Hong Kong Housing Authority

Lower Ngau Tau Kok Phase 1 and Phase 2

Air Ventilation Assessment - Expert Evaluation

ARUP

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Contents

1 Introduction

1.1 Project Background

Ove Arup and Partners Hong Kong Limited (Arup) was commissioned by Hong Kong Housing Authority (HKHA) to conduct environmental design studies for the Redevelopment of Lower Ngau Tau Kok Estate Phase 1 and Phase 2 (the Development). One of the tasks is to undertake an expert evaluation study on Air Ventilation Assessment (AVA) for the Development.

1.2 Study Objective

The objective of this study is to evaluate the wind performance of the Development using the methodology of Air Ventilation Assessment, based on the ***"Housing Planning and Lands Bureau – Technical Circular No. 1/06, Environment, Transport and Works Bureau – Technical Circular No. 1/06"*** issued on 19th July 2006 (the Technical Circular) and ***"Technical Guide for Air Ventilation Assessment for Development in Hong Kong – Annex A"*** (the Technical Guide). This report presents the findings for the study of Stage 1 – Expert Evaluation.

1.3 Study Tasks

The major tasks of this study is to carry out an expert evaluation on the characteristics of the site wind availability data of the development area and assessment of the wind performance under existing development situation and the proposed building design option in a qualitative way. The expert evaluation will cover the following tasks:

- Identify good design features
- Identify obvious problem areas and propose some mitigation measures
- Define "focuses" and methodologies of the Initial Study

2 Expert Evaluation

2.1 Wind Condition

To investigate the wind performance of the development site, the characteristic of the natural wind availability of the site is an essential item and should be understood in advance. As stipulated in the Technical Guide, the site wind availability data (V_∞) would be achieved using appropriate mathematical models (e.g. MM5 simulation).

Planning Department (PlanD) has set up a set of wind availability data of the Territory for AVA study, which could be downloaded at Planning Department Website (http://www.pland.gov.hk/misc/MM5/main.htm). The wind availability data of the Development obtained from the MM5 simulation is utilised for the Expert Evaluation, as shown in following figure.

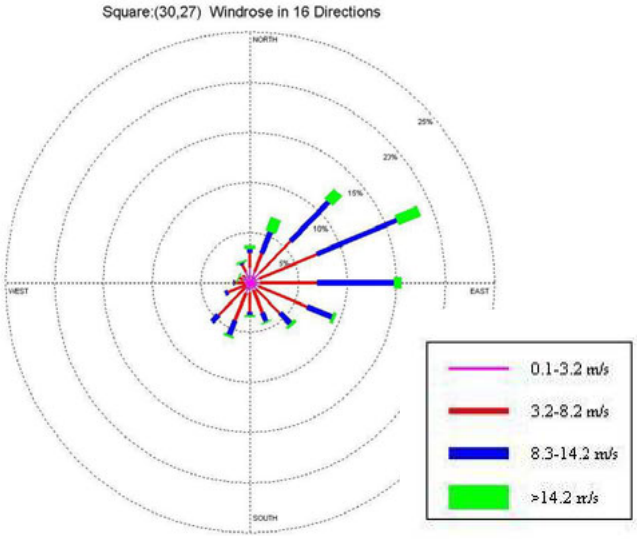

Figure 1. Wind rose for the Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2 obtained from MM5 database

The following table shows the probability of 16 wind directions. It is shown that the prevailing wind directions for the development site are from NE, ENE and E directions.

Wind Direction	Percentage of Occurrence (%)	Wind Direction	Percentage of Occurrence (%)	Wind Direction	Percentage of Occurrence (%)	Wind Direction	Percentage of Occurrence (%)
N	3.6	E	15.3	S	3.4	W	1.7
NNE	6.8	ESE	9.2	SSW	5.8	WNW	1.3
NE	12.6	SE	6.0	SW	5.5	NW	1.0
ENE	18.5	SSE	4.2	WSW	2.7	NNW	2.2

Table 1. Probability for 16 wind directions

Wind Direction	NNE	NE	ENE	E	ESE	SE	SSW	SW	Total
Percentage of Occurrence (%)	6.8%	12.6	18.5	15.3	9.2	6.0	5.8	5.5	79.7%

Table 2. Prevailing wind directions at the Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2 Quarters (probability exceeding 75% of time in a year)

2.2 Site Characteristics

The Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2 is located in Kwun Tong District adjacent to the Kowloon Bay MTR Station and a number of private and public housing developments. To the south of the Development is Upper Ngau Tau Kok Estate, to its west is Telford Gardens and Amoy Gardens to its north. These locations would be deliberately considered in the study.

Figure 2. Aerial photo for the Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2 ***(extracted from Google Earth)***

The site characteristic and surrounding building environment are summarized below for better understanding:

Site Area

- Hilly topography towards the east of the Development
- High ground coverage
- Irregular street pattern
- Varying building heights within the site
- Proposed building heights higher than those of the surrounding buildings

Surrounding Area

- Irregular street pattern
- Varying building heights
- Mid-rise to high-rise buildings

2.3 Preliminary assessment on site wind performance of Existing Condition

As described in Section 2.1, the 8 most prevailing wind directions are NNE, NE, ENE, E, ESE, SE, SSW and SW. Therefore, the wind performance of the existing site condition at pedestrian level are evaluated based on these wind directions and summarized as following:

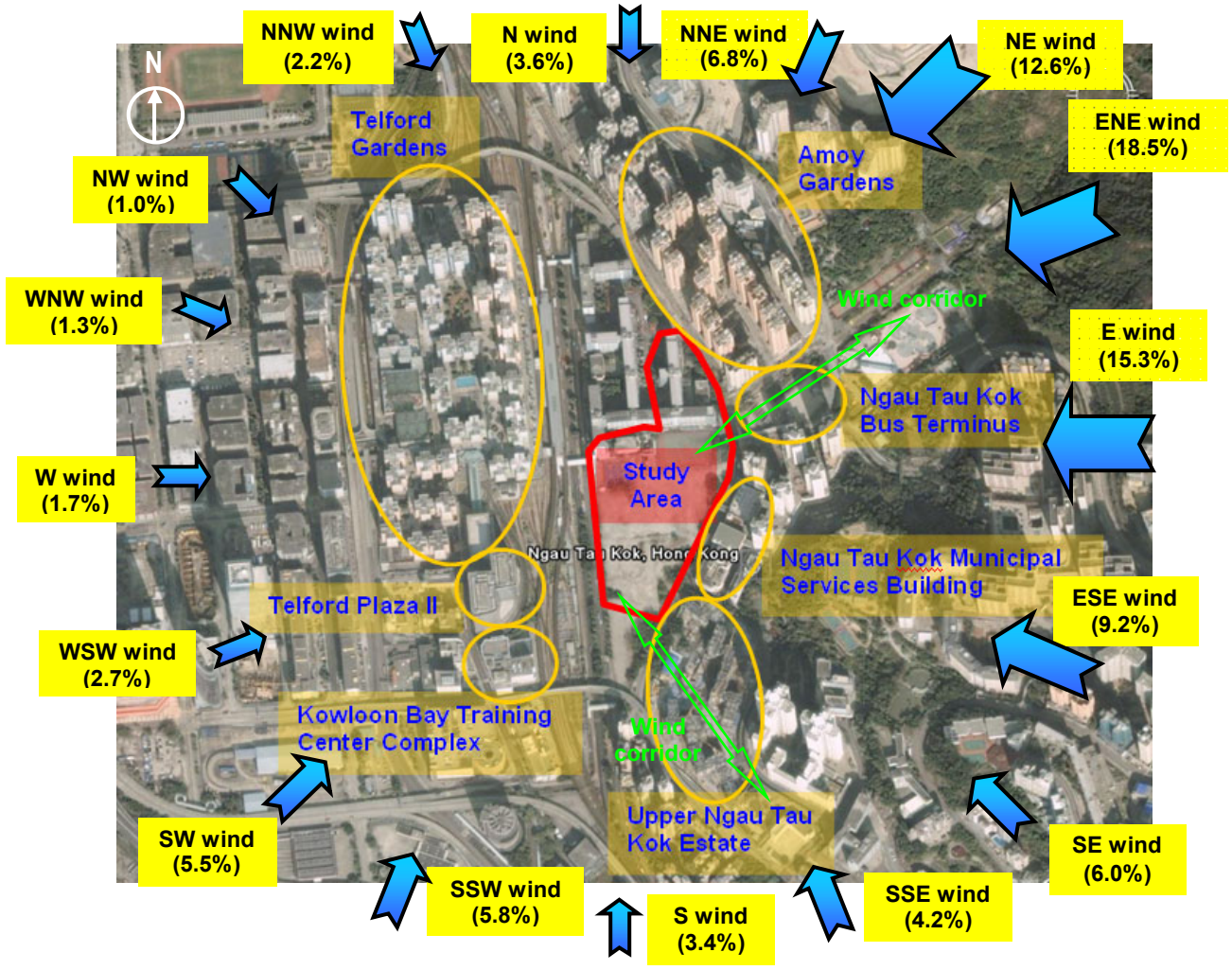

Figure 3. Existing condition of the Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2

- Under prevailing wind of NNE, NE, ENE and E directions, the wind approaching to the Development might be sheltered by the surrounding developments (e.g. Amoy Gardens). The major wind corridor under these wind directions is the space above the Ngau Tau Kok Terminus;
- Under ESE and SE wind conditions, wind sheltering effect by the windward developments would not be serious as the Ngau Tau Kok Municipal Services Building is relatively low-rise and wind corridor is provided at the Upper Ngau Tau Kok Estate;
- Under SSW and SW wind conditions, the wind approaching the Development might be sheltered by the high-rise developments including Kowloon Bay Training Center Complex, Telford Plaza II and Telford Gardens;
- On the other hand, the Development might also impose impact on the air ventilation performance of the surrounding area if air permeability is not sufficient, e.g. the E wind blowing to the Telford Gardens might be sheltered.

2.4 Preliminary assessment on site wind performance of Proposed Development

The Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2 comprises 6 nos. domestic blocks ranging from 33 to 47 storeys and a carport building. The gross site area is around 3.1 ha.

The following sections will discuss the pros and cons for the current scheme of the Proposed Development. The site layout of the Development is shown in the following figure.

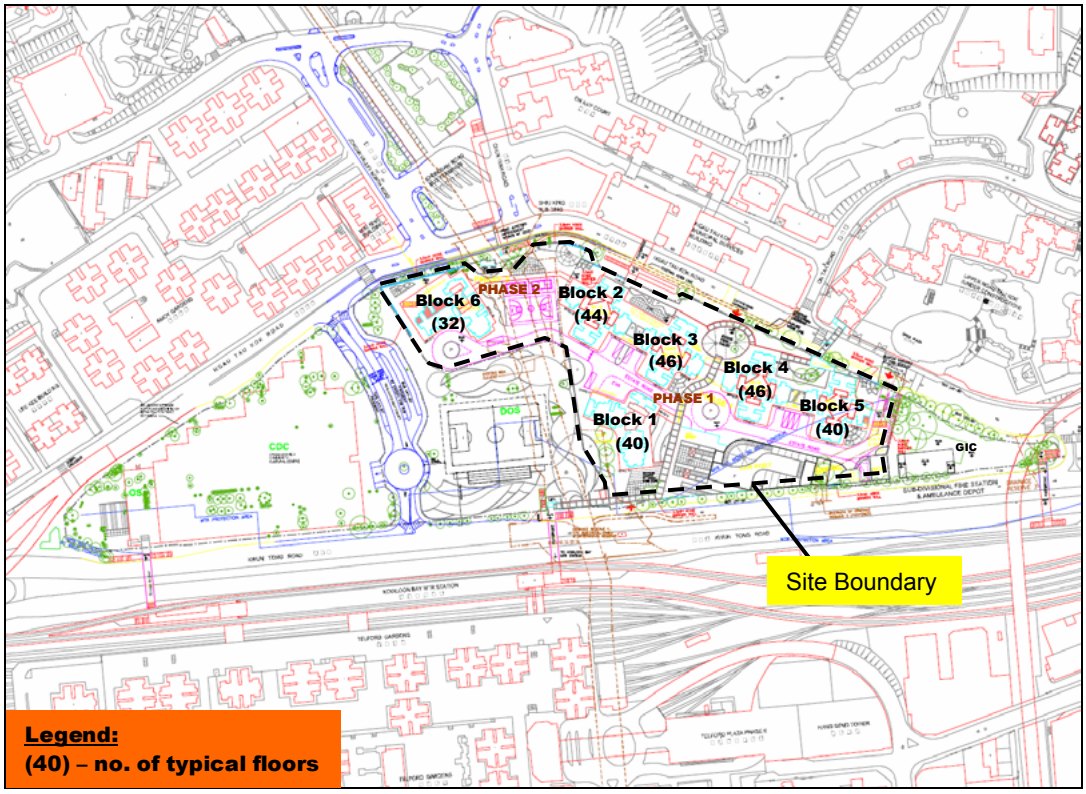

Figure 4. Site layout plan of the current scheme for the Redevelopment of Lower Ngau Tau Kok Estate Phase 1 & Phase 2

2.4.1 Good Design Features

The good design features of the Development include:

- Wind corridors are preserved between Phase 1 and Phase 2 by providing an opening between Block 2 and Block 6, with separation approximately equal to the building width. This, together with the Ngau Tau Kok Bus Terminus on the east and District Open Space (DOS) on the west, would allow wind penetration through the site for NNE, NE, ENE and E wind directions.
- For the four cruciform blocks at Phase 1, there is certain building gap between Block 3 and Block 4. This gap would allow wind penetration for ESE and SE wind conditions.

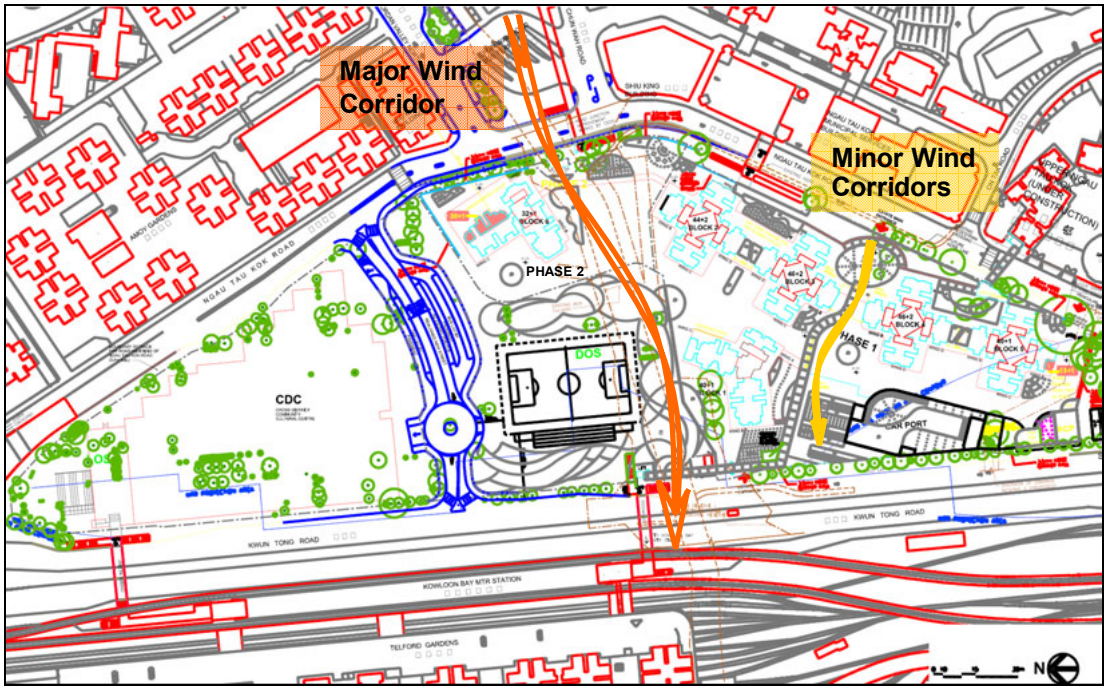

Figure 5. Wind corridors preserved at the Development for wind penetration

2.4.2 Problem and Focus Areas

Notwithstanding, there are some drawbacks for the proposed design of the Development.

- The building separation between Block 2 and Block 3 and that between Block 4 and Block 5 is small as compared to the building width. This might cause wind sheltering effect under E, ESE and SE wind conditions, which would in turn affect the air ventilation of the pedestrian walkway on the two sides of Kwun Tong Road.

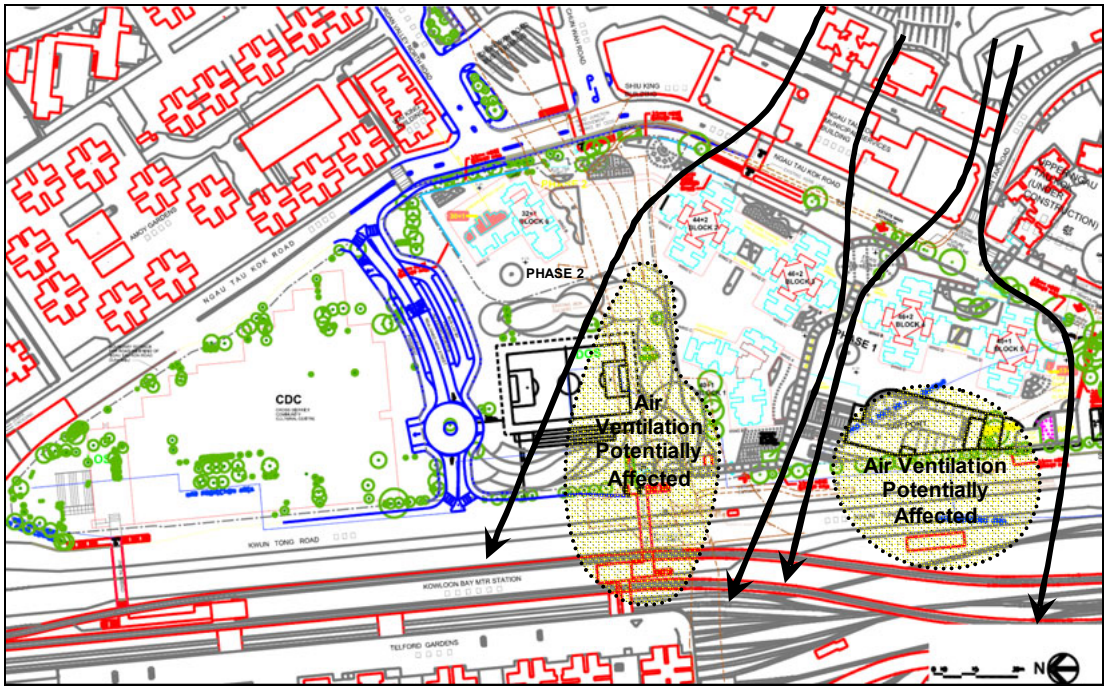

Figure 6. Potential wind sheltering by the cruciform blocks at Phase 1

- Similarly, the building separation between Block 1 and Block 3 is comparatively small. This would hinder the penetration of SSW or SW wind to the leeward DOS.

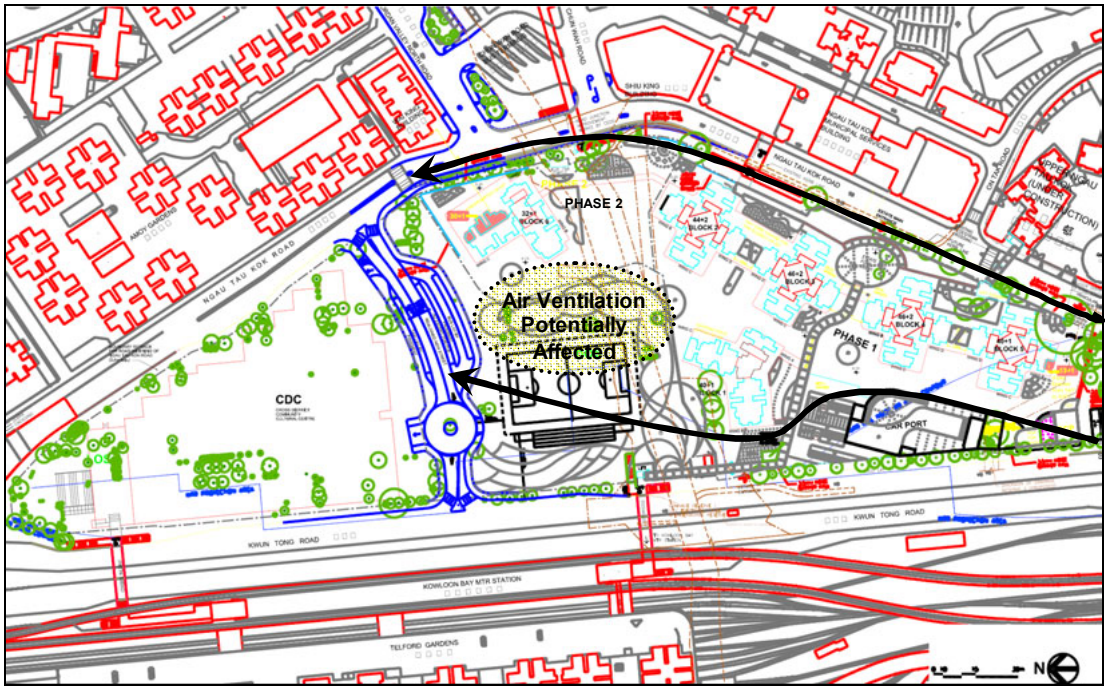

Figure 7. Potential wind sheltering under SSW and SW wind conditions

- As there are a number of facilities at the ground floor adjoining Block 2 and Block 3 (Day Care Centre for the Elderly) and adjoining Block 4 and Block 5 (EMO), the air permeability at the ground level of these four cruciform blocks is affected.

2.5 Recommendation

To enhance the wind performance, some improvement measures are suggested as follows:

- **Building separation** – to increase the separation between building blocks to enhance the air permeability of the Development especially under the prevailing wind directions, e.g. E and ESE wind;
- **Openings** – to provide large openings at ground level of the building blocks (e.g. elevated openings) to improve air permeability at the pedestrian level;
- **Ventilation Corridor** – building disposition to reserve ventilation corridor(s) to enhance wind penetration, especially for the prevailing wind directions of E and ESE.

The Expert Evaluation only aims at providing qualitative identification of wind performance of the site under existing condition and proposed design option. To quantitatively estimate the wind performance at the pedestrian level and determine the airflow pattern, it is recommended to carry out AVA Initial Study for master plan review.

3 Methodology for Initial Study

According to the Technical Guide, both Computational Fluid Dynamics (CFD) and wind tunnel are considered as the appropriate tools for Initial AVA Study.

3.1 Computational Fluid Dynamics (CFD)

For Initial AVA Study, the Technical Circular has recommended CFD analysis coupled with meteorological data collected from the MM5 to determine the Velocity Ratios (VR) at different concerned locations. The model will contain information of the surrounding buildings and site topography from Geographical Information System (GIS) platform. The airflow distribution within the flow domain, being affected by the site-specific design and the nearby topography, will be visualized under the prevailing wind conditions round the year.

3.2 Wind Tunnel

Initial AVA Study could also be carried out by wind tunnel with a large scale topographical model with reference to Hong Kong Observatory Waglan Island wind data. The flow inside the tunnel would be equipped with spires and floor roughness elements that provide replication of the turbulent wind flows that exist in lower atmosphere. The model can be equipped with wind sensors as required to gain the details of the local wind microclimate.

3.3 Recommendation on Study Tool for Initial AVA Study

Not as wind tunnel test, which could only provide wind velocity ratios at pre-determined discrete measurement points, CFD can perform graphical visualization of the overall airflow pattern of the studied site, benefit the designer on better and easy understanding of the wind performance of the site, study different design options in an effective way, especially at master layout design stage.

Therefore, Computational Fluid Dynamics (CFD) technique is proposed to be utilized in the Initial AVA Study in current project.