industry Association" (CIA) guidelines[/21/]. The fatality rates for outdoor and indoor population are presented in **Table 7.1**.

Table 7.1 Fatality Rate for Persons Outdoors and Indoors

Explosion Overpressure (barg)	Fatality Rate	
	Outdoors	Indoors
Heavy Explosion (> 0.3)	0.06	0.60
Light Explosion (>0.1 to 0.3)	0.00	0.01

7.3 Hazardous Impacts on Off-site Population

Population in the vicinity of the LPG Filling Station can be potentially affected by the hazardous events depending on the consequences. Fireball and BLEVE from the LPG road tanker have a radius of up to 59 m and a lift-off height of 118 m. LPG jet fire flame can extend up to 33 m for the road tanker leakage and 20 m for the filling hose failure. In the absence of ignition sources, the large flammable vapour cloud resulting from an instantaneous rupture of a LPG vessel or road tanker may drift downwind up to 200 m at high wind speeds. However, it is more likely the cloud would get ignited during its migration due to presence of plenty ignition sources such as moving vehicles, road lamps, and various human activities near the LPG Filling Station.

Partial or full height of the surrounding buildings (high-rise and low-rise) could be affected by fireball and BLEVE considering their size and lift-off. For people staying inside the buildings, intense thermal radiation of fireball and BLEVE would only affect the people near the window facing the LPG Filling Station, while others are protected by shielding of indoor obstacles and the building wall. The buildings facing the LPG Filling Station also provide shielding for the buildings behind.

Catastrophic failure of the storage vessel/ road tanker may lead to a large transient vapour cloud due to flashing of the pressurised flammable liquid upon a release. The transient cloud may migrate and disperse downwind away from the LPG Filling Station up to 200 m and dissipate in one (1) minute based on SAFETI 8.9 modelling. The maximum height of the vapour cloud could reach almost up to 40 m in its transient state, therefore only the lowest 14 floors of the buildings (assume 3 m per floor) would possibly be encompassed. People inside the building will not be affected by a flash fire of the transient vapour cloud due to lack of sufficient accumulation to the flammable concentration via ventilation.

The vapour cloud dispersed from a horizontal pressurised jet release could extend to up to three (3) m. In this QRA Study, the affected height is conservatively assumed as five (5) m. As a conservative approach, it is assumed that the lowest two (2) floors will be affected.

8. RISK ASSESSMENT

8.1 Risk Summation

Risk summation combines the estimation of the likelihood and consequences of hazardous events, as well as the meteorological data and population in the hazard effect zones, to give a numerical measure of risks around the fatalities. The risk analysis is conducted by the SAFETI 8.9 package and the outcome results are presented in terms of individual risk (as individual risk contours), and societal risk (as F-N curves or potential loss of life). The risk outcomes were compared with the criteria set out in the risk guidelines. Ignition sources with ignition probabilities in a given time period.

8.2 Risk Measures

The estimated off-site risk levels of hazardous installations has been compared with Hong Kong Government Risk Guidelines stipulated in Chapter 12 of the HKPSG by the Planning Department to determine the acceptability.

Societal Risk

Societal risks are presented graphically in Figure 8-1. The societal risk guideline is expressed in terms of lines plotting the frequency (F) of N or more fatalities in the off-site population from hazardous scenarios at the facility of concern. There are three areas as described below:

- **Acceptable** where the risk is so low that no action is necessary;
- **Unacceptable** where the risk is so high that they should be reduced regardless of the cost or else the hazardous activity should not proceed; and
- **ALARP** where the risk associated with the hazardous activity should be reduced to a level "As Low As Reasonably Practicable", in which the priority of measures is established on the basis of practicality and cost to implement versus the risk reduction achieved.

Individual Risk

The maximum level of off-site individual risk associated with the hazardous installations in Hong Kong should not exceed 1 in 100,000 years, i.e. 10^{-5} per year.

8.3 Risk Results

Individual Risk

The individual risk contour of 10^{-6} per year is within the LPG Filling Stations and the individual risk contours of 10^{-7} to 10^{-9} per year for the LPG Filling Stations are presented in Figure 8-2 and Figure 8-3.

The individual risk contour of 10^{-9} per year is well confined within the proposed study zone of the LPG Filling Station; therefore, all credible hazardous scenarios with frequency above 10^{-9} per year have been well considered in this QRA Study.

Therefore, it could be concluded that the individuals risk associated with the LPG Filling Station are in compliance with the Hong Kong Government Risk Guidelines in terms of individual risk.

Societal Risk

8.3.1.1 Potential Loss of Life

The top five (5) hazardous scenarios for the LPG Filling Stations during the Operation Phase (2029) were identified and summarised at Table 8.1 and Table 8.2.

Table 8.1 Top Five (5) Hazardous Scenarios Breakdown of PLL for Operation Phase (2029) (Sinopec)

Description	PLL
Flash fire event associated with catastrophic rupture scenario of LPG Vessel during 60% full for LPG vessel	6.20E-06
Flash fire event associated with catastrophic rupture scenario of LPG Vessel during 100% full for LPG vessel	2.67E-06
Flash fire event associated with catastrophic rupture scenario of LPG Road Tanker during 50% full for LPG Road Tanker	2.18E-06
Jet fire event associated with line rupture scenario of flexible hose from LPG Road Tanker to LPG Vessel during 50% full for LPG Road Tanker	2.07E-06
Fireball event associated with catastrophic rupture scenario of LPG Road Tanker during 50% full for LPG Road Tanker	1.85E-06
Others	4.56E-06
Total	**1.95E-05**

Fireball event associated with catastrophic rupture scenario of LPG Road Tanker during 50% full for LPG Road Tanker

Table 8.2 Top Five (5) Hazardous Scenarios Breakdown of PLL for Operation Phase (2029) (Shell)

Description	PLL
Flash fire event associated with catastrophic rupture scenario of LPG Vessel during 60% full for LPG vessel	2.90E-06
Fireball event associated with catastrophic rupture scenario of LPG Road Tanker during 50% full for LPG Road Tanker	2.69E-06
Jet fire event associated with line rupture scenario of flexible hose from LPG Road Tanker to LPG Vessel during 50% full for LPG Road Tanker	2.14E-06
Flash fire event associated with catastrophic rupture scenario of LPG Road Tanker during 50% full for LPG Road Tanker	1.85E-06
Fireball event associated with catastrophic rupture scenario of LPG Road Tanker during 100% full for LPG Road Tanker	1.32E-06
Others	4.90E-06
Total	**1.58E-05**

F-N Curve

F-N curves of the LPG Filling Stations for the Operation Phase (2029) are depicted in Figure 8-4 and Figure 8-5. F-N curves reside in the "Acceptable" region; the societal risks of the LPG Filling Station during Operation Phase (2029) are in compliance with Hong Kong Government Risk Guidelines in terms of societal risk.

9. CONCLUSION

This QRA Study has been conducted to evaluate if risks associated with the LPG Filling Station are in compliance with Hong Kong Government Risk Guidelines during Operation Phase (2029).

9.1 Individual Risk

The individual risk contour of 10^{-5} per year does not reach the LPG Filling Stations. Therefore, it could be concluded that the individual risk of the LPG Filling Stations are in compliance with the Hong Kong Government Risk Guidelines.

9.2 Societal Risk

The societal risks (F-N curves) of the LPG Filling Stations during Operation Phase (2029) are within the "Acceptable" region. Therefore, it could be concluded that the societal risk associated with the LPG Station during Operation Phase (2029) are in compliance with Hong Kong Government Risk Guidelines.

9.3 Conclusions

The individual risk and societal risk associated with LPG Filling Stations are in compliance with Hong Kong Risk Guidelines, no further mitigation measures are required.

As a good matter of engineering practice, it is recommended to ensure the effectiveness of fire protection system, fire fighting system and the associated safety management system for the proposed development in compliance with the engineering standards and codes.

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Figures

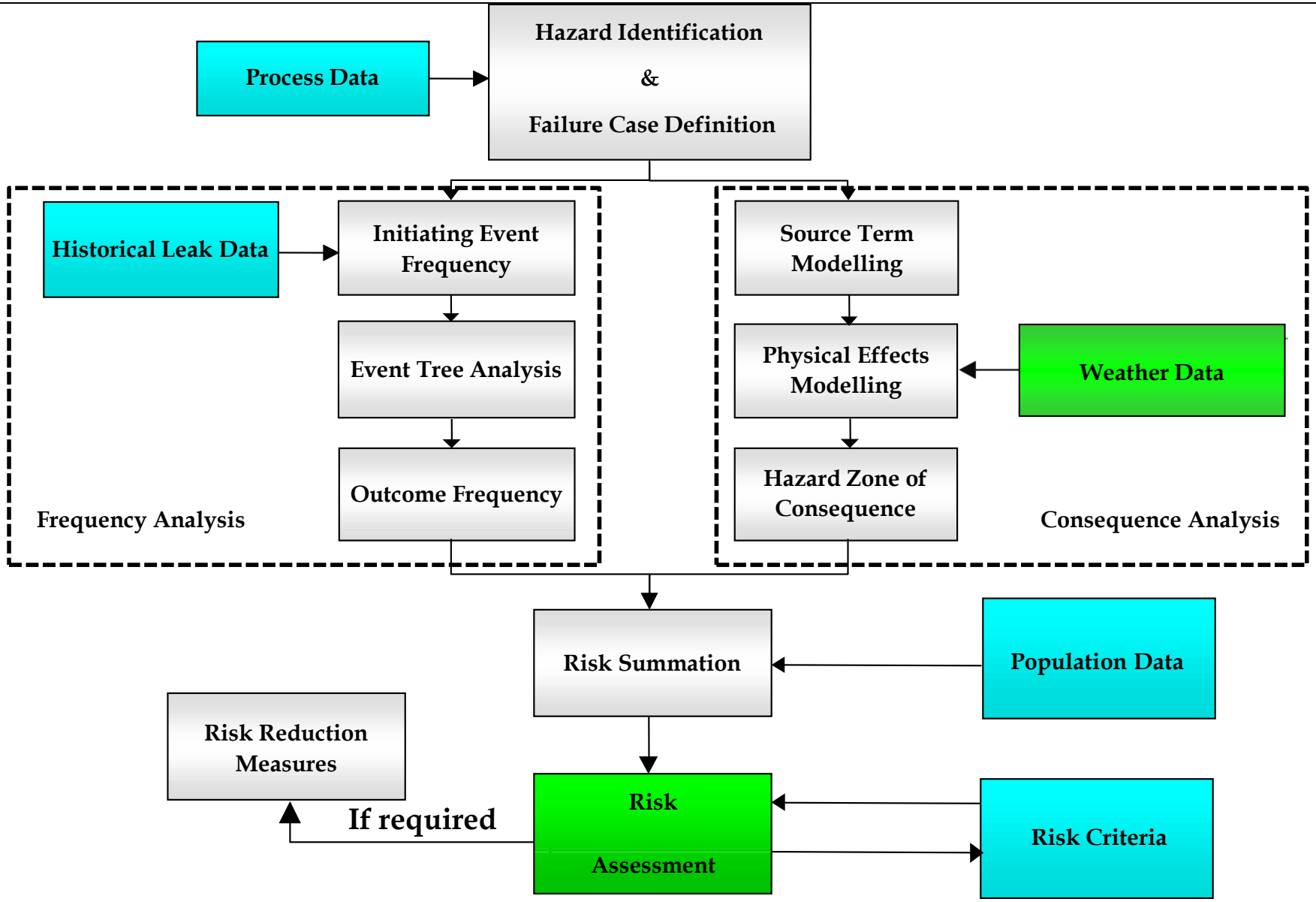


Figure: 2-1

Title: Quantitative Risk Assessment Methodology

Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon

RAMBOLL

Drawn by: VW

Checked by: SP

Rev.: 3

Date: Mar 2025

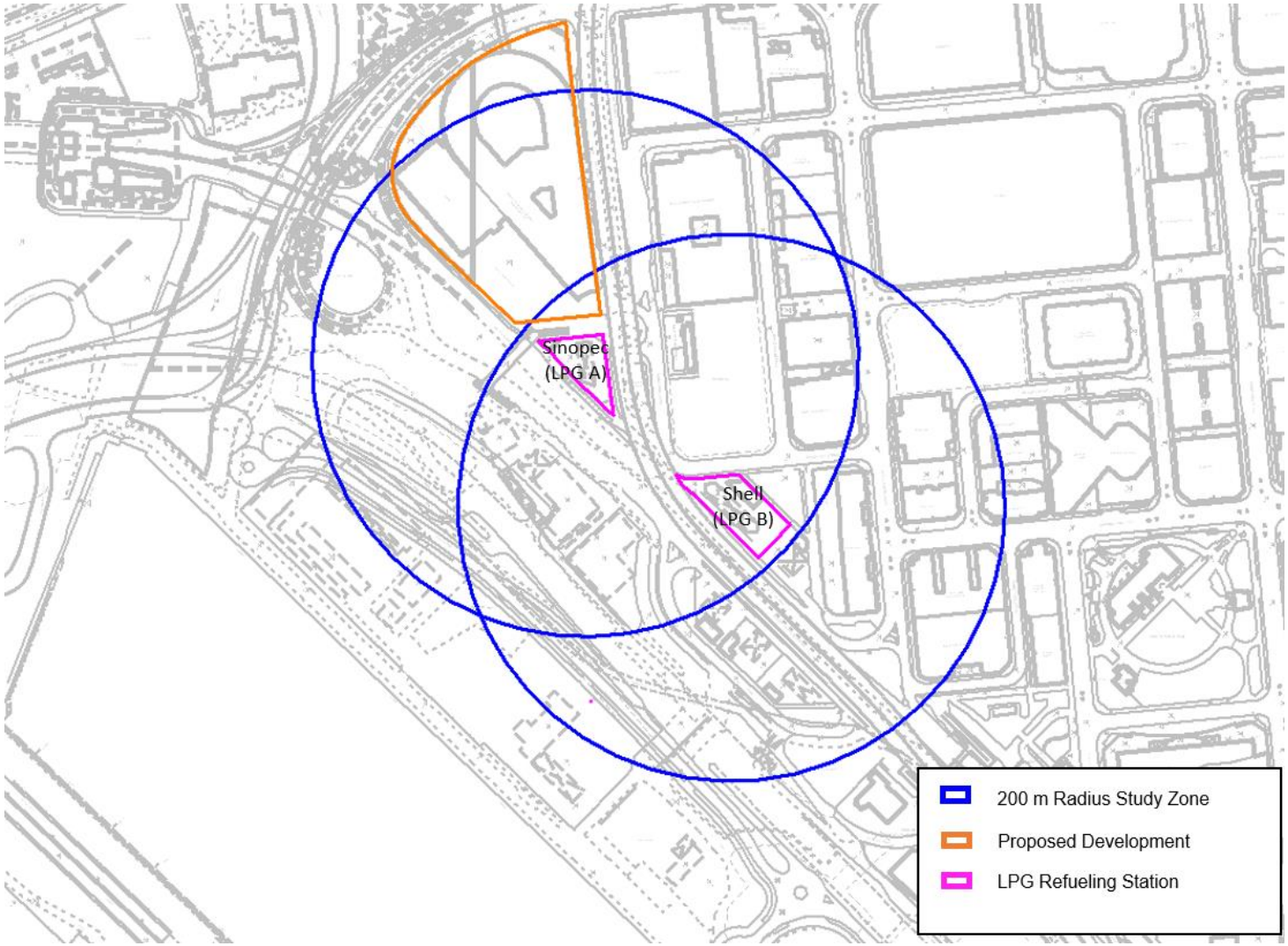


Figure: 3-1	RAMBOLL
Title: Location of the LPG Filling Stations	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

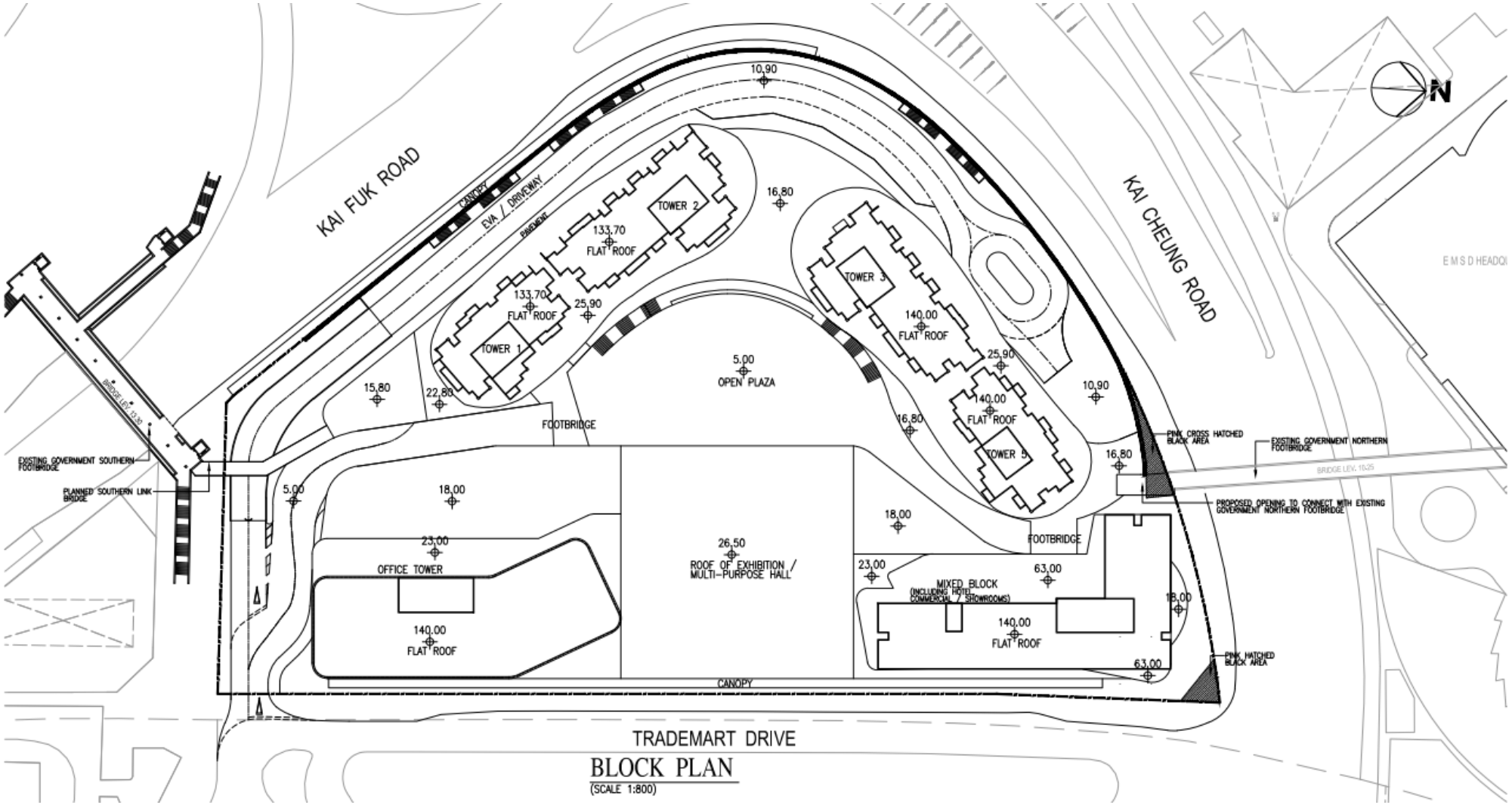
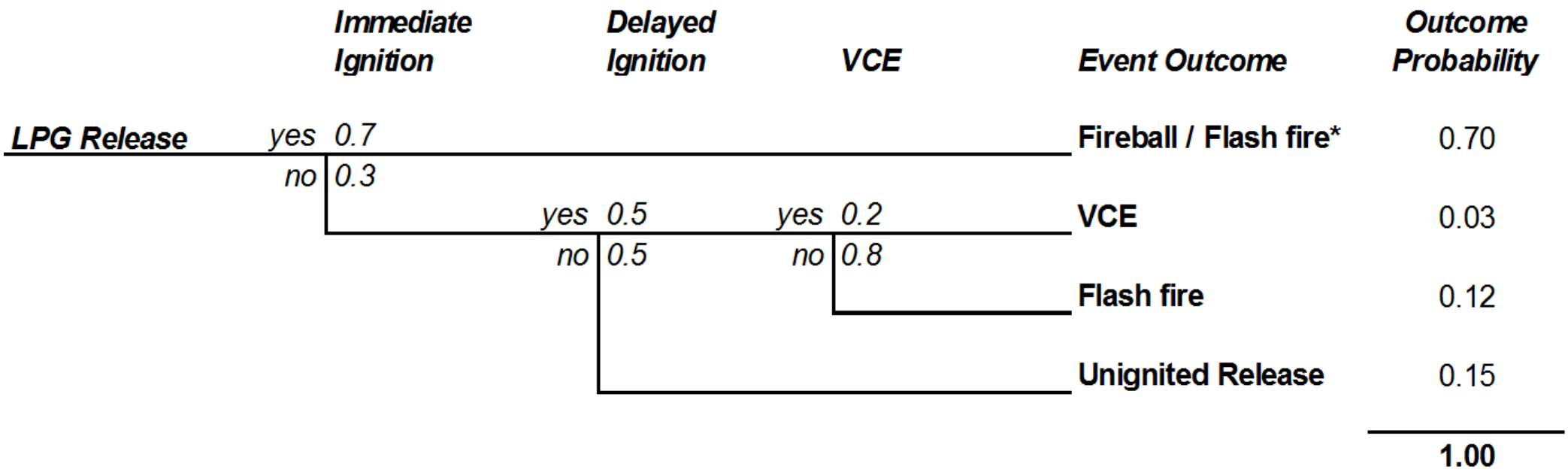


Figure: 4-1	RAMBOLL
Title: Layout of Proposed Development	Drawn by: VW
	Checked by: SP
Project: Proposed Residential (Flat), Social Welfare Facilities and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3
	Date: Mar 2025



*Fireball effects are negligible for the underground storage tank. Instead Flash Fire is considered.

Figure: 6-1	RAMBOLL
Title: Event Tree for Catastrophic Failure of LPG Storage Vessel	Drawn by: VW
	Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3
	Date: Mar 2025

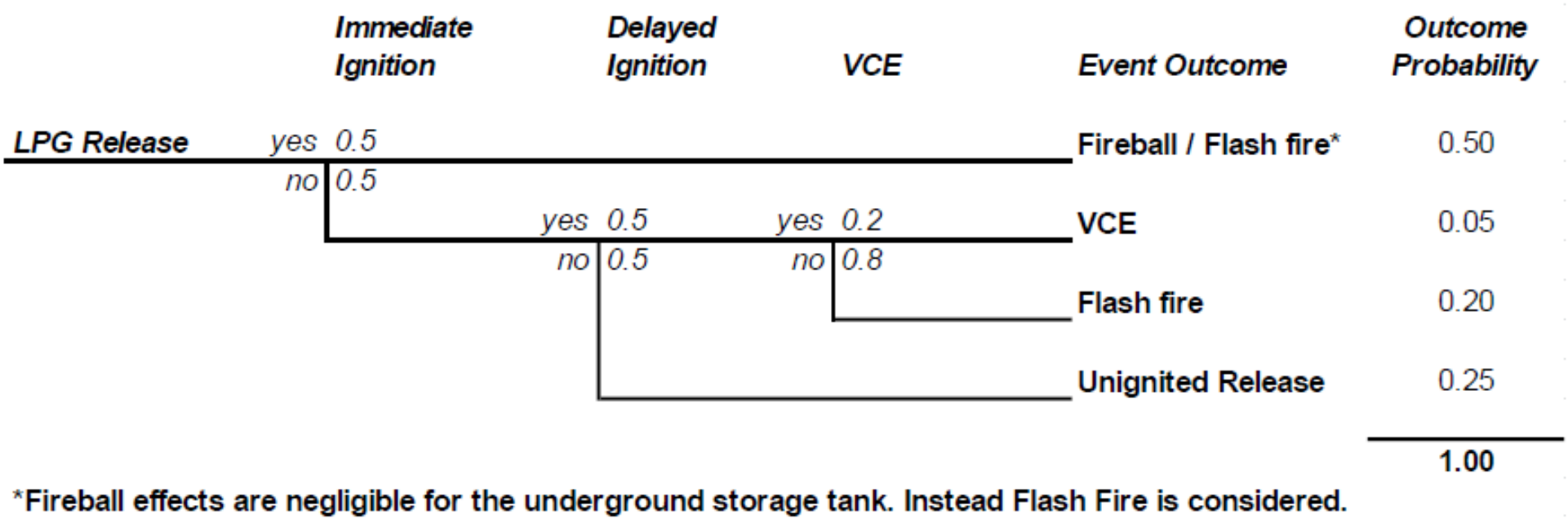


Figure: 6-2	RAMBOLL
Title: Event Tree for Catastrophic Failure of LPG Storage Vessel (60% Inventory)	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

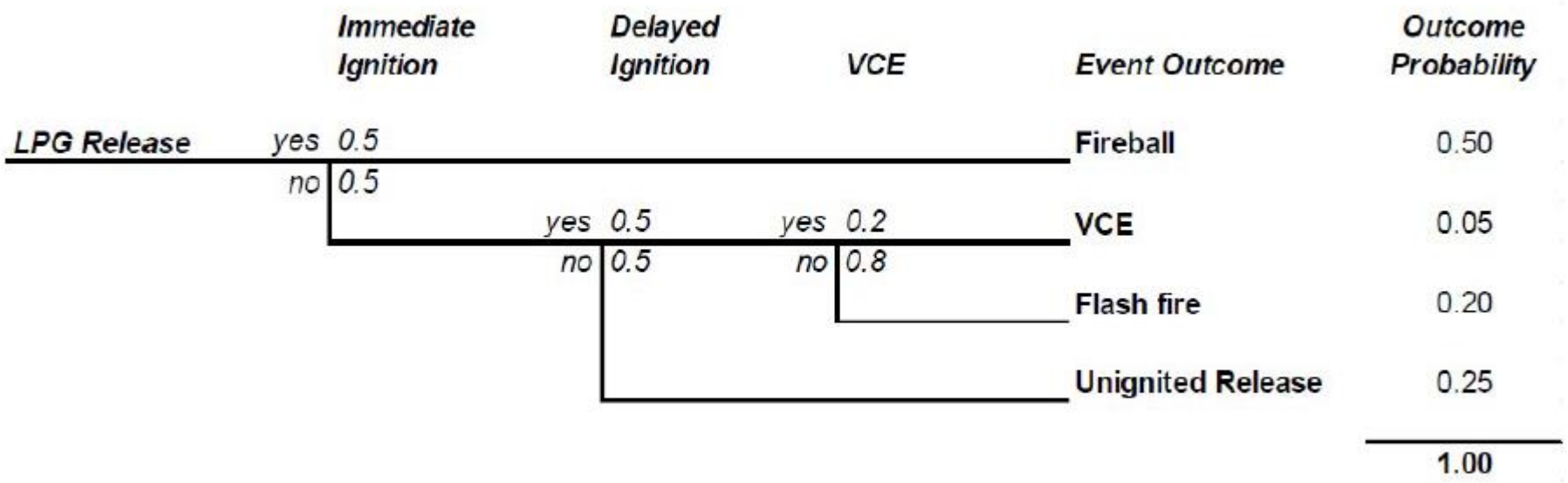


Figure: 6-3	RAMBOLL
Title: Event Tree for Catastrophic Failure of LPG Road Tankers	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

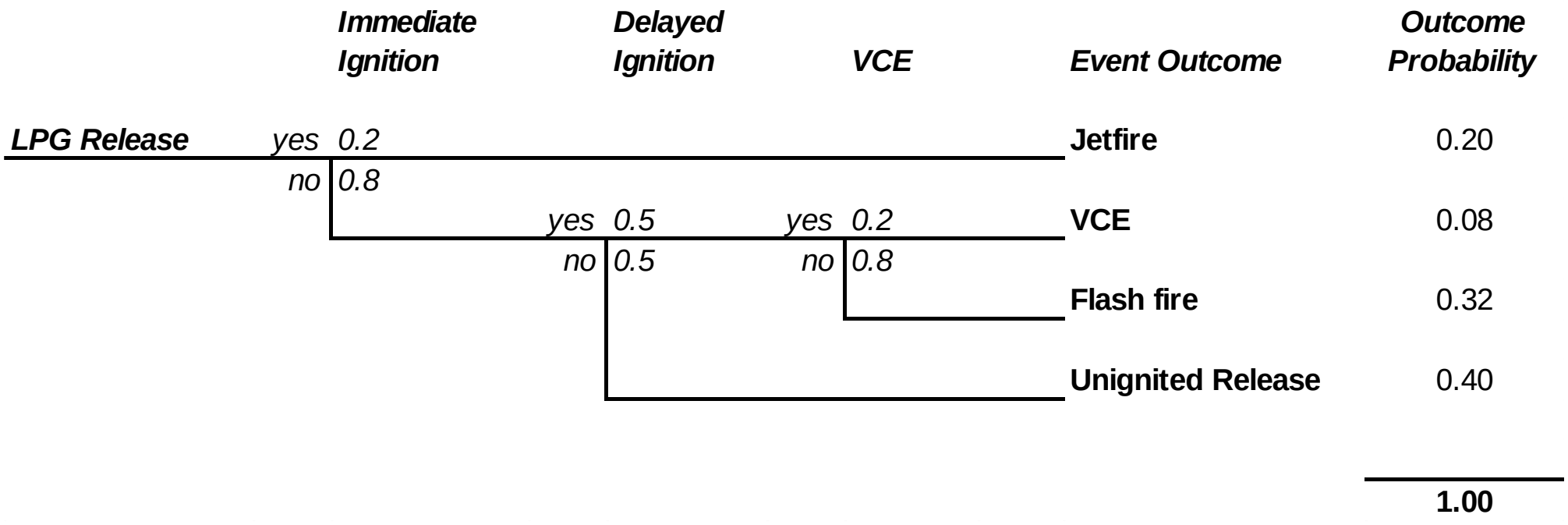


Figure: 6-4	RAMBOLL
Title: Event Tree for Partial Failure of LPG Storage Vessel	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

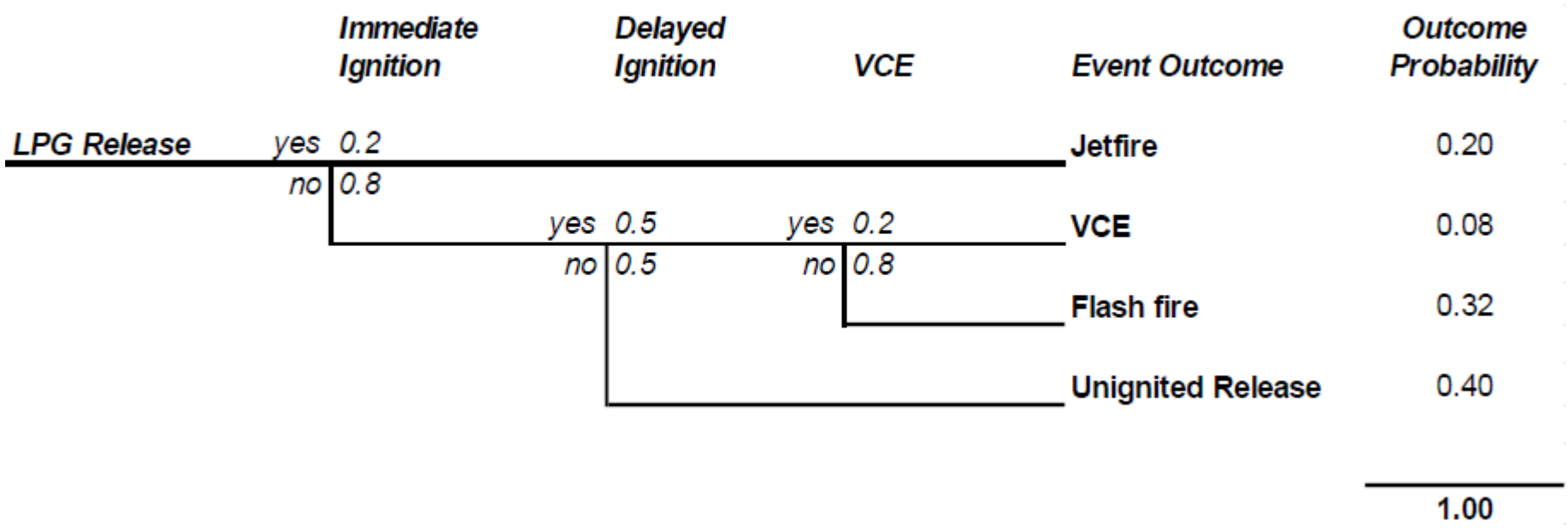


Figure: 6-5	RAMBOLL
Title: Event Tree for Partial Failure of LPG Road Tanker	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

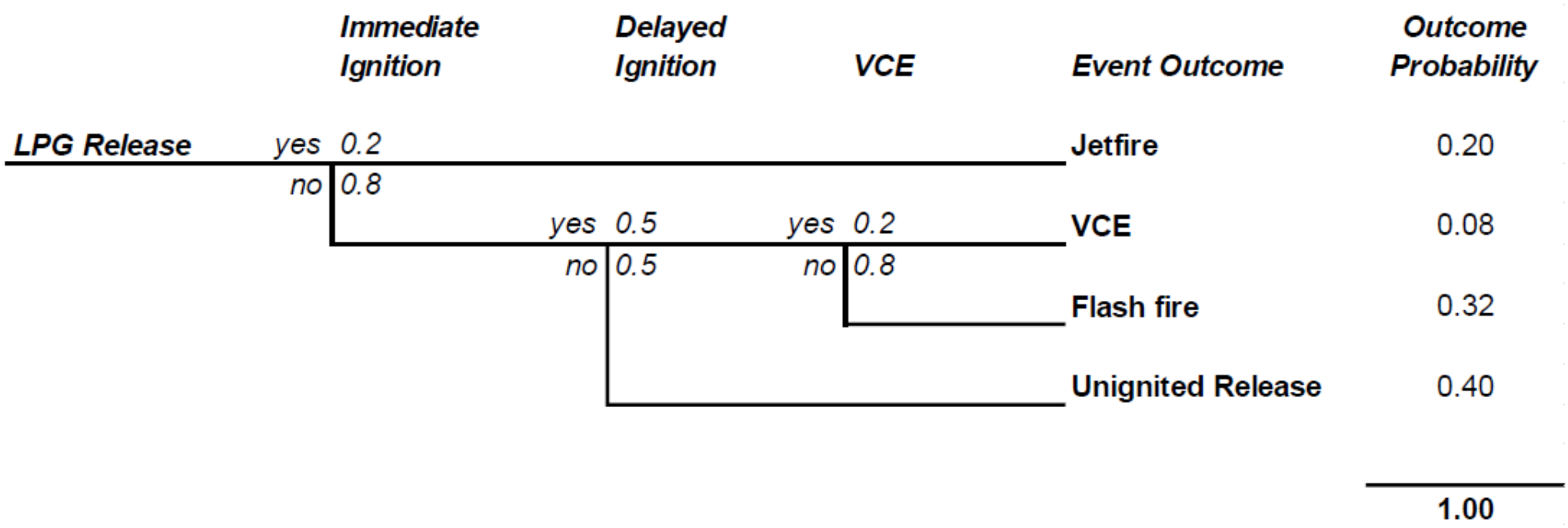
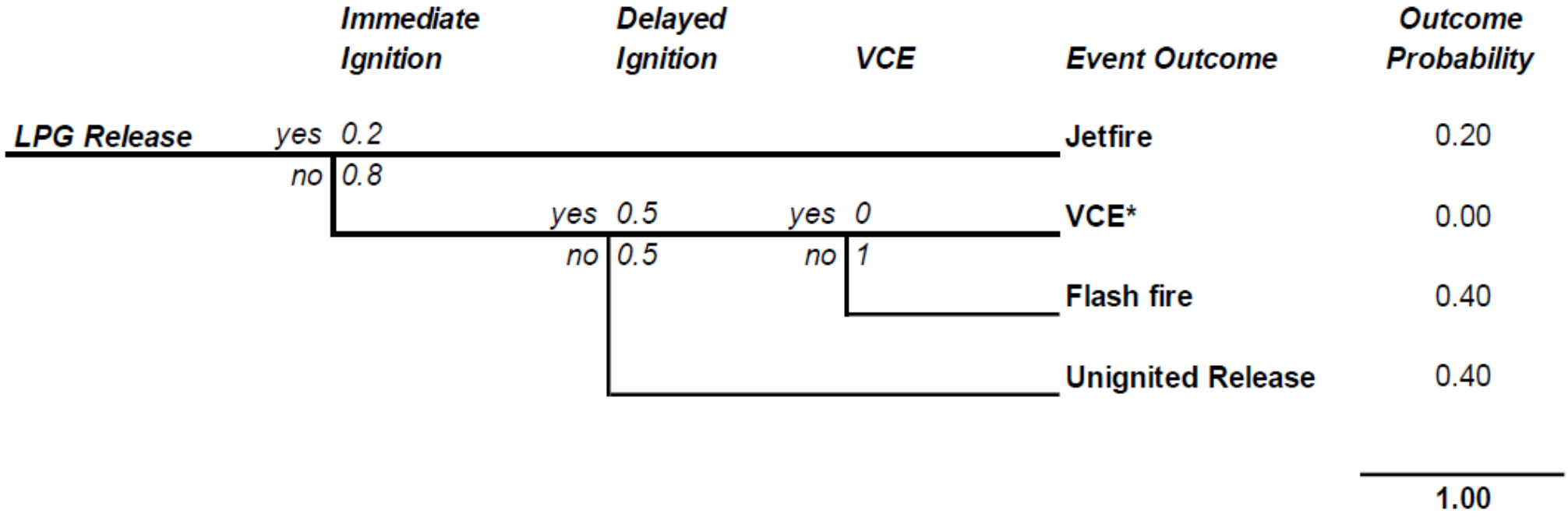
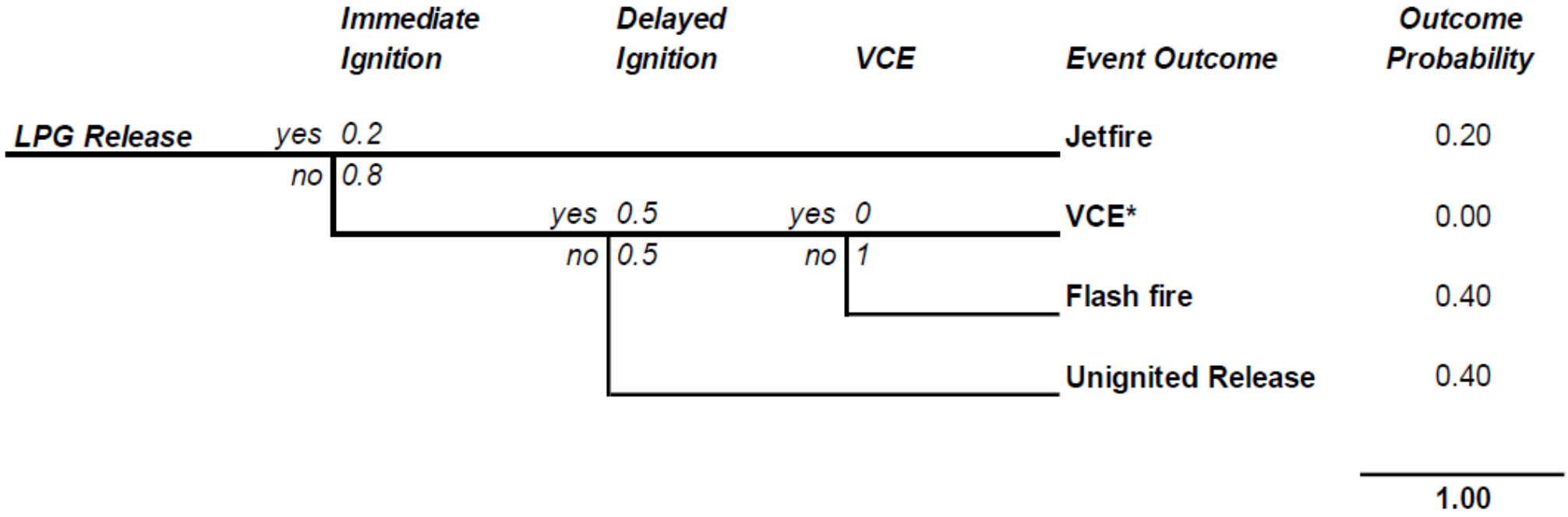


Figure: 6-6	RAMBOLL
Title: Event Tree for Guillotine Failure of Liquid Inlet Pipework and Flexible Hose of the Road Tanker and Submersible Pump Flange	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025



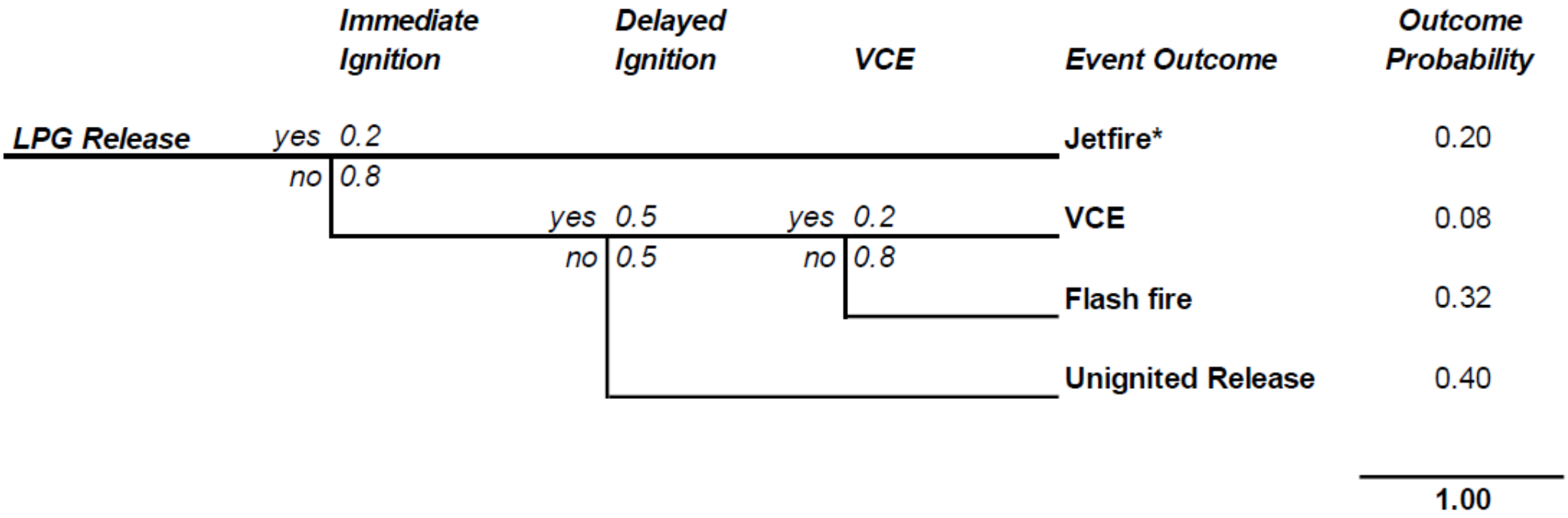
* VCE is not considered for a small release.

Figure: 6-7	RAMBOLL
Title: Event Tree for Partial Failure of Liquid Inlet Pipework and Flexible Hose of the Road Tanker and Submersible Pump Flange	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025



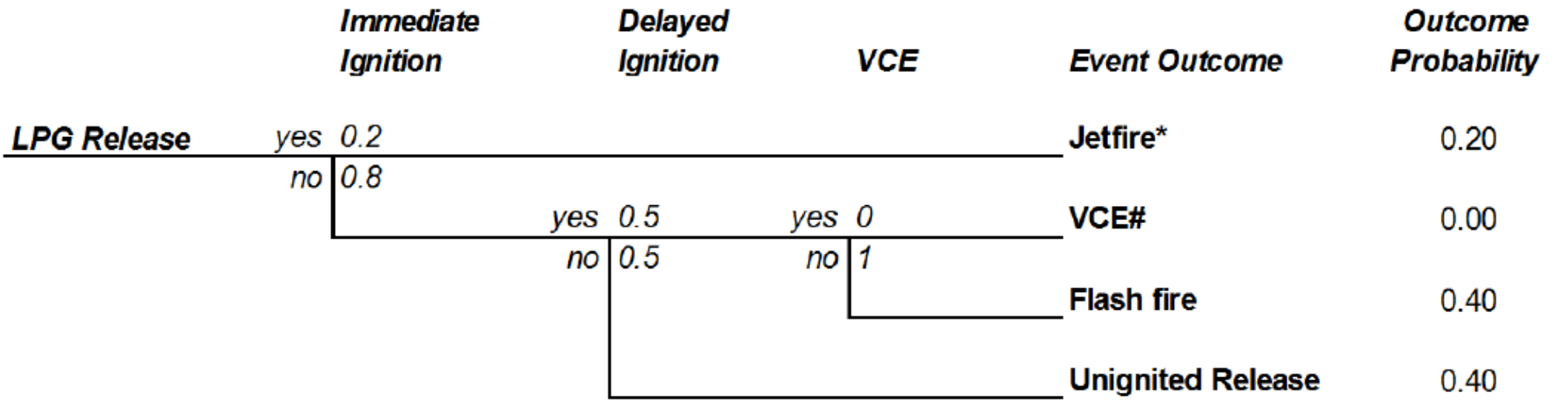
* VCE is not considered for a small release.

Figure: 6-8	RAMBOLL
Title: Event Tree for Failure of Dispenser and Flexible Hose of the Dispenser	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025



* Vertical Jetfire is considered for failure of the underground pipe.

Figure: 6-9	RAMBOLL
Title: Event Tree for Guillotine Failure of Liquid Supply Line to Dispenser	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025



* Vertical Jetfire is considered for failure of the underground pipe.
\# VCE is not considered for a small release.

Figure: 6-10	RAMBOLL
Title: Event Tree for Partial Failure of Liquid Supply Line to Dispenser	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

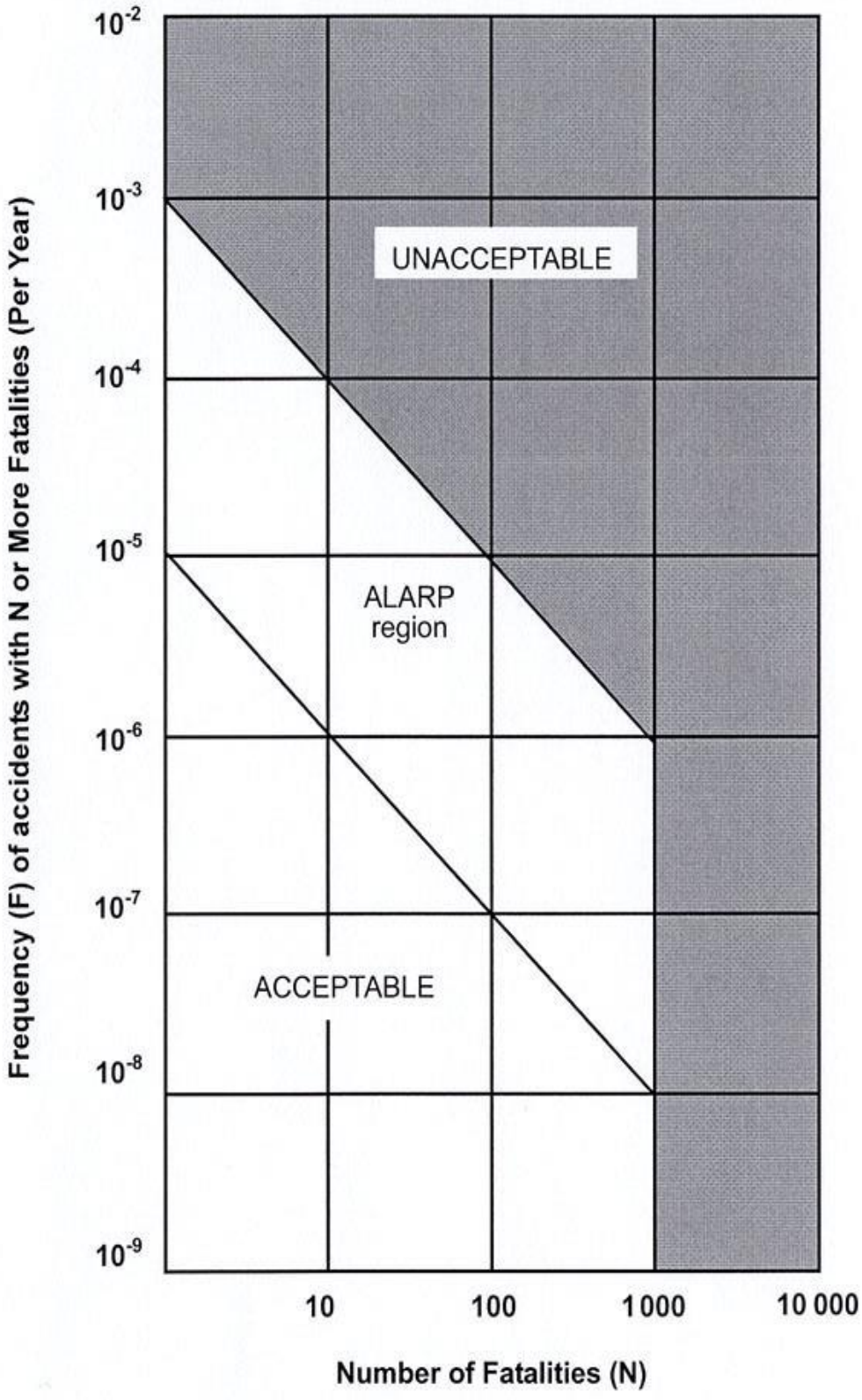


Figure: 8-1	RAMBOLL
Title: F-N Curves in comparison with Hong Kong Risk Guidelines	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

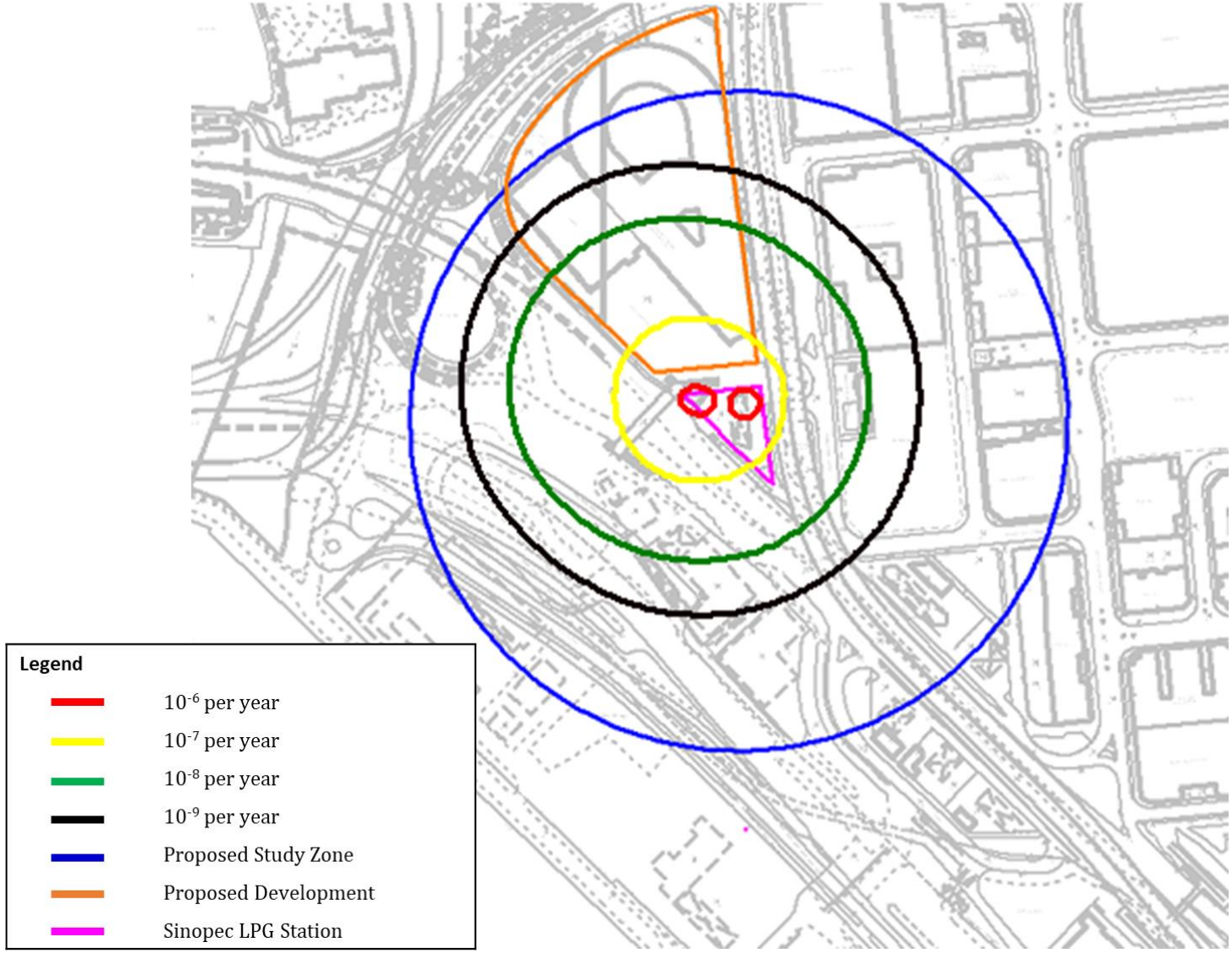


Figure: 8-2	RAMBOLL
Title: Location Specific Individual Risk Contours of the LPG Filling Station (LPG A Sinopec LPG Refueling Station)	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

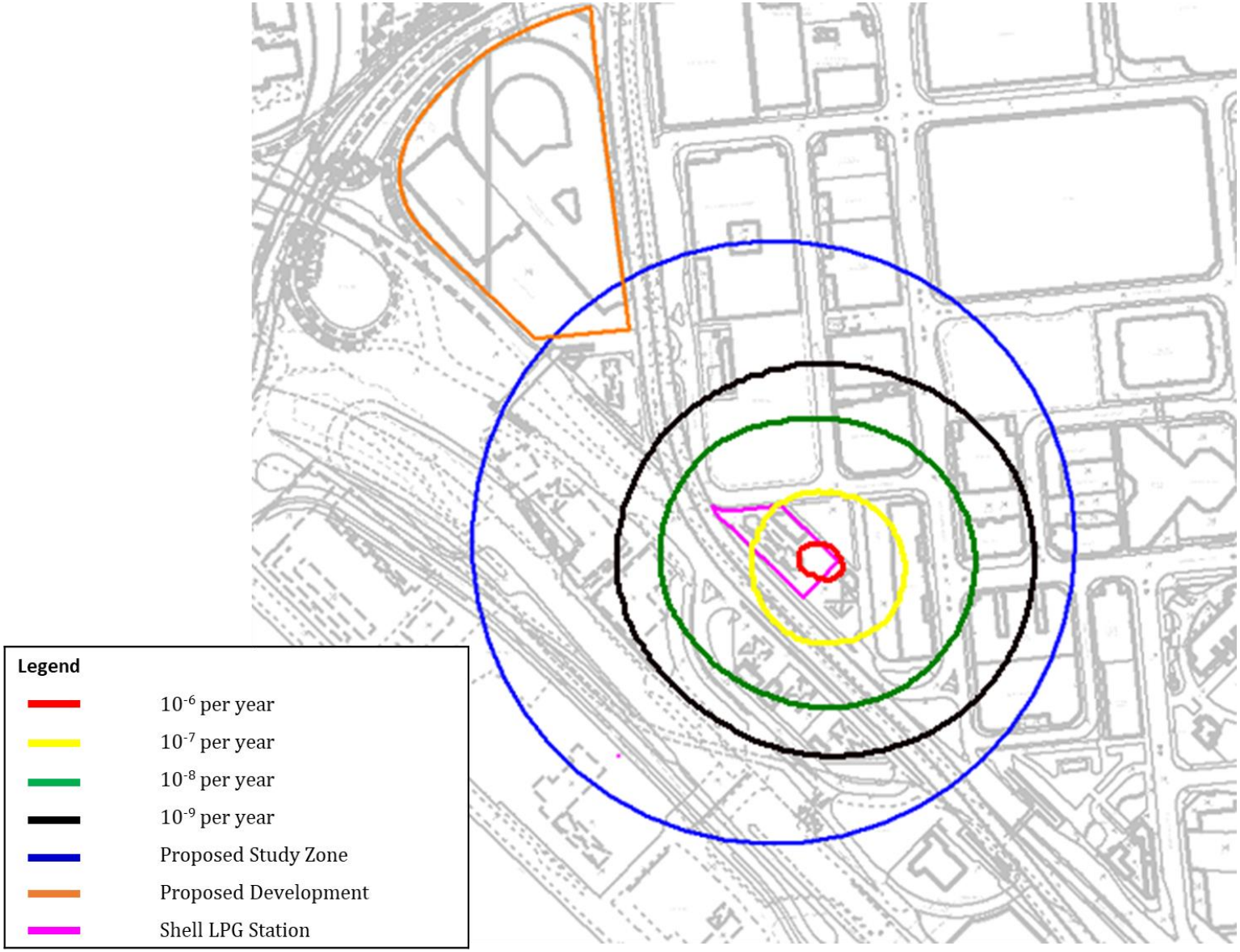


Figure: 8-3	RAMBOLL
Title: Location Specific Individual Risk Contours of the LPG Filling Station (LPG B Shell LPG Refueling Station)	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

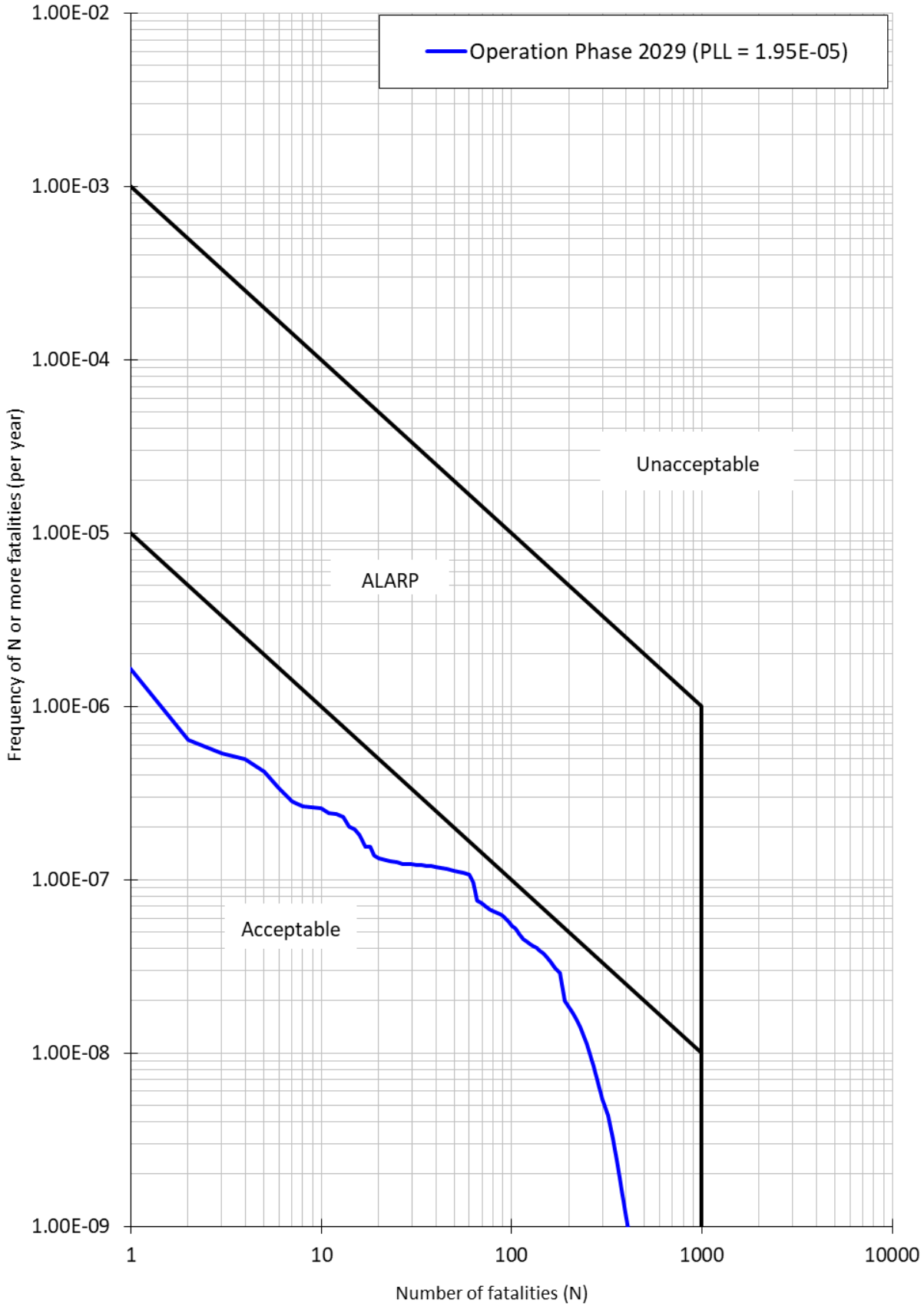


Figure: 8-4	RAMBOLL
Title: F-N Curves in comparison with Hong Kong Risk Guidelines (LPG A Sinopec LPG Refueling Station)	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

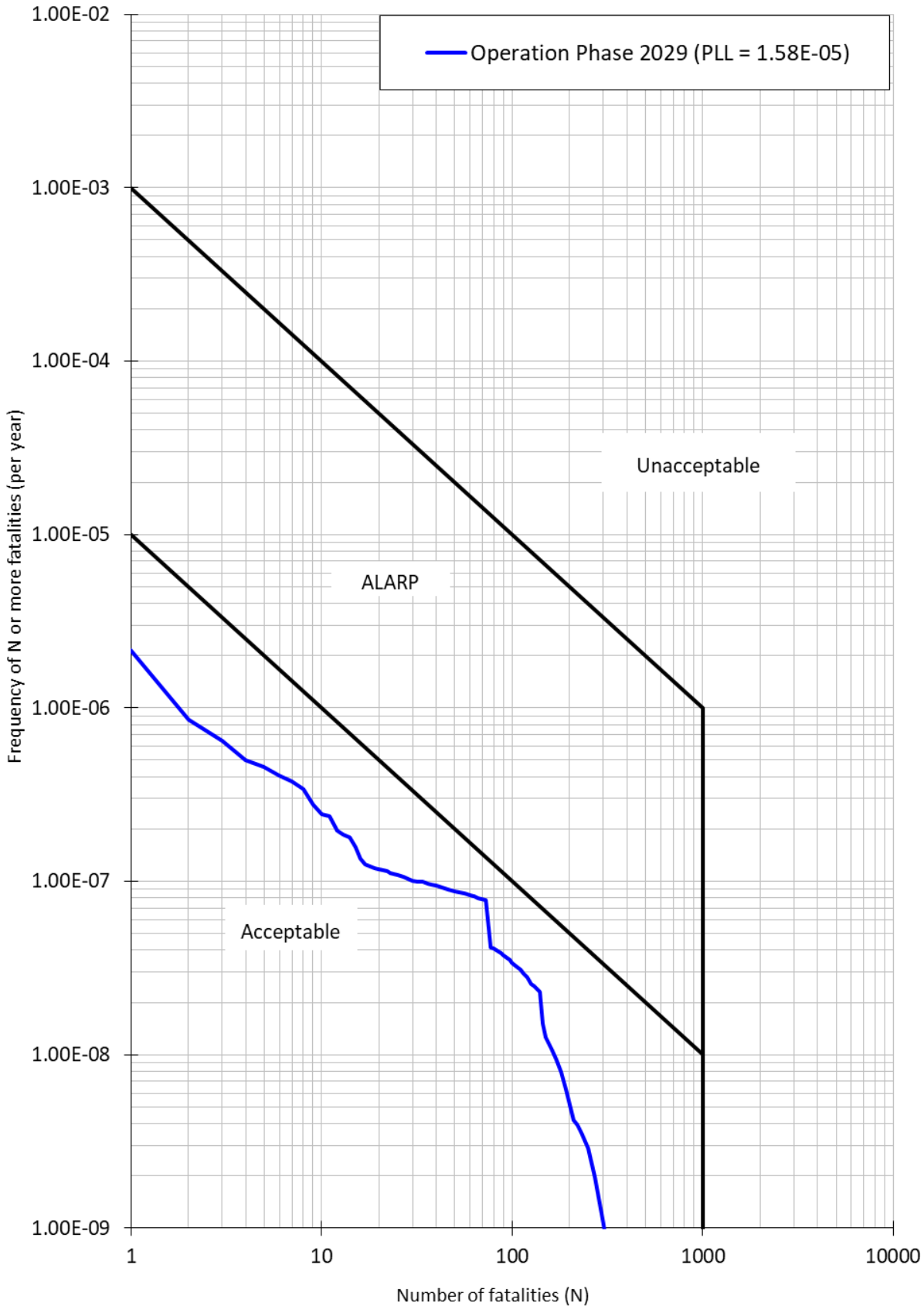


Figure: 8-5	RAMBOLL
Title: F-N Curves in comparison with Hong Kong Risk Guidelines (LPG B Shell LPG Refueling Station)	Drawn by: VW Checked by: SP
Project: Proposed Residential (Flat) and Permitted Commercial and Trade Mart Redevelopment with Minor Relaxation of Building Height Restriction, New Kowloon Inland Lot No. 6032, 1 Trademart Drive, Kowloon Bay, Kowloon	Rev.: 3 Date: Mar 2025

Appendix 4-1

Assumptions for this QRA Study

1.1 SURROUNDING DATA ANALYSIS

1.1.1 Meteorological Data

Assumption Number: 1.1.1

As per Appendix 4.B of "*Guidelines For Quantitative Risk Assessment, CPR 18E (Purple Book)*", at least six representative weather classes are recommended to be adopted in this QRA Study, covering the stability conditions of stable, neutral and unstable, low and high wind speed. At least the following six (6) weather classes have to be covered in terms of Pasquill classes.

Stability Class	Wind Speed (1)
B	Medium
D	Low
D	Medium
D	High
E	Medium
F	Low

(1): Low wind speed corresponding to 1 – 2 m s^{-1}
Medium wind speed corresponding to 3 – 5 m s^{-1}
High wind speed corresponding to 8 – 9 m s^{-1}

Several rules will be applied to classify the observations in the six weather classes:

1. Observations in the Pasquill stability classes A, A/B, B and B/C are grouped to class B while the wind speed of the weather class is equal to the average wind speed of the observations.

2. Observations in the Pasquill stability classes C, C/D, D are grouped to class D while the wind speed of the weather class is equal to the average wind speed of the observations. Wind speeds below 2.5 m s^{-1}, between 2.5 m s^{-1} and 6 m s^{-1} and above 6 m s^{-1} are classified as the wind speed categories low, medium and high respectively.

3. Observations in the Pasquill stability classes E and F are allocated on the basis of the wind speed. Wind speeds below 2.5 m s^{-1} and above 2.5 m s^{-1} are classified as weather classes F and E respectively. The wind speed in each weather class is equal to the average wind speed of the observations in the weather class.

Assumption Number: 1.1.1

The allocation of six (6) representative weather classes is shown in following figure.

Wind Speed	A	B	B/C	C	C/D	D	E	F
< 2.5 m s^{-1}	B medium			D low			F low	
2.5 – 6 m s^{-1}				D medium			E medium	
>6 m s^{-1}				D high				

Data available can be separated for night-time and daytime, in which case, the period of the day attributed to daytime should have the daytime and night-time statistics added correctly.

The mean temperature of 23.3°C and relative humidity of 78% recorded at the Hong Kong Observatory between years 1981–2010 were used in the modelling.

1.1.2 Surface Roughness

Assumption Number: 1.1.2

The roughness parameter reflects the average roughness over which cloud is dispersing. For consequence modelling conducted using *DNV Phast Risk*, a value of 50 cm should be selected representing a conditions of parkland, bushes, and numerous obstacles.

1.2 FREQUENCY ANALYSIS

1.2.1 Ignition Probability

Assumption Number: 1.2.1

Source		Ignition Probability
Continuous	**Instantaneous**	
< 10 kg s^{-1}	< 1,000 kg	0.2
10 – 100 kg s^{-1}	1,000 – 10,000 kg	0.5
> 100 kg s^{-1}	> 10,000 kg	0.7

A probability of 0.5 is assigned to delayed ignition, which may produce a flash fire or a VCE. The occurrence of a VCE requires an ignition of a dispersed gas cloud present in a confined or congested space. Given the relatively open nature of the surroundings of the Compound, an explosion probability of 0.2 is assumed in this QRA study.

1.2.2 Probability of Ignition for Ignition Sources

Assumption Number: 1.2.2

As per Appendix 4.A of "Guidelines For Quantitative Risk Assessment, CPR 18E (Purple Book)", the probability of ignition a time interval of one minute for a number of sources is listed as following table:

Source	Probability of Ignition in one minute
1. Point Source	
motor vehicle	0.4
flare	1.0
outdoor furnace	0.9
indoor furnace	0.45
outdoor boiler	0.45
indoor boiler	0.23
ship	0.5
ship transporting flammable materials	0.3
fishing vessel	0.2
pleasure craft	0.1
diesel train	0.4
electric train	0.8
2. Line Source	
transmission line	0.2 per 100 m
road	Note 1
railway	Note 1
3. Area Source	
chemical plant	0.9 per site
oil refinery	0.9 per site
heavy industry	0.7 per site
light industrial warehousing	as for population
4. Population Source	
residential	0.01 per person
employment force	0.01 per person

Note 1:
The ignition probability for a road or railway near the establishment or transport route under consideration is determined by the average traffic density. The average traffic density, d, is calculated as:
$d = NE/v$
where:
N: number of vehicles per hour (hr^{-1})
E: length of a road or railway selection (km)
v: average velocity of vehicle (km hr^{-1})

1.3 CONSEQUENCE ANALYSIS

1.3.1 Source Term Modelling

Assumption Number: 1.3.1

Most leak sources are at ground level or near ground level. Taking into account release source, 0 m and 1 m is considered a representative height for modelling underground facilities and aboveground facilities in this QRA study.

The averaging time considered for dispersion modelling is 18.75 seconds.

1.3.2 Fireball and BLEVE Effect

Assumption Number: 1.3.2

With regard to fireball, a 100% fatality is assumed for any person outdoors within the fireball radius.

1.3.3 Thermal Radiation of Fires

Assumption Number: 1.3.3

The following Probit equation is used to determine lethal doses for various fire scenarios:

$$Pr = -36.38 + 2.56 \times \ln(Q^{4/3} \times t)$$

where

Pr Probit corresponding to the probability of death (-)

Q heat radiation (W m^{-2})

t exposure time (s)

The exposure time, *t*, is limited to maximum of twenty (20) seconds.

1.3.4 Flash Fire Effect

Assumption Number: 1.3.4

With regard to flash fires, a 100% fatality is assumed for any person outdoors within the flash fire envelope. The extent of the flash fire is considered to be the distance to 100% of LFL.

1.3.5 Protection Factor

Assumption Number: 1.3.5

Protection factors are used to factor down the population so that only those exposed to hazardous scenarios are considered in the risk summation.

Protection for indoor population against thermal radiation and flash fire is considered by assuming that the indoor fatality rate is 10% of the outdoor fatality rate.

For persons within the fireball radius/ criteria zone, it was assumed that 50% of person would be killed and 50% indoor protection factor is applied in this QRA study.

Drainage Services Department, Harbour Area Treatment Scheme Stage 2A Environmental Impact Assessment, 2008.

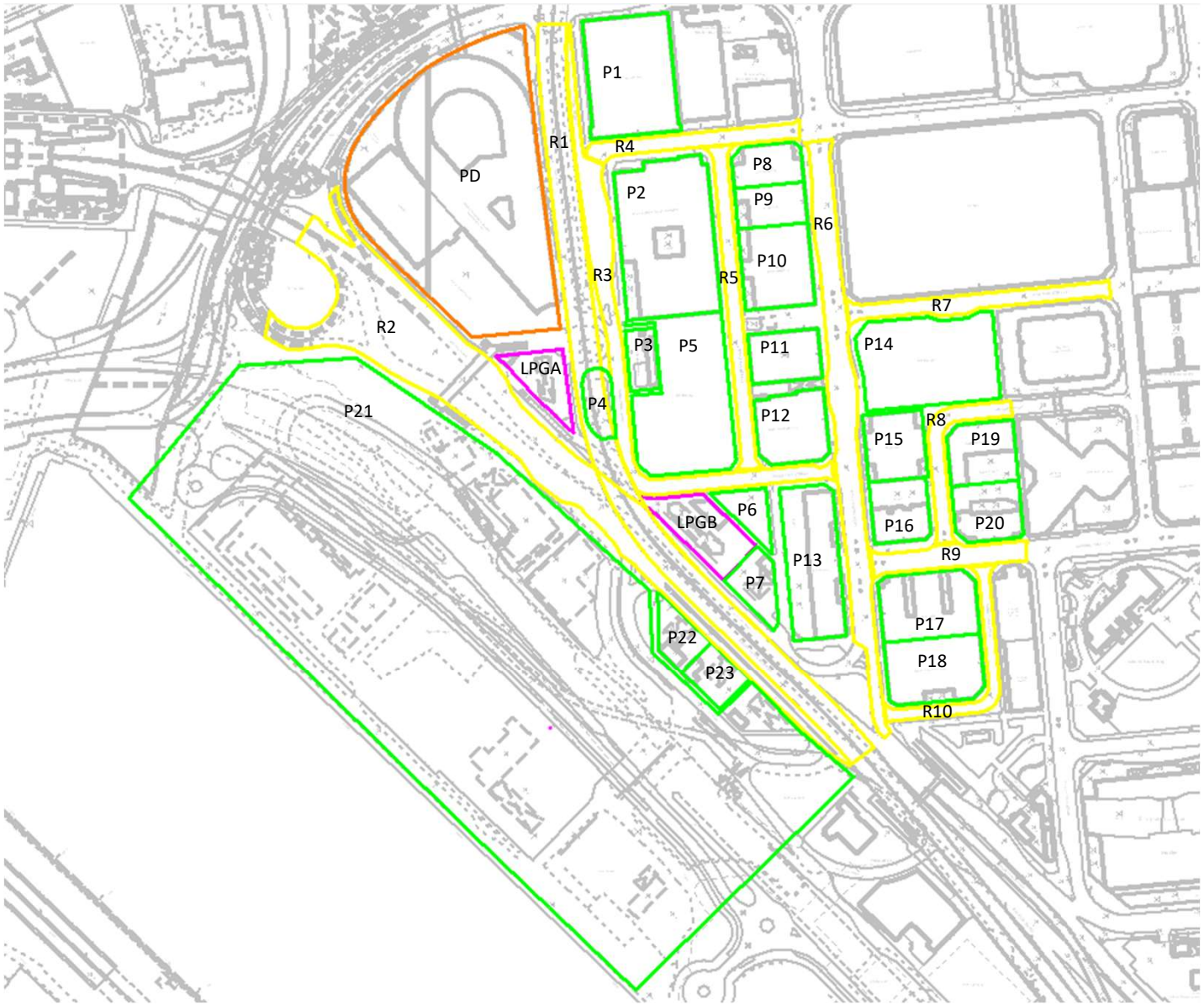
A.B. Reeves, F.C. Minah, V.H.K. Chow, Quantitative Risk Assessment Methodology for LPG Installations, Conference on Risk & Safety Management in the Gas Industry, EMSD&HKIE, Hong Kong, 1997.

Committee for the Prevention of Disasters, Guidelines for Quantitative Risk Assessment "Purple Book", CPR18E, 2005.

Appendix 4-2

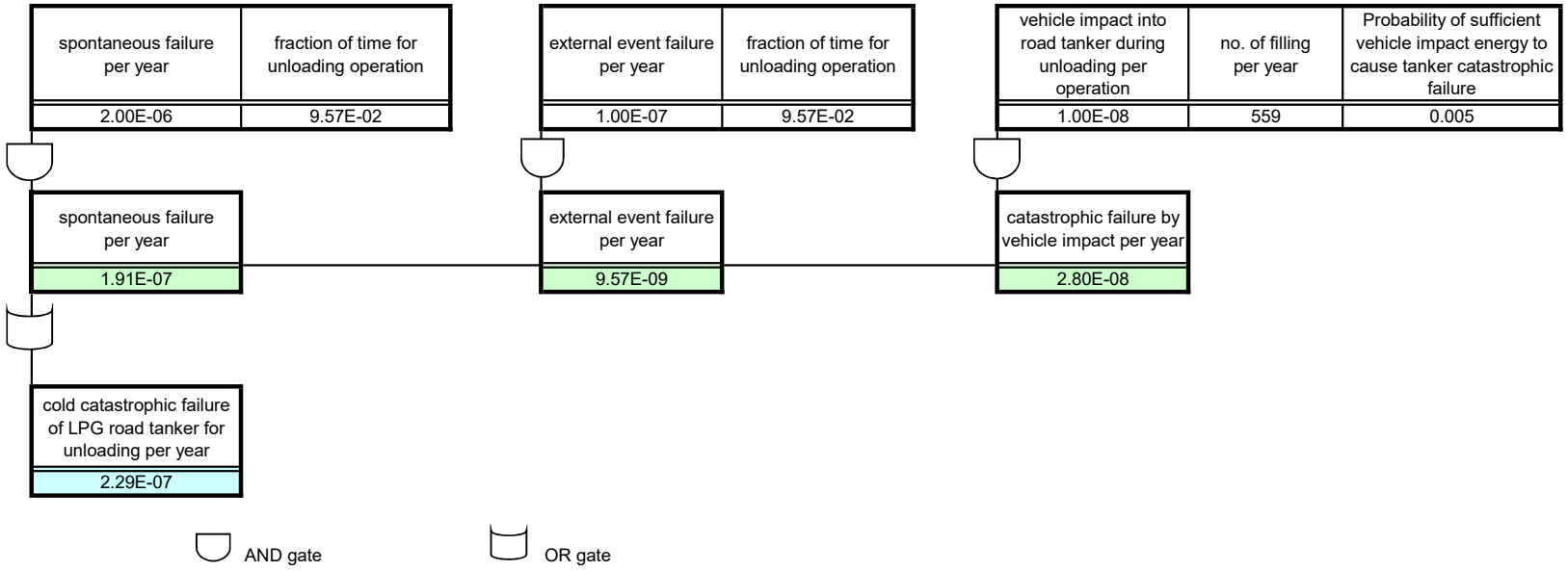
Off-site Population within Proposed Study Zone and Population Map

Ref	Name	2023 Base Case	2029 Operational Phase	Weekday Day	Weekend Day	Night	Fraction Indoors	No of Storeys	Remarks
LPGA	Sinopec LPG Station	18	18	15%	15%	1%	0%	1	It is based on the generic population assumption
LPGB	Shell LPG Station #1	18	18	15%	15%	1%	0%	1	It is based on the generic population assumption
P01	HSBC Building Kowloon Bay	200	200	100%	100%	10%	95%	5	It is based on the generic population assumption
P02	Hong Kong Post - Central Mail Centre	400	400	100%	100%	10%	95%	6	It is based on the generic population assumption
P03	Wang Chin Street Substation	0	0	100%	10%	10%	0%	1	It is based on the generic population assumption
P04	Carpark (under Kwun Tong Bypass)	4	4	70%	70%	10%	0%	0	It is based on the generic population assumption
P05	Business Building	1,274	1,274	100%	100%	10%	95%	10	It is based on EIA Study "Agreement No. CE 35/2006 (CE) Kai Tak Development Engineering Study cum Design and Construction of Advance Works – Investigation, Design and Construction"
P06	Construction Site 1 (Project: 0559744)	28	28	100%	100%	10%	20%	2	It is based on the information provided by client
P07	ESSO LPG Station #1	18	18	15%	15%	1%	0%	1	It is based on the generic population assumption
P08	Wing On Godown Building	288	288	100%	10%	10%	95%	7	It is based on the generic population assumption
P09	Camlux Hotel	370	370	50%	80%	90%	95%	7	It is based on the generic population assumption
P10	Jing Hin Industrial Building	288	288	100%	10%	10%	95%	5	It is based on the generic population assumption
P11	Legan Centre	200	200	100%	100%	10%	95%	6	It is based on the generic population assumption
P12	Kinetic Industrial Centre	288	288	100%	10%	10%	95%	7	It is based on the generic population assumption
P13	Billion Centre	400	400	100%	100%	10%	95%	35	It is based on the generic population assumption
P14	Lam Wah Street Playground	50	50	70%	100%	0%	0%	0	It is based on the generic population assumption
P15	Megacube	200	200	100%	100%	10%	95%	8	It is based on the generic population assumption
P16	YHC Tower	400	400	100%	100%	10%	95%	36	It is based on the generic population assumption
P17	Hong Leong Industrial Complex	288	288	100%	10%	10%	95%	8	It is based on the generic population assumption
P18	Kai Fuk Industrial Centre	288	288	100%	10%	10%	95%	7	It is based on the generic population assumption
P19	Corporation Square	400	400	100%	100%	10%	95%	16	It is based on the generic population assumption
P20	Enterprise Square Two	400	400	100%	100%	10%	95%	26	It is based on the generic population assumption
P21	Planned Commercial use	100	16,000	100%	100%	10%	95%	10	Derived based on worker density in Section 8, Ch5 of the HKPSG, plot ratio (5.8/8.0) and site areas (37,954m2/ 13,471m2) based on comments from Planning Department
P22	ESSO LPG Station #2	18	18	15%	15%	1%	0%	1	It is based on the generic population assumption
P23	Shell LPG Station #2	18	18	15%	15%	1%	0%	1	It is based on the generic population assumption
PD	Proposed Development	7,649	9,559	50%	80%	100%	95%	36	2023 base case population refers to the approved S.16 (A/K22/34); 2029 population provided by client
R01	Kwun Tong Bypass	97	102	100%	100%	20%	0%	0	It is based on site visit and ATC2022. No pedestrain was assumed along R01 (Kwun Tong Bypass). The parameters for traffic population are listed below: AADT: 69540; Distance: 0.59 km; Speed: 80 km/hr; and average occupancy: 2.7 people/vehicle
R02	Kai Fuk Road	207	218	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R02 (Kai Fuk Road). The parameters for traffic population are listed below: AADT: 68320; Distance: 0.73 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R03	Trademart Drive	21	21	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R03 (Trademart Drive). The parameters for traffic population are listed below: AADT: 367.6; Distance: 0.47 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R04	Wang Chin Street	22	22	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R04 (Wang Chin Street). The parameters for traffic population are listed below: AADT: 1838; Distance: 0.15 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R05	Wang Kee Street	22	22	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R05 (Wang Kee Street). The parameters for traffic population are listed below: AADT: 1838; Distance: 0.23 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R06	Wang Kwong Street	35	36	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R06 (Wang Kwong Street). The parameters for traffic population are listed below: AADT: 9190; Distance: 0.42 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R07	Lam Wah Street	22	22	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R07 (Lam Wah Street). The parameters for traffic population are listed below: AADT: 1838; Distance: 0.19 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R08	Lam Lok Street	21	22	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R08 (Lam Lok Street). The parameters for traffic population are listed below: AADT: 1838; Distance: 0.14 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R09	Sheung Yuet Road	21	21	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R09 (Sheung Yuet Road). The parameters for traffic population are listed below: AADT: 1838; Distance: 0.11 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle
R10	Wang Tung Street	22	22	100%	100%	20%	0%	0	It is based on site visit and ATC2022. 20 pedestrain was assumed along R10 (Wang Tung Street). The parameters for traffic population are listed below: AADT: 1838; Distance: 0.17 km; Speed: 50 km/hr; and average occupancy: 2.7 people/vehicle

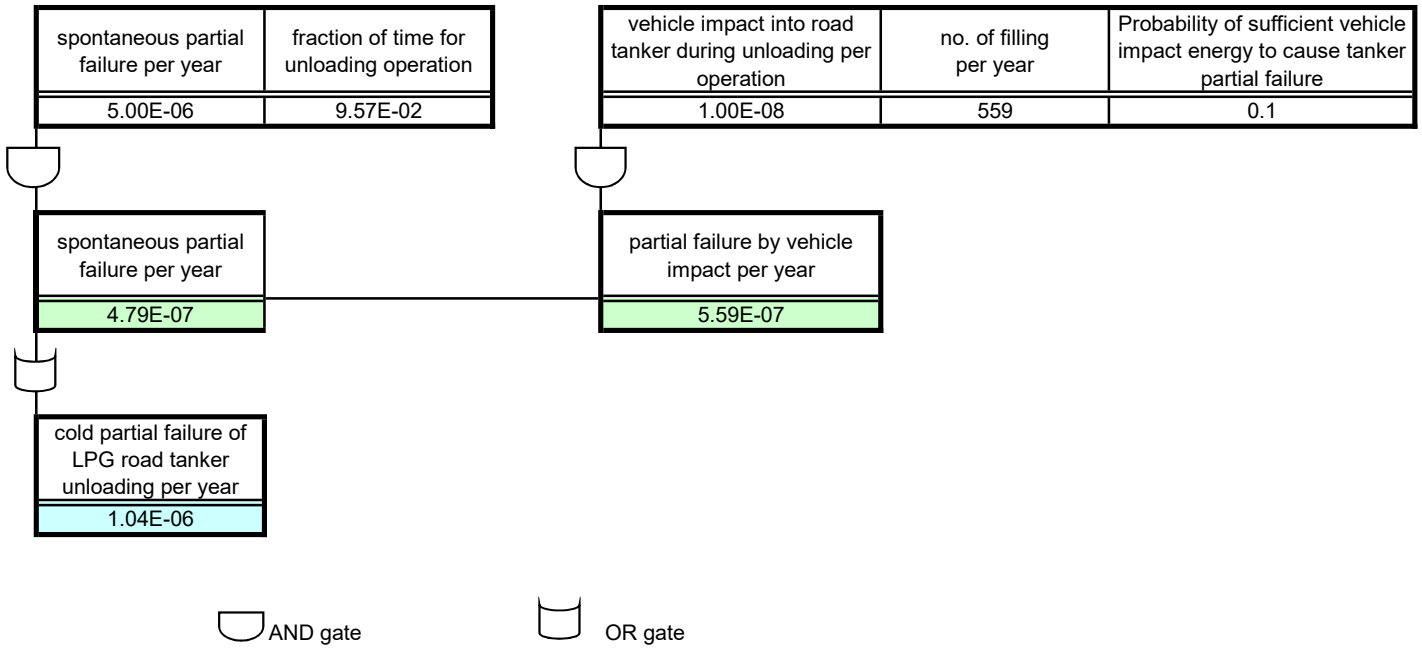

P1
R1
R4
PD
P2
P8
P9
R6
P10
R3
R5
R7
R2
P3
P5
P11
P14
LPGA
P4
P12
R8
P21
P15
P19
P6
LPGB
P16
P20
R9
P13
P7
P17
P22
P18
P23
R10

Appendix 6-1

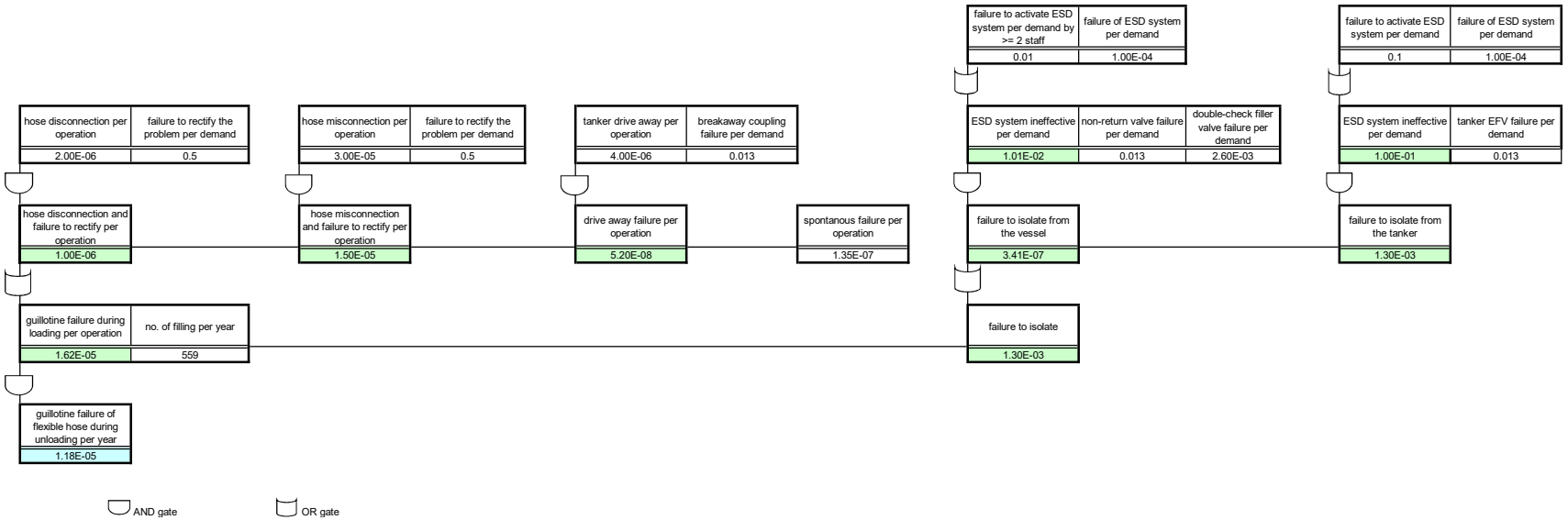
Fault Tree Analysis (LPG A Sinopec Filling Station)



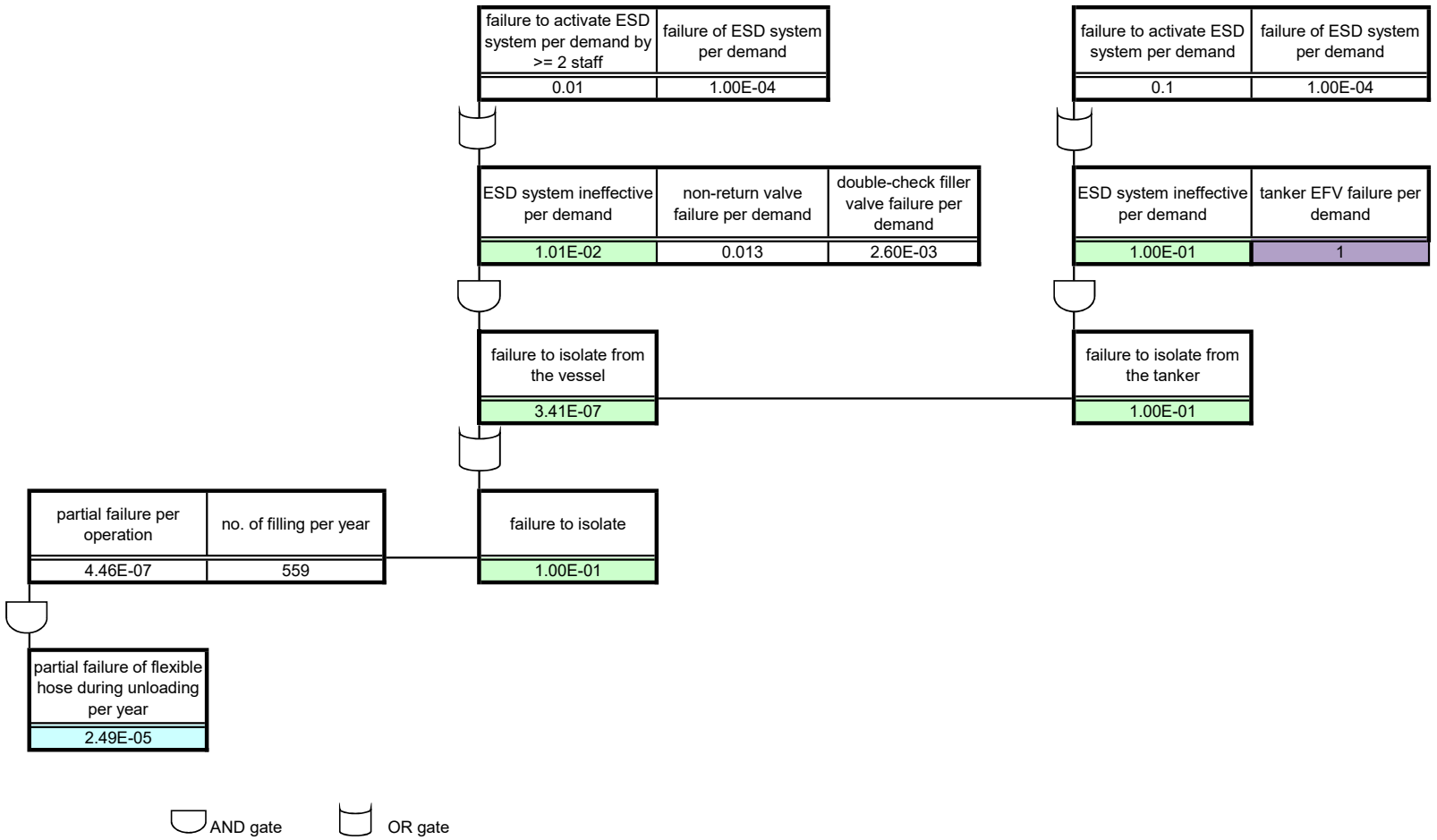
Cold Catastrophic failure of Road Tanker (LPG Filling Station)



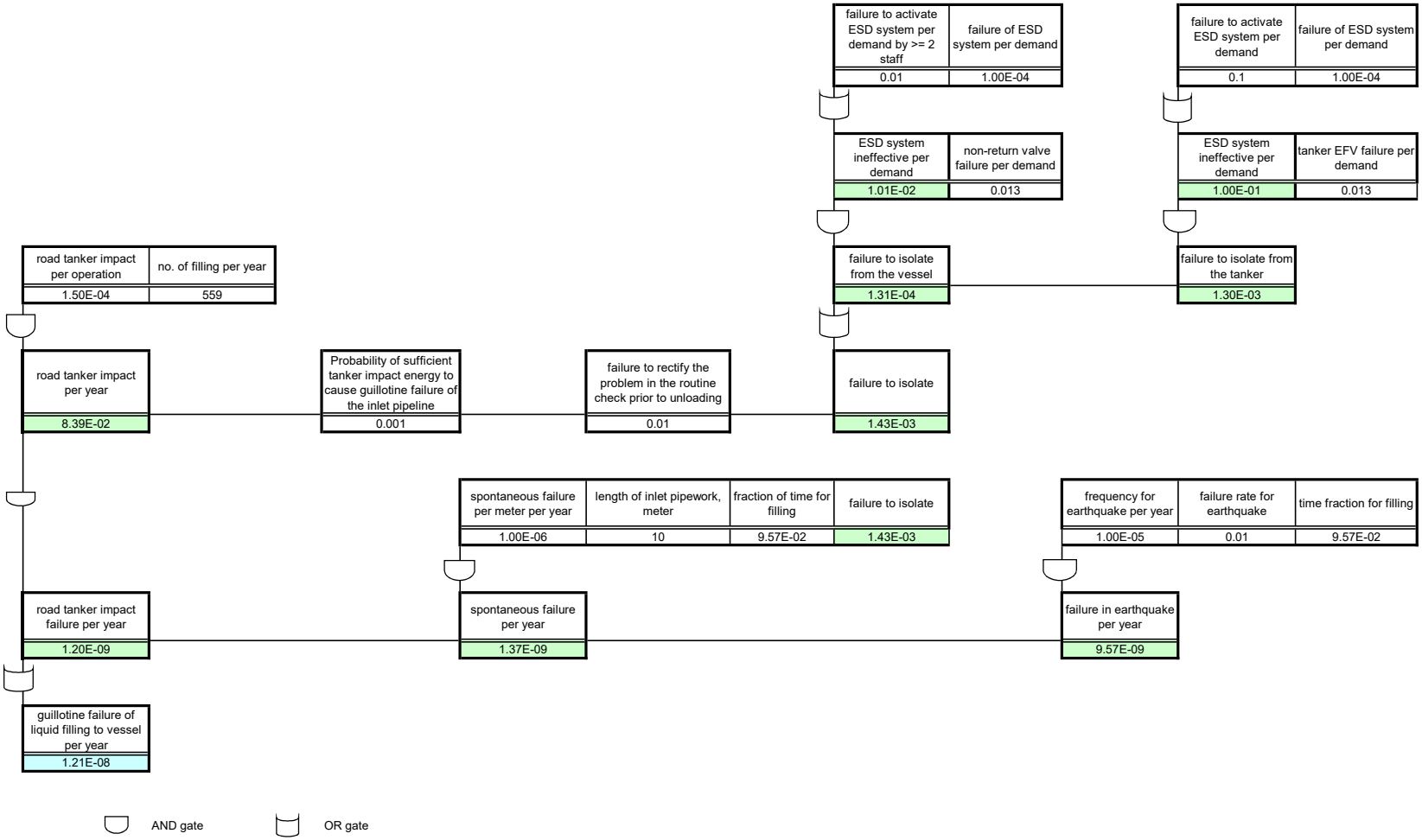
Partial failure of Road Tanker (LPG Filling Station)



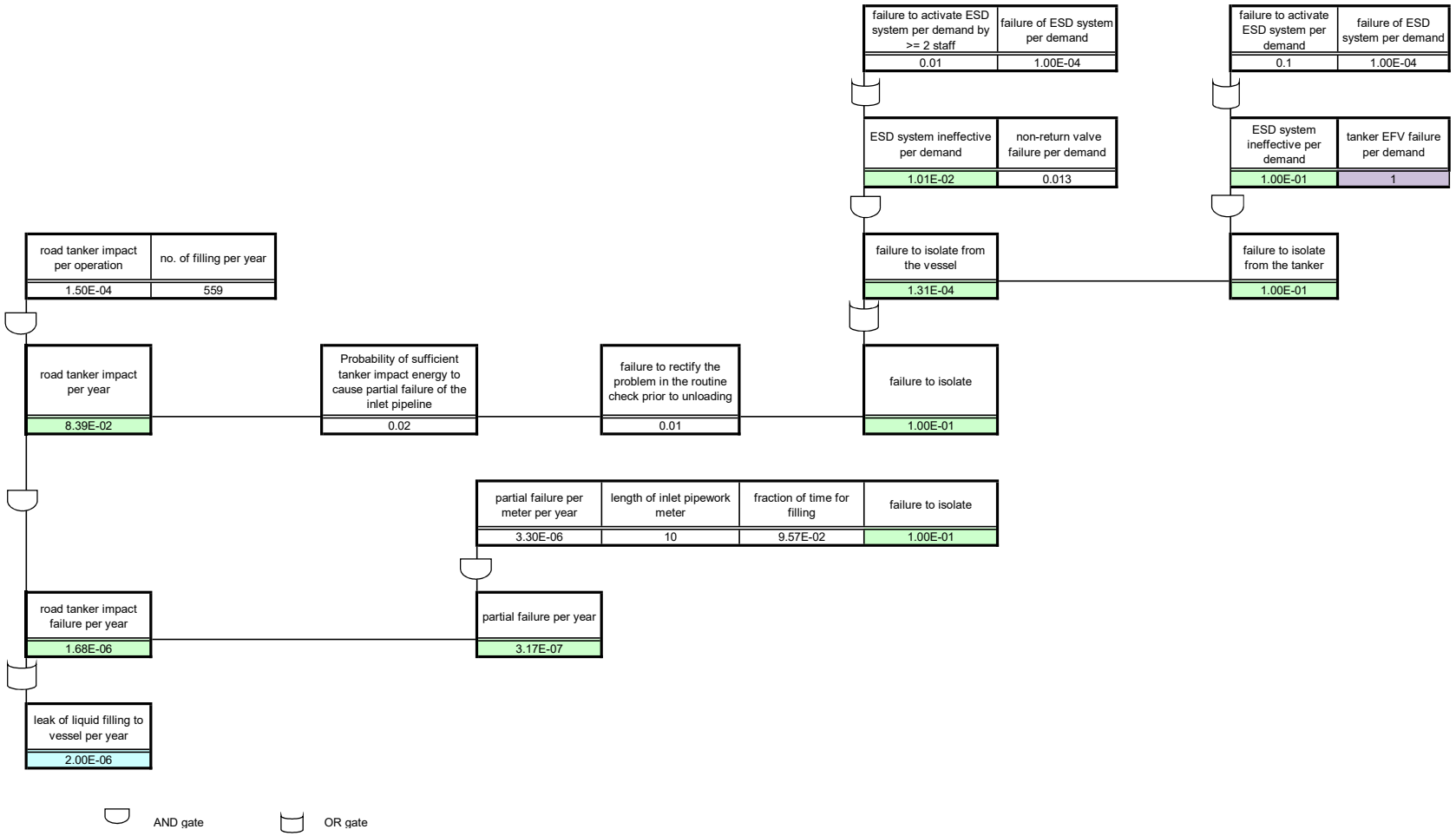
Guillotine failure of Flexible Hose during Unloading to the LPG vessel (LPG Filling Station)



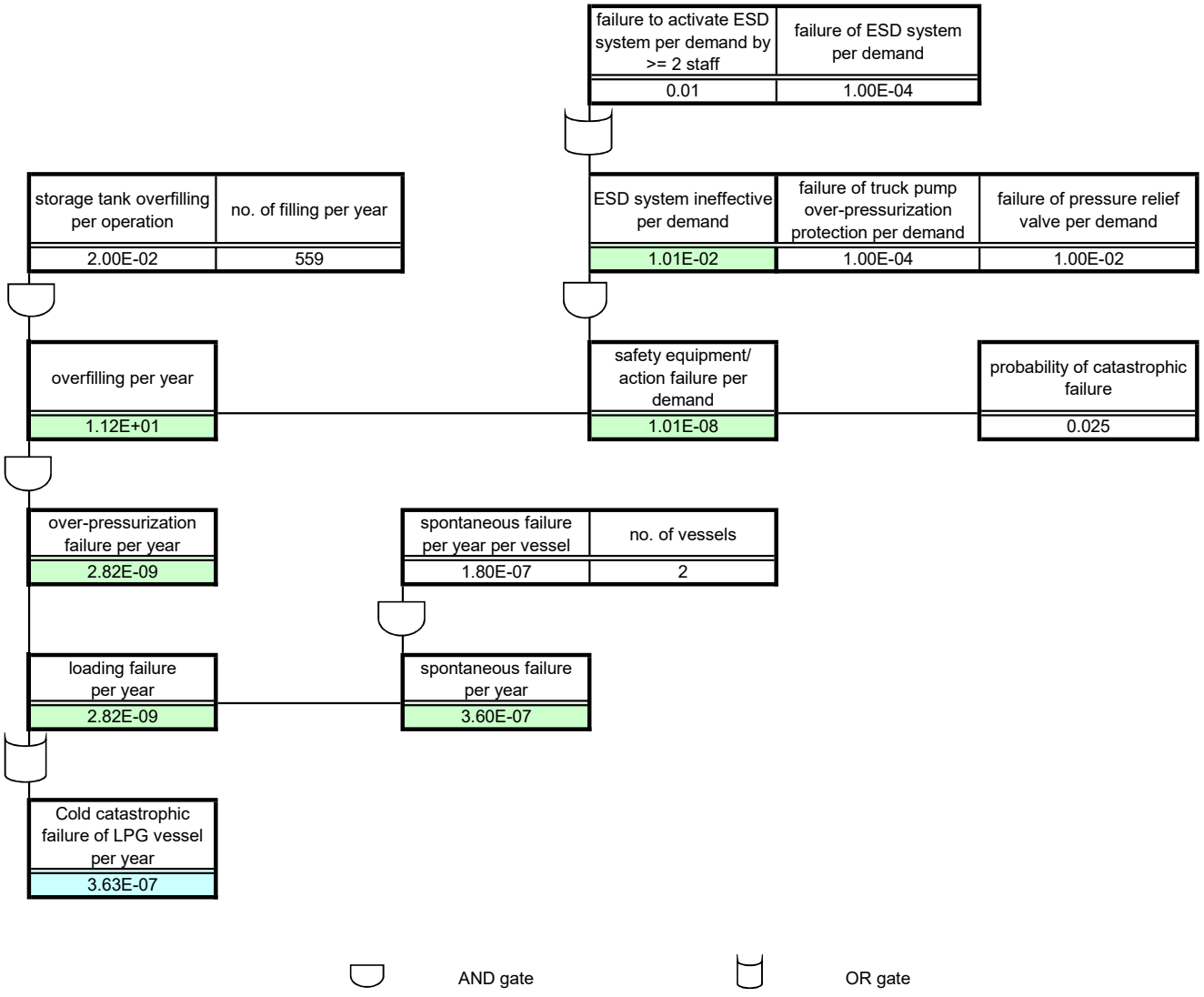
Partial failure of Flexible Hose during Unloading to the LPG vessel (LPG Filling Station)



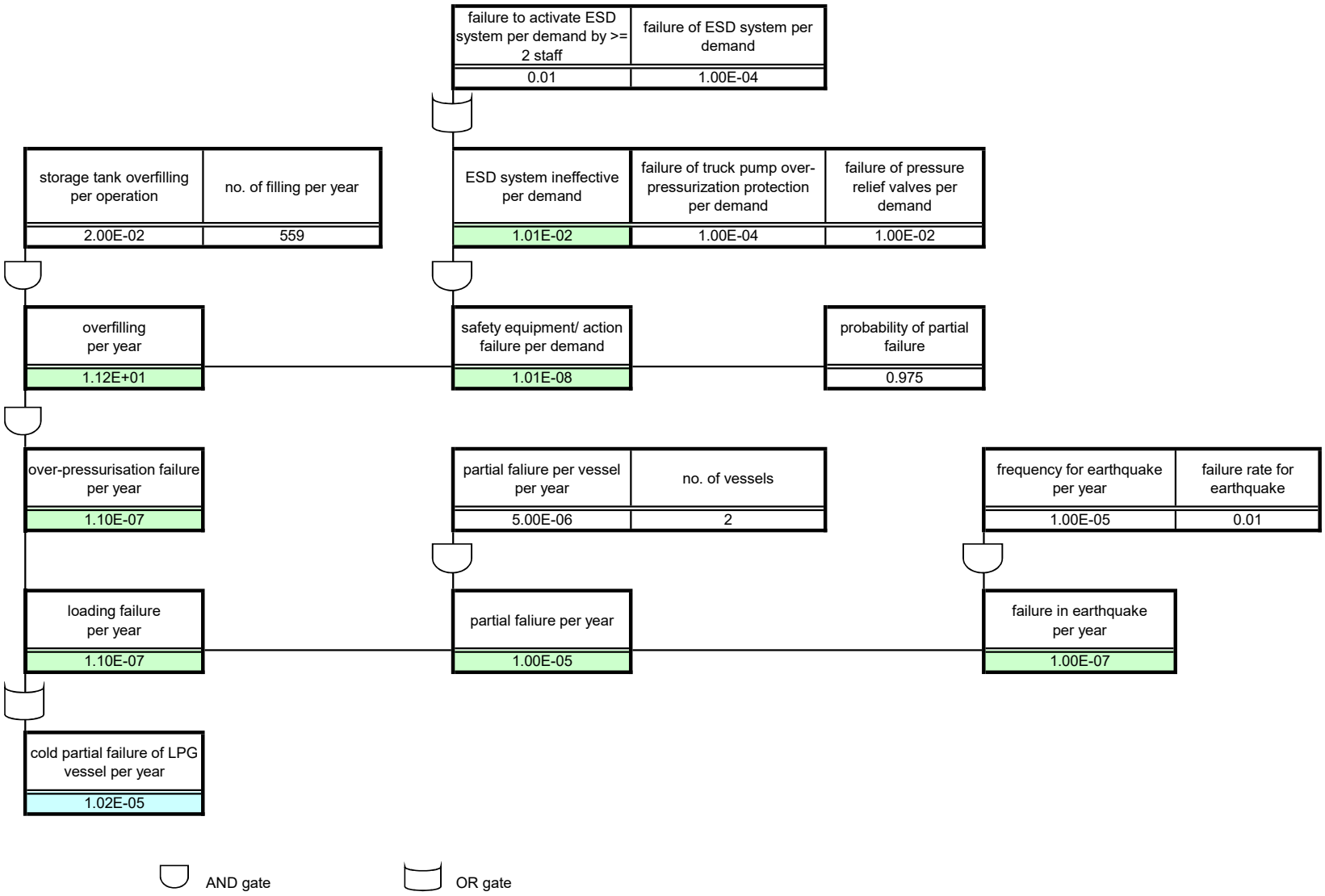
Guillotine failure of Inlet Pipeline (LPG Filling Station)



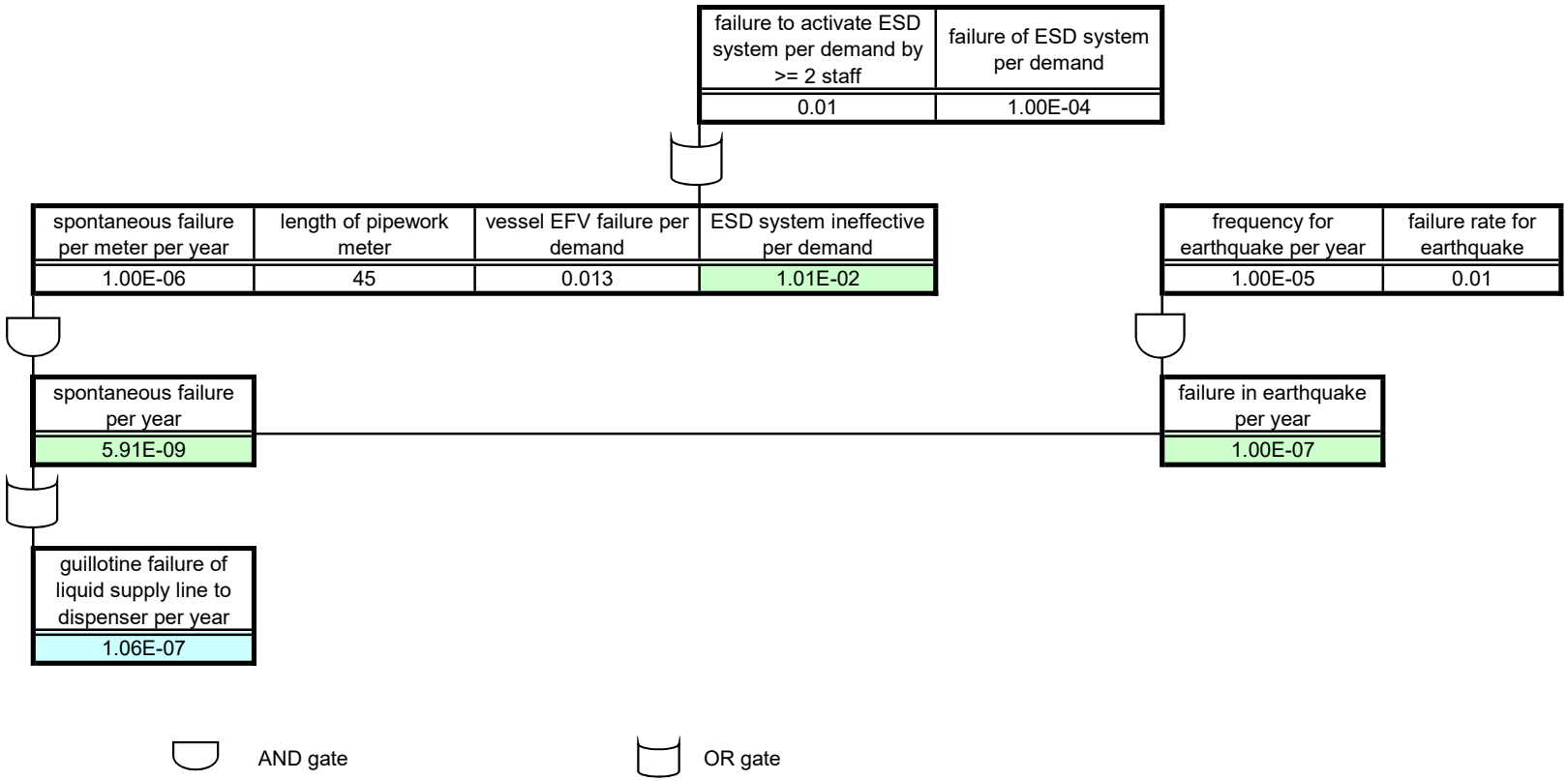
Partial failure of Inlet Pipeline (LPG Filling Station)



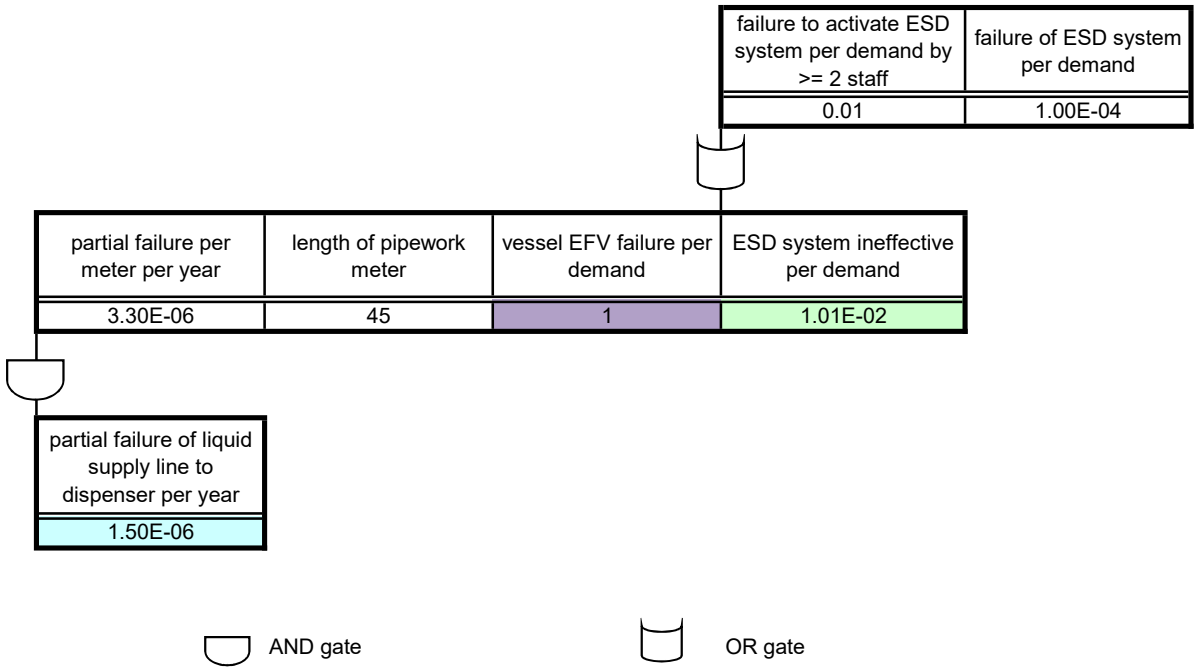
Cold Catastrophic Failure of LPG Vessel (LPG Filling Station)



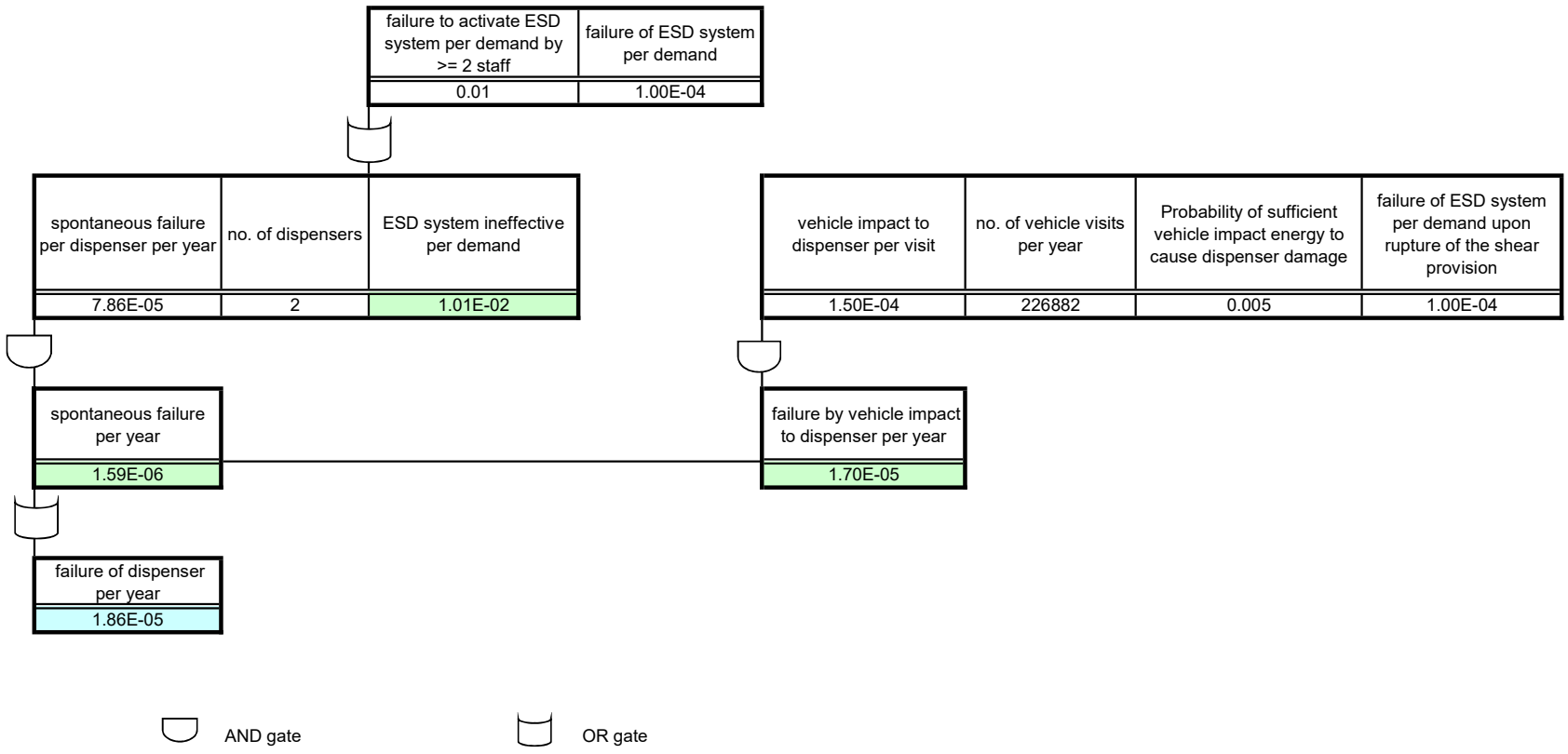
Partial Failure of LPG Vessel (LPG Filling Station)



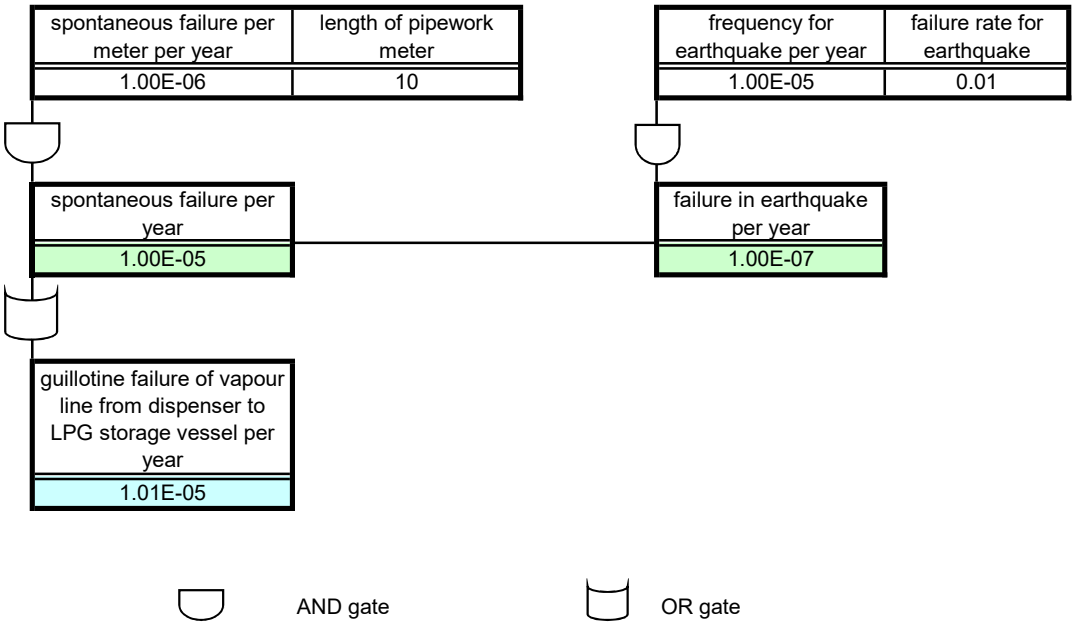
Guillotine failure of the Liquid Supply Pipeline to the Dispenser (LPG Filling Station)



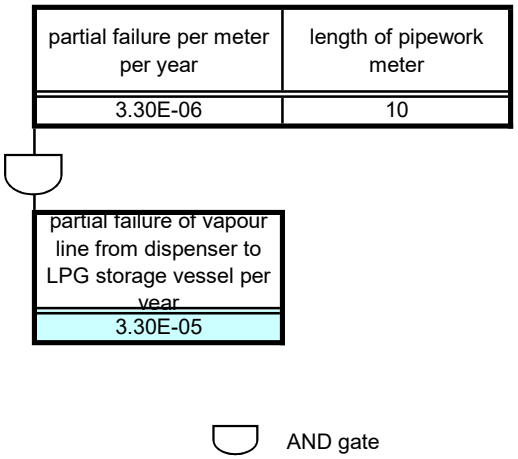
Partial failure of the Liquid Supply Pipeline to the Dispenser (LPG Filling Station)



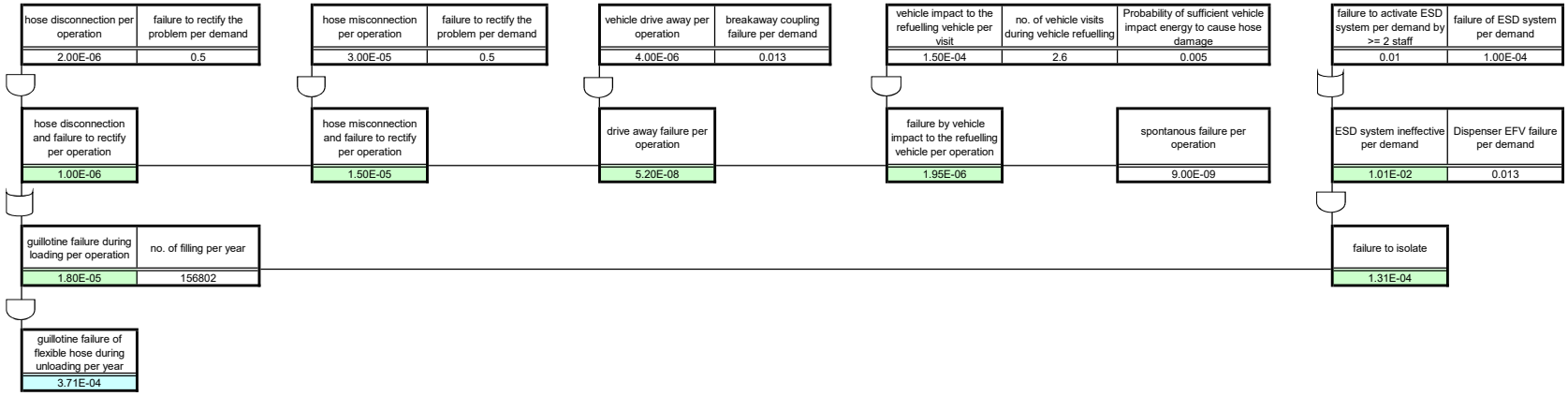
Failure of the Dispenser (LPG Filling Station)



Guillotine failure of Vapour Line from Dispensers to LPG Storage Vessel



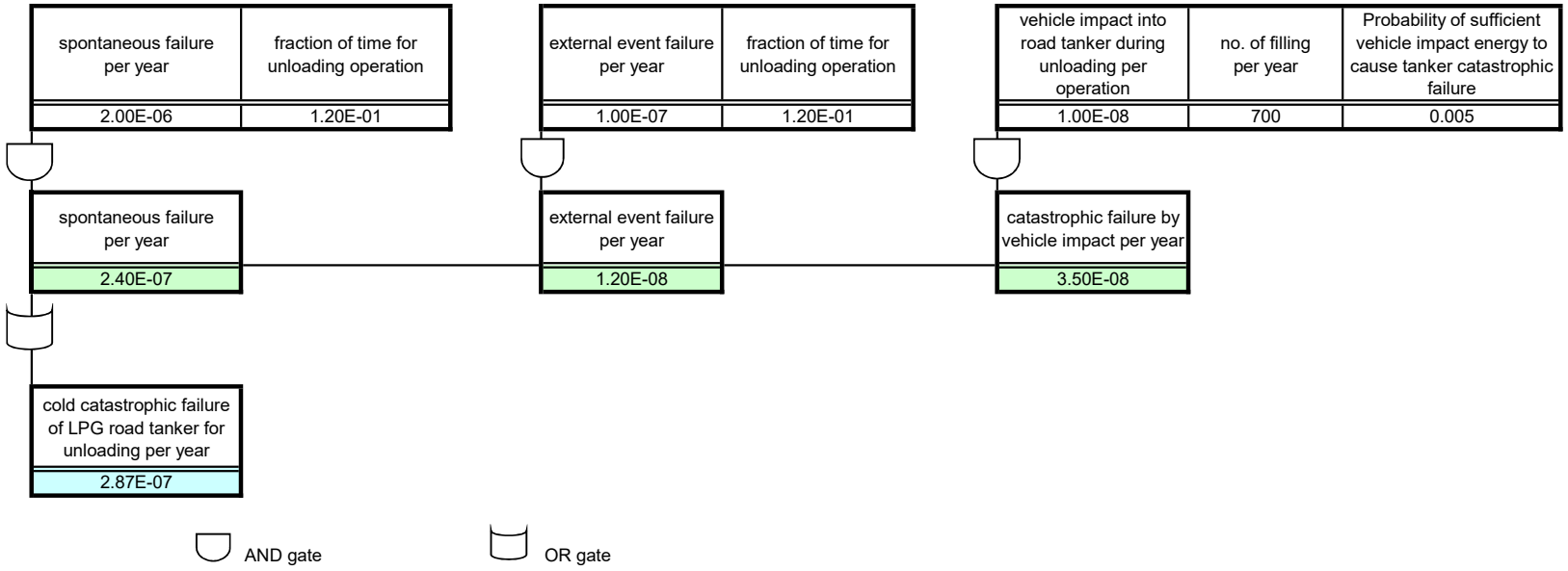
Partial failure of Vapour Line from Dispensers to LPG Storage Vessel



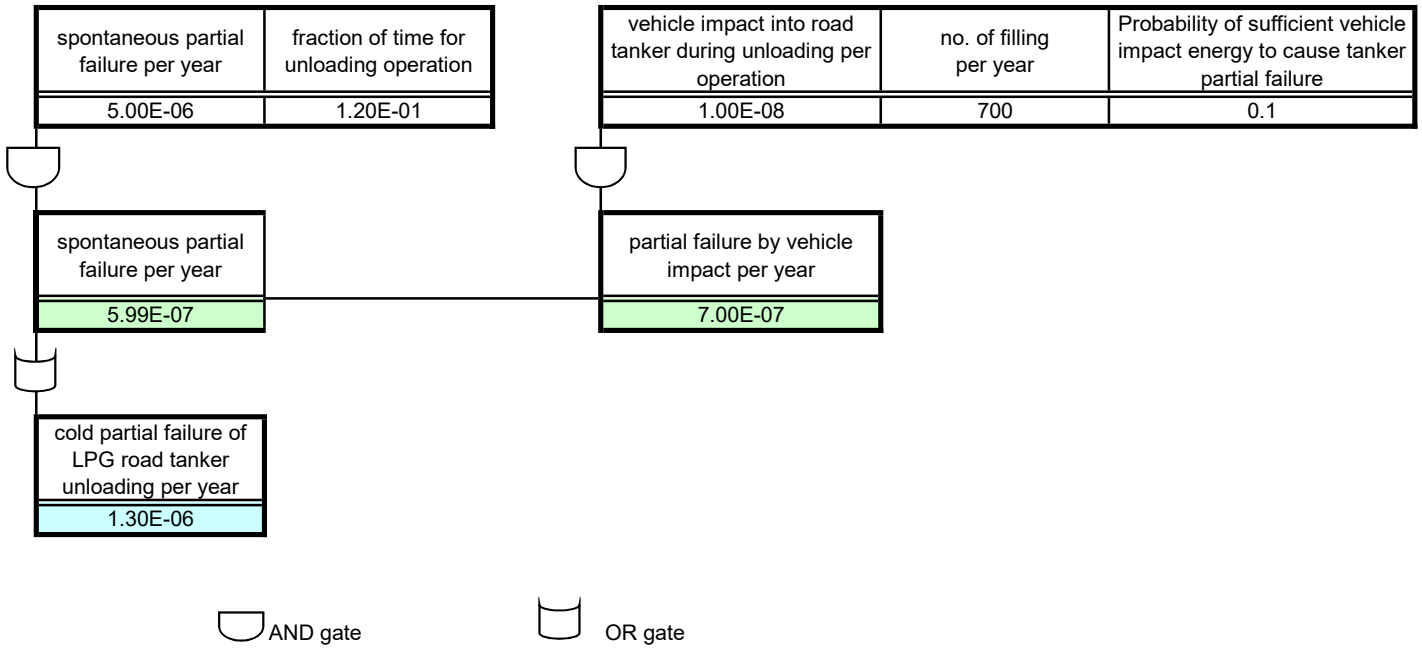
Guillotine failure of Flexible Hose during Filling to the LPG Vehicle (LPG Filling Station)

Appendix 6-2

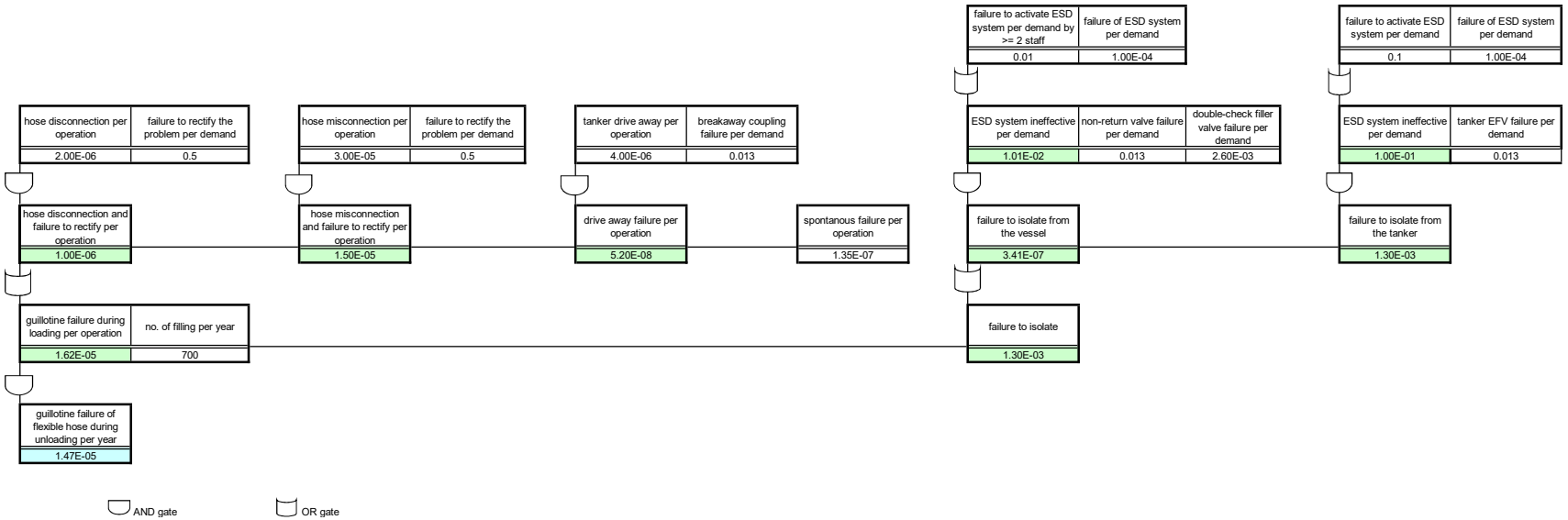
Fault Tree Analysis (LPG B Shell Filling Station)



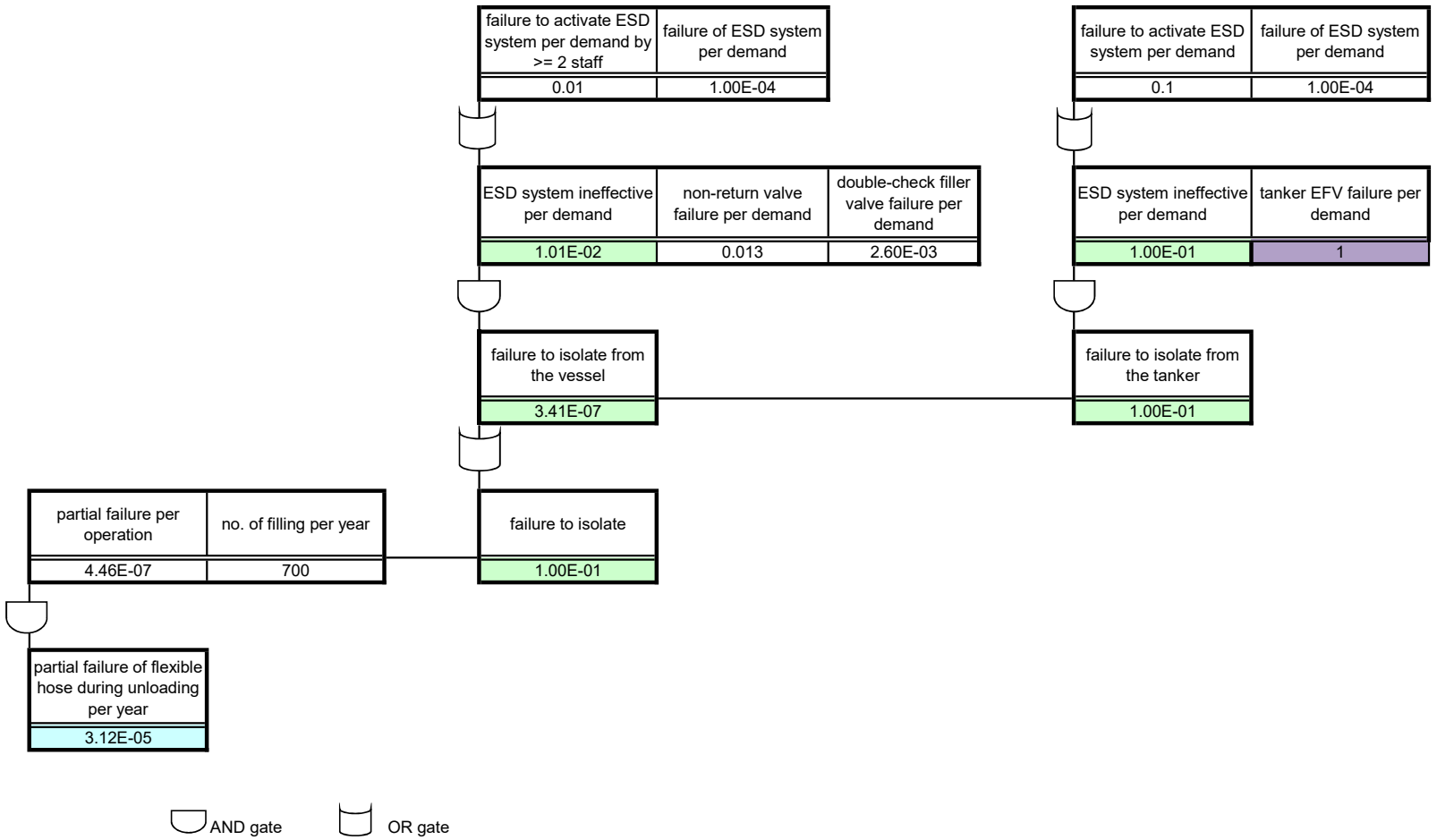
Cold Catastrophic failure of Road Tanker (LPG Filling Station)



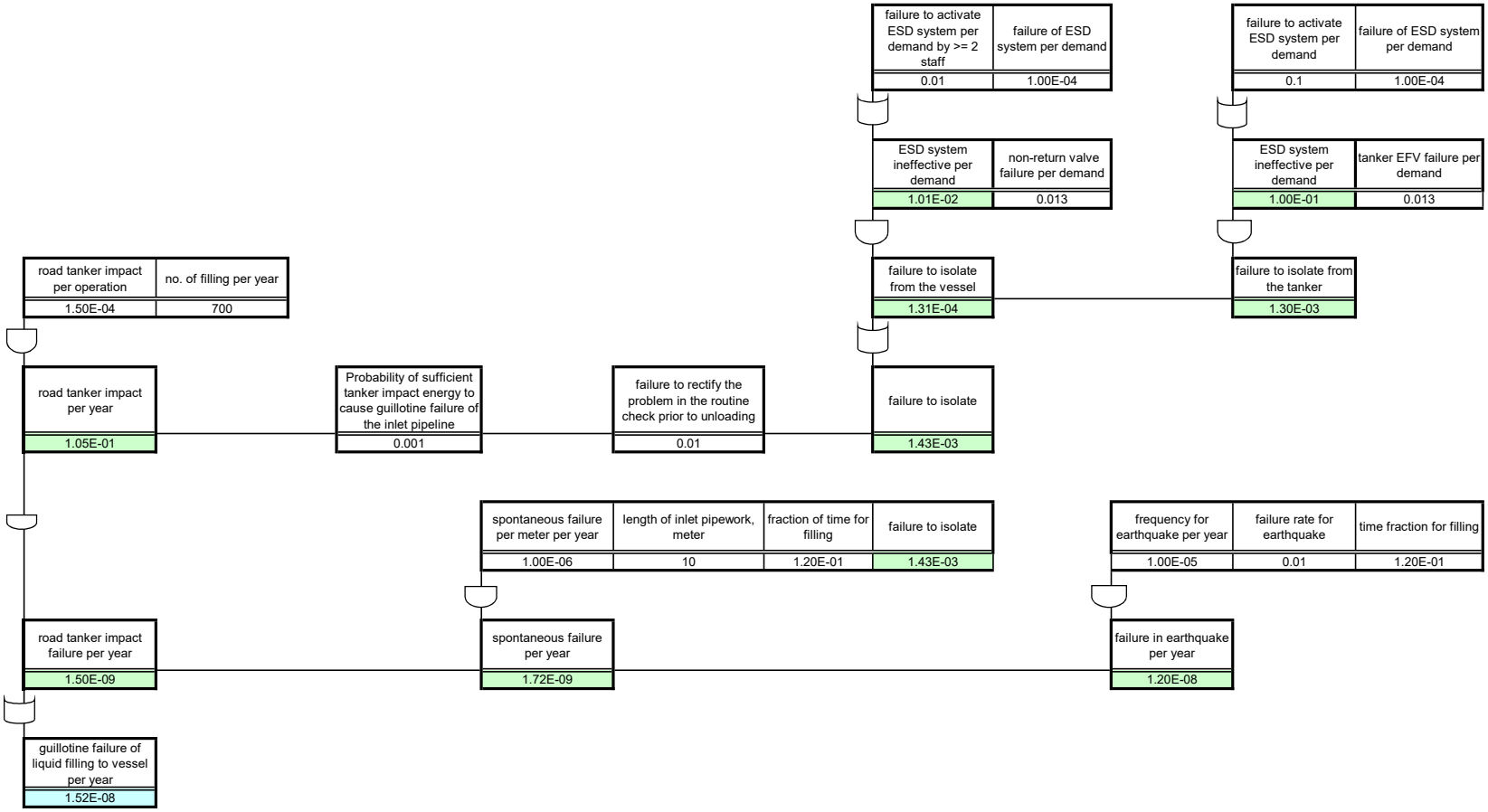
Partial failure of Road Tanker (LPG Filling Station)



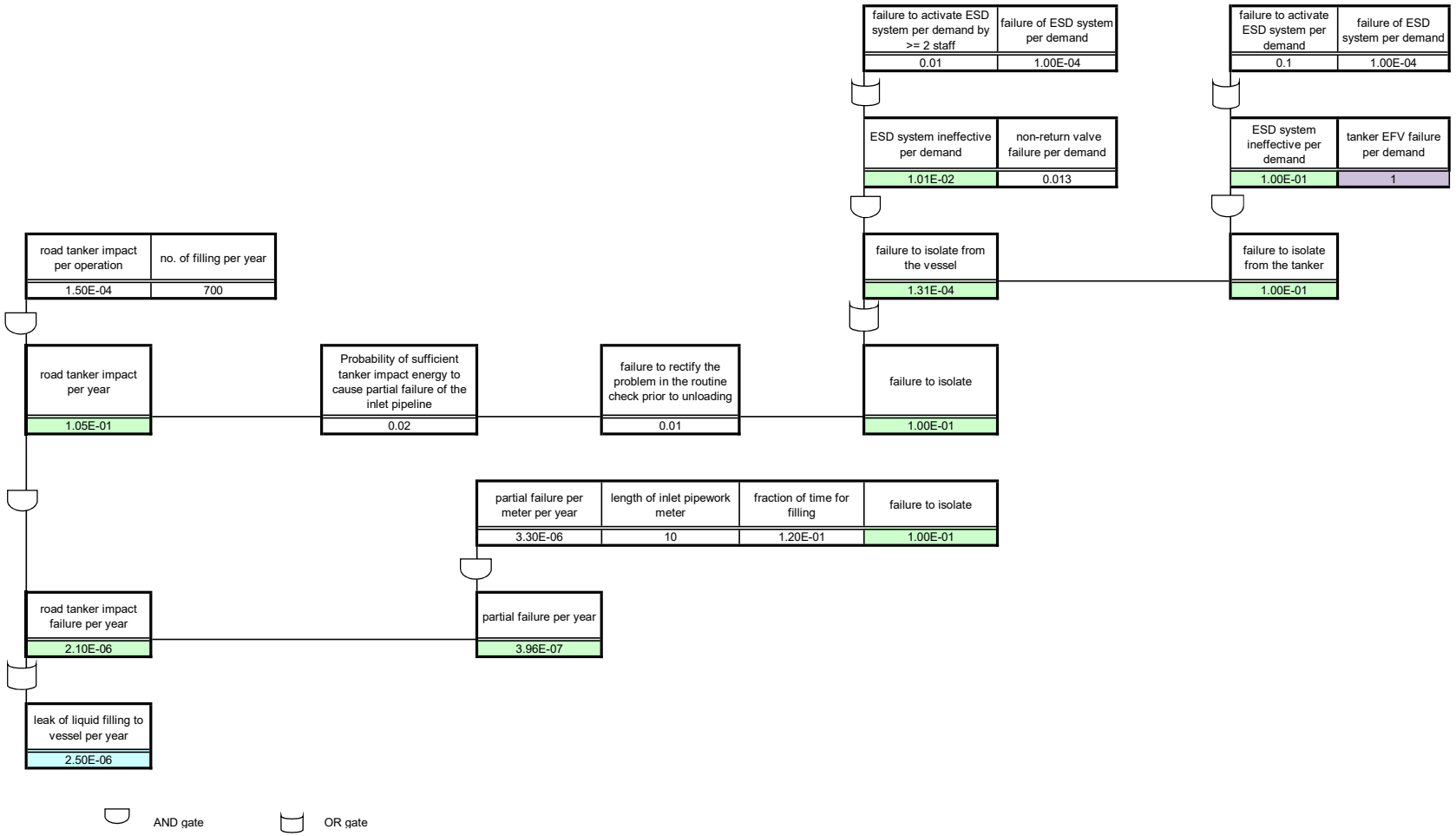
Guillotine failure of Flexible Hose during Unloading to the LPG vessel (LPG Filling Station)



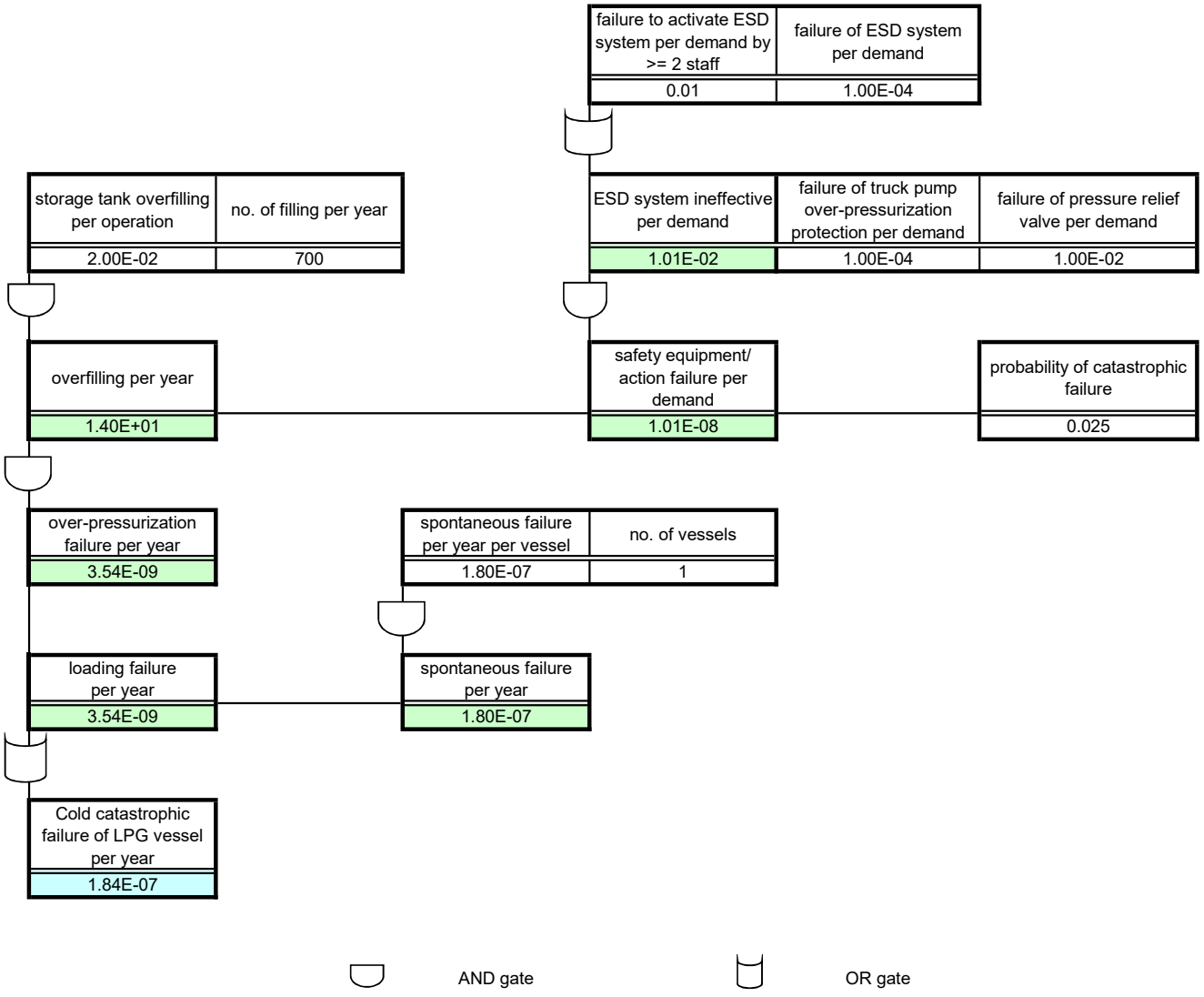
Partial failure of Flexible Hose during Unloading to the LPG vessel (LPG Filling Station)



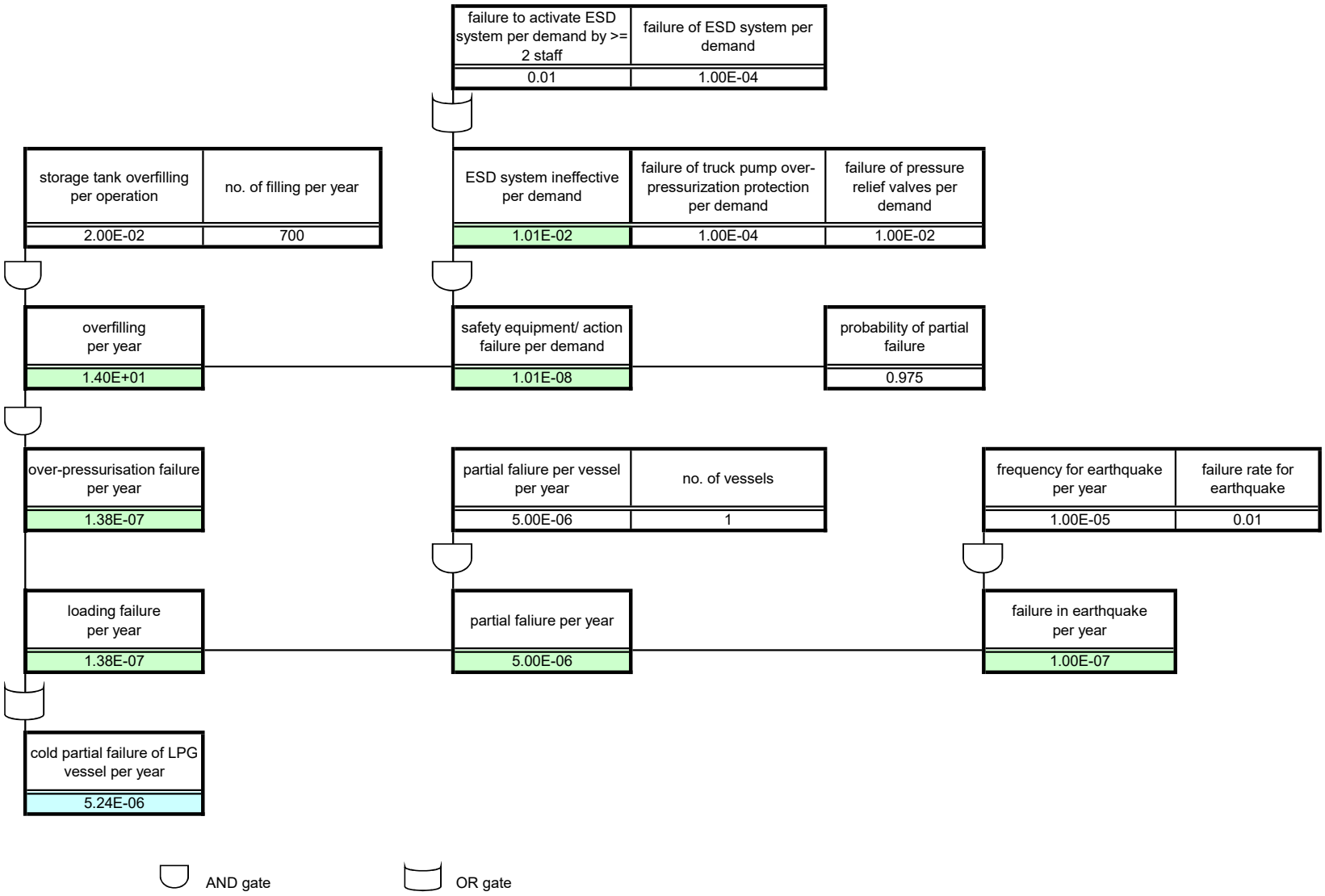
Guillotine failure of Inlet Pipeline (LPG Filling Station)



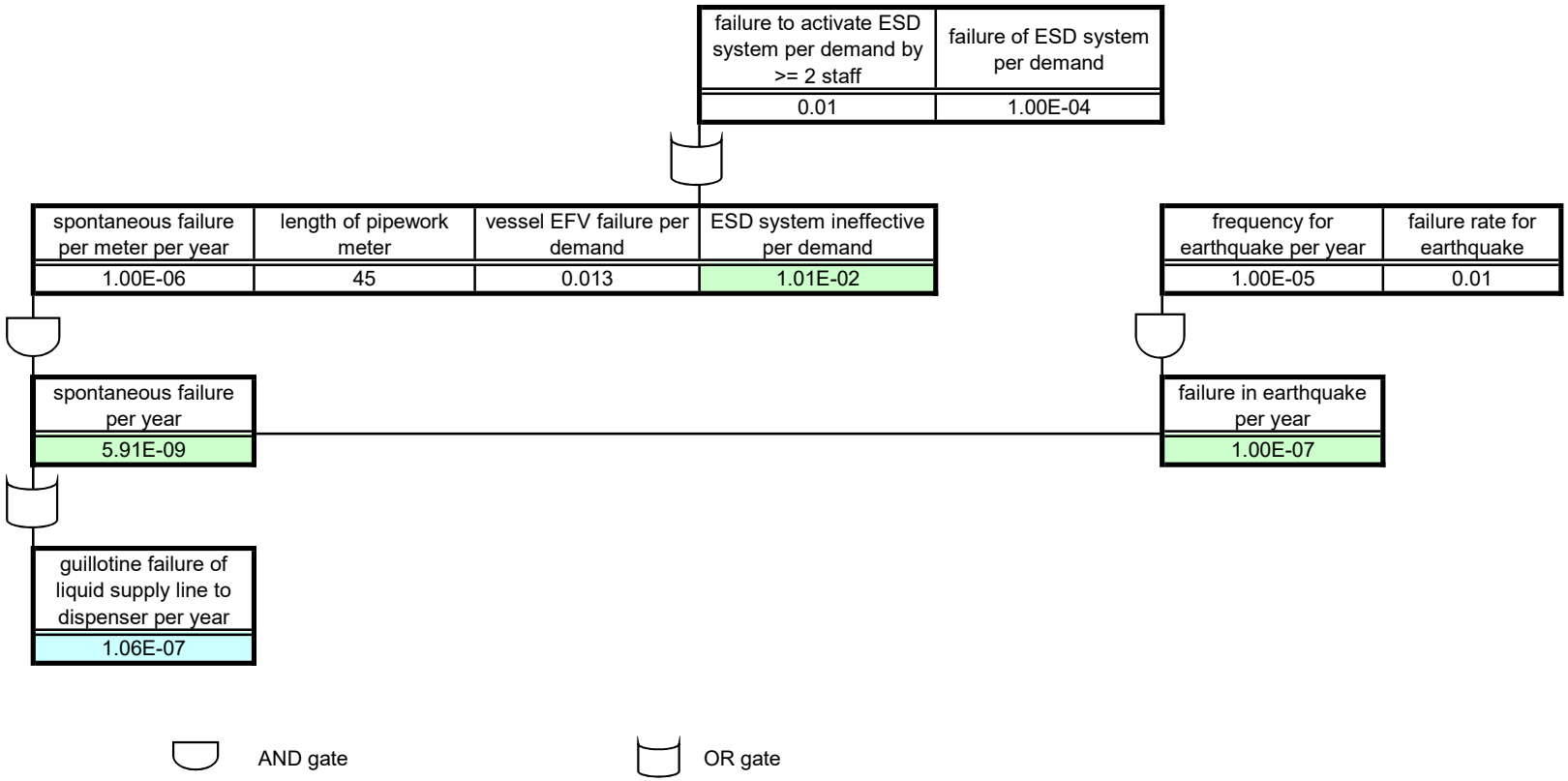
Partial failure of Inlet Pipeline (LPG Filling Station)



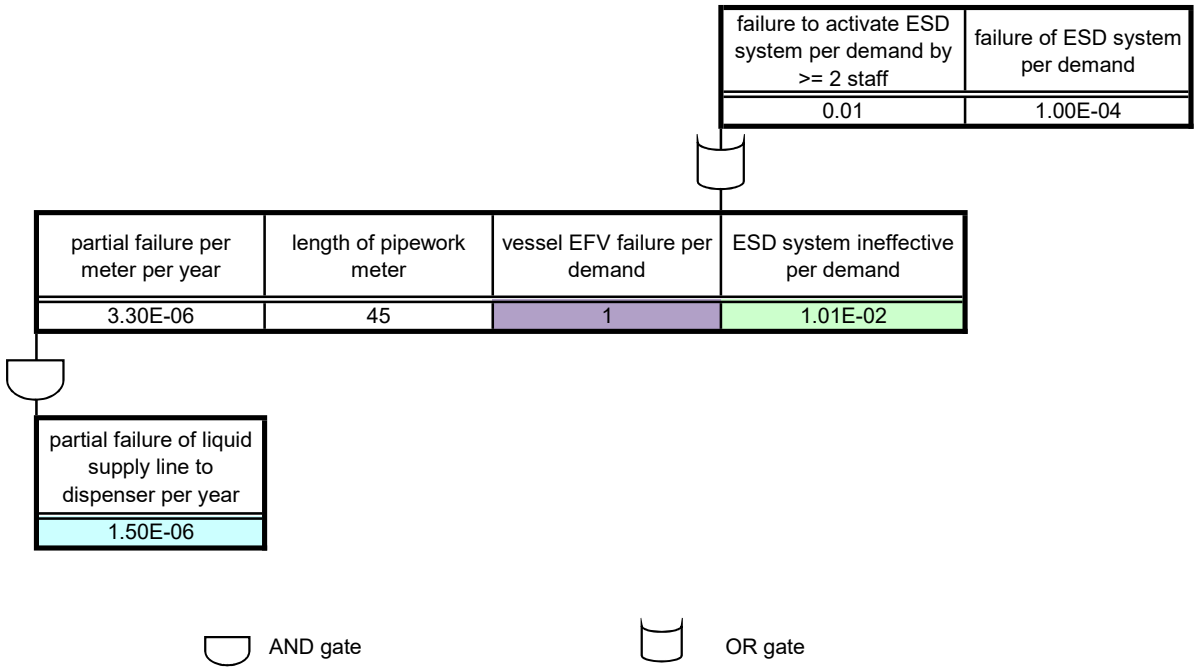
Cold Catastrophic Failure of LPG Vessel (LPG Filling Station)



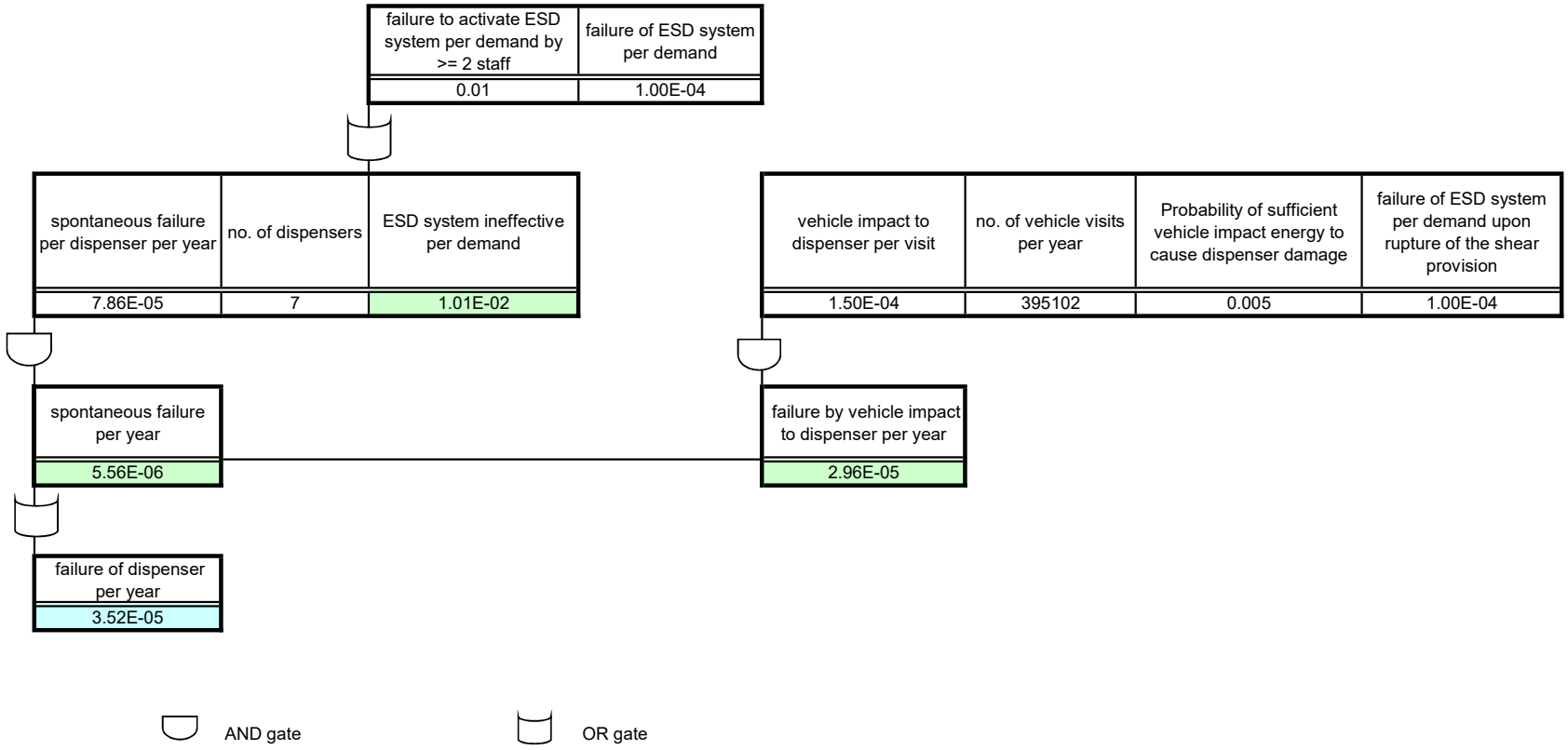
Partial Failure of LPG Vessel (LPG Filling Station)



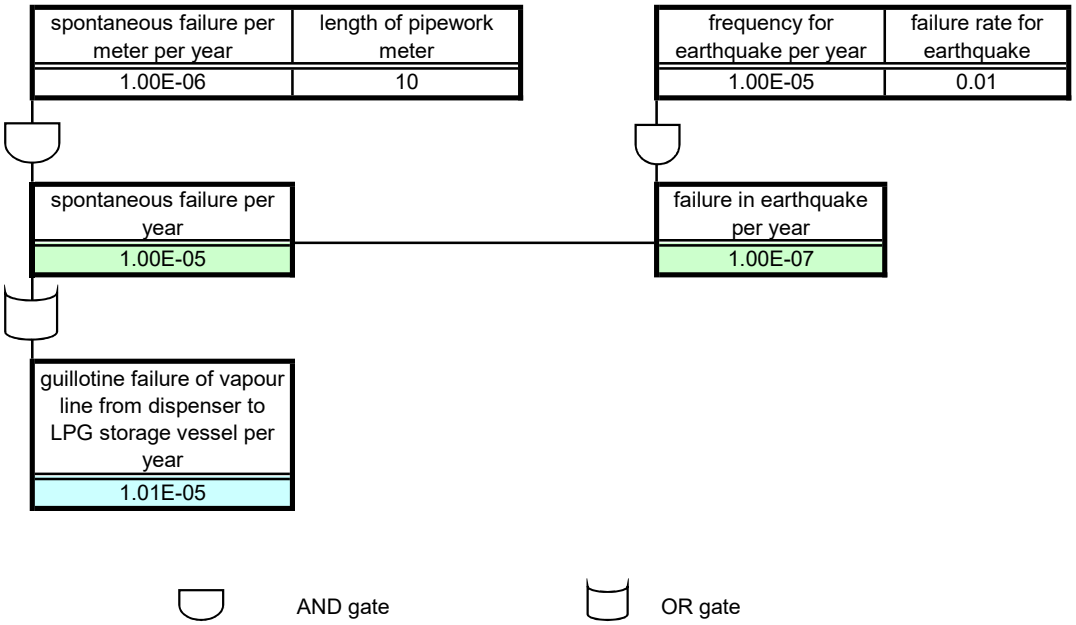
Guillotine failure of the Liquid Supply Pipeline to the Dispenser (LPG Filling Station)



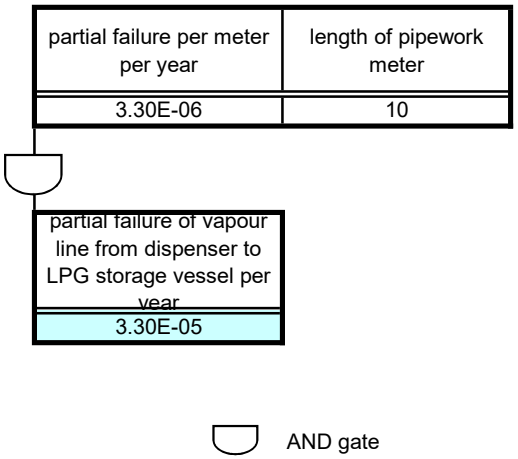
Partial failure of the Liquid Supply Pipeline to the Dispenser (LPG Filling Station)



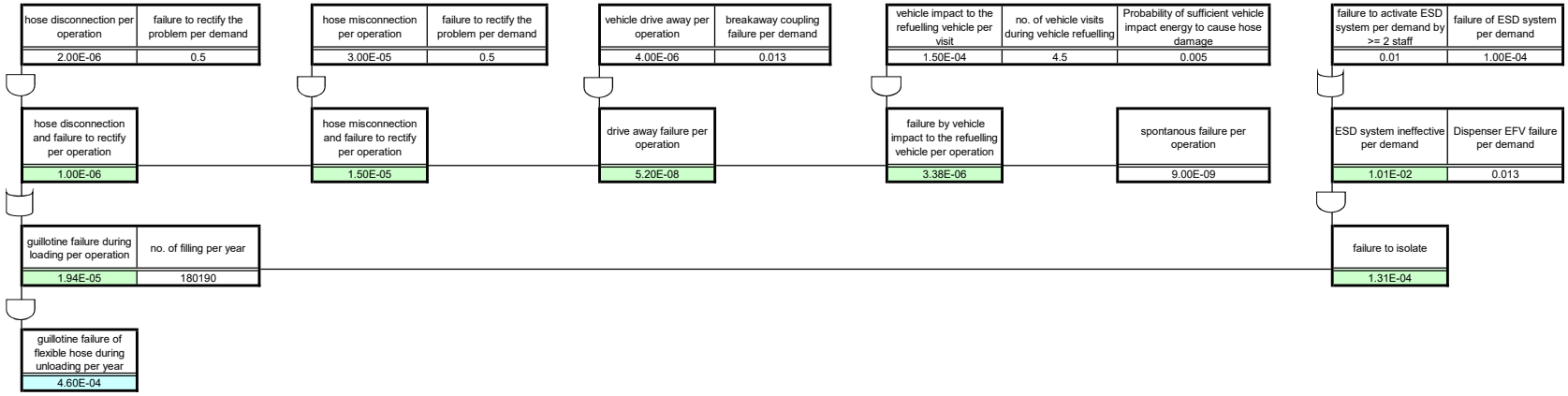
Failure of the Dispenser (LPG Filling Station)



Guillotine failure of Vapour Line from Dispensers to LPG Storage Vessel



Partial failure of Vapour Line from Dispensers to LPG Storage Vessel



Guillotine failure of Flexible Hose during Filling to the LPG Vehicle (LPG Filling Station)