MINISTRY OF TRANSPORT

**PROJECT MANAGEMENT UNIT THANG LONG**

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# PROJECT FOR CONSTRUCTION OF VIADUCT SECTION MAI DICH – SOUTH THANG LONG ON HANOI CITY RING ROAD NO.3

# ENVIRONMENTAL IMPACT ASSESSMENT

**(THE REPORT HAS BEEN REVISED AND SUPPLEMENTED UNDER COMMENTS OF APPRAISAL COMMITTEE IN MEETING ON APRIL 08TH 2013 IN MOT)**

**HA NOI, APRIL 2013**

MINISTRY OF TRANSPORT

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**PROJECT's EMPLOYER**

**CONSULTANT AGENCY**

**ORIENTAL CONSULTANTS Co., Ltd.**

**TRANSPORT ENGINEERING DESIGN INC.**

**HA NOI, APRIL 2013**

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# LIST OF ACRONYMS AND ABBREVIATIONS

**A**

| | |
|---|---|
| As | Arsenic |

**B**

| | |
|---|---|
| BOD | Biological Oxygen Demand |
| BGTVT | Ministry of Transportation |
| BXD | Ministry of Construction |
| BTNMT | Ministry of Natural Resources and Environment |

**C**

| | |
|---|---|
| Cd | Cadmium |
| CO | Carbon Monoxide |
| COD | Chemical Oxygen Demand |
| Cu | Copper |

**D**

| | |
|---|---|
| dBA | Decibel A |
| DO | Dissolved Oxygen |

**E**

| | |
|---|---|
| EA | Environmental Assessment |
| E. coli | Escherichia Coli |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EO | Environmental Officer |

**F**

| | |
|---|---|
| FAO | Food and Agricultural Organization |

**M**

| | |
|---|---|
| mg/l | Milligrams per litre |

| | |
|---|---|
| MOT | Ministry of Transportation |
| **N** | |
| ND | Decree |
| NH | National Highway |
| $NO_2$ | Nitrite |
| $NO_3$ | Nitrate |
| **P** | |
| Pb | Lead |
| PCs | People's Committees |
| PM10 | Particulate Matter < 10μm |
| POWM | Plan of waste management |
| PRC | Provincial Resettlement Committees |
| **Q** | |
| QD | Decision |
| QCVN | National technical regulation |
| **R** | |
| RAP | Relocation Action Plan |
| RCs | Resettlement Commissions |
| **S** | |
| $SO_2$ | Sulphur dioxide |
| **T** | |
| TB | Announcement |
| TCVN | Vietnamese Standard |
| TEDI | Transport Engineering Design Incorporated |
| TSP | Total Suspended Particulate |

| | |
|---|---|
| TSS | Total Suspended Solids |

**U**

| | |
|---|---|
| UBMTTQ | National Front Committee |
| UBND | People Committee |

**W**

| | |
|---|---|
| WHO | World Health Organization |

**Z**

| | |
|---|---|
| Zn | Zinc |

# INTRODUCTION

## 1. Background

Ha Noi Ring Road 3 has a length of 65km, connecting sections from Thang Long Bridge - Mai Dich - Thanh Xuan - North Linh Dam - Phap Van - Thanh Tri Bridge - Sai Dong - Phu Dong Bridge - Ninh Hiep - Dong Anh - Nam Hong - North Thang Long Road - Noi Bai - Thang Long. It plays important role in transportation system of Ha Noi City and surrounding areas because it serves not only inner-city traffic but also inter-region traffic and inter-provincial traffic.

Currently, section of Mai Dich - South Thang Long under Hanoi Ring Road 3 is one section of Pham Van Dong Street, which has extension of about 6 km, average road width of 24.7m and consists of 4 motorway lanes and two mixed lanes. This is a focal road, which serves as an important part of Hanoi Ring Road 3, and as the only one arterial road linking Hanoi with Noi Bai Airport currently. Therefore, on this road section, traffic congestion occurs frequently, especially in the peak hours.

The viaduct section of Mai Dich - Bac Linh Dam on Hanoi Ring Road 3 is under construction and would be brought to operation at the end of 2012. Meanwhile, a large number of vehicles, from the northern provinces would pass through Thanh Tri Bridge and the run on this viaduct section to reach Mai Dich Interchange. Therefore, the construction of the viaduct section from Mai Dich to South Thang Long becomes more and more imperative.

*"The Project for Construction of Viaduct Section Mai Dich- South Thang Long on Hanoi City Ring Road No. 3"* (hereinafter referred to as "the Project") is carried out in accordance with Decision 353/QD-BGTVT dated on 21/02/2012 on approval of preparation for the F/S of the project for construction of viaduct section Mai Dich-South Thang Long on Hanoi City Ring Road No.3. The Ministry of Transport is the agency who makes the investment decision for the Project. Project Management Unit (PMU) Thang Long is appointed as the Project Owner (Project's Employer). According to the notify 576/TB-BGTVT dated 05th September 2012 of the Ministry of Transport, the project will construct viaduct section Mai Dich - Nam Thang Long within extended the section Mai Dich – South Thang Long of RR3.

The Project has viaduct's length of about 4,803m on total length of the Project of 6,051.7m, passing the following 3 wards/ communes in Hanoi City: (1) Mai Dich Ward (Cau Giay District), (2) Co Nhue Commune (Tu Liem District), (3) Xuan Dinh Commune (Tu Liem District). Besides, Dich Vong Hau Ward (Cau Giay District) and Dong Ngac Commune (Tu Liem District) are not located in the Project area, but these

ward/commune would be affected by the Project in terms of air pollution, noise pollution, traffic congestion, v.v. during construction and operation of the Project.

## 2. Legal and Technical Basic of EIA Implementation

### 2a. Legal and Technical Basic

The EIA of the Project is carried out in accordance with legal regulations on environmental protection of Government of Japan, and with requirements from JICA (as the financial support agency).

***a1. Vietnamese Side***

- Regarding issues on environment and land use:
  - "National Law on Environmental Protection" (NLEP) was approved at the eighth session of XI$^{th}$ National Assembly of the Socialist Republic of Vietnam on November 29$^{th}$, 2005, and became effective from July 01, 2006;
  - "National Law on Land" was approved at the fourth session of XI$^{th}$ National Assembly of the Socialist Republic of Vietnam on November 26$^{th}$ , 2003;
  - "National Law on Road transportation" was approved at the fourth session of XII$^{th}$ - 4$^{th}$ round meeting by National Assembly of the Socialist Republic of Vietnam on November 13$^{th}$ , 2008 and became effective from July 01, 2009;
  - "National Law on Investment" was approved at the fourth session of XI$^{th}$ - 8$^{th}$ round meeting by National Assembly of the Socialist Republic of Vietnam on November 29$^{th}$ , 2005 and became effective from July 01, 2006;
  - "National Law on fire protection" was approved at the fourth session of X$^{th}$ - 8$^{th}$ round meeting by National Assembly of the Socialist Republic of Vietnam on June 29$^{th}$ , 2001 and became effective from October 04, 2001;
  - Decree No.59/2007/ND-CP dated April 09$^{th}$ , 2007 by The Vietnamese Government on Solid Waste Management;
  - Decree No. 29/2011/ND-CP dated April 18$^{th}$ , 2011 by Vietnamese Government on regulating Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment;
  - Circular No. 12/2011/TT-BTNMT dated on April 14, 2006 on harmful waste management;
  - Circular No.26/2011/TT-BTNMT dated July 18$^{th}$ 2011 on regulating in detail some articles of Decree No. 29/2011/ND-CP dated April 18$^{th}$ 2011 by Vietnamese Government on regulating Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) And Environment Protection

Commitment.

- Circular No.09/2010/TT-BTNMT on dated April 6th, 2010 on regulating environmental protection during transport infrastructure development;
- Circular No.02/2005/TT-BTNMT dated June 24th 2005 of Ministry of Natural Resources and Environment guiding the implementation of Decree No. 149/2004/ND-CP of July 27, 2004 of the Government;
- Circular No.13/2012/TT-BGTVT dated April 24th 2012 of Ministry of Transport amending and supplementing some articles of the No. 09/2010/TT-BGTVT Circular dated April 6th 2010 of the Minister of Ministry of Transportation regulations on environmental protection in the development of transport infrastructure;
- Decree No. 149/2004/ND-CP dated July 27 th 2004 of the Government regulations on licensing exploration, exploitation and use of water resources, discharge of wastewater into water sources;
- Decision No. 02/2004/QD-UBND dated October 1st, 2005 by Ha Noi People's Committee on regulating implementation of measures to reduce dust in the construction field in Hanoi City;
- Decision No. 55/2009/QD-UBND dated on 17/03/2009 by Ha Noi People's Committee on regulating to ensure order, safety and environmental hygiene during construction in Hanoi City.
- Decision No. 11/2010/QD-UBND dated February 23rd 2010 by Ha Noi People's Committee on regulating normal solid waste management in Ha Noi.
- Decision No. 56/2010/QD-UBND dated on December 17th 2010 on amendment and supplement of Article 13, Decision 11/2010/QD-UBND dated February 23rd 2010 by Hanoi People's Committee regulating normal solid waste management in Ha Noi.
- Circular No. 28/2011/TT-BTNMT of Ministry of Natural Resources and Environment Regulations on technical process of environmental monitoring ambient air and noise;
- Circular 29/2011/TT-BTNMT 08 dated January 01th 2011 of Ministry of Natural Resources and Environment Regulation on process monitoring techniques continental surface water environment;
- Circular No. 30/2011/TT-BTNMT of Ministry of Natural Resources and Environment technical process of environmental monitoring of groundwater;
- Circular No. 07/2010/TT-BXD July 28, 2010 of Ministry of Construction

issued national technical regulation "fire protection safety for house and works";

- Circular No. 18/2010/TT-BXD October 15, 2010 of Ministry of Construction regulations on the application of standards in construction activities;
- Decision No. 35/2010/QD-UBND August 16, 2010 of the Hanoi People's Committee Regulation on licensing exploitation of water resources, discharge of wastewater into water basins in the Hanoi City;
- Decision No. 04/2008/QD-BXD April 3, 2008 of the Ministry of Construction issued national technical standards for construction planning

– Regarding issues on project investment :

- "National Law on Construction" was approved at the fourth session of XIth National Assembly of the Socialist Republic of Vietnam on November 26th , 2003;
- Law No. 38/2009/QH12 of June 19, 2009 on amendment and supplement of some articles of Laws related to basic construction investment;
- "Road Traffic Law on" was adopted on 13th November, 2008 at the ninth session of XII th National Assembly of the Socialist Republic of Vietnam;
- Decree No. 12/2009/ND-CP dated February 10th, 2009on management of construction investment projects by the Vietnam Government;
- Decree No.209/2004/ND-CP dated December 16th 2004 on quality management of construction works and Decree No.49/2008/ND-CP dated on April 18th, 2008 on amendment and supplement of some articles of Decree No.209/2004/ND-CP.
- Decree No.99/2007/ND-CP on management of construction investment cost issued and Decree No.03/2008/ND-CP dated January 07th, 2008 on amendment and supplement of some articles of Decree No 99/2007/ND-CP;
- Decision No. 1327/QD-TTg dated August 24th , 2009 by Prime Minister on approval of the master plan on road traffic development in Vietnam to 2020, with orientations toward 2030
- Document 945/CP-KTN dated August 13th , 1998 by Prime Minister on approval of Feasibility Study (F/S) Report of Hanoi No.3 ring road construction project.
- Document of the ROW of Mai Dich – South Thang Long section under Hanoi Ring Road No.3 was approved by Hanoi People's Committee in Decision No.

76/QD-UB dated May 20th, 2005.

- Decision No. 103/QD-BGTVT dated January 14th, 2010 by Ministry of transport on approval of the widening project for Mai Dich – Noi Bai Section under Hanoi Ring Road No.3
- Decision No 3265/BGTVT-KHDT dated May 21st 2010 by Ministry of Transport on changing management function of Widening Project for Mai Dich to Noi Bai under Hanoi City Ring Road No.3
- Document No.1308/TTg-KTN dated July 23rd 2010 by Prime Minister on the transfer forms and sources of investment capital expansion project Ring Road 3 section Mai Dich - Noi Bai by BT Contract
- Document No. 187/QD-TTg dated February 13th 2012 by Prime Minister on agreeing policy of using unused balance loan from the Project of construction from Mai Dich – North Linh Dam Lake, Phase 2 so to prepare F/S for the project of construction for Mai Dich - Nam Thang Long viaduct;
- Decision 353/QD-BGTVT dated February 21st 2012 by Ministry of Transport on permit to preparation of FS for Mai Dich - South Thang Long viaduct project under Ring Road No.3, Hanoi;
- Notify 576/TB-BGTVT dated September 05th 2012 by Ministry of Transport on the conclusion of Deputy Minister Nguyen Hong Truong at the meeting of progress of construction projects along the RR3 – Ha Noi City.

– Other related documents.

***a2. On the JICA Side***

JICA Guidelines for Environmental and Social Considerations, 2010 (The project is A Category).

## 2b. Standards and Criteria

– QCVN03:2008/BTNMT, National technical standard on permissible limits of heavy metals in soils;

– QCVN05:2009/BTNMT. National technical standard on surrounding air quality;

– QCVN06:2009/BTNMT. National technical standard on some hazardous substance in surrounding air;

– QCVN09:2008/BTNMT, National technical standard on underground water quality;

- QCVN14:2008/BTNMT, National technical standard on domestic waste water;
- QCVN26:2010/BTNMT, National technical standard on noise level;
- QCVN27:2010/BTNMT, National technical standard on vibration level;
- QCVN07:2010/BTNMT, National technical standard on hazardous waste;
- QCVN 01:2008/BXD, National technical standard on construction planning;
- TCVN 6707:2009/BTNMT, hazardous waste - Warning signs and prevention;
- TCVN6705:2009/BTNMT, General solid waste - TCVN6706:2009/BTNMT on the classified hazardous waste;
- QCVN40:2011/BTNMT, National technical standard on industrial waste water;
- TCVN7210:2002 Vibration and shock. Vibration from road vehicles–permissible limits for environment of public and residential areas;
- Environmental standards of National Organizations as World Health Organization (WHO) and FAO – ISO – 9000; Canada Standard on deposit

**c. Documents and Data Made by the Project Owner**

Documents and data made by the Project Owner include:

- Report on Project for Construction of Viaduct Section Mai Dich – South Thang Long on Hanoi City Ring Road No.3 – Preparation of Feasibility Study.
- Results of survey of environmental resources, socio-economic condition in the project area, carried out by Environmental Consultancy Center - TEDI in February and March of 2012.
- Results of environmental survey (carried out by Environmental Consultancy Center – TEDI under contract with the Project Owner) in February and March of 2012,including survey on ambient air quality, noise, vibration, groundwater quality. Details of the environmental survey (sampling locations, parameters, frequency, measurement time, etc. are presented in the section on quality of the current physical environment in Chapter 2 of this report. In addition, three rounds of public consultation meeting were carried out (according to requirement of Vietnam and JICA) to disseminate information on the Project and concurrently collect comments/ opinions of affected people and other relevant entities, as mentioned in Chapter 6.

  Method to collect data was determined by experienced experts. The above-mentioned EIA surveys were carried out at the same time with other technical surveys for the Project investment; therefore, the data obtained through the surveys

are credible.

## 3. Methods applied for Environmental Impact Assessment (EIA)

### 3a. Methods of EIA

#### *a1. Statistical method*

The statistical method was applied to process data on natural conditions, hydrometeorology, socio-economic condition in Hanoi City, etc. Results of the data processing are described in the sections on current natural environment conditions (topography, geology, meteorology and hydrology) and socio-economic conditions of the Project area) of Chapter 2.

#### *a2. Method of Comparison*

This method was used to assess the existing environmental condition and the predicted impacts, by comparing the observed data or results of the prediction with the permissible limits stated in Vietnam National Standards, Vietnam National Technical Regulations, or other standards determined by the international organizations. The use of this method is described in the sections on existing condition of physical environment components in Chapter 2.

#### *a3. Quick-Assessment Method*

This method, set up by World Health Organization, was used in this report to estimate quantity of air pollutants emitted by the traffic flow, etc., and pollutants contained in wastewater generated by the Project activities. The use of this method is described in Chapter 3, sections on prediction of air pollutants, concentration of dust, pollutants in wastewater, etc.

#### *a4. Listing Method*

Listing method was used in many parts of this report. For example, it was used to recognize impacts in Chapter 3, Section 3.2: Impact Assessment in Construction Phase.

#### *a5. Model Method*

Model method includes:

- Gauss model, to predict concentrations of air pollutants (TSP, $SO_2$, CO, $NO_2$) dispersed on air.
- ASJ model 2003 (Japan), to predict noise levels, and effectiveness of the noise barriers.

The use of these models is described in Chapter 3, prediction of air pollutant concentration, prediction of noise levels during operation phase, etc.

*a6. Method of Expert*

This method was used through out all tasks of the EIA Study: from the step to prepare TOR of EIA, determine the scope of the study, to the steps to identify the environmental issues, carry out surveys on natural and ecological conditions, identify and analyze and propose the impact mitigation measures, establish the environmental monitoring program, etc. The use of this method is described in all chapters of this report.

**3b. Other Methods**

*b1. Method of social survey*

This method was used to:

- Investigate, interview the officials of communes/wards to collect data and information on local socio-economic condition, potential sources of pollution, etc., as well as their requests/expectations relating to the Project.
- Investigate, interview the key persons in the Project area to collect information on the issues relating to environmental protection.

The use of this method is described in Chapter 2, section on socio-economic conditions of the Project area.

*b2. Method of quantifying environmental quality*

The following equipments are used to take samples, and measure the parameters on environmental quality. Sampling sites are identified by the use of GPS equipment.

- Measurement of parameters on air quality
    - Using POCKET WEATHER TRACKER 4500, produced by Kestrel firm (America) to determine temperature, humidity, pressure, wind velocity and direction.
    - Using DUST TRAK MODEL 8520 AEROSOL MONITOR, made in Japan to determine concentration of SPM, PM10.
    - Sampling and analyzing in accordance to TCVN 5971:1995, TCVN 6137:1996 and TCN 325:89 BYT to determine concentration of toxic gas : CO, $NO_2$, $SO_2$.
- Measurement of parameters on noise and vibration
    - Using INTEGRATING SOUND LEVEL METER TYPE 6226, produced by ACO Co. Ltd (Japan) to measure noise.
    - Using VIBRATION LEVEL METER VM-1220E, produced by IMV

Corporation (Japan) to measure vibration.

- Measurement of parameters on groundwater quality
  - Taking water sample by American equipment. Treating and preserving water sample in accordance to TCVN 6663–14:2000, ISO 5667–14:1998;
  - Using WATER QUALITY CHECKER MODEL WQC-22A, produced by DKK-TOA Corporation (Japan) to measure unstable criteria: temperature, pH, conductivity, turbidity and DO.

The use of this method is described in Chapter 2, section on existing quality of physical environmental components.

***b3. Method of analysis and processing in laboratory***

Methods for analyzing groundwater and air samples are complied with Vietnam Standards on environment in 1995, 1998 and 2001. Analysis method is described in detail in Appendix. Water samples and air samples are analyzed by the Environmental Laboratory under Environmental Research Center - Institute of Meteorological and Hydrological. Environmental Laboratory was coded VILAS 255 and certified by the Quality Office - Directorate for Standards, Metrology and Quality.

The used of this method is described in Chapter 2, sections on existing quality of physical environment components.

## 4. Organization Implementing EIA

EIA report of the Project is prepared by representatives of the Project Owner (PMU Thang Long) with assistance from Transport Engineering Design Incorporated (TEDI) in association with Oriental Consultants Co., Ltd (OC).

- Project Owner: PMU Thang Long

✓ Representative: Vu Xuan Hoa Position: General Director

✓ Address: Group 23, Linh Nam Ward, Hoang Mai District, Ha Noi

✓ Tel: 04. 6430206 Fax: 04. 36430212

Consultants: Transport Engineering Design Incorporated (TEDI) in association with Oriental Consultants Co., Ltd (OC).

*Transportation Engineering Design Incorporated (TEDI)*

✓ Representative: Mr. Pham Huu Son Position: General Director

✓ Address: 278 Ton Duc Thang Street, Dong Da District, Hanoi City

✓ Telephone: 04.38514431 Fax: 04.38514980

*Oriental Consultants Co., Ltd. (OC)*

- Representative: Hiroaki Mukaichi Position: Project Director
- Address: 13rd floor, Tower B, Handi Resco Tower, 521 Kim Ma Street, Ba Dinh District, Ha Noi City.
- Tel: 04.37246906 Fax: 04.37246903

The following experts have involved in the preparation of this EIA report:

| | | | |
|---|---|---|---|
| 1 | Vu Xuan Hoa | Project owner's representative | General Director of PMU Thang Long |
| 2 | Do Minh Dung | Executive director of the project | Vice General Director of Transport Engineering Design Incorporated (TEDI) |
| 3 | Pham Van Xuan MA. Environmental Management - Environmental Geology. | Team Leader of EIA | Environmental Consultancy Centre (TEDI–ENVICO). |
| 4 | Nguyen Thanh Chinh MA, Environmental science | Environmental experts. | ditto |
| 5 | Eng. Pham The Giang, Environmental Hydrology | ditto | ditto |
| 6 | Bachelor Nguyen Dinh, Environmental science. | ditto | ditto |
| 7 | Engineer Nguyen Thi Hong Van, Environmental Economic | ditto | ditto |
| 8 | Bachelor Tran Phuong Lan, Environment Management, Environment's Law and Policy. | ditto | ditto |
| 9 | Bachelor Dang Vu Hien, Ecology | ditto | ditto |
| 10 | Le Viet Thang MA, Environmental Science and technical | ditto | ditto |
| 11 | Bachelor Pham Thanh Hao, Environmental Economic | ditto | ditto |
| 12 | Bachelor Bui Nguyen Pho, Environmental science. | ditto | ditto |
| 13 | Bachelor Le Viet Cao, Environment technology. | ditto | ditto |
| 14 | Bachelor Ngo Thi Thanh Hoa, Environmental technical. | ditto | ditto |
| 15 | Mr Koichi Oharu | Team leader | Oriental Consultants |

| | | | |
|---|---|---|---|
| | | | Company (OC) |
| 16 | Mrs Mihoko Ogasawara | Environmental and social experts | ditto |
| | And others | | |

# CHAPTER 1. BRIEF DESCRIPTION OF THE PROJECT

## 1.1. Name of Project

Project for Construction of Viaduct Section Mai Dich – South Thang Long on Hanoi City Ring Road No.3.

## 1.2. Project Owner

Organization of investment decision: Ministry of Transport (MOT)

- Address: 80 Tran Hung Dao Street, Hoan Kiem District, Hanoi City
- Tel: 04.9424015; Fax: 84.04.9423291

Project Owner: Thang Long Project Management Unit

- Representative: Mr. Vu Xuan Hoa Position: General Director
- Address: Group 23, Linh Nam Ward, Hoang Mai District, Ha Noi City
- Tel: 04. 36430206 Fax: 04. 36430212

## 1.3. Location of the Project

The Project plan is to construct a viaduct with a total length of 4,803m on the total length of Project of 6,501.7m, starting from northern part of Mai Dich Interchange and ending at the southern part of Thang Long Bridge on Hanoi City Ring Road No.3. Coordination of the starting point and the ending point of the project are as following.

| Items | Starting point (Km 0-558) | Ending point (Km5+500) |
|---|---|---|
| Location on Ring Road No.3 | South side of existing Mai Dich Flyover | South side of existing Thang Long Bridge |
| Coordination | N: 2326643.0030<br>E: 580849.2560 | N: 2332571.1890<br>E: 581615.7340 |

The Project area is located in the north side of Ha Noi City. It passes through territories of 3 wards/communes of 2 districts of Ha Noi City (i.e. Mai Dich Ward of Cau Giay District; Co Nhue Commune, and Xuan Dinh Commune of Tu Liem District). Besides, Dich Vong Hau Ward (Cau Giay District) and Dong Ngac Commune (Tu Liem District) are located near the Project area, and would be affected to some extent by the Project in terms of air pollution, noise, traffic congestion, etc. The Project alignment is almost the same one of the existing Pham Van Dong Street.

Characteristics of the Project site can be summarized as follows:

Topography: The Project area is located in downstream of the Red River Delta and limited by the Red River in the north, Ho Tay in the east, Nhue River in the west and residential area in the south, the Project site topography is relatively flat, elevation changes from +7 m ~+10 m and is divided by several drainage channels connecting Nhue River with HoTay Lake (Cau Da ditch - KM2+150, ditch KM3+100, etc.). The populated residential areas are limited by the roads with many narrow-long typed houses standing along the road.

The planned viaduct will not change the topographical characteristic of the land. It will also not affect the flows of the channels existing in the area. However, construction activities during construction phase may cause encroachment to or blockage of the flows of the drainage channels. Measures to mitigate these impacts should be taken into consideration during the project design. In addition, measures to mitigate impact to landscape of the area should also be taken into account.

Transportation: Pham Van Dong Street intersects with a series of urban roads (Ho Tung Mau – Xuan Thuy – Cau Giay; Hoang Quoc Viet, Xuan Dinh – Tan Xuan…) and other local roads. Roads in the Project area are generally paved and are taking very important role to the local socio- economic activities. However, traffic on these roads are generally heavy, and traffic jams are frequently occurred, especially during peak hours (between 6:00~8:00 and 16:00~18:00). In addition, during all night time (after 21:00), there is a large number of heavy trucks moving on Pham Van Dong Street. The Project would contribute to improve the traffic jam condition on the Ring Road No.3 and the surrounding roads. However, during construction phase, accessibility to the buildings along the construction site would be disturbed, and traffic jam would be occurred more at the intersections around the Project site, if without proper mitigation measures.

The project goes along the existing Pham Van Dong road and goes through many residential area as well as cut through some of works such as electrical lines, drainage canal. These works can be affected by construction activities of the project.

Specific works including:

Electrical lines: the project alignment cut through high voltage line system (with 2 poles and 300m of electrical cable, the height of electrical line is 10 to 15m from ground.

Ditches: the project alignment cut through the ditches with the width of 2 to 5m at locations Km2+150 and km3+100.

Light poles: Light lamp system is located in centre line and pavement along the roadsides of existing Pham Van Don. There are total of 568 light poles.

Conservation Area: The Project is located in the inner suburbs of Hanoi City where urban ecosystems dominated. Around the Project area, there is no site which is designated as nature reserve area with ecological value.

The relationship between project with plans:

The project is located in Hanoi ring road No.3 planning (this planning is completed). Detail of Hanoi ring road No.3 is presented in figure 1.1

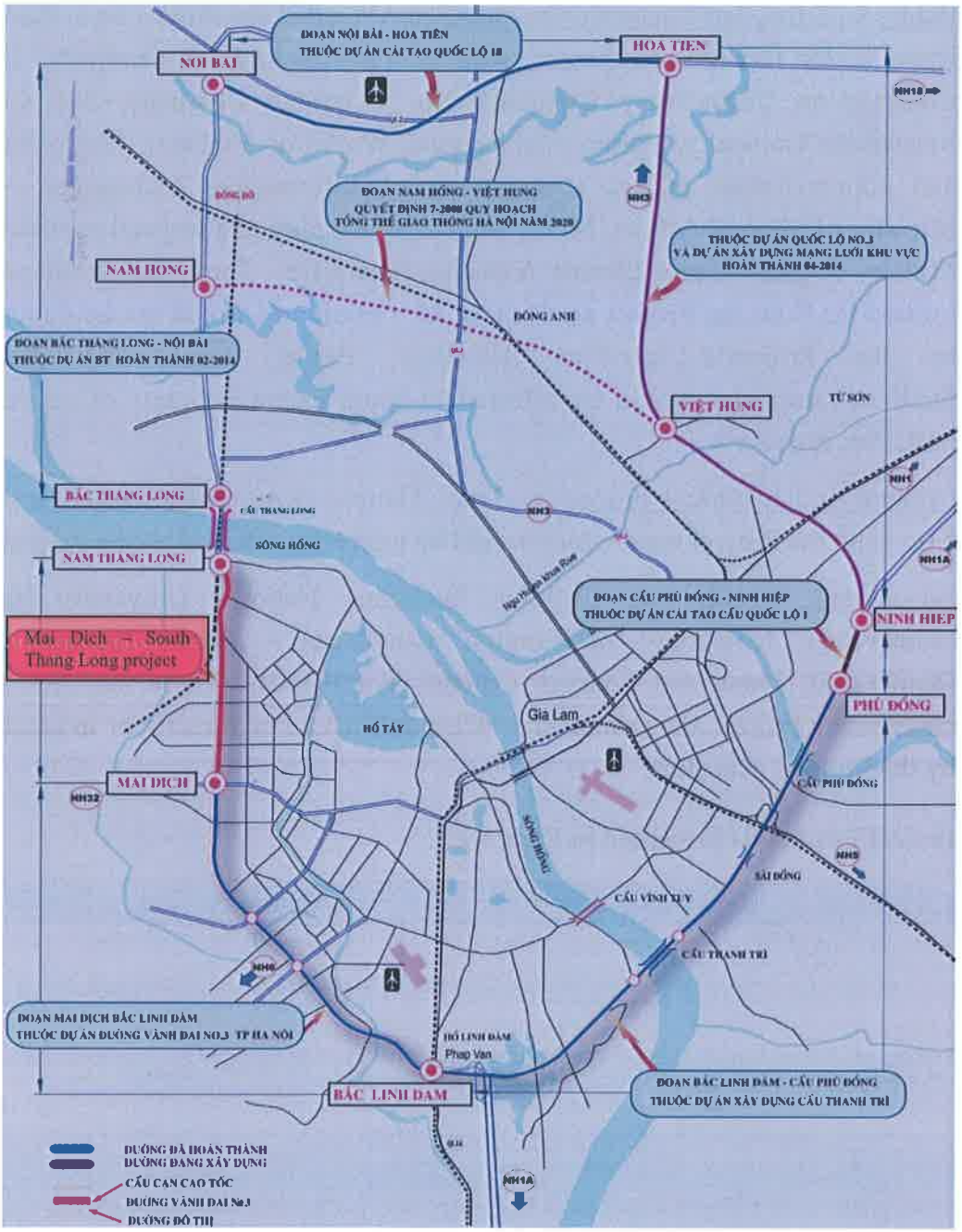



**Figure 1.1. Hanoi ring road No.3 planning map**

Residential area: Project area is densely populated, which create residential areas with high population density. The populated residential areas include Mai Dich Residential Area (Km0+660 ÷ 1+200); Co Nhue Residential Area ((Km2+150 ÷ 2+840); Xuan Dinh Residential Area (Km3+730 ~ Km4+920). Alternating between the residential area is agricultural land, administrative area and vacant land... Residential objects though not relocated but are directly affected by the activities of the Project according to the different levels.

Public facilities, large scaled companies, etc.: Around the Project area, there are many large- scaled facilities/companies, such as: 136 Construction Company, Thang Long Construction Consultancy Company No. 4 Bridge Company, 386 Construction Investment Company, Public Architectural Works of Vietnam, Metro Supermarket, and administrative offices (Department of Information Technology - MONRE, Ministry of Internal Affairs, Motor vehicle registration and inspection stations, Capital Military Region, Hanoi Electric Vehicles Enterprise). These facilities/companies are located far from the Project area (about 25 ÷ 60m) and would not be directly affected by the Project's activities. However, during construction phase, these facilities/companies would be affected to some extent in terms of accessibility, air pollution, noise, etc.

Cultural and historical properties: Gian Temple (Km4+320) located approximately 51m from the Project area, which would be indirectly affected by the Project.

Educational, health care facilities: Including National University Headquarters (Km0+100), University of Foreign Languages - Hanoi National University (Km0+270), Trade and Tourism College (Km0+360)... These facilities are located close to the Project site (about 21 ÷ 47m) and would be directly or indirectly affected by the Project' activities.

Project location is presented in Figure 1.2.

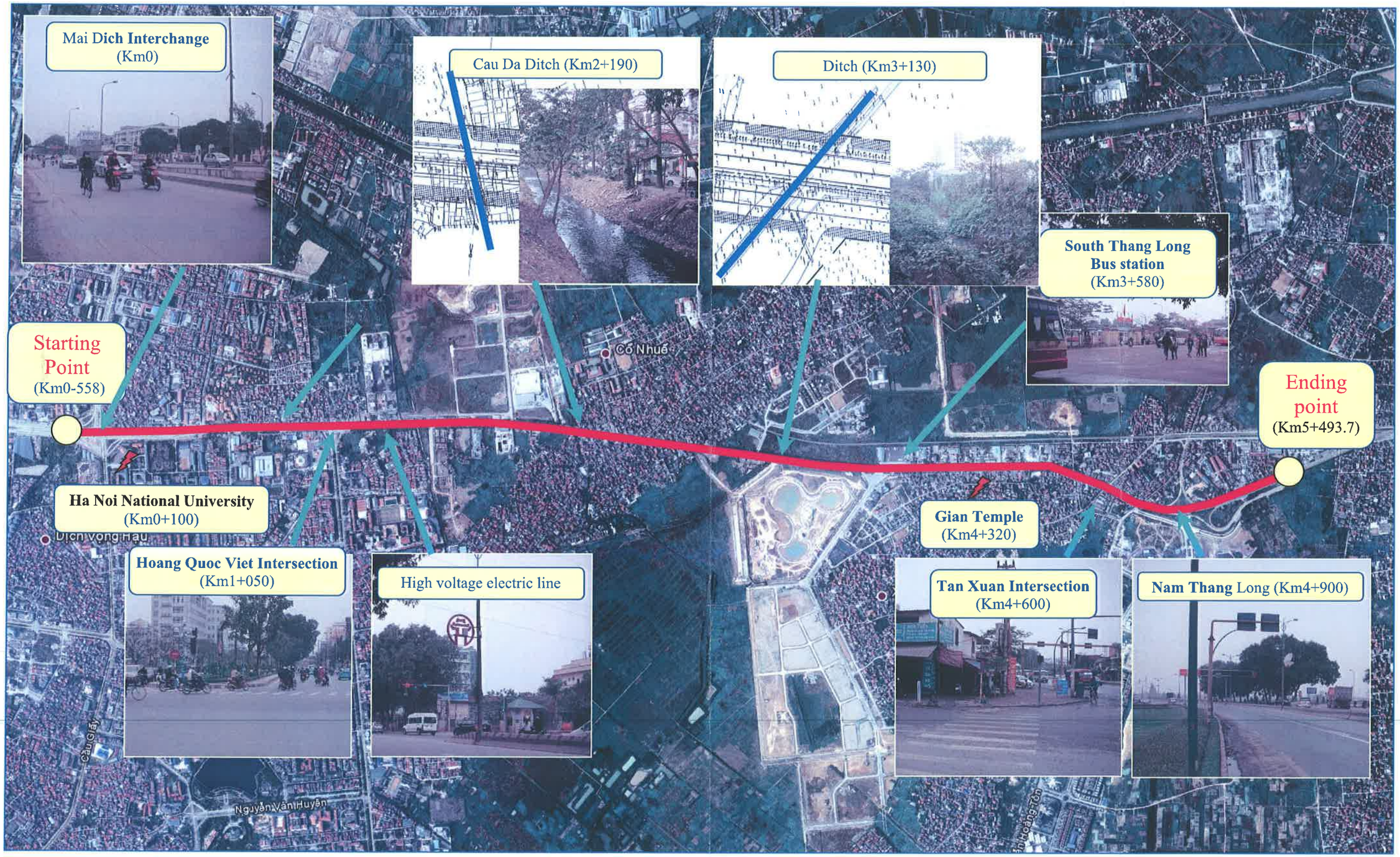



**Figure 1.2. Map of the Project Geographic Location**

Alignment of the planned viaduct is almost similar to the alignment of the existing Pham Van Dong Street. However, there are several alternatives on the location of the beginning point and the ending point of the planned viaduct as followings.

(1) Beginning Point

Mai Dich Flyover (F/O) has been in service for Urban Road at beginning point of the Project Section. Currently, construction work of viaduct was completed under Hanoi City Ring Road No. 3 Construction Project (H3RR Project) until south side of Mai Dich F/O. If Mai Dich F/O is remained and utilized as expressway viaduct for H3RR, vertical alignment of expressway viaduct become undulant as shown in Figure 1.3

However, it might be possible to set straight vertical alignment as alternative if Mai Dich F/O is demolished and reconstructed as expressway viaduct or North side of retaining wall for Mai Dich F/O is demolished.

Therefore, this study confirms the possibility of improvement for vertical alignment and compares them.

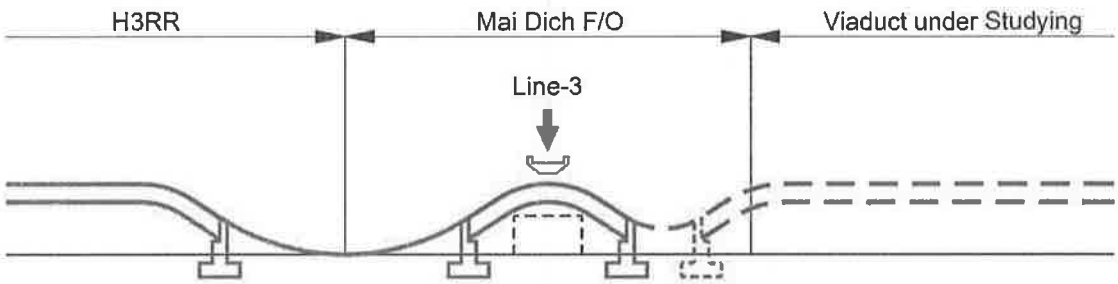



**Figure 1.3. Image of vertical alignment around beginning section**

There are three alternatives of beginning the end point of the Expressway Viaduct being considered (Figure 1.4).

According to comparing results based on a synthesis assessment of 3 factors, consisting of technique, economy and environment, Alternative-2 was selected.

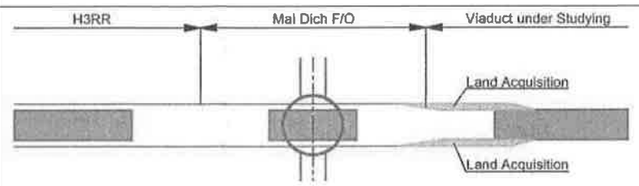
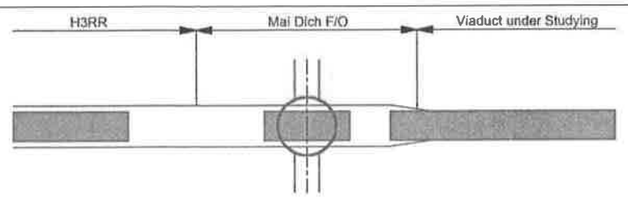
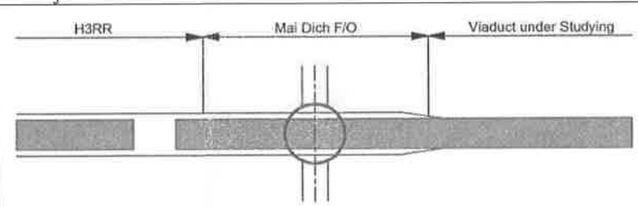
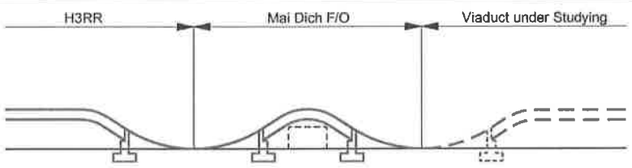
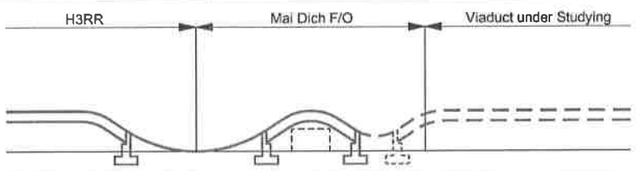
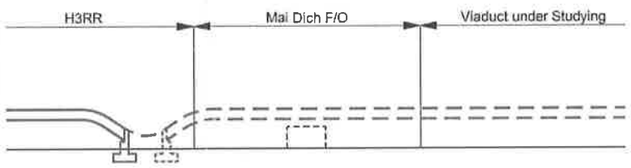
| Alternative | | Alternative-1 | Alternative-2 | Alternative-3 |
|---|---|---|---|---|
| Summary | | • Mai Dich F/O is utilized as the Expressway.<br>• Mai Dich F/O and expressway viaduct by the Project are connected at grade sections. | • North side of retaining wall for Mai Dich F/O is demolished.<br>• New viaduct is connected just after abutment of Mai Dich F/O. | • Existing Mai Dich F/O is demolished.<br>• New viaduct is connected to viaduct by H3RR Project directly, with the demolition of some section of retaining wall constructed by H3RR Project. |
| Figure | Plan |  |  |  |
| | Profile |  |  |  |
| Land Acquisition | | - 25 households need to be relocated.<br>Because of: - Long length of unutilized under viaduct as frontage road | • **No requirement**<br>Because of: - Utilization under viaduct as frontage road at narrow area | • **No requirement**<br>Because of: - Utilization under viaduct as frontage road at narrow area |
| Construction Cost | | - **Cheapest among alternatives**<br>Because of: - Shortest length of expressway viaduct<br>- No demolition of structure | • Expensive but cheaper than Alternative 3<br>Because of: - Demolition of retaining wall<br>- Length of expressway viaduct becomes shorter than Alternative 3. | • Most Expensive among alternatives.<br>Because of: - Long construction length of viaduct<br>- Demolition of Mai Dich F/O<br>- Demolition of retaining wall |
| Profile of the Expressway | | - Profile has the successive upgrade and downgrade, but it meets the criteria. | - Vertical alignment has the successive upgrade and downgrade, but it meets the criteria. | - **Good vertical alignment is provided.** |
| Constructability | | - **There is no impact to the existing traffic in Mai Dich Intersection.**<br>- **H3RR need not be demolished.**<br>- **There is almost no impact to the traffic in expressway viaduct by H3RR.** | - North side of Retaining wall of Mai Dich F/O must be demolished in order to connect with expressway viaduct by the Project.<br>- During construction of expressway viaduct, Mai Dich F/O needs to be closed for Traffic.<br>- **H3RR need not be demolished.** | - There is big impact to the existing traffic in Mai Dich Intersection during demolition of existing F/O and construction of new viaduct.<br>- Some section of Retaining wall by H3RR Project must be demolished in order to construct the new viaduct.<br>- Temporary ramp must be constructed at the end point of H3RR Project during the construction of new viaduct to secure the traffic flow. |
| Recommendation | | | **Recommended** | |
| | | • Alternative-2 is recommended for the following reason.<br>- Land acquisition is not required.<br>- Construction cost is cheaper than Alt-3.<br>- Almost no impact to the traffic in expressway viaduct by H3RR Project | | |

**Figure 1.4. Comparison of Development Plan around Beginning Point**

(2) Ending Point

H3RR is constructed by a viaduct, and connected to the existing Thang Long Bridge at the end point. According to existing condition as shown in Figure 1.4, there is large residential area and main signalized intersection in this area near this interchange. Therefore, the study of this section should be carried out considering the impact to these important factors.


**Figure 1.5. Existing Condition of South Thang Long Interchange**

The comparison study regarding vertical alignment around the end point was carried out among following three alternatives in accord with above existing condition (Figure 1.6).

According to comparing results based on a synthesis assessment of 3 factors, consisting of technique, economy and environment, Alternative-2 was selected.

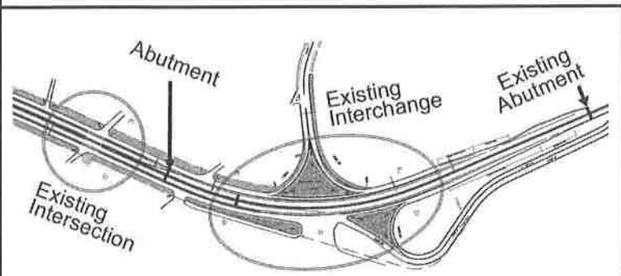
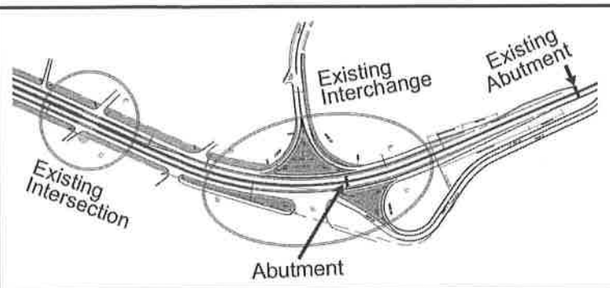
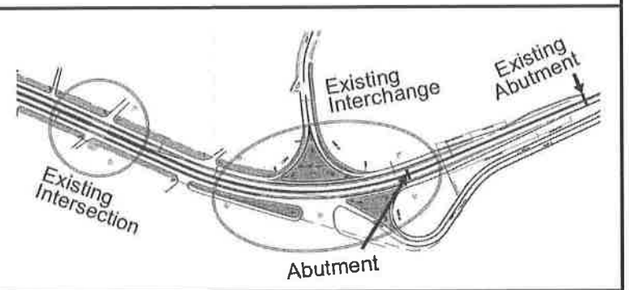
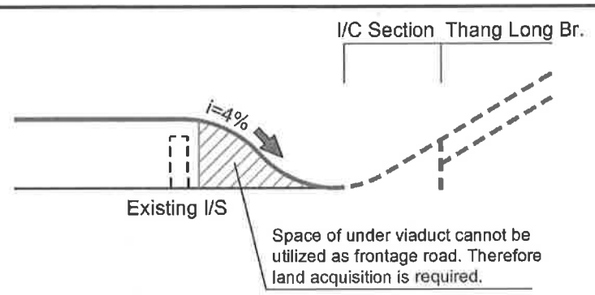
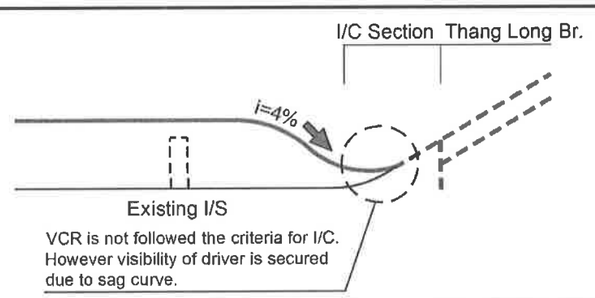
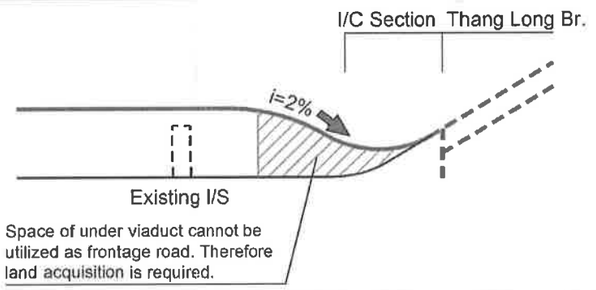
| | | Alternative-1 | Alternative-2 | Alternative-3 |
|---|---|---|---|---|
| Summary | | • End point of the viaduct (abutment) is located just after existing intersection.<br>• At-grade section is provided between existing interchange and existing abutment. | • End point of the viaduct (abutment) is located in the existing interchange.<br>• At-grade section is provided between existing interchange and existing abutment. | • End point of the viaduct (abutment) is located just before existing abutment.<br>• Almost all of the section is constructed as a viaduct. |
| Figure | Plan |  |  |  |
| | Profile |  |  |  |
| Advantage | | • Interchange section is secured vertical elements of 100km/h for Interchange. | • Land acquisition is not required.<br>• Abutment can be constructed easily with large construction yard by using island in the existing interchange. | • Interchange section is secured vertical elements of 100km/h for Interchange.<br>• Space below the viaduct can be utilized for the Highway. |
| Disadvantage | | • Land acquisition is the largest among alternatives. (Required 60 households relocation) | • Interchange section is not secured vertical elements of 100km/h for Interchange. | • Land acquisition is required. (Required 25 households relocation)<br>• Temporary ramp is required at the end point of Thang Long Bridge during the construction<br>• Large improvement is required for the existing interchange. |
| Recommendation | | | **Recommended** | |
| | | Alternative-2 is recommended from the following points of view.<br>• Land acquisition is not required.<br>• Large improvement is not required for existing interchange and the end point of Thang Long Bridge.<br>• Space below the viaduct can be utilized until just before existing interchange.<br>• Large construction yard is secured for the construction of abutment.<br>• *Although VCR (R=4500) is not followed the criteria for interchange, it is not affected to driver because interchange section is sag curve. Or if design speed is reduced to 80km/h, VCR is followed the criteria for interchange.* | | |

**Figure 1.6. Comparison of Development Plan around Beginning Point**

## 1.4. The Essential Content of Project

### 1.4.1. The Objective of the Project

The Project objective is to construct the viaduct section from Mai Dich to South Thang Long on the Hanoi City Ring Road No. 3. This viaduct section, after construction, would help to mitigate traffic congestion on the current Ring Road No.3, and consequently contribute to the socio-economic development of the City.

### 1.4.2. The Project Main Items

The main content of the Project is to build a express viaduct and 2 ramp in south of Mia Dich interchange, as well as completing the South Thang Long interchange. Total length of viaduct is 4,803m along the road lanes of the existing Pham Van Dong Street from Mai Dich Intersection to South Thang Long Bridge.

#### *1.4.2.1. Scale of Project*

- Starting point of the Project: km 0-558, south side of existing Mai Dich Flyover
- Ending point of the Project: km 5+493.7, south side of existing Thang Long Bridge
- Total length of the Project: 6,051.7m
- Starting point of Expressway Viaduct: 0+248.9
- Ending point of Expressway Viaduct: 5+39.9
- Total length of Expressway Viaduct: 4,791.0m
- Width of the viaduct: 24.0m.
- Technical specification: expressway with type A, grade of 100, 4 lanes. Design speed is 100 km/h.
- Study area: on Pham Van Dong Street with 24.7m in the width and 23.0m for some sections.
- For the urban road below: Constructing the new road structure for section that have to dig up during construction stage, new carpets the road surface by asphalt concretes with high porosity.

#### *1.4.2.2. Viaduct*

(1) Vertical Alignment

From the beginning point at Km-0 +558 is located in the south of the Mai Dich Bridge to M10 abutment of Mai Dich Bridge, vertical alignment is the same as present. From M10 abutment of the Mai Dich Bridge forward, vertical alignment goes up with a

slope of 4% connected to the viaduct (north side of retaining wall for Mai Dich F/O is demolished). From station of km4 +750, vertical alignment goes down with a slope 4% and connected to the approach road of Thang Long Bridge and ending at the ending point of the Km5 +500.

(2) Scale of cross section: viaduct is designed with the following scale

| | | |
|---|---|---|
| + | Express carriageway: | 4 x 3.75 = 15.00m |
| + | Emergency lanes: | 2 x 2.50 = 5.00m |
| + | Median strip: | 1 x 1.50 = 1.50m |
| + | Safety lanes: | 2 x 0.75 = 1.50m |
| + | Concrete Barrier: | 2 x 0.50 = 1.00m |
| | ***Total width:*** | ***= 24.00m*** |

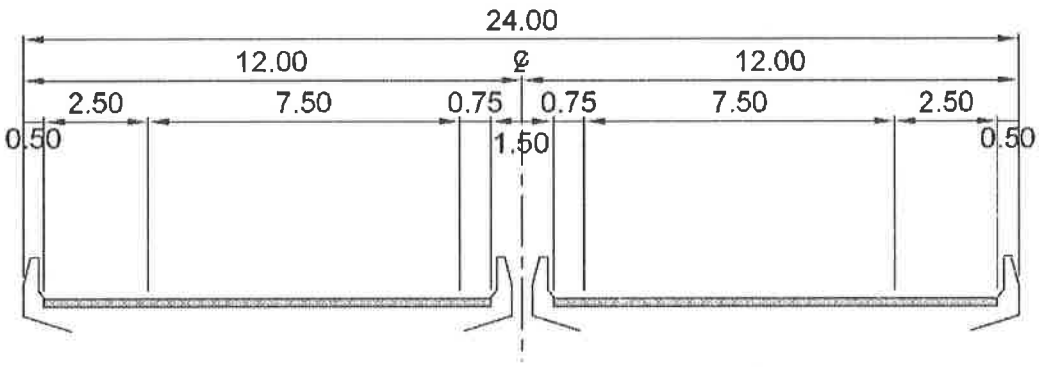



**Figure 1.7. Viaduct Cross Section**

(3) Scale design

Project is expected to be divided into the following four sections:

+ Narrow Section that with densely populated area in the ROW (From the beginning point Km0.248.9 to Km1 +240, Km2 +120 ÷ Km2 +760, and Km4+300 to ending point);

+ Standard section (From Km1 +240 ÷ Km2 +120, Km2 +760 ÷ Km 3 +400 and Km3+640 to Km4+300).

**Table 1.1. Scale of Viaduct Design according to Sections**

| Component | Narrow Section | Standard Section | |
|---|---|---|---|
| | | **Standard Section No.1 and No.2** | **Standard Section No.3** |
| Centre line | The centre line of express viaduct is the same as centre lines of the planning and existing Pham Van Dong street. | | |
| Sub-structure | Pier type: T-shaped pier column type, pier head of pres-tress concrete (located on the future median of Pham Van Dong street expansion). | | |
| | Foundation structure: reinforced concrete pile cap; rotation steel pipe pile with diameter D = 1.3 m. | Foundation structure: reinforced concrete pile cap; bored pile with diameter D = 1.5 m. | Foundation structure: reinforced concrete pile cap; rotation steel pipe pile with diameter D = 1.3 m. |
| Super-structure | Super T girder. | Super T girder. | |

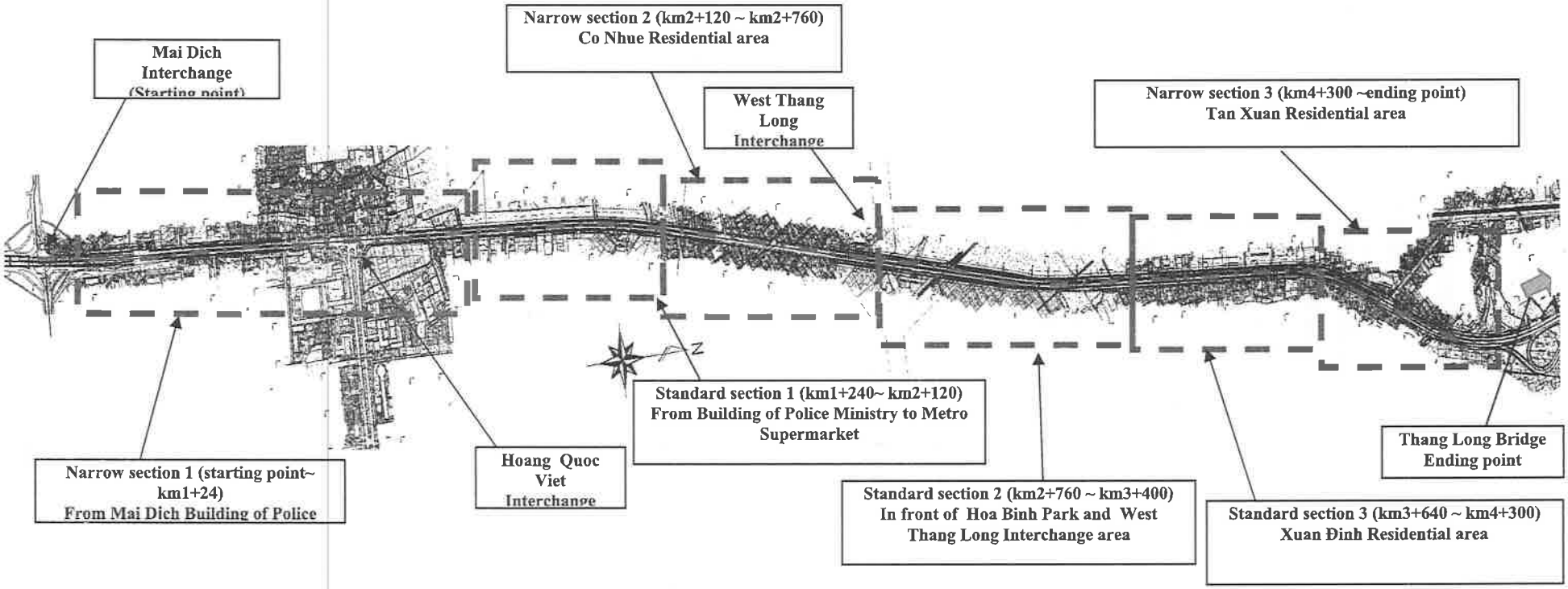



**Figure 1.8. Plan View of the Project's Sections**

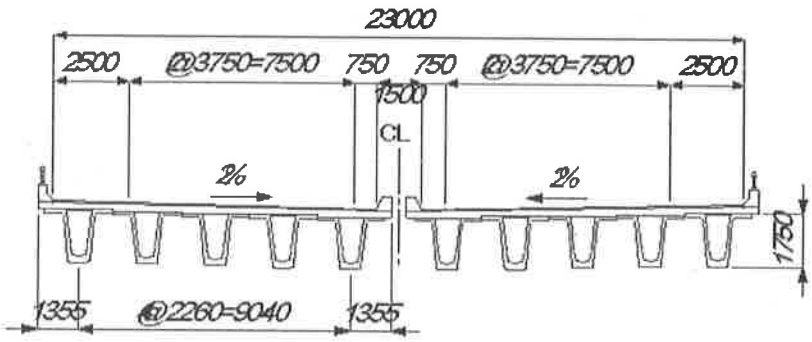



**Figure 1.9. Cross Section of Super-structure - Super T girder**

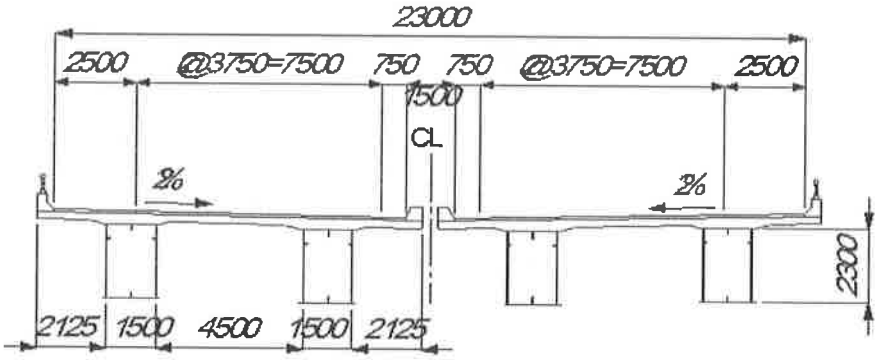



**Figure 1.10. Cross Section of Super-structure - Steel Box Girder**

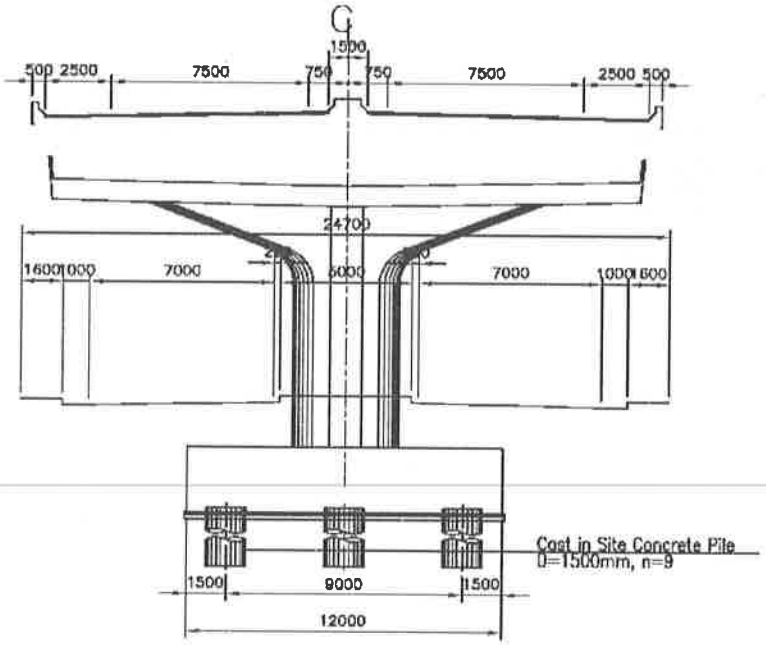



**Figure 1.11. Pier Type and Bored Pile Foundation D=1500**

**- Standard Section**

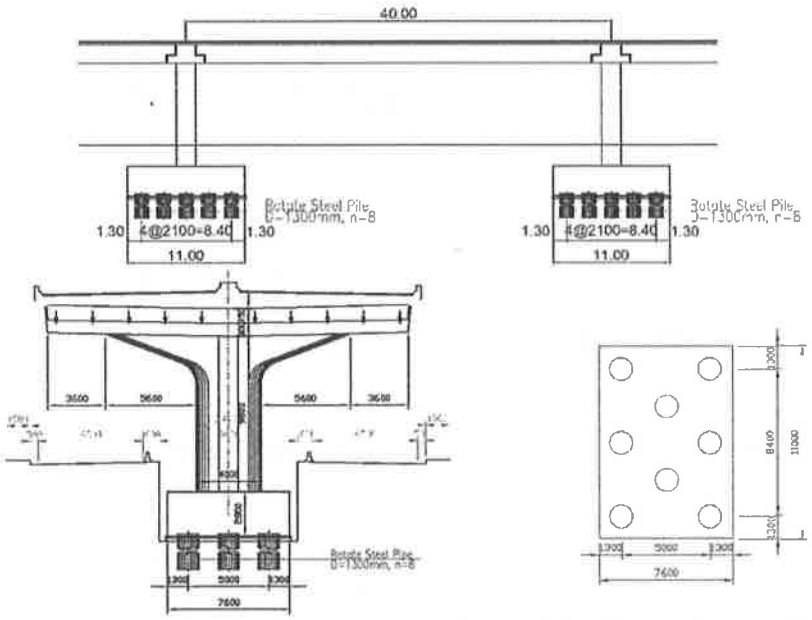
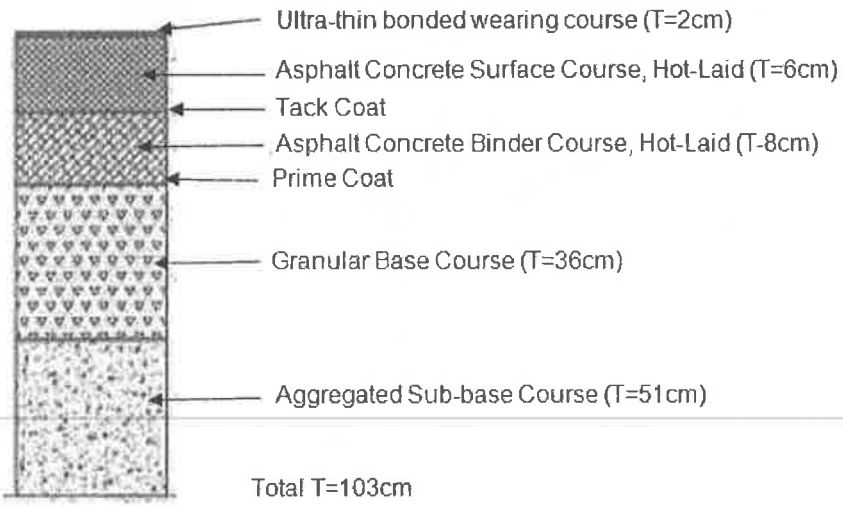



**Figure 1.12. Pier Type and Rotation Steel Pile Foundation D=1300 - Narrow Section**

(4) Pavement structure on viaduct

- Asphalt concrete surface (T=7cm)
- Ultra-thin bonded wearing course (2cm)

(5) Pavement structure on the road behind abutment




### *1.4.2.3. Urban Road*

Typical cross section of Urban Road consists of following components:

- Median: 1x5.00m = 5.00m
- Inner safe line: 2x0.25m = 0.50m

- Carriageway: 4x3.50m = 14.00m
- Outer safe line: 2x2.60m = 5.20m (average)
  2x1.50m = 3.00m (minimum)

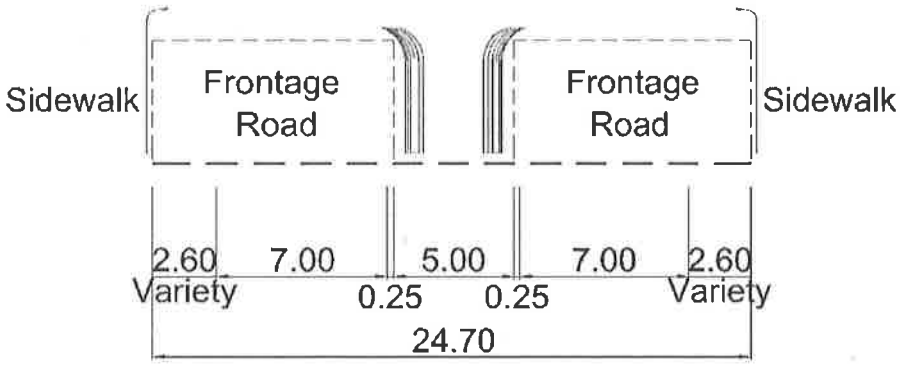
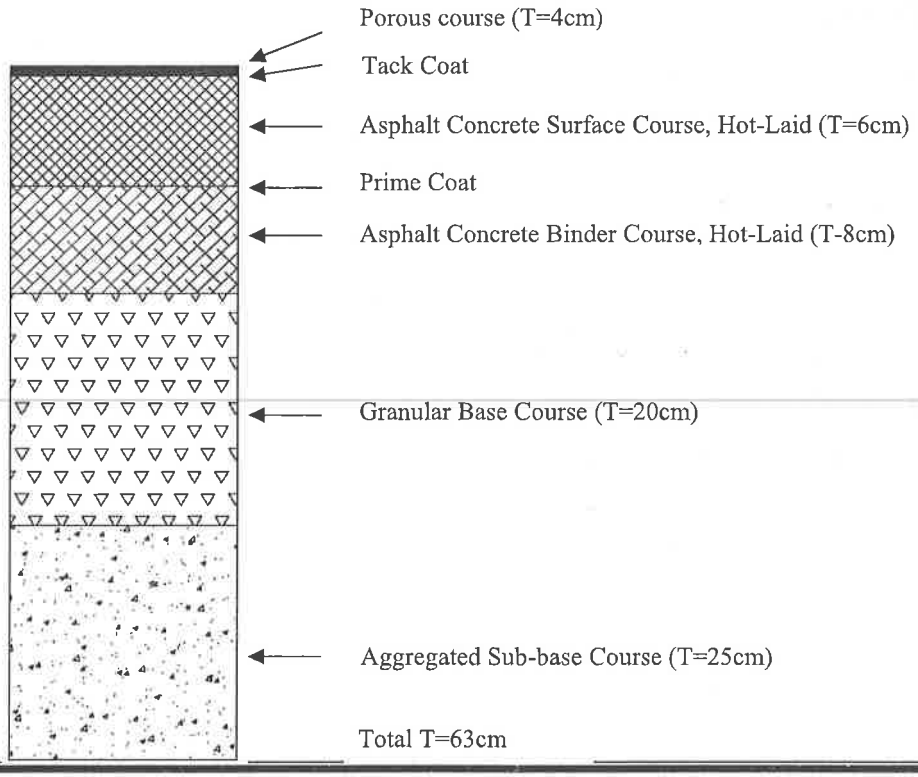



**Figure 1.13. Typical Cross Section of Urban Road**

Pavement of urban road:

- Existing road pavement will be used for urban road in stage 1 and will cover the surface by a layer of porous asphalt concrete, which is 4cm in thickness with high porosity.
- Except, transition section shall be installed all pavement because transition section is deflected from existing road which strength for pavement can be achieved. Therefore, the transition section is installed by the new pavement structure as follows:



### *1.4.2.4. Interchanges*

- Arrangement of 02 interchanges that are Mai Dich I/C and South Thang Long I/C. Two ramps of the south Mai Dich I/C are constructed and the South Thang Long I/C will be completed. The width of the ramps are B = 7.0m, including the following component:
  + Inner safe line: 1x0.50m = 0.50m
  + Carriageway: 1x3.50m = 3.50m
  + Outer safe line: 1x2.00m = 2.00m
  + Concrete Barrier for Viaduct: 2x0.50m = 1.00m

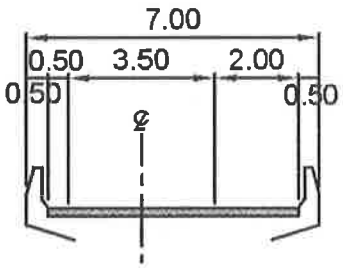
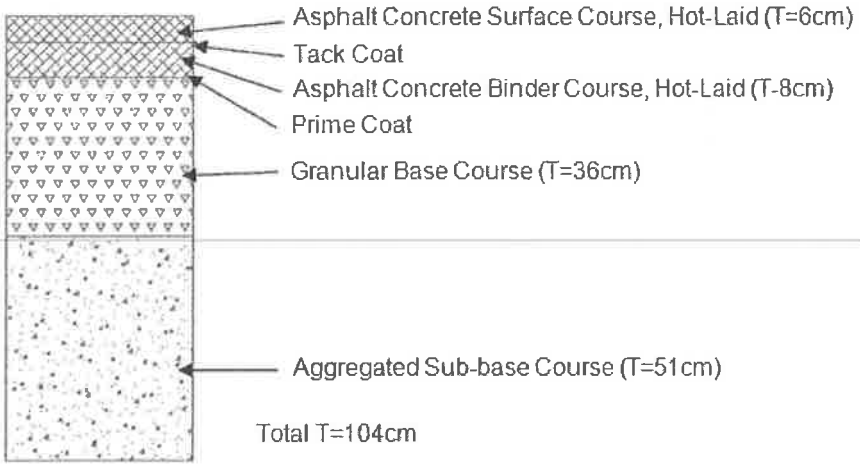



**Figure 1.14. Typical Cross Section of Ramp Way**

- Structure:
  + Due to the requirement of the long span for intersection, steel box girder bridge will be applied to the viaduct sections cross the Hoang Quoc Viet and Co Nhue Intersections;
  + Super T girder will be applied for the ramps (for stage 2);
  + Pavement structure of the ramps are as follows:



### 1.4.3. Ancillary Activities

#### *1.4.3.1. Land Acquisition*

The project does not acquire land and does not relocate. However, the public works and trees along the roadsides of Pham Van Dong and in the project area will must relocate to serve the construction activities. The affected public works are present in table following:

**Table 1.2. Quantity of relocated public works**

| No. | Affected works | Unit | Number |
|---|---|---|---|
| 1 | High voltage pole (220 KV) | Pole | 02 |
| 2 | High voltage line 220 Kv | m | 300 |
| 3 | Lighting poles | Cột | 568 |
| 4 | Trees | Cây | 1.263 |

#### *1.4.3.2 Construction Site and Access Roads*

For the standard section, the scope of construction will be arranged covering Pham Van Dong road with 27m of width (Figure 1:21 and 1:22). For the narrow section, scope of construction will be arranged in the middle separation lane of Pham Van Dong road with width from 7 ÷ 10.6 m, depending on the construction status of piers items (Figure 1:23). The project will arrange 2 camps in standard section (No.1 and No.2) and 1 construction site at location where cast the girders in Duong Noi Urban area. In each construction site will arrange workers' camps, executive offices, and the area of machinery.... At peak times, in each construction site along the alignment will have about 90 workers at the site and at the area where cast girders there are about 30 workers. Therefore, total of workers in the peak time serve the activities of the project at 3 construction sites are 210 people.

Road to transport the materials: The Urban Primary Road and the Frontage Road on the RR3 and other local roads such as Xuan Thuy Road, NH32, Hoang Quoc Viet, etc would be used as access roads to the construction site. The movement of construction vehicles in and out of the site would cause significant impacts to local traffic. Therefore, during construction phase, it needs to undertake proper traffic management and control to minimize these impacts.

#### *1.4.3.3. Material Supply*

Semi-finished materials (steel. stone aggregate. cement concrete. asphalt concrete ...) will be delivered by the licensed companies established around Hanoi City or other locals and transported to the site by special vehicles.

For components for steel box girder: Will be produced in steel factory in Hanoi or Haiphong then transported to the construction site by special vehicles.

The project is expected to buy cement concrete and asphalt concrete from the batching in Hanoi, specifically: cement concrete batching in Vinh Quynh at Km12 – NH 1A, Vinh Quynh commune, Thanh Tri district; Phu Thuy cement concrete batching at Km9 +500 – NH 5, Phu Thuy, Gia Lam; asphalt concrete batching of Investment and Construction Co., Ltd. 656 in the Gia Lam district and Dong Anh District; asphalt concrete batching of 703 construction and investment JSC in the area of Hoang Mai and Thanh Xuan District.

For Super T beams: Beams Casting area of project is expected to be located in Duong Noi urban area, this area is currently free land with an area of about 30.000m2 and it is very convenient for transportation and as implementation of the project items. Transport routes are Le Trong Tan road (Ha Dong), Le Van Luong road and Hanoi ring road No.3. Distance from this area to project is about 8-10km.

In addiction, construction materials including raw materials (soil. sand. stone) will be delivered by the licensed pit. The borrow pit, sand stock pile and quarry are estimated as follow:

(1) Luong Son Borrow pit

Luong Son borrow pit locates beside NH.6 and left side station Km44+300 at Luong Son Town, Luong Son District, Hoa Binh province. Main component of material is sandy clay with grits and fragments of rocks (weathered from siltstone). This borrow pit has been under management of Trung Dung Transport and Construction Joint Stock Company. Potential quantity has been estimated about 1,000,000m3.

Material can be transported by heavy trucks about 50km to project area.

(2) Chem Sand Stockpile

Chem sand stockpile locates beside right Red river bank and near Thang Long Bridge at Chem, Dong Ngac commune, Tu Liem District, Ha Noi City. This sand stockpile has been under management of Ha Noi material construction Joint Stock Company. The Chem sand stockpile can be supply sand types: Sand is used for filling embankment and coarse sand is used for concrete. Sand for filling embankment is exploited from Red river locating on Gia Lam District, Ha Noi City and coarse sand is exploited from Lo River locating on Phu Ninh and Doan Hung districts, Phu Tho Province. Yearly exploitation yield of the Company is about 500.000m3/year. Daily gathering capacity is approximately notified 2000m3/day.

Material can be transported by heavy trucks about 2km to project area.

(3) Sunway quarry

Sunway quarry is Ryolite, locates on Hoa Thach commune, Quoc Oai district, Ha Noi City. This quarry has been under management of Sunway Hatay Construction & Bilding materials Co., Ltd. Potential quantity at the quarry is approximately 20,000,000m3. Yearly exploitation yield of the Company is about 300,000m3/year.

Material can be transported by heavy trucks about 40km to project area.

(4) Cu Yen quarry

Cu Yen quarry is limestone, locates on Cu Yen commune, Luong Son district, Hoa Binh City. This quarry has been under management of Song Da No.7 Joint Stock Company. Potential quantity at the quarry is approximately 10,000,000m3. Yearly exploitation yield of the Company is about 100,000m3/year.

Material can be transported by heavy trucks about 50km to project area.

(5) Dong Ao quarry

Dong ao quarry is limestone, locates on Thanh Thuy commune, Thanh Liem district, Ha Nam province. This quarry has been under management of Transmeco Construction Aggregate Company Limited. Potential quantity at the quarry is approximately 10,000,000m3. Yearly exploitation yield of the Company is about 800,000m3/year.

Material can be transported by river way about 140km up to Chem stockpile (Red river) or by heavy trucks about 75Km up to starting point of the Project.

### *1.4.3.4. Power and Water Supply for Construction Works*

*(1) Water Supply*

The contractor will sign contract with Hanoi Water Company to provide domestic water for workers.

- Water use to construction will be provided from Red river surface water source or underground water: water used primarily for cleaning tires and anti-dust wet water near/ in the construction sites.
- For the construction workers: The Tender will sign contract with Hanoi Water Company to provide domestic water for workers. Water sources will be connected with Providing water system in project area.

*(2) Power Supply for the Project*

- Power supply used for daily activities at construction sites and construction will be provided by city's electric power grid. Power supply will be secured by contract

between the contractor and the Ha Noi Electric Power Company.

#### *1.4.3.5 Treatment of Waste Soil and Rock generated from Construction Activities*

Waste soil and rock generated from the construction works will be collected and temporarily stocked at the construction site, and then transported to Van Noi position for material waste site in Van Noi Commune, Dong Anh Rural District, Ha Noi City, which has been under management of Viet Nam Trading and Services Joint Stock Company. The position for material waste site area is about 4ha. Enclose volume is about 200,000$m^3$.

Soil disposal of project will be transported by trucks on road with a length of about 11km to disposal. Specific roadmap of transporting road as follow: from project to go through Long Bridge, NH23 extended NH 5, the North Thang Long - Noi Bai and the Van Noi disposal.

### 1.4.4. Construction Method and Overall Program

#### *1.4.4.1. Construction Method*

*(1) Introduction*

The construction method is planned under the precondition that the width of the existing Pham Van Dong street.

Bored pile type and rotation steel pier type are selected for the foundation and the substructure, respectively. For the superstructure, the following 2 types of girder are recommended.

- Steel Box Girder Bridge.
- Super-T Girder Bridge.

Super T Girder will be fabricated at fabrication yard and Steel Box girder will be fabricated at steel manufacturing factory. Fabricated girder is transported to the construction site by specialized vehicles and erection work will be commenced at site.

Overall flow chart for construction of viaduct is shown in Figure 1.15.

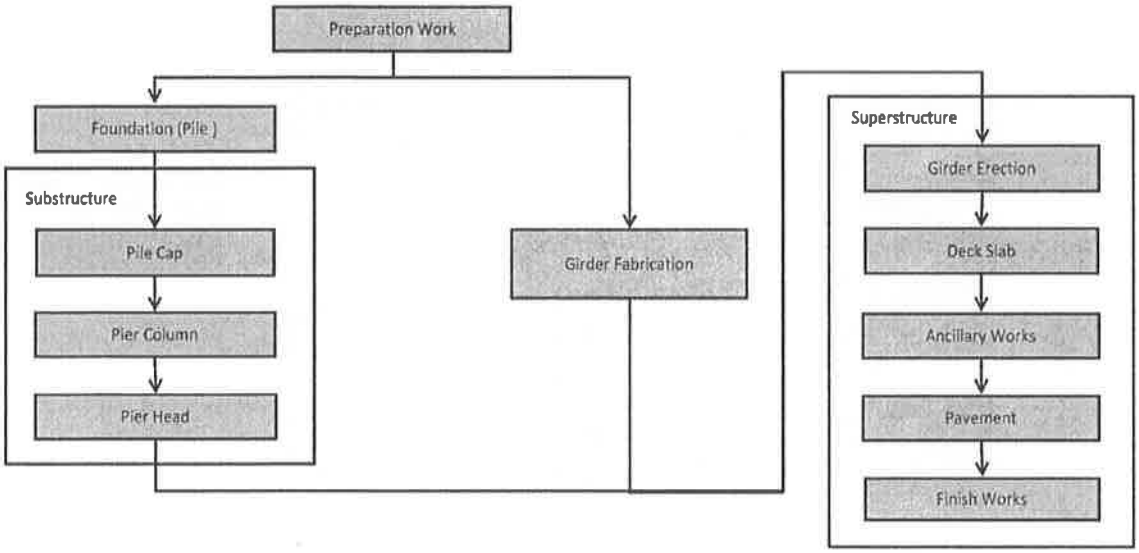



**Figure 1.15. Flow chart for overall construction of viaduct**

*(2) Bored Pile*

Bored Pile type with diameter of 1.5m is recommended for the foundation of the viaduct pier. After levelling of ground and carrying out the site survey, temporary steel casing will be installed into ground by vibrating machine. Bored hole will be excavated by bucket with protecting surface of excavated hole by bentonite slurry. In order to avoid negative impact to surrounding area, bentonite slurry treatment plant should be used.

After completion of excavation, bored hole needs to be cleaned by bentonite circulation method and cleaning bucket in order to avoid sedimentation at end of bored hole. Then, re-bar cage will be installed into bored hole.

Concrete will be casted into excavated hole by tremie pipe. After completion of concrete casting, temporary steel casing will be removed.

Flow chart for construction of bored pile is shown in Figure 1.16 and typical sketch for construction of bored pile is shown in Figure 1.17.

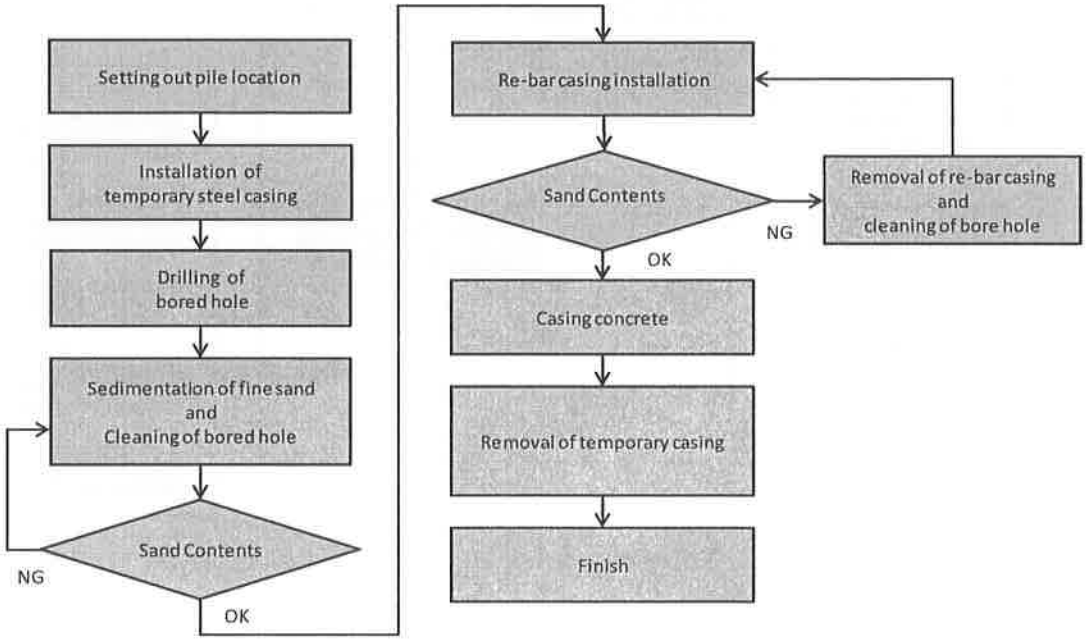



**Figure 1.16. Flow chart for construction of bored pile**

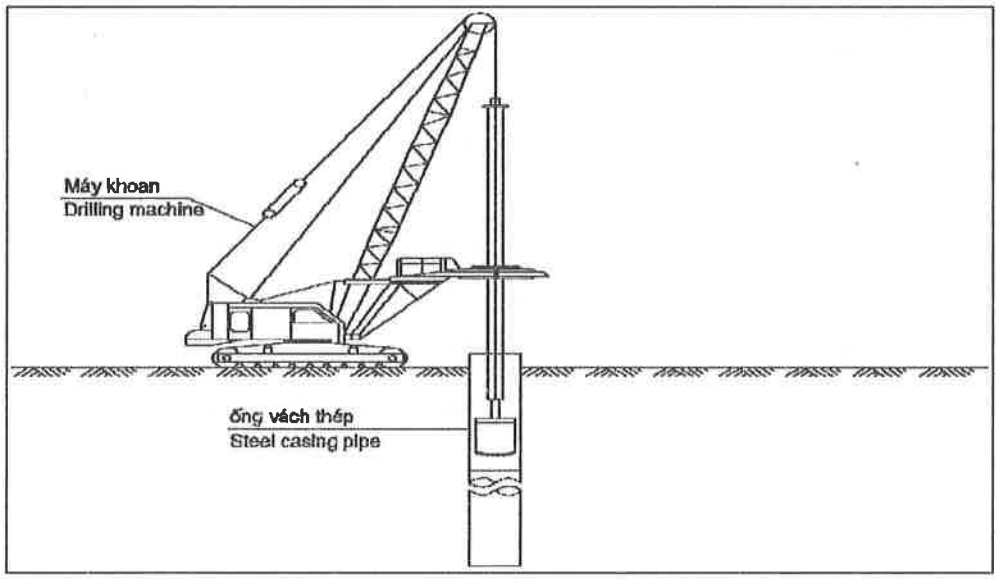



**Figure 1.17. Sketch for construction of bored pile**

*(3) Rotation steel pier foundation*

Rotation steel pier will be constructed by following sequence: Installation of drilling machine; Drilling of lower pile; Connection of upper pile by welding Drilling of upper pile; Connection and drilling of temporary pile; Removal of temporary pile.

*(4) Pile Cap*

Pile cap will be constructed by following sequence: Installation of sheet pile; Excavation; Demolition of pile head; Placement of blinding stone; Casting lean concrete; Installation of formwork and re-bar; Casting concrete and curing; Removal of formwork; Backfilling to top surface of pile cap. Typical sketch for construction of pile cap is shown in Figure 1.18.

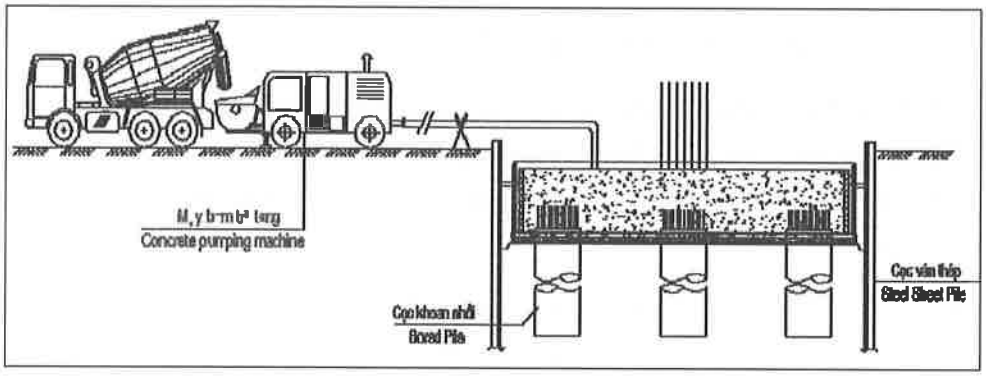



**Figure 1.18. Sketch for construction of pile cap**

*(5) Pier Column and Pier Head*

Pile Column and Pier Head will be constructed by following sequence: Installation of re-bar for column; Installation of formwork for column; Casting concrete and curing; Installation of re-bar for pier head; Installation of formwork for pier head; Casting concrete and curing; Introduction of pre-stress to pier head (applied for Super T girder).

Stretching the prestressed of Pier Head (only for schemes Super-T beams). Typical sketch for construction of pier head is shown in Figure 1.19.

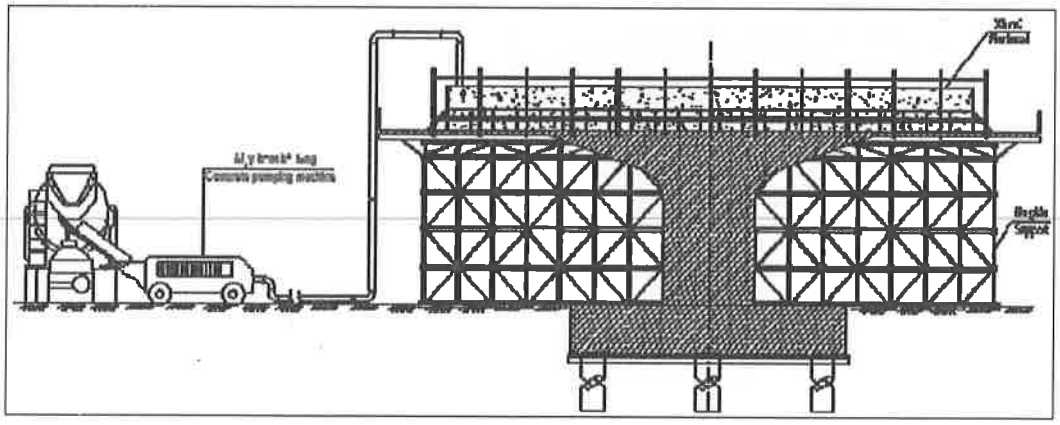


**Figure 1.19. Sketch for Construction of Pier Head**

(6) Construction of Superstructure

*(6a) Super T girder*

- Transport of girder; Erection of girder;
- Concrete casting of end cross beam; Concrete casting of deck slab.

*(6b) Steel Box Girder*

Main girder of Steel Box Girder consists of four blocks for each span. Erection of each block of main girder will be carried out with bent. After erection of each block onto bent, blocks will be connected by bolt.

Due to light weight of each block, it is possible to place crane and track for mobilize girder from manufacture within construction site. Therefore, it is not necessary to restrict traffic for detour road during erection work. Moreover, there is no restriction for erection time.

During erection of main girder block, cross beam to connect each main girder and bottom plate for composite deck slab will be erected in parallel. After completion of erection all steel members, installation of re-bar and casting for concrete will be carried out.

The construction flow of Steel Box Girder Bridge is shown in Figure 1.20.

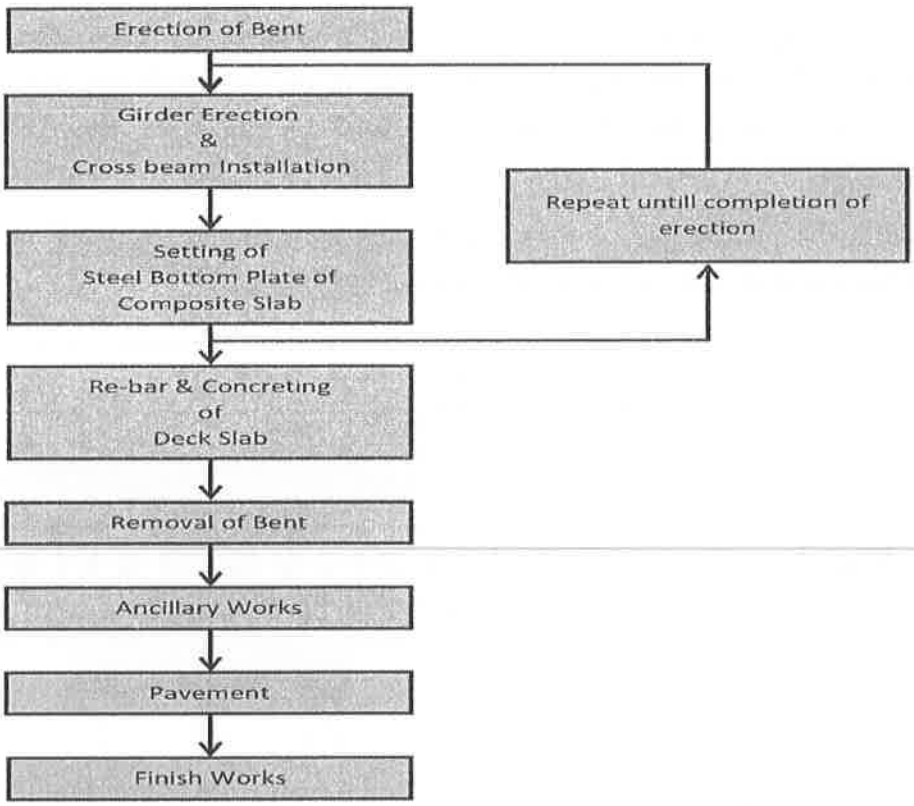



**Figure 1.20. Flow Chart for Construction of Steel Box Girder Bridge**

(7) Measures to ensure the traffic:

*(7a) Measures to ensure the traffic during construction stage of the viaduct*

Road ensuring traffic during construction of viaduct is divided into two types of standard section and narrow section. Specifically is able:

The standard: No houses within ROW, so the project uses area within the ROW to construction new road ensuring the traffic, within the scope of bridge construction with 27m of width covering the current Pham Van Dong. There are 2 options to construction road ensuring the traffic: Option of road to ensure traffic that is arranged inside the 2 range of bridge construction area (Figure 1:21) and the plan to ensure traffic is arranged in the 1 side of construction area of bridges (Figure 1:22).

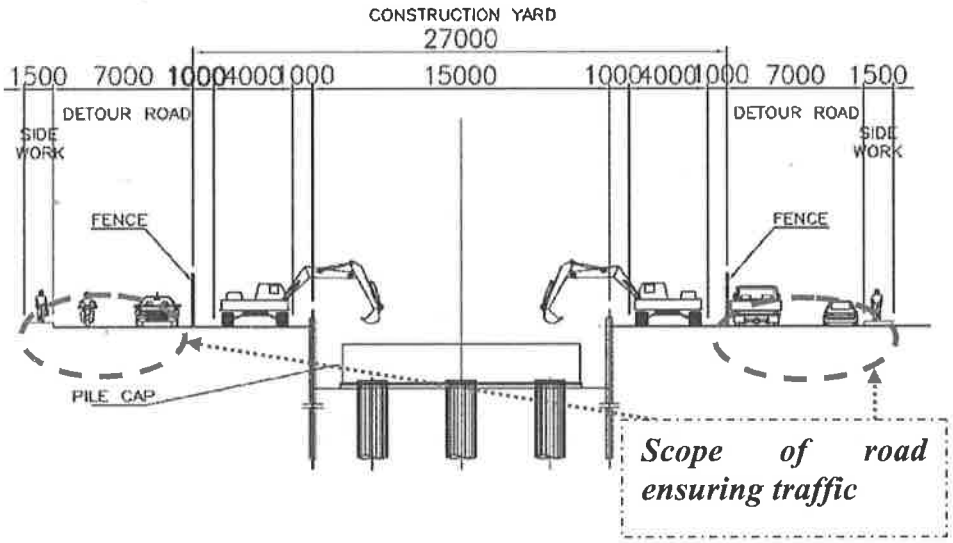



**Figure 1.21. Road ensuring the traffic located inside the 2 range of bridge construction area**

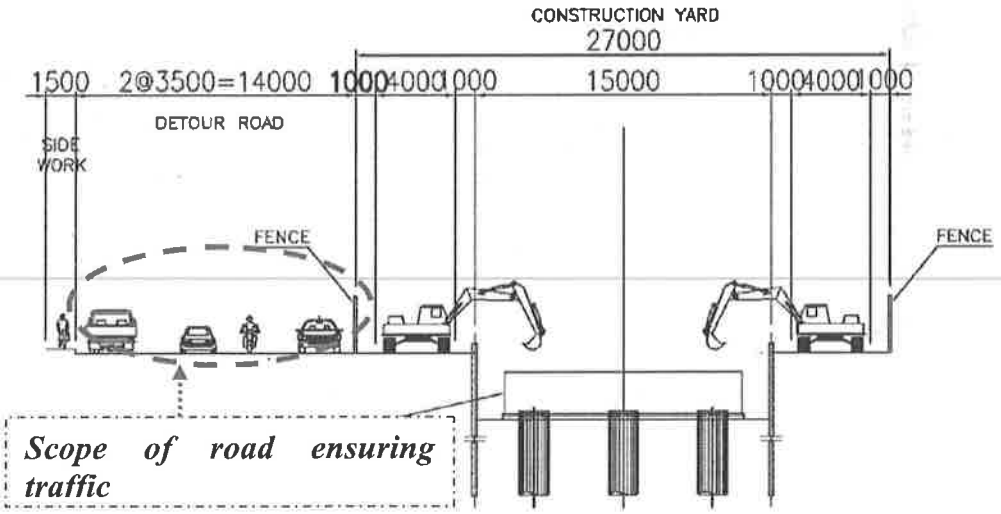



**Figure 1.22. Road ensuring the traffic is arranged in the 1 side of construction area**

The narow section: The range of road construction to ensure traffic is located in Pham Van Dong range. Therefore, there are only existing road surface and sidewalks that are used to construction site and road ensuring traffic. Traffic ensured plan is present in figure following (figure 1.23):

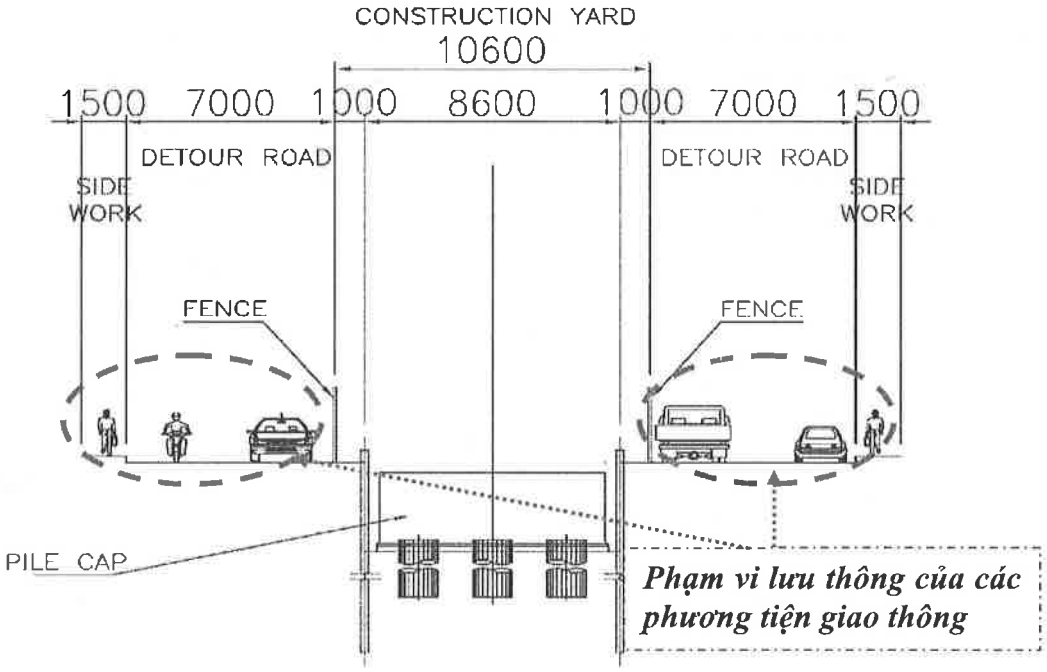



**Figure 1.23. Road ensuring the traffic in the narrow sections**

Construction organization: To ensure construction schedule the project will be arranged from 6 ÷ 7 construction teams of simultaneously on the road, the length line construction of each section for 1 team is about 600 ÷ 700m.

The construction of connected with Mai Dich bridge will be implemented Last when other sections has completed. When it closes traffic in the northern abutment. The entire road viaduct Linh Dam - Mai Dich will go down to the south ramp of Mai Dich bridge and run away on road ensuring traffic and Xuan Thuy road still operating normally.

*(7b) Measures to ensure the traffic during construction stage of the road surface:*

Items urban road surfacing will be implementation after the end of the viaduct construction, surfacing construction process is deployed on each side of the road, use the other side of the road to ensure traffic. After that, the remain side will also implement similar.

### *1.4.4.2. Volume of Construction*

Summary of the main items' volume of the project are presented in Table 1.2 and Table 1.3.

**Table 1.3. Summary table of the main items' volume of the road portion**

| No | Items | Unit | Quantity |
|---|---|---|---|
| 1 | Site Clearing | m2 | 46,375 |
| 2 | Demolition of Existing Structure | m3 | 21,351 |
| 3 | Common Excavation | m3 | 31,430 |
| 4 | Embankment Construction | | |
| | Selected and Granular Material | m3 | 68,913 |
| | Sub-grade | m3 | 4,160 |
| | Aggregate base and sub-base course | m3 | 20,012 |
| 5 | Drainage and Waterway Work | | |
| | Side Ditch | m | 11,290 |
| | Surface Drainage Discharge - Pipe Culvert (D300) | m | 1,553 |
| 6 | Pavement | | |
| | Very Thin Overlay Layer (2cm) | m2 | 12,305 |
| | A/C Surface Course (6cm) | m2 | 13,865 |
| | A/C Surface Course (7cm) | m2 | 89,425 |
| | A/C Binder Course (8cm) | m2 | 13,865 |
| | A/C Binder Course (7cm) | m2 | 89,425 |
| | Tack Coat | m2 | 115,595 |
| | Prime Coat | m2 | 101,890 |
| | Porous Asphalt concrete pavement (4cm) | m2 | 89,425 |
| 7 | Other items | | |
| | Rectangular Sign Post | m2 | 24 |
| | Circular and Triangular Sign Post | each | 28 |
| | Guardrail | m | 9,850 |
| | Median Block | m | 10,220 |
| | Interlocking Block | m2 | 35,210 |
| | Marking | m2 | 8,139 |
| | Lighting pole | each | 173 |

**Table 1.4. Summary of the Main Items' Volume of the Viaduct Portion**

| No | Items | Unit | Quantity |
|---|---|---|---|
| **I** | **Super - structure** | | |
| 1 | Number of super T girders | No | 1,166 |
| 2 | Weight of steel box girders | Ton | 4,789 |

| No | Items | Unit | Quantity |
|---|---|---|---|
| 3 | Stabilizing paint for anti-corrosion | m2 | 42,273 |
| 4 | Water proofing | m2 | 110,665 |
| 5 | Skid-resistance layer (3cm) | m2 | 110,665 |
| 6 | Fine AC course (5cm) | m2 | 110,665 |
| 7 | Expansion joint | L.m | 607 |
| 8 | Reinforcement of deck slab | Ton | 4,760 |
| 9 | Concrete of deck slab and cross beam (30Mpa) | | 26,799 |
| 10 | Elastomeric Bearings | | 2,364 |
| 11 | Precast parapet wall | L.m | 10,887 |
| 12 | Median | L.m | 9,584 |
| **II** | **Substructure** | | |
| 1 | Weight of pier column | Ton | 384 |
| 2 | Stabilizing paint for anti-corrosion | m2 | 1,683 |
| 3 | Reinforcement of abutment and pier | Ton | 7,913 |
| 4 | Concrete of abutment and pier 30Mpa and 35Mpa | | 56,876 |
| 5 | Pre-stressed cable of pier table | Ton | 437 |
| 6 | Pre-stressed cable of anchorage | No | 2,940 |
| 7 | Lean concrete 15Mpa | m3 | 1,168 |
| 8 | Blinding stone | m3 | 2,337 |
| 9 | Cast in place Piles D1.5m (on load) | L.m | 17,520 |
| 10 | Cast in place Piles D1.0m (on load) | L.m | 960 |
| 11 | Rotation Steel Piles D1.3m | L.m | 22,320 |
| 12 | Structural excavation | m3 | 81,197 |
| 13 | Backfill foundation | m3 | 45,014 |
| 14 | Filling sand in side abutment | m3 | 605 |
| **III** | **Retaining Wall** | | |
| 1 | M.S.E wall | m2 | 6,312 |
| 2 | Levelling pad | L.m | 1,908 |
| 3 | Precast parapet wall | L.m | 1,908 |
| 4 | median | L.m | 377 |
| **IV** | **Other works** | | |
| 1 | Anti-Noise Wall | m2 | 20,652 |
| 2 | Anti-Glare Fence | m2 | 5,163 |
| 3 | Lighting poles | each | 260 |
| 4 | Lighting 100W under bridge | each | 598 |
| 5 | Drainage Pipes | m2 | 11,569 |

### *1.4.4.3. Proposed Workers and Equipments*

Workers proposed to be mobilized and equipments proposed to be used are presented in Table 1.4 and 1.5.

**Table 1.5. Proposed Workers and Equipment for Road Portion**

| No | Items | Unit | Volume | No | Items | Unit | Volume |
|---|---|---|---|---|---|---|---|
| ***I*** | ***Labour*** | ***Labour*** | **42,624** | | | | |
| ***II*** | ***Equipment*** | ***shift*** | **9,540** | | | | |
| 1 | Bulldozer 140CV | shift | 5 | 12 | Vibration Wheeled Roller 25T | shift | 29 |
| 2 | Bulldozer 110CV | shift | 862 | 13 | Steel Wheeled Roller 10T | shift | 288 |
| 3 | Motor grader 110CV | shift | 5 | 14 | Needle Vibrator 1,5kW | shift | 160 |
| 4 | Dump Truck 10T | shift | 6,562 | 15 | Concrete Mixer 250l and 80l | shift | 238 |
| 5 | Road Sprinkler 5m3 | shift | 29 | 16 | Vibratory Plate Compactor 1kW | shift | 62 |
| 6 | Air Compressor 600m3/h | shift | 112 | 17 | Truck Crane 6T | shift | 30 |
| 7 | Welding machine 23kw | shift | 2 | 18 | Asphalt Finisher 130-140CV | shift | 124 |
| 8 | Crawler Excavator 1.6m3 | shift | 134 | 19 | Shovel 1m3 | shift | 2 |
| 9 | Wheeled Roller 16T | shift | 374 | 20 | Shovel 2,3m3 | shift | 138 |
| 10 | Wheeled Roller 25T | shift | 15 | 21 | Pressurized Bitumen Distributor 7T | shift | 213 |
| 11 | Asphalt Finisher 50-60m3/h | shift | 17 | | | | |

**Table 1.6. Proposed Workers and Equipment for Bridge Portion**

| No | Items | Unit | Volume | No | Items | Unit | Volume |
|---|---|---|---|---|---|---|---|
| ***I*** | ***Labour*** | ***Labour*** | 1.176.741 | | | | |
| ***II*** | ***Equipment*** | ***shift*** | 168.067 | | | | |
| 1 | Machine for rotation pile construction | shift | 698 | 24 | Tire Roller 25T | shift | 43 |
| 2 | Crane 100T | shift | 698 | 25 | Asphalt Finisher 130-140CV | shift | 102 |
| 3 | Road Sprinkler 5m3 | shift | 29 | 26 | Grinding Machine 2,7kW | shift | 8,140 |
| 4 | Asphalt Finisher 50-60m3/h | shift | 12 | 27 | Gantry crane 90T | shift | 9,796 |

| No | Items | Unit | Volume | No | Items | Unit | Volume |
|---|---|---|---|---|---|---|---|
| 5 | Crawler Excavator <=1,6m3 | shift | 106 | 28 | Virbrator 3kW | shift | 22,260 |
| 6 | Concrete Mixer 250l | shift | 150 | 29 | Needle Vibrator 2,8kW | shift | 4,950 |
| 7 | Hand Tamper | shift | 4,561 | 30 | Air Compressor 300m3/h | shift | 892 |
| 8 | Grab Excavator 1,2m3 | shift | 4,466 | 31 | Air Compressor 360m3/h | shift | 130 |
| 9 | Screening Machine | shift | 1,588 | 32 | Water Pump 6,5kW và 20kW | shift | 2,962 |
| 10 | Solution Mixer | shift | 1,588 | 33 | Bulldozer <=110CV | shift | 705 |
| 11 | Drilling Machine ED | shift | 3,204 | 34 | Motor grader 110CV | shift | 6 |
| 12 | Vibratory Plate Compactor 1kW | shift | 118 | 35 | Shovel 1m3 | shift | 1,120 |
| 13 | Mortar Pump 9m3 | shift | 338 | 36 | Agitating Truck 10,7m3 | shift | 3,886 |
| 14 | Mortar Mixer 80l | shift | 338 | 37 | Bending Machine 5kW | shift | 235 |
| 15 | Crane 16T | shift | 893 | 38 | Elevator 0,8T | shift | 235 |
| 16 | Needle Vibrator 1,5kW | shift | 11,203 | 39 | Welding machine 2,3kW | shift | 37,463 |
| 17 | Concrete Pump car 50m3/h | shift | 3,250 | 40 | Crawler Crane 25T | shift | 772 |
| 18 | Dump truck 10T | shift | 8,910 | 41 | Electric Winch 5T | shift | 3,660 |
| 19 | Shovel 2,3m3 | shift | 118 | 42 | Rope Chopper 10kW | shift | 6,417 |
| 20 | Air Compressor 600m3/h | shift | 892 | 43 | Pushing Machine 15kW | shift | 3,933 |
| 21 | Pressurized Bitumen Distributor 7T | shift | 144 | 44 | Jacking Device 25T | shift | 1,517 |
| 22 | Roller 10T | shift | 334 | 45 | Launching Vehicle | shift | 2,798 |
| 23 | Tire Roller 16T | shift | 154 | | | | |

### 1.4.5. Project Implementation Plan

*(1) Project Preparation*

Project preparation includes formulation of the project and basic design, appraisal and approval of investment project, negotiation and confirmation of source of budget for the Project.

*(2) Detailed Design and Preparation of Tender Documents*

Selection procedure for the Consultants who takes in charge of preparation of Detailed Design work needs to be completed before effective of loan.

Tender Documents will be prepared for each individual package and completed based upon order of priority set forth in the Bidding Plan.

*(3) Bidding*

Bidding procedures will follow Laws on Bidding. International Competitive Bidding (ICB) will be carried out.

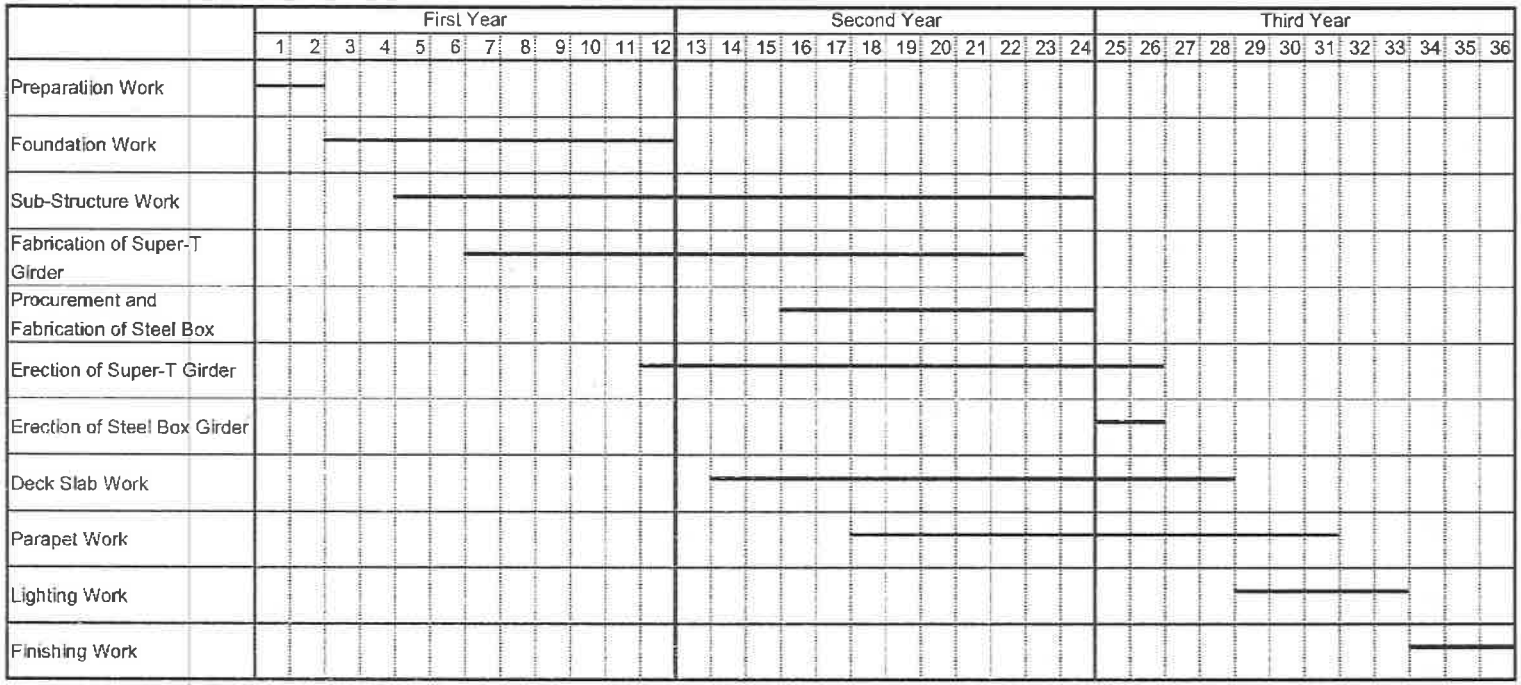
*(4) Construction and Construction Supervision*

The packaging must be conducted with the most scientific and reasonable considerations based on the Investment Project and Basic Design. The package of Consulting Services covers those of construction supervision as well.

Project Implementation Schedule is as follows:

- Preparation and approval of detailed design : 01/2014
- Preparation and approval of bidding document : 02/2014
- Completion of the bidding stage : 11/2015
- Commencement of Project : 12/2015
- Completion of construction : 11/2017

## Table 1.7. Overall Program of Construction of the Project



### 1.4.6. Capital Investment

The project will use the capital of official development assistance (ODA) of the Japan International Cooperation Agency (JICA) and counterpart funding. Total investment of the project are presented in Table 1.8.

**Table 1.8. Total Investment of Project**

| No | Items | Cost (VND) |
|---|---|---|
| | ***Total investment of the project (.....)*** | ***6,248,874,000,000*** |
| | ***In which, Environmental cost*** | **3,229,685,782** |
| 1 | Environmental management program | 1,838,050,000 |
| 2 | Environmental monitoring plan | 1,098,027,984 |
| 3 | VAT | 293.607.798 |

### 1.4.7. Project Implementation Schedule

#### *1.4.7.1. Implementation Schedule*

*(1) Investment Preparation*

Thang Long Project Management Unit prepares the investment plan and the EIA report, and submits them to Ministry of Transport for approval.

*(2) Investment Implementation*

After receiving the Investment Decision, the Project Owner will carry out the detail design with consultant's assistance. Regarding environmental and social considerations, the Project Owner will prepare the environmental management plan (EMP). EMP should describe in detail the impact mitigation measures and the design of the environmental treatment works in accordance with comments attached in the decision approving the EIA report. Simultaneously, the Project Owner will make the Technical Specification relating to environmental management to instruct the contractors in making their own detailed EMP.

During construction phase, the contractors will implement all environmental protection measures described in the EMP. The Project Owner will take responsibility to supervise the implementation of environmental protection measures, and will hire an environmental consultant to carry out the environmental monitoring. Results of environmental monitoring should be periodically reported to the Department of Natural Resources and Environment of Ha Noi City PC.

# CHAPTER 2. NATURAL, ENVIRONMENTAL, SOCIO-ECONOMIC CONDITIONS

## 2.1 Natural Conditions

### 2.1.1. Geographical and Geological Conditions

#### *2.1.1.1. Geographical Conditions*

Ha Noi City has a natural area of 3,344.6 $km^2$, lying in the center of the Red River Delta. The average elevation is from 5 to 20 meters above sea level. The elevation decreases from the north to the south and from the west to the east. Ha Noi City has topographical characteristic of a plain, which is formed by sediments of the rivers originated from the mountainous areas in the North and in the West. Mountains and hills can be found in the districts of Soc Son, Ba Vi, Quoc Oai, My Duc, with the mountain's peaks of Ba Vi (1,281 m); Gia De (707 m); Chan Chim (462 m); Thanh Lanh (427 m), and Thien Tru (378 m). There are some low mounds in the inner city, such as Dong Da mound, Nung mountain.

The Project area is topographically flat, elevation changes from +6.2m to 8.5m. Nhue River runs parallel with the planned viaduct in the west with the distance of about 1 ~ 1.5 km. The ending point of the planned viaduct is located about 1km far from the Red River and 800m from the right bank of the Red River Dyke.

The drainage system in the area including canals and ditches ensuring for sewage waste water into the drainage system of the city overall. There are also 2 water channel in Km2 +150 and Km3 +100. This will be a place of waste water received during construction and operation stages of project.

On human geography, the Project is located at the northwest gate of Ha Noi City and on the arterial road linking the capital with Noi Bai Airport. The Project is belong to area of: (1) Mai Dich Ward (Cau Giay District); (2) Co Nhue Commune, (3) Xuan Dinh Commune (Tu Liem District). Besides, Dich Vong Hau Ward (Cau Giay District) and Dong Ngac Commune (Tu Liem District) would be indirectly affected by the Project in terms of air pollution, noise, etc.

There are populous residential areas around Mai Dich Intersection, Co Nhue Intersection and Xuan Dinh Craft Village. Among them, the residential area around Mai Dich Intersection is the most densely populated. Business and trading take place in the crowded market areas and shopping centers. Traffic density in this area is very high, especially during the rush hours (6h ~ 8h and 16h ~ 18h). In residential area around Co Nhue Intersection and in Xuan Dinh Craft Village, population density is

relatively lower, but traffic flow is quite large especially in the direction from Hanoi to Noi Bai.

### *2.1.1.2. Geological Condition*

*(1) Regional Geology*

The plains spreading over the center of Hanoi City mainly consists of Quaternary sediments, which are Pleistocene or Holocene.

Referring to Hanoi Geological Map of scale 1/200,000 (F-48-XXVIII) (Published and copyrighted by Department of Geology and Minerals of Vietnam Hanoi 2005), the geology in the proposed project area comprises 4 formations as follows (Figure 2.1):

a) **Hanoi Formation – $Q_1^{2-3}$*hn*** (Layer code in the Geological Map mentioned above) Middle-Upper Pleistocene. Composed of two distinct sediments (Fluvio-proluvial sediments and Fluvial sediments).

**- Fluvio-proluvial sediments – $apQ_1^{2-3}$*hn*:** Distributed in the upper terrace of margin of plains (in Xuan Mai, Thach Thai, Hoa Lac, Viet Tri, Da Phuc, Kim Anh and Hiep Hoa areas) or covered by Quaternary formations in plains (found in deep exploratory drilling holes). Composed of boulder (over 256 mm) and pebble (4–64 mm) originated in quarts, chert, sandstone, conglomerate, effusive rocks and some tectite fragments, which grade off upward to dark yellow sand and silt. 2.5 m to 6 m in layer thickness. The silt yields spores and pollens. In a lot of places, fine-grained sediments of the upper part have been strongly weathered and lateritized from 0.5 m to 1 m in thickness.

**- Fluvial sediments – $aQ_1^{2-3}$*hn*:** Findable in almost all deep exploratory drilling holes. Composed of pebble (4–64 mm), granule (2-4 mm), sand, silt and clay. 4 m to 47 m in layer thickness. The yellowish-gray clayey silt yields freshwater algae.

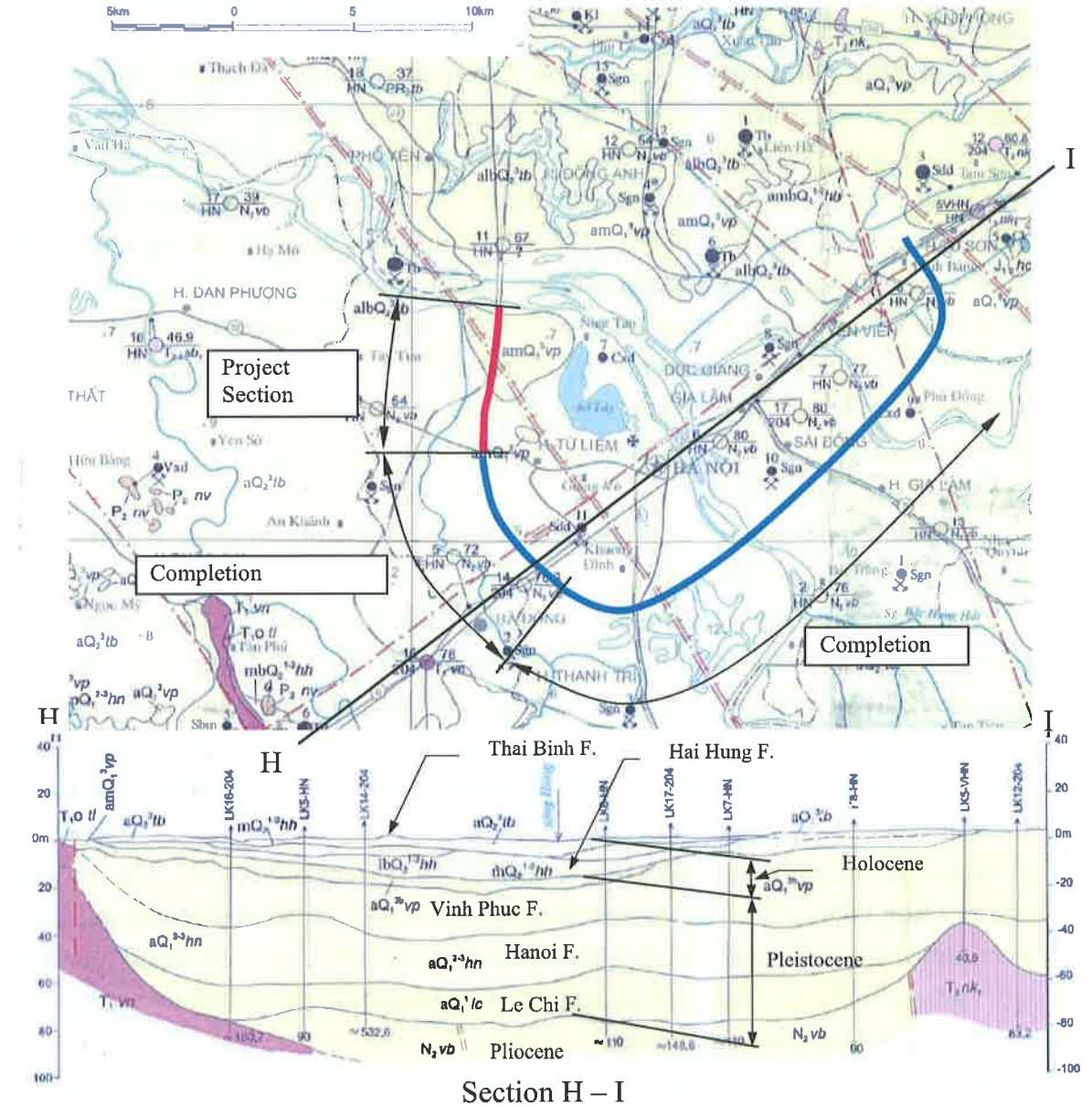
Hanoi Formation is underlain by Le Chi Formation of lower Pleistocene or other older formations unconformably, and is overlain by Vinh Phuc Formation also unconformably.

b) **Vinh Phuc Formation – $Q_1^{3b}$*vp***:

Upper Pleistocene. Composed of three distinct sediments (Fluvial, Fluvio-lacustrine-marshy and Fluvio-marine).

- **Fluvial sediments – $aQ_1^{3b}$*vp*:** Distributed in the lower terrace (Elevation 6 m to 20 m) in margin of plains (in Vinh Yen, Hiep Hoa, Me Linh, Soc Son, north Dong Anh, Thach That, Viet Tri and so on) or covered by Quaternary formations in plains (found in deep exploratory drilling holes - 20 m to - 40 m in depth). Composed of granule (2-4 mm), sand, diversely colored silt and clay. 6.2 m to 40 m in layer thickness. The silt and clay yield freshwater algae, spores and pollens.

## Figure 2.1 Geological Map along Hanoi Ring Road No. 3




ĐỆ TỨ - QUATERNARY

$Q_2^{tb}$ — **Hệ tầng Thái Bình** (a): cát, bột, sét màu xám nâu; (alb): bột, sét, tàn tích thực vật. Dày 3-35m.
**Thái Bình Formation** (a): greyish brown sand, clayey silt. (alb): silt, clay, plant debris. 3-35m thick.

$Q_2^{1-2}hh$ — **Hệ tầng Hải Hưng** (lb): bột, sét màu xám sẫm, xám đen, di tích thực vật, than bùn; (amb): bột, sét, cát, tàn tích thực vật, than bùn; (m): sét bột xám xanh, xám vàng, mụn đỏ. Chứa *Quinqueloculina, Ephidium, Ammonia, Nonion*, Polypodiaceae, *Cyathea*. Dày 2-35m.
**Hải Hưng Formation** (lb): dark-grey, black-grey silt, clay, plant remains, peat; (amb): silt, clay, sand, plant debris, peat; (m): greenish-grey, yellow-grey plastic silty clay. Bearing *Quinqueloculina, Ephidium, Ammonia, Nonion*, Polypodiaceae, *Cyathea*. 2-35m thick.

$Q_1^{3b}vp$ — **Hệ tầng Vĩnh Phúc** (a): sỏi, cát, bột sét, màu sắc loang lổ. Chứa *Eunotia monodon, Epithemia zebra*; (alb): bột, sét màu xám, xám đen, sét kaolin xám trắng. Chứa *Sassa, Pistacea, Anguliagra*: (am, m): sét, bột màu sắc loang lổ. Chứa *Cyclotella, Diploneis, Taxodium, Palmae*. Dày 2-32,5m.
**Vĩnh Phúc Formation** (a): motley-coloured granule, sand, clayey silt. Bearing *Eunotia monodon, Epithemia zebra*; (alb): grey, black-grey silt, clay, white-grey kaolin. Bearing *Sassa, Pistacea, Anguliagra*; (am): motley-coloured silty clay. Bearing *Cyclotella, Diploneis, Taxodium, Palmae*. 2-32.5m thick.

$Q_1^{2-3}hn$ — **Hệ tầng Hà Nội** (ap): cuội tảng, cuội, sỏi, sạn, cát lẫn bột sét màu vàng gạch. Chứa *Quercus, Ulmus*; (a): cuội, sỏi, sạn, cát, bột, sét màu xám vàng. Chứa *Navicula, Gomphonema, Carya, Ulmus*. Dày 2,6-47m.
**Hà Nội Formation** (ap): boulder, pebble, granule, dark-yellow sand, clayey silt. Bearing *Quercus, Ulmus*; (a): pebble, granule, grit, yellow-grey sand, silt, clay. Bearing *Navicula, Gomphonema, Carya, Ulmus*. 2.6-47m thick.

$Q_1^{1}lc$ — **Hệ tầng Lệ Chi** (a): cuội, sỏi, cát, bột sét, di tích thực vật. Chứa *Tilia, Trilamosporites*. Dày 7,5-24,2m.
**Lệ Chi Formation** (a): pebble, granule, sand, clayey silt, plant remains. Bearing *Tilia, Trilamosporites*. 7.5-24.2m thick.

- **Fluvio-lacustrine-marshy sediments – $albQ_1^{3b}vp$:** Distributed in Soc Son and Vinh Yen areas limitedly. Composed of gray silt and clay, black-gray clay, and white-gray kaolin. 5 m to 32.5 m in layer thickness. Bearing plant remains, mollusk fossils and freshwater algae.
- **Fluvio-marine sediments – $amQ_1^{3b}vp$:** Distributed limitedly on the surface of Mai Lam and Tu Son or covered by Quaternary formations in plains (found in deep exploratory drilling holes). Composed of gray clay and silt mixed into with a little sand. 2.5 m to 19.6 m in layer thickness. The beds exposed on the surface are lateritized and diversely colored. The silt yields freshwater algae, spores and pollens, which indicate the coastal estuarine environment.

  While the $C^{14}$ radioactive dating for which the borehole sample was taken in the depth of 3 to 15 m has been giving the values of 21,200+/-250 years and 28,500+/-300 years, namely it is corresponding to Late Pleistocene, the lower and upper boundaries of Vinh Phuc Formation have not been determined.

c) **Hai Hung Formation – $Q_2^{1-2}hh$:**

Lower-Middle Holocene. Composed of three sediments (Lacustrine-marshy, Fluvio-marine-marshy and Marine).

- **Lacustrine-marshy sediments – $lbQ_2^{1-2}hh$:** Formed before Flandrian Transgression. Distributed in margin of plains (in Ba Vi, Yen Lang, Binh Xuyen, Hiep Hoa and Yen Phong) or locally in some lowlands of plains (in Son Dong and Hoai Duc District). Composed of dark gray, black gray clay and silt bearing plant debris and lenses (0.5m-3.6m) of peat of high-quality. 13.5 m in maximum layer thickness.
- **Fluvio-marine-marshy sediments – $ambQ_2^{1-2}hh$:** Determinable at only drilling data in Chau Giang, Thanh Oai and Thuong Tin areas. Composed of silt and clay mixed into with fine sand, black-gray sandy mud and peat, bearing wood remains and Early-Middle Holocene foraminifera. The formation is underlain by marine bluish clay of Holocene conformably.
- **Marine sediments – $mQ_2^{1-2}hh$:** Found considerably widely in Thanh Oai, Thuong Tin and My Duc (Ha Tay Province) and determinable at drilling data of Son Dong – Nhon toward the south and southeast of Hanoi Geological and Mineral Resources Map. Composed mainly of bluish-gray, yellowish-gray, high-plastic clay and silty clay. The clay yield fossils as such foraminifera, spores and pollens, which indicate the littoral (coastal) and lagoonal environment. 6 m in layer thickness.

d) **Thai Binh Formation – $Q_2^3th$:**

Upper Holocene. Composed of two sediments (Fluvial and Fluvio-lacustrine-marshy sediments).

- **Fluvial sediments $aQ_2^3tb$:** Distributed mainly along great rivers, their tributaries. Composed of brownish-gray sand and silt in the lower part, silt and clay in the upper. 5 m to 35.5 m in layer thickness. These sediments are categorized into river bed (sandy gravel dune) and natural levee facies.
- **Fluvio-lacustrine-marshy sediments $albQ_2^3tb$:** Exposed limitedly in Van Tri, Uy No (Dong Anh District) and My Duc areas. Composed of silt, clay, with much plant debris, locally with peat lenses in the lower part in the area of Cham Me, Co Rua and so on, with wood remains and marshy grass in the upper part indicating that the deposition of peat is still in progress currently.

*(2) Geographical Composition*

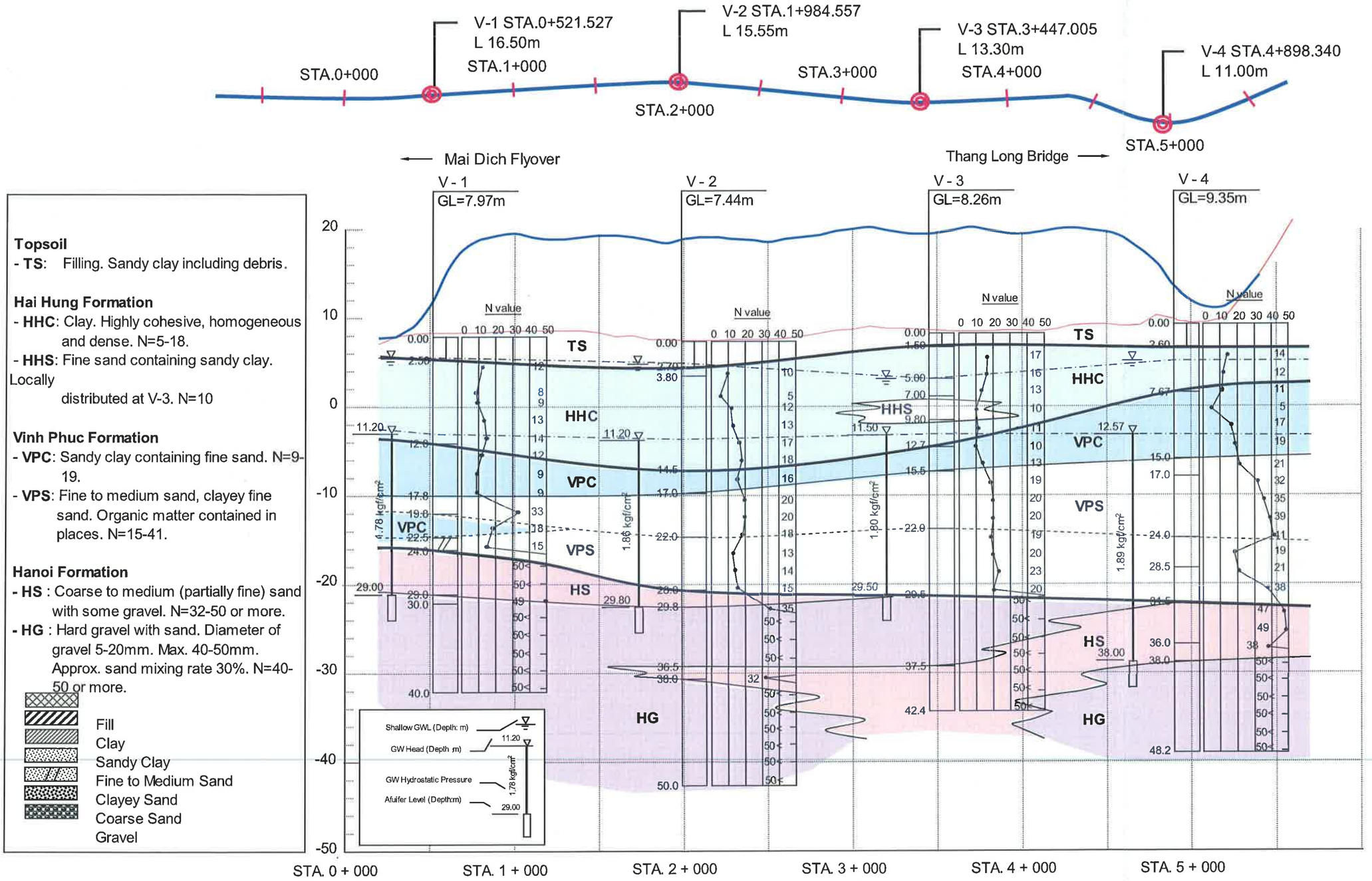
Based on results of the geological drilling survey conducted in April-May, 2012, in the Project area, locations of drilling survey are where expected to be allocated abutments and piers. The Project geological composition is identified as following (Table 2.1 and Figure 2.2).

**Table 2.1 Geological Composition**

| Geological Layer | Soil with Symbol | Description | SPT N-value |
|---|---|---|---|
| **Top Soil Layer** | | | |
| | Top Soil<br>**TS** | - Filling soil. Sandy clay including debris.<br>- 1.5-2.7m in thickness. | – |
| **Quaternary Pleistocene** | | | |
| **Hai Hung Formation** | Clayey Soil<br>**HHC** | - Highly cohesive, homogeneous and dense clay.<br>- Diversely colored, e.g. yellow, brownish gray, reddish brown and whitish gray.<br>- 5-12m in thickness. | 5 – 18<br>(Medium to Very hard) |
| | Sandy Soil<br>**HHS** | - Appears at V-3 only (2.8m thickness).<br>- Fine sand containing sandy clay.<br>- Brownish gray colored. | 10<br>(Loose to Medium) |
| **Vinh Phuc Formation** | Clayey Soil<br>**VPC** | - Sandy clay containing fine sand.<br>- Diversely colored, e.g. yellowish brown, reddish brown, brownish gray and whitish gray.<br>- 2.5-7.3m in thickness. | 9 – 19<br>(Hard to Very hard) |
| | Sandy Soil<br>**VPS** | - Upper: Fine to medium sand with clay.<br>- Lower: Fine sand with clay.<br>- Includes organic matters and pebbles.<br>- Brownish gray and yellowish gray colored.<br>- 6.2 (including VPC)-16.5m in thickness. | 15 – 41<br>(Medium to dense) |

| Geological Layer | Soil with Symbol | Description | SPT N-value |
|---|---|---|---|
| **Hanoi Formation** | Sandy Soil **HS** | - Coarse to medium (partially fine) sand including some gravel.<br>- Brownish gray, whitish gray and yellowish gray colored.<br>- 1.5-5m in thickness. | 35 – 50 or more (Dense to very dense) |
| | Gravelly Soil **HG** | - Hard gravel with sand of which mixing rate is approx. 30%.<br>- Diameter of gravel 5 – 20mm in on average, 40 – 50mm at maximum.<br>- Diversely colored, e.g. gray, whitish gray, yellowish gray and brownish gray.<br>- 8-20m in thickness. | 40 – 50 or more (Dense to very dense) |

It can say that the Project area is based on a geologically-stable area, thus soft soil treatment may not be required, and accident due to land subsidence may be limited.




**Topsoil**
- **TS**: Filling. Sandy clay including debris.

**Hai Hung Formation**
- **HHC**: Clay. Highly cohesive, homogeneous and dense. N=5-18.
- **HHS**: Fine sand containing sandy clay. Locally distributed at V-3. N=10

**Vinh Phuc Formation**
- **VPC**: Sandy clay containing fine sand. N=9-19.
- **VPS**: Fine to medium sand, clayey fine sand. Organic matter contained in places. N=15-41.

**Hanoi Formation**
- **HS** : Coarse to medium (partially fine) sand with some gravel. N=32-50 or more.
- **HG** : Hard gravel with sand. Diameter of gravel 5-20mm. Max. 40-50mm. Approx. sand mixing rate 30%. N=40-50 or more.

Fill
Clay
Sandy Clay
Fine to Medium Sand
Clayey Sand
Coarse Sand
Gravel

**Figure 2.2 Geological Profile of 4 Drilling Holes**

*(3) Groundwater*

a) Shallow Groundwater

Groundwater level of each drilling hole in April-May 2012 is observed in clayey soil of Hai Hung Formation **HHC**, as follows:

- V-1: GL-2.35 to 2.55m (Elev. +5.42 to +5.62m)
- V-2: GL-2.50 to 3.20m (Elev. +4.24 to +4.94m)
- V-3: GL-5.00 to 6.00m (Elev. +2.26 to +3.26m)
- V-4: GL-4.25 to 5.15m (Elev. +4.20 to +5.10m)

It is confirmed that the elevation range of the shallow groundwater is close to the mean water level of the Red River.

b) Deep Groundwater

Deep groundwater levels were determined as static water head of specific aquifers, i.e. gravelly soil layer of Hanoi Formation (**HG**), through use of piezometer system.

Hydrostatic pressures of **HG** at each hole are shown in Table 2.2 and Figure 2.3.

**Table 2.2 Hydrostatic Pressure of Aquifer (HG)**

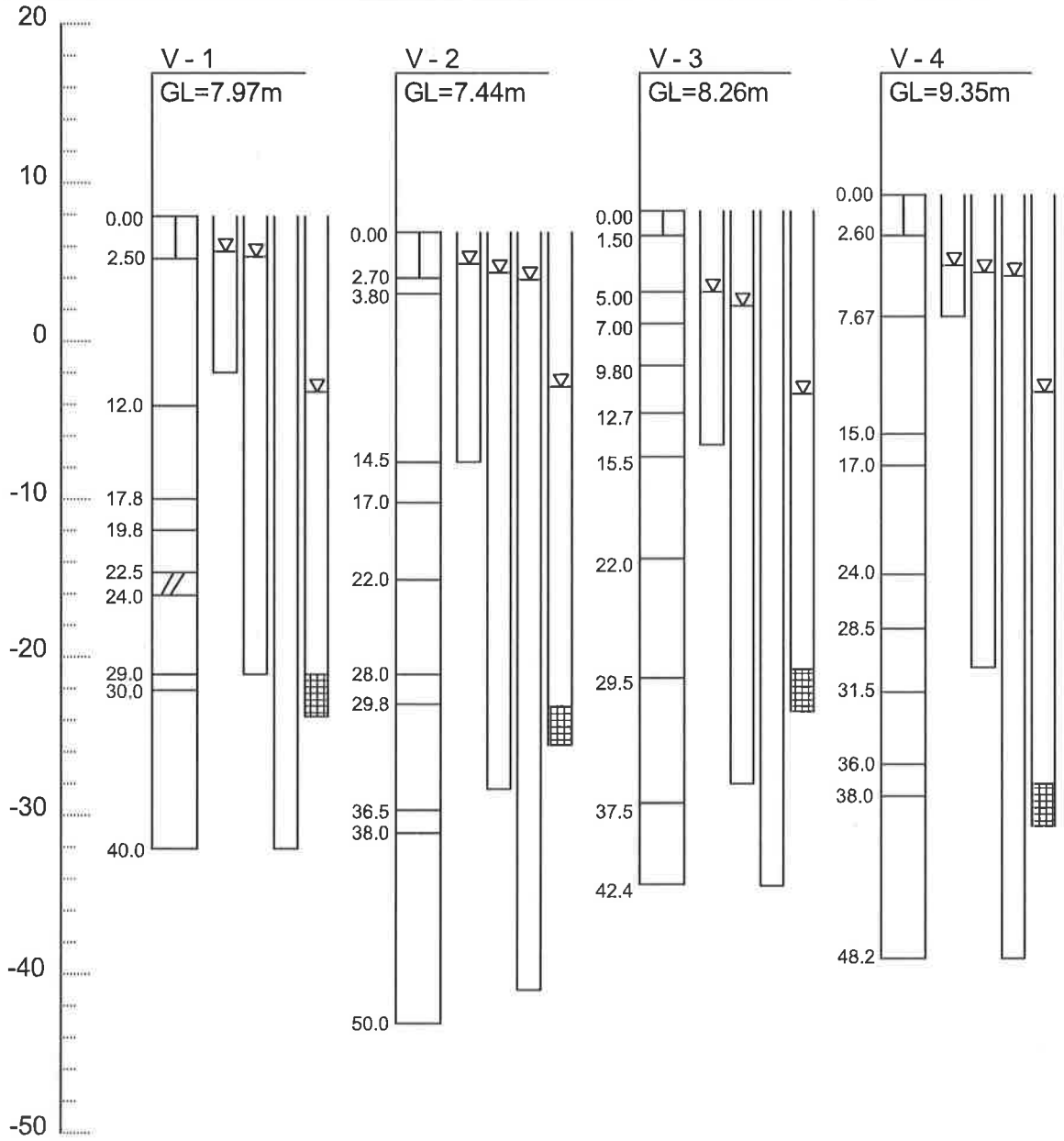
| | Elev. of top of aquifer (Depth) (m) | Elev. of static water head (Depth) (m) | Static water head (m) | Hydrostatic pressure kgf/cm$^2$ (kPa=kN/m$^2$) |
|---|---|---|---|---|
| V-1 | -21.03 (29.00) | -3.23 (11.20) | 17.80 | 1.78 (175) |
| V-2 | -22.36 (29.80) | -3.76 (11.20) | 18.60 | 1.86 (182) |
| V-3 | -21.24 (29.50) | -3.24 (11.50) | 18.00 | 1.80 (177) |
| V-4 | -28.65 (38.00) | -3.22 (12.57) | 18.93 | 1.89 (186) |

1kgf/cm$^2$=9.80665x10$^4$ Pa (N/m$^2$)

It is confirmed that the above elevations for static water head for deep groundwater level (average -3.4m) is lower than the mean water level of the Red River by 8 to 10m.

(c) The status using underground water

Currently people in the project area has been provided piped water for use in domestic. Some households exploit underground water to supplement water for the family, but they only used to bathing and washing. The water wells with an average depth of about 35 ÷ 40 m.




| Observation | | Shallow Ground Water | | | Deep GW |
|---|---|---|---|---|---|
| | | 1st Date | 2nd Date | 3rd Date | Static Water Head of HS & HG |
| V-1 | GW Elevation (Depth) m | +5.62 (2.35) | +5.42 (2.55) | | -3.23 (11.20) |
| | Depth of Drilling hole m | 10.00 | 29.00 | | 32.00 |
| V-2 | GW Elevation (Depth) m | +4.94 (2.50) | +4.44 (3.00) | +4.24 (3.20) | -2.76 (10.20) |
| | Depth of Drilling hole m | 14.50 | 35.75 | 48.00 | 33.00 |
| V-3 | GW Elevation (Depth) m | +3.26 (5.00) | +2.26 (6.00) | | -3.24 (11.50) |
| | Depth of Drilling hole m | 14.67 | 36.10 | | 31.50 |
| V-4 | GW Elevation (Depth) m | +5.10 (4.25) | +4.35 (5.00) | +4.20 (5.15) | -3.22 (12.57) |
| | Depth of Drilling hole m | 7.67 | 29.95 | 40.00 | 40.00 |

**Figure 2.3 Groundwater Level**

*(4) Fault*

According to geological studies, Hanoi area is predicted to contain Vinh Ninh deep fault system, running in the NW - SE direction from Thuong Cat to Dong Mo, parallel with the Red River. These faults locates in the depth of 18 - 20 km, with the vertical displacement of 2 ~ 3 km and a destroying zone of about 400 m. The Project area does not belong to this fault area.

*(5) Geological Catastrophe*

Earth quake and land subsidence are the major geological catastrophes in the project area:

*Earth quake:* the Project area lies within the effect range of an earthquake zone of 8 Richter. The buildings, especially underground buildings must be endured bigger force than this earthquake intensity.

*Land subsidence:* land subsidence in Ha Noi correlates with the load force of the buildings (with more than 7 ~ 10 floors) and the declination of groundwater level due to excessive groundwater exploitation. In the Project area, the land is subsiding with the speed of 5 ~ 20 mm a year.

According to the boring result in the Project area, there are deposits of Thai Binh Formation, Hai Hung Formation (created from sediment of river and swamps), Vinh Phuc Formation and Ha Noi Formation. Installation of bored cast-in-place piles into the average depth of 50m may penetrate the waterproof layers and cause adverse impacts to the groundwater quality. In addition, there are several large-scaled water supply facilities near the Project site (such as Mai Dich Water Supply Facility, Phap Van Water Supply Facility) which are exploiting groundwater. Moreover, in the Project area, many high-rise buildings are constructed or under construction. Therefore, the Project may make the issue on land subsidence in the area more serious with the construction of the on ground and underground structures.

### 2.1.2 Meteorological Condition

#### *2.1.2.1 Climate*

*(1) Climate characteristics*

Meteorological factors play a decisive role in the dispersion of air pollutants in the atmosphere and should be considered when assessing the ambient air quality.

Located in the northern plain, Hanoi City is influenced by the climate zone of subtropics characterized with humidity and monsoons: cold and dry in Winter, hot and rainy in Summer.

The characteristics of meteorological condition in the Project area are presented in Table 2.3 and Figure 2.3~ 2.4.

**Table 2.3. Characteristics of Meteorological Condition**

| Year | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | Av. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I. Temperature (°C)** | | | | | | | | | | | | | |
| 2006 | 18.3 | 18.4 | 20.3 | 25.4 | 30.3 | 30.2 | 30.0 | 28.1 | 28.2 | 27.4 | 24.7 | 18.3 | 25.0 |
| 2007 | 16.9 | 21.9 | 21.1 | 23.4 | 27.3 | 30.2 | 30.4 | 29.2 | 27.2 | 25.8 | 21.5 | 20.4 | 24.6 |
| 2008 | 15.2 | 13.8 | 21.4 | 24.7 | 27.6 | 28.6 | 29.4 | 29.0 | 28.3 | 26.5 | 21.4 | 20.1 | 23.8 |
| 2009 | 16.0 | 22.5 | 21.0 | 24.7 | 27.1 | 29.3 | 29.6 | 29.9 | 29.1 | 26.8 | 21.9 | 19.9 | 24.8 |
| 2010 | 18.1 | 20.9 | 21.9 | 23.5 | 28.7 | 30.9 | 30.7 | 28.6 | 28.7 | 25.7 | 22.8 | 19.4 | 25.0 |
| **2011** | 12.8 | 17.7 | 17.1 | 23.8 | 27.2 | 29.5 | 29.9 | 28.9 | 27.5 | 24.5 | 23.9 | 17.4 | 23.3 |
| **Av.** | **16.2** | **19.2** | **20.5** | **24.3** | **28.0** | **29.8** | **30.0** | **29.0** | **28.2** | **26.1** | **22.7** | **19.3** | **24.4** |
| **II. Rainfall level (mm)** | | | | | | | | | | | | | |
| 2006 | 1 | 25 | 34 | 18 | 278 | 97 | 247 | 365 | 183 | 28 | 116 | 1 | 1.393 |
| 2007 | 3 | 25 | 29 | 98 | 118 | 211 | 286 | 330 | 388 | 145 | 5 | 21 | 1.659 |
| 2008 | 27 | 14 | 20 | 122 | 184 | 234 | 424 | 305 | 199 | 469 | 259 | 75 | 2.332 |
| 2009 | 160 | 225 | 210 | 247 | 271 | 197 | 296 | 299 | 291 | 268 | 219 | 199 | 2.882 |
| 2010 | 81 | 8 | 6 | 56 | 150 | 175 | 280 | 274 | 172 | 25 | 221 | 12 | 1.460 |
| **2011** | 9 | 17 | 105 | 42 | 149 | 395 | 254 | 313 | 247 | 177 | 32 | 51 | 1.791 |
| **TB** | **47** | **52** | **67** | **97** | **192** | **218** | **298** | **314** | **247** | **185** | **142** | **60** | **1920** |
| **III. Humidity (%)** | | | | | | | | | | | | | |
| 2006 | 74 | 86 | 84 | 80 | 78 | 70 | 78 | 83 | 72 | 76 | 76 | 75 | 78 |
| 2007 | 69 | 81 | 88 | 79 | 75 | 77 | 78 | 81 | 81 | 77 | 67 | 77 | 78 |
| 2008 | 80 | 72 | 82 | 84 | 79 | 81 | 79 | 83 | 80 | 80 | 76 | 76 | 79 |
| 2009 | 72 | 84 | 82 | 82 | 81 | 77 | 79 | 78 | 76 | 75 | 66 | 74 | 77 |
| 2010 | 81 | 80 | 78 | 85 | 81 | 74 | 74 | 82 | 79 | 70 | 68 | 77 | 77 |
| **2011** | 71 | 83 | 80 | 80 | 76 | 80 | 77 | 80 | 80 | 78 | 76 | 67 | 77 |
| **TB** | **75** | **81** | **83** | **82** | **79** | **76** | **78** | **81** | **78** | **76** | **71** | **76** | **78** |
| **IV. Wind (m/s)** | | | | | | | | | | | | | |
| **TB** | 2.9 | 2.9 | 2.8 | 3.1 | 2.9 | 2.6 | 2.4 | 2.2 | 2.3 | 2.2 | 2.3 | 2.4 | 2.9 |

*Sources: Data from Lang Meteorological Station (2006 ÷ 2011)*

**Figure 2.4. Temperature Characteristic ($^0$C)**

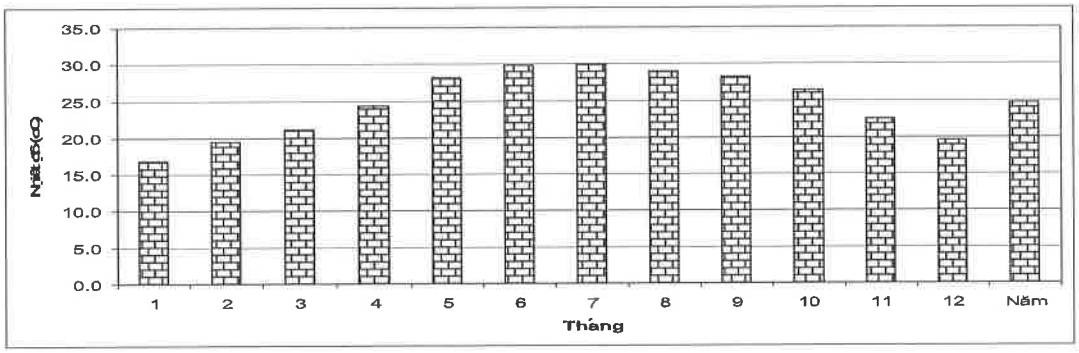
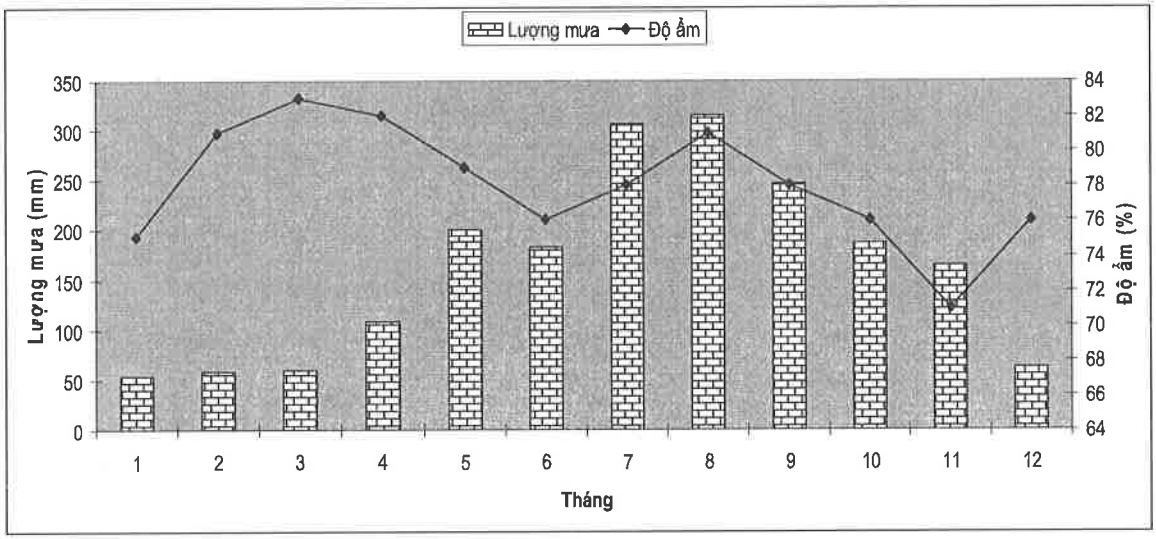



**Figure 2.5. Rainfall and Humidity**




- *Temperature:* the annual average temperature is about 24.6$^0$C. Every year, there are 4 months with average temperature of under 20$^0$C (from December to March of next year). The coldest month is January with average temperature of 16.9$^0$C. The hottest month is July with average temperature of up to 30$^0$C.
- *Rainfall:* The average annual rainfall is about 152 days. The rainy season lasts 6 months, from May to October making for 85% of annual rainfall. The rainfall increases from beginning of season to the end, and reaches the maximum in July, August (with a lot of storms) with average rainfall of about 300 mm. There is fewer rainfall in the other 6 months, from November to April. Rainfall is fewest during the first months of Winter, when only 6 ~ 8 rainy days are observed in a month. During 2006-2010 period (as shown in Table 2.2), the fewest rainfall was observed in January (54mm/month). The last months of Winter is the period of drizzle wet, when the rainfall is almost unchanged but the number of rainy days increases obviously (10 ~ 15 days per month).

- *Humidity*: The average annual humidity is 78%. The most humid period is observed in the last months of Winter (February, March, April), when the average humidity reaches about 82%. During the dry period, lowest humidity (71% in average) was observed in November.
- *Direction and velocity of wind*: popular wind direction in the Project area is the northeast and southeast with average annual wind speed of 2.9 m/s. In Winter, dry cold winds blowing from northeast to southwest with an average speed of 2.9 m/s. in Summer, moist warm winds blowing from southeast with average velocity of 2.4 m/s.

Project activities do not make change to climate or microclimate.

*(2) Atmospheric Stability*

Atmospheric stability in the Project area can be classified as type B (medium unstable) in daytime, considering the average wind speed (Table 2.3) and high solar radiation during daytime, and cloudy coverage during nighttime, in accordance with Pasquill classification's table (Table 2.4).

**Table 2.4. Atmospheric Stability's Classification (Pasquill, 1961)**

| Wind speed at the height of 10 m (m/s) | Solar radiation by day | | | Cloudy covering by night | |
|---|---|---|---|---|---|
| | Strong $h_o > 60^o$ | Medium $h_o = 35^o \div 60^o$ | Weak $h_o = 15^o \div 35^o$ | Less cloud < 4/8 | More cloud > 4/8 |
| < 2 | A | A-B | B-C | - | - |
| 2 | A-B | B | C | E | F |
| 3-4 | B | B-C | C | D | E |
| 5-6 | C | C-D | D | D | D |
| >6 | C | D | D | D | D |

*Remark:*

*A: high unstable.* *D: medium.* *$h_o$: height of sun.*

*B: medium unstable.* *E: medium stable.*

*C: weak unstable.* *F: stable.*

### *2.1.2.2. Special Weather Phenomenon*

Abnormal climate changes were observed occasionally in Hanoi City. Highest temperature (42.8°C) was recorded in May, 1926, and lowest temperature (2.7°C) was recorded in January, 1955. Some strong storms also occur in Hanoi area such as Storm No. 7 (in 1996) which hit the southern plain and caused severe losses of life and property.

### 2.1.3. Hydrographic Characteristic

The Hanoi ring road No.3 cut through two big rivers: the Red River and the Duong River. The following dyke systems were built along these rivers to prevent flood.

- The dyke system in the right bank of the Red River is classified as national dyke of Special Class;
- The dyke systems in the left bank of the Red River and both banks of the Duong River are classified as national dykes of Class 1.

The dyke system of the Red River creates two hydrological regimes along the river, namely: the hydrological regime of inner rivers (outside of the dyke), and the hydrological regime of the infield (inside of the dyke).

Sections Mai Dich - Nam Thang Long lies entirely in the infield (inside of the dyke). Distance from the ending point of the Project to the Red River dyke is about 800m, and to the Red River is about 1km. The planned viaduct is almost parallel to the Nhue River and about 1 ~ 1.5 km far from this river.

*(1) Hydrological Regime of the Red River*

The Red River comes from Wei Son Mountains, Yunnan Province, China, and runs to the sea at Ba Lat. Flow regime of the Red River is complex and depends heavily on the upstream current. River flow varies during two seasons: (1) flood season, and (2) drought season. Flood season lasts from June to October, one month later than the rainy season. The water flow during the flood season accounts for about 74.4% of the total annual flow. Dry season lasts from November to May (during 7 months) with the flow accounts for only 25.6% of the total annual flow. River water flow distribution is uneven: the flow in August (strongest flow) is ten times more than the flow in March (weakest flow).

In the rainy season, heavy rains usually cause flooding in many places in the area, though there are dyke systems along two banks of the Red River, and about 900 lakes (with water surface area larger than 1 ha) those can function as water reservoirs in the downstream area, and a series of reservoirs located in upstream. The most severe floods were observed in the years 1945, 1971, 1968, 1969 and 1996.

The Project area would not be affected by the hydrological regime of the Red River since it is located far enough from the river.

*(2) Hydrological Regime of the Nhue River*

Nhue River, a tributary of the Day River, is about 76km long. Its average width is 30m ~ 40 m. The river starts from Lien Mac Sewer, takes water from the Red River and ends at Phu Ly Sewer. It pours water into the Day River. The river basin area is about

1.075km², the average water level is 1.5 m ~ 1.8 m, and the average flow velocity is 2.39 m/s. Nhue River is an inland river, with the hydrological regime completely depending on the rainfall and drainage system in the area. In rainy season, flooding usually occurs when the inland rivers can not drain properly due to the high water level of the Red River and the Duong River.

The Project area would not be affected by the hydrological regime of the Nhue River, since it is 1 ~ 1.5 km far from this river.

*(3) Hydrological Regime of the Infield Canals*

In general, the irrigation system in the Project area is relatively built-up. Most of the inland canals are concreted and connected with the Nhue rivers through the culverts. The hydrological regime of the canals depends entirely on the rainfall regime of the infield and the operation of the culverts. The structures planned in the Project should be properly designed in order to avoid disturbance to these canals.

### 2.1.4. Current Physical Environment

In order to assess the current status of environmental quality, the Study Team had conducted a survey on ambient air quality, noise, vibration and groundwater quality at several sensitive sites in the Project area in February and March, 2012 (Figure 2.4).

#### *2.1.4.1. Site Selection to survey*

The survey sites were selected based on the following selection criteria:

- The site should have environmental condition representative to the entire local area;
- The site should have pollution sources representative to the local area;
- The areas around the site should be sensitive to the impacts caused by the Project.

Table 2.5 describes location of the survey sites, sampling frequency, survey parameters, etc.. Selected sites for the survey are shown in Figure 2.6.

**Table 2.5 Contents of the Survey on Current Environmental Quality**

| Item | Survey point | Parameter | Frequency |
|---|---|---|---|
| Air Quality | 05 points | Dust (TSP and PM10), toxic gases (CO, $NO_2$, $SO_2$) and micro climate elements (temperature, humidity, wind speed, wind direction and pressure). | 24 hours continuously, from 6 am to 6 am the following day.<br>Measure every 2 hours |
| Noise level | The same 05 points as of Air Quality measurement | $L_{eq}$, $L_{10}$, $L_{90}$. | 24 hours continuously, from 6 am to 6 am the following day.<br>Measure every 1 hour , each |

| Item | Survey point | Parameter | Frequency |
|---|---|---|---|
| | | | measurement made 3 times |
| Vibration | The same 05 points as of Noise measurement | Acceleration, velocity and frequency | 24 hours continuously, from 6 am to 6 am the following day. Measure every 1 hour , each measurement made 3 times |
| Underground water quality | 2 wells at residential area. | Temperature, pH, turbidity, conductivity, hardness, COD, DO, TS, Fe, As, Hg, Total Coliform, and E. Coli | Once a day |

*Source: the Study Team*

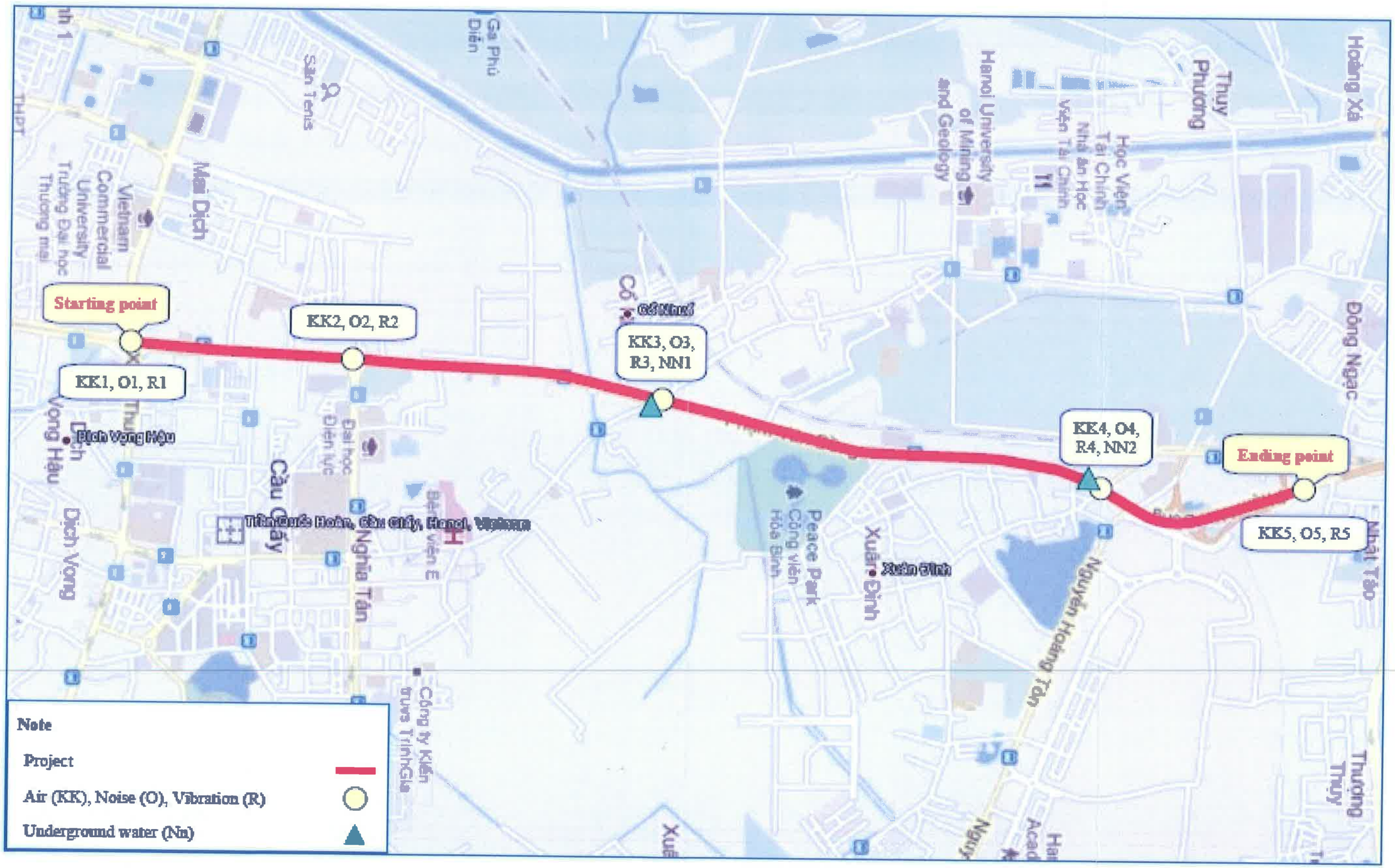
Table 2.6 shows the natural conditions and socio-economic conditions of the area around the survey sites at the time when the survey was carried out.

## Table 2.6. Natural Conditions, Socio-economic Conditions, etc. at the Survey sites

| Location | Symbol | Co-ordinate | Whether | Time | Traffic & Socio-economic Characteristics |
|---|---|---|---|---|---|
| **I. Air, Noise, Vibration** | | | | | |
| Starting Point of Project (Mai Dich intersection) | KK1; O1; R1 | 21°2'12"N; 105°46'50"E | Mostly Cloudy, no rain | 2 ÷ 3/2012 | Around the intersection is the Ha Noi National University, markets and residential area. Economic activity takes place vibrant. Traffic flow through at there is large, mostly motorcycles, cars and passenger cars. At peak hours occasionally occur locally jams under the bridge. |
| Hoang Quoc Viet intersection | KK2; O2; R2 | 21°2'46"N; 105°46'53"E | Mostly Cloudy, no rain | 2÷3/2012 | Surrounded by many small houses. Traffic density is high in both 2 directions Mai Dich - Noi Bai |
| Co Nhue Intersection | KK3; O3; R3 | 21°3'32"N; 105°46'59"E | Mostly Cloudy | 2 ÷ 3/2012 | Paved roads and good quality. Crowded population centres around the intersection. Vehicle traffic passing the area. Not going traffic jams |
| Xuan Dinh Intersection | KK4; O4; R4 | 21°4'40"N; 105°47'13"E | Mostly Cloudy | 2 ÷ 3/2012 | Two-way street that separated the band. There are many small houses in the area located at the intersection Tan Xuan. Traffic flow in large areas, due to the lower layer of motorcycles from the Thang Long bridge turn through the seam. |
| Ending point | KK5; O5; R5 | 21°5'9"N; 105°47'14"E | Mostly Cloudy | 2 ÷ 3/2012 | The left side is a residential area, the right side is agricultural land. Large vehicle traffic, including cars, trucks and passenger cars. |

| Location | Symbol | Co-ordinate | Whether | Time | Traffic & Socio-economic Characteristics |
|---|---|---|---|---|---|
| **II. Groundwater** | | | | | **Characteristic** |
| Xuan Dinh commune | NN1 | 21°4'41"N; 105°47'12"E | | 3/2012 | Hoa Cam flower shop, 52 Pham Van Dong |
| Co Nhue commune | NN2 | 21°3'32"N; 105°46'58"E | | 3/2012 | Hamlet 5, Co Nhue, Tran Cung |

**Figure 2.6. Location of Survey Sites of the Survey on Current Environmental Quality**



### *2.1.4.2. Ambient Air Quality*

*(1) Basis for Comparison*

QCVN05: 2009/BTNMT - National Technical Regulation on Ambient Air Quality.

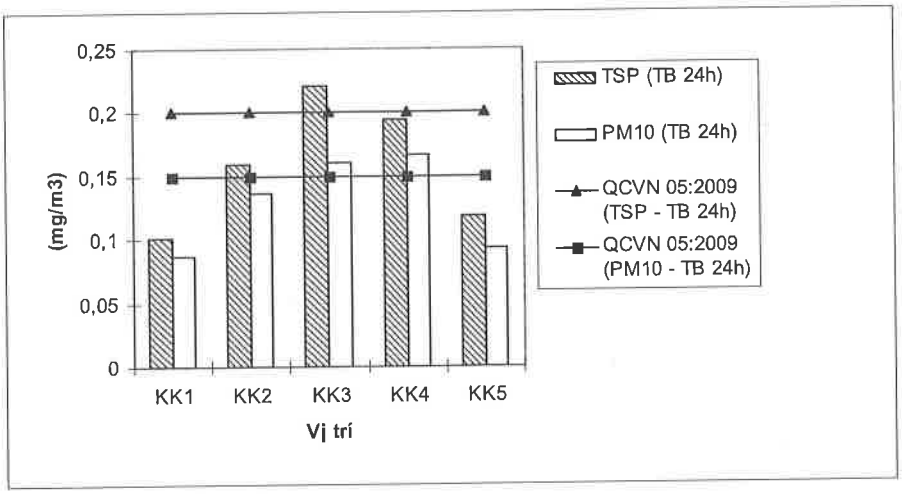
*(2) Assessment*

Table 2.7 and Figure 2.7 show result of the survey on current ambient air quality. Detailed result is presented in Appendix 3-Results of Environmental quality surveys.

**Table 2.7. Summary of the Survey on Current Ambient Air Quality**

| Location | Sign | Average Value | Concentration ($mg/m^3$) | | | | |
|---|---|---|---|---|---|---|---|
| | | | PM10 | TSP | CO | $NO_2$ | $SO_2$ |
| Mai Dich interchange | KK1 | 1h | 0.172 | 0.217 | 1.038 | 0.070 | 0.111 |
| | | 24h | 0.087 | 0.101 | 0.913 | 0.065 | 0.102 |
| Hoang Quoc Viet Interchange | KK2 | 1h | 0.197 | 0.262 | 1.454 | 0.090 | 0.147 |
| | | 24h | 0.136 | 0.159 | 1.050 | 0.071 | 0.116 |
| Co Nhue interchange | KK3 | 1h | 0.233 | 0.318 | 3.764 | 0.115 | 0.181 |
| | | 24h | 0.161 | 0.221 | 2.704 | 0.078 | 0.123 |
| Xuan Dinh interchange | KK4 | 1h | 0.257 | 0.277 | 2.325 | 0.105 | 0.170 |
| | | 24h | 0.167 | 0.195 | 1.637 | 0.074 | 0.119 |
| Ending point | KK5 | 1h | 0.121 | 0.142 | 1.458 | 0.096 | 0.181 |
| | | 24h | 0.093 | 0.118 | 0.990 | 0.065 | 0.104 |
| **QCVN 05:2009/ BTNMT** | | **1h** | - | **0.3** | **30** | **0.2** | **0.35** |
| | | **24h** | **0.15** | **0.2** | - | - | **0.125** |

*Source: the Study Team*




*Source: the Study Team*

**Figure 2.7. PM10 and TSP Concentrations Observed at the Survey Sites**

Compared with the QCVN 05:2009/BTNMT, it can be seen that:

- Concentration of toxic gases (CO, SO2, NO2) were lower than the allowable limits;
- Average PM10 (particulate matter) concentration during 24h observed at Co Nhue Intersection (KK3) was 0.161mg/$m^3$ and exceeded the allowable limit (0.15 mg/$m^3$). Similarly, at Xuan Dinh Intersection (KK4) this concentration (0.167 mg/$m^3$) exceeded the allowable limit. Besides, TSP (total suspended particulate) concentration observed in Co Nhue Intersection (KK3) during 1h (0.318mg/$m^3$) and 24h (0.221mg/$m^3$) exceeded the allowable limits. At the other survey sites, PM10 and TSP concentrations of are lower than the allowable limits.

*(3) The Cause of Pollution*

Dust pollution along the arterial roads is a serious problem in Hanoi as well as in other big cities in Viet Nam. This is mainly due to the heavy traffic flow, and the materials dropped from the vehicles transporting construction materials, etc.

### *2.1.4.3. Noise Level*

*(1) Basis for Comparison*

The National Technical Regulations on Noise - QCVN26: 2010/BTNMT.

*(2) Assesment*

Table 2.8 and Figure 2.8 show result of the survey on noise. Detailed result is presented in Appendix 3.

**Table 2.8. Noise Levels Observed at the Survey Sites**

| Location | Sign | Average Value | Noise Level (dBA) | | |
|---|---|---|---|---|---|
| | | | $L_{eq}$ | $L_{10}$ | $L_{90}$ |
| Mai Dich Interchange | O1 | 6h ÷ 21h | 73.2 | 79.8 | 70.5 |
| | | 21h ÷ 6h | 67.2 | 72.5 | 63.7 |
| Hoang Quoc Viet Interchange | O2 | 6h ÷ 21h | 78.1 | 87.5 | 72.8 |
| | | 21h ÷ 6h | 70.4 | 74.0 | 63.0 |
| Co Nhue interchange | O3 | 6h ÷ 21h | 78.8 | 87.5 | 71.2 |
| | | 21h ÷ 6h | 76.6 | 84.7 | 67.3 |
| Xuan Dinh interchange | O4 | 6h ÷ 21h | 76.9 | 85.4 | 73.3 |
| | | 21h ÷ 6h | 73.9 | 82.7 | 70.2 |
| Ending point | O6 | 6h ÷ 21h | 76.5 | 85.8 | 70.7 |
| | | 21h ÷ 6h | 75.5 | 84.2 | 65.5 |
| **QCVN26:2010/BTNMT** | | **6h ÷ 21h** | **70** | - | - |
| | | **21h ÷ 6h** | **55** | - | - |

*Source: the Study Team*

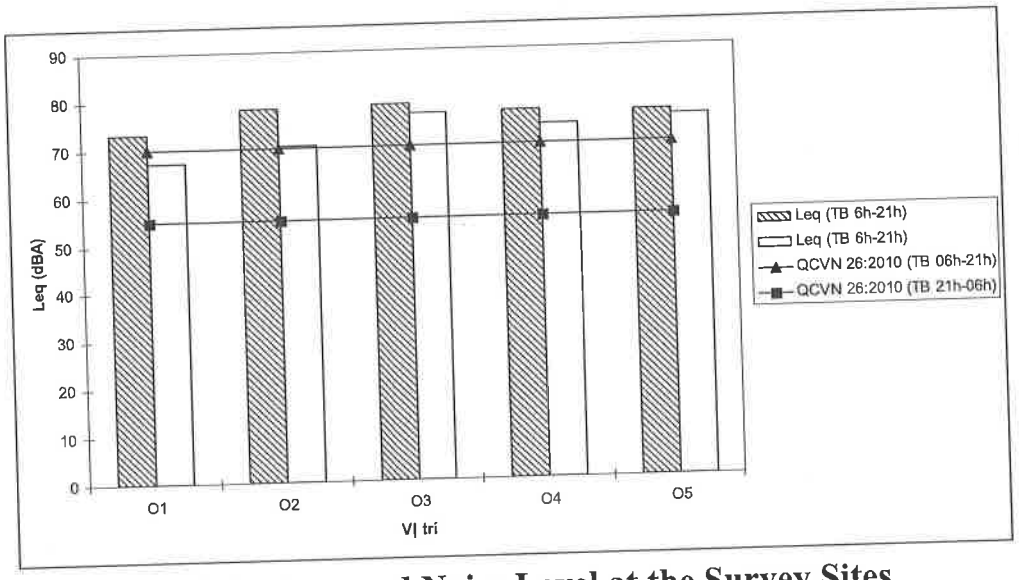



**Figure 2.8. Observed Noise Level at the Survey Sites**

Compare with the QCVN26:2012/BTNMT, it can be seen that: Noise levels ($L_{eq}$) observed at all survey sites exceeded the allowable limits from 3.2 to 8.1 dBA during day time and from 12.2 to 21.6 dBA during night time. The highest noise level (78.8 dBA during day time, and 76.6 dBA during night time) were observed at the intersection between Pham Van Dong Street and Co Nhue Road (O3).

*(3) Cause of Noise Pollution*

Pham Van Dong Street, belonging to Ring Road No.3 of the City, is an arterial road for vehicles to go in and out the City. Traffic volume on this street is very high, during both day time and night time. Excessive noise is likely generated from the movement of vehicles on the road, and the use of their klaxon. Besides, it seems that the intensive business activities along the road are also contributing to the excessive noise.

### *2.1.4.4. Vibration*

*(1) Basis for Comparison*

TCVN7210:2002, Vibration and shock – Vibration caused by road traffic – Maximum allowable limits in public and residential areas.

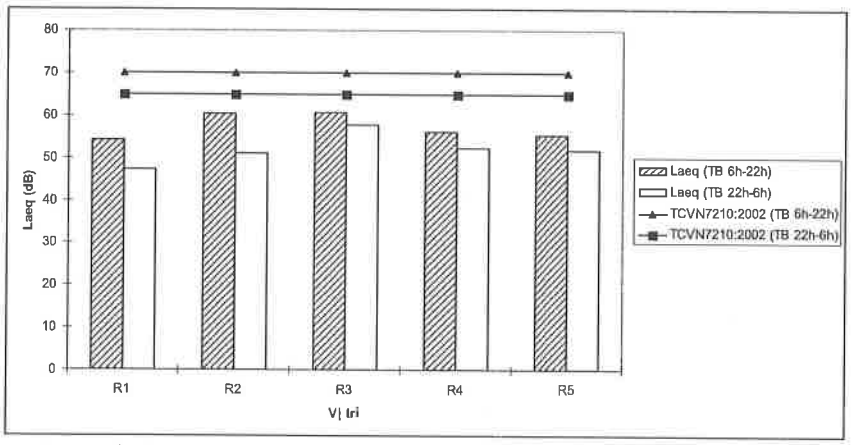
*(2) Assessment*

The result of survey on vibration level at the survey sites are presented in Table 2.9 and Figure 2.9. Observed data are shown in Appendix 3.

**Table 2.9 Observed Vibration Levels at the Survey Sites (dB)**

| Location | Sign | Average Level | Vibration Value | | |
|---|---|---|---|---|---|
| | | | $L_{aeq}$ | $L_{veq}$ | Frequency |
| Mai Dich Interchange | R1 | 6h ÷ 22h | 54.3 | 42.5 | 1-90Hz |
| | | 22h ÷ 6h | 47.3 | 39.3 | 1-90Hz |
| Hoang Quoc Viet Interchange | R2 | 6h ÷ 22h | 60.5 | 43.4 | 1-90Hz |
| | | 22h ÷ 6h | 51.0 | 41.7 | 1-90Hz |
| Co Nhue interchange | R3 | 6h ÷ 22h | 60.7 | 40.3 | 1-90Hz |
| | | 22h ÷ 6h | 57.9 | 43.2 | 1-90Hz |
| Xuan Dinh interchange | R4 | 6h ÷ 22h | 56.1 | 38.4 | 1-90Hz |
| | | 22h ÷ 6h | 52.4 | 35.9 | 1-90Hz |
| Ending point | R5 | 6h ÷ 22h | 55.5 | 39.6 | 1-90Hz |
| | | 22h ÷ 6h | 51.8 | 35.7 | 1-90Hz |
| **QCVN27:2010/BTNMT** | | **6h ÷ 22h** | **70** | - | - |
| | | **22h ÷ 6h** | **65** | - | - |

*Source: the Study Team*




*Source: the Study Team*

**Figure 2.9. Actuality of Vibration Level in Project's Area**

Compared with the National Standard QCVN 27:2010/BTNMT, the observed vibration levels at all survey sites during 24h were lower than the allowable limit.

### *2.1.4.5. Groundwater Quality*

*(1) Basis for Comparison*

QCVN09:2008/BTNMT - National Technical Regulation on Groundwater Quality.

*(2) Assessment*

Table 2.10 shows the result of the survey on groundwater quality at 2 sites along the Project area. Further details on the survey are shown in Appendix 3.

**Table 2.10. Result of Survey on Groundwater Quality of the Project Area**

| No | Parameter | Unit | Location | | QCVN 09:2008 /BTNMT |
|---|---|---|---|---|---|
| | | | Xuan Dinh | Co Nhue | |
| | | | NN1 | NN2 | |
| 1 | t° | *°C* | 15.3 | 15.8 | - |
| 2 | pH | - | 6.0 | 5.7 | ***5.5 ÷ 8.5*** |
| 3 | Conductivity | *s/m* | 33.3 | 26.7 | - |
| 4 | Turbidity | *NTU* | 1 | 1 | - |
| 5 | DO | *mg/l* | 1.2 | 1.8 | - |
| 6 | Hardness | *mg/l* | 38.4 | 35.2 | ***500*** |
| 7 | COD | *mg/l* | 1.22 | 1.13 | ***4*** |
| 12 | Fe | *mg/l* | 0.309 | 0.274 | ***5*** |
| 14 | As | *mg/l* | 0.0013 | 0.0011 | ***0.05*** |
| 15 | Hg | *mg/l* | 0.000141 | 0.000136 | ***0.001*** |
| 16 | Coliform | *MPN/ 100ml* | 0 | 0 | ***3*** |
| 17 | E. Coli | *MPN/ 100ml* | 0 | 0 | - |

*Source: the Study Team*

Compared with the QCVN09:2008/BTNMT, it is recognized that:

- Chemical and physical parameters (pH, TS, hardness, COD) meet allowed limit;
- Content of heavy metal is within allowed limit;
- Water is not polluted in terms of Coliform and E. Coli.

### 2.1.5 Biological Resource Condition

In the study area, there is no natural forest. Ecological system around the Project area is characterized as an urban eco-system with very few natural plants and wild animal species. Agricultural ecosystem makes up a small part in the paddy fields along the Project area. Vegetation distributing along the fields and along the banks of the former irrigation channels are mostly weeds. Animals are mainly pets such as dogs, cats and several rodent species. Only a few number of bird species (mostly passerine species) are observed.

The Project area is limited along the existing Ring Road No.3, and it would not cause impact to the eco-systems located far away in the rural areas or mountainous areas in

the region.

## 2.2. Socio-economic Condition

### *2.2.1. Socio-economic Condition of project area*

The planned viaduct (from Mai Dich to South Thang Long) will pass through the territories of : (1) Dich Vong Ward (Cau Giay District), (2) Xuan Dinh Commune (Tu Liem District), and (3) Co Nhue Commune (Tu Liem District). Besides, Dich Vong Hau Ward (Cau Giay District) and Dong Ngac Commune (Tu Liem District) are located near the planned viaduct, and would be affected indirectly to some extent by the Project. Figure 2.10 shows the map of the Project-affected wards/communes.

A socio-economic survey had been carried out in March, 2012, to grasp the socio-economic condition of the wards/communes in the Project area. Result of the survey is summarized in the following sections. The questionnaire used in this socio-economic survey is attached in Appendix 4.

*(1) Population*

The Project area consists of residential and agricultural areas mainly. The areas surrounding Mai Dich intersection are densely populous residential areas. While the northern part of the Project area is occupied by agricultural fields and low population density residential areas. The population density ranged approximately from 100 to 200 persons/ha in 2012. The social statistic data by each ward/commune is indicated in Table 2.11.

**Table 2.11 Population and Population Density by Ward/Commune in 2012**

| No | Ward/ Commune | Area (ha) | Population | No.of Household | Household Size (persons/HH) | Population Density (persons/ha) |
|---|---|---|---|---|---|---|
| 1 | Mai Dich | 194 | 23,416 | 6,389 | 3.4 | 121 |
| 2 | Co Nhue | 621 | 66,678 | 21,234 | 3.1 | 107 |
| 3 | Xuan Dinh | 556 | 40,805 | 10,344 | 3.9 | 73.3 |

*Source: Commune People's Committee compiled by the Study Team*

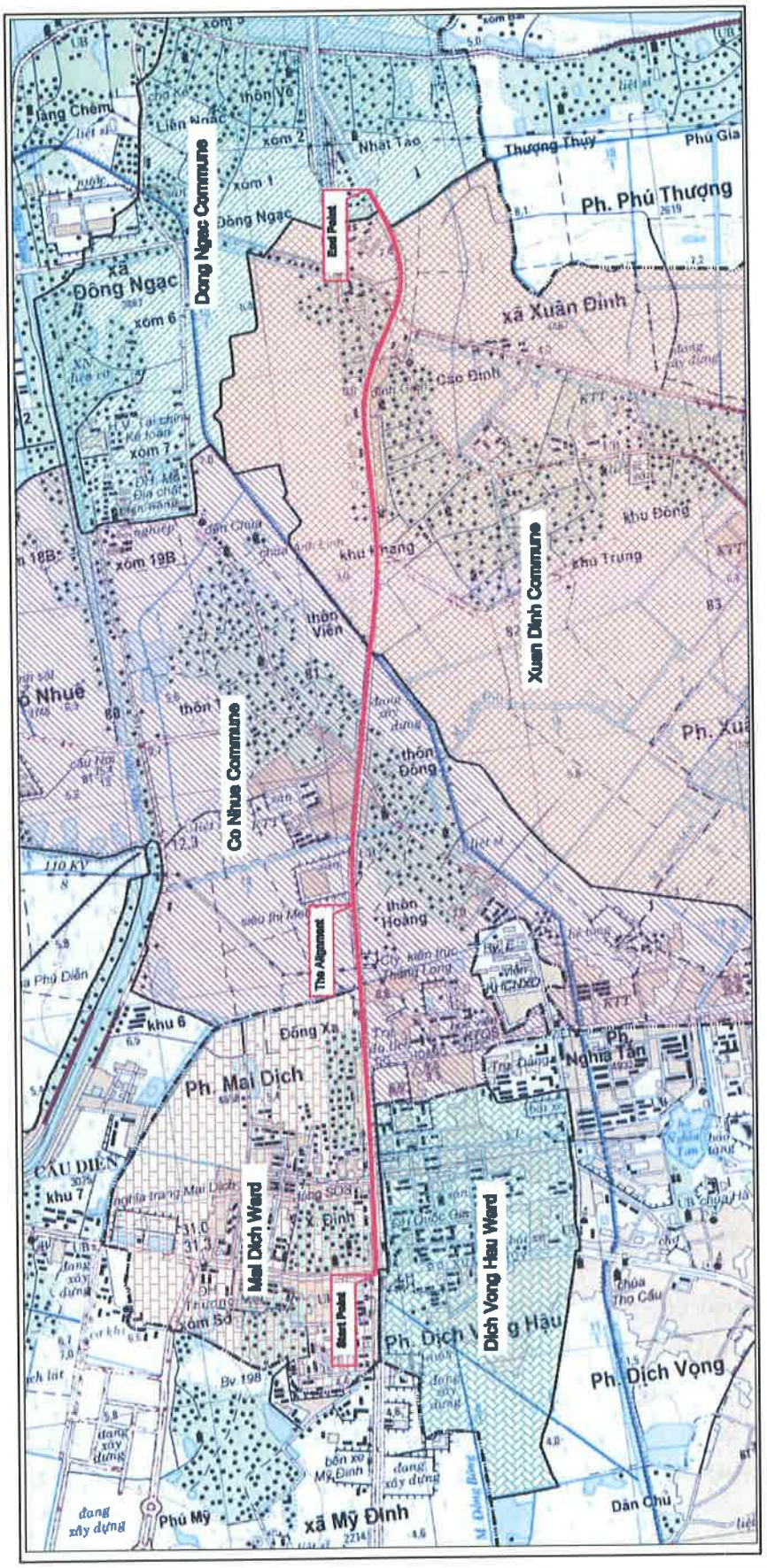



Figure 2.10 Map of Wards and Communes Affected by the Project

In terms of ethnic, population in the Project area consists of three ethnic groups namely Kinh, Thai and Muong. Most of the residents belong to Kinh ethnic group. A small number of Thai and Muong ethnic people are found in Mai Dich Ward. However, ethnic minorities are not found in the Project area.

**Table 2.12. Ethnic by Ward/Commune in 2012**

| No | Items | Unit | Mai Dich | Dich Vong Hau(*) | Co Nhue | Xuan Dinh | Dong Ngac(*) |
|---|---|---|---|---|---|---|---|
| | Ethnic | | | | | | |
| 1 | Kinh | HH | 6,819 | 5,500 | 16,987 | 10,344 | 6,433 |
| 2 | Ethnic minorities | HH | 20 | - | 2 | - | 69 |

*(*) Communes would be affected indirectly*

*(2) Economic activity*

Economic activities in the Project area are widely diverse. Many residents are working for the companies, government offices, or carrying out businesses relating to agriculture, service, trade, etc. Residents in the Project area, especially in the urban district, tend to work for enterprises or government offices. Besides, there are many renting houses and apartments for students and workers who studies or works in several universities and offices in the Project area. On the other hand, some agriculture activities are found in the northern part of the area. However size of the agricultural industry is relatively small.

Companies, factories and businesses are identified along the Project areas are shown in Table 2.15.

*(3) Road network and urban infrastructure*

Pham Van Dong Road, which runs under the planned viaduct, takes role as a trunk road in the Project area. Besides, there are three major roads which connect Pham Van Dong Road and other areas: Xuan Thuy Road, Hoang Quoc Viet Road, and Co Nhue Road. These roads are used as bus routes which are very important for the economic and social activities in the area.

In terms of road condition, most of these roads are paved and contribute a lot to the smooth transportation in the area. Railway, which connects the areas in southern and northern parts of Hanoi City, runs in parallel with the planned road at the section from Co Nhue to Nam Thang Long. The railway would not be affected by the Project because it is located far about 60m from the project alignment. In terms of social

infrastructure, the Project area is highly covered by urban services such as water supply, sewage and electricity.

Looking at the public facilities, in the Project area there are many local government offices, kindergartens, primary and secondary schools and health facilities (Table 2.13). Most of these facilities are located far more than 20 m from the project route.

**Table 2.13 Expected Project-affected Schools and Institutes**

| No | Objects | Location (Km) | Side | Distance (m) |
|---|---|---|---|---|
| 1 | The Headquarter of VNU | 0+100 | East | 21 |
| 2 | Foreign Language University -VNU | 0+220 | East | 22 |
| 3 | Mechanical Engineering Research Institute | 0+240 | West | 37 |
| 4 | College of trade and tourism | 0+310 | West | 32 |
| 5 | Herman High School | 0+480 | West | 42 |
| 6 | SOS Children's Village | 0+580 | West | 34 |
| 7 | Nguyen Binh Khiem | 0+880 | West | 47 |
| 8 | Co Nhue Commune People's Committee | 2+300 | East | Nearby |

*Source: The Study Team*

*(4) Cultural and religious facilities*

There is no any valuable cultural property such as world/ national heritage existing in the Project area. Several churches and temples are located at a certain distance from the planned road except Gian Temple, which is located in the east side of the road at km4+320 approximately 25m from the edge of ROW. This temple may be affected to some extent by the Project implementation.

*(5) Treatment of domestic waste*

Wastes generated in the Project area are collected by either Tay Do Environmental Company or Red River Environmental Company. There is no any waste disposal site in the Project area.

*(6) Land use*

As explained above, the Project area mainly consists of residential and agricultural areas. With regard to residential area, there are three large agglomerations namely Mai Dich Ward residential area, Co Nhue Commune residential area, Xuan Dinh Commune residential area. Location and distance from ROW of these residential areas are described in Table 2.14.

**Table 2.14 Expected Project Affected Residential Areas**

| No | Objects | Location (Km) | Side | Distance (m) |
|---|---|---|---|---|
| 1 | Mai Dich Ward Residential Area | 0+660 ~ 1+200 | West | Nearby |
| 2 | Co Nhue Commune Residential Area | 2+150 ~ 2+800 | Both | Nearby |
| 3 | Xuan Dinh Commune Residential Area | 3+730 ~ 4+400 | West | Nearby |
| | | 4+480 ~ 4+ 920 | Both | Nearby |

*Source: Study Team*

## 2.2.2. Economic Condition

### *2.2.2.1. Economic condition of the communes in the Project area*

- *Mai Dich Ward:* Economic activities are quite diversified, including commerce and service (75%), civil servant (23%), agriculture (2%); in which, main economic activity is business. Average monthly income per capita is 1.5 million VND.
- *Co Nhue Commune*: Main economic activity is commerce and service (52%). Others are: handicraft industry (38%), civil servant (5%), agriculture (5%). Main source of income is from the handicraft industry (traditional garment). Average monthly income per capita is 2.8 million VND.
- *Xuan Dinh Commune*: Main economic activity is commerce and service (50.7%), free labor (37%), civil servant (10%), traditional job and agriculture (2,3%). Main source of income is from commerce and service. Average monthly income percapita is 1 million VND.
- *Dich Vong Hau Ward:* Main economic activity is commerce and service (60%). Others are: free labor (21%), civil servant (15%), agriculture (4%). Average monthly income per capita is 1.2 million VND.
- *Dong Ngac Commune:* Main economic activity is commerce and service (65,6%). Others are: free labor (29,7%), agriculture (4,7%). Main source of income is from commerce and service. Average monthly income percapita is 2.8 million VND.

### *2.2.2.2. Economic Condition along the Project route*

Economic activities of the households living along the Project route are widely diverse, including corporate employees, commerce, service, education, public servants, etc. Households living close to the road sides are usually engaged in trading or housing for rent. There are various items subject to trading, such as daily commodities, machines, equipment, etc. Residents living back from the road sides are generally working as employee of companies or going to other areas for trading. Household running small shop on the sidewalk may have monthly income of about 3 million ~ 5 million VND, while households having house for rent or running business by themselves may have

monthly income up to 10 million ~ 20 million VND. A part number of households in the Project area have considerable income from renting their houses/rooms to students or workers.

### 2.2.3. Condition of the local road network

Most of roads in the Project area are paved with asphalt or concrete. Main roads include Pham Van Dong Street, Xuan Thuy Street, Hoang Quoc Viet Street, and Co Nhue Street. Besides, there are a number of crossing roads which link the residential areas with the main roads, such as Tran Quoc Hoan Road, Nguyen Hoang Ton Road, etc.

- *Pham Van Dong Street*: Road width is 24m including 4 motorized lanes and 2 mixed lanes (frontage road). Traffic flow is heavy during all day time and night time. According to result of a traffic survey conducted in 2011, average traffic volume on Pham Van Dong Street is 139,073 vehicles/day, of which motorcycles, passenger cars, buses, and trucks make up 74%, 11%, 8% and 7%, respectively.
- *Hoang Quoc Viet Street*: Road width is about 34m including the median of 12m wide, 4 motorized lanes, and 2 mixed lanes. Average traffic volume is 92,889 vehicles/day; of which motorcycles, passenger cars, buses, and trucks make up 75% , 12%, 9%, and 3%, respectively.
- *Xuan Thuy Street*: Road width is about 22m, including a median of 2m wide, 4 motorized lanes, and 2 mized lanes. Average traffic volume is 106,692 vehicles/day, of which motorcycles, passenger cars, buses, and trucks make up 75%, 16%, 6%, and 3%, respectively.
- *Co Nhue Street*: Road width is about 7m, including 2 mixed lanes. Traffic volume is about 59,553 vehicles/day, of which motorcycles, passenger cars, buses, and trucks make up 95%, 3%, 1%, and 1%, respectively.

### 2.2.4. Social Condition

#### *2.2.4.1. Social condition of the communes in the Project area*

- *Mai Dich Ward:* Total area is about 194.4ha. 6.839 households with 23.416 people, average 3 people in a household. Female accounts for 51% and the rate of natural population increase is 2,1 %. Moreover, number of students boarding here is rather huge (about 12.000 people). There are 148 households having disabled people, and 331 households are under preferential treatment policy. 99,7% of the population is Kinh and 20 households are other ethnic, they came from other area and they get married with the local people A number of people having education level of university, college and technical intermediate grade make up 34%, while a number of people at high-school level account for 42% and the rate of people at secondary school level is 24%. A number of poor households are low with only 15

households (0,22%). In term of religious culture, 99% people are not religious, 1% people is Catholic. The commune has two temples, one pagoda and one church, which are officially ranked. These properties are located over 1 km far away from the Project area. In term of technical infrastructure: electricity and tap-water are supplied to 100% households. Currently when it rains in the area, local flooding rarely occurs in the area except Dong Xa Group. The system of domestic waste water drainage which connected with the City's drainage system is working well. Volume of waste in the area is about 35 $m^3$/day which is collected and disposed at the City's waste treatment yard by Tay Do Environmental Company. In term of health care, infectious diseases, pulmonary tuberculosis, eye-related diseases ...are prevented by locality, the rate of malnourished children in the area is 7,76%. Traffic in the area is rather smooth with 100% concreted roads and asphalt roads including radius roads like Ho Tung Mau, Pham Hung... There are many institutes such as five (05) kindergartens; one (01) primary school; twenty seven (27) offices; one (01) medical station and one (01) market.

- *Co Nhue commune:* Total land area is 621 ha including 21.234 households and 66.678 people, 3 people per household on average. Female accounts for 50,5%, and the natural population growth rate is 1,6%. There are 420 households having disabled people, and 444 households are under preferential treatment policy. 99,9% households at the ward are Kinh and 2 households are other ethnics who came from other area. A number of people having education level of university, college and technical intermediate grade make up 20%, general education in the commune is secondary school. A number of poor households are low (19 households, 0,35%). In term of religion culture: 91% people are not religious, 4,5% households is Buddhist and 4,5% is Catholic. The commune has two temples, three pagodas and two churches, in which 6 properties are city-level historic ones. These properties located far away from the Project area. In term of infrastructure: electricity and tap-water are supplied to 100% households (however, a number of residents are using groundwater for daily life). Currently when it rains heavily in the area, flooding in some area does happen. The system of domestic waste water drainage which is connected to the City's system is working well. Waste volume at the area is about 30 $m^3$/day which is collected and disposed at the City's waste treatment yard by the Urban Environmental Company. In term of health care: contagious diseases, pulmonary tuberculosis, diseases with eyes ... are mostly prevented, the rate of malnourished children in the area is 7,7%. Traffic in the area is rather smooth with 100% concreted roads or asphalt roads including many main routes like Tran Cung, Co Nhue, Hoang Quoc Viet, Pham Van Dong... There are some school and institutes in the Commune such as two (02) kindergartens, two

(02) primary schools; one (01) secondary school; one (01) medical station and two (02) markets.

- *Xuan Dinh commune:* Total land area is 555,5 ha including 10.344 households and 40.805 people, 4 people per household on average. Female accounts for 51,4%, and the natural population growth rate is 0,84%. There are 94 households having disabled people, and 276 households are under preferential treatment policy. 100% households in the commune are Kinh. A number of people having education level of university, college and technical intermediate grade make up 25%, education is universalized to secondary school. A number of poor households are 83 households making up 0,8%. In term of religion and culture: 98% people are not religious, 2% people is Catholic. The ward has one temple which is the national-level historic work. The property located far away from the Project area. In term of infrastructure: electricity and tap-water are supplied to 100% households (however, a number of residents are using groundwater for daily life). Currently when it rains heavily in the area, flooding does not occur. The system of water drainage which is connected with the City's system is working well. The number of waste at the area is about 10 $m^3$/day which is collected and disposed at the City's waste treatment yard by the Urban Environment Company. In term of health care: contagious diseases, pulmonary tuberculosis, diseases with eyes ... are mostly prevented, the rate of malnourished children in the area is 10%. Traffic in the area is rather smooth with 100% concreted roads or asphalt roads including many main routes like Xuan Dinh, Nguyen Hoang Ton, Pham Van Dong... There are some schools and institutes in the Commune such as (one (01) primary school; one (01) high school; one (01) secondary school; one (01) hospital; one (01) medical station and one (01) market.

### *2.2.4.2. Social Condition along the Project Route*

- *Population and ethnic minorities:* Almost houses located near the sidewalk of the street are used for business purpose. A large portion of residents live in the houses set back from the street or along the alleys. In addition to local residents, there are many workers and students came from other provinces. Each household has four (04) people on average; the female population accounts for 51%. There is only a few numbers of poor households. There is not any ethnic minorities living along the Project route.
- *Historical and cultural building*: There are some cultural, religious and historical buildings in the Project area such as: Do Family Church, Hoang Ton Church, Khu Nhang Pagoda and Gian Temple. There are located at about 20 ~ 500m from the planned viaduct.

- *Health and education facilities:* along the planned viaduct, there are some health facilities such as medical station in Co Nhue Commune, Phuong Anh Clinic, South Thang Long Hospital; and other education facilities such as: University of Foreign Language, Hanoi Commercial & Tourism College, SOS Children's Village. The distance from these facilities to the planned viaduct is about 20 ~ 200m.
- *Other areas*: There is a planned Xuan Dinh – Co Nhue Urban Zone that is about 200 m from the planned viaduct, and the South Thang Long Bus Station located about 50 m from the planned viaduct.
- *Living standards and public services:* In general, residents living along the planned viaduct have stable and adequate living infrastructure. Local administration offices, schools, markets .... are located at convenient places and are easy to access. 100% of households can use tap-water (and well water) for eating, drinking and bathing and 100% households use electricity. In most of the area, domestic wastes are disposed by the Urban Environmental Company or by the residents themselves. There are not any drainage canal in some area on Pham Van Dong street and flooding does happen when it rains.

## 2.3. Sensitive Receptors along the Project Area

Table 2.15 shows all identified sensitive objects along the Project area which are likely to be affected by the Project.

**Table 2.15. Sensitive Receptors along the Project Area**

| No | Objects | Location (Km) | Side | Distance (m) |
|---|---|---|---|---|
| **I** | **Educational institutes, religious structures** | | | |
| 1 | The Headquarter of VNU | 0+100 | Right | 21 |
| 2 | Foreign Language University - VNU | 0+220 | Right | 22 |
| 3 | Mechanical Engineering Research Institute | 0+240 | Left | 37 |
| 4 | College of trade and tourism | 0+310 | Left | 32 |
| 5 | Herman High School | 0+480 | Left | 42 |
| 6 | SOS Children's Village | 0+580 | Left | 34 |
| 7 | Nguyen Binh Khiem High School | 0+880 | Left | 47 |
| 8 | Gian Temple | 4+280 | Right | 51 |
| **II** | **Enterprises and government offices** | | | |
| 1 | Fishery Mechanical Company | 0+410 | Left | 16 |
| 2 | Viet Nam Civil Engineering Company | 0+420 | Left | 25 |
| 3 | Viet My Technology Company | 0+640 | Right | 60 |
| 4 | Department of Information Technology MONRE | 0+700 | Right | 47 |

| No | Objects | Location (Km) | Side | Distance (m) |
|---|---|---|---|---|
| 5 | Ministry of Police | 1+240 | Left | 45 |
| 6 | Ha Noi Post Equipment and Services Company | 1+540 | Right | 50 |
| 7 | Ha Noi Environmental Monitoring and Analysis Center | 1+600 | Right | 25 |
| 8 | Metro Super Market | 1+900 | Left | 60 |
| 9 | People Committee of Co Nhue Commune | 2+320 | Right | 60 |
| 10 | Hanoi Electric Vehicles Enterprise | 3+580 | Left | 45 |
| 11 | Motor vehicle registration and inspection stations | 3+800 | Left | 35 |
| 12 | Thai Ha Railway Management Company | 3+830 | Left | 25 |
| 13 | 136 Construction Company | 3+910 | Left | 25 |
| 14 | Thang Long Construction Consultant Company | 3+950 | Left | 36 |
| 15 | Bridge Company No. 4 | 4+290 | Left | 40 |
| 16 | Thang Long Testing Company | 4+330 | Left | 17 |
| 17 | 665 Construction Company | 4+480 | Left | 44 |
| 18 | 386 Investment Construction JSC | 4+780 | Right | 33 |
| 19 | Thang Long Construction JSC No4 | 5+280 | Left | 30 |
| **III** | **Residential Area** | | | |
| 1 | Mai Dich Ward Residential Area | 0+660 ÷ 1+200 | Left | Nearby |
| 2 | Co Nhue Commune Residential Area | 2+150 ÷ 2+840 | Both | Nearby |
| 3 | Xuan Dinh Commune Residential Area | 3+700 ÷ 4+400 | Left | Nearby |
| 4 | Xuan Dinh Commune Residential Area | 4+480÷ 4+ 920 | Both | Nearby |

# CHAPTER 3. ENVIRONMENTAL IMPACT ASSESSMENT

In this chapter, all negative impacts and positive impacts caused by the Project to natural environment and society are examined.

Impacts caused by the Project are assessed based on the following approach: (1) analyzing impact source scientifically; (2) analyzing impact on receptors, based on experience from similar projects in the same situation; (3) consulting with scientists, experts and local people who are interested in the Project and clearly understand their area.

Based on the result of impact analysis and consultation with local people, the main impacts of the Project are summarized as follows:

Temporary land occupancy, interference in traffic

Erosion and sedimentation causing muddiness and blocking water flow

Air pollution, noise pollution, and vibration pollution during construction and operation phases

Groundwater pollution during construction phase

Waste management

Impacts caused by the stock and transportation of construction materials and waste soils

Impacts caused from workers came from outsides, worker camps, etc.

Environmental hazards including traffic accidents and collapse of structures

Table 3.1 presents the potential impacts which are identified based on the above-mentioned approaches.

**Table 3.1. Summary of primary assessment of impacts that may be caused by the Project**

| No | Item | Description | Assessment | | | Remarks |
|---|---|---|---|---|---|---|
| | | | *Preparation stage* | *Construction stage* | *Operation stage* | |
| | **Social Environment** | | | | | |
| 1 | Resettlement | Resettlement due to land occupancy (moving/land ownership) | No | No | No | There aren't households which will be removed. |
| 2 | Economic | Loss of economic | No | No | No | -as above- |

| No | Item | Description | Assessment | | | Remarks |
|---|---|---|---|---|---|---|
| | | | *Preparation stage* | *Construction stage* | *Operation stage* | |
| | activity | establishments such as land loss and change of economic structure | | | | |
| 3 | Traffic/Public utilities | Impact on schools, hospitals, and current traffic conditions | No | Yes | No | Due to construction activities |
| 4 | Split of community | Community divided by the line of cars on the road | No | No | No | The construction of viaducts items do not change or very small impact on the access of the community. |
| 5 | Cultural value | Damages to or loss of the value of churches, temples and other cultural assets | No | No | No | The Project is planned on the land acquired and cleared by other project.. |
| 6 | Rights of community | Obstruction of water rights, fishing rights, and other rights | No | No | No | There is no river in the project area. |
| 7 | Public health condition | Deterioration of public health and sanitary condition | No | Yes | No | Due to construction activities, workers came from outsides |
| 8 | Waste | Generated during construction | Yes | Yes | No | Solid wastes, wastewater, waste soils, hazardous wastes, etc. generated during construction |
| 9 | Accident | Material spillage<br>Work collapse<br>Traffic accident | Yes | Yes | No | Planned viaduct is at the height of 9m, under which there are urban roads, and heavy traffic flows. |
| 10 | Traffic | Traffic congestion | Yes | Yes | No | Construction machineries, construction site occupied existing road |
| | **Natural Environment** | | | | | |
| 11 | Topography and geology | Changes of topography and geology due to excavation and backfilling | No | No | No | Viaduct project is not carried out excavation and backfilling activities, so it will not affect the topography and geology of the project area. |

| No | Item | Description | Assessment | | | Remarks |
|---|---|---|---|---|---|---|
| | | | *Preparation stage* | *Construction stage* | *Operation stage* | |
| 12 | Soil erosion | Topsoil erosion by rainfall | No | Yes | No | Excavated soil would be eroded under heavy rain |
| 13 | Ground water | Change of distribution of groundwater by large scale excavation | No | Yes | No | Activities of the project are only done in a small scale. |
| 14 | Hydrological regime | Change of river flow and riverbed condition due to inflow | No | No | No | The location of the project is located far from the rivers and lakes. |
| 15 | Fauna and flora | Obstruction and extinction of species due to change of habitat | No | No | No | The project area is strongly urbanization. No valuable natural ecosystems within the project area. |
| 16 | Meteorology | Changes of temperature, rainfall, wind, etc. | No | No | No | Activities of the project are only done in a small scale. Therefore, the project activity does not change the meteorological conditions. |
| 17 | Landscape | Deterioration | No | Yes | No | Activities of project will not make deterioration of project area. |
| | **Pollution** | | | | | |
| 18 | Air pollution | Pollution caused by dust and exhaust gases | No | Yes | Yes | Due to construction and operation of the Project |
| 19 | Surface water pollution | Pollution by inflow of silt sand and effluent into rivers | No | No | No | Project does not cross over any river |
| 20 | Groundwater pollution | Pollution due to waste penetration from drilling pole | No | Yes | No | Cast-in-place drilling piles are planned which may pollute groundwater |
| 21 | Soil pollution | Pollution due to chemicals and dust | No | Yes | No | Activities of project will not create toxic substances contaminate ground. |
| 22 | Noise and vibration | Noise and vibration generated by vehicle and construction work | No | Yes | Yes | Noise/vibration may increase due to vehicles involved in construction work, and increased traffic flow in |

| No | Item | Description | Assessment | | | Remarks |
|---|---|---|---|---|---|---|
| | | | *Preparation stage* | *Construction stage* | *Operation stage* | |
| | | | | | | operation phase |
| 23 | Land subsidence | Deformation of land and land subsidence due to lowering of groundwater | No | No | No | The planned viaduct will stand on the deep ground layer, and would not cause change to groundwater level. |
| 24 | Offensive odor | Generated by exhaust gas from vehicles and at site | No | No | No | Activities of project will not create Offensive odor. |

## 3.1 Impact Assessment in Pre - Construction Phase

### 3.1.1 Analysis of the Project Alternatives

Without-the project alternative (zero-option)

Figure 3.1 presents traffic volume predicted on the section of Mai Dich - South Thang Long of Pham Van Dong Street in 2030. In case of without- the Project (zero-option), the traffic volume is estimated to be approximately 70,000 PCU/Day (passenger car unit) at the south of Hoang Quoc Viet Intersection. Meanwhile, if the Project is carried out (with-the Project), the traffic volume at this point is estimated to be around 43,000 PCU/Day. Or in other words, it is decreased by 39%.

Traffic volume estimated at the intersections of the Project in 2030, in case of: (1) without-the project, and (2) with-the project

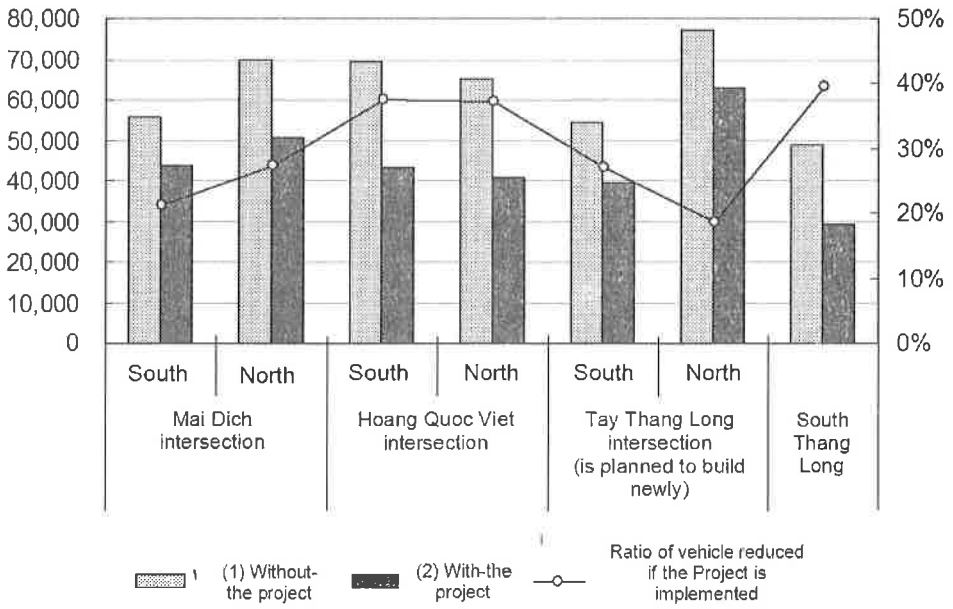


**Figure 3.1 Traffic volume estimated in 2030 on Pham Van Dong Street (comparison between the without-the project and with-the project)**

At the north of West Thang Long Intersection (to be built under the City's planning), the traffic volume estimated in 2030 is around 77,000 PCU/Day in case of without-the Project, however, it would be reduced to 63,000 PCU/Day or about 19% in case of with-the Project. If the Project is carried out, a large number of vehicles would use the elevated expressway. Accordingly, the traffic volume would decline significantly on Pham Van Dong Street. Traffic congestion would reduce considerably on this street.y. Air pollution, noise, road accident, consumption of fossil fuel, etc. would be reduced if the Project is implemented.

### 3.1.2. Impacts of Site Clearance

In order to serve the construction activities of the project, site preparation work will be done. The building will be relocated including 220KV high voltage poles (2 poles) and 220KV high voltage line (300m), street lighting poles in the separators and 2 sidewalks (568 lampposts), green trees on Pham Van Dong road (1,263 trees). (details is showed in table 1.2, chapter 1).

*High voltage pole relocation:* High-voltage power lines (220 kV) have an important role in providing electricity the production, business, economic, ... with scope is not only around the project area, but also on a large region neighborhood. Therefore, the electricity pole relocation will be temporary cut off electricity for the connection, thereby impact to economic activities, social of related areas if there is not solution accordingly.

In order to meet the above requirements, the project will agreement with professional agencies such as Hanoi Power Company implemented items relocation of 220kV high-voltage lines. It conduct to construct new line before by building underground line and switching station, when this item has been completed it will close the circuit at switch, with this measure the period of interruption to convert electrical circuit is not considerable. Thus, through the demolition and relocation activities of high voltage line, time uninterrupted power supply is negligible. The impact caused by relocation power poles were excluded.

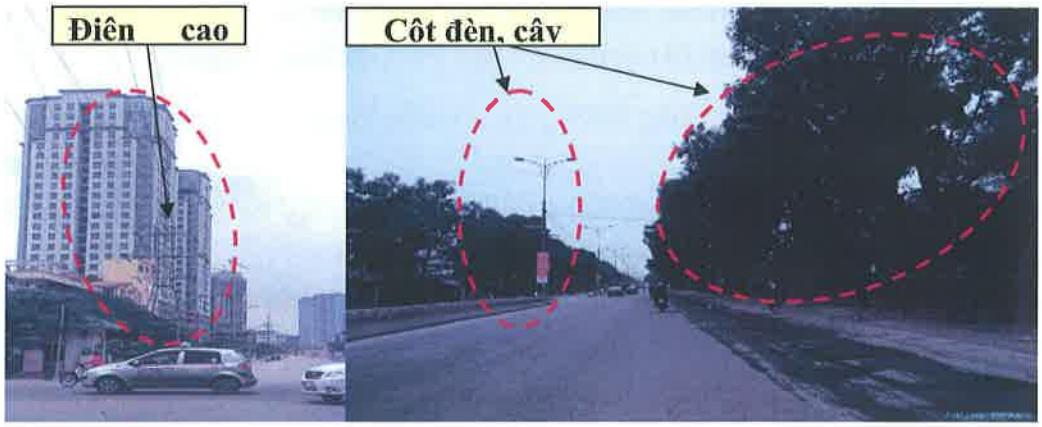



**Figure 3.2. The system of poles, cables and trees on Pham Van Dong**

The relocation activities of lighting poles on the road should need to have machineries to destroy, transport (occupy the road), generated rock and soil disposal drop on the road thereby obstructing traffic on Pham Van Dong, if implement these works at the peak time would causing traffic jams on Pham Van Dong, the risk accidents caused by power poles breakdown. The Impact need to have mitigation measures.

The demolition of lighting poles, can probably affect the urban lighting system as well as the socio-economic activities using these utilities of households living along the roadsides during construction stage. Impacts are required to be minimized.

*Cutting down trees:* with a relatively large number of trees within the project (1,263 trees with a large number of trees nacre) with a diameter of 0.1 ÷ 1 m were planted on both sides of the sidewalk Pham Van Dong. These trees have a role in air conditioning, landscaping, reduce dust and noise for residents living in the surrounding areas. The trees will be cut down to affect the regulation of climate, dust and noise the adjacent areas

In addition, the activity to cut down trees will generated waste (branches, wood, leaves, bark ...). Scatter around the area of the plant, the scatter in the shipping process, it is necessary mobilize of machineries to serve during trees cutting down process, transport will occupy the Pham Van Dong road cause obstructing traffic operations on Pham Van Dong, particularly in the peak hours will have high risk traffic congestion on the Pham Van Dong road, the risk of accidents caused by trees breakdown. Impacts are required to be minimized.

### 3.1.3. Impact Caused by the Preparation of Construction Site

#### *3.1.3.1. Impacts of Wastes*

*a. Solid waste*

In pre-construction phase, the construction sites shall be prepared by installation of fence, equipment, machinery, worker camps and etc. These activities shall produce wastes, such as unnecessary corrugated iron plates, woods, carton papers and etc. However, these wastes are generally common harmless wastes. It is difficult to predict the quantity of these wastes, due to the lack of information at this time. However, based on experiences obtained from other projects, it can say that the volume of these wastes is not big and impacts of them are not significant if proper mitigation measures are duly carried out.

***b. Dust and toxic gas generated from construction machines, transportation of materials and wastes***

The Project doesn't have quantities of demolition of houses and facilities. The Project have to remove 1,263 trees, including 500 trees with tree diameter of 50 cm, 350 trees with tree diameter of 30 ~ 50cm, rest is trees with tree diameter less than 30 cm. Soil and sand may fall on the Pham Van Dong Street during tree removing and transportation of trees, especially, this work commences at sunny and dry days. It is very difficult to estimate quantity of dust generated by this removing and transporting work, because this quantity is depending on weather and handling measures of contractor.

### *3.1.3.2. Risk of Landscape Degradation due to Solid Wastes – required to be mitigated*

As mentioned above, wastes generated during the pre-construction phase would not cause harmful impact to surrounding environment. However, if they are not promptly and properly collected, they would disperse to surrounding environment, and cause degradation of landscape and create unhygienic condition for the harmful pets (mice, cockroaches, etc.) to breed.

Wastes generated from the preparation of construction sites should be treated in accordance with Decree No. 59/2007/ND-CP dated April 9 2007 on solid waste management.

## 3.2 Impact Assessment in Construction Phase

Table 3.2 lists up all potential sources of impact (relating to waste and non-waste) during construction phase of the Project.

**Table 3.2. Potential sources of impact during construction phase**

| A | Sources of impact relating to waste | |
|---|---|---|
| No | Sources of waste | Type of Wastes |

| A | Sources of impact relating to waste | |
|---|---|---|
| No | Sources of waste | Type of Wastes |
| I | Construction of main items | |
| 1 | Viaduct | |
| - | Construction of substructure s | Dust, waste soils (excavated soil, bentonite mixed soil, spilled bentonite mixed sludge), solid wastes, waste oil, etc. |
| - | Construction of superstructure | Solid wastes |
| 2 | Access road | Dust, waste soils (excavated soil, solid wastes, waste oil, etc. |
| II | Supporting Activities | |
| 1 | Stock of materials and waste soils | Dust |
| 2 | Repair and maintenance of machinery | Waste oil and waste water |
| 3 | Management of worker camps | Waste water and domestic sewage |
| 4 | Operation of construction equipment | Dust and toxic gas |
| 5 | Transport of materials and waste soils | Dust and toxic gas |
| | Sources of impact relating to non-waste | |
| | Sources of impact | Impact factors |
| I | Construction of main items | |
| 1 | Viaduct | |
| - | Substructure | Noise |
| - | Superstructure | Noise, accidents |
| 2 | Access road | Noise, vibration |
| | Excavation and backfilling | Siltation |
| II | Supporting Activities | |
| 1 | Stock of materials and waste soils | Siltation |
| 2 | Concentration of workers | Deterioration of public security and order, conflict |
| 3 | Operation of construction machinery | Noise, traffic jam and unsafety |
| 4 | Transport of materials and waste soils | Noise, traffic jam and unsafety, damages of public utilities. |

### 3.2.1 Assessment of Impacts Relating to Waste

#### *3.2.1.1 Impacts on ambient air quality*

(a) Waste generation

During the construction phase, dust and toxic gases ($SO_2$, $NO_x$, CO, HC...) will be generated by:

Drilling, digging bored piles;

Activities of construction machinery (Horizontal construction) in the construction scope;

Transportation of waste soil and stone.

***1a. Dust generated by drilling, digging bored piles***

Construction of Pier Columns is planned (with a distance of 40m between two piers). At each pier, there would be 9 drilling piles with the average depth of 40m and diameter of 1.0 - 1.5m. Therefore, about 636$m^3$ of waste soil would be generated from each Pier Column.

Waste soil from bored piles has mixture of betonite, so it is wet, which is difficult to disperse dust. However, if it is dried, it will be the dust causing source. The quantity of this dust is very difficult to be quantified as it depends on the weather and contractors' disposal level.

***1b. Dust and toxic gas generated from horizontal construction***

Emissions of machinery and vehicles which take part in horizontal construction within the construction scope: A large quantity of machinery and vehicles shall be mobilized for construction of road and viaduct (Table 1.4 and 1.5, Chapter 1). Operation scope of this machinery and vehicles is limited within the site construction scope. Most of the machinery and vehicles uses diesel for operation. This is emission source of dust and toxic gases from burning fuels in vehicles engine. Forecast of total amount of dust and toxic gases is carried out in the following three steps.

Step 1: Determination of consumed oil in horizontal construction: According to "Norms of work construction expenses – Construction part (Decision of Ministry of construction No 1091/2011/QD-BXD date on December, 26th 2011) and Parameters for construction machinery and equipment pricing (Circular 06/2010/TT-BXD, date on May, 26th 2010 of Ministry of construction) the quantity of consumed diesel for machinery and vehicles taking part in the horizontal construction is determined;

Step 2: Determination of total quantity of dust and toxic gases generated from construction: WHO statistical results show that consuming 1 ton of diesel, a 3.5 to 16 ton truck shall emit into the air about 4.3kg TPS; 40kg $SO_2$, 55kg NO2, 28kg CO and 12kg VOC, and total amount of dust and toxic gases produced from horizontal construction activities in the each road section is calculated;

Step3: Calculation of emitted dust and toxic gates: Corresponding with the each item's length and the construction duration of time, the emission flow of dust and toxic gases generated from the horizontal construction activities in the each road section calculated (Table 3.3).

**Table 3.3. Emission Flow of Dust and Toxic Gases generated from**

## Horizontal Construction within the Construction Scope

*Unit: (mg/m.s)*

| No | Activity | Fuel (Tone diesel) | Length (m) | Time (Month) | Dust Emission Flow (mg/m.s) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TSP | $SO_2$ | $NO_2$ | CO | VOC |
| 1 | Road part | 104 | 535 | 24 | 0.051 | <0.001 | 0.645 | 0.328 | 0.141 |
| 2 | Viaduct part | 1098,1 | 4803 | 24 | 0.06 | <0.001 | 0.76 | 0.387 | 0.166 |

***1c. Dust generated from transportation of materials and waste soil and stone***

Emission volume from transportation activities (to the dumping area) for waste soil during construction process of bored piles is the most interest. This activity requires use of dump truck for transportation.

However, according to construction experience, it is seen that quantity of dust generated from waste soil transportation and vehicle tires is much bigger in many times than that generated from vehicle engines. Quantity of dust, however, depends on many factors such as construction work surface feature, place where vehicles go out and come in, the weather, workers', as well as contractors' and monitoring consultants' ability, knowledge and common sense. Therefore, it is difficult to estimate its quantity.

(b) Assessment

***Impact of dust during transportation: should be minimized***

The following pollutants are considered to be generated during construction phase and cause significant impacts on ambient air quality:

Dust generated from drilling, digging bored piles;

Dust generated from the activities of construction machinery (horizontal construction in the construction scope; and

Dust generated from transportation of waste soil and stone.

The construction of bored pile may generate small quantity of dust as discarded waste soil of bored pile has a high level of humidity.

Emission flow of dust and toxic gases from horizontal construction are: 0.06mg/ms of TSP; less than 0.001mg/ms of $SO_2$; 0.76mg/ms of $NO_2$; 0.387mg/ms of CO and 0.166mg/ms of VOC. Dust and toxic gases will diffuse in air, however concentration of dust and toxic gases has a low concentration, being much lower than Allowable Limit with QCVN 05:2009/BTNMT. The impact is assessed not significant.

However, according to experience of construction supervision, it is considered that trucks with transporting large volume of waste soil and stone on paved roads usually

generate dust with concentration of 5mg/m$^3$ to 7.5mg/m$^3$ at the road edge. But, it reduces quickly depending on the distance. Dust concentration generated from vehicle flow of transportation on aggregate roads reaches nearly Allowable Limit in the distance of about 50m ÷ 75m according to QCVN 05:2009/ BTNMT.

#### *3.2.1.2 Impact on Groundwater Quality*

**(1) Source of impact**

As shown in Figure 2.2, the upper aquifer in the Project area is found at the depth of about 30m~38m from the ground level. It is planned to construct bored pile in some sections (the standard section from Km1 +240 - Km2 +120, Km2 +760 - Km3 +400 and transition section from Km3 +400 - Km3 +640). Construction of bored piles will reach to the deep of this aquifer, therefore it would pollute groundwater in this aquifer, if there is no proper mitigation measures.

**(2) Assessment**

***Impact to groundwater quality - should be mitigated***

The bored piles with diameter of 1.5m are planned for foundation of viaduct piers. When using technology piles, penetration of surface water into the underground water during drilling is inevitable. Have been identified that technical piles with diameter of 1.5 m, length piles about 35 - 45m (average 40m) will be applied in the project. Accordingly, there is possibility that: (1) preferential flow paths are created along the drilling holes which allow contaminated surface water and leachates to move downwards through aquifer layers into underlying groundwater; (2) contaminated materials are driven into the aquifer during the drilling work and construction of piles; (3) groundwater is contaminated by concrete, cement paste or grout.

In particular, bentonite slurry would be used to support the wall of the drilling hole during pile construction process. If drilling work is not properly managed, when the bored pile is not filled with bentonite slurry or concrete, then surface water may penetrate into groundwater. And, during the process to install steel re-bar cage into the drilling hole, and inject concrete mortar to the hole, groundwater may be polluted by additives in cement mortar before concrete mortar has become harden.

Currently, groundwater along the Project area is being used by people living in the surrounding area (the location of residential areas around the sections in Km1 +240 - Km2 +120, Km2 +760 - Km3 +400, Km3 +400 - Km3 +640). Therefore, if the appropriate measures to prevent minimize groundwater pollution in the construction of bored pile location do not applied, the groundwater contamination will directly affect people's health as well as the socio-economic activities relate groundwater used.

Impact requires measures to prevent or minimize.

### *3.2.1.3 Impact of Wastes*

#### (1) Waste generation sources

The construction activities would generate a variety of wastes, including solid waste and wastewater.

- Solid waste:
  - + Excavated soil from construction of bored piles;
  - + Chemical wastes;
  - + Domestic wastes.
- Wastewater:
  - + Wastewater from construction activities;
  - + Domestic wastewater.

#### (2) Requirement of waste management

***2a. Solid waste management***

During construction, solid wastes are mainly generated from construction of viaduct, and from workers' activities. There are various types of waste, including:

- *Excavated soil from bored piles:* total amount of excavated soil is 61,310m$^3$ which is mainly bentonite-mixed soil generated from the bored piles for foundation of viaduct. Bentonite-mixed soil is chemically and physically not toxic, but it would make the road to be slippery if it is dropped on the roads. This excavated soil is required to be treated in accordance with Decree 59/2007/ND-CP on the solid waste management.
- *Chemical pollutants*: includes batteries, alkali or acid/alkali-containing scraps, and particularly, oil-containing wastes generated from the repair/maintenance of machinery at construction yard. It is very difficult to estimate the quantify of these wastes, since it depends on many factors such as the number and features of used machinery, works to repair/maintain machinery at construction yard, etc. However, based on experiences obtained from other similar projects, it may say that amount of these wastes are not big. Treatment of these hazardous chemical wastes is required in accordance with Circular 12/2011/TT-BTNMT on hazardous solid waste management.
- *Domestic wastes*: including wastes generated from worker camps, project offices, canteens, etc. These domestic wastes are mainly consisted of organic matters, easily-decomposed foods, and other hardly-decomposed wastes such as cans, nylon

bags and papers. On average, 1 worker will generate 0.5kg domestic wastes. The total domestic wastes general from 210 workers/ each worker camp is about 105kg. If without proper management, these solid wastes would cause unpleasant smell and create favorable condition for the development of harmful microorganism. These wastes are required to be treated in accordance with Decree 59/2007/ND - CP on the solid waste management.

***2b. Wastewater***

During construction, wastewater is mainly generated from construction activities and from worker camps.

- *Wastewater from construction activities*: Wastewater generated from construction of bored piles is generally in high pH level and rich in solid waste. In addition, wastewater generated from the machine repair/maintenance workshops usually contains a remarkable quantity of engine oil. Wastewater from construction activities is estimated at about 11$m^3$ per day at construction camps, of which content of engine oil is about 3mg/l. Oil-containing wastewater is required to be filtered out oil and the obtained waste oil is required to be treated in accordance with Circular 12/2011/TT-BTNMT on hazardous waste management.
- *Waste lubricating oil*: The number of machines/vehicles that needs to change engine oil estimated in a month during construction phase is 78 to 156 (or 117 on average). Each machine/vehicle may operate 8 hours/day, 26 days/ month, and may need to change about 7 liter of lubricating oil in a year. Therefore, the volume of waste engine soil is estimated to be about 820 liters in a year, or about 70 liters in a month.
- *Domestic wastewater*: domestic wastewater generated from worker camps includes wastewater from cooking ($V_{na}$), bathing, and toilet ($V_{tg}$). According to the norm of water applied for workers on sites TC 20TCN 4474–87 (water used for meals preparation, 25 liters/person/day), and according to TC 20TCN33–85 (water used for bathing and washing, 45 liters/person/day), and with suppose that 80% of used water will be discharged into the environment, the amount of wastewater generated from 210 workers/ each worker camp in a day is about 11.7$m^3$. Table 3.4. Presents pollutant loads in domestic wastewater based on the quick assessment document of WHO (*Source: WHO. 1993. Assessment of source of air, water and land pollution. A guide to rapid source inventory techniques and their use in formulating environmental control strategies. Part one: Rapid inventory techniques in environmental pollution).*

**Table 3.4. Presents pollutant load of Pollutants in Domestic Waste Water**

| No | Pollutant | Load of pollutant (kg/day) |
|---|---|---|
| 1 | BOD5 | 0.36 – 0.4 |
| 2 | COD | 0.58 – 0.82 |
| 3 | SS | 0.56 – 1.2 |
| 4 | Oil and grease | 0.08 – 0.24 |
| 5 | Total phosphorous | 0.006 – 0.03 |
| 6 | Coli form (MPN/100ml) | 40,000 – $40*10^6$ |

Therefore, domestic wastewater is required to be properly treated so as it should not exceed the wastewater standard stated in QCVN14:2008/BTNMT - National technical regulation on domestic waste water.

### 3.2.1.4. Impacts on water quality due to Bentonite solution arising

***(1) Impact factor***

Bentonite solution: bored pile construction activities will require solution of bentonite disposal. These are substances that can pollute the water (causing turbidity, sediment, etc.).

The route of project runs through drainage channels at Km2 +193 and Km3 +135. These are canals and drainages which play a role in the surrounding residential areas. The construction activities of the project may affect the drainage channel

**Figure 3.4. Drainage at Km2 +193**

*(2) Assessment*

*Pollute the water in the canals:* Thus, the surface water at Km3 +135 drainage channel can be affected by soil mixed with bentonite spill, spillage without appropriate precautions. At Km2+193 drainage channel position affects less than by the application of Steel Rotate Pile construction method, however the construction of the other items (excavation at the top of the pile, construction piers, etc.) can also give rise to solid waste affect the surface water environment if the waste is not collected, handled well.

Impact requires measures to mitigate.

### *3.1.2.5. Impacts on the drainage due to arising of waste from the construction of pile*

The Substructure construction, including construction of piles, construction of piers will generate sludge, disposal soil with scattered rocks on the road and when it's rain will put down the drainage culverts and manholes along Pham Van Dong road. During construction, soil and rock will accumulate in the culverts and it will minimize the capacity of drainage culverts that causes flooding the Pham Van Dong road surface when heavy rains occur. Impact requires measures to mitigate.

## 3.2.2 Assessment of Impacts Relating to Non-waste

### *3.2.2.1 Impact on Acoustic Environment*

**(1) Cause of impact**

Noise and vibration in construction phase irregularly occur only when operating machinery. During construction of the viaduct, noise would be generated from combination of construction machinery and equipment, including:

- Viaduct construction: combination of crane booms, welding machines, concrete pumper, concrete vibrators and lorries.
- Construction of access road: bulldozers, rammer, clamshell buckets, damp trucks, graders, roller and lorries.

**(2) Assessment**

*2a. Noise pollution - impact should be mitigated*

During construction phase of the Project, the following activities are considered as sources of noise:

Substructure construction (crane booms, welding machines, concrete pumper, concrete vibrators, lorries);

Superstructure construction (crane booms, welding machines, concrete pumper, concrete vibrators, lorries);

Improve landscape and site clearance (bulldozer, excavator).

Sprinkle road (spreader, truck, roller).

Noise generated from construction equipment is irregular, depending much on method of operation of machinery and equipment.

At present, not only in Viet Nam but also in many countries in the world, the following typical noise levels proposed by "US Environmental Protection Committee" (noise from construction equipment and plant NJID, 300.1, 31-12-1971) are used to manage noise source in during construction (Table 3.5).

**Table 3.5. Typical noise levels (dBA) from construction equipment in the Distance of 15 Meters**

| | | | | | |
|---|---|---|---|---|---|
| Site Clearance | | Digging and Earth moving | | Pneumatic tool | 81-98 |
| Bulldozer | 80 | Bulldozer | 80 | Crane | 75-77 |
| Front end loader | 72-80 | Backhoe | 72-93 | Welding machine | 71-82 |
| Dump struck | 83-94 | Dump truck | 83-94 | Concrete mixer | 74-88 |
| Grading and compacting | | Jack hammer | 80-93 | Concrete pump | 81-84 |
| Grade | 80-93 | Landscaping and clean-up | | Concrete vibrator | 76 |
| Roller | 73-75 | Bulldozer | 80 | Air compressor | 74-87 |
| Paving | | Excavator | 72-93 | Pneumatic tool | 81-98 |
| Spreader | | Truck | 83-94 | Bulldozer | 80 |
| 86-88 | | Paver | 86-88 | Cement and dump trucks | 83-94 |
| Truck | 83-94 | Structure Construction | | Truck | 83-94 |
| Tamper | 74-77 | | | | |

*Source: U.S. Environmental Protection Agency, Noise from Construction Equipment and Operation, Building Equipment and Home Appliances, NJID, 300.1, 31 December 1971*

Based on Table 3.4, noise levels generated from typical construction works of the Project are estimated by applying the following formula:

$$L_{\Sigma} = 10\lg \sum_{i}^{n} 10^{0,1.Li}$$

Of which:

$L_{\Sigma}$: total noise level

$L_i$: source noise level

N: total noise sources

Result of estimation of noise levels in construction phase is presented in Table 3.6.

**Table 3.6. Estimated noise levels (dBA) in construction phase**

| No | Items | Main used Equipment | Level of Source Noise (dBA) |
|---|---|---|---|
| 1 | Bridge construction | crane booms, welding machines, concrete pumper, concrete vibrators, lorries, excavator | 87,5 ~ 96,3 |
| 2 | Road construction | Pavers, trucks, compactors | 87,9 ~ 95 |

***2b. Noise impact on sensitive receptors - impact should be mitigated***

Noise degradation in distance is calculated by the following formula:

$\Delta L = 10 \lg (\frac{r_2}{r_1})^{1+a} (dB)$ (for line source)

In which:

$\Delta L$: noise degradation in the distance of $r_2$ in comparison with noise source;

$r_1$: distance of noise source ($r_1$=8m);

a: impact coefficient of surface topography on noise absorption and reaction (a=0.1 – grass land).

*(Source: Pham Ngoc Dang 2003. Air Environment. Publishing house - KHKT 2003.)*

The results are showed at table 3.7.

## Table 3.7. Noise impacts arising from project's construction activities

| No | Objects | Location (Km) | Distance (m) | Allowable Limits with the QCVN26:2012/BTNMT (dBA) | | | |
|---|---|---|---|---|---|---|---|
| **I** | **Educational institutes, religious structures** | | | **Min (6-21h)** | **Max (6-21h)** | **Min (21-6h)** | **Max (22-6h)** |
| 1 | The Headquarter of VNU | 0+100 | 21 | 25.5 | 34.3 | - | - |
| 2 | Foreign Language University - VNU | 0+220 | 22 | 25.3 | 34.1 | - | - |
| 3 | Mechanical Engineering Research Institute | 0+240 | 37 | 23.7 | 32.5 | - | - |
| 4 | College of trade and tourism | 0+310 | 32 | 24.2 | 33.0 | - | - |
| 5 | Herman High School | 0+480 | 42 | 23.2 | 32.0 | - | - |
| 6 | SOS Children's Village | 0+580 | 34 | 24.0 | 32.8 | - | - |
| 7 | Nguyen Binh Khiem High School | 0+880 | 47 | 22.8 | 31.6 | - | - |
| 8 | Gian Temple | 4+280 | 51 | 22.5 | 31.3 | - | - |
| **II** | **Enterprises and government offices** | | | | | - | - |
| 1 | Fishery Mechanical Company | 0+410 | 16 | 11.2 | 20.0 | - | - |
| 2 | Viet Nam Civil Engineering Company | 0+420 | 25 | 10.0 | 18.8 | - | - |
| 3 | Viet My Technology Company | 0+640 | 60 | 6.9 | 15.7 | - | - |
| 4 | Department of Information Technology MONRE | 0+700 | 47 | 7.8 | 16.6 | - | - |
| 5 | Ministry of Police | 1+240 | 45 | 8.0 | 16.8 | - | - |
| 6 | Ha Noi Post Equipment and Services Company | 1+540 | 50 | 7.6 | 16.4 | - | - |
| 7 | Ha Noi Environmental Monitoring and Analysis Center | 1+600 | 25 | 10.0 | 18.8 | - | - |
| 8 | Metro Super Market | 1+900 | 60 | 6.9 | 15.7 | - | - |
| 9 | People Committee of Co Nhue Commune | 2+320 | 60 | 6.9 | 15.7 | - | - |
| 10 | Hanoi Electric Vehicles Enterprise | 3+580 | 45 | 8.0 | 16.8 | - | - |

| No | Objects | Location (Km) | Distance (m) | Allowable Limits with the QCVN26:2012/BTNMT (dBA) | | | |
|---|---|---|---|---|---|---|---|
| 11 | Motor vehicle registration and inspection stations | 3+800 | 35 | 8.9 | 17.7 | - | - |
| 12 | Thai Ha Railway Management Company | 3+830 | 25 | 10.0 | 18.8 | - | - |
| 13 | 136 Construction Company | 3+910 | 25 | 10.0 | 18.8 | - | - |
| 14 | Thang Long Construction Consultant Company | 3+950 | 36 | 8.8 | 17.6 | - | - |
| 15 | Bridge Company No. 4 | 4+290 | 40 | 8.4 | 17.2 | - | - |
| 16 | Thang Long Testing Company | 4+330 | 17 | 11.1 | 19.9 | - | - |
| 17 | 665 Construction Company | 4+480 | 44 | 8.0 | 16.8 | - | - |
| 18 | 386 Investment Construction JSC | 4+780 | 33 | 9.1 | 17.9 | - | - |
| 19 | Thang Long Construction JSC No4 | 5+280 | 30 | 9.4 | 18.2 | - | - |
| **III** | **Residential Area** | | | | | - | - |
| 1 | Mai Dich Ward Residential Area | 0+660 ÷ 1+200 | Nearby | 14.9 | 23.7 | 29.9 | 38.7 |
| 2 | Co Nhue Commune Residential Area | 2+150 ÷ 2+840 | Nearby | 14.9 | 23.7 | 29.9 | 38.7 |
| 3 | Xuan Dinh Commune Residential Area | 3+700 ÷ 4+400 | Nearby | 14.9 | 23.7 | 29.9 | 38.7 |
| 4 | Xuan Dinh Commune Residential Area | 4+480÷ 4+ 920 | Nearby | 14.9 | 23.7 | 29.9 | 38.7 |

*Note: Educational institutes, religious structures and Enterprises and government offices... don't work at night;*

*Educational institutes, religious structures: special locations.*

Based on the sensitivity to noise, identified two groups that be affected, including:

- Common area: During the daytime, residential area will be affected by the noise pollution with the noise level exceeding Allowable Limit from 14.9 to 23.7dBA. At night, the impact noise level on these objects will exceed Allowable Limit from 29.9 to 38.7dBA. In which, the noise level only impact strongly on the households living in the first row of block, the noise level impact on the blocks that is at the rear of the first row of block will be reduced. The impact does not take place continuously, it shall be only produced when the equipments are operated. Enterprises and government offices will be impacted by noise level from 6.9 to 20.0dBA. However, the offices, factories and companies are covered by brick fences or walls so the impact noise level will be reduced significantly.
- Special areas: During the day, the special areas will significantly be affected by noise with the noise level exceeding Allowable Limits from 22.5 to 34.3 dBA.

***2c. Vibration caused by construction activities - impact is insignificant***

Impact of vibration is usually assessed separately by source. Therefore, for convenience, estimation of vibration level here is done with subject to the construction machine which generates high vibration level. Table 3.8 shows the vibration levels of several typical construction machines at the distance of 10m from the source.

**Table 3.8 Vibration levels of typical construction machines at the distance of 10m from the source**

| No | Equipment | Reference Vibration Level (Vertical Direction, dB) |
|---|---|---|
| 1 | Excavator | 80 |
| 2 | Bulldozer | 79 |
| 3 | Truck | 74 |
| 4 | Roller | 82 |
| 5 | Air compressor | 81 |

To estimate the vibration levels by distance, the following formula is used:

$L = L_0 - 10\log(r/r_0) - 8,7a(r - r_0)$ *(dB)*

In which:

L: vibration level calculated by dB in distance r m to the source;

Lo: vibration level calculated by dB measured in distance "ro" m from the source. Vibration in distance ro=10m is usually considered as source vibration.

a: vibration inner reduction coefficient to clay pavement, a=0.5.

Table 3.9 shows the estimation result.

**Table 3.9 Estimated vibration levels generated by several typical construction machines**

| No | Equipment | Vibration level at source ($r_0$=10m) | | Vibration level by distance | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | r=12m | | r=14m | | r=16m | | r=18m | |
| | | $L_{acq}$ (dB) | Lveq (mm/s) | $L_{acq}$ (dB) | Lveq (mm/s) | $L_{acq}$ (dB) | Lveq (mm/s) | $L_{acq}$ (dB) | Lveq (mm/s) | $L_{acq}$ (dB) | Lveq (mm/s) |
| 1 | Excavator | 80 | 1.72 | 70.5 | 0.58 | 61.1 | 0.20 | 51.9 | 0.07 | 42.6 | 0.02 |
| 2 | Bulldozer | 79 | 1.53 | 69.5 | 0.51 | 60.1 | 0.17 | 50.9 | 0.06 | 41.6 | 0.02 |
| 3 | Truck | 74 | 0.86 | 64.5 | 0.29 | 55.1 | 0.10 | 45.9 | 0.03 | 36.6 | 0.01 |
| 4 | Roller | 82 | 2.17 | 72.5 | 0.73 | 63.1 | 0.25 | 53.9 | 0.08 | 44.6 | 0.03 |
| 5 | Air compressor | 81 | 1.93 | 71.5 | 0.65 | 62.1 | 0.22 | 52.9 | 0.08 | 43.6 | 0.03 |
| 6 | Tilt hammer* | 80 | 1.72 | 70.5 | 0.58 | 61.1 | 0.20 | 51.9 | 0.07 | 42.6 | 0.02 |
| QCVN 6962:2001, Allowable Limit 75dB from 7h to 19h and baseline level from 22h to 6h | | | | | | | | | | | |
| DIN 4150, 1970 (Germany), 2mm/s: cause no damage; 5mm/s: cause mortar crack; 10mm/s: may cause damage to bearing structures; 20~40mm/s: cause damage to the bearing structures. | | | | | | | | | | | |

Comparing the estimated vibration levels with the Allowable Limit stated in QCVN 27:2010/BTNMT, it can say that, the highest vibration level came from the roller would reach the Allowable Limit at the location outside of the construction site. Almost public facilities are located at least 24m far from the boundary of the construction site, and would not be affected by vibration. Impact of vibration is assessed insignificant.

### *3.2.2.2. Impact to Local Traffic*


**Figure 3.5. Traffic conditions on roads**

Pham Van Dong Street along the construction scope of the project with a width of 24m

has a narrow median and sidewalks on the both sides. This is a two-way road which consists of 3 lanes for each way. There is great density of traffic on the route during the daytime; vehicles on the road include motorcycles, cars, besides large payload vehicles (buses, trucks carrying supplies whether in the evening), car containers and etc. Traffic congestion along at the peak hours of the day occurs often, especially there is severe traffic congestion occurs at some locations (Hoang Quoc Viet Intersection, Co Nhue Intersection, some passages that intersect with the path to the residential areas, etc.).

**(1) Cause of impact**

The following activities would affect to the local traffic during construction phase.

- Arrangement of construction sites (Construction site will be located within the area from 7-9m-wide in the center of existing Pham Van Dong Street), and operation of construction machines would cause traffic congestion;
- Transportation of waste soil: construction materials and waste soils may be dropped down on the road during transportation, and make the road slippery and cause damages to the public utilities along the road;
- Waste bentonite-mixed soil generated from the construction of bored pile would make the roads muddy and slippery if it spilled out on the road, thus this causes the risks of traffic accident.

**(2) Assessment**

***2a. Risk of traffic congestion due to preparation of construction sites and operation of construction machines - Impact is required to be minimized***

The arrangement of the construction site in the middle of the road with a width of at least from 7 to 10.6m in narrow sections and 27m in standard sections will reduce the area of the current width of carriageway (Table 3.10 and illustrated in Figure 3.5). Although still ensuring the way width of 7m along the construction areas, but with the current traffic flow on major roads is high, especially during peak hours will be combined with the number of vehicles on construction sites are at risk of the traffic jams. During the installation of bridge beams will have to close the road lane, so the movement of vehicles on Pham Van Dong Street in beam installation section will be affected although installation time period for each section is not more from 1 to 2 days and can divide to many different periods of the day.

In addition, the impact on traffic Pham Van Dong road also can affect the roads around the construction area of the project due to incremental traffic flow. However, if there are ramification measures, appropriate organized traffic on these roads, the impact on traffic will be minimized because these roads are wide roads (Pham Van Dong, Xuan

Thuy ...).

Impact requires measures to prevent, minimize.

| Before arrangement construction site | After arrangement construction site |
|---|---|

**Figure 3.5 Illustrations the scope of traffic flow narrowed when construction site arrangement**

**Table 3.10 Impact on traffic when construction site arrangement**

| Location | The width of the existing road traffic | Width of construction area covers all existing road | Width of traffic when arrange construction |
|---|---|---|---|
| ***Standard section*** | 23-24m | 27m | 15.5m or 17m |
| ***Narrow section*** | | 10.6m | 17m |

***2b. Risk of traffic accident due to the dropped construction materials and waste soils on the road during transportation -impact should be mitigated.***

As experienced from other construction projects, the drop of construction materials and waste soils on the road during transportation is observed often, especially in the area within 100 - 200m from the construction site. If there is no proper measure to prevent the drop of construction materials and waste soils on the road during transportation, the local peoples would be affected by dust, and the roads would be muddy and slippery in rainy day, leading to traffic accidents. This impact would become more severe when constructing the substructure of the viaduct (during about 24 months). When constructing the superstructure of the viaduct, this impact would be insignificant, because construction casting beams are away from project implementation scope, preparing to install the beams that are transported to the construction site

***2c. Risk of damage to public facilities due to transportation of materials/waste soils - impact is insignificant***

The arterial roads of Hanoi City (Ring Road 3, North Thang Long - Noi Bai Road, Nation Highway No.18, etc.) would be used for transportation of construction materials and waste soils. These roads are paved with asphalt of good quality to allow trucks of up to 40 tons. The trucks to be used for the Project are expected to have a load of less than 40 tons, otherwise trucks would hardly cause damage to the road surface.

***2d. Risk of slippery roads caused by dropped bentonite-mixed soil - impact should be mitigated***

According to the Project plan, Pier Columns located at the sections from Km1 +240 - Km2 +120 and Km2 +760-Km3 +400 will have bored pile foundation. Bored piles were drilled an average depth of 35 - 45m. In this condition, it is estimated that each Pier Column will generate approximately 570m$^3$ of waste soil which is mixed with bentonite slurry. If this waste soil is not properly collected and treated and with only 1% of this soil scattering on surrounding area, the surrounding area of 70m$^2$ would become muddy (10cm of mud in thickness). This muddy soil would cause the road became slippery and increase the risk of traffic accident. Most affected range at locations around the head - where digging activity place (Km1 +240 - Km2 +120 and section from Km2 +760 - Km3 + 400). In addition, sludge spillage could affect nearby areas without mitigation measures. Impact requires mitigation measures to prevent.

### *3.2.2.3 Impact due to Concentration of Workers*

**(1) Cause of impact**

A large number of workers would be needed to construct the Project. Concentration of such number of workers may cause the following impacts.

- Spread of infectious diseases;
- Deterioration of public order/security.

**(2) Assessment**

***2a. Risk of spread of infectious disease - impact should be mitigated***

Bad hygiene condition in the temporary houses, worker camps, etc. would cause infectious diseases such as malaria, eye disease, etc., and these diseases would widely spread to the surrounding areas. In addition, there is potential risk of spread of

infectious diseases like HIV/AIDS.

***2b. Risk of deterioration of public order/security – preventive measures are required***

Various business activities, trading and service are taking place in the Project area with a large number of merchants came from other areas. Thus, if workers are not well managed and educated, it is easy for them to cause deterioration of public order/security.

### *3.2.2.4 Impact to Public Facilities (Offices, Schools, etc.)*

**(1) Cause of impact**

Construction works would cause the following impacts to the public facilities (offices, schools) around the Project area.

- Generate dust and noise;
- Cause hindrance to access to public facilities.

**(2) Assessment**

***2a. Public facilities to be affected by dust and noise during construction***

Public facilities around the Project area may be divided into 3 groups as followings:

- *The cultural and educational group:* Vietnam National University - Hanoi, University of Foreign Languages, College of Trade and Tourism;
- *Administrative agencies:* Co Nhue Commune People's Committee, Engineering Research Institute, Department of Information Technology, Ministry of Public Security Office, Motor Registration and Inspection Station;
- *Enterprises*: Vietnam Company, No 136 Construction Company, Thang Long Bridge No. 4 Company, No 386 Investment Company Construction.

***2b. Hindrance to access to facilities/establishments - impact should be mitigated***

As mentioned in Section 3.2.2.2, "Impact to Local Traffic", incorrect handling of bentonite-mixed soil generated from the construction of bored pile would cause muddy and slippery condition on the roads when it is transported to the disposal site. Consequently, it may hinder people to access to the public facilities and other establishments. This impact would be severe during the peak hours of 6:00~8:00, 11:00~16:00, and 13:00~18:00 daily.

### *3.2.2.5. Impacts on the socio-economic activities in the locality*

(1) impact elements:

The project's activities in this area can create impact factors that impacts on social and

economic activities of the households in the project area, including:

- Site layout and material handling activity create the risk of traffic congestion in the area;
- Construction activities rising to dust, noise affects the surrounding area;
- Potential Construction items worsening environmental landscape.

## 3.3 Impact Assessment in Operation Phase

Table 3.11 lists up all predicted key potential impact sources during operation phase of the Project.

**Table 3.11 Predicted impact sources during operation phase of the Project**

| A | Waste related impact sources | |
|---|---|---|
| No | Activities | Types of waste |
| 1 | Traffic flow (vehicle engine) | Dust, emissions (CO, NO2, SO2, VOC) |
| 2 | Moving vehicles | Dust from road surface |
| 3 | Rainfall runoff | Heavy metal |
| B | Non-waste related impact sources | |
| No | Activities | Impact factors |
| - | Movement of vehicles | Noise, vibration |

### 3.3.1 Impact Sources related to Waste

#### *3.3.1.1. Impact on Air Environmental Quality*

#### a. Arising Waste

Operation of vehicles in operation phase may cause impact on ambient air quality due to emissions of dust and exhaus (CO, $NO_2$, $SO_2$, HC) from fuel burning and dust from the tire rolling on the road.

***a1. Dust and exhaust emissions (CO, $NO_2$, $SO_2$, HC) from fuel burning of vehicles from viaduct***

The estimated load of pollutants from duel burning of vehicle from viaduct in operation phase is done based on:

Traffic demand forecast in 2020 and 2030 (Table 3.12);

Emission coefficient of World Health Organization (Source: WHO. 1993. Assessment of source of air, water and land pollution. A guide to rapid source inventory techniques and their use in formulating environmental control strategies. Part one: Rapid inventory techniques in environmental pollution)

Traffic demand forecast by 3 section: Mai Dich ÷ Hoang Quoc Viet, Hoang Quoc Viet

÷ Co Nhue and Co Nhue ÷ Nam Thang Long are presented in Table 3.12.

**Table 3.12. Traffic Demand Forecast on Section of Mai Dich - South Thang Long**

| Section | Type | Year of 2020 | | | | | Year of 2030 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Viaduct | | Urban Road | | Total | Viaduct | | Urban Road | | Total |
| | | S (1) | N (2) | S | N | | S | N | S | N | |
| ***Traffic volume in rush hour (PCU/h)*** | | | | | | | | | | | |
| Mai Dich ÷ Hoang Quoc Viet | *Bike* | 0 | 0 | 923 | 1075 | *1998* | 0 | 0 | 1291 | 1356 | *2647* |
| | *Car* | 467 | 713 | 226 | 263 | *1669* | 1047 | 1036 | 399 | 410 | *2892* |
| | *Bus* | 358 | 356 | 181 | 207 | *1102* | 398 | 430 | 229 | 274 | *1331* |
| | *Truck* | 966 | 920 | 325 | 427 | *2638* | 792 | 842 | 434 | 533 | *2601* |
| | ***Total*** | **1791** | **1989** | **1655** | **1972** | ***7407*** | **2237** | **2307** | **2353** | **2573** | ***9470*** |
| Hoang Quoc Viet ÷ Co Nhue | *Bike* | 0 | 0 | 918 | 962 | *1880* | 0 | 0 | 1158 | 1210 | *2368* |
| | *Car* | 467 | 713 | 263 | 360 | *1803* | 1047 | 1036 | 425 | 470 | *2978* |
| | *Bus* | 358 | 356 | 189 | 224 | *1127* | 398 | 430 | 264 | 256 | *1348* |
| | *Truck* | 966 | 920 | 370 | 438 | *2694* | 792 | 842 | 442 | 529 | *2605* |
| | ***Total*** | **1791** | **1989** | **1740** | **1984** | ***7504*** | **2237** | **2307** | **2289** | **2465** | ***9298*** |
| Co Nhue ÷ South Thang Long | *Bike* | 0 | 0 | 963 | 852 | *1815* | 0 | 0 | 974 | 992 | *1966* |
| | *Car* | 467 | 713 | 320 | 428 | *1928* | 1047 | 1036 | 481 | 722 | *3286* |
| | *Bus* | 358 | 356 | 161 | 172 | *1047* | 398 | 430 | 235 | 220 | *1283* |
| | *Truck* | 966 | 920 | 299 | 390 | *2575* | 792 | 842 | 316 | 459 | *2409* |
| | ***Total*** | **1791** | **1989** | **1743** | **1842** | ***7365*** | **2237** | **2307** | **2006** | **2393** | ***8943*** |
| ***Traffic volume in rush hour (unit/h)*** | | | | | | | | | | | |
| Mai Dich ÷ Hoang Quoc Viet | *Bike* | 0 | 0 | 4615 | 5375 | *9990* | 0 | 0 | 6455 | 6780 | *13235* |
| | *Car* | 467 | 713 | 226 | 263 | *1669* | 1047 | 1036 | 399 | 410 | *2892* |
| | *Bus* | 143 | 142 | 72 | 83 | *440* | 159 | 172 | 92 | 110 | *533* |
| | *Truck* | 386 | 368 | 130 | 171 | *1055* | 317 | 337 | 174 | 213 | *1041* |
| | ***Total*** | **996** | **1223** | **5043** | **5892** | ***13154*** | **1523** | **1545** | **7120** | **7513** | ***17701*** |
| Hoang Quoc Viet ÷ Co Nhue | *Bike* | 0 | 0 | 4590 | 4810 | *9400* | 0 | 0 | 5790 | 6050 | *11840* |
| | *Car* | 467 | 713 | 263 | 360 | *1803* | 1047 | 1036 | 425 | 470 | *2978* |
| | *Bus* | 143 | 142 | 76 | 90 | *451* | 159 | 172 | 106 | 102 | *539* |
| | *Truck* | 386 | 368 | 148 | 175 | *1077* | 317 | 337 | 177 | 212 | *1043* |
| | ***Total*** | **996** | **1223** | **5077** | **5435** | ***12731*** | **1523** | **1545** | **6498** | **6834** | ***16400*** |
| Co Nhue ÷ South | *Bike* | 0 | 0 | 4815 | 4260 | *9075* | 0 | 0 | 4870 | 4960 | *9830* |
| | *Car* | 467 | 713 | 320 | 428 | *1928* | 1047 | 1036 | 481 | 722 | *3286* |
| | *Bus* | 143 | 142 | 64 | 69 | *418* | 159 | 172 | 94 | 88 | *513* |

| Section | Type | Year of 2020 | | | | | Year of 2030 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Viaduct | | Urban Road | | Total | Viaduct | | Urban Road | | Total |
| | | S (1) | N (2) | S | N | | S | N | S | N | |
| Thang Long | *Truck* | 386 | 368 | 120 | 156 | *1030* | 317 | 337 | 126 | 184 | *964* |
| | ***Total*** | **996** | **1223** | **5319** | **4913** | ***12451*** | **1523** | **1545** | **5571** | **5954** | ***14593*** |
| ***Traffic volume in rush hour (unit/h – classify by noise level)*** | | | | | | | | | | | |
| Mai Dich ÷ Hoang Quoc Viet | *Small unit (3)* | 467 | 713 | 2534 | 2951 | *6665* | 1047 | 1036 | 3627 | 3800 | *9510* |
| | *Large unit (4)* | 529 | 510 | 202 | 254 | *1495* | 476 | 509 | 266 | 323 | *1574* |
| | ***Total*** | **996** | **1223** | **2736** | **3205** | ***8160*** | **1523** | **1545** | **3893** | **4123** | ***11084*** |
| Hoang Quoc Viet ÷ Co Nhue | *Small unit* | 467 | 713 | 2558 | 2765 | *6503* | 1047 | 1036 | 3320 | 3495 | *8898* |
| | *Large unit* | 529 | 510 | 224 | 265 | *1528* | 476 | 509 | 283 | 314 | *1582* |
| | ***Total*** | **996** | **1223** | **2782** | **3030** | ***8031*** | **1523** | **1545** | **3603** | **3809** | ***10480*** |
| Co Nhue ÷ South Thang Long | *Small unit* | 467 | 713 | 2728 | 2558 | *6466* | 1047 | 1036 | 2916 | 3202 | *8201* |
| | *Large unit* | 529 | 510 | 184 | 225 | *1448* | 476 | 509 | 220 | 272 | *1477* |
| | ***Total*** | **996** | **1223** | **2912** | **2783** | ***7914*** | **1523** | **1545** | **3136** | **3474** | ***9678*** |

*Note: (1) South bound (from South Thang Long to Mai Dich)*

*(2) North bound (from Mai Dich to South Thang Long)*

*(3) Small unit = 0.5 x bike + car (Source: Phạm Ngọc Đăng (2003), "Air Environment", page 353)*

*(4) Large unit = bus + truck*

*Data source: Study team.*

In order to determine pollutant emissions load for each type of vehicle on road, emission coefficients of World Health Organization (WHO) has been used (Table 3.13).

## Table 3.13. Air Pollution Coefficient for Transportation Means of WHO

| Vehicle | Unit (U) | TSP (kg/U) | $SO_2$ (kg/U) | $NO_x$ (kg/U) | CO (kg/U) | HC (kg/U) |
|---|---|---|---|---|---|---|
| **1. Car (small car and pass. car)** | | | | | | |
| - Engine <1400 cc | 100 | 0.07 | 1.74S | 1.31 | 10.24 | 1.29 |
| | 0km | 0.80 | 20S | 15.13 | 118.0 | 14.83 |
| - Engine 1400-2000 cc | ton diesel | 0.07 | 2.05S | 1.33 | 6.46 | 0.60 |

| Vehicle | Unit (U) | TSP (kg/U) | $SO_2$ (kg/U) | $NO_x$ (kg/U) | CO (kg/U) | HC (kg/U) |
|---|---|---|---|---|---|---|
| - Engine >2000 cc | 1000km | 0.68 | 20S | 10.97 | 62.9 | 5.85 |
| | ton diesel | 0.07 | 2.35S | 1.33 | 6.46 | 0.60 |
| | 1000km | 0.06 | 20S | 9.56 | 54.9 | 5.1 |
| | ton diesel | | | | | |
| **Average** | **1000 km** | **0.07** | **2.05S** | **1.19** | **7.72** | **0.83** |
| **2. Truck** | | | | | | |
| - Gasoline running truck > 3.5 ton | 1000km | 0.4 | 4.5S | 4.5 | 70 | 7 |
| | ton diesel | 3.5 | 20S | 20 | 300 | 30 |
| - Small truck (diesel) < 3.5 ton | 1000km | 0.2 | 1.16S | 0.7 | 1 | 0.15 |
| | ton diesel | 3.5 | 20S | 12 | 18 | 2.6 |
| - Big diesel vehicle 3.5 -16 ton | 1000km | 0.9 | 4.29S | 11.8 | 6.0 | 2.6 |
| | ton oil | 4.3 | 20S | 55 | 28 | 2.6 |
| - Very big truck (diesel )>16 ton | 1000km | 1.6 | 7.26S | 18.2 | 7.3 | 5.8 |
| | ton | 4.3 | 20S | 50 | 20 | 16 |
| - Big Bus (diesel) >16 ton | oil | 1.4 | 6.6S | 16.5 | 6.6 | 5.3 |
| | 1000km | 4.3 | 20S | 50 | 20 | 16 |
| | ton oil | | | | | |
| **Average** | **1000km** | **0.9** | **4.76S** | **10.3** | **18.2** | **4.2** |
| **3. Motor bicycle** | | | | | | |
| - Engine <50cc. 2 stock | 100 | 0.12 | 0.36S | 0.05 | 10 | 6 |
| | 0km | 6.7 | 20S | 2.8 | 550 | 330 |
| - Engine >50cc. 2 stock | ton diesel | 0.12 | 0.6S | 0.08 | 22 | 15 |
| | 1000km | 4.0 | 20S | 2.7 | 730 | 500 |
| - Engine >50cc. 4 stock | ton diesel | | 0.76S | 0.30 | 20 | 3 |
| | 1000km | | 20S | 8 | 525 | 80 |
| | ton diesel | | | | | |
| **Average** | **1000km** | **0.08** | **0.57S** | **0.14** | **16.7** | **8** |

*Source: WHO, 1993.*

*Note: S – is sulphur concentration in the fuel. According to QCVN 01:2007/BTNMT: S=0,05%.*

These indicators, selected in calculating and forecasting of air quality, include: CO, $NO_2$, HC, $SO_2$ and total suspended particulate (TSP).

The emission coefficients of WHO (table 3.13) are applied in calculation of emissions from vehicles forecast in of 2020 and 2030 by section of Mai Dich - Hoang Quoc Viet that have the largest traffic volume.

Calculation results are presented in Table 3.14.

**Table 3.14. Emission Level from Predicted Vehicle Flow from Viaduct in 2020 and 2030 at Sections from Mai Dich to Hoang Quoc Viet (mg/m.s)**

| Section | Year | TSP | $SO_2$ | NOx | CO | HC |
|---|---|---|---|---|---|---|
| Mai Dich – Hoang Quoc Viet | 2020 | 0.070 | 0.055 | 0.642 | 3.251 | 0.351 |
| | 2030 | 0.083 | 0.081 | 0.938 | 5.243 | 0.563 |

***a2. Dust Generated from Operation of Vehicle Flow from viaduct***

Load of dust from vehicles operation (tires rolling up from road surface) from viaduct is determined based on:

The traffic demand forecast in peak hour;

Emission coefficient of dust swept from roads by the World Health Organization (Table 3. 15).

**Table 3.15 Emission Coefficient of Dust Swept from Roads**

| No | Type of road | Unit (U) | TSP (kg/U) |
|---|---|---|---|
| | ***Paved roads, the load of dust accumulated on road to the saturation threshold*** | | |
| 1 | Urban roads (width <10m. Vehicle flow <500 units/day) | 1,000 km | 15 |
| 2 | Urban roads (width> 10 m. Vehicle flow 500 ÷ 10,000 units/day) | 1,000 km | 10 |
| 3 | Highway (Vehicle flow > 10,000 units/day) | 1,000 km | 4.4 |
| 4 | Expressway (Vehicle flow > 50,000 units/day) | 1,000 km | 0.35 |

*Source: WHO. In 1993. Assessment of source of air, water and land Pollution. A guide to rapid inventory source use techniques and strategies in formulating Environmental Control. Part one: Rapid inventory techniques in Environmental Pollution.*

The results are presented in table 3.16.

**Table 3.16. Dust Flow Generated from Operation of Vehicle Flow from Viaduct at Sections from Mai Dich to Hoang Quoc Viet**

| Paragraph | 2020 | | | 2030 | | |
|---|---|---|---|---|---|---|
| | Traffic flow | Emission | Estimated load of dust | Traffic flow | Emission | Estimated load of dust |
| | *unit / h* | *kg/1.000km* | *mg/ms* | *unit / h* | *kg/1.000km* | *mg /ms* |
| Mai Dich ÷ Hoang Quoc Viet | 2219 | 0.35 | 0.216 | 3068 | 0.35 | 0.298 |

Since the dust generated in the same space and time, the total load is determined by the

load from 2 sources (Fuel burning and Dust Flow) (Table 3.17).

**Table 3.17. Dust and Toxic gas Generated from Viaduct at Sections from Mai Dich to Hoang Quoc Viet**

| Section | Year | Source | TSP | $SO_2$ | NOx | CO | HC |
|---|---|---|---|---|---|---|---|
| Mai Dich ÷ Hoang Quoc Viet | 2020 | Fuel burning (a1) | 0.070 | 0.055 | 0.642 | 3.251 | 0.351 |
| | | Dust Flow (a2) | 0.216 | - | - | - | - |
| | | *Total* | *0.286* | *0.055* | *0.642* | *3.251* | *0.351* |
| | 2030 | Fuel burning (a1) | 0.083 | 0.081 | 0.938 | 5.243 | 0.563 |
| | | Dust Flow (a2) | 0.298 | - | - | - | - |
| | | *Total* | *0.381* | *0.081* | *0.938* | *5.243* | *0.563* |

***a3. Dust and exhaust emissions (CO, $NO_2$, $SO_2$, HC) from fuel burning of vehicles from urban road***

The estimated load of pollutants from duel burning of vehicle urban road in operation phase is done the same as above (item a1).

Calculation results are presented in Table 3.18.

**Table 3.18. Emission Level from Predicted Vehicle Flow from Urban road in 2020 and 2030 at Sections from Mai Dich to Hoang Quoc Viet (mg/m.s)**

| Section | Year | TSP | $SO_2$ | NOx | CO | HC |
|---|---|---|---|---|---|---|
| Mai Dich – Hoang Quoc Viet | 2020 | 0.251 | 0.103 | 0.309 | 5.118 | 1.927 |
| | 2030 | 0.335 | 0.141 | 0.458 | 7.116 | 2.589 |

***a4. Dust Generated from Operation of Vehicle Flow from urban road***

Load of dust from vehicles operation (tires rolling up from road surface) from urban road is determined the same as above (item a2).

The results are presented in table 3.19.

**Table 3.19. Dust Flow Generated from Operation of Vehicle Flow from Urban road at Sections from Mai Dich to Hoang Quoc Viet**

| Paragraph | 2020 | | | 2030 | | |
|---|---|---|---|---|---|---|
| | Traffic flow | Emission | Estimated load of dust | Traffic flow | Emission | Estimated load of dust |
| | *unit / h* | *kg/1.000km* | *mg/ms* | *unit / h* | *kg/1.000km* | *mg /ms* |
| Mai Dich ÷ Hoang Quoc Viet | 10,935 | 0.35 | 1.063 | 14,633 | 0.35 | 1.423 |

Since the dust generated in the same space and time, the total load is determined by the load from 2 sources (Fuel burning and Dust Flow) (Table 3.20).

**Table 3.20. Dust and Toxic gas Generated from Urban road at Sections from Mai Dich to Hoang Quoc Viet**

| Section | Year | Source | TSP | $SO_2$ | NOx | CO | HC |
|---|---|---|---|---|---|---|---|
| Mai Dich ÷ Hoang Quoc Viet | 2020 | Fuel burning (a3) | 0.251 | 0.103 | 0.309 | 5.118 | 1.927 |
| | | Dust Flow (a4) | 1.063 | - | - | - | - |
| | | *Total* | *1.314* | 0.103 | 0.309 | 5.118 | 1.927 |
| | 2030 | Fuel burning (a3) | 0.335 | 0.141 | 0.458 | 7.116 | 2.589 |
| | | Dust Flow (a4) | 1.423 | - | - | - | - |
| | | *Total* | *1.758* | 0.103 | 0.309 | 5.118 | 1.927 |

To predict the level of pollution emissions from vehicles at the route of the project and of potential impacts to air quality in the operation phase of the project, Breeze ISC mathematical model used to assess the environmental impact model is based on Gauss method (diffusion model pollutants for line source) for of case of the spread of pollutants in the atmosphere has the form described as follows:

$$C(x,y,z) = \frac{M}{2\pi\sigma_y\sigma_z U}\exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right]+\exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

To simplify the calculations, considering a source of pollution is continuous and infinite length is located in the center of the road, at a height of 5 meters from the ground (the average height of viaduct and urban road). The total load is determined by the load from all sources (Fuel burning and Dust Flow from viaduct and urban road – present at table 3.21). Air pollutants is spread out by the air flow (wind direction is Northeast in the winter and is the Southeast in the winter).

**Table 3.21. Total air pollution Generated from Combination of Viaduct and Urban Road at Sections from Mai Dich to Hoang Quoc Viet**

| Section | Year | Sourse | | TSP | $SO_2$ | NOx | CO | HC |
|---|---|---|---|---|---|---|---|---|
| Mai Dich ÷ Hoang Quoc Viet | 2020 | Viaduct | Fuel burning (a1) | 0.070 | 0.055 | 0.642 | 3.251 | 0.351 |
| | | | Dust Flow (a2) | 0.216 | - | - | - | - |
| | | Urban road | Fuel burning (a3) | 0.251 | 0.103 | 0.309 | 5.118 | 1.927 |
| | | | Dust Flow (a4) | 1.063 | - | - | - | - |
| | | *Total* | | *1.6* | *0.158* | *0.951* | *8.369* | *2.278* |
| | 2030 | Viaduct | Fuel burning (a1) | 0.083 | 0.081 | 0.938 | 5.243 | 0.563 |
| | | | Dust Flow (a2) | 0.298 | - | - | - | - |

| Section | Year | Sourse | | TSP | $SO_2$ | NOx | CO | HC |
|---|---|---|---|---|---|---|---|---|
| | | Urban road | Fuel burning (a3) | 0.335 | 0.141 | 0.458 | 7.116 | 2.589 |
| | | | Dust Flow (a4) | 1.423 | - | - | - | - |
| | | *Total* | | *2.139* | *0.222* | *1.396* | *12.359* | *3.152* |

According to the method of Gilbert M. Masters (1991), the concentration of pollutant at distance x (m) toward the end of the road with the wind conditions is infinite line source and at a height near the ground, the wind is blowing perpendicular to the line source is determined by the following formula:

$$C_{(x)} = \frac{2E}{\sqrt{2\pi}.\sigma_z U},$$

*Of which:*

*E - Emissions per unit length of the line source per unit time (g / ms).*
*σz - Diffusion coefficient of the atmosphere vertical z (m) (Gaussian model).*
*U - wind speed, m / s.*

- Wind velocity: wind distribution rule by exponential function is used to regulate wind velocity (U ref) at observation height (Z ref) to define wind velocity at emission height (hs). Equation of average wind velocity at emission height is as follows:

$$u_s = u_{uef} \cdot \left(\frac{h_s}{z_{ref}}\right)^p$$

In which p is exponential coefficient of distribution function of wind velocity. P value is defined as a function of atmospheric stable level and wind velocity is in urban or rural area. In the case of Project with atmospheric stability of B, p value = 0.15.

Dispersion coefficient: equations having the forms almost suitable for Pasquill – Gifford curves (Turner, 1970) are used to calculate δx and δy (measured by m). The equation used to calculate δy is as follows:

$$\delta_y = 465.11628(x)\tan(TH)$$

In which: TH = 0,017453293[c-dln(x)]

In the above equation distance of wind direction end x is calculated in km and being correlative with atmospheric stability of class B, coefficient, c = 18.330 and d = 1.8096. Wind velocity and direction is calculated by each day in a year.

δy is calculated in meter and x – km. The equation used to calculate δz is as follows:

$\delta_z = ax^b$

in which distance of wind direction end x is calculated in km and δz – m. Coefficients a and b is referred by the list of coefficients of stable level of Pasquill.

- Definition of emission level: emission level of vehicle flows on viaduct and urban road based on predicted vehicle flows in 2020 and 2030 is stated in table 3.19.
- Calculation implementation: calculation of emission level of vehicle flows on viaduct and urban roads based on predicted vehicle flows in 2020 and 2030, implementation steps are undertaken in order:
  - o Taking data of emission level into ISC Breeze and calculation done by wind perpendicular directions with road;
  - o Simultaneous calculation of 2 total sources (viaduct and urban road) on the calculation system in the module.

The results of predicted distribution of pollutants in rush hour of predicted year based on vehicle flows are present in tables 3.22.

**Table 3.22. Forecasting Distribution of Pollution Concentrations at Sections from Mai Dich to Nam Thang Long of 2020 and 2030**

| Years | Indicates | Season | Distribution of concentration by distance (1) (mg/m³) | | | | | GHCP (2) |
|---|---|---|---|---|---|---|---|---|
| | | | 0m | 5 | 10m | 25m | 50m | |
| 2020 | *TSP* | Winter | 0.076 | 0.075 | 0.072 | 0.061 | 0.048 | **0.3** |
| | | Summer | 0.092 | 0.090 | 0.087 | 0.074 | 0.058 | |
| | $SO_2$ | Winter | 0.007 | 0.007 | 0.007 | 0.006 | 0.005 | **0.35** |
| | | Summer | 0.009 | 0.009 | 0.009 | 0.007 | 0.006 | |
| | $NO_2$ | Winter | 0.045 | 0.044 | 0.043 | 0.036 | 0.029 | **0.2** |
| | | Summer | 0.054 | 0.054 | 0.051 | 0.044 | 0.035 | |
| | *CO* | Winter | 0.397 | 0.390 | 0.375 | 0.321 | 0.253 | **30** |
| | | Summer | 0.479 | 0.472 | 0.453 | 0.387 | 0.305 | |
| | *HC* | Winter | 0.108 | 0.106 | 0.102 | 0.087 | 0.069 | **5** |
| | | Summer | 0.130 | 0.128 | 0.123 | 0.105 | 0.083 | |
| 2030 | *TSP* | Winter | 0.105 | 0.103 | 0.099 | 0.085 | 0.067 | **0.3** |
| | | Summer | 0.127 | 0.125 | 0.120 | 0.103 | 0.081 | |
| | $SO_2$ | Winter | 0.011 | 0.010 | 0.010 | 0.009 | 0.007 | **0.35** |
| | | Summer | 0.013 | 0.013 | 0.012 | 0.010 | 0.008 | |
| | $NO_2$ | Winter | 0.066 | 0.065 | 0.063 | 0.053 | 0.042 | **0.2** |
| | | Summer | 0.080 | 0.079 | 0.076 | 0.065 | 0.051 | |
| | *CO* | Winter | 0.586 | 0.577 | 0.554 | 0.474 | 0.373 | **30** |

| Years | Indicates | Season | Distribution of concentration by distance (1) (mg/m³) | | | | | GHCP (2) |
|---|---|---|---|---|---|---|---|---|
| | | | 0m | 5 | 10m | 25m | 50m | |
| | | Summer | 0.708 | 0.697 | 0.669 | 0.572 | 0.451 | |
| | HC | Winter | 0.149 | 0.147 | 0.141 | 0.121 | 0.095 | 5 |
| | | Summer | 0.180 | 0.178 | 0.171 | 0.146 | 0.115 | |

*Note: (1) Distance from the Urban Road edge (13.85m from the centre-line)*

*(2) Allow limit of QCVN 05:2010/BTNMT & QCVN 06:2010/BTNMT*

**b. Assessment**

***Pollution of Dust and Toxic Gases - Impact is unremarkable***

In comparison between predicted results of dust and toxic gases emission arising from vehicles operation (Subsection a1, a3), dust generated from operation of vehicle flow (Subsection a2, a4) and Allowable Limit of QCVN 05:2010/BTNMT and QCVN 06:2010/ BTNMT, it can be seen that:

Until 2020 and 2030, ***in the peak hour:*** at the road edge, dust concentration and toxic gases (TSP, CO, $NO_2$, $SO_2$ and HC) is lower than the Allowable Limit . Impact on air quality in 2020 and 2030 is unremarkable.

### *3.3.1.2 Impact due to Rainfall Runoff*

**(1) Wastes**

When studying chemical features of the soil layer on the road surface, Clark and his colleagues indicated that contents of heavy metals in the soil layer on road surface is dependent on traffic modes, and is correlative with the traffic flow on the road. Table 3.23 shows their research result on chemical contents in soil layer on road surface.

**Table 3.23. Chemical characteristics of the soil layer on road surface**

| Parameters | Content (mg/ kg) |
|---|---|
| pH | 6.7 – 7.6 |
| Oil | 5 – 73 |
| Clo | 0.1 – 4 |
| $NO_3^-$ | 3 – 386 |
| $SO_4^{2-}$ | 34 – 2,700 |
| Cd | 1.3 (average) |
| Cr | 2 – 35 |
| Cu | 24 – 310 |
| Fe | 24 – 65 |

| Parameters | Content (mg/ kg) |
|---|---|
| Pb | 19 – 553 |
| Ni | 2 – 73 |
| Zn | 90 – 577 |

*Source: Clark and his colleagues. Chemical characteristics of the soil layer on road surface. CIWEM Magazine.*

Clark and his colleagues also observed and found out that quantity of pollutants on road surface accumulated under dry weather will become balance after 10 days. After 10 days deposit speed will be equal to dispersion speed due to air turbulence. The balance will be maintained until "the sweeping away" occurs. This phenomenon is defined as when the wind blowing with speed of more than 5.8 m/s or raining with rainfall of over 7 mm/hour. The rainfall will wipe pollutants off the road surface. After 20 ~ 30 minutes of rain, concentration of pollutants in the rainfall runoff becomes insignificant.

**(2) Assessment**

***Pollutants in rainfall runoff - impact would be eliminated***

In operation phase, rainfall runoff which contains heavy metals on the surface of the viaduct expressway may cause pollution to the surrounding watercourses. However, according to the Project design, rainwater from the viaduct will be collected and discharged to the drainage system of the city. As a result, this impact would be eliminated.

### 3.3.2 Impact Sources not related to Waste

#### *3.3.2.1 Impact on Acoustic Environment*

**(1) Cause of impact**

***1a. Noise from Operation of Vehicle Flow***

In operation phase, noise level caused by traffic flow is normally unstable (quickly change with time) and depends heavily on many factors such as traffic volume, types of vehicles, features of roads, topography, etc. Therefore, in general, the equivalent steady sound level of a noise energy-averaged over a period of time is used to examine and assess noise level caused by traffic flow in the peak hours.

Model ASJ 2003 is used to predict the equivalent sound level Leq averaged in one hour (dBA) at sensitive receptors along the road. This model is developed by "Acoustic Society of Japan" (ASJ) and is being widely used in Japan. Calculation method of ASJ Model 2003 is presented below.

– Prediction method and calculation formula:

Noise level caused by a moving vehicle is calculated by the following formula:

$$L_{AE} = 10 \lg\left(\frac{1}{T}\sum_{i=1}^{n} 10^{0.1L_1} \Delta t_i\right)$$

In which:

- $L_{AE}$: sound exposure level at a certain time
- Δti: a certain period of time set to calculate $L_{AE}$
- Li: source noise level in a period of time Δti

The average equivalent noise level of vehicle flows can be calculated by the following formula:

$Leq = L_{AE}\text{-}10 + 10 \lg N \lg (T / t_0)$

In which:

- N: traffic volume;
- Leq: average equivalent noise level, dBA;
- T, $t_0$: time interval in second ($t_0$ = 1 second).

Calculation process has been programmed.

Noise levels at source are calculated by the following formula, applied for continuous vehicle flow:

$L_{WA} = 46.7 + 30\log_{10}V$ (for small vehicles as passenger car, motorcycle, small truck, car);

$L_{WA} = 53.2 + 30\log_{10}V$ (for big vehicles as bus, heavy truck).

V: vehicle's speed.

– Input of Model

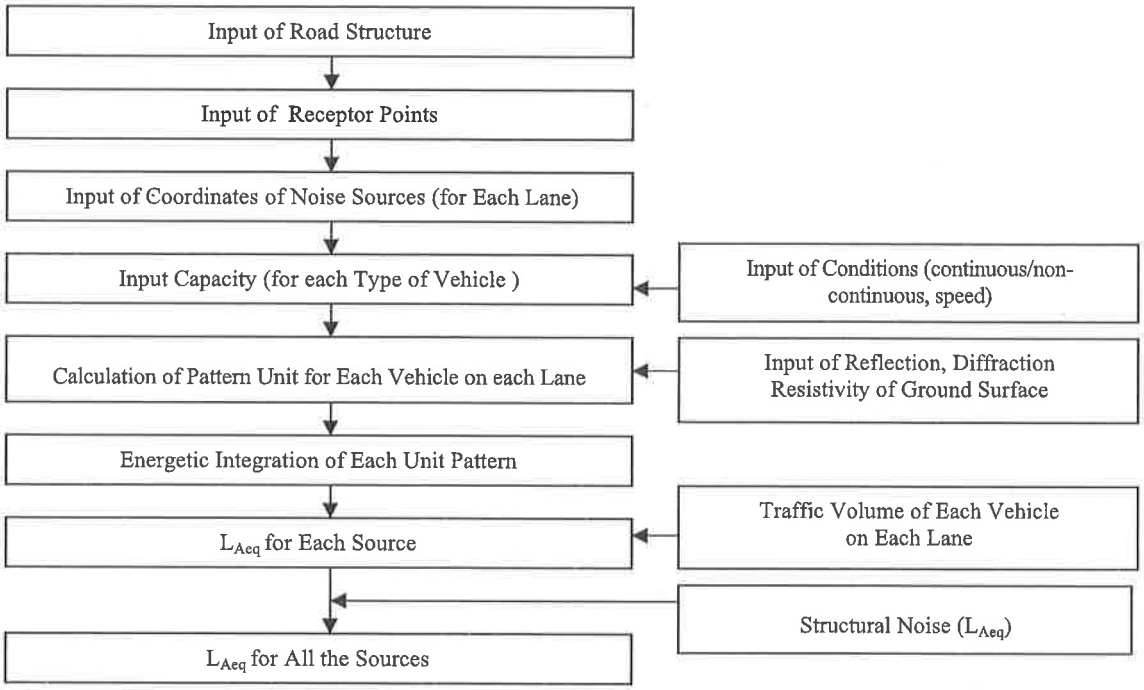
+ Vehicle flow in 2020 and 2030 in rush hour
+ Vehicle flow's speed (Table 3.24).

**Table 3.24 Vehicle speed in rush hour**

| Section | Unit | 2020 | | 2030 | |
|---|---|---|---|---|---|
| | | Urban | Viaduct | Urban | Viaduct |
| Mai Dich – Hoang Quoc Viet | km/h | 47.9 | 61.3 | 38.5 | 53.3 |
| Hoang Quoc Viet – Co Nhue | km/h | 46.9 | 61.3 | 40.5 | 53.3 |
| Co Nhue – South Thang Long | km/h | 41.7 | 61.3 | 30.4 | 53.3 |

*Source: study team*

The prediction flowchart of the ASJ Model 2003 applied to the project is as follows:




Results of noise predicted from the operation of vehicles from viaduct in 2020 and 2030 are presented in table 3.24 ~ table 3.27. Predicted results were compared with QCVN 26:2010/BTNMT, the AL to the common areas during the day is 70dBA.

The illustrations of noise prediction from vehicle flow are presented in figure 3.8~ figure 3.10 (results predicted of the Mai Dich – Hoang Quoc Viet Section in 2020 is used as illustrative examples).

**Table 3.25. Prediction of noise levels from the traffic flow in Section of Mai Dich - Hoang Quoc Viet**

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| Viaduct | 30m | 73.2 | 72.6 | 72.1 | 71.1 | 70.6 | 68.7 | 72.4 | 71.9 | 71.4 | 70.3 | 69.9 | 67.9 |
| | 28.5m | 73.4 | 72.8 | 72.3 | 71.1 | 70.7 | 68.7 | 72.6 | 72.1 | 71.5 | 70.4 | 69.9 | 67.9 |
| | 27m | 73.6 | 73 | 72.4 | 71.2 | 70.7 | 68.7 | 72.9 | 72.3 | 71.6 | 70.5 | 70 | 67.9 |
| | 25.5m | 73.9 | 73.2 | 72.5 | 71.3 | 70.8 | 68.6 | 73.1 | 72.5 | 71.8 | 70.6 | 70 | 67.9 |
| | 24m | 74.2 | 73.4 | 72.7 | 71.4 | 70.8 | 68.6 | 73.4 | 72.7 | 71.9 | 70.6 | 70.1 | 67.8 |
| | 22.5m | 74.4 | 73.6 | 72.8 | 71.4 | 70.9 | 68.4 | 73.7 | 72.8 | 72.1 | 70.7 | 70.1 | 67.7 |
| | 21m | 74.7 | 73.8 | 72.9 | 71.5 | 70.9 | 68.1 | 74 | 73 | 72.2 | 70.7 | 70.1 | 67.4 |

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| | 19.5m | 75 | 74 | 73 | 71.5 | 70.9 | 67.7 | 74.3 | 73.2 | 72.3 | 70.8 | 70.1 | 67 |
| | 18m | 75.3 | 74.1 | 73.1 | 71.5 | 70.8 | 67.2 | 74.5 | 73.4 | 72.4 | 70.7 | 70 | 66.5 |
| | 16.5m | 75.6 | 74.3 | 73.2 | 71.3 | 70.4 | 66.4 | 74.8 | 73.5 | 72.4 | 70.6 | 69.6 | 65.6 |
| | 15m | 75.8 | 74.4 | 73.1 | 70.6 | 69.5 | 65.2 | 75.1 | 73.6 | 72.4 | 69.8 | 68.8 | 64.5 |
| | 13.5m | 76 | 74.3 | 72.4 | 69.1 | 67.9 | 64 | 75.3 | 73.5 | 71.7 | 68.3 | 67.1 | 63.2 |
| | 12m | 76 | 72.1 | 69.5 | 66.6 | 65.7 | 62.6 | 75.2 | 71.3 | 68.8 | 65.8 | 64.9 | 61.9 |
| | 10.5m | 66.6 | 66.3 | 65.5 | 64.1 | 63.6 | 61.5 | 65.8 | 65.6 | 64.8 | 63.4 | 62.8 | 60.8 |
| | 9m | 60.4 | 62.6 | 62.8 | 62.3 | 62 | 60.6 | 59.7 | 61.8 | 62 | 61.6 | 61.3 | 59.9 |
| | 7.5m | 59.4 | 60.8 | 61.3 | 61.2 | 61.1 | 60.1 | 58.5 | 59.9 | 60.4 | 60.4 | 60.3 | 59.3 |
| | 6m | 58.3 | 59.2 | 59.7 | 60 | 60 | 59.3 | 57.3 | 58.2 | 58.9 | 59.2 | 59.2 | 58.5 |
| | 4.5m | 57.6 | 58 | 58.5 | 59 | 59 | 58.7 | 56.5 | 57 | 57.6 | 58.1 | 58.2 | 57.9 |
| | 3m | 57 | 57.2 | 57.6 | 58.1 | 58.2 | 58.1 | 55.9 | 56.2 | 56.6 | 57.2 | 57.3 | 57.2 |
| | 1.5m | 56.5 | 56.5 | 56.8 | 57.3 | 57.4 | 57.5 | 55.4 | 55.5 | 55.8 | 56.4 | 56.5 | 56.7 |
| Urban road | 30m | 72.9 | 72.7 | 72.4 | 71.6 | 70.8 | 68.9 | 72.3 | 72.1 | 71.8 | 71 | 70.2 | 68.3 |
| | 28.5m | 73.1 | 72.9 | 72.6 | 71.6 | 70.8 | 68.9 | 72.4 | 72.2 | 71.9 | 71 | 70.2 | 68.3 |
| | 27m | 73.3 | 73 | 72.7 | 71.6 | 70.8 | 69 | 72.6 | 72.4 | 72.1 | 71 | 70.2 | 68.4 |
| | 25.5m | 73.4 | 73.2 | 72.8 | 71.6 | 70.9 | 69 | 72.8 | 72.5 | 72.2 | 71 | 70.2 | 68.4 |
| | 24m | 73.6 | 73.3 | 73 | 71.6 | 70.9 | 69 | 73 | 72.7 | 72.3 | 71 | 70.3 | 68.4 |
| | 22.5m | 73.8 | 73.5 | 73.1 | 71.6 | 70.9 | 69 | 73.2 | 72.8 | 72.4 | 71 | 70.3 | 68.4 |
| | 21m | 74 | 73.7 | 73.2 | 71.6 | 71 | 69 | 73.4 | 73 | 72.6 | 70.9 | 70.4 | 68.4 |
| | 19.5m | 74.2 | 73.8 | 73.4 | 71.6 | 71 | 68.9 | 73.6 | 73.2 | 72.7 | 71 | 70.4 | 68.3 |
| | 18m | 74.4 | 74 | 73.5 | 71.6 | 71.1 | 68.7 | 73.8 | 73.3 | 72.8 | 71 | 70.5 | 68.1 |
| | 16.5m | 74.7 | 74.2 | 73.6 | 71.7 | 71.1 | 68.6 | 74 | 73.5 | 73 | 71.1 | 70.5 | 68 |
| | 15m | 74.9 | 74.4 | 73.7 | 71.7 | 71.2 | 68.4 | 74.2 | 73.7 | 73.1 | 71.1 | 70.6 | 67.8 |
| | 13.5m | 75.1 | 74.6 | 73.8 | 71.8 | 71.2 | 68.3 | 74.5 | 73.9 | 73.2 | 71.2 | 70.6 | 67.6 |
| | 12m | 75.4 | 74.7 | 73.8 | 71.8 | 71.3 | 68.2 | 74.7 | 74.1 | 73.1 | 71.2 | 70.7 | 67.6 |
| | 10.5m | 75.7 | 74.9 | 73.8 | 71.9 | 71.3 | 68.2 | 75 | 74.2 | 73.1 | 71.2 | 70.7 | 67.5 |
| | 9m | 76 | 75.1 | 73.7 | 71.9 | 71.3 | 68.1 | 75.3 | 74.4 | 73.1 | 71.3 | 70.7 | 67.5 |
| | 7.5m | 76.7 | 75.4 | 73.7 | 72 | 71.4 | 68.1 | 76.1 | 74.7 | 73.1 | 71.4 | 70.7 | 67.5 |
| | 6m | 77.6 | 75.6 | 73.8 | 72 | 71.2 | 68.1 | 76.9 | 74.9 | 73.1 | 71.4 | 70.6 | 67.5 |
| | 4.5m | 78.3 | 76 | 73.9 | 72 | 70.9 | 68.1 | 77.6 | 75.4 | 73.2 | 71.4 | 70.3 | 67.5 |
| | 3m | 78.5 | 76.1 | 74.1 | 71.8 | 70.7 | 68.1 | 77.8 | 75.5 | 73.5 | 71.2 | 70.1 | 67.5 |
| | 1.5m | 78.5 | 76 | 74.5 | 71.5 | 70.6 | 68.1 | 77.8 | 75.4 | 73.9 | 70.9 | 70 | 67.5 |
| Combination | 30m | 76.1 | 75.7 | 75.3 | 74.4 | 73.7 | 71.8 | 75.4 | 75 | 74.6 | 73.7 | 73 | 71.1 |

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| of viaduct and urban road | 28.5m | 76.3 | 75.9 | 75.4 | 74.4 | 73.8 | 71.8 | 75.6 | 75.2 | 74.7 | 73.7 | 73.1 | 71.1 |
| | 27m | 76.5 | 76 | 75.6 | 74.4 | 73.8 | 71.8 | 75.8 | 75.3 | 74.9 | 73.7 | 73.1 | 71.2 |
| | 25.5m | 76.7 | 76.2 | 75.7 | 74.5 | 73.8 | 71.8 | 76 | 75.5 | 75 | 73.8 | 73.2 | 71.2 |
| | 24m | 76.9 | 76.4 | 75.8 | 74.5 | 73.9 | 71.8 | 76.2 | 75.7 | 75.1 | 73.8 | 73.2 | 71.1 |
| | 22.5m | 77.1 | 76.6 | 76 | 74.5 | 73.9 | 71.7 | 76.4 | 75.8 | 75.3 | 73.8 | 73.2 | 71.1 |
| | 21m | 77.4 | 76.7 | 76.1 | 74.5 | 73.9 | 71.6 | 76.7 | 76 | 75.4 | 73.8 | 73.3 | 70.9 |
| | 19.5m | 77.6 | 76.9 | 76.2 | 74.6 | 74 | 71.4 | 76.9 | 76.2 | 75.5 | 73.9 | 73.3 | 70.7 |
| | 18m | 77.9 | 77.1 | 76.3 | 74.6 | 73.9 | 71.1 | 77.2 | 76.4 | 75.6 | 73.9 | 73.3 | 70.4 |
| | 16.5m | 78.2 | 77.2 | 76.4 | 74.5 | 73.8 | 70.6 | 77.4 | 76.5 | 75.7 | 73.8 | 73.1 | 70 |
| | 15m | 78.4 | 77.4 | 76.5 | 74.2 | 73.4 | 70.1 | 77.7 | 76.7 | 75.8 | 73.5 | 72.8 | 69.5 |
| | 13.5m | 78.6 | 77.4 | 76.2 | 73.6 | 72.9 | 69.6 | 77.9 | 76.7 | 75.5 | 73 | 72.2 | 69 |
| | 12m | 78.7 | 76.6 | 75.2 | 73 | 72.3 | 69.3 | 78 | 75.9 | 74.5 | 72.3 | 71.7 | 68.6 |
| | 10.5m | 76.2 | 75.5 | 74.4 | 72.5 | 72 | 69 | 75.5 | 74.8 | 73.7 | 71.9 | 71.3 | 68.3 |
| | 9m | 76.1 | 75.3 | 74.1 | 72.4 | 71.8 | 68.8 | 75.4 | 74.7 | 73.4 | 71.7 | 71.2 | 68.2 |
| | 7.5m | 76.8 | 75.5 | 74 | 72.3 | 71.7 | 68.8 | 76.1 | 74.8 | 73.3 | 71.7 | 71.1 | 68.1 |
| | 6m | 77.6 | 75.7 | 73.9 | 72.3 | 71.5 | 68.7 | 76.9 | 75 | 73.3 | 71.7 | 70.9 | 68 |
| | 4.5m | 78.3 | 76.1 | 74 | 72.2 | 71.2 | 68.6 | 77.6 | 75.5 | 73.3 | 71.6 | 70.6 | 67.9 |
| | 3m | 78.5 | 76.2 | 74.2 | 72 | 70.9 | 68.5 | 77.8 | 75.5 | 73.6 | 71.3 | 70.3 | 67.9 |
| | 1.5m | 78.6 | 76.1 | 74.6 | 71.7 | 70.8 | 68.5 | 77.9 | 75.4 | 73.9 | 71 | 70.2 | 67.8 |

*Note: (1) Distance from the Urban Road edge (13.85m from the center-line)*

*(2) Height from the earth surface*

*Cell with Grey highlight: noise levels in excess of Allowable Limi according to QCVN 26:2010 (70dBA)*

## Table 3.26. Prediction of noise levels from the traffic flow in Section of Hoang Quoc Viet – Co Nhue

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| Viaduct | 30m | 73.2 | 72.6 | 72.1 | 71.1 | 70.6 | 68.7 | 72.4 | 71.9 | 71.4 | 70.3 | 69.9 | 67.9 |
| | 28.5m | 73.4 | 72.8 | 72.3 | 71.1 | 70.7 | 68.7 | 72.6 | 72.1 | 71.5 | 70.4 | 69.9 | 67.9 |
| | 27m | 73.6 | 73 | 72.4 | 71.2 | 70.7 | 68.7 | 72.9 | 72.3 | 71.6 | 70.5 | 70 | 67.9 |
| | 25.5m | 73.9 | 73.2 | 72.5 | 71.3 | 70.8 | 68.6 | 73.1 | 72.5 | 71.8 | 70.6 | 70 | 67.9 |
| | 24m | 74.2 | 73.4 | 72.7 | 71.4 | 70.8 | 68.6 | 73.4 | 72.7 | 71.9 | 70.6 | 70.1 | 67.8 |

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| | 22.5m | 74.4 | 73.6 | 72.8 | 71.4 | 70.9 | 68.4 | 73.7 | 72.8 | 72.1 | 70.7 | 70.1 | 67.7 |
| | 21m | 74.7 | 73.8 | 72.9 | 71.5 | 70.9 | 68.1 | 74 | 73 | 72.2 | 70.7 | 70.1 | 67.4 |
| | 19.5m | 75 | 74 | 73 | 71.5 | 70.9 | 67.7 | 74.3 | 73.2 | 72.3 | 70.8 | 70.1 | 67 |
| | 18m | 75.3 | 74.1 | 73.1 | 71.5 | 70.8 | 67.2 | 74.5 | 73.4 | 72.4 | 70.7 | 70 | 66.5 |
| | 16.5m | 75.6 | 74.3 | 73.2 | 71.3 | 70.4 | 66.4 | 74.8 | 73.5 | 72.4 | 70.6 | 69.6 | 65.6 |
| | 15m | 75.8 | 74.4 | 73.1 | 70.6 | 69.5 | 65.2 | 75.1 | 73.6 | 72.4 | 69.8 | 68.8 | 64.5 |
| | 13.5m | 76 | 74.3 | 72.4 | 69.1 | 67.9 | 64 | 75.3 | 73.5 | 71.7 | 68.3 | 67.1 | 63.2 |
| | 12m | 76 | 72.1 | 69.5 | 66.6 | 65.7 | 62.6 | 75.2 | 71.3 | 68.8 | 65.8 | 64.9 | 61.9 |
| | 10.5m | 66.6 | 66.3 | 65.5 | 64.1 | 63.6 | 61.5 | 65.8 | 65.6 | 64.8 | 63.4 | 62.8 | 60.8 |
| | 9m | 60.4 | 62.6 | 62.8 | 62.3 | 62 | 60.6 | 59.7 | 61.8 | 62 | 61.6 | 61.3 | 59.9 |
| | 7.5m | 59.4 | 60.8 | 61.3 | 61.2 | 61.1 | 60.1 | 58.5 | 59.9 | 60.4 | 60.4 | 60.3 | 59.3 |
| | 6m | 58.3 | 59.2 | 59.7 | 60 | 60 | 59.3 | 57.3 | 58.2 | 58.9 | 59.2 | 59.2 | 58.5 |
| | 4.5m | 57.6 | 58 | 58.5 | 59 | 59 | 58.7 | 56.5 | 57 | 57.6 | 58.1 | 58.2 | 57.9 |
| | 3m | 57 | 57.2 | 57.6 | 58.1 | 58.2 | 58.1 | 55.9 | 56.2 | 56.6 | 57.2 | 57.3 | 57.2 |
| | 1.5m | 56.5 | 56.5 | 56.8 | 57.3 | 57.4 | 57.5 | 55.4 | 55.5 | 55.8 | 56.4 | 56.5 | 56.7 |
| Urban road | 30m | 72.7 | 72.5 | 72.2 | 71.4 | 70.7 | 68.7 | 72.5 | 72.2 | 72 | 71.1 | 70.4 | 68.5 |
| | 28.5m | 72.9 | 72.7 | 72.4 | 71.4 | 70.6 | 68.8 | 72.6 | 72.4 | 72.1 | 71.1 | 70.4 | 68.5 |
| | 27m | 73.1 | 72.8 | 72.5 | 71.4 | 70.7 | 68.8 | 72.8 | 72.5 | 72.2 | 71.1 | 70.4 | 68.6 |
| | 25.5m | 73.2 | 73 | 72.6 | 71.4 | 70.7 | 68.8 | 73 | 72.7 | 72.4 | 71.1 | 70.4 | 68.6 |
| | 24m | 73.4 | 73.1 | 72.8 | 71.4 | 70.7 | 68.8 | 73.1 | 72.8 | 72.5 | 71.1 | 70.5 | 68.6 |
| | 22.5m | 73.6 | 73.3 | 72.9 | 71.4 | 70.8 | 68.8 | 73.3 | 73 | 72.6 | 71.1 | 70.5 | 68.6 |
| | 21m | 73.8 | 73.4 | 73 | 71.4 | 70.8 | 68.8 | 73.5 | 73.2 | 72.8 | 71.1 | 70.6 | 68.6 |
| | 19.5m | 74 | 73.6 | 73.2 | 71.4 | 70.9 | 68.7 | 73.7 | 73.3 | 72.9 | 71.2 | 70.6 | 68.5 |
| | 18m | 74.2 | 73.8 | 73.3 | 71.4 | 70.9 | 68.6 | 73.9 | 73.5 | 73 | 71.2 | 70.7 | 68.3 |
| | 16.5m | 74.4 | 74 | 73.4 | 71.5 | 71 | 68.4 | 74.2 | 73.7 | 73.2 | 71.2 | 70.7 | 68.1 |
| | 15m | 74.7 | 74.2 | 73.5 | 71.5 | 71 | 68.2 | 74.4 | 73.9 | 73.3 | 71.3 | 70.8 | 68 |
| | 13.5m | 74.9 | 74.3 | 73.6 | 71.6 | 71.1 | 68.1 | 74.6 | 74.1 | 73.3 | 71.3 | 70.8 | 67.8 |
| | 12m | 75.2 | 74.5 | 73.6 | 71.6 | 71.1 | 68 | 74.9 | 74.2 | 73.3 | 71.4 | 70.8 | 67.7 |
| | 10.5m | 75.4 | 74.7 | 73.6 | 71.7 | 71.1 | 68 | 75.2 | 74.4 | 73.3 | 71.4 | 70.9 | 67.7 |
| | 9m | 75.7 | 74.9 | 73.5 | 71.7 | 71.1 | 67.9 | 75.4 | 74.6 | 73.3 | 71.5 | 70.9 | 67.7 |
| | 7.5m | 76.5 | 75.1 | 73.5 | 71.8 | 71.2 | 67.9 | 76.2 | 74.9 | 73.3 | 71.6 | 70.9 | 67.7 |
| | 6m | 77.4 | 75.4 | 73.6 | 71.8 | 71 | 67.9 | 77.1 | 75.1 | 73.3 | 71.6 | 70.8 | 67.7 |
| | 4.5m | 78.1 | 75.8 | 73.7 | 71.8 | 70.8 | 67.9 | 77.8 | 75.6 | 73.4 | 71.6 | 70.5 | 67.6 |
| | 3m | 78.2 | 75.9 | 73.9 | 71.6 | 70.5 | 67.9 | 78 | 75.7 | 73.7 | 71.3 | 70.2 | 67.6 |

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| | 1.5m | 78.3 | 75.8 | 74.3 | 71.3 | 70.4 | 67.9 | 78 | 75.6 | 74.1 | 71.1 | 70.1 | 67.6 |
| Combination of viaduct and urban road | 30m | 76 | 75.6 | 75.2 | 74.2 | 73.6 | 71.7 | 75.4 | 75.1 | 74.7 | 73.8 | 73.1 | 71.2 |
| | 28.5m | 76.2 | 75.8 | 75.3 | 74.3 | 73.7 | 71.7 | 75.6 | 75.2 | 74.8 | 73.8 | 73.2 | 71.2 |
| | 27m | 76.4 | 75.9 | 75.5 | 74.3 | 73.7 | 71.7 | 75.8 | 75.4 | 75 | 73.8 | 73.2 | 71.3 |
| | 25.5m | 76.6 | 76.1 | 75.6 | 74.4 | 73.7 | 71.7 | 76.1 | 75.6 | 75.1 | 73.9 | 73.3 | 71.3 |
| | 24m | 76.8 | 76.3 | 75.7 | 74.4 | 73.8 | 71.7 | 76.3 | 75.8 | 75.2 | 73.9 | 73.3 | 71.2 |
| | 22.5m | 77.1 | 76.4 | 75.9 | 74.4 | 73.8 | 71.7 | 76.5 | 75.9 | 75.4 | 73.9 | 73.3 | 71.2 |
| | 21m | 77.3 | 76.6 | 76 | 74.4 | 73.9 | 71.5 | 76.8 | 76.1 | 75.5 | 73.9 | 73.4 | 71 |
| | 19.5m | 77.5 | 76.8 | 76.1 | 74.5 | 73.9 | 71.3 | 77 | 76.3 | 75.6 | 74 | 73.4 | 70.8 |
| | 18m | 77.8 | 77 | 76.2 | 74.5 | 73.9 | 71 | 77.3 | 76.5 | 75.7 | 74 | 73.4 | 70.5 |
| | 16.5m | 78.1 | 77.1 | 76.3 | 74.4 | 73.7 | 70.5 | 77.5 | 76.6 | 75.8 | 73.9 | 73.2 | 70.1 |
| | 15m | 78.3 | 77.3 | 76.4 | 74.1 | 73.3 | 70 | 77.8 | 76.8 | 75.9 | 73.6 | 72.9 | 69.6 |
| | 13.5m | 78.5 | 77.3 | 76.1 | 73.5 | 72.8 | 69.5 | 78 | 76.8 | 75.6 | 73.1 | 72.4 | 69.1 |
| | 12m | 78.6 | 76.5 | 75 | 72.8 | 72.2 | 69.1 | 78.1 | 76 | 74.6 | 72.5 | 71.8 | 68.7 |
| | 10.5m | 76 | 75.3 | 74.2 | 72.4 | 71.8 | 68.8 | 75.6 | 75 | 73.9 | 72.1 | 71.5 | 68.5 |
| | 9m | 75.9 | 75.1 | 73.9 | 72.2 | 71.6 | 68.7 | 75.6 | 74.8 | 73.6 | 71.9 | 71.3 | 68.3 |
| | 7.5m | 76.6 | 75.3 | 73.8 | 72.2 | 71.6 | 68.6 | 76.3 | 75 | 73.5 | 71.9 | 71.3 | 68.3 |
| | 6m | 77.4 | 75.5 | 73.7 | 72.1 | 71.3 | 68.5 | 77.1 | 75.2 | 73.5 | 71.8 | 71.1 | 68.2 |
| | 4.5m | 78.1 | 75.9 | 73.8 | 72 | 71 | 68.4 | 77.8 | 75.6 | 73.5 | 71.8 | 70.7 | 68.1 |
| | 3m | 78.3 | 76 | 74 | 71.8 | 70.8 | 68.3 | 78 | 75.7 | 73.8 | 71.5 | 70.5 | 68 |
| | 1.5m | 78.3 | 75.9 | 74.4 | 71.5 | 70.6 | 68.3 | 78 | 75.6 | 74.1 | 71.2 | 70.3 | 68 |

*Note: (1) Distance from the Urban Road edge (13.85m from the center-line)*

*(2) Height from the earth surface*

*Cell with Grey highlight: noise levels in excess of Allowable Limi according to QCVN 26:2010 (70dBA)*

## Table 3.27. Prediction of noise levels from the traffic flow in Section of Co Nhue– South Thang Long

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| Viaduct | 30m | 73.2 | 72.6 | 72.1 | 71.1 | 70.6 | 68.7 | 72.4 | 71.9 | 71.4 | 70.3 | 69.9 | 67.9 |
| | 28.5m | 73.4 | 72.8 | 72.3 | 71.1 | 70.7 | 68.7 | 72.6 | 72.1 | 71.5 | 70.4 | 69.9 | 67.9 |
| | 27m | 73.6 | 73 | 72.4 | 71.2 | 70.7 | 68.7 | 72.9 | 72.3 | 71.6 | 70.5 | 70 | 67.9 |

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| | 25.5m | 73.9 | 73.2 | 72.5 | 71.3 | 70.8 | 68.6 | 73.1 | 72.5 | 71.8 | 70.6 | 70 | 67.9 |
| | 24m | 74.2 | 73.4 | 72.7 | 71.4 | 70.8 | 68.6 | 73.4 | 72.7 | 71.9 | 70.6 | 70.1 | 67.8 |
| | 22.5m | 74.4 | 73.6 | 72.8 | 71.4 | 70.9 | 68.4 | 73.7 | 72.8 | 72.1 | 70.7 | 70.1 | 67.7 |
| | 21m | 74.7 | 73.8 | 72.9 | 71.5 | 70.9 | 68.1 | 74 | 73 | 72.2 | 70.7 | 70.1 | 67.4 |
| | 19.5m | 75 | 74 | 73 | 71.5 | 70.9 | 67.7 | 74.3 | 73.2 | 72.3 | 70.8 | 70.1 | 67 |
| | 18m | 75.3 | 74.1 | 73.1 | 71.5 | 70.8 | 67.2 | 74.5 | 73.4 | 72.4 | 70.7 | 70 | 66.5 |
| | 16.5m | 75.6 | 74.3 | 73.2 | 71.3 | 70.4 | 66.4 | 74.8 | 73.5 | 72.4 | 70.6 | 69.6 | 65.6 |
| | 15m | 75.8 | 74.4 | 73.1 | 70.6 | 69.5 | 65.2 | 75.1 | 73.6 | 72.4 | 69.8 | 68.8 | 64.5 |
| | 13.5m | 76 | 74.3 | 72.4 | 69.1 | 67.9 | 64 | 75.3 | 73.5 | 71.7 | 68.3 | 67.1 | 63.2 |
| | 12m | 76 | 72.1 | 69.5 | 66.6 | 65.7 | 62.6 | 75.2 | 71.3 | 68.8 | 65.8 | 64.9 | 61.9 |
| | 10.5m | 66.6 | 66.3 | 65.5 | 64.1 | 63.6 | 61.5 | 65.8 | 65.6 | 64.8 | 63.4 | 62.8 | 60.8 |
| | 9m | 60.4 | 62.6 | 62.8 | 62.3 | 62 | 60.6 | 59.7 | 61.8 | 62 | 61.6 | 61.3 | 59.9 |
| | 7.5m | 59.4 | 60.8 | 61.3 | 61.2 | 61.1 | 60.1 | 58.5 | 59.9 | 60.4 | 60.4 | 60.3 | 59.3 |
| | 6m | 58.3 | 59.2 | 59.7 | 60 | 60 | 59.3 | 57.3 | 58.2 | 58.9 | 59.2 | 59.2 | 58.5 |
| | 4.5m | 57.6 | 58 | 58.5 | 59 | 59 | 58.7 | 56.5 | 57 | 57.6 | 58.1 | 58.2 | 57.9 |
| | 3m | 57 | 57.2 | 57.6 | 58.1 | 58.2 | 58.1 | 55.9 | 56.2 | 56.6 | 57.2 | 57.3 | 57.2 |
| | 1.5m | 56.5 | 56.5 | 56.8 | 57.3 | 57.4 | 57.5 | 55.4 | 55.5 | 55.8 | 56.4 | 56.5 | 56.7 |
| Urban road | 30m | 71.5 | 71.2 | 71 | 70.1 | 69.4 | 67.5 | 69.4 | 69.2 | 68.9 | 68.1 | 67.3 | 65.4 |
| | 28.5m | 71.6 | 71.4 | 71.1 | 70.1 | 69.4 | 67.6 | 69.6 | 69.3 | 69.1 | 68.1 | 67.3 | 65.4 |
| | 27m | 71.8 | 71.5 | 71.2 | 70.2 | 69.4 | 67.6 | 69.7 | 69.5 | 69.2 | 68.1 | 67.3 | 65.5 |
| | 25.5m | 72 | 71.7 | 71.4 | 70.2 | 69.5 | 67.6 | 69.9 | 69.6 | 69.3 | 68.1 | 67.4 | 65.5 |
| | 24m | 72.1 | 71.8 | 71.5 | 70.2 | 69.5 | 67.6 | 70.1 | 69.8 | 69.4 | 68.1 | 67.4 | 65.5 |
| | 22.5m | 72.3 | 72 | 71.6 | 70.2 | 69.5 | 67.6 | 70.3 | 70 | 69.6 | 68.1 | 67.4 | 65.5 |
| | 21m | 72.5 | 72.2 | 71.8 | 70.1 | 69.6 | 67.6 | 70.5 | 70.1 | 69.7 | 68.1 | 67.5 | 65.5 |
| | 19.5m | 72.7 | 72.3 | 71.9 | 70.2 | 69.6 | 67.5 | 70.7 | 70.3 | 69.9 | 68.1 | 67.5 | 65.4 |
| | 18m | 72.9 | 72.5 | 72 | 70.2 | 69.7 | 67.3 | 70.9 | 70.5 | 70 | 68.1 | 67.6 | 65.2 |
| | 16.5m | 73.2 | 72.7 | 72.1 | 70.3 | 69.7 | 67.2 | 71.1 | 70.7 | 70.1 | 68.2 | 67.6 | 65.1 |
| | 15m | 73.4 | 72.9 | 72.3 | 70.3 | 69.8 | 67 | 71.4 | 70.8 | 70.2 | 68.2 | 67.7 | 64.9 |
| | 13.5m | 73.6 | 73 | 72.3 | 70.4 | 69.8 | 66.8 | 71.6 | 71 | 70.3 | 68.3 | 67.7 | 64.8 |
| | 12m | 73.9 | 73.2 | 72.3 | 70.4 | 69.9 | 66.7 | 71.9 | 71.2 | 70.3 | 68.3 | 67.8 | 64.7 |
| | 10.5m | 74.1 | 73.4 | 72.3 | 70.5 | 69.9 | 66.7 | 72.1 | 71.4 | 70.2 | 68.4 | 67.8 | 64.6 |
| | 9m | 74.4 | 73.6 | 72.3 | 70.5 | 69.9 | 66.7 | 72.4 | 71.6 | 70.2 | 68.4 | 67.8 | 64.6 |
| | 7.5m | 75.2 | 73.8 | 72.3 | 70.6 | 70 | 66.7 | 73.2 | 71.8 | 70.2 | 68.5 | 67.9 | 64.6 |
| | 6m | 76.1 | 74.1 | 72.3 | 70.6 | 69.8 | 66.7 | 74 | 72.1 | 70.2 | 68.5 | 67.7 | 64.6 |

| Noise from | Height (2) | Noise levels by distance (1) (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Year of 2020 | | | | | | Year of 2030 | | | | | |
| | | 0m | 5m | 10m | 20.15m | 25m | 50m | 0m | 5m | 10m | 20.15m | 25m | 50m |
| | 4.5m | 76.7 | 74.6 | 72.4 | 70.6 | 69.5 | 66.6 | 74.7 | 72.5 | 70.3 | 68.5 | 67.4 | 64.6 |
| | 3m | 76.9 | 74.7 | 72.7 | 70.3 | 69.2 | 66.6 | 74.9 | 72.6 | 70.6 | 68.3 | 67.2 | 64.6 |
| | 1.5m | 77 | 74.6 | 73.1 | 70.1 | 69.1 | 66.6 | 75 | 72.5 | 71 | 68 | 67.1 | 64.6 |
| Combination of viaduct and urban road | 30m | 75.4 | 75 | 74.6 | 73.6 | 73.1 | 71.1 | 74.2 | 73.8 | 73.3 | 72.4 | 71.8 | 69.8 |
| | 28.5m | 75.6 | 75.2 | 74.7 | 73.7 | 73.1 | 71.2 | 74.4 | 73.9 | 73.5 | 72.4 | 71.8 | 69.9 |
| | 27m | 75.8 | 75.3 | 74.9 | 73.7 | 73.1 | 71.2 | 74.6 | 74.1 | 73.6 | 72.5 | 71.9 | 69.9 |
| | 25.5m | 76 | 75.5 | 75 | 73.8 | 73.2 | 71.2 | 74.8 | 74.3 | 73.7 | 72.5 | 71.9 | 69.9 |
| | 24m | 76.3 | 75.7 | 75.1 | 73.8 | 73.2 | 71.1 | 75.1 | 74.5 | 73.9 | 72.5 | 72 | 69.8 |
| | 22.5m | 76.5 | 75.9 | 75.3 | 73.9 | 73.3 | 71.1 | 75.3 | 74.6 | 74 | 72.6 | 72 | 69.8 |
| | 21m | 76.8 | 76.1 | 75.4 | 73.9 | 73.3 | 70.9 | 75.6 | 74.8 | 74.1 | 72.6 | 72 | 69.5 |
| | 19.5m | 77 | 76.2 | 75.5 | 73.9 | 73.3 | 70.6 | 75.8 | 75 | 74.2 | 72.6 | 72 | 69.3 |
| | 18m | 77.3 | 76.4 | 75.6 | 73.9 | 73.3 | 70.3 | 76.1 | 75.2 | 74.4 | 72.6 | 72 | 68.9 |
| | 16.5m | 77.5 | 76.6 | 75.7 | 73.8 | 73.1 | 69.8 | 76.4 | 75.3 | 74.4 | 72.6 | 71.7 | 68.4 |
| | 15m | 77.8 | 76.7 | 75.7 | 73.5 | 72.7 | 69.2 | 76.6 | 75.4 | 74.4 | 72.1 | 71.3 | 67.7 |
| | 13.5m | 78 | 76.7 | 75.4 | 72.8 | 72 | 68.6 | 76.8 | 75.5 | 74.1 | 71.3 | 70.5 | 67.1 |
| | 12m | 78.1 | 75.7 | 74.2 | 71.9 | 71.3 | 68.2 | 76.9 | 74.3 | 72.6 | 70.3 | 69.6 | 66.5 |
| | 10.5m | 74.8 | 74.2 | 73.1 | 71.4 | 70.8 | 67.8 | 73 | 72.4 | 71.3 | 69.6 | 69 | 66.1 |
| | 9m | 74.6 | 73.9 | 72.7 | 71.1 | 70.6 | 67.6 | 72.6 | 72 | 70.8 | 69.2 | 68.7 | 65.9 |
| | 7.5m | 75.3 | 74 | 72.6 | 71.1 | 70.5 | 67.5 | 73.3 | 72.1 | 70.6 | 69.1 | 68.6 | 65.7 |
| | 6m | 76.1 | 74.2 | 72.5 | 71 | 70.2 | 67.4 | 74.1 | 72.2 | 70.6 | 69 | 68.3 | 65.6 |
| | 4.5m | 76.8 | 74.7 | 72.6 | 70.9 | 69.9 | 67.3 | 74.8 | 72.6 | 70.6 | 68.9 | 67.9 | 65.4 |
| | 3m | 77 | 74.7 | 72.8 | 70.6 | 69.6 | 67.2 | 75 | 72.7 | 70.8 | 68.6 | 67.6 | 65.3 |
| | 1.5m | 77 | 74.7 | 73.2 | 70.3 | 69.4 | 67.1 | 75 | 72.6 | 71.1 | 68.3 | 67.5 | 65.2 |

*Note: (1) Distance from the Urban Road edge (13.85m from the center-line)*

*(2) Height from the earth surface*

*Cell with Grey highlight: noise levels in excess of Allowable Limi according to QCVN 26:2010 (70dBA)*

**Figure 3.7. Prediction of Noise from Viaduct in Section of Mai Dich - Hoang Quoc Viet in 2020**

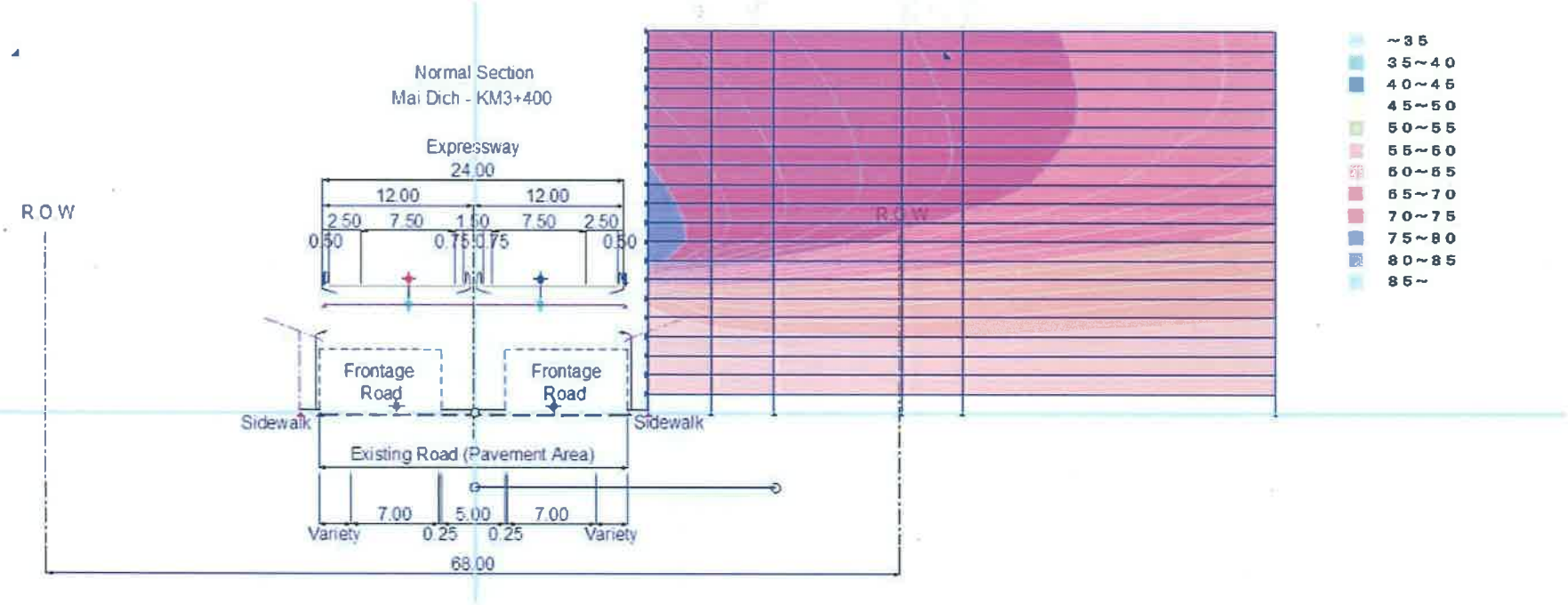


**Figure 3.8. Prediction of Noise from Urban Road in Section of Mai Dich - Hoang Quoc Viet in 2020**

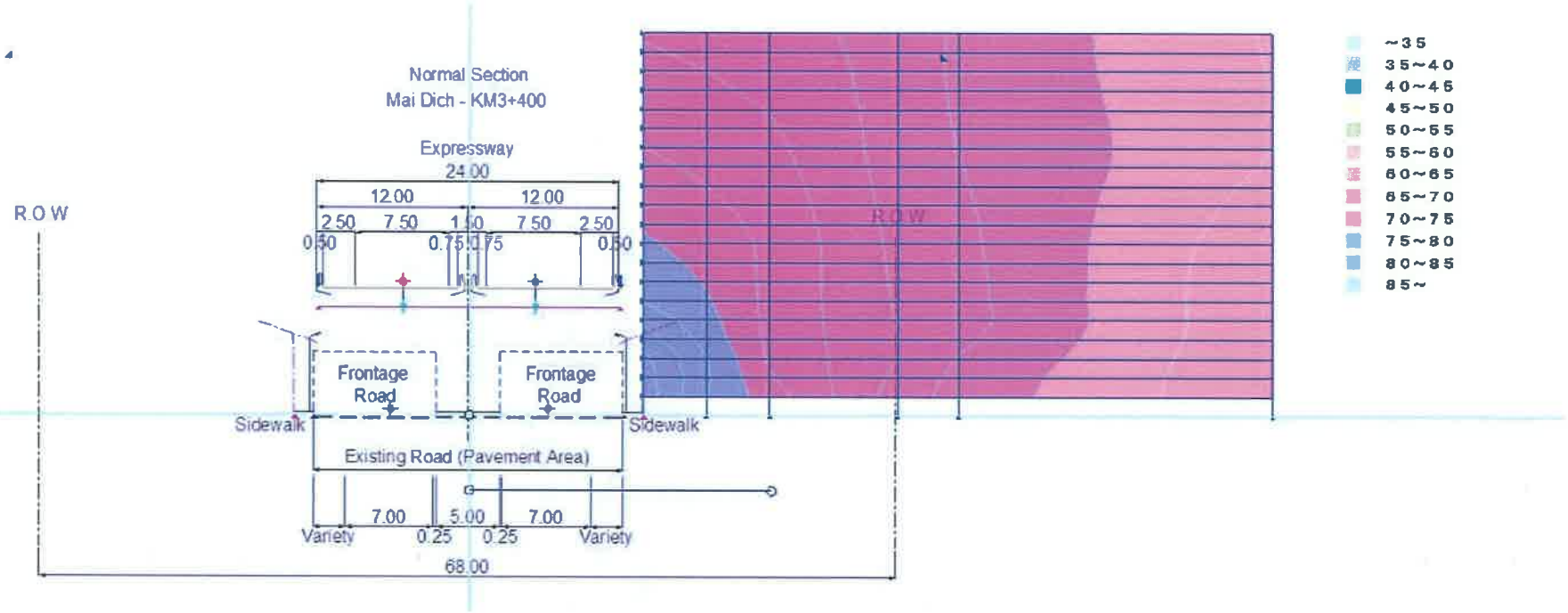
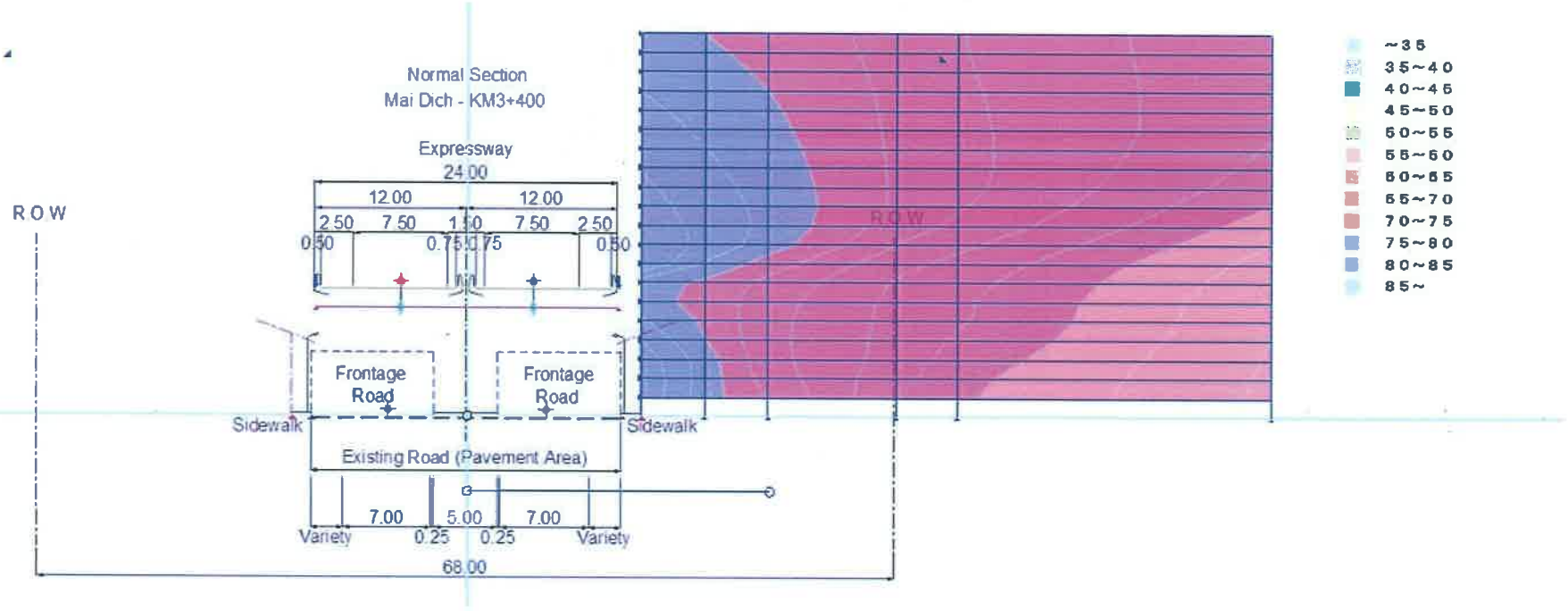


**Figure 3.9. Prediction of Noise from Combination of Viaduct and Urban Road in Section of Mai Dich - Hoang Quoc Viet in 2020**



*1b. Vibration emitted by traffic flow*

- For viaduct: traffic flow on the viaduct would hardly create vibration and would not affect receptors on the ground.
- For urban road: the vibration level observed under the worst condition is 60,7dB (table 2.9) when the traffic flows at speed of about 40km/h. When the traffic flows at speed increasing by 10km/h, the vibration level would increase by 3dB. Since the design speed of urban road is 60km/h, vibration level is estimated at 66,7dB in 2020 and 2030.

(2) Assessment

*2a. Impact of noise from traffic flow - impact should be mitigated*

Compare forecast results with Allowable Limit of QCVN 26/2010/BTNMT (70dBA during the day), found that: ***in the peak hours:***

Noise level in 2020 is bigger than this in 2030 because of traffic speed in 2020 is significantly bigger than it in 2030;

Most of the houses locate along Urban Road edge (13.85m from center-line) has the height < 9.5m (< 4 floors). In 2020, noise level at these objects is higher than AL from 4.6 ~ 8.6 dBA;

The highest noise level at 3 floors house is higher than AL 6.6 dBA (table 3.28).

***Conclusions:*** Impact should be mitigated.

Accoding to the survey data along the route, there are only some houses with over 3 floors, most of them are equal to and lower than 3 floors (from 1 to 3 floors). The calculation of noise level at the locations of these house are presented in the following table 3.28.

## Table 3.28. Noise level at the house that have more than 3 floors

| Height [2] (m) | Noise level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 21 | | | | | | | | | | | | |
| 19.5 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 16.5 | | | | | | | | | | | | |
| 15 | 72.2 | 72.3 | 71.5 | 72.5 | | 72.3 | 71.5 | 72.1 | | | | |
| 13.5 | 71.7 | 71.8 | 70.9 | 72.0 | | 71.8 | 70.9 | 71.6 | | | | |
| 12 | 71.3 | 71.4 | 70.4 | 71.5 | 72.2 | 71.4 | 70.4 | 71.2 | 72.1 | 72.2 | 72.2 | 72.4 |
| 10.5 | 70.9 | 71.0 | 70.0 | 71.2 | 71.9 | 71.0 | 70.0 | 70.7 | 71.8 | 71.9 | 71.9 | 72.1 |
| 9 | 70.5 | 70.7 | 69.7 | 70.8 | 71.7 | 70.7 | 69.7 | 70.4 | 71.6 | 71.7 | 71.7 | 71.9 |
| 7.5 | 70.3 | 70.4 | 69.6 | 70.6 | 71.6 | 70.4 | 69.6 | 70.1 | 71.4 | 71.6 | 71.6 | 71.9 |
| 6 | 70.0 | 70.2 | 69.4 | 70.3 | 71.3 | 70.2 | 69.4 | 69.9 | 71.1 | 71.3 | 71.3 | 71.7 |
| 4.5 | 69.9 | 70.0 | 69.3 | 70.1 | 71.0 | 70.0 | 69.3 | 69.8 | 70.8 | 71.0 | 71.0 | 71.4 |
| 3 | 69.8 | 69.9 | 69.3 | 70.0 | 70.8 | 69.9 | 69.3 | 69.7 | 70.6 | 70.8 | 70.8 | 71.1 |
| 1.5 | 69.8 | 69.9 | 69.2 | 70.0 | 70.7 | 69.9 | 69.2 | 69.7 | 70.5 | 70.7 | 70.7 | 71.0 |
| *Note* | *5 floors (Km0+200), 34m [1]* | *5 floors (Km0+205), 33m* | *5 floors (Km0+280), 40m* | *5 floors (Km0+360), 32m* | *4 floors (Km0+420), 26m* | *5 floors (Km0+480), 33m* | *5 floors (Km0+490), 40m* | *5 floors (Km0+500), 35m* | *4 floors (Km0+660), 27m* | *4 floors (Km0+660), 26m* | *4 floors (Km0+670), 26m* | *4 floors (Km0+670), 24m* |

| Height [2] (m) | Noise level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 21 | | | | | | | | | | | 76.0 | |
| 19.5 | | | | | | | | | | | 76.2 | |

| Height [2] (m) | Noise level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 18 | | | | | | | | | | | 76.3 | |
| 16.5 | | | | | | | | | | | 76.5 | |
| 15 | | 72.2 | | 73.3 | | | | | | 76.3 | 76.6 | |
| 13.5 | | 71.7 | | 72.8 | | | | | | 76.2 | 76.6 | |
| 12 | 71.3 | 71.3 | 73.7 | 72.2 | 72.7 | 72.2 | 72.6 | 72.6 | 72.8 | 75.1 | 75.5 | 68.2 |
| 10.5 | 70.9 | 70.9 | 73.1 | 71.8 | 72.3 | 71.8 | 72.2 | 72.2 | 72.4 | 73.9 | 74.1 | 67.8 |
| 9 | 70.5 | 70.5 | 72.9 | 71.6 | 72.1 | 71.6 | 72.0 | 72.0 | 72.2 | 73.6 | 73.8 | 67.6 |
| 7.5 | 70.3 | 70.3 | 72.9 | 71.6 | 72.1 | 71.6 | 72.0 | 72.0 | 72.2 | 73.6 | 73.9 | 67.5 |
| 6 | 70.0 | 70.0 | 72.8 | 71.3 | 72.0 | 71.3 | 71.9 | 71.9 | 72.1 | 73.5 | 74.1 | 67.4 |
| 4.5 | 69.9 | 69.8 | 72.8 | 71.0 | 71.9 | 71.0 | 71.7 | 71.8 | 72.1 | 73.6 | 74.4 | 67.3 |
| 3 | 69.8 | 69.7 | 72.9 | 70.8 | 71.6 | 70.8 | 71.4 | 71.5 | 71.8 | 73.9 | 74.5 | 67.2 |
| 15 | 69.8 | 69.7 | 72.9 | 70.6 | 71.3 | 70.6 | 71.1 | 71.2 | 71.5 | 74.0 | 74.4 | 67.1 |
| *Note* | *4 floors (Km0+990), 34m* | *5 floors (Km2+200), 33m* | *4 floors (Km2+240), 15m* | *5 floors (Km2+240), 25m* | *4 floors (Km2+245), 21m* | *4 floors (Km2+250), 25m* | *4 floors (Km2+260), 22m* | *4 floors (Km2+280), 21,5m* | *4 floors (Km2+420), 20m* | *5 floors (Km2+820), 7m* | *7 floors (Km2+840), 5,5m* | *4 floors (Km2+880), 50m* |

| Height [2] (m) | Noise level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| 21 | | 72.0 | | | | | | 72.9 | 72.3 | | | |
| 19.5 | | 71.9 | | | | | | 72.9 | 72.2 | | | |
| 18 | | 71.7 | | | | | | 72.8 | 72.0 | 71.8 | | |

| | Noise level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16.5 | | 71.4 | | | | | | 72.5 | 71.7 | 71.6 | | |
| 15 | | 70.9 | | | | | | 72.1 | 71.2 | 71.1 | | |
| 13.5 | | 70.3 | | | | | | 71.4 | 70.6 | 70.5 | | |
| 12 | 67.8 | 69.6 | 71.3 | 73.0 | 76.1 | 72.6 | 73.5 | 70.8 | 70.1 | 69.8 | 71.4 | 71.8 |
| 10.5 | 67.5 | 69.1 | 70.8 | 72.2 | 74.3 | 71.9 | 72.6 | 70.4 | 69.5 | 69.3 | 70.9 | 71.3 |
| 9 | 67.3 | 68.7 | 70.6 | 71.9 | 74.1 | 71.6 | 72.2 | 70.1 | 69.1 | 68.9 | 70.7 | 71.0 |
| 7.5 | 67.2 | 68.5 | 70.5 | 71.9 | 74.2 | 71.6 | 72.2 | 69.8 | 68.9 | 68.7 | 70.6 | 71.0 |
| 6 | 67.1 | 68.3 | 70.2 | 71.8 | 74.5 | 71.5 | 72.2 | 69.5 | 68.6 | 68.5 | 70.4 | 70.9 |
| 4.5 | 67.0 | 68.2 | 69.9 | 71.8 | 75.1 | 71.5 | 72.2 | 69.2 | 68.5 | 68.3 | 70.1 | 70.7 |
| 3 | 66.9 | 68.1 | 69.6 | 71.9 | 75.2 | 71.5 | 72.3 | 69.0 | 68.4 | 68.2 | 69.8 | 70.4 |
| 15 | 66.8 | 68.0 | 69.4 | 72.0 | 75.1 | 71.4 | 72.6 | 68.9 | 68.3 | 68.2 | 69.6 | 70.1 |
| *Note* | *4 floors (Km2+881), 55m* | *7 floors (Km2+860), 38m* | *4 floors (Km3+840), 25m* | *4 floors (Km3+920), 14m* | *4 floors (Km4+180), 4m* | *4 floors (Km4+255), 16m* | *4 floors (Km4+260), 12m* | *7 floors (Km4+400), 29m* | *7 floors (Km4+401), 35m* | *6 floors (Km4+420), cách 36,5m* | *4 floors (Km4+450), 24m* | *4 floors (Km4+455), 21m* |

| Height [2] (m) | Noise level (dBA) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | | | | |
| 21 | | | | | | | | | | | | |
| 19.5 | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | |
| 16.5 | | | | | | | | | | | | |
| 15 | | 69.7 | | | | | | | | | | |
| 13.5 | | 69.1 | | | | | | | | | | |
| 12 | 71.8 | 68.5 | 71.1 | 73.8 | 71.5 | 73.5 | 71.0 | 70.9 | | | | |
| 10.5 | 71.3 | 68.2 | 70.7 | 72.9 | 71.0 | 72.6 | 70.6 | 70.5 | | | | |
| 9 | 71.0 | 67.9 | 70.5 | 72.5 | 70.8 | 72.2 | 70.4 | 70.2 | | | | |
| 7.5 | 71.0 | 67.8 | 70.3 | 72.4 | 70.7 | 72.2 | 70.2 | 70.0 | | | | |
| 6 | 70.9 | 67.7 | 70.0 | 72.3 | 70.6 | 72.2 | 69.8 | 69.6 | | | | |
| 4.5 | 70.7 | 67.6 | 69.7 | 72.4 | 70.3 | 72.2 | 69.5 | 69.3 | | | | |
| 3 | 70.4 | 67.5 | 69.4 | 72.5 | 70.0 | 72.3 | 69.3 | 69.1 | | | | |
| 15 | 70.1 | 67.4 | 69.3 | 72.9 | 69.7 | 72.6 | 69.1 | 69.0 | | | | |
| *Note* | *4 floors (Km4+460), 21m* | *5 floors (Km4+490), 46m* | *4 floors (Km4+495), 26m* | *4 floors (Km4+500), 11m* | *4 floors (Km4+540), 23m* | *4 floors (Km4+720), 12m* | *4 floors (Km4+880), 27m* | *4 floors (Km4+880), 28m* | | | | |

*Note: (1) Distance from the Urban Road edge (13.85m from the center-line)*

*(2) Height from the earth surface*

*Cell with Grey highlight: noise levels in excess of Allowable Limi according to QCVN 26:2010 (70dBA)*

*2b. Impact of vibration from traffic flow – insignificant impact*

The following formula is used to predict vibration level:

$L = L_0 - 10 \log (r/r_0) - 8.7\ a\ (r - r_0)$

In which:

L: vibration in dB in distance of r meter to the source;

L0: vibration in dB measured in distance of "$r_0$" meter from the source. For traffic, $r_0$ is usually considered as source vibration.

a: vibration's inner reduction coefficient to rock base – 0.01; sand and mud base – 0.1; and clay base – 0.5

Calculation result shows that vibration level is reduced to 48.5 dB at edge of the Urban Road (13.85m in distance from center-line). This vibration level is lower than vibration level compared with TCVN 7210:2002 *"of vibration caused by road traffic, applied for residential areas with areas of commerce, production and service"*. For this reason, the residents living along the route would not be affected by vibration from traffic flow on the urban road.

*3.3.2.2Affect to the landscape due to appears of viaduct*

The appears of viaduct will affect the landscape around areas such as obstructing vision, change the current landscape. The construction of viaduct were calculated the factors in the future when all of ring road 3 is expanded as planned. Thus, the appearance of roads in the short term but may obstructing vision, but in the future, when road was extended below, these effects will not or will be minimized.

*3.3.2.3 Positive Impact*

**a. Social Benefits**

The Project is expected to contribute to the development of local society and economy by enabling the exploitation of development potentials in the localities and areas, enhancing market economy, etc. It would benefit industries and entities apart from transportation sector by helping them reduce their inventories, avoiding damages caused by delays in delivery of raw materials, machinery, etc. Moreover, non-production industries such as commerce, services, etc. would also be benefited.

**b. Benefits to local communities**

The Project would bring benefits not only to the users of the viaduct expressway (drivers and passers) but also to the manufacturers, businesses, services providers, consumers, people living around the Project area such as farmers, animal husbandary and people engaged in exploiting, trading and processing activities, etc. As a result, the

Project would contribute to increasing national income.

**c Benefits by reducing traffic congestion and pollution**

When the viaduct is put into operation, traffic flows on Ring Road 3 would be smoothly, and traffic congestion would be reduced significantly. Reducing traffic congestion would help improve economic efficiency by reducing fuel costs, waiting time, and emission of harmful pollutants to the environment.

## 3.4 Impacts due to incidents

### 3.4.1 Technical Incidents

The superstructure of the viaduct will be constructed at the elevation about 9m from the ground. Therefore, there would be the risk of work collapse due to technical fault, especially when installing the steel girders. If accident occurs, it would cause damage not only to worker's life, but also to the life of many people on the urban road.

### 3.4.2 Incident of Fire and Explosion

During construction phase, oil and petrol will be used for the operation of construction equipment. Oil and petrol have a major component of compounds carbuahydro (96 ~ 99%) which is very easy to cause fire and explosion, especially when being mixed with the air and catching sparks.

### 3.4.3 Labour Safety

Labor accidents would happen at any activity during construction if the contractor fails to comply with workplace safety process.

The prime causes of accidents include:

Deficiencies in technology design: such as formwork protection measures, landslide prevention measures, etc. can lead to work collapse and accidents;

Deficiencies in construction arrangement: unreasonable allocation of shifts, improper arrangement of work, overlapping, using non-standard materials, cutting construction procedures, etc.;

Technical uncertainty: machinery, modes, equipment incomplete or damaged such as lack of safety, lack of cover, lack of prevention signal system ...;

Violation of process and regulation of technical safety;

Cause of risks: accidents caused by transporting vehicles, sliding on scaffolding, electric shocks, etc. On rainy days, there is a high risk of accidents because of slippery ground, electrical problems, etc.

## 3.5 Comments on Degree of Detail of Assessment, Reliability of Assessment

### 3.5.1 Degree of Detail of Assessment

Impacts that may be caused by each activity of the Project during pre-construction phase, construction phase, and operation phase have been identified and assessed, while taking into consideration the natural environment, natural resources and socio-economic condition in the Project area. Impacts that may be caused by the Project include: relocation of public utilities, impact on ambient air quality, noise, groundwater quality; impact on traffic, impact due to concentration of workers, waste control and management, incidents of fire and work collapse, etc. If the Project is not implemented, these impacts would not occur, but traffic congestion, which is a serious problem in the Project area, can not be resolved.

Impacts have been assessed in detail, as the waste sources were quantified based on available data on vehicles, machinery, materials to be used; technology to be applied; human resource for the Project, etc. and in following to the standards, norms, and other relevant regulations of Vietnam or international organizations, or experiences of the construction company associations.

### 3.5.2 Reliability of Assessments

#### *3.5.2.1 Methods of Forecast*

Checklist was used to determine impact sources and impact receivers, and extent of impact accordingly. This helped to examine impact-mitigation measures. Methodology and implementation methods are considered scientifically rational and practical.

Forecast of quantity of wastes generated from sources was based on specification of vehicles, machinery and materials to be used for construction works; technology to be applied; labor force, etc. in following the norms of Vietnam and international organizations.

Impacts were identified and extent of impacts were determined on the basis of receptors' sensitivity and scale of waste sources. Impact assessment was conducted by comparing forecasted pollutant concentrations, noise levels, etc. with the current standards, national technical regulations on environment, international standards applied in the developing countries, etc. Methodology is considered rational. However, weather conditions, as well as construction methods would be changed to some extent. In addition, some of the quantification or semi–quantification methods applied in the study are developed for rapid estimations only, and input data are not definitely accurate. Therefore, some quantification results may not be highly precise. Accordingly, construction supervision and environmental monitoring should be undertaken during the whole period from the pre-construction phase to the construction phase, and results of monitoring should be used to supplement to the

impact prediction and impact assessment, and to adjust the impact mitigation measures.

### *3.5.2.2 Calculation Methods*

**(1) Prediction of air pollutant concentration**

- *Prediction of air pollutant emission in construction phase:* Machines/equipment to be used in construction was predicted on the basis of state norms. Prediction method is considered reliable. Prediction of quantities of air pollutants and dust emitted from the construction machines/equipment was then conducted, based on pollution emission coefficients developed by international organizations and experiences of international construction associations. Impact of air pollution to each sensitive receptor was assessed separately for each source of emission. Estimation methodology is considered rational. However, construction work would change in actuality, and it would lead to the different quantity of air pollutants emitted. Extent of impact would change depending on construction condition in actuality. Therefore, ambient air quality monitoring should be duly implemented during construction phase to enable adjustment of impact mitigation measures.
- *Prediction of air pollutant concentrations in operation phase:* The Model of ISC Breeze was used to predict emissions and air pollutant concentrations from traffic flow. This model is considered as an effective tool to predict air pollutant concentration. It can be applied for various types of emission source, such as point source, linear source, plane source, etc. The model allows many options for illustrating impacts from different emission sources. The typical emission sources include chimney, road, conveyer belt, railway, residential area, small-sized industrial zone, etc. Besides, the model can also be applied for temporary emission sources such as stockyard, waste spilling site, etc. It may also be applied for the low-open emission sources such as fuel turbine, rock quarry, etc. Input data for the model include: quantity of each pollutant at emission sources (g/m.s), geometrical form of sources, length and width of line, height above sea level, receptor locations, meteorological figures such as wind speed, wind direction, temperature, air pressure, atmospheric stability class, disorder height, etc. Main mathematical formula of the module are based on Gausse formula, applying for linear emission source, using integral calculus of surface area, wind direction, and perpendicular to wind direction. Line sources are subdivided into separated rectangles with ratio of length and width of 10/1 and comply with north – south and east – west relation. The concentration of receptor locations of all line source components by wind direction is calculated both by vertical wind direction (x) and horizontal one (y). It is reasonable that Cartesian coordinate system, wind speed is taken from Lang

meteorological data in average years; diffusion coefficient complies with Pasquill – Gifford curves (Turner, 1970), atmospheric stability Class B, emission level is calculated according to pollution coefficient of WHO.

**(2) Prediction of noise pollution**

ASJ–Model 2003 was used to forecast noise level generated from the traffic flow on the viaduct expressway and on the urban road. The ASJ Model–2003 allows to predict noise level for various types of noise source, as well as noise levels at sensitive receptors along the alignment (residential areas, schools, hospitals). The model is considered providing highly reliable results.

The ASJ Model 2003 was developed mainly by "the Acoustic Society of Japan" based on many complex formula according to A-method (A-method is also called "Precision Method"), and B-theory of acoustic diffusion (B-method is also called "engineering method"), in which process of description and calculation of noise intensity is based on a sequence of fixed sound frequency per unit of time, changing in the range of 1 minute to 30 minutes. The process of sound wave dispersion calculation in ASJ Model 2003 is described and separated on the basis of process of sound echo with regression equations. The input parameters of vehicle flow are separated by various lanes and that flow is considered unchanged in number of regular vehicles on the road.

Basic calculation equation is based on division of each vehicle flow into different sections, at one of which the total sound intensity is calculated with receptors and each of vehicle. Total sound intensity is divided and calculated for one meter area of road surface on the basis of matching pursuit algorithm. Calculation is reasonable and reliable. However, the noise forecast excludes features of topography and sample vehicle, so it is necessary to verify in practice.

# CHAPTER 4. IMPACT MITIGATION MEASURES

## 4.1 Impact Mitigation Measures in Preparation Phase

### 4.1.1. Impact Mitigation Measures of land clearance

(1) Description of Mitigation Measures

To ensure traffic on the Pham Van Dong road as well as to properly treat wastes generated from trees relocation works and power poles relocation, the following measures should be carried out:

- Relocation of trees and electric poles each side of the road, they will be relocated one by one.
- Arranging traffic controller at implementation location.
- Conducting the demolition items (trees, lighting poles, electrical poles) in the appropriate time. Don't conduct in peak times to ensure traffic on this road.
- Installation of temporary signs in the area of trees relocation and power poles relocation.
- Installation of temporary fencing around area of trees relocation and power poles relocation.
- Collection, transportation and cleaning of soil and twigs and clean the road at end of each day. Focusing treatment the wastes from road.
- Installation of lighting system in around construction site and lighting pole systems on the sidewalks.

(2) Area and time subject to the implementation of measures

- *Area*: the whole project area.
- *Time*: during the time to prepare the construction site

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Mitigation impact measures traffic and waste in trees relocation and power poles relocation are feasible, since they are not difficult to be implemented by any common Vietnamese contractors

### 4.1.2. Waste Management and Treatment

(1) Description of Mitigation Measures

In order to properly treat wastes generated from the demolition works, and construction site leveling, the following measures should be carried out:

- *Collecting and temporary stocking wastes:* Wastes generated from the installation

of equipment, construction site preparation, etc. should be collected and stocked temporarily at the proper places in the construction site.

- *Transporting wastes to the designated disposal site*: temporary-stocked wastes should be immediately transported to the disposal site designated by Hanoi City (Nam Son landfill in Soc Son District).

(2) Area and time subject to the implementation of measures

- *Area*: the whole project area.
- *Time*: during the time to prepare the construction site

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Proposed measures for waste collection are reasonable and conformable with the requirements of Decree No. 59/2007/ND-CP by the Government on solid waste management, Decision No.11/2010/QĐ-UBND dated 23/02/2010 by Hanoi City PC on the management of general solid wastes in Hanoi City territory, and Decision No.56/2010/QĐ-UBND dated 17/12/2010 by Hanoi City PC on amending Decision No.11/2010/QD-UBND on the management of general solid wastes. Proposed measures are feasible and effective. Residual impacts are not considerable.

### 4.1.3. Request completed preparatory work for during pre-construction phase

(1) Description of Mitigation Measures

The following measures should be carried out, in order to disseminate information on the Project and on the environmental mitigation measures to local communities in the Project area, thus to obtain local people's consensus:

- *Information disclosure:* After the EIA report is approved by Ministry of Transport, the Project Owner should prepare and approve the Environmental Management Plan (EMP) and publicize it at the offices of wards/commune PCs where the public consultations were done. The contents of EMP shall comply with Article 22 of Decree 29/2011/ND-CP dated 18/4/2011 by the Government on strategic environmental assessment, environmental impact assessment and environmental protection commitment. By the disclosure of EMP, local people can obtain information on the Project and can participate in supervising the Project implementation.
- *Installation of information boards*: Boards to provide information on location of the construction site, etc. should be installed at proper places to prevent people from unintentionally-entering the construction site. Signs/boards to make cautions on construction safety should also be installed properly in the construction site to prevent accidents.

(2) Area and time subject to the implementation of measures

- Area:
  + Disclosure of information: at Mai Dich Ward, Co Nhue Commune, Xuan Dinh Commune.
  + Installation of boards/signs at the ROW and around the construction site.
- *Time*: before the commencement of construction phase.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

The Project Owner has responsibility to implement these measures as stated in the approved EIA report, and in Article 22 of Decree 29/2011/ND-CP dated 18/4/2011 by the Government on strategic environmental assessment, environmental impact assessment and environmental protection commitment.

## 4.2 Impact Mitigation Measures in Construction Phase

### 4.2.1 Waste-Related Impacts

#### *4.2.1.1 Measures to Mitigate Impacts on Ambient Air Quality*

(1) Description of Mitigation Measures

Purpose of this recommendation is to minimize impacts caused by dust generated from: (1) drilling bored piles, and (2) transporting construction materials and waste soils. The following measures should be implemented to limit these impacts to ambient air quality:

- *Establishing Construction Working Plan:* when legal procedures for the Project implementation are completed, Construction Working Plan should be set up which should include the following items: earth work implementation method, equipment mobilization and arrangement method, construction site sanitation protection method, working safety and public health protection method.
- *Using vehicles/machines conformable with gas emission standard*: transportation vehicles to be used for the Project must be conformable with gas emission standard stated in "TCVN 6438-2005 - road transport means - maximum allowable limit of gas emission". Old vehicles, machines should not be used for transportation of materials/spoils and for construction. Carrying over permissible capacity should be prohibited.
- *Arrangement of transportation time in accordance with regulations*: waste soil generated from pier construction must be taken out from the site daily. Transportation of waste soil to the Van Noi disposal site (in Dong Anh District, Hanoi City) should be carried out during night time. Construction materials and

waste soil must be watered before being transported on sunny and dry days. Materials having the potential to create dust shall not be loaded to a level higher than the side and tail boards of the truck, and shall be covered by a clean tarpaulin in good condition, to avoid dropping and dust emission. The tarpaulin shall fully cover the truck booths and be tightly tied according to Decision No. 02/2005/QD-UBND issued by Hanoi PC on measures to mitigate dust generated from construction works.

- *Proper arrangement of construction site and storage of waste soil to limit dust emission*: the construction site should be separated with the urban road by the roofing iron barriers with 3m in height, to reduce dust spreading from the construction site. Materials should be keep within these barriers. Waste soil stocked at site should be covered to limit dust diffusion on sunny days and erosion on rainy days.
- *Watering the areas where dust is easy to spread*: the construction site should be regularly sprayed with water to maintain humidity; soil and dry dumping materials should be sprayed with water at least twice in a dry day (one in the morning and other one in the afternoon) to minimize dust diffusion in the air. Water spraying vehicles shall be used for watering the road traffic (7m wide on each side). The vehicle used for spraying water should have specifications of a standard water spaying vehicle. The holes arranged on the hose installed in the vehicle should be able to adjust in order to spray water on the whole area that needs to be sprayed.
- *Control and management all activities that may diffuse dust*: if the monitoring result shows that dust concentration exceeded the allowable limit (of 0,3mg/m3, according to QCVN05:2009/BTNMT), and may cause adverse impact to health of local residents or workers at the construction sites, mitigation measures should be timely undertaken, and suspension of construction work until the consequence is overcome should be considered (with agreement of Construction Supervision Consultant - CSC).

(2) Area and time subject to the implementation of measures

- *Area:* all areas around the Project area
- *Time*: during the construction phase

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Mitigation impact measures on ambient air quality in construction phase are feasible, since they are not difficult to be implemented by any common Vietnamese contractors. However, it is very difficult to fully control dust diffusion in the area with many dust generation sources as required by QCVN 05:2009/BTNMT. Therefore, residual impacts on ambient air quality should be particularly concerned during the Project

implementation. Through the supervision and monitoring activities, the Project owner should undertake further necessary measures to keep ambient air quality in acceptable level.

#### *4.2.1.2 Measure to Mitigate Impacts on Groundwater Quality*

(1) Description of Mitigation Measures

At Narrow sections (Km0+000 ÷ Km1+240, Km2+120 ÷ Km2+760, Km3+640 ÷ ending point), the Project applies rotation steel pile technology. This is new construction technology, not use bentonite or other additives and will not affect groundwater quality.

The following measures should be carried out to reduce the risks of groundwater pollution during the works to construct the bored piles of the viaduct at Standard section (Km1+240÷Km2+120, Km2+760÷Km3+400) and transition section (Km3+400÷Km3+640):

- *Using standardized bentonite to prevent groundwater pollution*: when drilling bored piles, standardized bentonite (with density, viscosity, sand content, glue percentage, amount of water loss, thick of clay coat and etc. in accordance with the *Vietnam Construction Standard No 326:2004 - Bored piles - Standards of construction and acceptance*) should be used. Additives to maintain pH, viscosity and etc. will not be required when using standardized bentonite, in order to completely prevent potential pollution of underground water resources.
- *Making the banks around the drilling hole to prevent dirty water flowing into the hole*: banks around the drilling hole should be installed while drilling, and these banks should be maintained throughout the construction process of bored pile to prevent dirty water flowing into the drilled hole.

(2) Area and Time subject to the implementation of measures

- *Area*: Km1+240 ~ Km2+120, Km2+760 ~ Km3+400 and Km3+400 ~ Km3+640.
- *Time*: During construction of bored piles at standard section and transition section.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Proposed measures are effective because they are basically feasible preventive measures, which eliminate the risk of causing groundwater pollution by additives in bentonite and dirty water. Based on the terms described in the bidding documents and the contract documents, the Project owner should require the Contractor to duly implement the mitigation measures, and require the construction supervision consultant to follow up the works done by the Contractor. The feasibility of the proposed measures is assured.

#### *4.2.1.3 Waste Management during Construction Phase*

***a. Solid Waste Management***

- *For waste soil from bored piles*: soil mixed with bentonite and spilled bentonite sludge generated from the bored holes should be temporarily stockpiled in the nearby sites within the construction area. The temporary stockpiling sites should be enclosed by the banks to prevent waste soil/sludge spilling to outside area. The waste soil/sludge should be roughly dehydrated to be easily transported to the disposal site in Soc Son District in accordance with regulations of Hanoi City PC.
- *For excavation soil from piles construction*: excavation soil will be temporarily stockpiled in the area near the construction site, away from the sensitive areas (schools, temples and etc.). During construction, the construction area (including the excavation soil areas) will be wet by spreading water at least 2 times a day. Excavation soil should be transported to the disposal site as soon as possible.
- *For wastes of chemical origin*: The wastes should be properly collected, stored and treated in accordance with Circular 12/2011/TT-BTNMT on the management of harmful wastes. Accordingly, these wastes should be collected in specified containers for hazardous wastes. These containers should have the lid to avoid spillage and should be placed at suitable location within the construction site. Hazardous wastes should be periodically removed from the construction site to the treatment facilities by the specified companies under the contract signed with the Contractor. The specified company should have license to transport and treat hazardous wastes in accordance with Circular No. 12/2011/TT-BTNMT.
- *For domestic wastes*: domestic solid wastes should be collected and temporarily stocked in the waste containers in the construction site (expected to project will use 04 portable toilets that kinds of 05 compartments and 01 toilets that kinds of 03 compartments, 12 mobile trash). In addition, garbage bin and temporary toilet should be arranged in the worker camps. Based on the contract with Hanoi URENCO, the Project owner should require the Contractor to properly treat wastes in accordance with Decree 59/2007/ND-CP dated 09/04/2007 on solid waste management; Decision 11/2010/QD-UBND by Hanoi City PC dated on 02/23/2010 promulgating regulations on management of common solid wastes in Hanoi; and Decision 56/2010/QD-UBND dated 12/17/2010 by Hanoi City PC on amendment of Decision 11/2010/QD-UBND on management of common solid wastes.

***b. Waste Water Treatment***

- *For wastewater generated form construction works*: wastewater should be directed

- *For waste oil and wastewater from engine maintenance*: Wastewater should be collected and directed through the container which have the trap to collect waste oil (The trap may be simply made by a geotextile sheet that can keep waste oil while allowing water to flow through), oil remains in the container, the water flowing through the trap is discharged into the drainage system of the city. The geotextile sheet should be regularly cleaned up to maintain its effectiveness. Collected waste oil should be stocked in the dedicated containers for disposal in accordance with Circular 12/2011/TT-BTNMT dated 14/04/2011 on the management of hazardous wastes.
- *For domestic wastewater*: Domestic wastewater should be diverted into the drainage system of the construction site, and flowed through the slot screens to exclude garbage, and settled in the containers to exclude sand, soil, etc. before discharged into the drainage system of Ha Noi City.

### 4.2.2 Impacts not Related to Waste

#### *4.2.2.1 Measures to Mitigate Noise*

(1) Description of Mitigation Measures

The contractors should undertake the following measures to reduce impact of noise from the construction works:

- *Proper arrangement of materials stockyards/stockpiles, and proper management of working schedule*: The stockyards/stockpiles, machine/vehicle maintenance workshops and etc. should not be allocated within 200m from schools, hospitals, religious facilities, and other noise-sensitive receptors. Equipment with excessive noise emission should not be used when carrying out construction work near these facilities. Electric power generators (if any) should be placed in the construction site enclosed by the barriers to reduce noise emission. The telephone number for resident to make complaint on excessive noise, etc should be established, and announced on local newspapers and on the notice boards allocated around the construction site.
- *Reduce noise at the noise source*: When carrying out construction near the noise-sensitive receptors such as school, hospital, church, temple, etc., construction machines (which is fixed or moved only in a short distance and operates continuously for a long time) with low noise emission should be selected. In fact, contractors themselves can take the initiative in applying construction methods

- *Limiting operation of many equipment at a same time*: Operation schedule of equipment and construction activities should be suitably scheduled to limit noise generating at a same time in order to reduce consonant noise, particularly when carrying out construction near sensitive areas such as schools, hospitals, pagodas and etc.
- *Implementation of construction norms*: The following norms should be implemented to reduce noise during construction phase: (a) use only well-maintained equipment at construction sites; (b) regularly repair equipment during construction period; (c) use equipment, engines and motors equipped with proper silencers or mufflers during construction; (d) switch off machinery when it is not in operation to reduce accumulated noise.
- *Ensure working safety for workers*: Workers who works near the electric power generator or the powered equipment which generates noise level of more than 80dBA should be equipped with soundproof helmets.
- *Mitigating noise generated from transportation activities*: switching off the engine when it is not necessary and avoiding unnecessary actions which generate noise when driving vehicle. Prohibiting vehicles involved in the Project to use air-horn when moving near the sensitive facilities.

(2) Area and time subject to the implementation of measures

- *Area:* construction sites near the sensitive receptors.
- *Time*: during construction phase.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Although the noise level during construction phase may be reduced to some extent by implementing the recommended mitigation measures, it may be very difficult to perfectly control the noise sources, due to the difficulty to replace all old construction equipment at once. Residual impacts of noise pollution during construction phase, therefore, should be particularly considered during the construction phase. Moreover, depending on construction plan, noise may be accumulated in the construction area. Therefore, the Project owner, through the monitoring activities, should strengthen the mitigation measures when it is necessary to keep the noise in acceptable level. Besides, the contractors should provide local residents with information on the detailed construction schedule, to make them understand and accept the temporarily occurred noise, and support the Project.

#### *4.2.2.2 Measures to Mitigate vibration*

(1) Description of Mitigation Measures

The following measures should undertake to reduce impact of vibration from the construction works:

- *Reduce vibration level at the vibration source*: When carrying out construction near the sensitive receptors such as school, hospital, church, temple, house resident and etc., construction machines and construction technology (which is fixed or moved only in a short distance and operates continuously for a long time) with low vibration emission should be selected. In fact, contractors themselves can take the initiative in applying construction methods with selected equipment of low noise emission for each specific construction work to reduce noise at source. The Project owner, based on requirement of each sensitive receptor should request Design Consultant and contractors to select proper construction technology and construction equipment to mitigate impact of vibration as much as possible.
- *Limiting operation of many equipment causes vibration at a same time*: Operation schedule of equipment and construction activities should be suitably scheduled to limit vibration generating at a same time in order to reduce consonant vibration, particularly when carrying out construction near sensitive areas such as schools, hospitals, pagodas, etc.
- *Application of new technology*: rotation steel pile technology which has low vibration construction method is applied at narrow sections (Km0+000 ~ Km1+240, Km2+120 ~ Km2+760 and Km3+640 ~ ending point).

(2) Area and time subject to the implementation of measures

- *Area:* construction sites near the sensitive receptors, especially the Narrow sections
- *Time*: during construction phase

(3) Assessment of effectiveness of mitigation measures and the residual impacts

The vibration level during construction phase may be reduced to some extent by implementing the recommended mitigation measures, it should be very difficult to perfectly control the vibration sources, due to the difficulty to replace all old construction equipment at once. Therefore, the residual vibration impacts during construction should be of particular interest.

#### *4.2.2.3 Measures to Mitigate Impacts on Transportation of Materials and Waste*

(1) Description of Mitigation Measures

The following measures should be carried out to prevent and minimize the risk of occurrence of traffic accident due to the spillage of construction materials, waste soil, bentonite-mixed sludge, etc. on the road during transportation:

- *Rationally organizing construction*: construction work should be limited within the construction site enclosed by the barriers of 3m in height. Vehicles involved in the construction should use the specified gates to go in/out the construction site. At these gates, signals and lights should be installed to prevent wrong access and accidents.
- *Rational transportation schedule*: transportation of materials should be banned during peak hours (6:00~8:00 and 16:00~18:00), and should be scheduled after 21:00.
- *Rational load and speed*: the trucks transporting materials/waste soils should not be overloaded and keep limitted speed..
- *Preventing spillage of materials*: the trucks with lid should be used for transportation of materials/waste soils. Otherwise, materials/soils loaded on the truck should be fully covered by geotextile sheet. Wheel washing facilities shall be provided at the exit of construction site to prevent dusty material from being carried off-site on vehicles and deposited on public roads. Wash-water shall have sand and silt settled out and removed at least once in a week to ensure the continued efficiency of wheel wash operations.
- *Preventing spillage of waste soil and bentonite sludge*: waste soil and bentonite sludge should be temporarily stockpiled in the suitable area within the construction site. The stockpiling area should be bounded to avoid spillage of soil/sludge to outside areas. The sludge should be preliminary dehydrated and transported to Van Noi disposal site in Dong Anh District in accordance with regulations of Hanoi PC.
- *Collecting spilled materials/soils and cleaning up the road*: if there are materials/soils spilled on the road during transportation, the spilled materials/soils should be immediately collected and removed, and the road should be cleaned. Roads around the construction site should be sprayed once a day before the morning peak hours (before 6:00AM)

(2) Area and Time subject to the implementation of measures

- *Area:* construction site and transport routes of materials / waste soils;
- *Time*: during construction phase.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

The recommended measures which are based on content of construction work, traffic situation and level of impact, are expected to be able to minimize traffic congestion

and ensure traffic safety.

Recommended measures are simple, feasible and effective. However, to ensure residual impact is acceptable, the Project owner should strictly supervise the works done by the contractors, and request contractors to duly implement the mitigation measures described in the approved EIA Report, as well as other additional measures if necessary. Residual impact is not significant.

#### *4.2.2.4. Measures to Mitigate Impacts to Public Facilities (offices, schools ...)*

(1) Description of Mitigation Measures

The following measures should be carried out to ensure accessibility of people to the public facilities around the area:

- *Construction of Temporary Depositing Basin*: Bentonite solution will be directed to a temporary depositing basin to collect the residues bentonite
- *Preventing spillage of waste soil and bentonite sludge*: Waste soil and bentonite sludge should be temporarily stockpiled in the suitable area within the construction site. The stockpiling area should be bounded to avoid spillage of soil/sludge to outside areas. The sludge should be preliminary dehydrated and transported to the designated disposal site in Soc Son District in accordance with regulations of Hanoi PC.
- *Collecting spilled materials/soils and cleaning up the road*: If there are materials/soils spilled on the road during transportation, then the spilled materials/soils should be immediately collected and removed, and the road should be cleaned up to ensure easy smooth accessibility to the public facilities.

(2) Area and time subject to the implementation of measures

- *Area*: on all access roads to public facilities (cultural, educational, administrative, and business organizations).
- *Time*: during boring pile construction.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Mitigation measures are simple, feasible and high effective. However, to ensure that residual impact is acceptable, the Project owner should strictly supervise contractors in order to ensure the due implementation of mitigation measures described in the approved EIA Report, and other additional measures (if necessary). Residual impact is not significant.

### *4.2.2.5. Measures to Mitigate Impacts to traffic*

**(1)** Description of Mitigation Measures

The following measures should be carried out in order to avoid impacts to traffic on the Pham Van Dong Street:

- *Construction implementation in the form of rolling*: each construction team covers from 3 to 5 piers. After completion will change to another pier.
- *Scope of application*: When construction of piers only use area between the current Pham Van Dong road with width of 10.6m (narrow section) and 27m (standard section), can reduce to 7m on day time therefore impact on traffic is very small.
- *Traffic Control outside the Project area*: Vehicles will follow the right dike of Red river and Xuan La road.
- Reasonably arranging scope of the vehicle circulation on Pham Van Dong in the narrow section and the standard section: For the standard section can use the land in one or both of side to construct access road.
- *Arranging construction sites*: the site layout within 10.6m between the current lane, 7m wide left on each side serve to ensure the current traffic on the road. Arranging temporary barrier is aligned along construction site and fixed to ensure smooth traffic arangement.
- Construction access road 7m each side to ensure traffic is almost existing;
- The barrier of construction site is arranged fixed line, ensuring traffic smoothly.
- When construct piles, that used only in the area between the existing road, can be reduced to 7m (translation barrier) during the day so the traffic impact is very small;
- Quick completion of construction of the pile (1 pile is 1.5 ÷ 2 days, 1 steel rotation pipe is 8h).
- Construction of shape using scaffolding frame format, will be covered, ensuring don't impact to traffic below of lanes 7m bottom of the sides.
- Construction of employing measures beam vertical beam above. Arrangement of scaffolding and roof system to ensure the safety of vehicles in circulation below.
- Collecting road materials and usually cleaning.
- *Application of rapid methods of construction, safety*:

  o Quick completion of construction of the pile (one bored piles 1.5 ~ 2 days and one rotation steel pile 1 day)

  o Construction of the head used scaffolding frame format, with a roof, ensure traffic does not affect the bottom of 7m lanes on both sides.

o Construction of employing measures beam vertical beam above. Arrangement of scaffolding and roof system to ensure the safety of vehicles in circulation below;

- *Collecting materials and clean lines regularly*
- *Set signs*: Signs board system for construction area will be located on two sides of the road construction along the existing road in the driving position for easy recognition.
- *Traffic Guide*: traffic guide will arrange to ensure the rational flow of traffic during construction. Flag man will arrange at site also. Main responsibility of these people is to guide traffic movement in and around the construction area.

(2) Area and time subject to the implementation of measures

- *Area*: Along route Pham Van Dong current, concentrated in the narrow section (Km0 ÷ Km1 +240, Km2 +120 ÷ Km2 +760, Km3 +640 ÷ last line)
- *Time*: During the construction period.

(3). Assessment of effectiveness of mitigation measures and the residual impacts

The measures are based on the content of construction, traffic status every area and level of impact can minimize traffic congestion. The mitigation measures are studied based on the principle of ensuring the traffic on the road during the construction approach as it is now. Residual impacts are negligible.

### *4.2.2.6. Measures to Mitigate Impacts to local flooding*

**(1)** Description of Mitigation Measures

Aim to minimize the impact of local flooding when heavy rains occur, the following measures will be applied:

- *To perform the correct sequence of construction*: construction made only after checks found that across multiple works well.
- *Checked regularly*: Regularly check along the construction area, if it detects the local inundation, will perform at work include: cleared for drainage, water to the natural flow ...
- *Clean scattered sand*: Do not let them drop down the drains, ditches nearby;
- *Use rotation steel pipe pile foundation construction method*: Measures does not require excavation, therefore, should not require a temporary drainage system;
- *Storm water runoff drainage*: Due to the Project occupy only about 9m of the road-bed for construction site, issue of surface water drainage is less affected if it is heavy rain. Additionally, the temporray ditch will be constructed inside the construction site for collection of water runoff, ensuring the drainage issue;

*Immediate treatment*: In the event of local flooding in some locations, pump may be arranged to drain water.

(2) Area and time subject to the implementation of measures

- *Area*: Along route Pham Van Dong current focus in the dex flood occurs when precipitation as neighbors Dong Sa ...
- *Time*: During the construction period.

(3). Assessment of effectiveness of mitigation measures and the residual impacts

Mitigation measures are simple, high effective and not much material requirement. However, to ensure increasing the effect of recommended measures, the Project owner should strictly supervise contractors in order to ensure the residual impact is not significant.

#### *4.2.2.7. Measures to Mitigate Impacts due to the Concentration of Workers*

(1) Description of Mitigation Measures

Measures to mitigate impacts due to the concentration of workers should be carried out in accordance with the provisions of Hanoi City PC (Article 11, Decision 55/2009/QD-UBND dated 03/17/2009 on regulations to ensure public order, safety and environmental hygiene during construction works in the Hanoi City), as follows:

- *Applying safety construction method*: Construction workers working at site should be equipped with safety clothes, equipment.
- *Worker management*:
  - + Construction workers should be provided with proper living condition and health care during construction. Construction worker camp should be appropriately provided with clean water, electric power, etc. Registration of temporary residence for workers came from outside regions should be completed. Education should be provided to workers to promote their understanding and respects on local cultural, religious, custom. Drinking while working, gambling in construction site, etc. should be prohibited. Working schedule (including working time and rest time) should be made and disseminated to workers.
  - + Educating workers about how to deal with people who drives on the roads around the construction site, and with people living in the area.
- Cooperation with local authorities:
  - + The Project owner should cooperate with local authorities, including the Fatherland Front Committee, Women's Union, etc. to promote workers'

caution about social evils, prostitution, epidemics, HIV, etc. in the area.

+ The Project owner should work closely with local authorities in improving public hygiene when epidemic appears in the region.
+ The Project owner should cooperate with local authorities in preventing and eliminating social evils.

- *Hiring local labour force:* Local people, including unskilled people, both male and female, should be hired to undertake simple works. For works that require trained worker, the contractors should firstly select workers among the hired local workers, to provide them with training on necessary skills so that they can undertake such works.

(2) Area and time subject to the implementation of measures

- "Worker's management" to be applied at site, during construction phase.
- "Cooperation with local authorities" and "Hiring local labour force" should be applied during construction phase for all communes/wards in the Project area.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

The recommended measure is feasible, because it refers to contractors' responsibility as stipulated in Vietnam regulations on work safety and environmental hygiene.

## 4.3 Impact Mitigation Measures in Operation Phase

### 4.3.1. As for noise pollution

#### *4.3.1.1. Urban road under viaduct*

(1). Description of mitigation measures

a. Mitigation measures are studied

To reduce the noise level in the 1st, 2nd and 3rd stories of the houses adjacent the Pham Van Dong road in the operation phase of the Project when the project of extending the Pham Van Dong road does not implement. The measures including: (i) Installation of Noise Barrier, (ii) Installation of Noise Absorption Board below the viaduct girders, (iii) surfacing the roadbed of urban road by Noise Absorption Asphalt layer that was studied, detail content of measure as following:

(i) Noise Barrier Installed

Installation of Noise Barrier along the edges of sidewalks for sections that have houses.

*Advantages:*

- It well to reduce noise, easy construction

- Used time is long

*Disadvantages:*

- Distance from the noise barrier position at the edge of sidewalks to the door of houses is 1.5 m. Thus, the living and trading of households living nearby the road will have many difficulties.

- Cost for this measure is large.

*Conclusion:*

Due to disadvantages of this measure, that the application of measures to reduce noise wall installation is not feasible.

(ii) Absorption Board Installed

Installation of Noise Absorption Board on the entire area of the bottom of viaduct

*Advantages:*

- Don't occupy the around space.

*Disadvantages:*

- Effective in reducing the impact on the surrounding population is not high.

- Cost for this measure is large.

*Conclusion:*

The measure has large cost and effective in reducing noise is not high that the application of measures is not feasible.

(iii) Using Noise Absorption Asphalt

Installation of Noise Absorption Asphalt layer at entire of urban road from starting point to ending point.

*Advantages:*

- Easily to construct, construction time is quick.

- Cost for this measure is medium.

*Disadvantages:*

- Effective of Noise Absorption of this asphalt will be reduced depending time.

*Conclusion:*

The feasibility of the measure is high.

b. Recommend the Mitigation measures that is applied to reduce noise from activities

of vehicle flow on urban road below:

Measures install Noise Absorption Asphalt layer has medium cost and easily to construct. Recommend apply this measure.

(2) Area and time subject to the implementation of measures

- *Area:* entire Project section
- *Time*: During operation phase

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Noise Absorption Asphalt measures will be reduced about 2dB for the 1st, 2nd and 3rd stories houses of the adjacent the Pham Van Dong road and about 1dB for more stories house (Detailed calculation results are presented in Appendix 5). The measures is feasible, however, efficiency of absorb sound of this surface layer will be reduced by the extraction time. It is necessary to maintenance for this surface in accordance with the maintenance process of the road. Residual effects of noise is still there, but at an acceptable level.

#### *4.3.1.2. Viaduct*

(1) Description of Mitigation Measures

To reduce the noise level from 4rd or more of stories of the houses adjacent the Pham Van Dong road in the operation phase of the project, The measures including: (i) Installation of Noise Barrier, (ii) surfacing the roadbed of urban road by Noise Absorption Asphalt layer that was studied, detail content of measure as following:

*a. Noise Barrier Installed on the viaduct*

Noise Barrier will be installed at handrail of viaduct. The project has designed with structure of viaduct to ensure can be installed noise barrier with 4 to 6m of high. However, the researchers calculated the specific height, type of noise barrier, materials, etc. will be implemented in a independent project in the next step.

*Advantages:*

- It well to reduce noise, easy construction

- Used time is long

- In accordance with the general policy to install noise barrier along the viaduct on Ring road No.3, which minimize noise level in the present as well as in the future for the buildings along the alignment of the project.

*Conclusion:* The feasibility of the measure is high

*b. Using Noise Absorption Asphalt*

Noise Absorption Asphalt is installed on the viaduct at over 3rd stories houses

*Advantages:*

- Construction time is quick.

- Cost for this measure is medium.

*Disadvantages:*

- Effective of Noise Absorption of this asphalt will be reduced depending time.

- It is difficult to construct due to surfacing follow one by one section.

- Along the project alignment, the over 3rd stories houses is widely separated and discrete. Therefore, this measure at independence locations that have buildings is also discrete, in addiction the thickness of general asphalt is less than Noise Absorption Asphalt's so road-bed will be uneven, not smoothly.

*Conclusion:*

The measure is not feasible

*c. Proposed Application measures for the Project*

- Recommend apply install noise barrier at handrail of viaduct from starting point to ending point of the project.
- The researchers calculated the specific height, type of noise barrier, materials, etc. will be implemented in a independent project in the next step.
- The structure of viaduct must ensure can install the noise barrier over than 6m of high.

(2) Area and time subject to the implementation of measures

- *Area:* The entire Project.
- *Time*: During construction phase.

(3) Assessment of effectiveness of mitigation measures and the residual impacts

According to preliminary calculations, installation of noise walls have a height of about 3m will have effectiveness of noise mitigate with appropriate funding. However, the researchers calculated the specific height, type of noise barrier, materials, etc. will be implemented in a independent project in the next step.

The measures are feasible, long-term, consistent with the general policy that installation of noise barrier along the entire viaduct of the Ring Road No. 3. Residual effects of noise is still there, but at an acceptable level.

### *4.3.2. Measures to Mitigate Impacts to storm water runoff*

(1) Description of Mitigation Measures

Rain water drawn from surface containing heavy metals can contaminate surface water around. To minimize this impact, the following mitigation measures should be implemented

- Fire-extinguisher, water tank for fire fighting should be arranged all time at the construction site. These should be regularly checked and maintained
- Regulation of shielding materials: Truck not be shielded carefully will be prohibited from moving on the highway.
- Moisten: regular spray water onto the surface of the dry season (2 times / day).

(2) Area and time subject to the implementation of measures

– *Area:* Along the Project

– *Time:* operation phase of Project

(3) Assessment of effectiveness of mitigation measures and the residual impacts

Mitigation measures are also regulations on work safety and sanitation for the project should be feasible.

## 4.4 Measures to Prevent and Cope with Accidents, Hazards

### 4.4.1 Coping with Accidents during Construction

The following measures should be carried out to prevent accident when building the upper structures of the viaduct:

- The Contractors should prepare the detailed construction plan, and submit to the Project owner for consideration. The Project owner should, while referring to relevant regulations on construction works, carefully consider the construction plan submitted by the contractor, and approve the plan which is considered the most rational and safest. Construction works should be duly implemented in accordance with the approved construction plan.
- Contractors should set up an emergency plan, which includes the preparation of facilities and equipment to be needed in case of emergency, rescue team, personnel organization, rescue procedure (commander, order of actions, etc.), list of addresses to contact in case of emergency (including adjacent hospitals).
- These measures should be ready to implementation during the construction of the upper structures of the viaduct.

### 4.4.2 Prevention of Fire and Explosion Risk

At least, the following measures should be carried out to prevent fire and explosion during construction works.

- Construction plan should be carefully prepared, so as the volume of fuels for construction works to be stored in the construction site is the minimum. These fuels should be stored in the dedicated containers which are allocated separately and far away from combustible sources. The fuel storages should be equipped with the temperature monitor and fire alarm equipment.
- Fire-extinguisher, water tank for fire fighting should be arranged all time at the construction site. These should be regularly checked and maintained.
- Education and training should be provided to workers to enhance their awareness and capacity to prevent and counter with fire and combustion.
- These measures should be ready during all time of construction phase.

### 4.4.3 Measures to Prevent Working Accidents

At least, the following measures should be applied to prevent accidents during construction works.

- Contractors should set up regulations on safety during construction work;
- Contractors should set up the plan to carry out periodical physical examination for officials and workers;
- Contractors should provide workers with training and information on hygiene at work;
- Workers should be equipped with necessary safety working equipment;
- System to inform and instruct workers on safety at work should be ready during construction phase.
- Contractors should set up an emergency plan, which includes the preparation of facilities and equipment to be needed in case of emergency, rescue team, personnel organization, rescue procedure (commander, order of actions, etc.), list of addresses to contact in case of emergency (including adjacent hospitals).
- These measures should be ready to carry out all time during construction phase.

# CHAPTER 5. ENVIRONMENTAL MONITORING AND MANAGEMENT PROGRAM

## 5.1. Environmental Management Plan

### 5.1.1. Objectives

The Environmental Management Plan (EMP) is prepared with aim to manage the environmental protection tasks in pre-construction phase, construction phase.

It includes:

Propose a plan to manage the implementation of measures to mitigate environmental impacts, which are approved by environmental management agencies and converted into articles of the technical guidelines of the Project;

Ensure the proper management of wastes, enable the system to response quickly to environmental problems and incidents emergency decision.

Continuously collect information on the change of environmental quality during the Project implementation, to timely detect adverse impacts and propose measures to prevent and mitigate environmental impacts in compliance with requirements of TCVN 2001, 2002; QCVN 2008, 2009 and 2010.

Information collected during the environmental management process should have the following characteristics:

*Precision of data*: precision of observed data should be assessed by the similarity between data and reality;

*Typical features of data*: data collected at a monitoring site should represent environmental condition of the area surrounding the site;

*Consistency of data*: data collected at different sites at different time are comparable to each other. Comparability of data is called consistency of data;

*Continuous monitoring ability*: data should be continuously collected by the environmental monitoring program during the Project implementation.

*Data synchronization*: data should be enough information about what itself that element and relative element.

### 5.1.2. Outlines of the Environmental Management Plan

Outlines of the Environmental Management Plan (EMP) are presented in Table 5.1.

## Table 5.1. Outlines of the Environmental Management Plan

| No | Activities | Environmental impact | Works and measures for environmental Protection | Cost of Works and Measures for Environmental Protection | Implementation and completion time | Responsibility for implementation | Responsibility for monitoring |
|---|---|---|---|---|---|---|---|
| **I** | **Preconstruction phase of the project** | | | | | | |
| | Demolition of works (relocation of electrical poles, demolition of lighting poles, cutting trees) | - *W*ater pollution due to wastes;<br>- Obstructing traffic by dropping waste or machineries;<br>- Appears risks from the demolition works. | - Collection and transportation of waste.<br>- Installation of temporary fencing around tree relocation position, electrical poles.<br>- Installation of signal boards.<br>- Make reasonable relocation. | Spending on mitigation measures implementation has been included in the total investment of the project. | Completed after the construction site preparation | The contractor, under the contract with the Employer. | Project owner |
| - | Preparation for construction site | ***Environmental landscape***<br>Landscape degradation caused by solid waste | Waste treatment as required by the Decree 59/2007/ND-CP, Decision No.11/2010/QD-UBND, Decesion No.56/2010/QD-UBND. | Spending on mitigation measures implementation has been included in the total investment of the project. | Completed after the construction site preparation | The contractor, under the contract with the Employer. | Project Employer |
| **II** | **Construction phase of the project** | | | | | | |
| **1** | **Air environment** | | | | | | |
| - | Drilling bored piles | ***Residential and air environment quality***<br>The soil excavated from bored files may be a source of dust | The preventive measures are proposed, including:<br>– Proper arrangement of construction site and storage of waste soil to limit dust emission<br>– Watering to avoid the risk of dust dispersion.<br>– Temporary disposal site covered with canvas, and tied tightly to avoid dust dispersion | Spending on mitigation measures implementation has been included in the total investment of the project.<br>Spending is presented below, part of the treatment, management and environmental monitoring | 24 months of construction | The contractor, under contract with the Employer. | Supervision consultant, under contract with the Employer. |
| - | Material storing | | | | As above | As above | As above |
| - | Transporting materials and waste | ***Residential and air environment quality***<br>Dust pollution caused by a scattering of materials and discarded earthwork, or dust lifted by the wheel on road exceeds the allowed standard. Residential area and offices along this express alignment are affected by dust. | The preventive measures are proposed, including:<br>– Watering and covering materials and discarded earthwork during transportation.<br>– Cleaning roads in the area nearby site entrance.<br>– Collecting material left on Pham Van Dong road along the route of the project.<br>– Using vehicles/machines conformable with gas emission standard | As above | As above | As above | As above |
| **2** | **Acoustic environment** | | | | | | |
| - | Operation of construction equipment and machinery | ***Residents, other receptors***<br>When operating construction machinery, noise will affect some households and other sensitive receptors. | The preventive measures are proposed, including:<br>– Application of common principles:<br>o The stockyards/stockpiles, machine/vehicle maintenance workshops, etc. should not be allocated within 200m from schools, hospitals, religious facilities, and other noise-sensitive receptors<br>o Construction machines with low noise emission should be | Spending on mitigation measures implementation has been included in the total investment of the project.<br>Spending is presented below, part of the treatment, management and environmental monitoring | 24 months of construction | The contractor, under contract with the Employer. | Supervision consultant, under contract with the Employer. |
| | | | | | | As above | As above |

| No | Activities | Environmental impact | Works and measures for environmental Protection | Cost of Works and Measures for Environmental Protection | Implementation and completion time | Responsibility for implementation | Responsibility for monitoring |
|---|---|---|---|---|---|---|---|
| | | | selected<br>o Limiting operation of many equipment at a same time<br>o All vehicles parked at the construction site will be turned off the engine.<br>o Equipment and machineries in the construction site will be checked regularly.<br>– Drivers are well-educated to have good behavior, to avoid making unnecessary noise.<br>– Prohibiting vehicles involved in the Project to use air-horn when moving near the sensitive facilities | | | | |
| 3 | **Groundwater environment** | | | | | | |
| - | Construction of bored pile at bridge foundation | **Groundwater environmental quality**<br>Upper-aquifer groundwater are at risk of pollution due to additives in bentonite or dirty water overflowing into drilling wall. | The preventive measures are proposed, including:<br>– Using standardized bentonite to prevent groundwater pollution<br>– Making the banks around the drilling hole to prevent dirty water flowing into the hole | The budget is shown below, the treatment works, management and environmental monitoring | Time for construction of bored piles | As above | As above |
| 4 | **Surface water environment** | | | | | | |
| - | Construction of bored pile at bridge foundation | **Surface water environmental quality**<br>Surface water in ditch at Km2+150 and Km3+100 may be affected by run-off bentonite<br>**Affect to drainage capacity of the drainage ditch**<br>The wastewater drainage work may be affected by waste generated causing reduce depth or width of the drainage ditch | Temporary depositing basin (Figure 5.2) will be expected to built near the ditches of the station Km2+190 and Km3+130, where required to minimize sediment to ditch, to collect not only common solid waste that all residues betonite<br>Implementing true sequence of construction, regularly check and cleaning spilled sand.<br>Processing immediately if there is local flooding. | Spending on mitigation measures implementation has been included in the total investment of the project.<br>Spending is presented below, part of the treatment, management and environmental monitoring | 24 months of construction | As above | As above |
| 5 | **Transportation** | | | | | | |
| - | Construction site | **Traffic**<br>The risk of traffic congestion is caused by roadway occupancy currently used as construction sites | The preventive measures are proposed, including:<br>– Remote flow distribution: Vehicles will follow the right dike of Red river and Xuan La road.<br>– Arrangement of the Construction Site with 9 meters wide at between the current Pham Van Dong road, rest on each side 7m wide using assurance of current traffic on existing road. Used scaffolding frame format, with a roof, ensure traffic on two side of the construction during to the construction of piers and bridge deck does not affected.<br>– Arranging barrier construction is aligned and fixed to ensure smooth traffic agreement. | Spending on mitigation measures implementation has been included in the total investment of the project. | 24 months of construction | As above | As above |
| - | Operation of construction equipment | **Traffic**<br>The risk of traffic congestion construction equipment's occupancy on the road. | The preventive measures are proposed, including:<br>– Not transporting machines during peak hours. Priority transporting construction facilities after 21h.<br>– Prohibiting from gathering construction machinery and equipment on | Spending on mitigation measures implementation has been included in the total investment of the project. | 24 months of construction | As above | As above |

| No | Activities | Environmental impact | Works and measures for environmental Protection | Cost of Works and Measures for Environmental Protection | Implementation and completion time | Responsibility for implementation | Responsibility for monitoring |
|---|---|---|---|---|---|---|---|
| | | | the road outside the construction site.<br>– Construction faculties allowed operating only within the scope of construction site.<br>– Propagandizing and providing information for construction vehicle controller to understand and comply with regulations. | | | | |
| - | Materials and discarded earthwork transportation | **Traffic**<br>Traffic problems because of material scattering and slippery road. | The preventive measures are proposed, including:<br>– Not transporting materials during peak hours. For remaining time, transport vehicles having to be approved by Hanoi Department of transport, prioritized transportation of materials after 21h.<br>– Transporting with proper loadings and speed as regulated.<br>– Covering transport vehicles with canvas to avoid material dropping.<br>– The facilities removed from soil and mud on the wheel before leaving construction site.<br>– Collecting scattered earthwork and regularly cleaning road surface within 500 m around construction site.<br>– Washing road nearby construction site in the morning, before rush hour (6 pm). | Spending on mitigation measures implementation has been included in the total investment of the project.<br>Spending on standard nozzle is VND 500,000 per one. | As above | As above | As above |
| **6** | **Environmental landscape and socio-economic activities** | | | | | | |
| | Construction activities | ***Environmental landscape, economic activity***<br>Landscape degradation and negative effects on business activities due to dust, noise, traffic congestion and waste. | Well implementing and maintaining measures to minimize environmental impacts on air, acoustic environment, traffic and waste treatment and management.<br>– Construction of Temporary Depositing Basin<br>– Preventing spillage of waste soil and bentonite sludge<br>– Collecting spilled materials/soils and cleaning up the road | Spending on mitigation measure implementation to minimize impacts on air, acoustic environment, traffic and waste treatment and management. | 24 months of construction | The contractor, under contract with the Employer. | Supervision environment consultant, , under contract with the Employer. |
| **7** | **Impact of workers concentration** | | | | | | |
| - | Workers concentration | **Public Health**<br>Surrounding residential area may be spread by epidemics and infectious diseases such as malaria, eye diseases and even HIV.<br>**Security and order violation**<br>Influence on construction workers, local communities, visitors caused by the risk of security and order violation. | The preventive measures are proposed, including:<br>– Implementing management measures for workers, including creating favorable condition for good hygiene, registration of temporary residence, citizen education.<br>– Coordinating with localities to propagandize against social evils and ensure security and order. | Spending on mitigation measures implementation has been included in the total investment of the project.<br>Spending on moveable toilets and recycle bin is presented below, part of environmental treatment. | 24 months of construction. | As above | As above |
| **8** | **Waste management and requirement** | | | | | | |
| - | Activities during the Project execution | **Quality of life**<br>*Waste generation and waste treatment requirements:* solid waste (discarded earthwork, construction solid waste, domestic solid waste, hazardous solid waste), residential waste water, oil and oil-containing waste (waste oil, oil- | – Developing a plan of waste management for common waste and hazardous waste<br>– Storing non-usable wastes at temporary dumps of construction site and transporting to the waste dumps within a day.<br>– Collecting, storing and treating garbage and domestic waste under | Spending on mitigation measures implementation has been included in the total investment of the project.<br>Spending on moveable toilets and | 24 months of construction. | As above | As above |

| No | Activities | Environmental impact | Works and measures for environmental Protection | Cost of Works and Measures for Environmental Protection | Implementation and completion time | Responsibility for implementation | Responsibility for monitoring |
|---|---|---|---|---|---|---|---|
| | | containing waste water). | Decree 59/ND-CP.<br>– Acquiring and handling waste oil and oil-containing waste in particular containers under Circular 12/2011/TT-BTNMT. | recycle bin, containers of hazardous waste is presented below, part of environmental treatment | | | |
| **III** | **Operation phase of the project** | | | | | | |
| **1** | **Acoustic environment** | | | | | | |
| - | Operation of Vehicle Flow | ***Residents, other receptors***<br>When operating of vehicle flow, noise will affect some households and other sensitive receptors | – Using Noise Absorption Asphalt along the urban road under viaduct<br>– Installing noise barrier on the viaduct | Spending on mitigation measures implementation has been included in the total investment of the project. | During operation phase | The contractor, under contract with project owner economy. | Supervision environmental consultant, under contract with project owner. |
| **2** | **Surface water** | | | | | | |
| - | Storm water runoff | Rain water drawn from surface containing heavy metals can contaminate surface water around | – Fire-extinguisher, water tank for fire fighting should be arranged all time at the construction site.<br>– Regulation of shielding materials: Truck not be shielded carefully will be prohibited from moving on the highway.<br>– Moisten: regular spray water onto the surface of the dry season (2 times / day). | Spending on mitigation measures implementation has been included in the total investment of the project. | As above | As above | As above |
| **IV** | **Environmental incidents** | | | | | | |
| 1 | Site preparation and demolition of uorks | Dangerous, unsafe and traffic collisions for vehicle | Installation of signs, fences,<br>Collecting and quick handling<br>Disclosure of information to the population. | Spending on mitigation measures implementation has been included in the total investment of the project. | Completed during preparation stage | The contractor, under contract with project owner economy. | Project owner |
| | Construction and assembling overpass girder | Erection girder bridges at the height of over 8m will have a risk of work collapse. | **Response to technical problems**<br>Strictly reviewing alternatives of construction organization, as well as planning for vehicles and equipment in case of incidents. | Spending on mitigation measures implementation has been included in the total investment of the project. | During super construction construction. | The contractor, under contract with project owner economy. | Supervision environmental consultant, under contract with project owner. |
| 2 | Petroleum storage | Fire incidents in motorcycle maintenance area where stores and provide petroleum and fuel for vehicles. | **Fire prevention**<br>Storing enough fuel to operate construction machinery. Arranging fire extinguishers, pool water fire extinguishers at the site. Training, popularizing and increasing workers' capacity and awareness of fire safety. | As above | As above | As above | As above |
| 3 | Construction activities | Labor accidents may occur at any activities during construction process if the employer and worker have failed to comply with safety procedures | **Prevention of occupational safety incidents**<br>Developing regulations on occupational safety and emergency planning in case of accidents. | As above | As above | As above | As above |

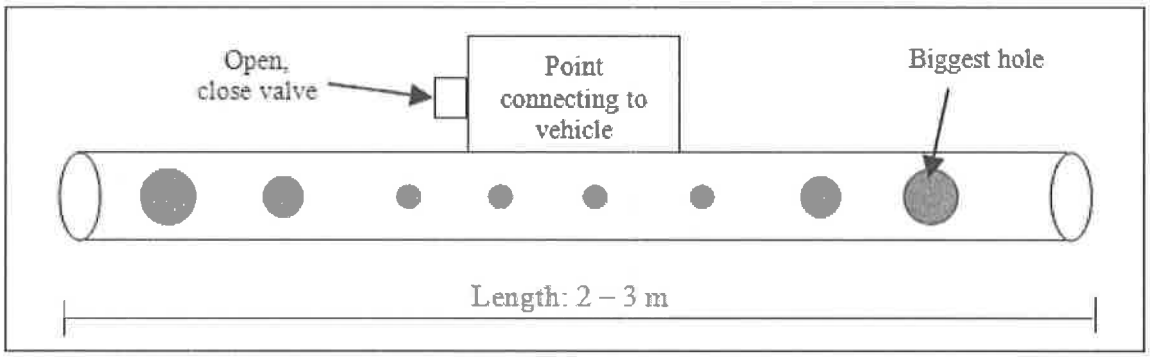
**Technical characteristics of environmental treatment facilities**

**(1) Nozzle**

Using normal cylinder watering tap to moisten subgrade or limit dust usually brings unexpected results when the object is easily eroded.

Using cylinder watering tap with small holes in the center and big holes in 2 tips will help to reduce the erosion caused by water pressure influence on the ground (figure 5.1). This device is installed on watering-cart for replacing general water blow system.

**Figure 5.1. The standard nozzle**




**(2) Movable toilets and waste bin, containers of hazardous waste**

In the Project area, it is require to locate:

06 mobile toilets of five-room type;
12 domestic garbage containers, 200–litter plastic type, with caps;
12 containers for hazardous waste, 100–litter plastic type, with caps.

Amount and specific location will change to depend characteristic of each construction site.

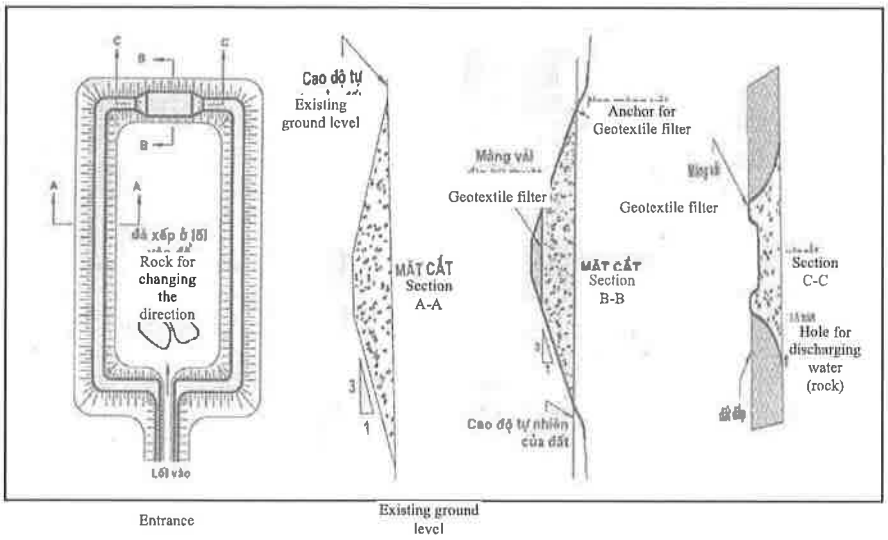
**(3) Temporary Depositing Basin**

Temporary depositing basin (Figure 5.2) will be expected to built near the ditches of the station Km2+190 and Km3+130, where required to minimize sediment to ditch, to collect not only common solid waste that all residues betonite.

Temporary bentonite tank can be a pit. It creates the conditions for depositing the residue to the bottom while collecting run-off water or pumping waste solution of betonite from the bored piles. Water is filtered by temporary bentonite tank, which can be to discharge into the ditch. Chemicals can be used to agglomerate and precipitate fine size when the time is limited or tank with small volume. Tank will be maintenance regularly. When residue accounted for 50% of the tank volume, residue will be taken

away and buried under regulations.

**Figure 5.2. Temporary Depositing Basin**




## 5.1.3. EMP Implementing Organization

### *5.1.3.1. EMP Implementing Organization in Pre-construction Phase and Construction Phase*

Figure 5.3 and Table 5.2 show entities who should be involved in the implementation of EMP in pre-construction phase and construction phase.

**Figure 5. 3. EMP implementing organization in pre-construction and construction phase**

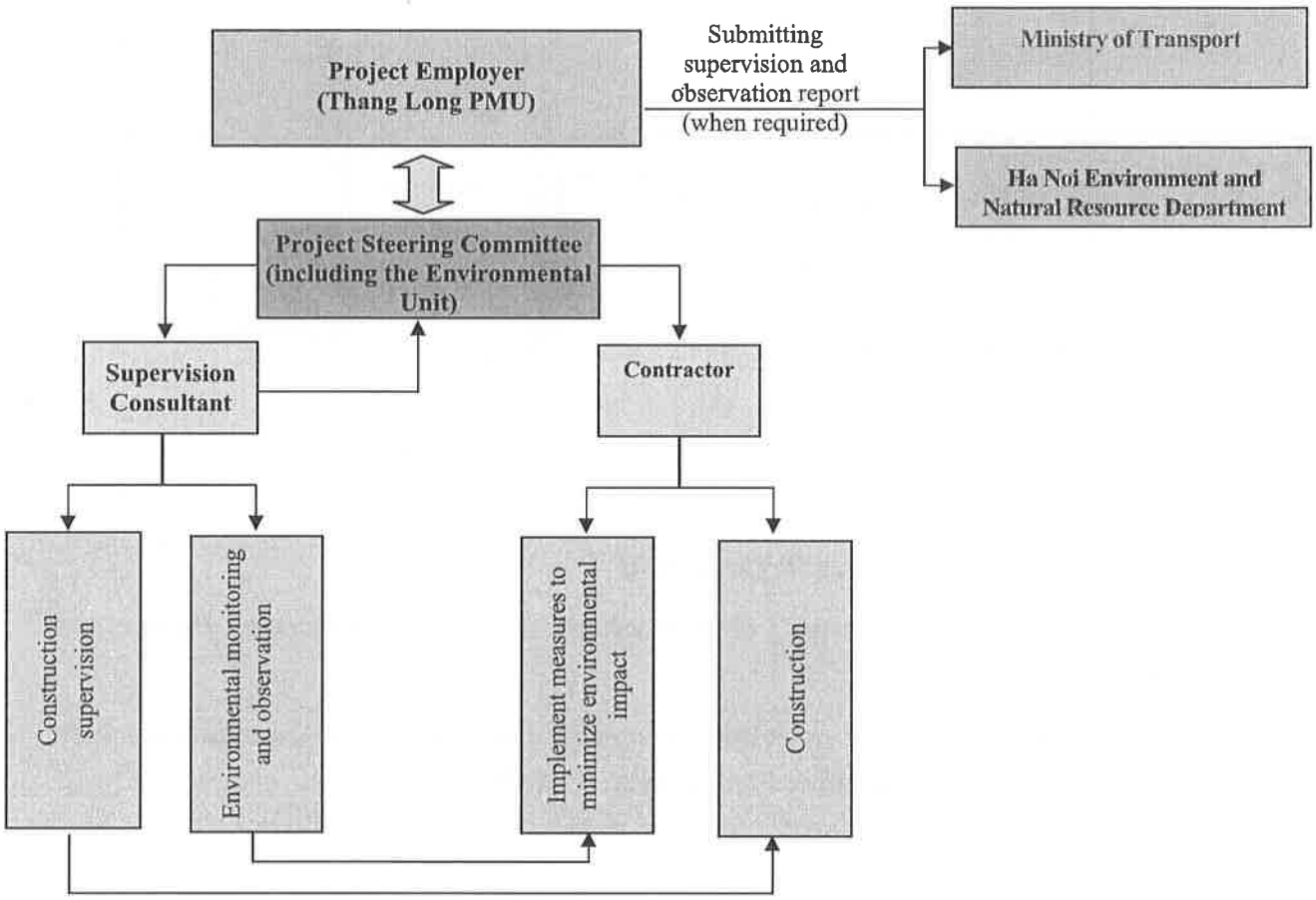



**Table 5.2. Role and responsibility of entities who should be involved in the EMP implementation in Pre-construction and Construction Stage of Project**

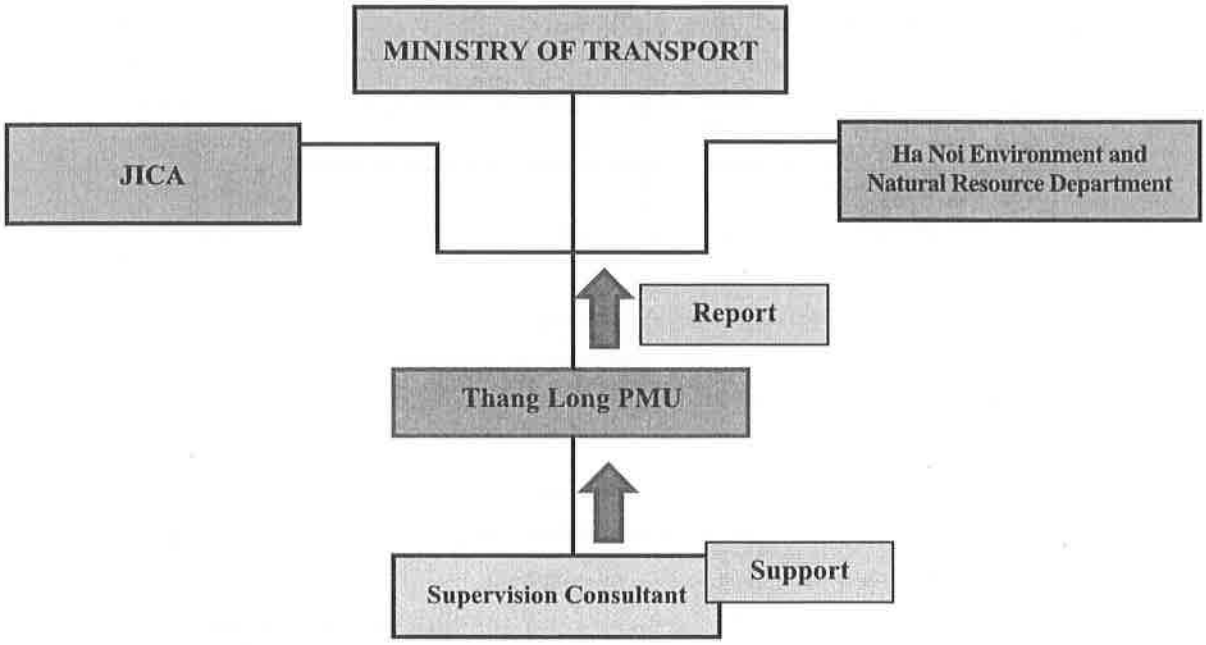
| Role | Responsibility in the environmental aspects |
|---|---|
| Thang Long Project Management Unit | – Issuing documents, assigning the task to the units under its management.<br>– Receiving and handling management and monitoring periodical reports of Project Steering Committee. |
| Project Steering Committee | - Signing contracts with contractors and consultants.<br>- Organizing, appointing the division of environment to take responsibility for environmental issues of Project.<br>- Providing finance for environmental monitoring and management in the pre-construction stage and construction stage.<br>- Receiving periodical management reports of environmental consultant and reporting periodically to PMU Thang Long, Departments of Environment and Natural Resources of Hanoi. |

| Role | Responsibility in the environmental aspects |
|---|---|
| Environmental Unit | – Observing directly monitoring and management activities<br>– Inspecting periodically construction activities to ensure that construction units implement fully responsibility defined in assigning documents relative to mitigation measures on environmental impacts. In case, regulations are not carried out, Environmental unit is responsible for reporting directly to Project Director, who has the right to suspend construction units' work.<br>– Considering and analyzing environmental management reports during Project construction.<br>– Supporting and cooperating with supervisor of construction. |
| Construction units | - Being responsible for fully implementing environmental protection measures written in the assigning documents of Project Employer and in the approved EIA report.<br>- Under management of supervision consultants and adjusting or enhancing measures when supervision consultants and environmental unit require. |
| Environmental Supervision Consultant | – Monitoring and supervising environment.<br>– Managing the implementation of environmental mitigation measures of the construction units defined in writing by project employer.<br>– Informing the construction units directly about any potential environment issues, which can be impediments to Project process.<br>– Reporting supervision results regularly to the steering committee |

### *5.1.3.2. EMP Implementing Organization in Operation Phase*

EMP Implementing Organization in Operation Phase is presented in Figure 5.4.

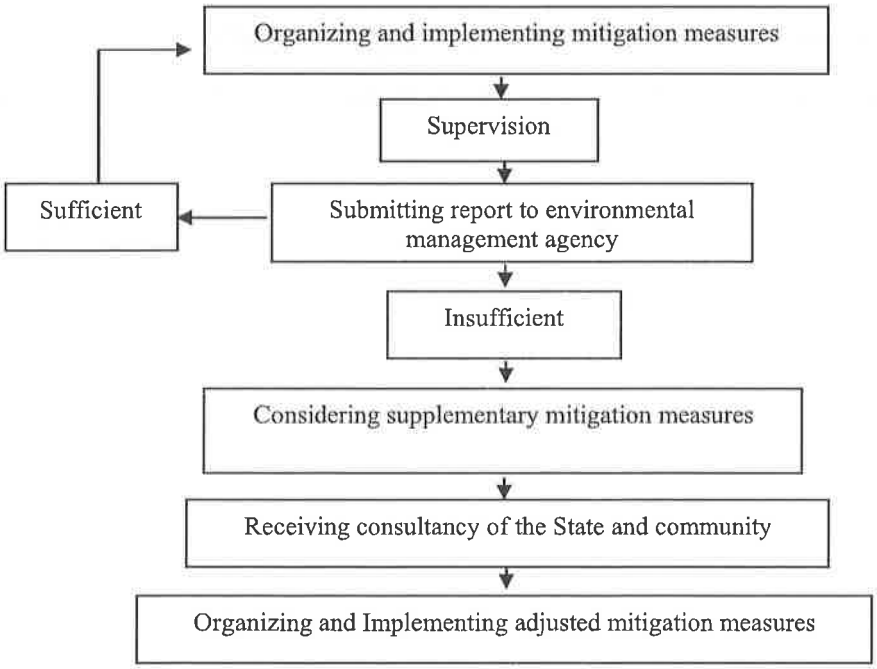
**Figure 5.4. EMP Implementing Organization in Operation Phase**




### *5.1.3.3. EMP Implementation Mechanism*

EMP implementation mechanism is shown in Figure 5.5.

**Figure 5. 5. Mechanism and sequence of EMP implementation**




## 5.1.4. Main Items Subject to EMP

Items to be managed in pre-construction phase and construction phase include:

- Management of preparation and construction;
- Safety plan in construction;
- Management of materials, construction equipment and warehouses, docks and grounds;
- Plan and progress of construction works;
- Management of construction vehicles, machines, equipment;
- Management of waste;
- Management of mitigation measure implementation;
- Management of plans for preventing and coping with environmental problems; and
- Management of labour safety in construction.

### 5.1.5. Cost Estimation for EMP Implementation

#### *5.1.5.1. Estimated cost for environmental treatment works*

Table 5.3 shows estimated cost for environmental treatment work items.

**Table 5.3. Estimated cost for environmental work items**

| No. | Treatment work items | Unit | Volume | Price (VND) | Amount (VND) |
|---|---|---|---|---|---|
| | ***Construction phase*** | | | | |
| 1 | Standard nozzle | each | 3 | 500,000 | 1,500,000 |
| 2 | Movable toilet | each | 6 | 90,000,000 | 540,000,000 |
| 3 | Movable trash can | each | 12 | 1,150,000 | 13,800,000 |
| 4 | Harmful trash container | each | 12 | 1,600,000 | 19,200,000 |
| 5 | Temporary Depositing Basin | each | 2 | 12,000,000 | 24,000,000 |
| | **Total** | | | | **598,500,000** |

#### *5.1.5.2. Estimated cost for environmental management*

Table 5.4 shows estimated cost for environmental management.

**Table 5.4. Estimated cost for environmental management**

| No. | Item | Unit | Volume | Price (VND) | Amount (VND) |
|---|---|---|---|---|---|
| ***I*** | ***Pre-construction stage*** | | | | ***22,050,000*** |
| 1 | Environmental Management Officer (1 person) | months | 1 | 21,000,000 | 21,000,000 |
| 2 | Other expense | % | 5 | 21,000,000 | 1,050,000 |
| ***II*** | ***Construction stage*** | | | | ***814,800,000*** |
| 1 | Environmental Management Officer (1 person) | months | 36 | 21,000,000 | 756,000,000 |

| No. | Item | Unit | Volume | Price (VND) | Amount (VND) |
|---|---|---|---|---|---|
| 2 | Computer | Piece | 1 | 15,000,000 | 15,000,000 |
| 3 | Digital Camera | Piece | 1 | 5,000,000 | 5,000,000 |
| 4 | Other expenses | % | 5 | 776,000,000 | 38,800,000 |
| *III* | ***Operation stage*** | | | | ***529,200,000*** |
| 1 | Environmental Management Officer (1 person) | months | 24 | 21,000,000 | 504,000,000 |
| 2 | Other expense | % | 5 | 504,000,000 | 25,200,000 |
| | **Total** | | | | **1,366,050,000** |

## 5.2. Environmental Monitoring Program

### 5.2.1. Objectives

Environmental Monitoring Program is set up to ensure that all impacts of the project including forecasted impacts in Chapter 3 and supplemented impacts in construction shall be controlled; feasibility of mitigation measures shall be enhanced and all complaints of public shall be solved effectively. The objectives of the program include:

- Checking the accuracy of forecasts and adjusting them;
- Ensuring mitigation measures to be implemented and controlling their effectiveness;
- Detecting the impacts that had not been forecasted in pre-construction phase; and
- Recommending mitigation measures for these impacts.

### 5.2.2. Basic for Environmental Quality Supervision

Supervision of quality of environment around the construction area should be done in accordance with the following regulations and technical conditions:

- Law of Environmental Protection 2005, and other legal documents relating to environmental impact assessment;
- National technical regulations on environment;
- Circular No.28/2011/TT-BTNTM on regulating technical process of ambient air and noise observation;
- Circular No.30/2011/TT-BTNMT date on August 1, 2011 on regulating technical process of under ground water observation
- Pollution forecasted and described in the EIA report;
- Status of environmental quality in the Project area.

### 5.2.3. Contents of the Environment Monitoring Program

#### *5.2.3.1. Items to be monitored*

Ambient air monitoring items include:

- *Air quality:* the task of ambient air quality monitoring is:
  - Observe concentrations of air pollutants in construction sites and in the surrounding residential area where are affected by the Project.;
  - Forecast and evaluate the concentrations of pollutants in ambient air that may be caused by the Project's activities in order to establish supplementary mitigation measures.
- *Noise, vibration*: the task of noise and vibration monitoring is:
  - Observe noise level at construction site and surrounding residential areas which are affected by the project;
  - Forecast and evaluate the noise levels that may generated by the project's activities to establish supplementary mitigation measures.
- *Groundwater quality:* the task of groundwater monitoring is:
  - Observe concentrations of pollutants in groundwater;
  - Forecast and evaluate the increasing of pollutants in groundwater to establish supplementary mitigation measures.

#### *5.2.3.2. Selection of monitoring sites*

Environmental monitoring sites were selected based on the measuring location during project formation, as well as these sites are located in the areas sensitive to impacts that may be caused by the Project in the construction phase and in operation phase.

The selected environmental monitoring sites are shown in Table 5.5 and Figure 5.6. The selected monitoring sites cover all sources of impact in construction site and can be representative to all impact receptors (i.e. residential areas and sensitive receptors identified around the Project area).

**Table 5.5. Environmental monitoring sites**

| No. | Location | Code | Coordinates |
|---|---|---|---|
| **I** | **Air, noise, vibration environment** | | |
| 1 | Beginning point of the project (Mai Dich Intersection) | KK1; O1; R1 | 21°2'12"N; 105°46'50"E |
| 2 | Hoang Quoc Viet Intersection | KK2; O2; R2 | 21°2'46"N; 105°46'53"E |

| No. | Location | Code | Coordinates |
|---|---|---|---|
| 3 | Co Nhue road Intersection | KK3; O3; R3 | 21°3'32"N; 105°46'59"E |
| 4 | Xuan Dinh road Intersection | KK4; O4; R4 | 21°4'40"N; 105°47'13"E |
| 5 | Ending point of the Project | KK5; O5; R5 | 21°5'9"N; 105°47'14"E |
| **II** | **Groundwater** | | |
| 1 | Xuan Dinh Commune | Nn1 | 21°4'41"N; 105°47'12"E |
| 2 | Co Nhue Commune | Nn2 | 21°3'32"N; 105°46'58"E |

### *5.2.3.3. Environmental Monitoring Program*

Environmental Monitoring Program is showed in Table 5.6.

**Table 5.6. Environmental Monitoring and Observation Program**

| No. | Items | Location | Parameter | Frequency | Expense (VND) | Compared standard |
|---|---|---|---|---|---|---|
| **I** | **Pre-construction phase** | | | | **132.394.140** | |
| 1 | Air | 05 | TSP, PM10, NO2, SO2, CO and micro climate (temperature, humidity, wind speed and wind direction, pressure ) | Monitor one time for 24 hours. | 72.600.000 | QCVN05:2009/ BTNMT |
| 2 | Noise | 05 | Leq | | 9.360.000 | QCVN26 2010/ BTNMT |
| 3 | Vibration | 05 | Speed and accelerator | | 18.000.000 | QCVN27: 2010/ BTNMT |
| 4 | Underground water | 02 | t°, pH, turbidity, TS, E.Coli, Coliform | | 4.300.000 | QCVN 09:2008/ BTNMT |
| 5 | Other cost (*) | | | | 28.134.140 | |
| **II** | **Construction phase** | | | | **544.205.024** | |
| 1 | Air | 05 | TSP, PM10, NO2, SO2, CO and micro climate (temperature, humidity, wind speed and wind direction, pressure ) | Observation during 24 months, every 6 months/time.. | 290.400.000 | QCVN05:2009/ BTNMT |
| 2 | Noise | 05 | Leq | | 37.440.000 | QCVN26 2010/ BTNMT |
| 2 | Vibration | 05 | Speed and accelerator | | 72.000.000 | QCVN27: 2010/ BTNMT |
| 3 | Underground | 02 | t°, pH, turbidity, TS, | | 2.720.000 | QCVN 09:2008/ |

| No. | Items | Location | Parameter | Frequency | Expense (VND) | Compared standard |
|---|---|---|---|---|---|---|
| | water | | E.Coli, Coliform | | | BTNMT |
| 4 | Other cost (*) | | | | 151.645.024 | |
| **III** | **Operation phase** | | | | **543.822.960** | |
| 1 | Air | 05 | TSP, PM10, NO2, SO2, CO and micro climate (temperature, humidity, wind speed and wind direction, pressure ) | Observation during 24 months, every 6 months/time. | 290.400.000 | QCVN05:2009/ BTNMT |
| 2 | Noise | 05 | Leq | | 37.440.000 | QCVN26 2010/ BTNMT |
| 3 | Vibration | 05 | Speed and accelerator | | 72.000.000 | QCVN27: 2010/ BTNMT |
| 4 | Other cost (*) | | | | 143.982.960 | |
| | **TOTAL (without VAT)** | | | | **1.098.027.984** | |

*Note: (*) Other expenses include labor expense of environmental quality observation, travelling expense, expense of rental car for observation, expense for report's preparation....*

## 5.3. Total estimated cost for environmental activities

The total estimated cost for the environmental activities of the Project (including cost for environmental treatment works, management, and environmental monitoring) is shown in Table 5.7.

**Table 5.7. Total estimated cost for environmental activities**

| No. | Item | Expense (VND) | Notes |
|---|---|---|---|
| *1* | *Environmental Management Program* | *1,964,550,000* | |
| - | Environmental treatment works | 598,500,000 | Table 5. 3 |
| - | Environmental management | 1,366,050,000 | Table 5. 4 |
| *2* | *Environmental monitoring program* | *1,498,288,546* | Table 5. 6 |
| | **Total** | **3,462,838,546** | |

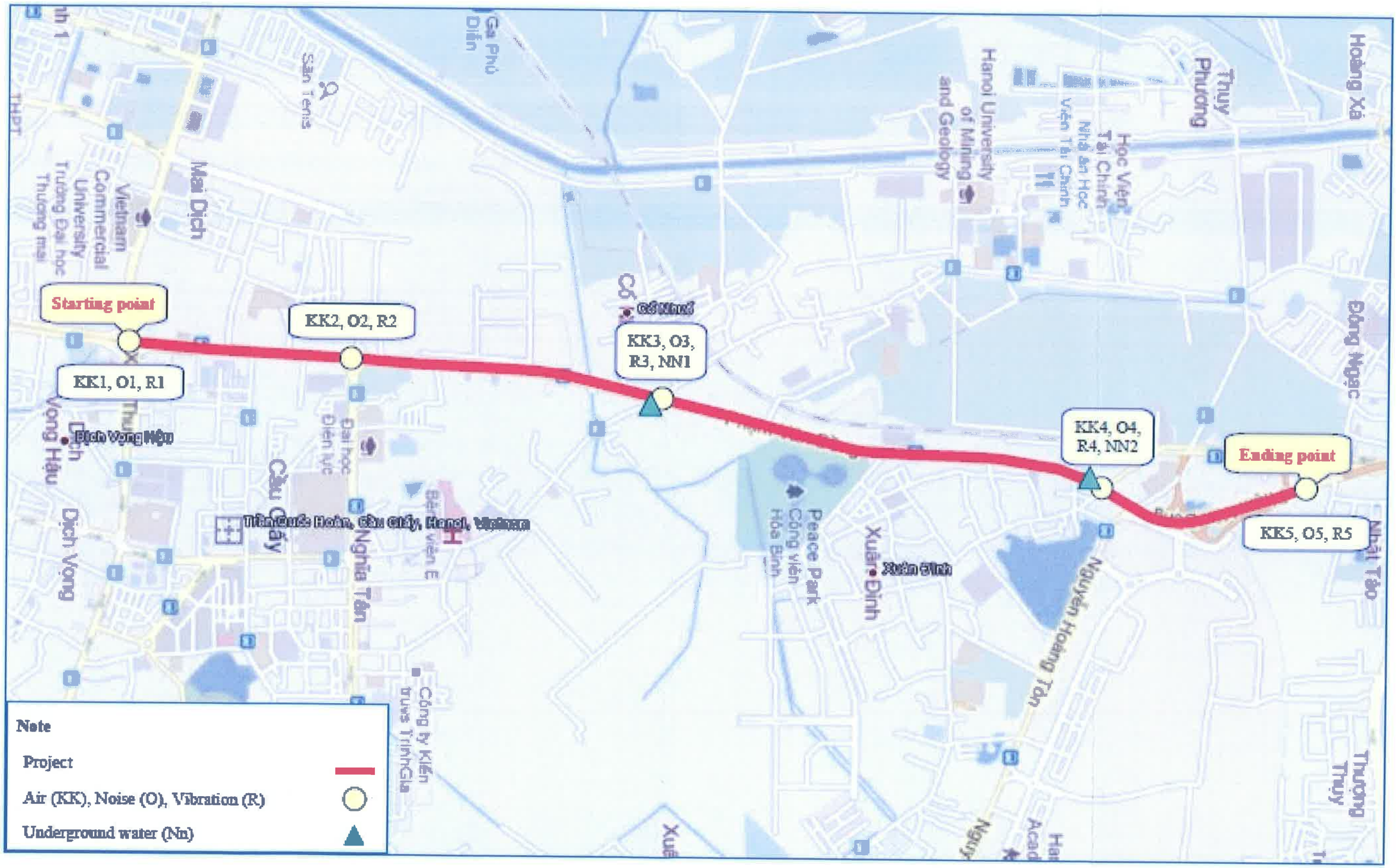



**Figure 5.6. Location map of environmental monitoring sites**

# CHAPTER 6 PUBLIC CONSULTATION

## 6.1 Public Consultation Meeting – First Round (March 2012)

In the process of preparation of EIA report for the Project to Construct the Viaduct Section Mai Dich - South Thang Long on Hanoi Ring Road III, in accordance with the Environmental Protection Law 2005, the Project Owner (Thang Long Project Management Unit) had sent the official letter No. 315/PMUTL-DA1 on March 12, 2012 to relevant agencies and organizations regarding the consultation with local communities. The consultation includes: explanation on the Project outlines, its negative impacts on environment, recommended mitigation measures, and requirement of opinions in written from the local communities.

The agencies and organizations subject to the consultation include:

- Representatives of the People's Committees of Mai Dich Ward, Dich Vong Hau Ward (Cau Giay District); Co Nhue Commune, Xuan Dinh Commune, and Dong Ngac Commune (Tu Liem District) of Hanoi City.
- Representatives of local mass organizations (Fatherland Front in Mai DichWard, Dich Vong Hau Ward (Cau Giay District); Co Nhue Commune, Xuan Dinh Commune, and Dong Ngac Commune (Tu Liem District);

The Project Owner adequately received the response in written from the agencies and organizations subject to the consultation as mentioned above. (See Appendix 4 - Consultation with the community).

In addition, in response to the request of Co Nhue Commune, a public consultation meeting was held on March 20, 2012 at the office of Co Nhue Commune PC.

(1) Comments from the ward/commune PCs, and the local Fatherland Front Committees

Local authorities have received official document of Thang Long Project Management Unit reported on the main investment categories, the environmental problems, the solution of environmental protection of Construction of Viaduct Section Mai Dich – South Thang Long on Hanoi City Ring Road No.3 Project. On the basis of studying this report, relate documents (and general opinions dialogue between the project owner and leadership of local officials), the local People's Committee of the projects have feedback in writing to the project owner. Sum up the opinions of the People's Committees of communes / wards are presented in Table 6.1.

## Table 6.1. Summary of Public Consultation

| TT | Commune / Ward | Authority/ organization | Comments obtained through the public consultation | | |
|---|---|---|---|---|---|
| | | | Negative impacts of projects on environment | Measures to minimize negative impacts | Requests/comments |
| A | Mai Dich Ward, Cau Giay District | People's Committee | - The Project would cause direct impact to daily activities, movement, business activities, of people living along Pham Van Dong Street. | - Agree to recommended negative impact mitigation measures. | - Request PMU Thang Long to duly observe laws and legal regulations during the project implementation.<br>- During the construction process, impact mitigation measures should be duly implemented.<br>- Construction schedule should be properly controlled. Detour roads should be reasonably arranged. |
| | | Fatherland Front Committee | - There are many negative impacts on the natural environment as the project reported.<br>- Effects on people's health.<br>- Economic life of the people are also affected, especially at roadside households.<br>- The socio-cultural activities are also affected. | - Agree with the measures have reported, As true to the commitment. | - Always make sure under the commitment.<br>- Regular contact with the local authority.<br>- Propagation and mobilization of the people, apologize and compensation timely if there is mistakes to the people. |
| 2 | Dich Vong Hau ward, Cau Giay | People's committee | - Due to projects implementation area near important traffic hub and a major university should affect on traffic, noise | - Construction requirements quickly, neat, do not drop materials, waste, | - Covering, labor safety and environmental sanitation is guaranteed. |

| TT | Commune / Ward | Authority/ organization | Comments obtained through the public consultation | | |
|---|---|---|---|---|---|
| | | | Negative impacts of projects on environment | Measures to minimize negative impacts | Requests/comments |
| | District | | and environmental sanitation in the construction process. | construction and avoid impacting on environmental. | |
| | | Fatherland Front Committee | - Location of construction on the high road is very narrow, this is the most difficult of the project, will impede traffic on the route Pham Van Dong.<br>- Environment in Dich Vong Hau is not affected significantly. | - Widening temporary road at two sides of PVD street.<br>- Covering to ensure safety during the construction.<br>- Construction should be held at night and off-peak hours.<br>- Complete works in the shortest time. | - Using the best measure to solve difficulties mentioned as above. |
| 3 | Co Nhue Commune, Tu Liem district | People's committee | - Reaching agreement with mentioned comments by project. | - Reaching agreement with mitigation measures of project. | |
| | | Fatherland Front Committee | - Reaching agreement with comments, calculated by PMU and Consultancy. | - Reaching agreement with mitigation measures the impact on environmental of the project as proposed. | - Requesting publicized to peoples;<br>- Further study the effects of channels to Nhue river. |
| 4 | Xuan Dinh ward, Tu Liem | People's committee and Fatherland | - Impact on traffic and congestion. Dust pollution from construction.<br>- Impact on drainage in the area. | - Classification traffic and full put the traffic signs.<br>- Seriously implementing the | - Proposal publicly at the head of People's Committee for people to know about project.<br>- Organizing conferences to report on people, |

| TT | Commune / Ward | Authority/ organization | Comments obtained through the public consultation | | |
|---|---|---|---|---|---|
| | | | Negative impacts of projects on environment | Measures to minimize negative impacts | Requests/comments |
| | district | Front Committee | - Causing labor safety, labor accidents. | mitigation measures as proposed. | people do for the project. |
| 5 | Dong Ngac ward, Tu Liem district | People's committee and Fatherland Front Committee | - Impact on traffic congestion. Dust pollution caused by construction.<br>- Affect drainage in the area.<br>- Causing occupational safety, occupational accidents. | - Traffic management and placing signs, signs in full.<br>- Seriously implement the mitigation measures proposed. | - Project should implement early.<br>- Streamlined, reducing the load vehicles passing through the area of construction. |

In addition, the Thang Long PMU was assisted by ENVICO (environmental consultant) in organizing several discussion meetings with responsible persons in local communities. The local leaders has contributed many valuable ideas about environmental issues of the project, and focused on the following main content:

- In preparation stage: co-operating with local authorities to propagate for people to know and clearly understand about scope of the project, construction planning, together with measures to minimize environmental impacts arising from Project activities.
- During construction stage:
  Sanitation: All localities proposed in the construction process to ensure sanitation of the local environment. They asked the project must have a plan to collect, treat construction wastes, do not spill pollution of environment. Project must take measures to minimize dust at residential areas;
  Public health: local authorities worried affects people's health due to dust. They requested the project owner seriously implement measures to minimize effects of dust; reduce noise as committed to the written consultation of the project;
  Transport: all localities proposed separate traffic lanes scheme, signs, signpost specific, reasonable plan construction to avoid congestion and traffic accidents.

Most localities proposed projects must have a plan propaganda for people to know and understand, and require projects must closely coordination with the authorities when conflicts occur.

(2) Opinions of Community Representatives

In addition to local government consulting directly with the Thang Long Project Management Unit in the form of a written response, Co Nhue commune government also held a dialogue between the project owner with representatives of organizations and communities directly affected by the Project - Minutes of the meeting backed attached in Annex 5 - public consultation. In the meeting, Vice Chairman of the Co Nhue People's Committee clearly pointed that: in addition to taking suggestions for the project, this meeting was the nature of advocacy through secretaries, heads of the population groups/areas within the scope of the project affected and propaganda to know people. At the meeting, opinions of representatives of organizations and communities primarily focused on the construction phase, namely:

- The construction period: Projects should report the construction specific time.
- Problems related to traffic: ensuring specific separate traffic to reduce congestion.
- The problem of waste treatment, waste water: The project must have specific plans for waste management of construction activities, waste water and waste water

construction. For the current situation, Co Nhue commune have overloaded waste. All waste from people's activities water ends up to Cau Da river which is very polluted.

- The public health: at the meeting, most ideas are concerned to the project will affect people's health due to dust, local flooding, traffic congestion. They require the project owner must strictly implement measures to minimize effects of dust; reduce noise as committed, and the project owner has requested specific remedies for the construction company fails compliance with the environmental protection measures have been proposed.
- Problems affecting on economic, social workers when the concentration will affect the local general living.
- Flooding problem: Project owner must survey with specific plans for drainage during the construction, not to inundation occurs locally.
- Sanitation: the reviews are recommended in the construction process to ensure the sanitation of the local environment. They asked Projects must have a plan to collect and treat waste in construction, not to spill or pollution spillage unhygienic environment must take measures to minimize dust does not affect the population;
- Water and power sources problem supply to the project: The project owner must have specific plans for water and power sources for the project. Water and power source at local is already overloaded, not enough to supply.

(3) Feedback and Commitment of Project Owner for Suggestions, Proposals and Requirements of Consulted Agencies and Organizations

For the opinion of the People's Committee and represents the residential community the project owner has to acquire and integrate the EIA report. Which clearly report:

- In the preparation phase: the project is done on the land was made available with the removal of technical infrastructure, the project will draw up plans to comply with reasonable and construction procedures to reduce time to maximum power interruption, communications.
- During the construction phase:
    - The social impact by focusing affects workers and workplace safety has been provided in the EIA report in Chapter 3.
    - The environmental treatment works including wet sprinklers, movable toilets and garbage collection bins specified in Chapter 5. Program management and environmental monitoring.
    - Measures of spray water to prevent dust, arrangement of traffic control, and coordinate with local government to ensure security and order and ensure

safety has been clearly stated in Chapter 4. Preventive measures to minimize negative impacts and prevention and response to environmental incidents.

- In opinions to ensure environmental sanitation, public health, social security and social order ...: The Projects promised comply with the mitigation measures offered in the assessment report dynamic environment. At the same time the project will coordinate with local public activities, impacts and mitigation measures of the project for people to know.
- On the influence of the underground: when project planning, Consulting design fully explored underground in the area, at the same time, when the project is implemented, all issues related to infrastructure of the locality have been considered within the scope of the research Projects under the lower ring road III by the Hanoi People's Committee build investment. Therefore, this project will not affect this underground system.

Also, at the dialogue meeting was held at Co Nhue people's committee head office, the project owner answered, namely:

- Thang Long Project Management Unit was assigned as Project investor construction by the Ministry of Transport;
- Projects implementation time: after expansion Project Ring Road III under low (a width of 65 - 68m) is done the ground clearance (estimated 2015). Projects will carry out construction viaduct in the middle so will not have clearance and relocation of infrastructure projects as well as the service works is people's life. Issues related to infrastructure of local studies have been reviewed within the Ring Road III Projects under Hanoi People's Committee is low due to construction;
- Consultant must receive the opinions and take reasonable opinions in to report;
- Consultant must add regulations of the state and donors on HIV prevention programs and environmental monitoring problems.
- For environmental monitoring: project agency will follow the provisions of the donors and the State management agency on the environment of the Ministry of Public Security, Ministry of Transport, local and investor.

## 6.2 Public Consultation Meeting – The 2nd and the 3th Round (January and February, 2013)

### 6.2.1 Necessities and objectives of the public consultation the 2nd and the 3th Round

September 5, 2012, the Ministry of Transport announced No. 576/TB-BGTVT in which the content of Japan did not agree to use ODA loans for investment projects to widing the ring road No.3 Mai Dich - Nam Thang Long section. Also in this notice,

the Ministry of Communications and Transport Management Unit Advisory Steering Thang Long OC study technical solutions to invest online viaduct in conditions not extend Ring Road 3 the Mai Dich - Nam Thang Long . Therefore, the content of the project compared to the previous period have been many changes.

According to the Vietnamese regulations on environmental protection and JICA' requirements, PMU Thang Long has directed OC Consultant co-work with local authorities organize two more rounds of public consultation meeting for the project.

Main objectives of the public consultation meetings are:

a) Diffusion of change information on the Project plan to project-affected-people and local communities.
b) Collection of opinions and comments of project-affected-people and local communities on the Project plan, specially on environmental impacts and the proposed impact mitigation measures.
c) Explaining comments of project-affected-people and local communities on environmental impacts and the proposed impact mitigation measures. Promotion of the active participation of project-affected-people and local communities comment on the Project.

### 6.2.2 Content of the Public Consultation Meeting

The first round of meeting should include the following items: (i) diffusion of information on the Project (background, development needs, etc.); (ii) explanation on the Project alternatives, and anticipated impacts; (iii) collection of participants' opinions/comments on the Project to reflect into the Environmental impact assessment report (EIA); (iv) promotion of public participation into the Project implementation plan.

The second round of meeting should have the following items: (i) explanation on the EIA in order to clearly explain impact mitigation measures; (ii) Explaining addition opinions/comments of participant on environmental impacts and the proposed impact mitigation measures.

### 6.2.3 Venues and Time to Organizing the Public Consultation Meetings

The 2nd round and 3th round of public consultation meeting had been organized with cooperation from the PCs of wards/communes in concern. Participants to the meetings include:

- Representatives of ward/commune PCs
- Project-affected households
- Representatives of local socio-economic organizations

A leaflet which describes outlines of the Project, identified potential impacts, recommended impact mitigation measures, contact address of the Project Owner, etc. had been printed and distributed to participants of the meeting several days before the meeting.

The meetings were organized at the following venues and days (Table 6.2.

**Table 6.2 Avenue and time of organization of the public consultation meetings**

| No. | Venue | Day | |
|---|---|---|---|
| | | Second round | Thirth round |
| 1 | Co Nhue Commune (Tu Liem District) | January 8, 2013 | January 15, 2013 |
| 2 | Xuan Dinh Commune (Tu Liem District) | January 25, 2013 | February 1, 2013 |
| 3 | Mai Dich Ward (Cau Giay District) | January 17, 2013 | February 5, 2013 |

### 6.2.4 Result of the 2nd and 3th Round of the Public Consultation Meetings

Currently, there were 6 public consultation meetings to be organized in Co Nhue, Xuan Dinh commune and Mai Dich ward, the results of these consultations are shown in the following section.

*(1) The results of the meeting in Co Nhue commune*

The results of the 2nd round and 3th round meeting in Co Nhue commune are shown in the following table 6.3 and table 6.4:

**Table 6.3 Summaries of the results of consultations in Co Nhue commune**

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| 1 | Dust pollution | What are the dust pollution mitigation measures?<br>How to treat dust in any way, because old people and young children are vulnerable affected by dust? | Spraying water along the project alignment with frequency of 2 times per day.<br>Use machines of adequate emission standards "TCVN 6438-2005 - road transport - the maximum permitted limit of the emissions."<br>Arranging time to transport of waste in accordance with (shipping the same day);<br>Use of waste land cover sheet and setting equipment cleaning for truck wheels.<br>Control and management activities in order to limit the dust emission level: Ban of all forms of waste burned in the project area;<br>Monitoring the environmental during construction phase. |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| 2 | Underground water pollution | In addition to use city's water , many households near the project area still use ground water from small wells. When construct of the foundation and piers will affect groundwater, what are mitigation measures of the project? | - For standard section (Km1+240÷Km2+120, Km2+760÷Km3+400) and transition section (Km3+400÷Km3+640): (The Project use the method of construction of bored piles):<br>+ Use standard bentonite to avoid polluted groundwater according to standard 326:2004 TCXDVN - bored pile construction standards and testing;<br>+ Constructing growns to prevent sewage overflow.<br>- For narrow sections (Km0÷Km1+240, Km2+120 -Km2+760, Km3+640 - Endpoint):<br>- Project using rotation steel pipe methods to construc foundation pier. For this technology will not use bentonite and water. Therefore do not affect groundwater quality residential area. |
| 3 | Noise and vibration pollution | What are measures to reduce noise ans vibration, especially at night? | - Reduce noise, vibration from the source of noise and vibration: Selection of construction machinery does not give rise to noise, vibration great for specific tasks;<br>- For narrow section near houses: Apply methods of construction rotation steel pipe, this is the modern method of construction, create very low noise and vibration. Arrangement reasonably of the store, material storage areas and control the operation time of machinery;<br>- To limit the concurrent operation of the equipment noise and vibration;<br>- Reduce noise from transport activities: Speed Limit is strictly forbidden to use the air horn near sensitive areas (residential, offices, schools, etc.). |
| 4 | Impact on traffic | - If the construction method viaduct above and does not extend the road below how will solve the traffic problems?<br>- Viaduct almost takes up the space of the | - Remote Streaming: vehicle flow will take the road along the Red river and Xuan La road;<br>- Arrangement of the site within 9 meters between the existing lanes, rest on each side 7 meters of width service to ensure traffic on existing roads.<br>- Bypass on each side 7m wide to ensure traffic closer to the present; |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | street below, the project proposal concerned the most traffic problems at intersections, horizontal lines near residential areas. The traffic plan to ensure the project like? | - Barriers sure construction is aligned and fixed layout, ensuring smooth traffic.<br>- When construction only used the pile in the area between the existing roadway with a width of about 9m, can be reduced to 7m (barrier) during the day so the traffic impact is very small;<br>- Completion of construction of the pile quickly (one bored piles 1.5 to 2 days, 1 rotation steel pipe are 8 hours).<br>- Construction of the head used scaffolding frame format, with a roof, ensure traffic does not affect the bottom of 7m lanes on both sides.<br>- Constructing beams use working methods beams along the top. Arrangement of scaffolding and roof system to ensure the safety of vehicles in circulation below.<br>- Gather materials and clean lines regularly. |
| 5 | Flooding the road surface | Currently, there is only one direction drainage is the Cau Da River, when implement the project during 4 years, so what are measures to solve drainage problem? | - Clean sand spillage, do not let them drop down the nearby drainage canal, ditches;<br>- Construction method of steel pipe pile foundation do not need excavation should not require a temporary drainage system;<br>- Measures for rain water runoff: Due to the project only occupies a 9m long way to the construction yard so surface water drainage problems when rainfall is less affected. Besides, inside the site will collect runoff groove, ensure the drainage problem;<br>- In the event of local flooding in some locations may be arranged pump to solve. |
| 6 | Impact by focusing workers | Security issues and order, safety, etc. will how when workers from other localities come? | - Workers management: Registration of temporary residence for workers from other local authorities;<br>- Coordinate with local authorities in the management and education of workers;<br>- Use of local labor to do the simplest jobs. |
| 7 | The impacts by waste and waste treatment | Environmental sanitation (garbage, etc.), how will be collected and treated? | - Solid waste:<br>+ For soil, rock disposal and domestic waste: Collecting, treating and transport to the waste dump on the day. |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | | + For chemical waste: Collecting and stored in special containers and handled in accordance with Circular 12/2011/TT-BTNMT dated 04.14.2011 on hazardous waste management.<br>- Waste water:<br>+ For waste water from construction activities and waste water: Waste water must be directed through the channels but trash and garbage collection of container to settle to remove the dirt. After preliminary treatment, waste water can escape through the city's sewer system.<br>+ For waste oil and wastewater from the operation and maintenance of machinery: the collection and use of waste containers and used drums containing dedicated to handling Circular 12/2011/TT-BTNMT on 14/04/2011 management of hazardous wastes. |
| 8 | Dissemination issues | - What agency that will explain people's opinion/comments, and solve consequences caused by the project to the people?<br>- How is monitoring mechanism of the environmental impact? | - The initial information about the project was presented to the local people and in the first meeting (on January 08, 2013).<br>- After the EIA will be approved by the authorities, the project will be publicized in the local People's Committee to the local authorities and people understand. Content in the approved EIA report will include monitoring mechanism for environmental impacts. |

## Table 6.4 Summaries of the results of discussions in 3rd meeting in Co Nhue commune

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| 1 | Mr. Chu Van Duc (Hamlet 6A – Co Nhue commune):<br>- Impacts cause of geology deformation when construction will affected on houses along road site, to propose Project explain more detail this issue. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br><br>- Project has proposed solution to drill pier piles: For sections have sufficient distance from residential area, Project will use bored piles. For narrow sections are nearby residential areas, Project will use rotation steel pier; this is modern construction method and don't use |

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| | | bentonite solutions therefore don't affect on underground water. Through practical construction in developed countries, the using rotation steel pier not impact on geological strata and the construction works located near construction area. |
| 2 | Mr. Do Duc Khai (Hamlet Dong 1 – Co Nhue commune)<br>Before construction of project, the section of Pham VanDong road was polluted by noise and durst, however the project should keep in mind some following issues:<br>- To ensure security order during the construction of project.<br>- To need solutions to support the lives of business actions along the road sites;<br>- To need medical assistance solutions (eg medical examination for people living along the road sites, etc.) | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- In the project bid contract specifies the contractor have to declare all workers sojourning in the police headquarters to management.<br>- The support policies for affected households by the project will comply with the provisions of the state and of the Hanoi People's Committee to benefit the affected people. |
| 3 | Mr. Nguyen Van Lieu (Hamlet Hoang 3 – Co Nhue commune):<br>- To propose test health for people.<br>- About traffic issue: After hearing the consultants presented mitigation measures of projects to ensure traffic, sympathy and support to all project given measures. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The support policies have been explained in the answer above.<br>- Traffic issue: All of length of project (along the construction sites) will be installed lane of road to ensure traffic. Along the alignment will be installed construction sites with 9 meter in width and may be minimize 7 meter during the day. The material, structural used to cover ensuring the safety of road |
| 4 | Mr Nguyen Viet Lang (Hamlet Hoang 3 – Co Nhue commune):<br>- To propose project explain detail about environmental monitoring plan of project to | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- According to Vietnamese regulations on environmental management, there is consultant carry out environmental |

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| | compare with environmental before construction.<br>- In measure to ensure traffic, materials which will be used to cover are safety for vehicle operate on road below? | monitoring works during preparation, construction and operation stages of project. Frequency of monitoring will be under EIA report approval decision. Result of monitoring will be periodically report to state management authority (for this project is the Department of Natural Resources and Environment of Hanoi)<br>- About structural and materials to cover below the construction area has been explained in the answer above. |
| 5 | Mr. Duong Hoang Giang (Secretary of the Youth Union):<br>- Agree with the comments and mitigation measures that the project and the consultants propose;<br>- How are the management and implementation of mitigation measures during construction stage? | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- In the economic contract between the project and contractors are binding provisions require contractors to undertake mitigation measures outlined in the EIA report, committed comply with the technical provisions in transport of materials, waste and regulations on waste dumps, etc.<br>- Monitoring: In addition supervision consultants representing the project owner there are other agencies, departments of Hanoi will check the compliance and implementation of the environmental mitigation measures of the project. |

*(2) The results of the meeting in Mai Dich ward*

The results of the 2nd round and 3th round meeting in Mai Dich ward are shown in the following table 6.5 and table 6.6:

**Table 6.5 Summaries of the results of consultations in Mai Dich ward**

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| 1 | Durst pollution | - When construction will have impacts relative durst. To propose project should have mitigation measures. | - Spraying water along the project alignment with frequency of 2 times per day.<br>- Use machines of adequate emission standards "TCVN 6438-2005 - road transport - the maximum permitted limit of the emissions."<br>- Arranging time to transport of waste in accordance with (shipping the same day);<br>- Use of waste land cover sheet and setting equipment cleaning for truck wheels. |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | | - Control and management activities in order to limit the dust emission level: Ban of all forms of waste burned in the project area;<br>- Monitoring the environmental during construction phase. |
| 2 | Noise pollution | - Distance of the road after the completion of the nearby houses.<br>- The major environmental impact (dust, noise) definitively proposed construction period.<br>- Recommend the implementation of the project must comply with the proposed measures. | *Construction stage:*<br>- Reduce noise, vibration from the source of noise and vibration: Selection of construction machinery does not give rise to noise, vibration great for specific tasks;<br>- For narrow section near houses: Apply methods of construction rotation steel pipe, this is the modern method of construction, create very low noise and vibration. Arrangement reasonably of the store, material storage areas and control the operation time of machinery;<br>- To limit the concurrent operation of the equipment noise and vibration;<br>- Reduce noise from transport activities: Speed Limit is strictly forbidden to use the air horn near sensitive areas (residential, offices, schools, etc.).<br>*Operation stage:*<br>- Currently the residential area along both sides Project was noise pollution. However, the noise level will increase as project will be opened. The project proposed measures to minimize noise is to use drainage pavement. |
| 3 | Impact on traffic | When construction will affect traffic, how the traffic plan to ensure specific? | - *To limit the construction area*: When construct the pipe only use area within 9 meters between the existing lanes, rest on each side 7 meters of width service to ensure traffic on existing roads.<br>- *Remote Streaming*: vehicle flow will take the road along the Red river side and Xuan La road;<br>- *Traffic Guide*: Will arrange regulate traffic at both ends of the construction section of pier foundation;<br>- *Arrangement of the site:* Arrangement of the |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | | site within 9 meters between the existing lanes. Barriers sure construction is aligned and fixed layout, ensuring smooth traffic.<br>- Bypass on each side 7m wide to ensure traffic closer to the present;<br>- *Application of rapid and safety construction methods:*<br>+ Construction in narrow sections: Construction of piers, beams, bridge deck on the principle of rolling. The project will implement 1 group from 3 to 5 piers at the same time;<br>+ Time to use scaffolding for construction hands reaching piers, beam work, construction of the deck is about 20 days: Hands reaching the head (10 days), tuberculosis beam (2 days), the construction of the deck (8 days); |
| 4 | Impact on drainage system | Currently, Pham Van Dong road hasn't got good drainage system, so the when constructing should be noted drainage issue of system. | - *Conduct follow sequence of construction*: Only construct after the drainage system has been checked and ensure to work properly.<br>- *Check regularly*: Regularly check along the construction area, if it detects the local inundation, will timely carry out some work as: cleared for drainage, oriented water to flows naturally, etc.<br>- Clean sand spillage, do not let them drop down the nearby drainage canal, ditches;<br>- Construction method of rotation steel pipe pile foundation do not need excavation should not require a temporary drainage system;<br>- *Measures for rain water runoff*: Due to the project only occupies a 9m long way to the construction yard so surface water drainage problems when rainfall is less affected. Besides, inside the site will collect runoff groove, ensure the drainage problem;<br>- In the event of local flooding in some locations may be arranged pump to solve. |
| 5 | Safety issues | Monitoring, sanitation and | - The project is committed to closely |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | safety are very important, recommend project take care to this issue. | monitoring the mitigation measures during construction to ensure the implementation of mitigation measures approved in the environmental impact assessment.<br>- The safety, environmental sanitation will be provided for the contractor in the construction process. These work to ensure the project's residual impact is negligible. |
| 6 | Business actions | When construct the project will affect on business action of household located along the road sides. Recommend project support them during construction stage. | - Application of rapid methods of construction, finish each section (1 group from 3 to 5 pier) will limit affected time (about 1-2 months) on business action of households living along the road sides.<br>- Business actions of people living along the road sides will be affected by durst, traffic congestion from construction activities of the project. Therefore, the application of effective measures to reduce and maintain the measures according to time proposed as well as strengthening measures to check included in the contents of economic contracts for the implementation of measures to reduce least for the environmental impact of air traffic ... will prevent the affected business actions at the construction area<br>- Issues related to the support affect the business actions of the households along the road in the construction stage, the project will continue research base on the Vietnamese regulations. |
| 7 | Damage to the public facilities | Upon completion of the viaduct without embellishment the road below will be damaged and can not use. | - |

## Table 6.6 Summaries of the results of discussions in 3rd meeting in Mai Dich ward

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| 1 | Mr. Pham Duc Hanh<br>- What's exactly time will start construction? | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The exactly time will start construction don't determine because of project is in the process of establish the report of investment projects. |
| 2 | Mr. Kieu Dinh Khuong<br>- When construction should to ensure sure the problem:<br>- Private drains from the application when rain water does not overflow into the residential area.<br>- For documents stored locally on community consultation meetings.<br>- in the process of construction supervision and management workers. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The project will review more about the proposal to build new drainage canals along the road sides.<br>- EIA report of the project will contain adequate measures to minimize environmental impact. After the EIA report is approved by the Ministry of Transport, it will be public at the PC of commune/ward. |
| 3 | Mrs. Do Thi Thang<br>- The project should construct the drainage system along the road section to the Doan ke Thien road and Tran Quoc Hoan road.<br>- When construct the viaduct, people don't business, recommend take care to life of people living along the road sides. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The project will review more about the proposal to build new drainage canals along the road sides.<br>- The project understand about affected on the business during construction stage. The project will raise this idea into research objectives of the project in the next stage on the principle of minimizing the impact and support most people base on Vietnamese regulations. |
| 4 | Mr Pham Van Giang<br>- The local residential community appreciate the investment decisions viaduct of the state in the present time. However, should note the harmony between the interests of the state and the people.<br>- These issues have been raised in two meetings should write in | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The public consultation comments will be recorded in the minutes of the meeting and is reflected in the EIA report of the project. After the EIA report is approved by the Ministry of Transport, it will be public at the PC of commune/ward. |

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| | minutes of meeting and hand on local authority. Before construction, the investor should commit to ensure the environmental with local authority | |
| 5 | Mr. Tran Van Binh<br>- Project Owner and has fairly complete answer for questions of people and local communication in the first meeting.<br>- In addition to the commitment problem, should have policies during construction stage to minimize affected on people, especially the business action. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- Mitigation measures have been research and raise base on science basis and Vietnamese regulation. For the requirements of the community that does not have specific regulations existing at that time of the project will continue research in the next steps of the project. |

*(3) The results of the meeting in Xuan Dinh commune*

The results of the 2nd round and 3th round meeting in Xuan Dinh commune are shown in the following table 6.7 and table 6.8

**Table 6.7 Summaries of the results of consultations in Xuan Dinh commune**

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| 1 | Durst pollution | - When construction will have impacts relative durst. To propose project should have mitigation measures. | - Spraying water along the project alignment with frequency of 2 times per day.<br>- Use machines of adequate emission standards "TCVN 6438-2005 - road transport - the maximum permitted limit of the emissions."<br>- Arranging time to transport of waste in accordance with (shipping the same day);<br>- Use of waste land cover sheet and setting equipment cleaning for truck wheels.<br>- Control and management activities in order to limit the dust emission level: Ban of all forms of waste burned in the project area;<br>- Monitoring the environmental during |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | | construction phase. |
| 2 | Noise and vibration impacts | - When construct the viaduct will create noise that effect on people living along the road side. How are mitigation measures? | <u>*Construction stage:*</u><br>- Reduce noise, vibration from the source of noise and vibration: Selection of construction machinery does not give rise to noise, vibration great for specific tasks;<br>- For narrow section near houses: Apply methods of construction rotation steel pipe, this is the modern method of construction, create very low noise and vibration. Arrangement reasonably of the store, material storage areas and control the operation time of machinery;<br>- To limit the concurrent operation of the equipment noise and vibration;<br>- Reduce noise from transport activities: Speed Limit is strictly forbidden to use the air horn near sensitive areas (residential, offices, schools, etc.).<br><u>*Operation stage:*</u><br>- Currently the residential area along both sides Project was noise pollution. However, the noise level will increase as project will be opened. The project proposed measures to minimize noise is to use drainage pavement. |
| 3 | Impact on traffic | - When construct the project will affect on movement of vehicles and people along the road side. To propose project should timely carry out follow project schedule and ensure traffic safety. | - *To limit the construction area*: When construct the pipe only use area within 9 meters between the existing lanes, rest on each side 7 meters of width service to ensure traffic on existing roads.<br>- *Remote Streaming*: vehicle flow will take the road along the Red river side and Xuan La road;<br>- *Traffic Guide*: Will arrange regulate traffic at both ends of the construction section of pier foundation;<br>- *Arrangement of the site:* Arrangement of the site within 9 meters between the existing lanes. Barriers sure construction is aligned and fixed layout, ensuring smooth traffic.<br>- Bypass on each side 7m wide to ensure |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | | traffic closer to the present;<br>- *Application of rapid and safety construction methods:*<br>+ Construction in narrow sections: Construction of piers, beams, bridge deck on the principle of rolling. The project will implement 1 group from 3 to 5 piers at the same time;<br>+ Time to use scaffolding for construction hands reaching piers, beam work, construction of the deck is about 20 days: Hands reaching the head (10 days), tuberculosis beam (2 days), the construction of the deck (8 days); |
| 4 | Flooding the road surface | Pham Van Dong current drainage system is not secure, when construct the project materials can block and cause flooding the project area. Recommend the project should have solutions to protect drainage system, if there are incidents need to timely coordinate with local authority to solve. | - *Conduct follow sequence of construction*: Only construct after the drainage system has been checked and ensure to work properly.<br>- *Check regularly*: Regularly check along the construction area, if it detects the local inundation, will timely cary out some work as: cleared for drainage, oriented water to flows naturally, etc.<br>- Clean sand spillage, do not let them drop down the nearby drainage canal, ditches;<br>- Construction method of rotation steel pipe pile foundation do not need excavation should not require a temporary drainage system;<br>- *Measures for rain water runoff*: Due to the project only occupies a 9m long way to the construction yard so surface water drainage problems when rainfall is less affected. Besides, inside the site will collect runoff groove, ensure the drainage problem;<br>- In the event of local flooding in some locations may be arranged pump to solve. |
| 5 | Impacts cause of waste and waste treatment | - Environmental issues as increasing of waste, sanitation, etc. are very important. Recommend the project have | - Solid waste:<br>+ For soil disposal and domestic waste: collection, processing, and transport to the waste dump on the day.<br>+ For waste related chemical: Collecting and |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | appropriate treatment measures. | stored in special containers and handled in according to with Circular 12/2011/TT-BTNMT dated 14.04.2011 on hazardous waste management.<br>- Waste water:<br>+ For the waste water from construction activities and domestic water: Waste water must be directed through the channels have trash mesh to collect in containers to remove sediment deposition. After preliminary treatment, waste water can escape through the city's drainage system.<br>+ For waste oil and waste water from the maintenance of machinery: collect and use of waste containers and used drums containing dedicated to handling follow Circular 12/2011/TT-BTNMT on 14/04/2011 management of hazardous wastes.<br>- The equipment, environmental treatment works:<br>+ Layout container domestic waste, hazardous waste (plastic tanks 100-200 liters, with cover;<br>+ Arrange mobile toilets (3 compartments). |
| 6 | Monitoring and construction safety | Monitoring, sanitation and safety are very important, recommend project take care to this issue. | - The project is committed to closely monitoring the mitigation measures during construction to ensure the implementation of mitigation measures approved in the environmental impact assessment.<br>- The safety, environmental sanitation will be provided for the contractor in the construction process. These work to ensure the project's residual impact is negligible. |
| 7 | Business actions | When construct the project will affect on business action of household located along the road sides. Recommend project support them during construction stage. | - Application of rapid methods of construction, finish each section (1 group from 3 to 5 pier) will limit affected time (about 1-2 months) on business action of households living along the road sides.<br>- Business actions of people living along the road sides will be affected by durst, traffic congestion from construction activities of the project. Therefore, the application of |

| No. | Environmental Issue | Opinions/comments of local communities | The proposed impact mitigation measures |
|---|---|---|---|
| | | | effective measures to reduce and maintain the measures according to time proposed as well as strengthening measures to check included in the contents of economic contracts for the implementation of measures to reduce least for the environmental impact of air traffic ... will prevent the affected business actions at the construction area<br>- Issues related to the support affect the business actions of the households along the road in the construction stage, the project will continue research base on the Vietnamese regulations. |

**Table 6.8 Summaries of the results of discussions in 3rd meeting in Xuan Dinh commune**

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| 1 | Mr. Nguyen Ngoc Hue:<br>- The Construction actions of project will affect directly on business action of people living along the road sides during the construction step of pier and indirectly affected during all construction stage of project. Recommend project give the policies to minimize their difficult.<br>- Recommend publicly posted mitigation measures, the project's commitment to the people can monitor the environmental impact during the construction project. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The project understand about affected on the business during construction stage. The project will raise this idea into research objectives of the project in the next stage on the principle of minimizing the impact and support most people base on Vietnamese regulations.<br>- EIA report of the project will contain adequate measures to minimize environmental impact. After the EIA report is approved by the Ministry of Transport, it will be public at the PC of commune/ward. |
| 2 | Mr. Nguyen Van Nam<br>- In the process of construction and construction supervision, I suggest to establish a group representative of contractors, the local and people to monitor the contractor's commitments during the construction stage. | Mr. Pham The Giang (Vice Director of TEDI-Envico) explain:<br>- The mitigation measures will be included in the tender documents, the contractor must comply with the commitments stated in the environmental impact assessment report of the project. This is the basis for the monitoring, inspection, review the report has been approved |

| No. | Opinions of participants | Response of consultant representative |
|---|---|---|
| | | and listed in the local public. |

# CONCLUSION, RECOMMENDATION AND COMMITMENT

## I. Conclusion

1. Impacts caused by each activity of the Project during pre-construction phase, construction phase, and operation phase have been identified through the intensive studies including review of existing documents, environmental surveys, socio-economic survey, public consultation meetings, etc. Impacts caused by each Project's activity to each impact-receiver have been quantified whenever possible. Consequently, ambient air pollution, noise, traffic congestion/accident (due to the operation of construction vehicles and spillage of materials/waste soils during construction), and degradation of landscape are anticipated to be potential impacts that may be caused by the Project. These impacts were carefully analyzed, and measures to avoid or mitigate these impacts were proposed.
2. Proposed measures are considered feasible and effective. However, to ensure that the residual impacts are acceptable, it is suggested that environmental supervision (including supervision on ambient air quality, noise, vibration) shall be conducted in order to enable proper and timely countermeasures:
   - Air environment and noise, vibration at Project area are required to be supervise in construction and operation phases.
   - Environment incidents: there are potential risks of technical, fire and labour accident, therefore, there must have a Plan of safety should be well organized. This plan must be conducted with supervision to assure the leftover impacts get acceptable;
   - Environment management and supervision will be conducted during all three stages: preparation for construction, construction and operation. The Project investor is responsible for the work of environment management and supervision, providing fully, timely expenses for this activity. The expense for the environment protection work is estimated at 1.8 billion vnd and included in the Project's total cost
3. The consultancy work from the community in 05 communes has been conducted in line with requirements of the Law on environment protection
4. After the Project's new investment has been approved by Ministry of Transport, the Project Investor shall build up Plans for environment management, technical instruction for the environment. The plans are bound in the detailed design step to work as the basis for the deployment of the environment management plan of

execution units.

## II. Recommendation

Coordinating and receiving support from Department of Natural Resources and Environment of Ha Noi City, as well as People's Committees of communes and wards in Project area, together with the local authorities are quite necessary to carry out the tasks of environmental protection during Project implementation period from construction phase until its completion.

## III. Commitment

1. Correctly implement methods for decreasing bad effects, preventing and dealing with environmental problems mentioned at Chapter IV, build environmental treatment constructions and implement environmental supervisory task (Chapter V) after resettlement report of the project is approved by Ministry of Transport. Project manager commits to supply these activities with all expense. In which the following should be paid attention

   a. Respect all values of local communities and continuously hold the meetings to discuss, exchange and refer to the opinions with the local people about the works having impact on the surroundings under the project implementation area;

   b. Implement the environmental management and weave the policies, programs and experience of environmental management in the management by the investor toghether;

   c. Constantly improve and innovate the measures minimizing the pollution by supervising, monitoring, constrolling, inspecting and checking. Strictly comply the information and report system about the full implementation of the items stipulated in the assessment report on environmental impacts approved and the requires in the approval decision in accordance with Decree No. 29/2011/ND-CP issued by Vietnamese Government on April 18, 2011 on guidance to strategic environmental assessment, Environmental Impact Assessment and Environmental Protection Commitment and Circular No.26/2011/TT-BTNMT dated on 18 July 2011, guiding in detail numbers of articles of Decree No. 29/2011/ND-CP dated 18 April 2011 on strategic environmental assessment (SEA), environmental impact assessment (EIA) and environment protection commitment

   d. Committing to manage the refuse well;

e. Committing on cooperation with the local to deal with labour employment issues, health protection, and security order keeping within of Project scale;

2. During construction, ensuring to conform with national and international standards and codes with regards to environment, to assure air quality, surface and underground water, sediment reaching national and international environmental standards, including:

   a. Environmental Protection Law issued on November 29th, 2005 of Socialist Republic of Vietnam;

   b. Decree No. 29/2011/ND-CP issued by The Vietnamese Government on April 18, 2011 on guidance to strategic environmental assessment, Environmental Impact Assessment and Environmental Protection Commitment;

   c. Decree N$^{o}$. 59/2007/ND-CP on Solid Waste Management issued by The Vietnamese Government on April 09, 2007;

   d. Circular No.26/2011/TT-BTNMT dated on 18 July 2011, guiding in detail numbers of articles of Decree No. 29/2011/ND-CP dated 18 April 2011 on strategic environmental assessment (SEA), environmental impact assessment (EIA) and environment protection commitment;

   e. Circular No. 12/2011/TT-BTNMT dated on April 14, 2006 on management of hazardous wastes;

   f. Conforming to Vietnamese Standards of Environment in 1998, 1999, 2001, 2002...; Vietnamese National Technical Regulation in 2008, 2009, 2010, including:

      - QCVN05:2009/BTNMT. National technical regulation on ambient air quality;
      - QCVN06:2009/BTNMT. National technical regulation on hazardous substance in ambient air;
      - QCVN09:2008/BTNMT, National technical regulation on ground water quality;
      - QCVN14:2008/BTNMT, National technical regulation on domestic waste water;
      - QCVN26:2010/BTNMT, National technical regulation on noise level;
      - QCVN27:2010/BTNMT, National technical regulation on vibration level;
      - QCVN40:2011/BTNMT, National technical regulation on industrial waste water;

- TCVN7210:2002 Vibration and shock – Vibration emitted by roads traffic – Maximum limits in the environment of public and residential areas.

g. Conforming to standards of measuring and analyzing methods (mentioned in Introduction);

h. Transport standards of designing.

3. Project owner commits to solve claims of the community pertaining to environment problems as regulated in the law in term of claims, accusation and other regulations documented in Chapter XIV "Inspection, violation handling, solving of claims, accusation and damage compensation for the environment" of Environmental Protection Law issued in 2005.