Chapter 15

ENVIRONMENTAL STUDY

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15.1 Study Purpose

Laws for environmental protection have been enacted for attainment of suitable economic development in Vietnam. The law requires an Environmental Impact Assessment (EIA) for all highway projects at the feasibility study phase.

The main purpose of the EIA is to identify the existing significant environmental elements that would have a high possibility of being affected by the implementation of the project and to formulate mitigation measures for the minimalization of adverse impacts. The time period for the EIA must cover pre-construction phase, construction phase and post-construction phase in regards to whatever it is that is directly or indirectly affected.

In August 1995, the JICA Study Team contracted a local consulting firm, Center for Environmental Engineering of Towns and Industrial Areas (CEETIA) to conduct an EIA as part of the Feasibility Study on the Highway No.18 Improvement in Vietnam in accordance with the relevant laws and regulations in force in Vietnam and JICA Guideline. The time frame for the EIA was estimated for three months, from August 1995 to November 1995.

15.2 Scope of Works

15.2.1 Assessment work

Assessment work has been conducted by CEETIA, and the study team has planned and supervised the work. The work items for this EIA are shown as follows:

- Investigation of existing environmental conditions;
- Identification of adverse impacts related to the project;
- Environmental impact assessment;
- Reporting.

15.2.2 Environmental Investigation Area

The Environmental Investigation Area was covered by 200 m wide strips (i.e., area on both sides of road within 100m from road center) along the following stretches of existing Highways Nos.2, 18, 401 and 286:

- Noi Bai - Bac Ninh	:	31 km
- Bac Ninh - Chi Linh	:	36 km
- Hong Gai - Mong Cai (Bac Luan)	:	169 km

In addition to the above, the environmental investigation area also covers the bypass sections of a total length of about 67 km.

15.3 Environmental Investigation Items

The items to be investigated are as follows:

(1) Social environment

- Resettlement of inhabitants;
- Social and economic activities;
- Construction waste;
- Historical sites and cultural property;
- Water rights.

(2) Natural environment

- Flora and fauna;
- Quarry sites for embankment materials.

(3) Pollution

- Air quality;
- Noise and vibration;
- Water quality.

15.4 Summary of Project Description

The study covers the area between Noi Bai and Bac Luan and its environs.

Topographically speaking, the study route runs through three zones; plains zone from Noi Bai to Bac Ninh and Pha Lai; Midland zone from Pha Lai to Chi Linh and mountain coastal zone from Hon Gai (Ha Long City to Mong Cai (Bac Luan).

The studied Highway No. 18 is divided into 5 sections :

- Section 1 : Noi Bai - Bac Ninh, L = 31.3 km
- Section 2 : Bac Ninh - Chi Linh, L = 36.4 km
- Section 3 : Hon Gai - Cam Pha - Cua Ong, L = 38.7 km
- Section 4 : Cua Ong - Ba Che - Tien Yen, L = 43.5 km
- Section 5 : Tien Yen - Mong Cai (Bac Luan), L = 86.9 km

The each section has the following alternative routes to assure selection of the optimum route :

- Section - 1, Alternative A (L = 30.9km)
  Alternative B - 1 (L = 30.9km)
  Alternative B - 2 (L = 31.3km)
  Alternative B - 3 (L = 30.9km)

- Section - 2, Alternative A - 1 (Existing Road)
  Alternative A - 2 (L = 2.25km/Pha Lai Bridge Road)

Alternative A - 3 (L = 2.00km/Pha Lai Bypass)
Alternative A - 4 (L = 3.95km/Que Vo Bypass)

- Section - 3, Alternative A (Existing Road
Alternative B - 1 (L = 3.30km/Ha Tu Bypass)
Alternative B - 2 (L = 5.34km/Cam Pha Bypass)

- Section - 5, Alternative A (Existing Road)
Alternative B - 1 (L = 5.60km/Tien Yen Bypass)
Alternative B - 2 (L = 4.54km/Dam Ha Bypass)
Alternative B - 3 (L = 7.01 km/Ha Coi Bypass)
Alternative C (L = 3.36km/Realignment in Ha Coi Town)

Detailed descriptions of each section and alternative route are introduced in chapters 6 and 9.

15.5 Existing Environmental Resources and Conditions

15.5.1 Geography and Geology

According to the topographic situation, the study route runs through three ecological zones:

(1) Plains zone (From Noi Bai to Bac Ninh and Pha Lai)

This zone is agglomerate terrain. This is the characteristic terrain of the Red River delta with sedimentary components of clay and sand. The average elevation of the area is 5 m - 7 m above sea level and is flat.

(2) Midland zone : (From Pha Lai to Chi Linh)

The existing terrain is higher than flood level. There are several types of soil in this zone. They are:

- Alluvial soil with strong viscosity and weak viscosity;
- Degraded and barren soil;
- Gravel bearing eroded soil; and
- Degraded red-brown soil.

(3) Mountain coastal zone (From Hon Gai to Mong Cai)

In the higher elevations of this zone, altitudes average over 30 m above sea level, while the shore area averages between 1 m - 4 m.

There are several types of soil in this zone. They are:

- Mangrove, saline soil;
- Saline soil with light, medium and high salinity; and
- Acid saline soil.

15.5.2 Climate

The study route is located along the northern border of Red River delta. The climate is tropical and humid, in the monsoon climate zone. It is cold and dry in winter, hot and humid in summer. Due to the influence of the sea in midland and mountain zone, the air temperature changes gradually, the average monthly temperature is between 16° - 28°. The hottest period of time is from June to July with the average temperature of 30°. The absolute maximum temperature is 37.9° - 40°. The coldest is in January with temperatures of 13° to 14°. The absolute minimum temperature is 3° to 5° in plains zone and 15° in midland and mountain zone. The humidity changes little from month to month, ranging from 70% to 88%.

Rainfall :

The average annual rainfall	:	1,600 mm
The maximum rainfall	:	2,358 mm
Minimum rainfall	:	1,000 mm
Average monthly rainfall	:	250 mm to 317 mm

Rainy season begins in May and lasts to October and contributes 80% to 90% of the yearly rainfall.

Wind : In summer, the wind blows from the south and southeast direction with a frequency of 60% to 70% and maximum velocity of 30 m/s to 40 m/s. In winter, the wind blows from the north and northeast direction with maximum velocity of 20 m/s.

15.5.3 Watersheds and Hydrological Features

Plain zone : According to statistics and monitoring data of the study area, there were several huge floods in 1945, 1971 and 1986. Among them the flood occurring in 1971 was the biggest. The flooding time lasted for one month because the Mai Lam dike had broken.

Midland and mountain zone : The rivers crossing the route are branches of Bach Dang River , Luc River and are connected with Halong Bay. Cai Lan port is situated in the north of this estuary. Luc River in Hon Gai has uniform daily tide for most of days of the month. The highest tide level is 4.35 m. High tides occur in January, June, July and December. Low tides occur in March, April, August, September. The average level of high tide is between 2.5 m and 3.5 m. The average low tide level is 0.5 m.

15.6 Environmental Impact Assessment

15.6.1 Social Environment

(1) Survey Method

In order to determine probable socio-economic impact of Highway No. 18, twelve communities located along the study route were selected at random to be surveyed. The locations for survey and study were areas on either side of the roads within 0 - 100 m from centerline of existing road. The preliminary list of communities was selected based on proximity of the community to the study route, using 1:50,000 scale topographic maps combined with information gathered during pre-survey field visits. This list included Phu Lo, Dong Phong, Ham Son, Tien An, Pha Lai, Dao Vien, Sao Do, Hong Ha, Cam Pha, Tien Yen, Quang Ha and Hai Yen. The list was then narrowed down to 12 sites to include villages which represent different aspects: relatively wealthy or poor, suburban or rural, commercial or agricultural. 120 households were randomly selected to be interviewed. In cases where a respondent was not available, a new household was selected.

In each community, community leaders were interviewed first for general information. Then a questionnaire prepared in Vietnamese was administered to the heads of the randomly selected households. The questionnaire asked for information on family structure, occupations, employment status, household income, land ownership, affected land, building structure and year built, as well as attitudes towards the highway project. Responses from Community leaders and household questionnaires were tabulated for statistical analysis of data.

(2) Social and Economic Situation

The surveyed results of the 12 communities indicate that there are two socio-economic zones along the study route. In the zone from Noi Bai to Chi Linh where the most of the people are farmers, they cover 85% - 96%, and small percentages of 4% - 15% are non-agricultural sector. Only in Bac Ninh and Sao Do town, approximately 100% of the population works in a non-agricultural sector. In the zone of Hon Gai, most of the people are non-agricultural sectorwith the percentage of 94% - 100% of the population running their own commercial activities such as shops, restaurants and hotels. In some places such as Hai Ninh, the farmers occupied high percentages.

In general, agricultural households possess an area of land for cultivating 800 m^2 to 3,700 m^2, and the housing and garden areas are 160 m^2 to 360 m^2. Non- agricultural households in urban areas who have not much area for housing, possess only 25 m^2 to 100 m^2 per household.

Income of the pure farmers is very low such as in Pha Lai, Dao Vien, the average monthly income is 30,000 to 100,000 dongVN/household and maximum income is 250,000 dongVN/ household. For non-agricultural employment, the average income is 280,000 to 500,000 dongVN/household.

In Vietnam, the urban areas are developed along the route, especially along the highways, thus along the section from Hon Gai to Mong Cai, there are many "mini-towns" developed. The housing density in those areas is higher than other places. This problem should be considered upon the selection of an alternative for alignment and/ or a by-pass route.

Inhabitants along the route generally accept the project, citing improved life-style and positive economic development impacts to their communities. However, land acquisition is cited as a major issue.

(3) Houses and Other Facilities of Affected Area

Since August 1995, most houses and building facilities along Highway No. 18 have been set-back. These set-back houses and facilities had been illegally located within the area of the right-of-way according to the government road protection regulations of Decree 203/HDBT dated 21/12/1982. However, to maintain the proper width of right-of-way for the improvement of Highway No. 18, additional set-back of approximately 2 m shall be required for these houses and building facilities.

On the basis of the existing route alignment for Highway No. 18 improvement, there are 7129 houses affected which would be subject to removal relocation. In addition to these houses, other facilities such as temples, churches, factories, schools, clinics and hospitals, hotels and restaurants, cemeteries, public facilities, shops and offices would also to be affected. Most of these facilities are in the same situation as those houses located along the route. The number of existing houses and facilities is shown in Table 15.1.

Table 15.1 Numbers of Facilities and Lots to be Affected by Widening along Existing Route

Section	Location	Route length (Existing)	Number of Facilities and Lots									Required Road Width (Clear Area)
			Houses	Temples	Factories	Schools	Hospitals	Hotels Rst.	Cemeteries	Pub. Fclties	Shops Off.	
1	Noi Bai - Bac Ninh	30.9 km	1242	0	2	1	1	0	2	3	1	46.0m (=23.00x2)
2	Bac Ninh - Chi Linh	36.9 km	1153	0	1	0	1	0	0	5	3	30.5m (=15.25x2)
3	Hong Gai - Cua Ong	39.8 km	2232	1	16	10	7	1	0	72	24	30.5m (=15.25x2)
4	Cua Ong - Tien Yen	43.5 km	721	1	3	4	0	0	0	6	0	27.5m (13.75x2)
5	Tien Yen - Bac Luan	86.9 km	1781	1	4	2	3	2	2	38	8	27.5m (13.75x2)
	Total	238.0 km	7129	3	26	17	12	3	4	124	36	

Considering the above situation, various alternative routes were reviewed, introducing bypass routes for minimalizing the number of affected houses and other facilities in each section. Chapter 9, Selection of The Route Location will be referred to, including Tables 9.1 to 9.10. To minimize the number of affected house and other facilities, comparison study has been made to select an appropriate route alternative in each section.

As the result of study efforts, the number of affected houses is reduced to 3,732. The numbers of the other affected facilities are also reduced. The number of affected facilities along alternative routes are shown in Table 15.2.

Table 15.2 Number of Houses and Facilities to be Affected by Widening along Alternative Route Alignment

Section	Location	Route length (Planned)	Number of Facilities and Lots									Required Road Width (Clear Area)
			Houses	Temples	Factories	Schools	Hospitals	Hotels Rst.	Cemeteries	Pub. Felties	Shops Off.	
1	Noi Bai - Bac Ninh	31.3 km	3	0	0	1	0	0	0	1	0	46.0 m (=23.00x2)
2	Bac Ninh - Chi Linh	36.4 km	425	0	3	0	1	0	1	3	1	30.5 m (= 15.25x2)
3	Hon Gai - Cua Ong	38.7 km	1863	0	15	10	6	1	0	58	11	30.5 m (= 15.25x2)
4	Cua Ong - Tien Yen	43.5 km	567	1	3	3	0	0	0	4	0	30.5/27.5 m (=15.25/13.75 x 2)
5	Tien Yen - Bac Luan	86.9 km	874	1	0	1	1	0	2	7	4	27.5m (=13.75x2)
	Total	236.8km	3732	2	21	15	8	1	3	73	16	

In comparison of the number of the affected facilities and lots between existing routes and alternative routes, numbers were cut roughly in half thanks to the efforts of appropriate route selection in each section.

According to the survey for the year of house construction, 3,060 houses (82%) out of 3,732 affected were built after the issuance of Decree 203/HDBT dated 21/12/1982, and only 672 houses (18%) were constructed before the Decree. Therefore, the 3060 houses could be legally removed when the government widens Highway No. 18. Appropriate negotiations will be required for the relocation or demolition of the 672 houses for the widening of Highway No. 18.

On the basis of socio-economic environmental impact for resettlement related to land acquisition for the improvement of Highway No. 18, the resettlement of inhabitants has been recognized as the most important issue and the reduction of number should be considered.

Considering the wider range of environmental impact, areas on both sides within 100 m of the road center line have been surveyed along the existing

route. The table 15.3 shows the number of houses and other facilities within these areas.

Table 15.3 Number of Houses and Other Facilities on Both Sides (Except the Clear Area) Within 100 m of Road Center

Section	Affected Area W = (100 - Clear Area) x 2 m									Clear Area (m)
	Houses	Temples	Factories	Schools	Hospitals	Hotels Rst.	Cemeteries	Pub. Fclties	Shops Off.	
1	1788	2	4	3	0	1	7	6	1	46.0 (=23.00x2)
2	3097	0	0	4	1	1	11	2	3	30.5 (= 15.25x2)
3	12415	2	29	18	8	4	3	67	35	30.5 (= 15.25x2)
4	1262	0	1	4	1	0	3	7	0	27.5 (=13.75x2)
5	1618	2	0	5	3	0	6	29	2	27.5 (=13.75x2)
Total	20,180	6	34	34	13	6	30	111	41	

(4) Resettlement and compensation

1) Regulation for Resettlement and Compensation (Legal Framework for Resettlement and Compensation)

According to the current regulations, transfer of land for construction of urban transportation project must be based on the following land laws:

- Decree No.87/CP, dated August 17th 1994, in which the government stipulated the price table of types of land.
- Decree No.89/CP, dated August 17th 1994, in which the government collects the payment for land use and land service fee.
- Decree No.89/CP, dated August 17th 1994, in which the government stipulates compensation for recovering land by the government authorities for purposes of national defense, and national and public utility.

2) Resettlement of Inhabitants

According to the on-site surveys, 7,129 houses will be affected in the case that the existing roads are widened to the 2-lane road with shoulders or the 4-lane road with shoulders. Some cemeteries and cultural properties will also be affected, causing many disturbances. One major socio-economic impact of highway construction is the induced regional and local economic impact. A second major impact is the acquisition of residential and agricultural land.

3) Land acquisition and Compensation

Highway No. 18 will pass through rural and urban residential areas. This will require the acquisition of agricultural and residential land as well as the relocation of households currently residing along the route.

The summarized cost for compensation is shown in Tables 15.4 and 15.5. The compensation cost index/ha for the 12 surveyed communities is indicated as follows:

Table 15.4 Compensation Cost for Residential and Garden Land

Compensation cost	Urban community	Townlets community	Rural community
Maximum cost mil.dong VN/ha	67,500	15,000	9,500
Minimum cost mil.dong VN/ha	26,000	6,000	2,300
Average cost mil.dong VN/ha	26,000	10,500	5,510

Table 15.5 Compensation Cost for Agricultural Land

Unit : Million

Compensation cost	Urban community	Townlets community	Rural community
Maximum cost dong mil.VN /ha	193	193	193
Minimum cost mil.dong VN/ha	11	11	5.6
Average cost mil.dong VN/ha	102	102	100

4) Grave plot transfer regulations and compensation:

There are no regulations on grave plot transfer at state level, so the average legal compensation for transferring of the grave s (applicable as Thang Long - Noi Bai Highway) will be applied as follows:

- Ground grave plot : 150,000 - 200,000 dongVN/grave plot
- Constructed grave plot : 200,000 dongVN/grave plot (average : 350,000 dongVN/grave plot).
- Crematory grave plot : 2,000,000 dongVN/grave plot

(5) Land Use, Historical Sites, Cultural Properties and Aesthetics

1) Land-Use Condition

Land along the Highway No.18 is used for different purposes. Surveyed data and 1:50,000; 1:20,000 scale maps indicated the using purposes along the study route. In the areas within 100 m from center line of the road

(including of out-skirt area of the highway and also the right-of-way according to Decree 203/HDBT dated 21/12/1982 on Road Protection Regulations) were surveyed and calculated.

Survey results of land-use in the study area are as follows: Agricultural land: 2,207 ha, occupied 44.8% of total land; Forest land: 1,684 ha, occupied 34.2%; and the remaining of 21% included historic land, housing land covering an area of 565 ha; Industrial land is minimal (0.7%). Mangrove land, bare hills are not higher than 9 % of total land area.

Potential impacts on existing land use and aesthetics have been analyzed based on land-use maps and surveys. The process has involved studying land-use along the study route based on topographic maps and extensive field work.

2) Protection regulations of historical sites and cultural properties:

a. Law of protection and using of historical - cultural relics and places of scenic beauty enforced promulgated on March 31 1984 of the president of State Council.

b. The Decree (No. 288 of the Cabinet Council on December 31 1985 of the Socialist republic of Vietnam) of the cabinet council stipulated the implement law protection and using historical cultural relics and sights.

c. The cultural later No.20 VH/TT on July 22 1986 of Culture - Information Bureau conducted the law enforcement for protection and use of historical cultural relics and sites.

3) Historical Remains and Cultural Properties:

Along the study route there are 3 of historical sites and cultural properties certificated by the state. There are as follows :

- Ngo Xa temple located at 35 m from existing road at Section 1 (Phu Lo - Bac Ninh).

- Cam Pha church located at existing road at Section 3 (Hong Gai - Cua Ong).

- Tien Yen church located at 35 m from existing road at Section 5 (Cua Ong - Tien Yen).

Besides above-mentioned temple and churches, there are no valuable histrocial sites of importance on a national level, although there are a number of which are of importance on a community level. There are several religious buildings partially recognized as historical and cultural properties, cemeteries, as well as war memorials and other public properties. Most of the valuable or sensitive sites and properties are

located 20 m away from the edge of the road. Therefore, when the road is widened some facilities such as schools, hospitals and temples will be around the adjacent area may be affected by noise, dusts.

Some amount of religious buildings, cultural properties, etc., are located within road widening areas. In the case of existing route alignment, 3 temples, 17 schools, 12 hospitals and 4 cemeteries were counted. These sites will be affected if existing route alignment is selected.

According to the alternative route alignment selecting bypass route as a minimum option, the total affected numbers will be reduced to 2 temples, 15 schools, 8 hospitals and 3 cemeteries.

Concerning the impact on historical and cultural properties to be removed, it is supposed that the alternative route alignment is a better choice than re-alignment of the existing route.

4) Impacts on Aesthetics

Some impact on visual aesthetics will result from the study route and there is concern for sensitive areas. The areas involved on the proposed route are temples and the proposed bridges. During the construction period, amounts of soil, rocks, wastes shall be temporarily produced. These may lead to the changing of the landscape and terrain condition in some places, but these changes would be minor.

The bridges' design should consider a combination of the natural view of the river and the attractive image of the bridge, otherwise negative visual impact may arise. It is recommended that the design of the bridges consider structure type and create attractive facade detailing, colour and shading to enhance the appearance of the entire structure.

5) Tourism Potential

Ha Long Bay is certificated as world heritage by UNESCO, and is an attractive tourist area. Highway No. 18 will contribute to reduce the time from Hanoi to reach the tourist area. This location will acquire a good amount of income from service activities for the country when the highway is improved. Other impact includes changes in land use as a result of roadway construction. Industrial and commercial development is predicted for both the vicinity of highway and along the secondary roads serving the highway with the potential to alter population patterns and employment opportunities in the project areas.

(6) Water Rights

1) Regulation of Water Rights

At present there are no local regulations for water resources in the area. All matters related to water resources are under state regulations. The

Ministry of Water Resources has been preparing "a draft water law" to submit to the parliament in the near future. This law consists of 9 volumes and 52 articles, concerning rules on management, exploitation, use, conservation and investment of water resources; responsibilities of offices organizations, individuals to prevent water-caused damages, water pollution; protection of water resource projects; issuing and withdrawing licenses of water use, exploitation and waste water.

In general, water resources in these areas are mainly used for irrigation and domestic purposes. Regarding water rights for fishery, the "Regulations of Protection and Development of Aquatic Products Resource" (25/4/1989) consists of rules on state management for such resources; responsibilities and benefits of offices, organizations and individuals for exploitation, protection and development of such resources. But water resources are equally used in all fields of the nation's activities, and the regulation was enacted to forbid damage to aquatic products and pollution to their living environment.

2) Regulation of Fishery

"Regulations of Protection and Development of Aquatic Products Resources" law was approved on 25 April 1989 by the government. The law consists of rules on governmental management for these resources; responsibilities and benefit of offices, organizations, individuals for exploitation, protection and development for these resources. It is forbidden to damage aquatic products, or to cause pollution to living environment of these products.

Aquatic life within the study area consists mainly of fresh water fish in rivers, irrigation channels and ponds. There are several kinds of fish such as: Cyprinus carpio, Cirrhina molitorella, Spinibarbichthys denticulatus, Milopharyrgodon piceus, Ctesopharyrgodon idellus, Hypophthalmichthys molitrix, Megalobrama termiralis, Clarias macrocephalus, etc.

According to the data collected from statistics department of the communities, fish yield capacity in these areas is 0.4 - 0.5 t/ha/year. However fishery is not a major source of income, and catching or breeding fish is not their main occupation.

There are some small fishery ponds utilized as multi-purpose water use, and these fishery ponds located where roadway passes may have their areas reduced or be partially damaged resulting in a decrease of yield. There seemed to be very few commercially-oriented fishery ponds along the proposed route.

15.6.2 Natural Environment

(1) Regulations of Protection for Natural Environment and Bilateral and Multilateral Convention on Wildlife

On 15th May 1985, Vietnam Government laws prohibiting from hunting elephants or birds in town (21st June 1960). In order to control the hunting and trade of rare and endangered animals the Ministry of Vietnam Forestry promulgated decision No.297/OD dated June 2nd 1983 prohibiting the hunting of 38 species of forest animals and also forbidding trade of these species alive or their products. Protection of natural forest resources is stated in articles 2 and 3 of chapter 2 of Environmental Protection Law of Vietnam dated 10th January 1994 by the Vietnamese government. In September 1994, Convention International for Trade of Endangered Species (CITES) was issued by Ministry of Vietnam Forestry.

(2) Flora

Climate characteristics, geographic location, composition and thickness of soil cover contribute to the existence of flora. Most species are useful for medicine, food for people and animals. Among these with high economic value are Longan, Litchi, Squanosa, and Zapota. Vegetation distribution in project area shows mixture of natural remaining secondary vegetation cover and agricultural vegetation and ma-made forest.

1) Plains Zone

There is a delta agricultural ecosystem in the surveyed area. It is located between the mountains of Soc Son district and Red River alluvium veranda so it has a diversified natural ecosystem.

Secondary bushes and grasses grow naturally and they are protected by people because of their economic value such as Alternathera Forsk, Centella L., Chrysanthemum L., Eclipta L., Gnaphalium, Pluchea Cass, Heliotropium L., Euphorbia I., Cereus Mill, Lemna L. They grow along fields, road, the banks of river, in ponds, swamps and irrigation canals.

Crops grown agriculturally include double rice cropping (winter rice crop from January to May and summer crop from June to December) and 1 vegetable growing crop (winter - spring crop) between the yearly double rice cropping within an area of 1.591.5 ha, 65.49% natural land. Types of vegetables cultivated include Brassicaceae, Convolvulaceae, Cucurbitaceae species and genera Manihot Mill, Arachis L., Pachyrrhizus Rich, Sesamum L., etc.

Vegetation in gardens which are of varying long-term and short-term economic value are found in residential and farming areas. They include Dimocarpus Longan Lour, Litchi chinensis Sonn, Annona squamosa (L.), Camelia Sinensis (L) Kuntze., Artocarpus J.R.Forter, Zapota (L.) Van-Royen, Zizyphus mauritiana Lam., etc.

2) Midland and Mountain Zone

a. Mangrove Forest Ecosystem

A mangrove forest ecosystem is found mainly in Tien Yen bay and some estuaries. The mangrove forest had grown to a height of 20 - 30 m before being destroyed. The present and remaining mangrove trees are all bushes and are submerged at the time of high tides.

b. Young Sand-bank Ecosystem

Some types of vegetation as Sea Water Spinach, Impomoeprae, Vitex rogtundifolia and Lannaea pinnatif grow.

c. Natural Forest Ecosystem

Primary forests have been destroyed and only remaining secondary forests can be found within the surveyed areas.

d. Secondary Bush and Savanna Ecosystem

Secondary bushes such as Alternathera Forsk, Centella L., etc., grow naturally and they are protected by people because of their economic value.

In general, there is a rather common vegetation scheme and not so much of an ecological valuable area. However, the study route would cut through some forested land and plantations. In order to assess the impact to vegetative cover from constructing Highway No. 18, if there is an ecologically valuable area identified, sample surveys for those areas will be conducted and the proposed route may be adjusted if necessary.

The forest system along the route is not in such valuable ecological condition but it will not be destroyed. A mangrove forest which had grown to a height of 20 - 30 m, would have been considered a valuable asset, but unfortunately has been destroyed; at present the only mangroves are bushes.

(3) Fauna:

The fauna composition found along the study route could be gained from data of the fauna present in the adjacent protected areas. According to studied data, there were 18 species of wild mammals, 60 species of birds, and 20 species of reptiles. But due to agricultural development, industry, and roads, the natural primary forest vegetation as well as wildlife disappeared. They were either killed or migrated to deeper places inland.

At present time there are estimated to be 42 species of non-aquatic animals. These include carnivores (Felis bengalensis, Viverra zibetha, Herpestes urva, Viverricula indica) and Ciconiformes, Gruiformes, Anseriformes, Fanconiformes, Cuculiformes (bird species) and Colubridae (except Xenochrophis piscator). There are other minor component species, mostly rodents, some of which have negative economic impact, digging holes in canals, rice fields, and inside the industrial areas. Some species such as Fanconiformes are seasonal, and return in summer and autumn months, and increase diversity of species. Carnivorous species live mainly in low-hilly areas.

Rodents live in the agricultural ecosystem and in residential and industrial areas. Colubridae also is found living in these places (excluding Xenochrophis piscator living in over-flooded places). Swamp-dwelling birds consist of Ciconiformes, Gruiformes, Anseriformes. Coraciformes, Passeriformes live in agricultural areas. Amphibians live in holes in canals and swamps. Fishes and benthos live mainly in lakes, Ca Lo river and irrigation canals. Besides wild animals, there are some species of domestic animals which are mainly raised in the communities.

An assessment of fauna diversity was conducted by recording observations made within the sample plots. The diversity of mammals, birds, reptiles and amphibians was measured. During the surveys, only common species were recorded. There are not many areas of natural vegetation or habitat within the study area. Construction and related activities should be better operated to cause minimal disturbance to such natural resources.

In general, in wider range of the study area vicinity, there are threatened or endangered species of animals as listed in the Vietnamese Red Data Book. There are following threatened species such as Viverra zibetha, Vivericuba indica and Ptyas mucosus, and also endangered species such as Lutra lutra, Ptyas korros, Naja naja and Zanenis mucosus. However these rare species do not inhabit the vicinity of the study routes.

(4) Fire Risk

One of the most serious impacts would be increased fire risk. Within the forested area, the hot or dry season is from October to December. Monthly temperatures throughout the year should be marginally lower within these uplands compared to other places. The forest cover might also reduce temperature and may be vulnerable to fire. Wind speeds also would encourage the spread of any fire outbreak. These winds would also have a drying affect on the exposed forest edges not only increasing the fire risk but also having a slight ecological impact on the flora, tending to drive out fauna and flora dependent on moisture conditions.

In sum, impacts on forest ecology from the Highway No. 18 include loss of forest and watershed areas, and increased fire risk.

(5) Borrow Pits for Embankment Materials

The project area has great potential in mineral and building materials They include:

- Coal mines in Hon Gai, Cam Pha, Cua Ong, Mong Duong, Quang Ninh, etc.
- Clay, sand, gravel in Thanh Tuoc, Day Dieu, Trung Gia, Long Van.
- Rocks in Dong Mo, Kien Khe, Dong Trieu, Yen Cu.
- Kaolin quartz, silicate.
- Antimony deposits, etc.

The borrow pits and quarry sites are discussed in detail in section 6.2

15.6.3 Pollution

(1) Air Quality

The assessment of air quality impacts involved monitoring existing air quality to obtain basic information, and air quality modeling to predict future pollutant levels resulting from vehicle emissions. The results were then compared with the standards.

Existing air quality was monitored at of 4 locations. The locations were selected to include a variety of sites. Monitoring locations are shown in Figure 15.1.

1) Existing Ambient Air Monitoring

Ambient air quality was monitored from 10 to 14/9/1995 along the section 2 (locations A1; A2) and from 5 to 8/9/1995 along the section 3 (locations A3; A4). The monitoring period for each location took place over a period of 24 hours (12 times once every two hours).

2) Monitoring Location

The four monitoring locations for air quality surveying are as follows :

Location A1	:	at Km1 + 350, Vu street, Dai Phuc community, Bac Ninh town (agricultural land).
Location A2	:	at Km27 +500, Pha Lai town (industrial land).
Location A3	:	at Km124, Ha Long city (residential land).
Location A4	:	at Km154 + 900, Cam Pha town (residential land).

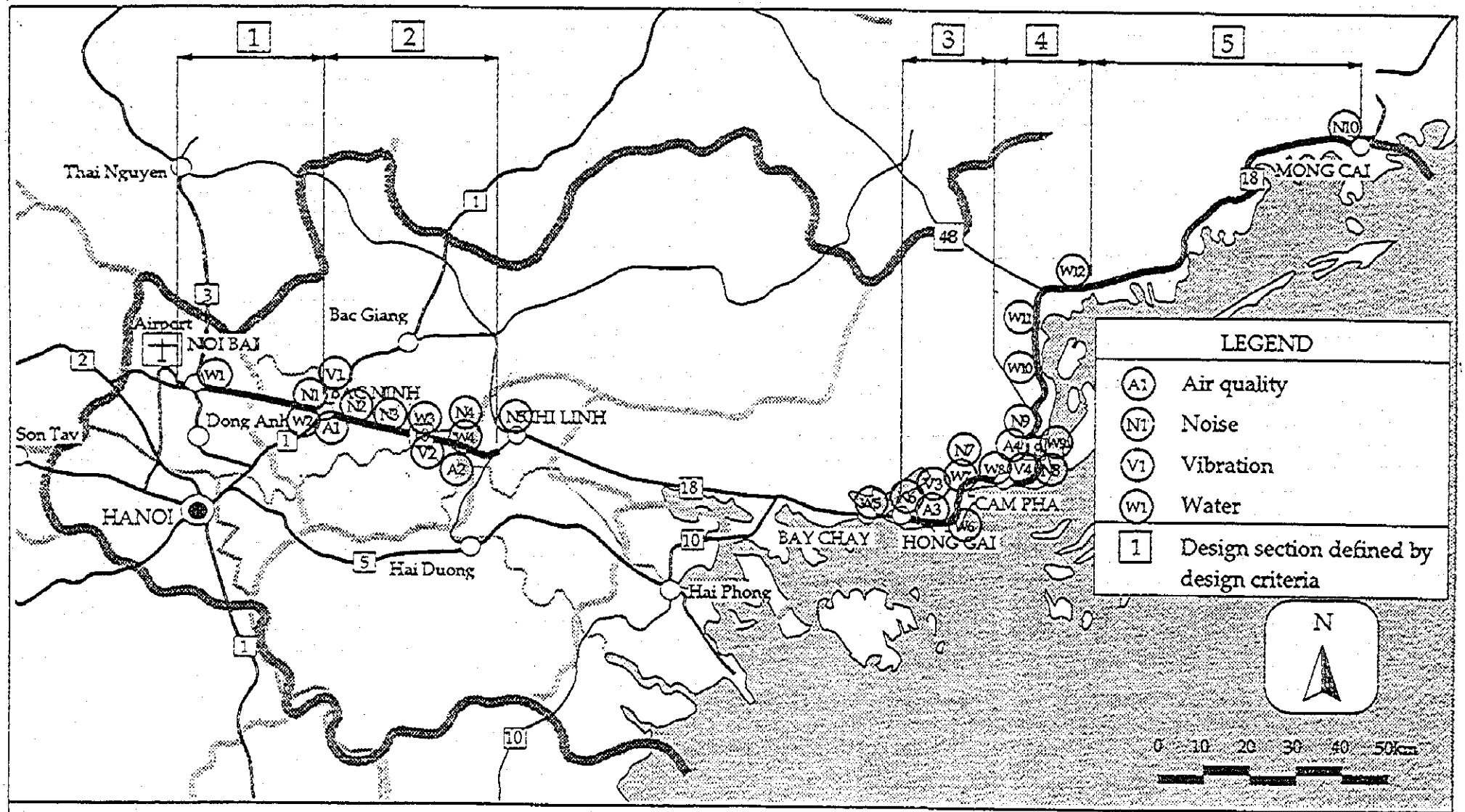

Figure 15.1 Monitoring Locations of Pollution
(Air Quality, Noise, Vibration and Water Quality)

The pollutants monitored were carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), total suspended particle (TSP), and lead (Pb). Hourly meteorological data including temperature, pressure, wind speed and wind direction, were obtained at each station for monitoring period. Vietnamese standards TCVN 5937 - 1995 for air quality are shown in the Table 15.6

Table 15.6 Permission Value of the Basic Criteria in Atmosphere (mg/ m^3)

	Pollutants	1 hour	Average 8 hours	Average 24 hours
1	TSP	0.30	-	0.20
2	CO	40.00	10.00	5.00
3	SO_2	0.50	-	0.10
4	NO_2	0.40	-	0.10
5	O_3	0.20	-	0.06
6	Pb	-	-	0.005

In all surveyed points, at daytime, the concentrations of TSP are higher than the permission value. At point Km154 + 900 of A4 (Cam Pha town), the average value surveyed is 0.60 mg/m^3, which is three times higher than permission value. At peak hours, the concentration of TSP ranges from 0.88 mg/m^3 to 1.18 mg/m^3, 2.9 to 3.9 times higher than permission value. At location Km124 of point A3 (Ha Long city), surveyed average value is 0.56 mg/m^3, 2.8 times higher than permission value. At peak hours, the concentration of TSP ranges from 0.76 mg/m^3 to 0.98 mg/m^3, which 2.5 to 3.3 times is higher than permission value. At point of Km27+500 (A2), the average value surveyed is 0.39 mg/m^3, 1.9 times higher than permission value. At peak hours, the concentration of TSP ranges from 0.75 mg/m^3 to 0.82 mg/m^3, 2.5 to 2.7 times higher than permission value. At point Km1+ 350 of A-1 (Vu Street, Bac Ninh town), the concentration of TSP is the smallest, the average value surveyed is 0.35 mg/m^3, but 1.7 times higher than permission value. At peak hours, the concentration of TSP ranges from 0.60 mg/m^3 to 0.75 mg/m^3, 2.2 to 2.5 times higher than permission value.

The average value of SO_2 is 0.034 mg/m^3 (point A4), 0.027 mg/m^3 (point A2, A1) and 0.019 mg/m^3 (point A3). All values are lower than permission value. The summary of air-monitoring results are shown in Table 15.7.

Table 15.7 Summary of Air-Monitoring Results

No.	Parameters (mg/ m3)	Locations			
		Point A1	Point A2	Point A3	Point A4
1	CO - 1 hour	3.35	2.154	3.645	3.439
	- Average 24 hours	2.19	1.674	2.467	2.510
2	NO_2 - 1 hour	0.036	0.08	0.025	0.036
	- Average 24 hours	0.017	0.023	0.014	0.020
3	SO_2 - 1 hour	0.06	0.06	0.042	0.077
	- Average 24 hours	0.027	0.027	0.019	0.034
4	TSP - 1 hour	0.75	0.82	0.98	1.18
	- Average 24 hours	0.35	0.39	0.56	0.60
5	Pb - 1 hour	0.004	0.005	0.005	0.007
	- Average 24 hours	0.002	0.003	0.003	0.003

3) Emission Database

A database for motor vehicles emissions in Vietnam is not readily available, as there is no systematic emission monitoring at present. But according to Annex No. 4 of Degree No. 175/ CP of Vietnamese government dated 18th October 1994, the guideline for implementation of the Vietnamese standard emissions of vehicles in accordance with the law on environmental protection, are as follows (Table. 15.8):

Table 15.8 Standard Emissions of Vehicles

Pollutants (g/km)	Pass. Car	Bus	Truck	M.Cycle
CO	65.0	87.0	67.0	12.0
NO_2	8.5	10.2	10.5	2.5
HC	6.0	7.1	7.1	5.0

4) Calculation of Emissions at Peak Hour

The traffic volume at a peak hour is computed from the daily traffic volume for the year 2015.

Heavy vehicles are defined as those which are heavier than pickup trucks (under 2 tons). This includes buses and large trucks, but not the light buses which belong to the pickup truck category.

From the data above, and the fact that leaded gasoline will be phased out in the near future (from 1996) according to Decree No.36/CP, 6th July 1995, by the Government of Vietnam. Lead will not be an important pollutant and need not be modeled. Only carbon monoxide and oxides of nitrogen were modeled, as they are the relevant pollutants specified under the ambient

air quality standards of the Pollution Control Department and can be adequately modeled. By the Vietnamese Standards TCVN 5937 - 1995, the respective standards for 1-hour (only peak hour concentrations are studied) are as follows :

Carbon monoxide : 40 mg/m^3
Nitrogen dioxide : 0.4mg/m^3

It is important to note that oxides of nitrogen are not the same as nitrogen dioxide, but consist of mostly nitric oxide (NO) which is not a concerned pollutant, so the comparison of modeled results to the standard can not be made directly. In past studies of air pollution modeling from line sources, it was usually found that the level of NOx was much higher than the ambient air quality standard for NO_2, but actual measurements performed by the Pollution Control Center in the past have never shown violations of the NO_2 standard.

The average value of CO is 2.510 mg/m^3 (point A4), 2.467 mg/m^3 (point A3), 2.191 mg/m^3 (point A1) and 1.674 (point A2). All values are lower than permission value.

5) Carbon Monoxide and Nitrogen Dioxide

Calculation by the air quality modeling for definition of carbon monoxide (CO) and nitrogen dioxide (NO_2) concentration was realized for 3 sections of the road: Noi Bai - Chi Linh and Hon Gai - Cam Pha - Mong Cai (Bac Luan).

A summary of important data of CO and NO_2 of 3 - sections of the road is given in the following Table 15.9 and 15.10.

Table 15.9 CO and NO_2 Values (mg/ m^3) with Wind Angle to Road (a = 90^o)

Height of receptor z (m)	Distance (down wind) from axis of the road x(m)	Noi Bai- Chi Linh		Hon Gai - Cua Ong		Cua Ong - Bac Luan	
0	9	-	-	-	-	1.06	0.15
	15	1.86	0.31	3.65	0.57	0.75	0.11
	24	1.23	0.20	2.48	0.39	0.55	0.08
	30	1.03	0.17	2.09	0.33	0.47	0.07
	45	0.76	0.12	1.54	0.24	0.35	0.05
1	9	2.69	0.44	5.8	0.80	0.99	0.14
	15	1.77	0.29	3.49	0.54	0.73	0.10
	24	1.21	0.20	2.43	0.38	0.54	0.08
	30	1.02	0.17	2.07	0.32	0.46	0.07
	45	0.75	0.12	1.53	0.24	0.35	0.05

Data of Tables 15.9 - 15.10 indicate that CO and NO_2 concentration of a wind-direction angle, 45 degrees to the road is higher than that of 90 degrees.

a. Case I : Section from Noi Bai to Chi Linh.

When the wind direction angle to the road is 45°, the concentration of carbon monoxide at the edge of the clear area (23.0m apart from the axis of the road/Type D Typical Cross Section) is 1.74mg/m^3 at ground level. The receptors above this point are exposed to 1.71mg/m^3 at 1m high, which is well below the ambient air quality standards.

Table 15.10 CO and NO_2 Values (mg/m^3) with Wind Angle to Road (a = 45°)

Height of receptor z (m)	Distance (down wind) from axis of the Road x(m)	Noi Bai- Chi Linh		Hong Gai - Cua Ong		Cua Ong - Bac Luan	
		CO	NO_2	CO	NO_2	CO	NO_2
0	9	-	-	-	-	1.50	0.21
	15	2.64	0.43	5.18	0.8	1.07	0.15
	24	1.74	0.29	3.51	0.55	0.77	0.11
	30	1.46	0.24	2.96	0.46	0.66	0.09
	45	1.07	0.18	2.18	0.34	0.50	0.07
1	9	3.81	0.63	6.4	1.13	1.41	0.20
	15	2.50	0.41	4.54	0.77	1.03	0.15
	24	1.71	0.28	3.45	0.54	0.76	0.11
	30	1.44	0.24	2.92	0.46	0.66	0.09
	45	1.06	0.18	2.16	0.34	0.50	0.07

At further distances the concentration of CO drops at a faster rate as the plume spreads to a higher altitude.

It is clear that even if the peak level were sustained for 8 hours, the concentration of carbon monoxide will still be much less than 10 mg/m^3 by Vietnamese 8 - hour standard.

The NO_2 concentration is in a ratio of 1 to 0.165 with that of carbon monoxide, so the profile is exactly the same but 0.165 times the carbon monoxide concentration at the same location. Thus the predicted NO_2 concentration at the edge of road (15m away from the road axis) is 0.41 mg/m^3.

The highest level of NO_2 concentration at 1m altitude is 0.63 mg/m^3 and at 9m downwind point away from axis of the road, this concentration is higher than standard value (0.4 mg/m^3). But the concentration at each downwind point of 23.0 (clear area) and 36.0m (edge of right-of-way) is lower than the standard value (0.4mg/m^2). Therefore, these concentration values are acceptable to the standard.

b. Case II : Section from Hong Gai to Cam Pha - Cua Ong.

CO and NO_2 concentration in the air at this section are higher than at other sections.

The results of calculation with the wind direction at an angle of 45 degrees are that the predicted CO and NO_2 concentrations at the edge of the right of way (32.5m) at 1.0m above ground level are 2.79 mg/m^3 and 0.44 mg/m^3 respectively.

Therefore, the CO concentration at any distance will still be much less than the 40mg/m^3 Vietnamese peak hour standard, but the NO_2 concentration will still be less than standard value (0.4 mg/m^3) only at the point of 35m to 40m apart from axis of the Road.

c. Case III : Section from Cua Ong to Mong Cai (Bac Luan).

The average traffic volume in this road section is the smallest, compared with other road sections. Therefore CO and NO_2 concentrations in the air about this road section will still be less than standard value at any distance and any height.

Future air quality was predicted in terms of carbon monoxide and nitrogen oxides (NOx) using line source Gaussian modeling. The modeling was conducted for a number of different sections. The results indicate low pollutant levels at the edge of the right-of-way for all the sections.

6) Other Pollutants

a. Total Suspended Particles (TSP) :

Suspended particle matter cannot be modeled satisfactorily due to the fact that it may be deposited as it travels downwind and because dust pollution resources are not only from emission from vehicles, and also from vehicles traveling on dirt roads, etc. The Thailand DRI (1992) emission database indicates that a gasoline-powered car emits 2.74 grams per kilometer, at any speed of driving, a pickup or van using diesel oil emits 4.48 g/km, and large vehicles (buses, trucks) emit 9.31 grams per kilometer.

The results of monitoring of Highway No.18 and of many other roads show that total suspended particulate in the air about any road in Vietnam is often higher than the standard value (0.3 mg/m^3).

b. Hydrocarbons :

Hydrocarbon pollutants are not currently regulated by ambient air quality for transportation projects in Vietnam. In the US and other countries, the control of hydrocarbons emissions serves mainly to

prevent photochemical oxidation reactions, which is an urban problem. The impact of hydrocarbon emissions in this study is considered insignificant.

c. Sulfur Dioxide :

Sulfur dioxide is the result of burning fuels containing sulfur. The environment monitoring database indicates that sulfur dioxide emission from a gasoline car emits 0.5 grams per kilometer , a pickup or van 0.775 grams per kilometer, and a large vehicle 1.8 grams per kilometer. The number of vehicles using diesel fuel is small. Therefore the sulfur dioxide emission is much smaller than other pollutants. Therefore sulfur dioxide will not be a significant issue for transportation projects.

Construction activities will result in the generation of airborne dust, and exhaust gases as well as particles. The concrete batcher plant is a potential source of cement and rock dust. The constructors will be required to implement measures to control the level of airborne dust, in particular cement dust, originating from the construction.

Mitigation measures are proposed to minimize dust emissions during construction period.

(2) Noise

1) Method of Sound Level Measurement.

The purpose of the noise measurement was to determine the existing noise levels along the proposed route. The existing noise level was monitored for one day continuously at each location, with the instantaneous noise level measured at one hour intervals until a statistically reliable sample of the 24 - hour equivalent sound level was achieved.

The practice of measurement was according to International Standards Organization (ISO) recommendations that microphones be set 1.2 - 1.5 m above the ground level, measurement should be made at a point more than 1m away from any reflective object, and other procedures.

10 locations were chosen for measurement of noise level along the study route :

Location N1 :	At Km0 + 350, Nguyen Quang Dao street, Bac Ninh town (Land use is residential).
Location N2 :	At Km1 + 350, Vu street, Dai Phuc community, Bac Ninh town (Land use is residential).
Location N3 :	At Km10 + 150, Que Vo town (Land use is industrial).
Location N4 :	At Km 27 + 500, Pha Lai town (Land use is industrial).
Location N5 :	At Km 37 + 450, Chi Linh town (Land use is residential).
Location N6 :	At Km 124, Ha Long city (Land use is business and commercial).

Location N7 : At Km 137 + 150, Quang Hanh community (Land use is forest and mountain).
Location N8 : At Km 154 + 900, Cam Pha town (Land use is residential).
Location N9 : At Km 159 + 720, Cua Ong town (Land use is residential).
Location N10 : At Km 299 + 100, Mong Cai town (Land use is agricultural).

The noise level monitoring was conducted from 5/8/1995 to 8/8/1995 for 5 locations: N6, N7, N8, N9, N10 along the northern route. From 10/9/1995 to 14/9/1995 for 5 locations: N1, N2, N3, N4, N5 along the southern route.

2) Parameters Monitored

The following parameters were measured in order to achieve the monitoring of existing conditions and to serve as the basis for predicting future conditions.

a. 24-hour equivalent sound level (L_{eq} (24))

24-hour equivalent sound level is measured to determine the value of steady-state sound that people are exposed to during the continuous period of 24 hours in order to assess its impacts based upon a generally accepted standard.

b. Day sound level (Ld)

Sound level averaged by time from 6hr A.M to 18hr PM (By Annex No.4 of Decree N175/CP by the Government of Viet Nam, 18th October 1994).

c. Night - sound level (Ln)

Sound level averaged by time from 18hr PM to 22hr PM day (by same Decree too).

Day and night sound levels are measured to characterize the average sound level which is perceived by people in residential areas throughout the day and night.

d. Hourly volume of vehicles of two traffic directions.

Equivalent sound levels were measured for 3 continuous days and night locations along the study road. Vietnamese noise level standards (see Table 15.11) for commercial and residential areas near the routes are 70 dBA for the time from 6h to 18h, 65 dBA from 18h to 22h and 55dBA from 22h to 6h AM.

Table 15.11 Vietnamese Noise Level Standard

Area	6 am. to 6 pm.	6 pm. to 10 pm.	10 pm. to 6 am.
Category I	55 dBA	50 dBA	45dBA
Category II	65 dBA	60 dBA	50 dBA
Category III	70 dBA	65dBA	55 dBA
Category IV	75 dBA	70 dBA	60 dBA
Category V	80 dBA	75dBA	65 dBA

Note: Category I: Areas that require quiet such as hospitals, kindergartens, schools, libraries, research institutes.
Category II: Residential areas, hotels, offices.
Category III: Business areas, surrounding areas 15 m from the main traffic roads, markets, stations, bus stops.
Category IV: Handicraft and light industrial area.
Category V: Heavy industrial

3) Monitoring Results

The results of the noise monitoring are summarized in Table 15.12. Existing noise levels along the routes varied primarily depending on areas proximity to existing routes. The highest levels were measured at Ha Long City - location N6, which is in an existing urban area.

Table 15.12 Results of Noise Monitoring

Locations	24-hours equivalent noise level (dBA) ($L_{eq}(24)$)	Day - sound level (dBA) ($L_{eq}(d)$) 6 AM to 6 PM	Night - sound level (dBA) ($L_{eq}(n)$) 6 PM to 10 PM
N1	62.8	64.4	61.4
N2	64.8	69.1	62.0
N3	61.9	69.7	54.5
N4	64.3	71.6	60.5
N5	65.7	69.7	62.9
N6	72.2	75.4	70.7
N7	63.0	65.0	62.2
N8	71.5	74.8	69.5
N9	66.1	67.2	65.2
N10	66.7	72.4	63.2

At Ha Long City monitoring location N6 the 1 day-sound level ($L_{eq}(d)$) is 72.2 dBA, which is higher than the critera for community noise level in Viet Nam of 70 dBA. The day-sound level ($L_{eq}(d)$) at this location was 74.5

dBA, which is 5.4 dBA higher than the standard value and the night-sound level ($L_{eq}(n)$) was 70.7 dBA; 5.7 dBA higher than standard.

The second highest noise levels were measured at Cam Pha Town - location N8. At this location 24hr average equivalent sound level was 71.5 dBA. The day-sound level ($L_{eq}(d)$) was 74.8dBA, 4..5dBA higher than the noise criteria.

At Mong Cai Town - location No. 10, noise levels were higher than permission value during the daytime, between 8h00 - 9h00 and between 14h00 - 18h00. At other hours, noise levels were lower than permission value. The average nighttime noise levels (18hr - 22hr) were about 63.2 dBA and lower than standard value.

At another monitoring location of Highway No. 18 (locations: N1, N2, N3, N5, N7, N9) the day-sound levels were generally in the range of 62 - 70dBA and the night-sound levels were in the range of 55 - 65 dBA, around standard values, and do not constitute noise pollution.

4) Noise Prediction Model.

Estimation of highway noise impact is performed with a general highway noise model, which predicts the equivalent noise level L_{eq}, this is average energy noise level and also is adequate requirement for the most noise assessment cases. Obtained L_{eq} can be compared with Vienamese and international noise level standards such as TCVN, ISO and USEPA.

The highway noise model in this study calculates the one hour L_{eq}, or $L_{eq(h)}$. The model was developed by the U.S. Federal Highway Administration (FHWA) and is based upon calculating the hourly L_{eq} for automobiles, medium trucks, and heavy trucks separately and then adding these logarithmically to obtain the overall hourly L_{eq}. The model arrives at a predicted noise level through a series of adjustment to a reference sound level, which is the energy mean emission level.

The input data accounts for variations in (i) traffic characteristics (volume, speed); (ii) topography (vegetation, barriers, height and distance); and (iii) roadway characteristics (configuration and grades). The computational sequence used in the FHWA model is as follows :

a. Reference energy mean emission levels are obtained from "National Reference Energy Mean Emission Levels as a Function of Speed" (FHWA, 1977, 1978). The term is L_oE_i and varies for each class of vehicle.

b. A flow adjustment term is added with the number of vehicles per hour (N_i), reference distance (D_o), speed (S_i), and time (T) (in this case 1 hour). The term is $+10\log (N_i D_o)/ (S_i T)$.

c. A distance adjustment, $10\log (D_o/ D)^{(1+a)}$ is added, where D is the actual distance, D_o is 15 meters, and "a" is site parameter (for reflective ground, "a" is zero).

d. A shielding adjustment term can be added according to specific sites such as barriers, etc.

The results are the total noise from all types of vehicles. In the study, the two sides of the roads were considered separately. Summing up the calculated results from (1) to (5) gives the peak-hour equivalent sound level ($L_{eq(h)}$). In order to obtain $L_{eq(24)}$, the average of a series of noise calculation can be calculated. Due to the general traffic flow patterns, which are heavy during the day and light during the night, the $L_{eq(24)}$ is usually 2 - 4dBA less than the peak $L_{eq(h)}$.

5) Noise Modeling Input

a. Traffic Volume and Speed

Traffic volume information for input to the model was reviewed , and from the existing peak hour and daily traffic, it was found that 8 - 10 percent of the daily traffic is in the peak hour. In this study, 10 percent of the predicted daily traffic volume is assumed to occur in the peak hour. The following is the estimate of traffic velocity and peak hourly volume in both directions. Velocities have been adjusted to reflect volume - velocity relationships noted on highways, that is, reduced velocities are expected during higher traffic volumes.

The predictable average vehicle volumes per day in two directions in the year 2015 of Highway No 18 are shown in Table 15.13.

Table 15.13 Forecast Reference Noise Level at 5 Sections

No.	Traffic volume Veh./day					Heavy	Veh/peak	Ave.speed	Ref. noise
	Car.	Bus	Truck	1/2MC	Total	traffic	hour	km/h	level(dBA)
1	2550	2300	1550	4225	10625	14.6	1063	48	73.7
2	3850	3150	5950	17050	30000	19.8	3000	48	76.5
3	2650	4200	11400	13875	32125	35.5	3213	48	77.8
4	700	1200	2350	700	4950	47.5	495	48	74.2
5	700	1300	2050	1775	5825	35.2	583	48	73.6

Note: MC: Motorcycle

Reference noise level at peak hour was determined at a point 1.2 - 1.5 meters above ground level and 7.5 meters from axis of vehicle lane.

b. Physical Characteristics of Highway No.18

The slopes of route section are 1% at Noi Bai - Bac Ninh, 2% at Bac Ninh - Chi Linh section and Hong Gai - Cam Pha - Cua Ong section, 4% at Cua Ong - Tien Yen and Tien Yen - Mong Cai (Bac Luan) sections. The slopes of route are changed at ± 2%, then noise level of the route will changed at ± 1 dBA. Therefore reference noise level at peak hour at Noi Bai - Bac Ninh section will be 73.7 + 0.5 = 74.2 dBA, at Bac Ninh - Chi Linh section will be 76.5 + 0.5 = 77 dBA, at Hon Gai - Cam Pha - Cua Ong section 77.8 + 1= 78.8 dBA, at Cua Ong - Tien Yen section: 74.2 + 1 = 75.2 dBA, and at Tien Yen - Mong Cai (Bac Luan) section: 73.6 + 1 = 74.6 dBA.

c. Background Noise

The background noise (generally 50 to 60 dBA 24-hour equivalent noise level) was not considered significant since the addition of such low level would not add to the effects from the highway traffic significantly. Therefore it is not included in the modeling input.

6) Modeling Result and Predicted Impact.

Results of calculation are shown in Table 15.14

Table 15.14 Forecasted Noise Level (dBA) from Road Center Line at Peak Hour in 2015

Section of Route	Distances from road center line (m)						
	12	19	34	49	64	79	94
1Noi Bai - Bac Ninh	74.2	71.2	68.2	66.4	65.2	64.2	63.4
2. Bac Ninh - Chi Linh	77.0	74.0	71.0	69.2	68.0	67.0	66.2
3. Hon Gai - Cam Pha,Cua Ong	78.8	75.8	72.8	71.0	69.8	68.8	68.0
4. Cua Ong - Tien Yen	75.2	72.2	69.2	67.4	66.2	65.2	64.4
5. Tien Yen - Mong Cai (Bac Luan)	74.6	71.6	68.6	66.8	65.6	64.6	63.8
Distance adjustment (dBA)	0	3	6	7.8	9	10	10.8

It can be seen that the maximum 1-hour noise level is quite stable at 75 dBA at the edge of the route, except the noise level of Hong Gai - Cam Pha, Cua Ong section, it is 77 and 78.8 dBA. This is because as traffic volume increases, speed of the traffic decreases according to the N (volume) and V (speed) relationship.

Noise modeling results and noise monitoring results also show that the noise level at peak hour traffic is highest at Hong Gai - Cam Pha- Cua Ong section. In this section at the point 60m from the route the noise level will be sufficient to comply with the criteria of 70 dBA for general urban areas.

But at other sections, this critical distance becomes smaller; only about 30m. Therefore it is necessary to employ measures for mitigation of noise level along the Hong Gai - Cam Pha - Cua Ong route section.

7) Construction Impact

The Federal Highway Administration of the USA requires that vicinity land use or activities which may be affected by construction noise be identified during project development studies, and the measures to minimize or eliminate the impacts should be determined (Rupert, 1979). The A - weighted sound level ranges of construction equipment are as follows (Table 15.15).

Table 15.15 A-Weighted Sound Level Ranges of Construction Equipment

Type of Equipment	Noise Level at 15 meters in dBA	General Service Administration (USA) requirement less than
Compactor (rollers)	72 - 88	
Front Loaders	72 - 96	75
Backhoes	72 - 93	75
Tractors	73 - 96	75
Scrapers, graders	77 - 95	75 - 80
Pavers	82 - 92	80
Trucks	70 - 96	75
Concrete Mixers	71 - 90	75
Movable cranes	75 - 95	75
Generators	70 - 82	75
Compressors	69 - 86	75
Jackhammers and drills	76 - 99	75
Pile drivers (peak levels)	90 - 104	95
Vibrators	70 - 80	75

From the above list it can be seen that some equipment used on federal government projects in the U.S.A must have noise abatement measures.

In order to determine impacts of construction on the proposed routes, five scenarios are presented for special construction activities as follow:

8) Mitigation Measures

Excessive noise level at sensitive receptors can only be mitigated with some from noise barriers. It is recommended that the hospitals, clinics and schools should be provided with noise barriers, if these locations are within 60 meters from the traffic axis, particularly for Hong Gai - Cam Pha - Cua Ong section of the route.

And also non-structure measures such as traffic regulations of driving speed, vehicle horns, repairing and adjustment of vehicle machinery as well as warning sign system should be considered in the high-level noise-affected urban area.

Table 15.16 Affected Sensitive Receptors and Noise Barrier Requirement in Section 3 (Hong Gai - Cua Ong)

Facility	No.	Affected ratio (%)	Number of noise barriers required
Temples, Pagodas	2	100%	2
Schools	15	20% affected	3 (Need noise barrier)
Hospitals, Clinics	8	100% affected	8 (Need noise barrier)

In the Section 3 from Hon Gai - Cua Ong, the following lengths are needed to provide noise barriers to mitigate the noise level. These buffer structures are to be installed as parts of the wall of each facility. The height of walls vary from 2m to 3m depending on the conditions of each facility.

Temples, Pagodas	2nos. x 25m	=	50m
Schools	3nos. x 30m	=	90m
Hospitals, Clinics	8nos. x 10m	=	80m
			220m in length

A noise barrier wall 3m in height can functionally reduce the noise level by about 5 dB for their mitigation measure, however this barrier wall installation could be replaced by double glass installed noise-protection windows for aesthetic considerations.

Double glass installed noise-protection windows will reduce noise level 5 to 10 dBA.

Trees are not a very effective noise reduction measure, providing about 1 to 2 dBA attenuation for 8 - 10 meters of dense-leaf trees. Considering the width of the right-of-way, the trees will not be a functional noise reduction measure. However, trees can be pleasing aesthetically and add psychological benefit. Roadside tree plantings will be implemented as shown in Table 15.17.

Table 15.17 Number of Trees in Urban, Populated Areas and Areas Where are Aesthetically Important

Section	Location	Route length	Planting length	No. of Trees	Planting Interval	Note	
						Clear Area	Location
1	Noi Bai - Bac Ninh	31.3km	2.0km	500	8.0m	w=23.00x2	Major intersct.
2	Bac Ninh - Chi Linh	36.4km	9.0km	2250	8.0m	w=15.25x2	Major intersct.
3	Hon Gai - Cua Ong	38.7km	22.0km	5500	8.0m	w=15.25x2	Urban area/M.IS
4	Cua Ong - Tien Yen	43.5km	7.0km	1750	8.0m	w=15.25/ 13.75x2	Major intersct.
5	Tien Yen - Bac Luan	86.9km	8.0km	2000	8.0m	w=13.75x2	Major intersct.
	Total	236.8km	41.0km	12000			

The cost of noise barrier walls of 220m in length has been included in the estimated construction cost of the section 3. The cost of 12000 trees also is included for each section.

(3) Vibration Impact

1) Monitoring Locations

Locations of monitoring vibration along the proposed route were as follows:

- Location V1 : Km 1 + 350 - Vu Street, Bac Ninh Town (land use is agricultural).
- Location V2 : Km 27 - 500, Pha Lai Town (land use is industrial).
- Location V3 : Km 124, Ha Long City (land use is residential).
- Location V4 : Km 154 + 900 Cam Pha town (land use is residential).

2) Monitoring Procedure

Vibration monitoring complied with the Institution of Highway and Transportation's Traffic impact assessment guidelines and the Institute of Environmental Assessment's Guidelines for the environmental assessment of road traffic (IEA 1993).

In this work, monitoring was performed every two days over the period of one day. More careful consideration was taken at peak hours.

3) Standards and Criteria

Since there is no specific standard in Vietnam for evaluation of vibration induced by traffic, the following available standards and documents are considered :

a. TCVN 5126-90 - Permissible levels of vibration at working places;

b. Decree No 175/CP, dated 18th October 1994, by the Vietnamese government for implementation of the law on environmental protection, Annex N3 - Permissible levels of vibration (Table 8.1);

c. ISO/ TC 108/ SC 4N 190. Annex A - Guide to effects of vibration on health;

d. Traffic induced vibration in buildings (TRL 1990); and

e. Damage to structures from ground-borne vibration (BRE 1990).

Those documents were taken as reference to estimate vibration impact. Furthermore, the guide line of the limits of vibration levels applied now in Japan for environmental impact assessment as 60 - 65 dB at daytime and 55 - 60 dB at nighttime in residential areas and 5 dB higher in other developed areas for that qualification is also used.

It should be noted since acceleration amplitude (m/s^2) is equal to 2 x Pi x Frequency in Hz x velocity amplitude, a vibration acceleration level of 60 dBA at 10Hz will be equal to a peak velocity of 0.16 mm/s (imperceptible to people according to the Reichter and Meister scale). It is thus concluded that the level 0.16 mm/s should be kept as the limit which should not be exceeded.

4) Monitoring Results

The monitoring was conducted from September 5 to 6, 1995, along the northern route (Cam Pha and Ha Long) and from September 12 to 13, 1995 along the southern route (Bac Ninh and Pha Lai).

a. As expected, the monitoring indicates that existing vibration levels are very low along the proposed route. The highest measurements were at Ha Long City. Maximum velocities and accelerations measured at four locations at 7.5 m away from the road were generally below 0,09 mm/s and respective 0,01 m/s2 except for the case of 0,2 mm/s and respective 0,03 m/s2 at the Ha Long monitoring location at 16hr to 18 hr.

   According to the Guide to Effects of Vibration on Health, Comfort and Perception, and according to Decree No.175/ CP by Government of Vietnam, Annex No.3 - Table 8.1, and compared to

the DIN 4150, the vibration levels caused by traffic on Highway No.18 road are below the permissible limits of vibration for human being as well as for structures.

According to the Reichter - Meister criteria, which evaluates impact based on velocity and frequency, 100% of monitored values would be imperceptible or barely perceptible to humans. Compared to the DIN 4150 scale which estimates vibration impact to buildings, all results measured were at the no-damage level.

b. Vibration levels vary greatly depending on many factors; among them the most affected are the characteristics of type of soil bed and various speeds of travelling vehicles. Therefore, measured results at Ha Long increase considerably in levels of vibration, though the surface of Highway is fair, because a large portion of the road rests on clay or loam beds and it is not far from the ferry port. At the remaining monitoring locations, it is seen that the attenuations of vibration of the route are not significant because the soil bed is rock, or sand and silt.

Table 15.18 Permissible Levels of Vibration (By Annex No.3 of Degree No.175/ CP dated 18th October 1994 by Government of Vietnam)

Areas	Permissible rectification acceleration (m/s^2)		Permissible linear acceleration (m/s^2)
	Vertical vibration	Horizontal vibration	
I. Quiet areas (hospital, school, library)	0.540	0.380	-
II. Residential	0.270	0.190	-
III. Commercial, near main route, market place	0.081	0.057	0.066
IV. Light industrial, domestic raft	0.054	0.038	0.045

5) Modeling Results and Predicted Impact

If the road is built on rock bed, which can transmit the vibration best, L will approach Lo - 10 log (r/ro) which means - 3dB per doubling of distance. A vibration velocity of 2.5 mm/s at 10 Hz (84dB) at 3 m from the road will be 73 dB at 24 m away (Table 15.19), which is not an acceptable level. On the other hand, the level will be only 57dB at the same distance (24 m) if the road is built on sand and silt, and practically zero if the road is built on clay or loam.

Table 15.19 Vibration in Decibels on Soil Bed Type in Relation to Distance

Distance from road (m)	Vibration in Decibels Type of Soil Bed		
	Rock bed	Sand/ silt	Clay/ loam
3	84	84	84
6	81	78	68
12	77	69	39
24	73	57	n.a

Note : n.a = not applicable.

The level of 84 dB at 3 m distance is assumed to be worst case. In Japan, large size trucks produce only 70 dB or less at this distance. But in Vietnam, levels up to 84 dB were recorded at some sites of national highways (Routes Nos.1, 5, 6). It should be noted that vibration is judged per occurrence, not by the average of all occurrences.

A large portion of the Highway No. 18 route will be on bedrock, but the construction calls for a layer above the rock, which can be considered as a sand and gravel bed. While it is not possible to predict exactly the effect of such construction on vibration levels, the worst case should be a level of around 57 dB at the edge. The level should be lower on the section 3, 4, 5 of Highway No.18 route, which has soils of clay loam to sand bed with a similar type of construction. In conclusion, it is expected that with the right-of-way proposed, the vibration level will be lower than 60dB (0.16mm/s at 10Hz) at the edge of the right-of-way (24m from the edge of the road).

The bridge viaduct sections will have less of an impact due to the rigid, massive concrete structure which will have a damping effect on vibration.

If heavy trucks produce 70 dB of vibration at a distance of 3 m from the road, as in Japan, the worst case at 24 m will be about 43 dB, which is far lower than the standard for vibration levels in residential areas (60dB). Well-constructed highways produce about 1.3 mm/s vibration velocity, which is about 78 dB at 10Hz, due to smooth road surfaces which cause less vibration. It is desirable to improve road surfaces and maintain them on a level customary in Japan.

No significant difference in vibration impact is expected between the proposed and alternative routes.

Table 15.20 Summarized Monitoring Results Along Highway No. 18

Measured Points	Vibration parameter		Location							
			Bac Ninh		Pha Lai		Ha Long		Cam Pha	
			min	max	min	max	min	max	min	max
A 7.5m from road	Velocity	RMS (103mm/s)	4	95	4	80	6	200	3	20
		Level (dB)	36	66	38	64	41	72	36	50
	Accel-eration	RMS (10 - 3mm/s)	3	14	3	20	4	30	3	11
		Level (dB)	20	33	20	36	22	40	20	31
B 20m from road	Velocity	RMS (10-3mm/s)	3	20	3	42	4	30	2	15
		Level (dB)	36	52	36	58	38	56	32	50
	Accel-eration	RMS (10-3mm/s)	3	6	3	6	4	10	3	6
		Level (dB)	20	26	20	26	20	30	20	26
C 30m from road	Velocity	RMS (10-3mm/s)	3	12	3	12	3	9	3	10
		Level (dB)	36	48	33	48	36	45	36	46
	Accel-eration	RMS (10-3mm/s)	2	5	3	5	3	5	3	5
		Level (dB)	16	24	20	24	16	24	20	24

Vibration monitoring was conducted along the proposed route to obtain basic vibration levels as well as information on characteristics of surface vibration propagation and attenuation. Future vibration levels were then estimated, and compared to a generally accepted standard, or allowable vibration level. Construction impacts were evaluated based on predicted and recommended maximum vibration levels from specific types of construction activities. Based on the findings, impacts are summarized and mitigation measures are recommended.

Vibration levels were predicted by modeling the attenuation of waves propagated along the ground surface. The worst case is predicted to be a vibrations level of 57 dB at the edge of the road. Proper maintenance of the roadway and strict control of overweight vehicles is, however, required to mitigate vibration impacts. The impacts of vibration levels is considered insignifican. Proper maintenance of the roadway and strict control of overweight vehicles is, however, required to mitigate vibration from piling activities.

(4) Water Resources and Quality

Meteorological data for the study areas were collected and summarized, and the surface and ground water hydrology and drainage were discussed. Water sampling for suspended solids, biochemical oxygen demand, dissolved oxygen,

pH, conductivity, and fecal coliform was conducted at 12 locations along the route. Soil information was implemented to assess impacts relating to erosion.

1) Surface Hydrology

a. Plains Zone (Characteristics of Water Resources)

Along the route in the plains zone, especially the section from Noi Bai to Bac Ninh, 5% of the surrounding area always overflows (about 10% in rainy season), which is mainly distributed along the rivers and streams of the area. Those are Noi Bai Lake (10 ha), Ngoi Bac Lake (10 ha) and Noi Phat Lake (7 ha). Volume of water current in the rivers and streams is different in each season. Rainy season from June to September accounts for 70% of water and dry season from October to May equals to 30% of water volume. Volume of water of Ca Lo river is 0.66 K m^3 and annual average flow is 21 m^3/s. The volume of water includes ponds, lakes, swamps is about 50,000 m^3.

Water use is generally divided into domestic use, agricultural use, irrigation, fisheries and industrial use. Total quantity of surface water is about 600,000 m^3/year. The water for fisheries is taken from swamps, lakes, ponds and rivers in the area.

b. Foothills and Mountain Zones :

The Highway No.18 crosses several streams. These streams have all function as drainage receiving and supplying of water for the surrounding agricultural areas.

2) Ground Water Hydrology

a. Plain Zones

Underground water comes from shallow wells (approx. 7,800 wells). Water for bathing, washing, drinking is mainly taken from shallow wells (digged well depth is 5 to 10m, drilled well depth is 10-15m). 97 % of all households have their own wells for daily water supply. Water volume from the wells amounts to about 700,000 m^3/year (0.25 m^3/day/household). Water for domestic use is partly taken from ponds, lakes and Ca Lo River (about 50,000 m^3/ year). Water demand for one person is 0.05 m^3/day, for the entire population, 750,000 m^3/year.

b. Midland and Mountain Zones

Underground water from shallow wells (8,794 wells) is used in foothill areas. In the mountain zone, most people use springs and rivers as water sources. In the study area, there are many lakes, ponds which are used for fish culture and to supply water for agricultural purposes.

Water for bathing, washing, drinking is mainly taken from shallow wells (digged well depth is 5 to 10 m, drilled well depth is 10-15m). There are 8,794 wells in the area (accounting for 70 % of all households).

3) Drainage

A review of drainage patterns is important for several reasons. Firstly, drainage systems are very important for determining where flooding of the highway may occur due to insufficient drainage. Secondly, drainage patterns are used in determining where water flows could be disposed during and after construction of the route. Finally, information on drainage system is useful in identifying watér bodies which are susceptible to pollution resulting from construction of the highway improvement

Catchment and subcatchment areas may be defined with reasonable accuracy within the mountainous sections of the proposed route. Because the route runs mostly through farming land, the surface hydrology can only be approximated based on the local natural and man-made drainage system. In many cases, the direction and volume of surface water flow for a given area is identified by the local man-made land forms, consisting of levies, rice fields, and other irrigation systems as well as roads and other structures which affect water flow. Rice fields themselves can act as significant reservoirs. In periods of heavy rainfall, local depressions or basins having a lower elevation will minimize the flooding problem.

4) Existing Water Quality

Analyses of existing conditions of water quality were conducted by pH, Salinity, Oil, DO, SO_4, COD, BOD_5, Zn, Cd, Hg, Cu, Pb concentration.

The sampling and analyzing of the samples have been conducted at 12 locations along the study route from 1/9/1995 to 3/9/1995. The locations of sampling are as follows.

Location	N1	:	Ca Lo river
	N2	:	A branch of Cau river
	N3	:	Cau Dung bridge, 13 km from Bac Ninh
	N4	:	Pha Lai ferry port
	N5	:	Hon Gai ferry port
	N6	:	Lu Phong spring
	N7	:	Quang Hanh spring
	N8	:	Wastewater canal at the end of Cam Pha town
	N9	:	Bridge 10, Cua Ong
	N10	:	Mong Duong river
	N11	:	Tien Yen box culvert
	N12	:	Tien Yen dike

Summarized results of water quality of the rivers and sea along Highway No.18 are shown in Table 15.21. It is shown that in comparisons with the standard values, the water quality of all surveyed locations were not higher

than permissible value. Most canals and ponds have great capacity for self-purification; DO concentration values were high. In general, the quality of surface water resources in surveyed area meet the required standards for fishery and irrigation purposes.

Table 15.21 Summarized Results of River and Sea Water Quality Along Highway No.18

Order	Sampling Location	Concentration					
		Oil mg/1	pH	NH_4 mg/1	NO_2 mg/1	COD mg/1	BOD_5 mg/1
1	Bai Chay ferry port	0.015	8.47	0.059	0.006	6.5	1.5
2	Cam Pha coal port	0.09	8.59	0	0.028	4.5	1.5
3	Cua Ong coal port	0.275	8.66	0	-	-	-
4	Ba Che	0	8.33	0	0.025	3.3	1.8
5	Tien Yen	0.145	8.65	0.02	0.013	3	1.8
6	Dam Ha	0.115	8	0.027	0.022	5.9	1.5
7	Ha Coi	0.24	8.22	0.026	0.066	5.8	3.5

5) Water Quality Standards

Vietnamese Standard for Water Quality - Coastal water quality TCVN 5943 stipulated as follows:

Table 15.22 Water Quality - Coastal Water Quality Standards

Order	Criteria	Unit	Permissible Value		
			Bathing	Fishery	Others
1	Temp.	^oC	30		
2	Odor	-	nil		
3	pH	-	6.5-8.5	6.5-8.5	6.5-8.5
4	DO	mg/l	>4	>5	>4
5	BOD_5	mg/l	<20	<10	<20
6	TSS	mg/l	25	50	200
7	Asen	mg/l	0.05	0.01	0.05
8	Amoniac	mg/l	0.1	0.05	0.01
9	Cadimi	mg/l	0.005	0.005	0.01
10	Pb	mg/l	0.1	0.1	0.1
11	Cr (VI)	mg/l	0.05	0.05	0.05
12	Cr (III)	mg/l	0.1	0.1	0.2
13	Clo	mg/l	-	0.01	-
14	Cu	mg/l	0.02	0.01	0.02
15	Florua	mg/l	1.5	1.5	1.5
16	Zn	mg/l	0.1	0.1	0.1
17	Mn	mg/l	0.1	0.1	0.1
18	Fe	mg/l	0.1	0.1	0.3
19	Hg	mg/l	0.005	0.005	0.01
20	Oil and Grease	mg/l	nil	nil	0.3

6) Erosion and Sedimentation

a. Soil Characteristics

Soil erosion is an important consideration for the project. Uncontrolled erosion can result in small scale landslides, saturation of nearby waterways, and sediment overwash on nearby farmland.

Soil types have been seen along the Highway No.18 and there are degraded and hungry soil (Noi Bai, Phu Lo); alluvial and water-bearing soil (Yen Phong, Que Vo); sand and gravel-bearing yellow soil (Hong Gai); sand (Cam Pha); degraded red-brown soil (Ba Che); mangrove, saline soil ; alluvial yellow-brown soil; Red- yellow soil; Gravel-bearing erosive soil.

Along the sections from Noi Bai to Chi Linh, degraded and barren soil, alluvial and water bearing soil are common. Along the sections from Hon Gai to Mong Cai, light yellow soil and red-brown soil are common. Other types of soil are distributed in small areas.

b. Erosion

Erosion will vary according to the height of the fill and cut slopes, but about 50 to 55 tons per ha per year is estimated in general in Viet Nam. This amounts to 75 to 80 tons per kilometer of roads per year. The following measures should be taken to minimize the volume of erosion from the slopes of fills and cuts during the earthwork;

- In areas where the construction work may cause on adverse impact, earthwork involving filling and cutting will be restricted to avoid washout during the rainy season,
- The slopes of fills and cuts should be protected by grass or concrete slope protection work immediately after the fill or cut work,
- Drainage system at the toe and/or shoulder edge of fill or cut slopes should be provided.

c. Impact on Water Quality

One of the principle impacts on water quality result from erosion of exposed soils during and after construction, temporary damming, or diversion of streams which could affect those who would use water downstream. Changes in embanked land form may also alter drainage patterns. Soil particles are washed down to surface water when it rains, causing increased concentrations of suspended solids which can damage aquatic life. Toxic substances such as oils from construction equipment pose a secondary treat to water quality during construction, as does waste generated by the highway construction

crews. During operation, erosion can occur from the embankment slope of the highway if vegetative cover is insufficient.

In general, impact on water quality is not serious, only temporary increasing of turgidity to the water bodies at periods of earthwork and bridge foundation work.

5) Construction Waste

The of Highway No. 18 improvement project includes excavation and embankment (borrowed), of which sites should be considered from a view point of environment, in particular disposed materials. The Table 15.23 is the quantity of excavation and embankment (borrow) in each section.

Table 15.23 Quantity of Excavation and Embankment by Section

Section	Road Length (km)	Excavation (m^3) (Soil and Rock)	Embankment (m^3)
1	31.3	0	1,465,000
2	36.4	15,000	307,000
3	38.7	748,000	946,000
4	43.5	1,234,000	204,000
5	86.9	582,000	562,000

Section No.4 (from Cua Ong to Tien Yen) has a problem of construction waste sites due to the high volume of excavation, but the excavation volume of the other sections is minimal or balanced with embankment volume.

The following measures should be undertaken for the waste of excess material for the section 4;

- To carefully select disposal sites for excess materials which will be concurred by the provincial authority;
- To limit construction steps leaving much bare soil to dryer seasons whenever possible;
- To limit the length and grade of slopes and keep the bare soil exposed to a minimum;
- To establish ground cover planting on bare earth as soon as possible;
- To provide sufficient drainage ditches or culverts which should be connected with appropriate disposal river or creek;
- To provide roads to the sites for hauling

15.7 Impacts and Mitigation Measures

15.7.1 Socio-economics

Accompanying the improvement of Highway No. 18 are certain potential negative impacts which may be unavoidable. However, measures must be taken to alleviate such impacts as much as possible.

Among the negative impacts that can be avoided by careful management procedures during construction are :

- Stress generated by uncertainty in the affected communities.
- Discord between the local inhabitants and the construction workers.
- Severance and isolation of existing communities.

Recommended strategies for trying to ensure that these problems are:

- Ensure that the main project contractor is responsible for the provision of accommodation for workers of adequate hygiene facilities on the site, of on-site first-aid facilities and of occupational health and safety training for all workers.

- The provision of resources to local health agencies to enable them to run public health and hygiene campaigns targeting both the workers and the local communities.

- Undertaking an audit of local labor skills, establishing a register of local labour with the appropriate skills wanting to obtain construction work.

Among the unavoidable impacts, the route construction would need to relocate a number of farming households situated at the proposed site, and the loss of livelihood by a number of people with businesses at the current situation. These impacts might be unavoidable; however, careful planning could significantly reduce their adverse consequences. Such planning should include:

- The payment of adequate compensation to farmers to assist them in resettling somewhere they themselves consider appropriate.

- If possible, the provision of land reasonably nearby for farmers forced to move.

In choosing and designing strategies to cope with the social impacts of the route construction, it is most important that the responsibility of provincial authorities is fully recognized and respected. At the same time, however, some consideration should be given to ways in which local authorities might be institutionally strengthened in order to assist them in coping with a project of the size of state level.

15.7.2 Health and Safety

Human health and safety, both within the construction workforce and among the local populations may be issues for concern during the construction and after construction phase.

(1) Safety

An educational program on work safety during construction should be introduced, and the use of safety equipment explained to all workmen and required protective clothing should be issued to all workers on the sites. Also it will be necessary to set up on-site emergency first-aid systems, emergency transportation, and to make arrangements for the treatment of sick or injured members of the workforce at local clinics or hospitals.

(2) Construction and Traffic Noise

Construction noise will be inevitable, however the constructor will be required to implement standard methods to reduce the impact of noise in the vicinity of the project.

(3) Site and Waste Management

To ensure the maintenance of environmental health during the construction period, it is recommended that all sewerage and waste from the construction site or construction camp should be disposed of in an acceptable manner which does not cause pollution to the country or contaminate the ground water or surface water to the vicinity area.

15.8 Environmental Management

15.8.1 Management Plan

Construction and operation of Highway No.18 will have some negative impacts together with great positive impacts. It is proposed that negative impacts are mitigated as outlined in Table 15.24 and assessed through the monitoring program outline in Table 15.25. The mitigation and monitoring program comprises the proposed environmental management plan for the project.

Construction mitigation measures should be written into construction contracts whenever possible. It is proposed that environmental inspectors be hired by the constructor to oversee implementation of the mitigation and monitoring program during construction. Report on the mitigation and monitoring program should be prepared by them and sent to the Office of Environmental Policy and Planning and Department of Highway every 3 months.

15.8.2 Conclusions

1) The general analysis on the EIA of the Highway No.18, Chi Linh, Hong Gai, Cam Pha, Mong Cai (Bac Luan) section improvement project has shown that the project would bring the betterment, more effectiveness and

positive impacts to the physical resources in the project area, as well as the socio-economic development in northern Vietnam. The negative and harmful impacts of the project are inconsiderable as they are still at low levels.

2) The possible measures to mitigate negative impacts for natural, physical, ecological and socio-ecological resources and measures to monitor environment have been described and recommended in each paragraph and Table 15.24 aiming at ensuring the suitable development of the project areas.

3) The EIA report has been prepared in line with requirements outlined in implementing the Article 18 of the Law on Environmental Protection promulgated on January 10, 1994 in Vietnam. The report could be the one of the important documents needed for consideration and approval of the next development stages of the project.

Table 15.24 (1): Environmental Mitigation Measures

CONSTRUCTION PERIOD

Resource and Potential Environmental Impact	Mitigation	Location
1. Physical Resources 1.1 Air Quality - Fugitive dust from construction activities	Use wetting sprays for dust suppression during demolition, excavation, grading, loading, unloading and routes of delivery vehicle which cross areas of exposed earth.	Construction sites and surrounding areas
	Wash paved roads.	Construction sites and surrounding areas
	Enclose stockpiles.	Construction sites and storage areas
	Store bulk cement in closed silos with fabric filter.	Construction sites and storage areas
	Shroud the aperture for dry mix bacher.	Dry mix bather area
	Perform concrete mixing at isolated sites.	Concrete mixing area
	Confine vehicles to designated routes.	Road network between borrow pits and construction sites.
	Perform monitoring program.	Construction sites.
1.2 Water Quality and Erosion -Water quality degradation due to construction camps and equipment	Build construction camps not closer to the water bodies.	Construction camps
	Provide construction crews with adequate lavatories and solid waste disposal bins. Properly dispose of waste from bins.	Construction sites and camps
	Inspect construction equipment for leaks of petroleum based products such as oil and gas.	Construction sites
- Erosion and water quality degradation due to solids from construction sites	Limit construction steps which leave much soil bare to the dry season whenever possible.	Construction sites
	Limit length and grade of slopes and keep area of bare soil exposed to a minimum.	Slopes at construction sites
	Establish ground cover on bare earth as soon as possible on margins, median areas and the buffer zone.	Exposed areas
- Erosion and water quality degradation due to solids from construction sites	Use smallest construction segment lengths feasible to minimize bare soil exposed	Construction sites
-Erosion and water quality degradation due to solids from borrow pits.	See Section 1.3 below.	

Table 15.24 (2): Environmental Mitigation Measures

CONSTRUCTION PERIOD

Resource and Potential Environmental Impact	Mitigation	Location
1.3 Land Resources -Land degradation due to borrow pits used to obtain fill material	Make and implement borrow pit selection and control action plan.	Borrow pit sites
	Keep borrow pit sites as concentrated as possible and avoid leaving steep slopes.	Borrow pit sites
	Convert borrow pit sites to reservoirs after use.	Borrow pit sites
-Disturbance of land surface at construction sites	Revegetate land surface with appropriate ground cover species.	All exposed soil surfaces
1.4 Noise -Excessive noise from construction activities	Locate concrete mixing sites at sufficient distance from houses and more distance from hospital and schools, such that Leq (24) < 70 dBA.	Concrete mixing sites
	Use alternative (non-hammer) pile driving techniques near populated areas such that peak noise < 95 dBA	Piling for bridge near populated areas
	Enclose generators such that noise levels at sensitive receptors are less that 70 dBA. Perform monitoring program.	Generators
1.5 Vibration -Excessive vibration from construction activities.	Use hydraulic pressure or vibrator pile drivers when piling within 50 meters of sensitive sites.	Bridge near clinic and hospital
	Reduce speed of heavy vehicles near populated areas.	Near hospital, clinic and residential areas
1.6 Flood Control and Drainage -Temporary blockage of existing drainage resulting in flooding or stagnation of water	Provide alternative drainage to prevent flooding and stagnation of water. Also see Section 1.2 above.	Construction sites and borrow pit sites
2. Ecological Resources 2.1 Aquatic Ecology	Consider controlling turbidity caused by earth works	Bridge construction site
2.2 Forest Ecology -Destruction of forest and watershed	Build construction camps outside of forest area	Construction camps site
3. Human Use Values 3.1 Transportation -Severance of normal traffic patterns during construction	Create detour routes for major roads and highways if necessary.	Critical traffic areas

Table 15.24 (3): Environmental Mitigation Measures

CONSTRUCTION PERIOD

Resource and Potential Environmental Impact	Mitigation	Location
3.2 Water Use -Disruption of water supply	Inform downstream water users, especially farmers, of planned diversions and stops in water as well as drainage paths.	Downstream of construction sites if necessary
3.3 Human settlements -Displacement of people living along the route.	Compensate displaced households at a rate sufficient to purchase equivalent land, plus relocation expenses	Affected houses, facilities, lands for widening road and bypass route.
4. Quality of Life 4.1 Public Health -Public health impacts due to noise.	See Section 1.4 above	

Table 15.24 (4): Environmental Mitigation Measures

OPERATION PERIOD

Resource and Potential Environmental Impact	Mitigation	Location
1. Physical Resources 1.1 Air Quality -Degradation of ambient air quality due to vehicle emissions from to the road.	Regulations and inspections of motor vehicle emissions.	Along the route
1.2 Water Quality and Erosion -Degradation of water quality due to erosion.	Maintain vegetative cover on slopes and medians.	Cut slopes, berms of embankments
-Degradation of water quality due to toxic spills.	Provide warning sign for toxic spills on Highway	Along the route
1.3 Noise -Increase in ambient noise levels due to vehicles on the road.	Install noise barriers in areas where hospitals and school are in close distance to the highway.	Hospital, clinics and schools area at Section 3
	Impose a speed limit and strictly control access for overloaded vehicles.	Entire route
1.4 Vibration -Vibration due to truck traffic	Maintain road surface in good condition.	Entire route
1.5 Flood Control and Drainage -Increased flooding due to highway.	Pay attention to flooding potential and drainage in mountainous area along northern route.	Mountainous area long the route at Section 4, 5.
	Control vicinity land use and development.	Highway embankment at Section 1, 2.
2.Ecological Resources 2.2 Forest Ecology -Increased risk of forest fires	Assess vulnerable areas if necessary.	Forested area at Section 4, 5.
	Provide control training and education for forestry officials.	Forested area at Section 4, 5.
	Maintain natural vegetation in bare sloped area whenever possible.	Forested area at Section 4, 5
	Provide fire warning signs and fire fighting equipment.	Forested area at Section 4, 5
	Clear undergrowth in vulnerable areas.	Edge of right-of-way
-Encroachment in forest reserve	Provide warning sign and strictly limit access to forest from highway	Forested area
-Destruction of forests and watersheds	Establish fund for environmental education.	Forested areas and watersheds

Table 15.24 (5): Environmental Mitigation Measures

OPERATION PERIOD

Resource and Potential Environmental Impact	Mitigation	Location
-Animal victims on roadway	Provide warning sign for wildlife crossing	Forested area at Section 4, 5.
3.Human Use Values 3..1Land Use -Uncontrolled growth of industrial and commercial areas.	Government-mandated land use plans for major intersection areas, as well as roadways connecting the highway to urban growth centers.	Connecting roads of highway N0.18.
4.Quality of Life 4.1 Historical and Cultural Values -Degradation of appearance of hospital, temples and schools	Plant trees that will provide a dense screen of foliage, a fast growing evergreen. Species selection to be determined by the provincial Land Development Department.	Hospital , temples, Schools site
-Increase in ambient noise levels at hospital ,clinics and schools	See Section 1 . 3 above.	
4.2 Aesthetics -Adverse visual impact of highway	Provide ground cover planting on the exposed soil surfaces of the highway as described in section 1.3 of construction mitigation measures.	Exposed soil surfaces
	Plant trees to create a visual landscaped scenery and barrier between the highway in areas of specific aesthetic value , as described in section 4. 1 of operation mitigation measures.	Hospitals, temples and schools listed in section 4.1 of operation mitigation measures
4.3 Public Health -Degradation of ambient air quality and increase in ambient noise levels	See Section I above	
4.4 Highway Safety and Accident Response	Develop and implement an accident response plan	Along the route
- Death and injury from accidents	Perform routine and periodic maintenance.	Along the route
	Implement traffic management system.	Along the route

Table 15.25: Proposed Monitoring Program

Topic	Estimated Cost (US$ / Year)	Location	Parameters	Frequency	Duration
CONSTRUCTION PHASE					
Noise	8,000	Along construction sites	$L_{eq(24)}$, L_{10}	Every 3 months	3 days per measurement
Ambient Air Quality	4,000	Along construction sites	24-hr TSP	Every 3 months	3 days per measurement
Vibration	4,000	Blasting and piling locations	Peak particle velocity	When work in progress	1 day per measurement
Environmental Inspector	40,000	Combined for all sites	1 env. engineer and 1 env. scientist		
OPERATIONS PHASE:					
Air Quality	Depends on design 4,000	Six locations along the route	24-hr TSP 1-hr CO	Reports on daily monitoring.	
Noise	1,200	Six locations along the route	$L_{eq(24)}$, L_{10} Traffic volume	Every 5 years	3 days per measurement
Vibration	1,200	Six locations along the route	Peak particle velocity	Every 5 years	3 days per measurement
Sewage Treatment Effluent	800	Service areas	Suspended solid, BOD fecal caiform	Every 3 months	
Receiving Water Body	1,200	Service areas	Suspended solid, BOD fecal caiform	Every 3 months	

Chapter 16

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 16 CONCLUSIONS AND RECOMMENDATIONS

16.1 Section No.1 : Noi Bai - Bac Ninh

Section No.1 from Noi Bai to Bac Ninh is planned for construction as a four-lane road in its final stage with a design speed of 120 km/hr. Two lanes are to be completed and opened to traffic by the year 2001, and two more lanes should be added in the year 2013.

16.2 Section No.2 : Bac Ninh - Chi Linh

The existing stretch of Highway No.18 between Bac Ninh and Chi Linh is to be widened to two lanes with a shoulder width of 2.0m on both sides, and opened to traffic in the year 2001. The present proposal does not include further widening because of the later opening (2007) of the parallel alternate highway.

16.3 Section No.3 : Hong Gai - Cua Ong

It is recommended that the construction of four-lane urban-type highway should be completed by the end of 2000 to meet traffic demands.

16.4 Section No.4 : Cua Ong - Tien Yen

It is recommended that the existing road should be widened to attain two-lane road with 6.0m carriageway width and 1.0m shoulders on both sides except for the Cua Ong - Mong Duong section which should have two-lane carriageways of 7.0m width with 2.0m shoulders on both sides. The initial stage construction should be completed by the end of 1999 including pavement overlay and the construction of 12 bridges. The final stage construction (2010 opening) is comprised of the widening to two (2) lane road and no bridge constructoin.

16.5 Section No.5 : Tien Yen - Bac Luan

The section between Tien Yen and Bac Luan is planned to be widened to attain the two-lane road with 6.0m wide carriageway and 1.0m wide shoulders on both sides for the most part of entire length of 86.9km. However, a two-lane urban highway with bicycle lanes and sidewalks is provided in Mong Cai for about a 1.3km stretch to meet urban conditions.

The construction is divided into two stages as follows:

- Initial stage : (opening at 2000)
  - Pavement overlay;
  - 28 bridges;
  - Half of Tien Yen Bypass;
  - Dam Ha By-pass; and
  - Widening of access road of 700m to Ca Long bridge.

- Final stage : (opening at 2010)
  - Widening to two-lane road;
  - 10 bridges;
  - Remaining half of Tien Yen By-pass; and
  - Realignment in Ha Coi Town.

16.6 Project Cost

The estimated project costs (in January 1996 prices) of each section are shown in Table 16.1.

Table 16.1 Estimated Project Costs in 1996 Prices

(Unit : Million Dong)

Section No.	Section	Length (Km)	Initial Stage	Final Stage	Total
1.	Noi Bai-Bac Ninh	31.3	664,379	591,105	1,255,484
2.	Bac Ninh - Chi Linh	36.4	531,438	-	531,438
3.	Hong Gai - Cua Ong	38.7	836,030	-	836,030
4.	Cua Ong - Tien Yen	43.5	61,966	219,589	281,555
5.	Tien Yen - Bac Luan	86.9	150,942	452,825	603,767
Total		236.8	2,244,755	1,263,519	3,508,274

Total Project Costs for initial stage in current prices, with 1.0% and 10.0% per annum escalation allowance for foreign and local currencies respectively are computed as shown in Table 16.2.

Table 16.2 Estimated Project Costs for Initial Stage in Current Prices

(Unit : Million Dong)

Section No.	Section	Length Km	Current Prices of Initial Stage
1.	Noi Bai - Bac Ninh	31.3	771,828
2.	Bac Ninh - Chi Linh	36.4	617,640
3.	Hong Gai - Cua Ong	38.7	970,659
4.	Cua Ong - Tien Yen	43.5	69,654
5.	Tien Yen - Bac Luan	86.9	169,583
Total		236.8	2,599,364

16.7 Organization, System, and Training

(1) A maintenance/management office for Highway No. 18 should be set up at the soonest possibility. This will enable transfer of knowledge (technology) and on-the-job training through the construction/improvement project itself.

(2) In order to be able to deal with daily maintenance and emergency repairs, re-organization of RMU No. 2 will be necessary. Intermediate/large-scale repair work should be contracted (this will lead to advancement of local contractors' skills) through a gradual changeover to a contract base, as a step in marketization. RMU will continue to play a vital role in data-gathering, and emergency repair work.

16.8 Environment

(1) Buffer walls are required for certain facilities (religious, educational, and medical) along the Hong Gai - Cua Ong segment to reduce noise levels.

(2) More than one million cubic meters of excess soil will be produced by construction in Section 4, in contrast to other sections where mainly fill becomes necessary or where cut and fill balance out. The following points need to be heeded in regards to selection of dumping sites.

- Excavated soil should not be dumped or left as is in excessively rainy or dry seasons.
- Dump sites in which exposed or graded surfaces of excavated soil can be minimized should be selected.
- Planting or seeding of dumped soil should be undertaken immediately.
- Proper drainage facilities should be supplied to prevent adverse environmental affects (e.g., water contamination, filling, maddiness, etc.) down stream from the locations.
- Access roads to dump sites should be supplied.

Appendices

APPENDICES

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CHAPTER 4
CURRENT ROAD TRANSPORT PROFILE AND RESULTS OF TRAFFIC SURVEY

Appendix A-4.1 Classified Traffic Count Survey Data

The purpose of traffic counting survey is to find such characteristics as traffic volumes, hourly fluctuations, vehicle compositions at the selected cross sections; and to determine factors to be used in expanding the data collected on sampling basis.

The 24-hour survey was carried out at ten (10) locations on August 3 and 4, 1996. Five (5) out of the 10 locations was the same as the OD interview survey locations. The 12-hour survey was carried out at eleven (11) locations on the same days. The location is shown in Figure 4.1 of main text.

The following is summary of the surveyed data;

Classified Traffic Count Survey - Summary

Survey Site No.	Time	Duration	Direction	NMV	MC	Car	BUS		TRUCK				TOTALS			
				Bicycle Cyclo	Motor Cycle	Sedan Jeep, Van	Bus (Small)	Bus (Large)	Light (Pick-up)	2-axle (Comm.)	3-axle (Comm.)	4+axle (Comm.)	NMV	Motor Cycle	MV Total	Grand Total
1	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hanoi - Lang Son	1,545	889	229	141	68	41	291	99	2	1,545	889	871	3,305
	- ditto -	2*24 hrs.	Lang Son - Hanoi	1,473	920	273	177	33	52	311	121	2	1,473	920	969	3,362
2	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Bac Giang - Bac Ninh	3,972	3,887	442	295	95	114	313	42	2	3,972	3,887	1,303	9,162
	- ditto -	2*12 hrs.	Bac Ninh - Bac Giang	3,001	3,807	415	275	112	86	364	34	3	3,001	3,807	1,289	8,097
3	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Hanoi - Bac Ninh	3,000	5,820	613	271	136	144	538	54	13	3,000	5,820	1,769	10,589
	- ditto -	2*12 hrs.	Bac Ninh - Hanoi	2,754	4,525	545	289	125	117	509	45	4	2,754	4,525	1,634	8,913
7	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Vinh Yen - Phu Lo	3,479	3,869	903	324	230	180	396	22	3	3,479	3,869	2,058	9,406
	- ditto -	2*12 hrs.	Phu Lo - Vinh Yen	3,298	4,032	815	276	203	104	396	29	2	3,298	4,032	1,825	9,155
9	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Hanoi - Phu Lo	3,117	3,648	876	261	305	171	668	93	32	3,117	3,648	2,406	9,171
	- ditto -	2*12 hrs.	Phu Lo - Hanoi	3,706	3,627	804	263	276	79	613	63	21	3,706	3,627	2,119	9,452
11	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hanoi - Hai Phong	2,986	3,126	895	356	197	127	955	151	111	2,986	3,126	2,792	8,904
	- ditto -	2*24 hrs.	Hai Phong - Hanoi	3,462	2,998	983	344	188	115	983	125	113	3,462	2,998	2,851	9,311
13	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hong Gai - Hai Phong	2,130	1,632	233	158	89	72	76	6	4	2,130	1,632	638	4,400
	- ditto -	2*24 hrs.	Hai Phong - Hong Gai	1,640	1,576	293	164	93	63	79	2	0	1,640	1,576	694	3,910
14	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hai Phong - Thai Binh	589	426	56	3	90	11	175	8	0	589	426	343	1,358
	- ditto -	2*24 hrs.	Thai Binh - Hai Phong	651	452	60	5	82	18	165	5	0	651	452	335	1,438
15	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Bac Ninh - Pha Lai	3,801	1,606	125	32	24	35	109	12	0	3,801	1,606	337	5,744
	- ditto -	2*12 hrs.	Pha Lai - Bac Ninh	3,521	1,553	139	31	22	21	108	10	0	3,521	1,553	331	5,405
16	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hai Hung - Hanoi	528	423	124	31	27	16	143	19	1	528	423	361	1,312
	- ditto -	2*24 hrs.	Hanoi - Hai Hung	602	483	108	27	27	22	134	18	0	602	483	336	1,421
17	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Chi Linh - Dong Trieu	1,121	805	342	95	124	125	347	32	3	1,121	805	1,068	2,994
	- ditto -	2*24 hrs.	Dong Trieu - Chi Linh	1,853	1,027	310	97	113	98	369	25	1	1,853	1,027	1,013	3,893

Classified Traffic Count Survey - Summary

Survey Site No.	Date & Time	Duration	Direction	NMV	MC	Car	BUS		TRUCK				TOTALS			
				Bicycle Cyclo	Motor Cycle	Sedan Jeep, Van	Bus (Small)	Bus (Large)	Light (Pick-up)	2-axle (Comm.)	3-axle (Comm.)	4+axle (Comm.)	NMV	Motor Cycle	MV Total	Grand Total
18	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Hai Phong - Bai Chay	1,830	2,970	421	250	237	142	347	13	1	1,830	2,970	1,411	6,211
	- ditto -	2*12 hrs.	Bai Chay - Hai Phong	3,262	4,360	488	246	220	152	258	27	0	3,262	4,360	1,391	9,013
19	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hong Gai - Bai Chay	1,814	3,599	594	80	148	52	304	16	0	1,814	3,599	1,194	6,607
	- ditto -	2*24 hrs.	Bai Chay - Hong Gai	1,864	3,523	574	140	164	56	307	12	1	1,864	3,523	1,254	6,641
20	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hong Gai - Cam Pha	750	1,311	381	191	366	42	359	54	0	750	1,311	1,393	3,454
	- ditto -	2*24 hrs.	Cam Pha - Hong Gai	935	1,424	385	323	272	62	361	62	0	935	1,424	1,465	3,824
21	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Cua Ong - Cam Pha	1,323	1,900	418	373	259	116	244	122	1	1,323	1,900	1,533	4,756
	- ditto -	2*12 hrs.	Cam Pha - Cua Ong	741	1,267	396	366	265	106	258	214	1	741	1,267	1,606	3,614
22	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Mong Cai - Cua Ong	2	78	54	39	43	12	35	8	0	2	78	191	271
	- ditto -	2*12 hrs.	Cua Ong - Mong Cai	2	67	93	57	53	37	33	2	0	2	67	275	344
23	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Mong Cai - Tien Yen	166	204	50	39	51	3	21	7	0	166	204	171	541
	- ditto -	2*12 hrs.	Tien Yen - Mong Cai	203	209	96	98	67	3	44	8	0	203	209	316	728
26	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Hai Duong - Chi Linh	1,096	652	177	51	85	31	312	8	0	1,096	652	664	2,412
	- ditto -	2*24 hrs.	Chi Linh - Hai Duong	1,039	577	183	33	70	26	297	5	0	1,039	577	614	2,230
27	95/8/3 6:00 - 95/8/5 6:00	2*24 hrs.	Chi Linh - Bac Giang	1,225	445	8	3	3	62	13	0	0	1,225	445	89	1,759
	- ditto -	2*24 hrs.	Bac Giang - Chi Linh	1,195	417	10	3	7	48	16	0	0	1,195	417	84	1,696
29	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Bac Ninh - Dong Anh	3,561	1,418	24	1	10	42	42	5	0	3,561	1,418	124	5,103
	- ditto -	2*12 hrs.	Dong Anh - Bac Ninh	3,208	1,387	31	1	11	46	31	7	0	3,208	1,387	127	4,722
30	95/8/3 & 8/4 6:00-18:00	2*12 hrs.	Noi Bai - Thang Long	887	1,941	1,777	432	91	69	113	3	2	887	1,941	2,487	5,315
	- ditto -	2*12 hrs.	Thang Long - Noi Bai	789	2,632	2,216	484	110	88	133	6	1	789	2,632	3,038	6,459

Appendix A-4.2 Roadside OD Interview Survey Data

The purpose of OD survey is to collect vehicle OD tables, forecast future OD tables and to estimate future traffic volumes on the Highway No. 18.

Total number of locations to be surveyed are five (5), the location of OD survey is shown in Figure 4.1 of Main Text.

The survey consists of two (2) days of 12-hour (6:00 - 18:00) survey. The survey was done on August 3 and 4, 1996.

The survey was carried out for the following vehicle types:

- motorized passenger vehicles:
  1) Passenger cars
  2) Buses
- motorized goods vehicles:
  3) Pick-up trucks
  4) Trucks with 2 axles
  5) Trucks with 3 axles

ROADSIDE OD INTERVIEW SURVEY DATA

STATION NO. 11

O	D	Type	Trip No.
15	1	Car	128
		Bus	90
		Truck	102
		Total	320
15	6	Car	6
		Bus	0
		Truck	2
		Total	8
15	7	Car	0
		Bus	0
		Truck	4
		Total	4
15	8	Car	2
		Bus	12
		Truck	14
		Total	28
15	11	Car	2
		Bus	0
		Truck	18
		Total	20
15	12	Car	0
		Bus	0
		Truck	2
		Total	2

O	D	Type	Trip No.
15	13	Car	26
		Bus	26
		Truck	84
		Total	136
15	14	Car	0
		Bus	0
		Truck	34
		Total	34
15	16	Car	0
		Bus	4
		Truck	4
		Total	8
15	27	Car	0
		Bus	0
		Truck	2
		Total	2
15	28	Car	2
		Bus	4
		Truck	2
		Total	8
15	29	Car	0
		Bus	2
		Truck	4
		Total	6

O	D	Type	Trip No.
15	30	Car	0
		Bus	2
		Truck	0
		Total	2
15	31	Car	0
		Bus	12
		Truck	2
		Total	14
15	32	Car	0
		Bus	6
		Truck	14
		Total	20
	Grand Total		612

ROADSIDE OD INTERVIEW SURVEY DATA

STATION NO. 13

O	D	Type	Trip No.
1	15	Car	14
		Bus	0
		Truck	0
		Total	14
1	19	Car	0
		Bus	4
		Truck	3
		Total	7
1	21	Car	1
		Bus	0
		Truck	0
		Total	1
11	17	Car	1
		Bus	0
		Truck	0
		Total	1
11	19	Car	1
		Bus	0
		Truck	1
		Total	2
11	20	Car	0
		Bus	0
		Truck	1
		Total	1

O	D	Type	Trip No.
13	17	Car	0
		Bus	0
		Truck	1
		Total	1
13	21	Car	1
		Bus	0
		Truck	2
		Total	3
14	17	Car	0
		Bus	0
		Truck	1
		Total	1
15	16	Car	4
		Bus	0
		Truck	0
		Total	4
15	18	Car	5
		Bus	12
		Truck	0
		Total	17
15	19	Car	18
		Bus	24
		Truck	11
		Total	53

O	D	Type	Trip No.
15	20	Car	4
		Bus	4
		Truck	9
		Total	17
15	21	Car	6
		Bus	8
		Truck	8
		Total	22
15	26	Car	5
		Bus	0
		Truck	0
		Total	5
16	17	Car	0
		Bus	0
		Truck	2
		Total	2
16	18	Car	3
		Bus	2
		Truck	0
		Total	5
16	19	Car	9
		Bus	21
		Truck	13
		Total	43

STATION NO. 13 (Cont'd)

O	D	Type	Trip No.
16	20	Car	1
		Bus	0
		Truck	2
		Total	3
16	21	Car	0
		Bus	3
		Truck	4
		Total	7
16	26	Car	2
		Bus	0
		Truck	0
		Total	2
19	26	Car	2
		Bus	0
		Truck	0
		Total	2
19	32	Car	11
		Bus	12
		Truck	1
		Total	24
19	33	Car	7
		Bus	11
		Truck	0
		Total	18
20	32	Car	0
		Bus	0
		Truck	2
		Total	2
21	32	Car	1
		Bus	6
		Truck	4
		Total	11
	Grand Total		268

O	D	Type	Trip No.

ROADSIDE OD INTERVIEW SURVEY DATA

STATION NO. 16

O	D	Type	Trip No.
1	11	Car	28
		Bus	9
		Truck	15
		Total	52
1	16	Car	22
		Bus	3
		Truck	24
		Total	49
1	17	Car	0
		Bus	0
		Truck	2
		Total	2
1	18	Car	13
		Bus	14
		Truck	11
		Total	38
1	19	Car	22
		Bus	5
		Truck	7
		Total	34
1	20	Car	2
		Bus	2
		Truck	5
		Total	9

O	D	Type	Trip No.
1	21	Car	0
		Bus	2
		Truck	2
		Total	4
1	23	Car	0
		Bus	0
		Truck	2
		Total	2
1	32	Car	0
		Bus	0
		Truck	5
		Total	5
5	11	Car	0
		Bus	0
		Truck	5
		Total	5
5	16	Car	0
		Bus	0
		Truck	11
		Total	11
5	18	Car	2
		Bus	2
		Truck	0
		Total	4

O	D	Type	Trip No.
5	19	Car	2
		Bus	0
		Truck	0
		Total	2
5	20	Car	0
		Bus	2
		Truck	0
		Total	2
6	11	Car	2
		Bus	0
		Truck	5
		Total	7
6	16	Car	5
		Bus	0
		Truck	0
		Total	5
6	18	Car	9
		Bus	2
		Truck	0
		Total	11
6	19	Car	0
		Bus	3
		Truck	0
		Total	3

STATION NO. 16 (cont'd)

O	D	Type	Trip No.
7	11	Car	0
		Bus	0
		Truck	2
		Total	2
8	19	Car	0
		Bus	5
		Truck	0
		Total	5
8	23	Car	0
		Bus	3
		Truck	0
		Total	3
26	19	Car	0
		Bus	0
		Truck	2
		Total	2
27	11	Car	0
		Bus	0
		Truck	15
		Total	15
27	16	Car	0
		Bus	0
		Truck	5
		Total	5

O	D	Type	Trip No.
29	11	Car	2
		Bus	0
		Truck	2
		Total	4
29	16	Car	0
		Bus	0
		Truck	5
		Total	5
30	23	Car	0
		Bus	0
		Truck	2
		Total	2
31	11	Car	0
		Bus	2
		Truck	2
		Total	4
31	16	Car	0
		Bus	0
		Truck	2
		Total	2
32	11	Car	5
		Bus	0
		Truck	14
		Total	19

O	D	Type	Trip No.
32	16	Car	0
		Bus	0
		Truck	15
		Total	15
32	18	Car	0
		Bus	2
		Truck	2
		Total	4
32	19	Car	0
		Bus	0
		Truck	2
		Total	2
32	20	Car	0
		Bus	0
		Truck	5
		Total	5
32	21	Car	0
		Bus	0
		Truck	2
		Total	2
32	23	Car	2
		Bus	0
		Truck	7
		Total	9
	Grand Total		350

ROADSIDE OD INTERVIEW SURVEY DATA

STATION NO. 17

O	D	Type	Trip No.
1	16	Car	0
		Bus	7
		Truck	43
		Total	50
1	17	Car	5
		Bus	0
		Truck	9
		Total	14
1	18	Car	13
		Bus	7
		Truck	30
		Total	50
1	19	Car	144
		Bus	86
		Truck	81
		Total	311
1	20	Car	26
		Bus	3
		Truck	26
		Total	55
1	21	Car	0
		Bus	0
		Truck	4
		Total	4

O	D	Type	Trip No.
1	23	Car	0
		Bus	0
		Truck	8
		Total	8
5	23	Car	0
		Bus	3
		Truck	0
		Total	3
6	16	Car	0
		Bus	3
		Truck	8
		Total	11
8	19	Car	5
		Bus	0
		Truck	0
		Total	5
9	16	Car	0
		Bus	0
		Truck	4
		Total	4
11	16	Car	13
		Bus	7
		Truck	64
		Total	84

O	D	Type	Trip No.
11	17	Car	4
		Bus	0
		Truck	13
		Total	17
11	18	Car	0
		Bus	7
		Truck	21
		Total	28
11	19	Car	21
		Bus	14
		Truck	13
		Total	48
11	20	Car	4
		Bus	7
		Truck	30
		Total	41
11	21	Car	0
		Bus	3
		Truck	9
		Total	12
12	19	Car	0
		Bus	3
		Truck	0
		Total	3

STATION NO. 17 (cont'd)

O	D	Type	Trip No.
12	20	Car	0
		Bus	7
		Truck	0
		Total	7
12	21	Car	0
		Bus	3
		Truck	0
		Total	3
13	11	Car	0
		Bus	0
		Truck	13
		Total	13
13	16	Car	9
		Bus	3
		Truck	13
		Total	25
13	18	Car	4
		Bus	3
		Truck	9
		Total	16
13	19	Car	38
		Bus	7
		Truck	13
		Total	58

O	D	Type	Trip No.
13	20	Car	0
		Bus	7
		Truck	4
		Total	11
13	23	Car	4
		Bus	0
		Truck	0
		Total	4
14	17	Car	0
		Bus	0
		Truck	4
		Total	4
14	19	Car	4
		Bus	0
		Truck	0
		Total	4
16	18	Car	0
		Bus	3
		Truck	4
		Total	7
16	19	Car	8
		Bus	3
		Truck	4
		Total	15

O	D	Type	Trip No.
16	20	Car	4
		Bus	0
		Truck	4
		Total	8
27	16	Car	0
		Bus	0
		Truck	4
		Total	4
27	17	Car	0
		Bus	3
		Truck	0
		Total	3
27	20	Car	0
		Bus	0
		Truck	4
		Total	4
28	18	Car	0
		Bus	3
		Truck	4
		Total	7
28	19	Car	4
		Bus	0
		Truck	0
		Total	4

STATION NO. 17 (cont'd)

O	D	Type	Trip No.
28	21	Car	0
		Bus	3
		Truck	0
		Total	3
31	19	Car	4
		Bus	0
		Truck	4
		Total	8
32	16	Car	0
		Bus	0
		Truck	4
		Total	4
32	18	Car	0
		Bus	0
		Truck	4
		Total	4
32	19	Car	8
		Bus	7
		Truck	17
		Total	32
32	20	Car	4
		Bus	10
		Truck	8
		Total	22

O	D	Type	Trip No.
32	21	Car	0
		Bus	3
		Truck	0
		Total	3
32	23	Car	0
		Bus	0
		Truck	21
		Total	21
	Grand Total		1,042

O	D	Type	Trip No.

ROADSIDE OD INTERVIEW SURVEY DATA

STATION NO. 19

O	D	Type	Trip No.
1	19	Car	103
		Bus	30
		Truck	17
		Total	150
1	20	Car	23
		Bus	19
		Truck	15
		Total	57
1	21	Car	4
		Bus	13
		Truck	3
		Total	20
1	23	Car	4
		Bus	13
		Truck	6
		Total	23
2	19	Car	0
		Bus	2
		Truck	0
		Total	2
3	21	Car	4
		Bus	0
		Truck	0
		Total	4

O	D	Type	Trip No.
5	19	Car	4
		Bus	0
		Truck	0
		Total	4
5	20	Car	0
		Bus	2
		Truck	0
		Total	2
5	23	Car	0
		Bus	0
		Truck	3
		Total	3
6	19	Car	4
		Bus	2
		Truck	0
		Total	6
6	20	Car	0
		Bus	4
		Truck	0
		Total	4
8	19	Car	0
		Bus	2
		Truck	0
		Total	2

O	D	Type	Trip No.
8	20	Car	0
		Bus	0
		Truck	3
		Total	3
8	23	Car	0
		Bus	2
		Truck	0
		Total	2
11	17	Car	0
		Bus	0
		Truck	3
		Total	3
11	19	Car	11
		Bus	7
		Truck	15
		Total	33
11	20	Car	0
		Bus	9
		Truck	6
		Total	15
11	21	Car	0
		Bus	6
		Truck	0
		Total	6

STATION NO. 19 (cont'd)

O	D	Type	Trip No.
11	23	Car	0
		Bus	4
		Truck	0
		Total	4
12	22	Car	0
		Bus	0
		Truck	3
		Total	3
13	19	Car	19
		Bus	2
		Truck	6
		Total	27
13	20	Car	0
		Bus	7
		Truck	0
		Total	7
13	21	Car	4
		Bus	17
		Truck	0
		Total	21
13	23	Car	4
		Bus	2
		Truck	0
		Total	6

O	D	Type	Trip No.
14	19	Car	0
		Bus	0
		Truck	3
		Total	3
15	17	Car	0
		Bus	2
		Truck	0
		Total	2
15	19	Car	45
		Bus	4
		Truck	9
		Total	58
15	20	Car	4
		Bus	7
		Truck	15
		Total	26
15	21	Car	8
		Bus	6
		Truck	0
		Total	14
15	23	Car	8
		Bus	2
		Truck	6
		Total	16

O	D	Type	Trip No.
16	19	Car	79
		Bus	23
		Truck	73
		Total	175
16	20	Car	26
		Bus	2
		Truck	50
		Total	78
16	21	Car	4
		Bus	0
		Truck	3
		Total	7
16	22	Car	0
		Bus	2
		Truck	3
		Total	5
16	23	Car	11
		Bus	0
		Truck	3
		Total	14
17	19	Car	19
		Bus	2
		Truck	15
		Total	36

STATION NO. 19 (cont'd)

O	D	Type	Trip No.
17	21	Car	4
		Bus	0
		Truck	0
		Total	4
17	23	Car	0
		Bus	0
		Truck	3
		Total	3
18	19	Car	133
		Bus	28
		Truck	43
		Total	204
18	20	Car	11
		Bus	7
		Truck	15
		Total	33
18	22	Car	0
		Bus	0
		Truck	3
		Total	3
18	23	Car	8
		Bus	4
		Truck	17
		Total	29
27	19	Car	8
		Bus	0
		Truck	3
		Total	11
27	23	Car	0
		Bus	2
		Truck	0
		Total	2
28	19	Car	4
		Bus	0
		Truck	0
		Total	4
28	20	Car	0
		Bus	0
		Truck	3
		Total	3
28	21	Car	8
		Bus	0
		Truck	0
		Total	8
28	22	Car	0
		Bus	0
		Truck	3
		Total	3
28	23	Car	0
		Bus	2
		Truck	0
		Total	2
32	20	Car	0
		Bus	2
		Truck	0
		Total	2
33	19	Car	4
		Bus	9
		Truck	3
		Total	16
33	20	Car	8
		Bus	11
		Truck	9
		Total	28
33	21	Car	4
		Bus	6
		Truck	0
		Total	10
33	23	Car	4
		Bus	2
		Truck	12
		Total	18
		Grand Total	1,224

CHAPTER 5
TRANSPORT MODELING AND DEMAND FORECASTS

Appendix A - 5.1

PROVINCE - BASED MODAL VEHICLE TRIP TABLES
PASSENGER CAR, BUS AND TRUCK MODES
YEARS 1995, 2005 AND 2015

YEAR 1995 MODAL VEHICLE TRIP MATRIXES
SIMPLIFIED SUPERZONE SYSTEM

PASSENGER CARS

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	2678	147	215	31	218	10	105	142	119	184	799	537	0	5185
2	148	147	9	64	1	65	6	55	6	5	24	11	0	541
3	215	9	210	44	126	1	10	10	6	3	32	12	12	690
4	33	62	45	1121	121	1	0	5	4	1	9	5	11	1418
5	218	2	127	120	0	0	0	37	4	3	12	25	5	553
6	11	65	1	1	0	0	0	34	0	0	6	5	0	123
7	105	5	11	0	0	0	0	29	0	0	18	23	0	191
8	142	55	10	5	36	35	29	0	0	1	21	73	0	407
9	119	5	7	5	4	0	0	0	0	3	20	0	0	163
10	185	5	2	1	3	0	0	0	4	0	0	0	0	200
11	799	24	33	8	12	6	18	21	20	0	0	16	0	957
12	538	11	11	6	25	6	22	73	0	0	15	0	0	707
13	0	0	13	10	5	0	0	0	0	0	0	0	0	28
TOTAL	5191	537	694	1416	551	124	190	406	163	200	956	707	28	11156

BUSES

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	491	461	216	61	172	57	60	104	43	166	448	392	0	2671
2	462	34	10	20	5	5	11	21	2	0	27	21	0	618
3	215	11	33	4	4	3	11	0	0	0	0	26	1	308
4	61	21	3	1669	88	2	0	1	4	3	6	10	37	1905
5	172	4	3	90	0	0	5	14	1	1	23	7	9	329
6	57	6	3	1	0	0	0	9	0	0	20	7	0	103
7	59	10	13	0	5	0	0	18	0	0	29	33	0	167
8	104	23	0	1	14	9	17	0	0	12	18	14	0	212
9	44	1	0	4	2	0	0	0	0	2	37	0	0	90
10	167	0	0	3	0	0	0	11	2	0	0	7	0	190
11	448	27	0	8	23	21	28	18	37	0	0	48	0	658
12	391	21	26	8	7	7	34	14	0	7	49	0	0	564
13	0	0	1	36	9	0	0	0	0	0	0	0	0	46
TOTAL	2671	619	308	1905	329	104	166	210	89	191	657	565	47	7850

TRUCKS

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	485	608	397	83	299	92	343	190	204	279	435	839	0	4254
2	610	245	27	60	15	55	20	9	4	15	47	81	0	1188
3	397	29	114	47	65	13	17	33	2	0	9	77	11	814
4	83	59	49	1241	60	5	7	24	1	5	9	18	6	1567
5	300	14	66	60	0	11	20	85	3	15	20	75	71	740
6	92	55	12	7	10	0	0	7	0	0	2	38	5	228
7	344	21	17	6	20	0	0	70	0	1	25	80	0	584
8	189	9	33	24	85	8	69	0	0	23	41	68	0	549
9	205	4	2	1	4	0	0	0	0	2	73	0	0	291
10	279	13	0	4	14	0	2	23	2	0	12	0	0	349
11	435	50	9	9	20	1	24	41	73	12	0	65	0	739
12	838	81	77	17	75	38	80	68	0	0	65	0	0	1339
13	0	0	12	7	71	6	0	0	0	0	0	0	0	96
TOTAL	4257	1188	815	1566	738	229	582	550	289	352	738	1341	93	12730

(1) Refer Figure 5.9 for superzone illustration.
(2) Matrixes contain daily vehicle trips crossing a zone boundary as defined by the 33 zone system (refer Figure 5.4)

YEAR 2005 MODAL VEHICLE TRIP MATRIXES

SIMPLIFIED SUPERZONE SYSTEM

PASSENGER CARS

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	7072	426	618	304	575	27	270	361	341	594	2500	1543	0	14631
2	427	588	36	204	4	244	22	201	22	23	110	46	0	1927
3	617	37	809	141	481	5	36	38	26	12	146	48	41	2437
4	307	200	140	2950	351	2	0	14	14	3	30	16	27	4054
5	576	6	481	352	0	0	0	125	15	13	49	96	15	1728
6	27	245	4	3	0	0	0	116	0	0	23	21	0	439
7	270	21	38	0	0	0	0	95	0	0	72	84	0	580
8	363	204	36	13	125	115	96	0	0	2	85	269	0	1308
9	340	23	26	13	15	0	0	0	0	17	89	0	0	523
10	594	23	12	4	13	0	0	1	16	0	0	0	0	663
11	2501	108	148	29	49	24	72	85	89	0	0	70	0	3175
12	1542	46	47	18	95	21	83	270	0	0	69	0	0	2191
13	0	0	42	27	16	0	0	0	0	0	0	0	0	85
TOTAL	14636	1927	2437	4058	1724	438	579	1306	523	664	3173	2193	83	33735

BUSES

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	1316	1321	665	280	513	145	148	266	114	467	1244	1046	0	7525
2	1321	110	38	56	16	16	30	66	5	0	88	66	0	1812
3	667	37	125	11	14	9	36	0	0	0	0	88	3	990
4	283	58	12	4301	254	3	0	2	9	8	17	24	98	5069
5	513	16	12	254	0	0	17	42	5	1	77	22	30	989
6	145	16	9	3	0	0	0	24	0	0	58	19	0	274
7	149	28	39	0	14	0	0	46	0	0	78	91	0	445
8	268	65	0	2	44	24	44	0	0	34	52	38	0	571
9	113	5	0	10	3	0	0	0	0	7	106	0	0	244
10	470	0	0	7	2	0	0	34	6	0	0	21	0	540
11	1243	86	0	19	76	58	79	52	107	0	0	145	0	1865
12	1048	66	85	22	24	19	90	39	0	21	145	0	0	1559
13	0	0	4	93	29	0	0	0	0	0	0	0	0	131
TOTAL	7536	1808	989	5063	989	274	444	571	246	538	1865	1560	131	22008

TRUCKS

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	589	752	387	612	530	129	449	273	367	487	651	1211	0	6437
2	754	464	44	289	39	124	40	21	12	39	118	188	0	2132
3	386	46	140	210	148	21	28	59	5	0	17	142	12	1214
4	613	290	211	8475	493	32	25	108	6	26	42	105	16	10442
5	530	40	148	493	0	33	59	272	15	58	70	251	127	2096
6	130	122	23	31	33	0	0	19	0	0	4	101	8	471
7	449	41	28	27	59	0	0	159	0	5	61	193	0	1022
8	275	19	59	107	272	19	160	0	0	73	112	178	0	1274
9	367	11	5	6	14	0	0	0	0	9	258	0	0	670
10	487	41	0	25	59	0	5	73	8	0	42	0	0	740
11	651	116	17	42	70	3	61	112	257	41	0	186	0	1556
12	1211	190	142	105	252	101	193	179	0	0	185	0	0	2558
13	0	0	12	15	126	8	0	0	0	0	0	0	0	161
TOTAL	6442	2132	1216	10437	2095	470	1020	1275	670	738	1560	2555	163	30765

(1) Refer Figure 5.9 for superzone illustration.

(2) Matrixes contain daily vehicle trips crossing a zone boundary as defined by the 33 zone system (refer Figure 5.4)

YEAR 2015 MODAL VEHICLE TRIP MATRIXES
SIMPLIFIED SUPERZONE SYSTEM

PASSENGER CARS

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	13636	1224	1408	481	1279	36	474	603	639	1292	5302	3154	0	29528
2	1225	2882	158	600	22	632	72	647	78	96	453	175	0	7040
3	1409	159	2613	331	1629	10	100	95	74	40	476	148	101	7185
4	481	602	330	5775	811	4	0	22	26	9	64	39	41	8204
5	1279	21	1628	809	0	0	0	312	42	42	155	292	37	4617
6	36	631	10	3	0	0	0	172	0	0	45	38	0	935
7	476	73	99	0	0	0	0	188	0	0	179	201	0	1216
8	603	647	94	23	312	172	188	0	0	4	201	617	0	2861
9	640	78	75	25	42	0	0	0	0	45	237	0	0	1142
10	1291	98	40	9	42	0	0	4	44	0	0	0	0	1528
11	5302	452	476	65	155	44	180	202	237	0	0	202	0	7315
12	3154	175	147	37	292	38	202	616	0	0	202	0	0	4863
13	0	0	101	42	37	0	0	0	0	0	0	0	0	180
TOTAL	29532	7042	7179	8200	4621	936	1216	2861	1140	1528	7314	4866	179	76606

BUSES

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	2153	4019	1535	470	1163	219	202	383	175	1000	2280	1813	0	15412
2	4021	660	248	206	96	65	106	267	23	0	443	311	0	6446
3	1534	247	605	33	62	29	109	0	0	0	0	315	11	2945
4	472	206	32	8517	678	6	0	3	17	19	40	87	176	10253
5	1164	97	63	678	0	0	44	130	13	6	290	83	93	2661
6	220	65	29	6	0	0	0	47	0	0	147	45	0	559
7	203	105	108	0	44	0	0	82	0	0	179	196	0	917
8	383	268	0	3	129	48	82	0	0	95	126	89	0	1223
9	176	23	0	16	13	0	0	0	0	20	277	0	0	525
10	1000	0	0	19	6	0	0	95	20	0	0	71	0	1211
11	2281	442	0	39	291	147	179	126	277	0	0	422	0	4204
12	1812	314	314	88	83	45	195	88	0	71	420	0	0	3430
13	0	0	12	175	93	0	0	0	0	0	0	0	0	280
TOTAL	15419	6446	2946	10250	2658	559	917	1221	525	1211	4202	3432	280	50059

TRUCKS

SZONE(1)	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	1070	1120	570	1172	985	208	662	495	784	890	1012	3503	0	12471
2	1122	745	71	617	78	210	62	38	26	78	190	578	0	3815
3	570	70	218	452	290	38	44	107	12	0	28	431	21	2281
4	1177	616	454	21027	1171	71	51	255	18	63	89	437	34	25463
5	985	77	289	1171	0	71	113	630	40	142	145	963	269	4895
6	208	209	39	70	69	0	0	38	0	0	6	335	14	988
7	661	63	42	51	113	0	0	288	0	9	99	574	0	1900
8	495	37	109	255	630	38	288	0	0	166	219	644	0	2881
9	784	26	11	19	40	0	0	0	0	23	611	0	0	1514
10	891	77	0	64	142	0	9	166	24	0	84	0	0	1457
11	1012	193	28	89	144	7	97	219	610	85	0	596	0	3080
12	3504	578	431	437	964	334	575	646	0	0	596	0	0	8065
13	0	0	20	35	268	14	0	0	0	0	0	0	0	337
TOTAL	12479	3811	2282	25459	4894	991	1901	2882	1514	1456	3079	8061	338	69138

(1) Refer Figure 5.9 for superzone illustration.
(2) Matrixes contain daily vehicle trips crossing a zone boundary as defined by the 33 zone system (refer Figure 5.4)

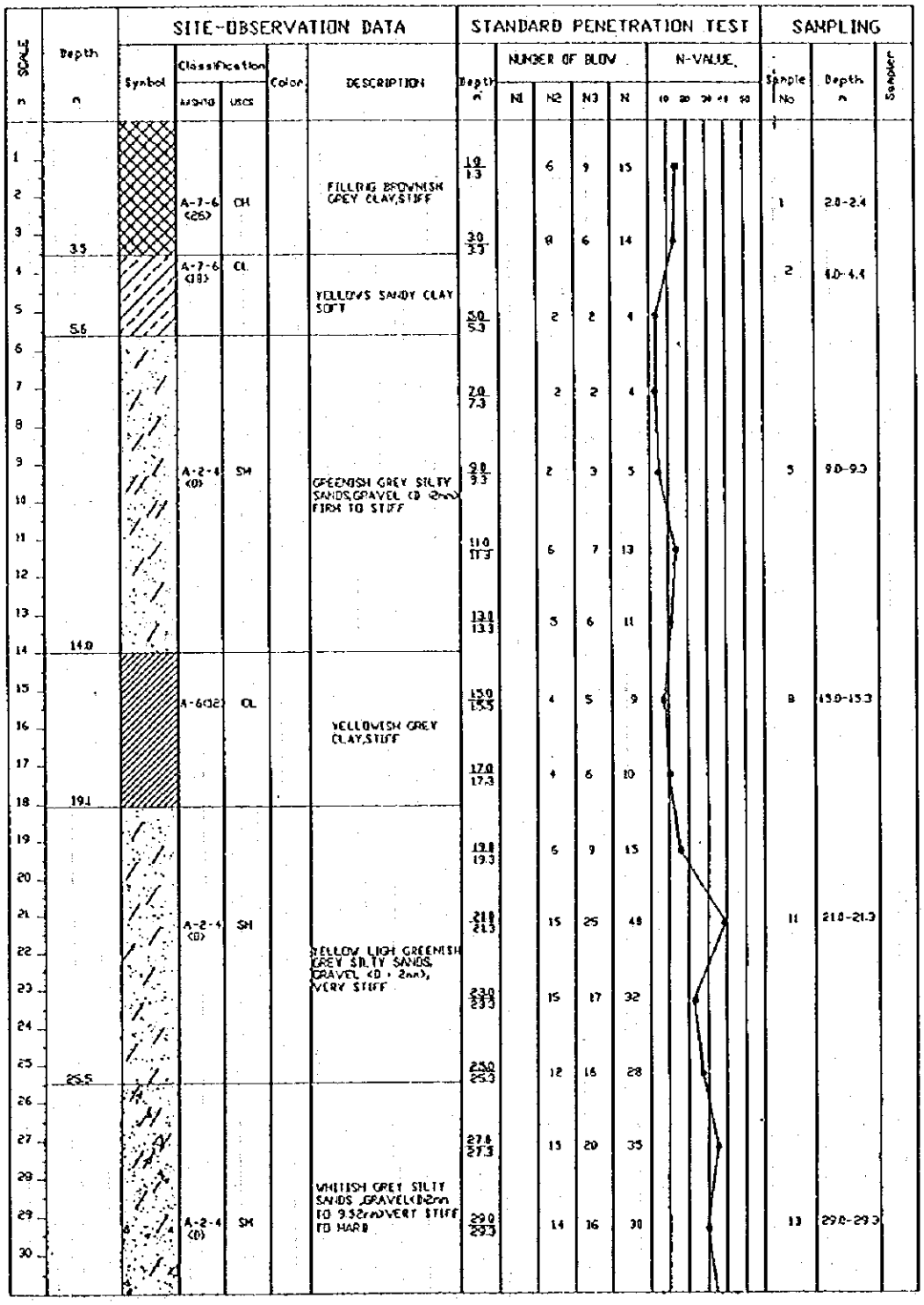
CHAPTER 6
PHYSICAL CONDITIONS OF STUDY AREA AND ENGINEERING SURVEY

Appendix A - 6.1

BORING LOGS

ALTITUDE Datum (+5.5) m COMPLETE DATE September 25th 1995

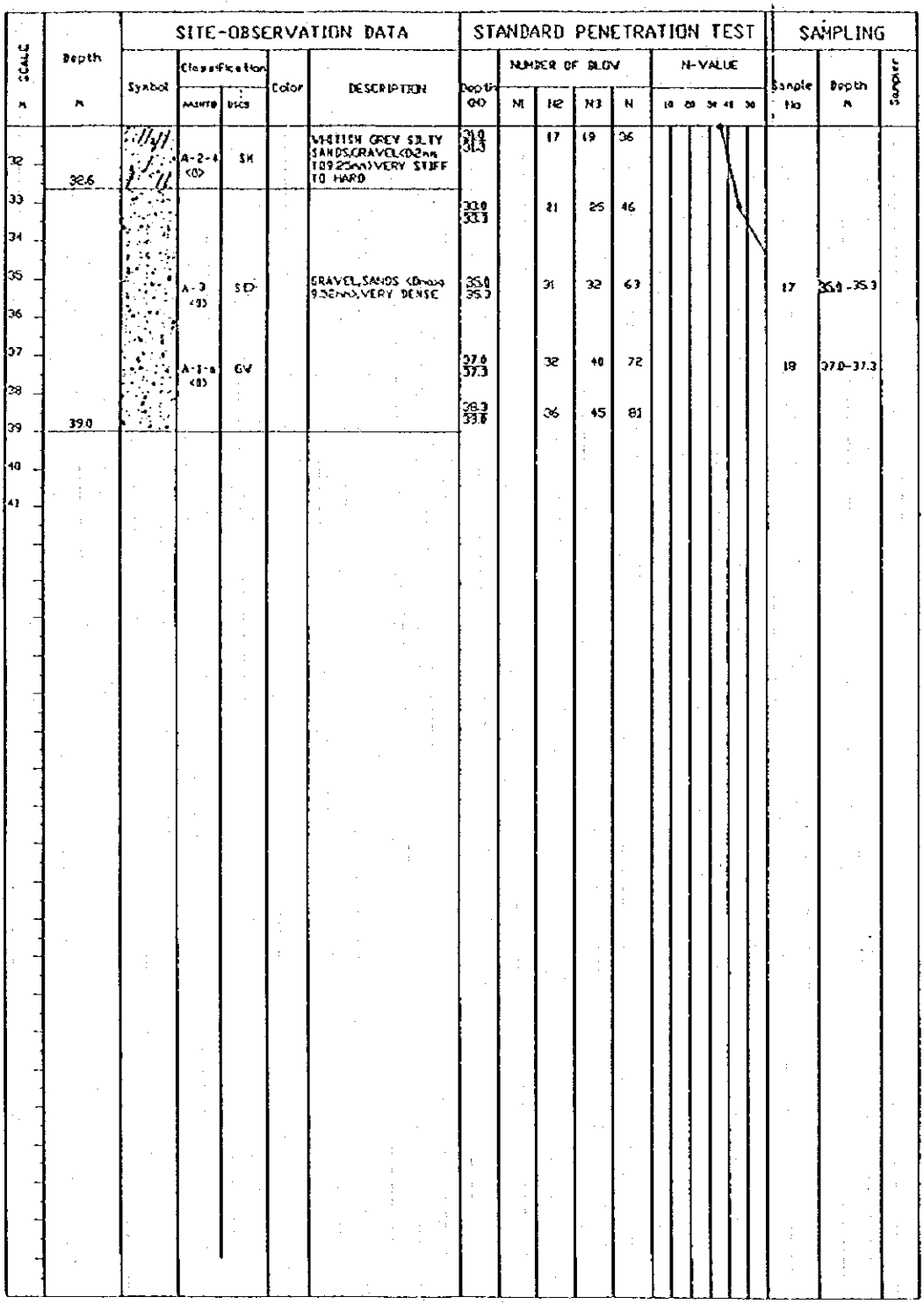
LOCATION CA LO BRIDGE BOREHOLE No. B1 WATER GL. -0.5 m



HIGHWAY NO. 18 IMPROVEMENT	**Appendix A - 6.1 Boring Logs (1)**

ALTITUDE Datum (+5.5) : m COMPLETE DATE September 25th 1995

LOCATION CA LO BRIDGE BOREHOLE No: B1 (Continue) WATER GL: +0.5 m

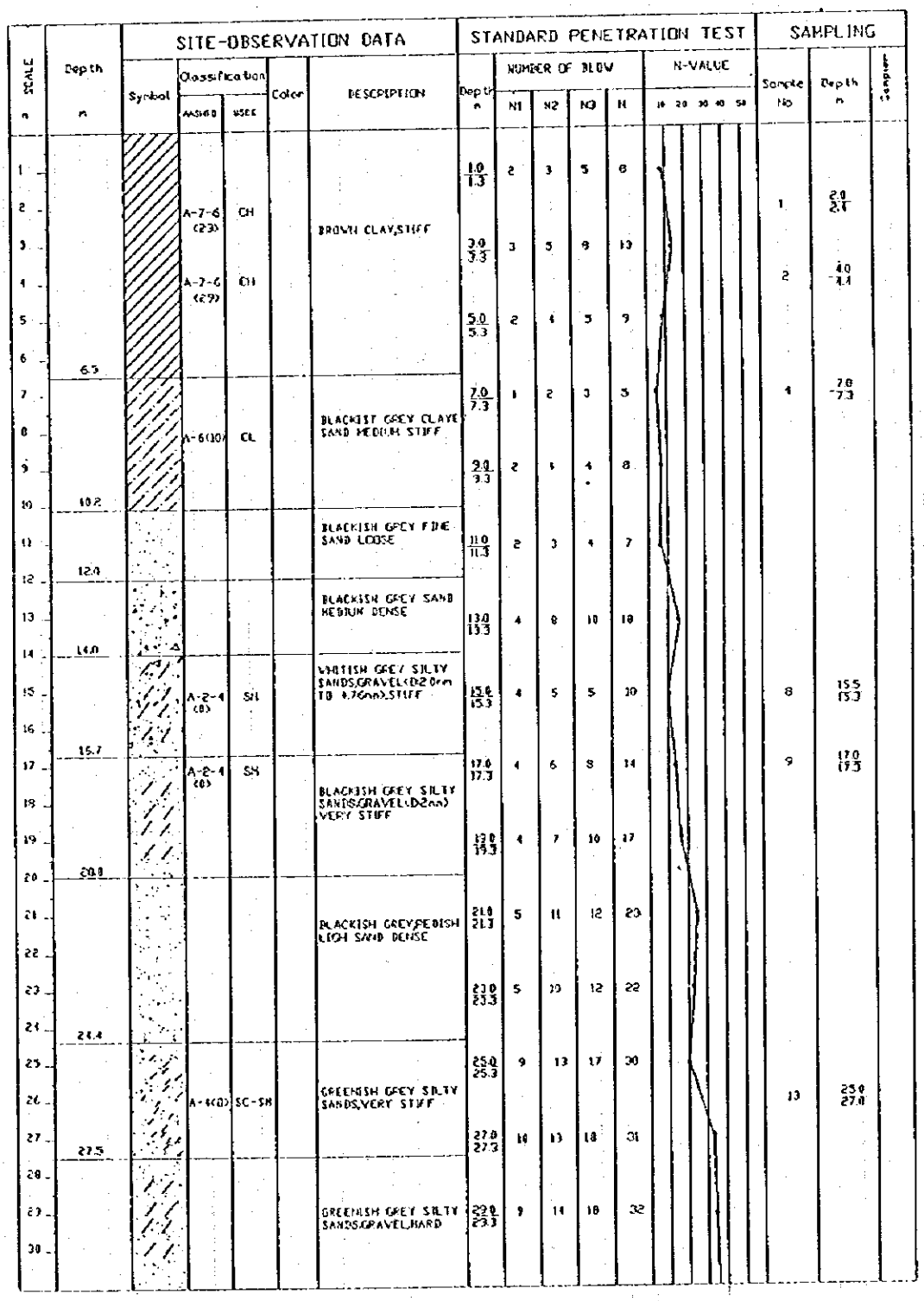


HIGHWAY NO. 18 IMPROVEMENT

Appendix A - 6.1 Boring Logs (1)

ALTITUDE Datum < +6.5 > m COMPLETE DATE September 25th

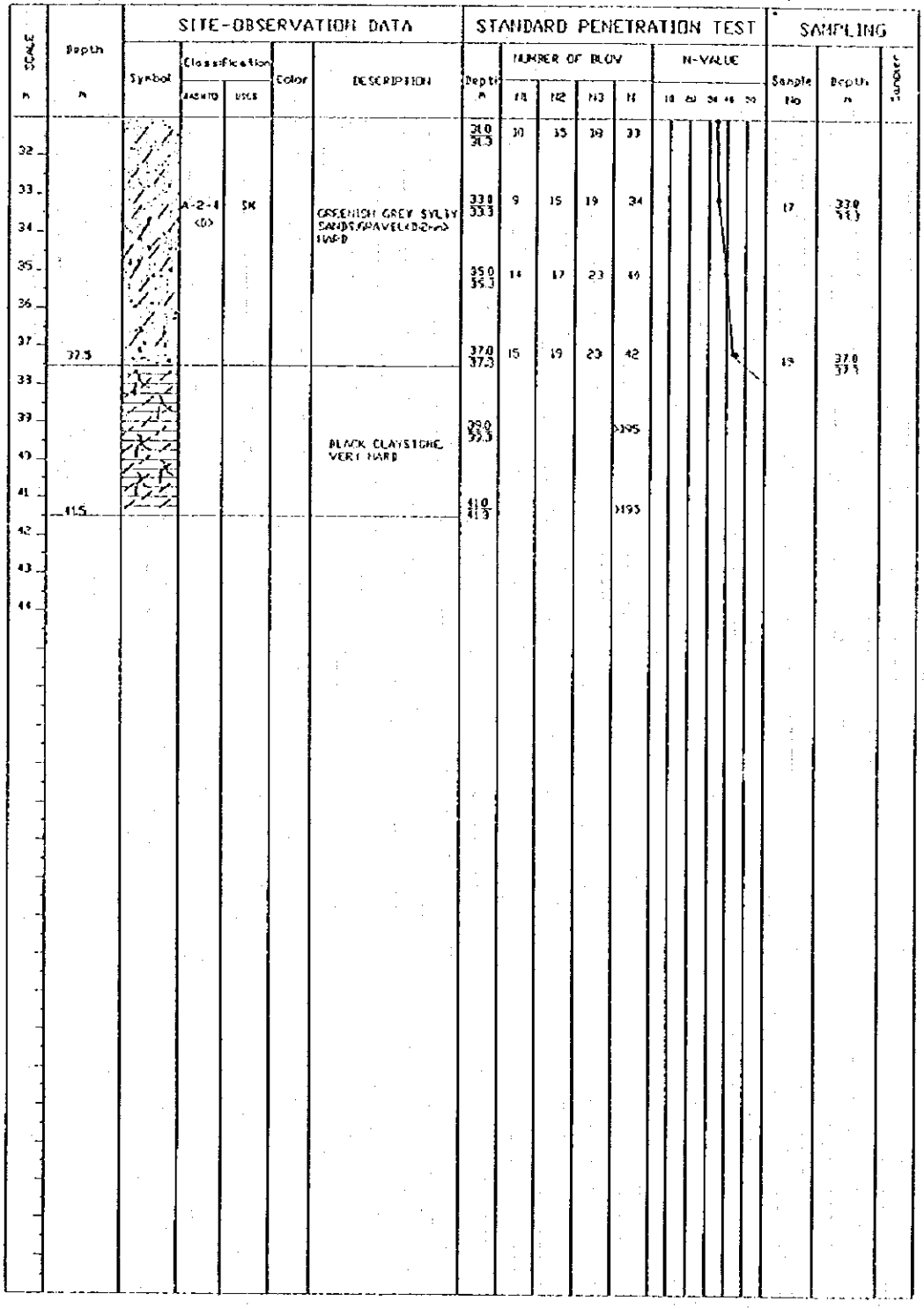
LOCATION NGU HUYEN KHE BRIDGE BOREHOLE No. 82 WATER G.L. +2.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (2)

ALTITUDE Datum (+6.5) m COMPLETE DATE September 25th 199[illegible]

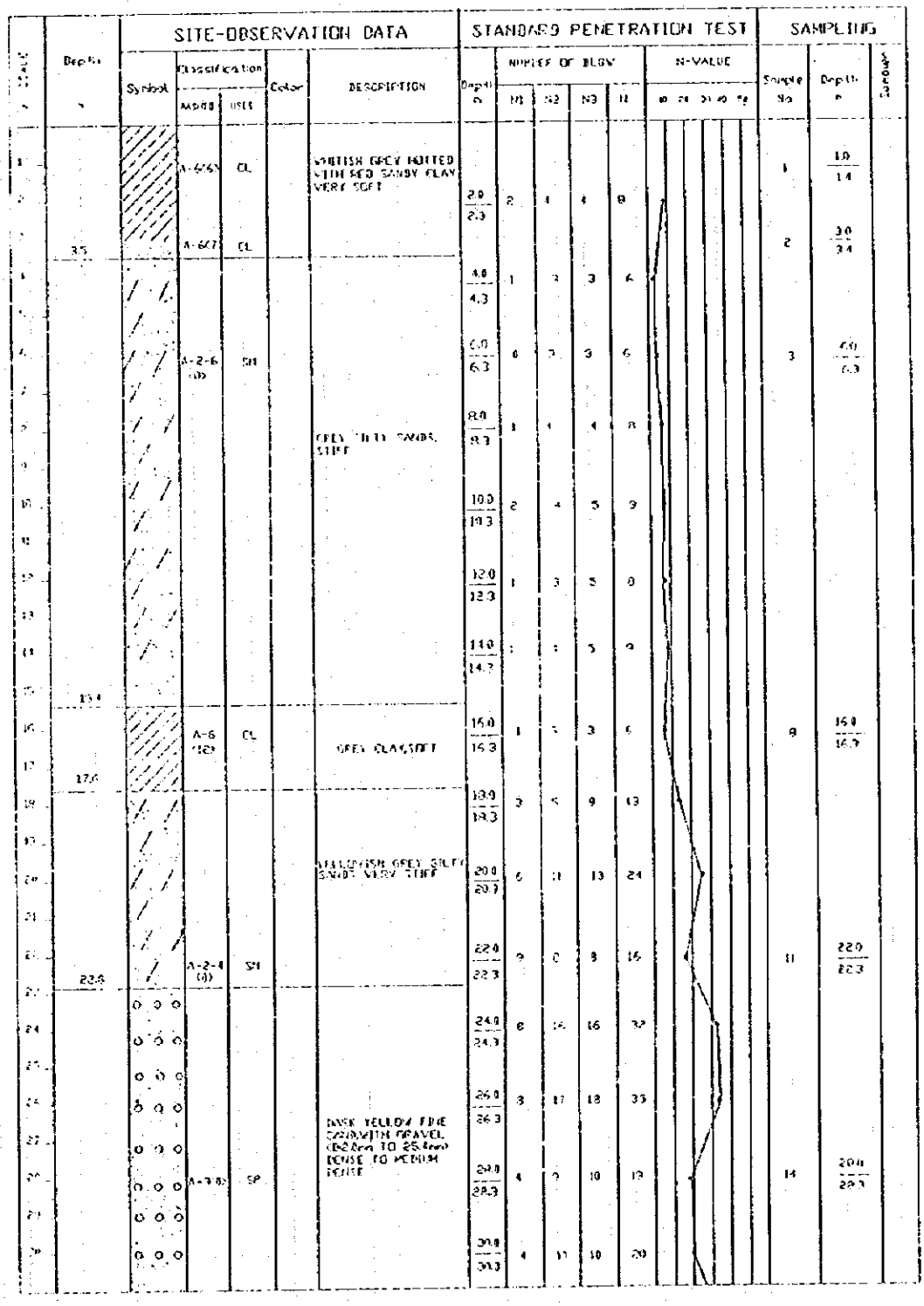
LOCATION NGU HUYEN KHE BRIDGE BOREHOLE No. B2 (Continue) WATER GL. +2.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (2)

ALTITUDE Datum(+4.8)= m. COMPLETE DATE September [illegible] 1995

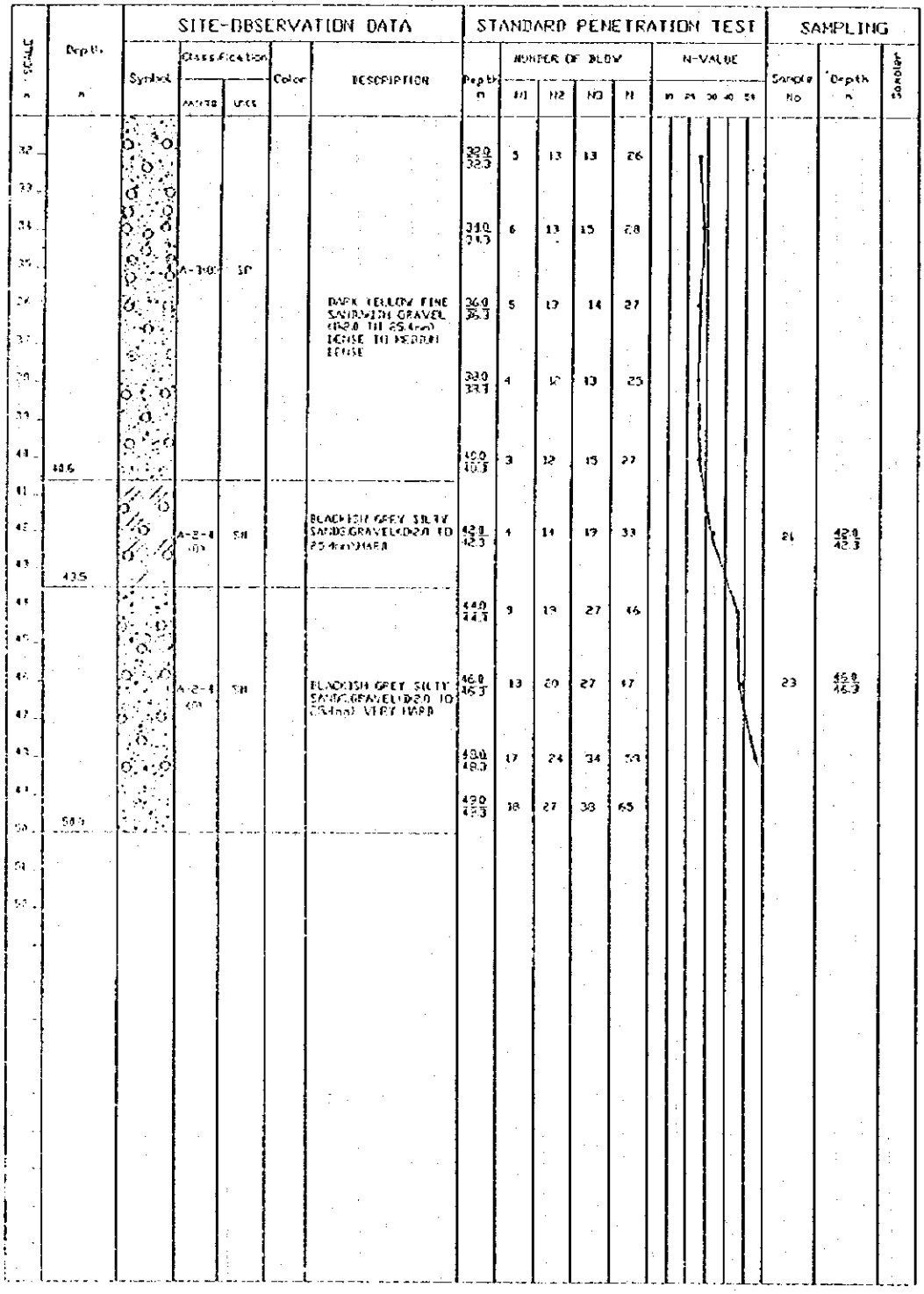
LOCATION BAC NINH FLY-OVER CROSSING BOREHOLE No. B3 WATER GL.-1.2 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (3)

ALTITUDE Datum (+4.2) m COMPLETE DATE September 27th 1995

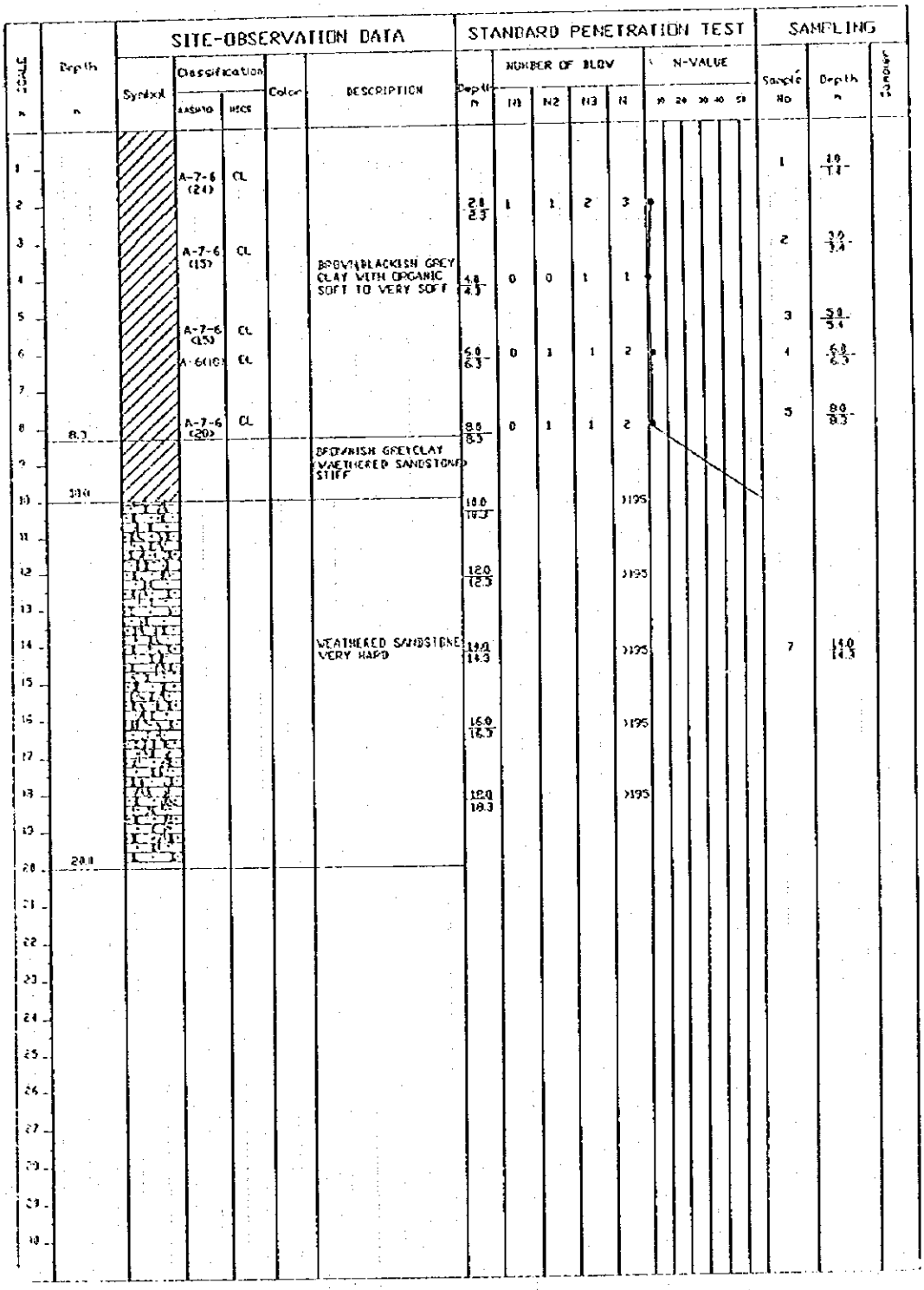
LOCATION BAC NINH FLY-OVER CROSSING BOREHOLE No. B3 (Continue) WATER G.L. +1.2 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.3 Boring Logs (3)

ALTITUDE Datum (+2.5) m COMPLETE DATE September 28th 1995

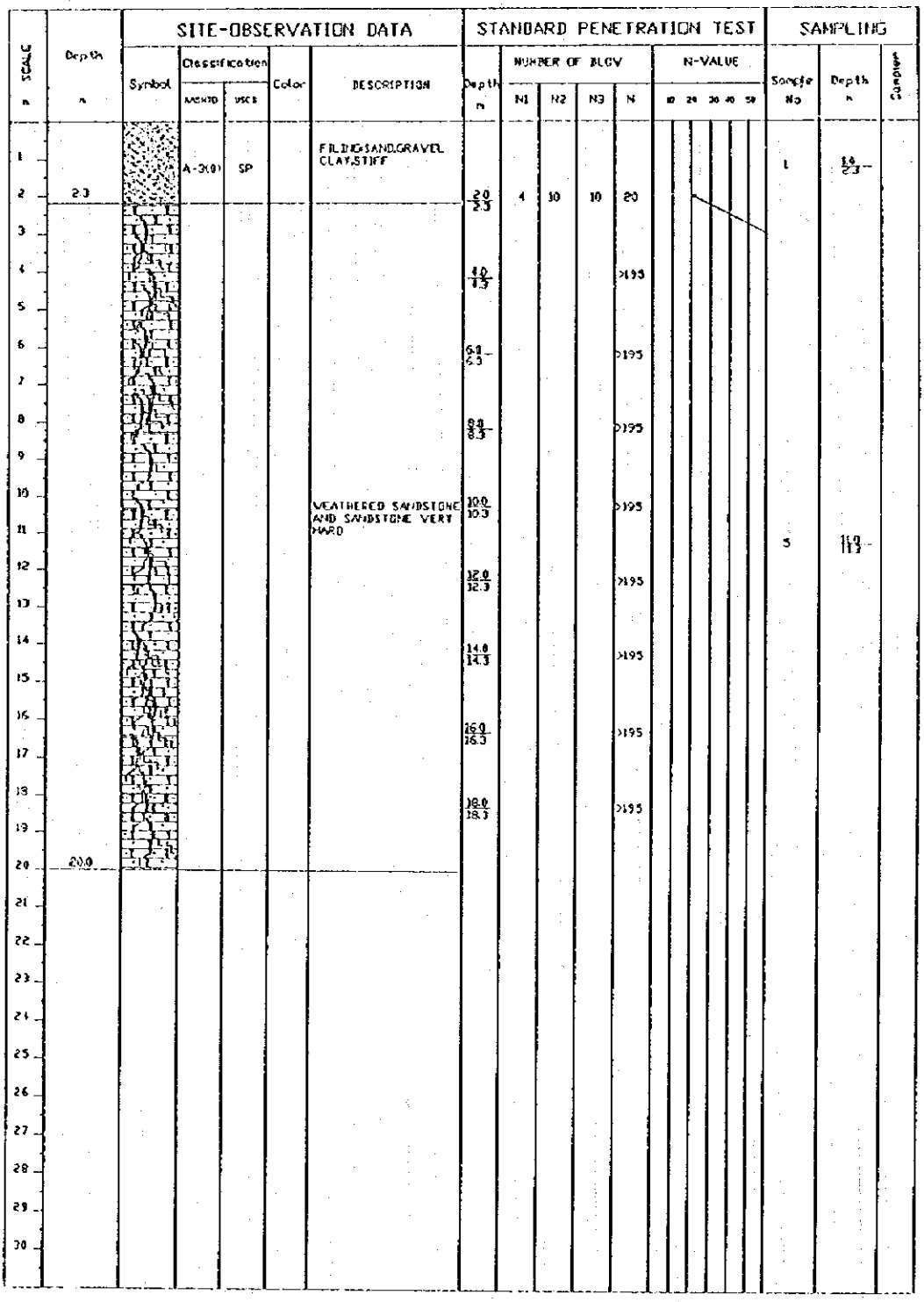
LOCATION PHA LAI BOREHOLE No. B4 WATER G.L. +1.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (4)

ALTITUDE Datum (+3.7) m COMPLETE DATE September28th 1995

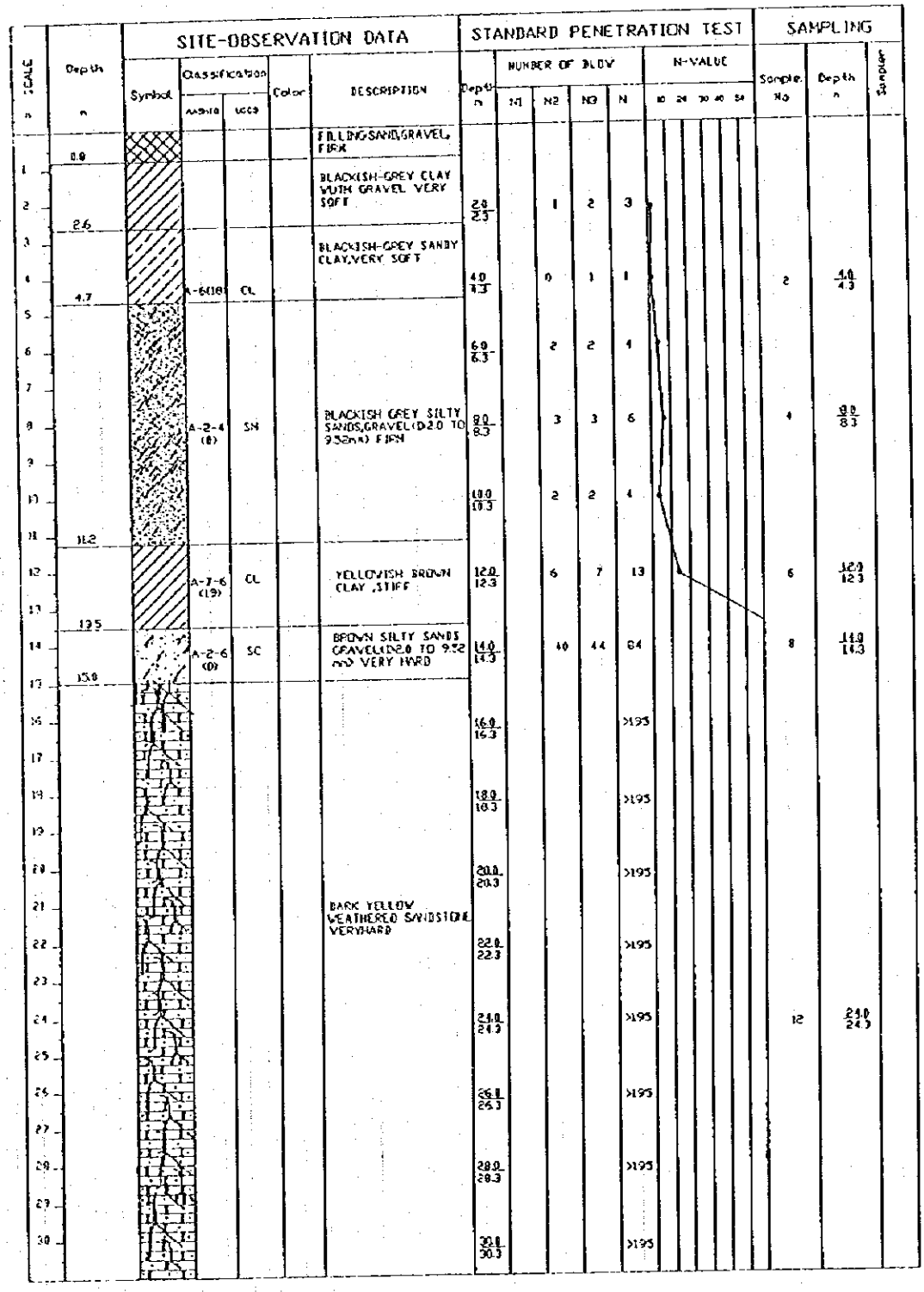
LOCATION PHA LAI BRIDGE BOREHOLE No. B5 WATER G.L. -1.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (5)

ALTITUDE Datum (+4.1) m COMPLETE DATE September 26th 1995

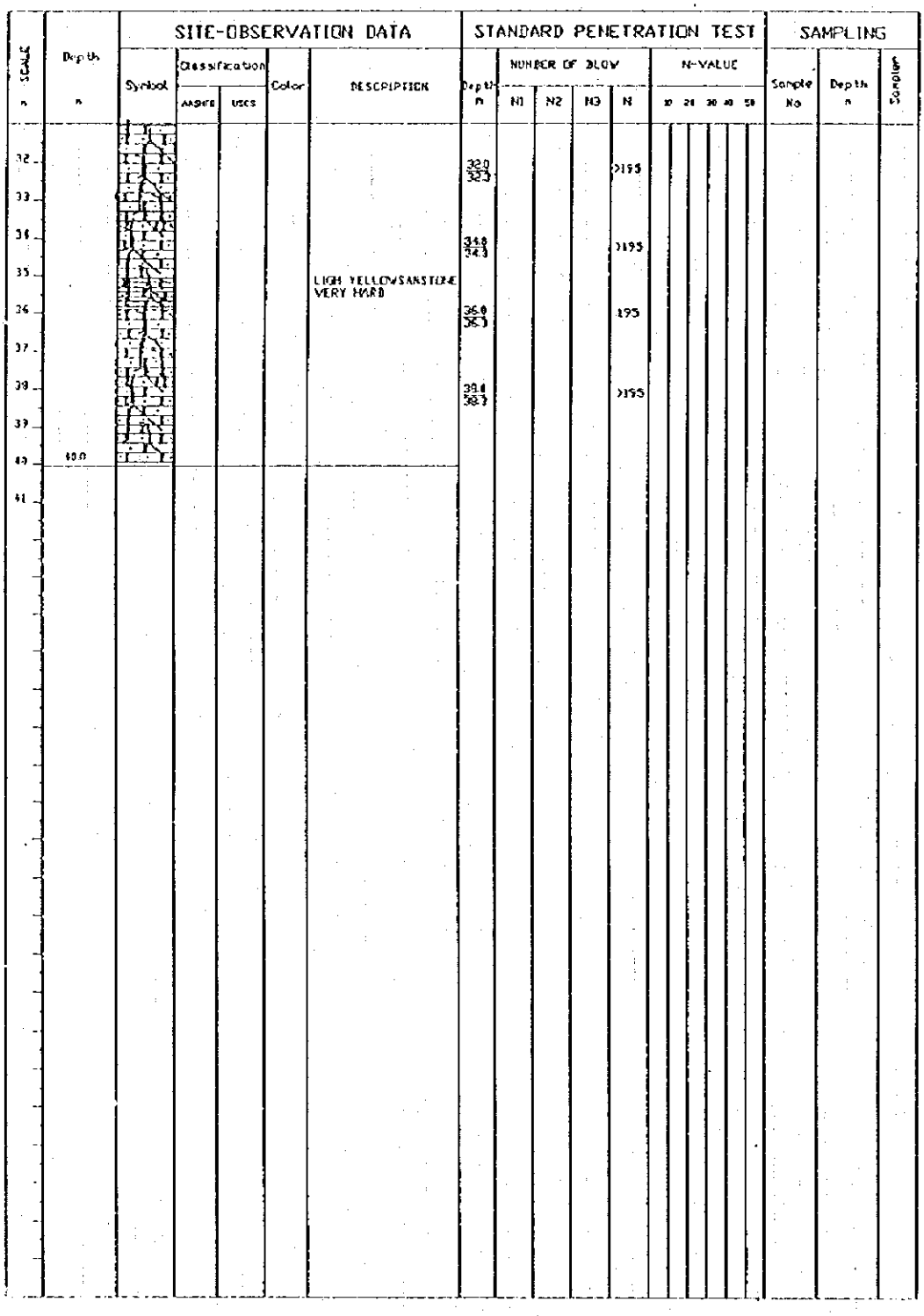
LOCATION PHA LAI BRIDGE BOREHOLE No. B6 WATER GL. +0.6 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (6)

ALTITUDE Datum (+4.1) m COMPLETE DATE September 26th 1995

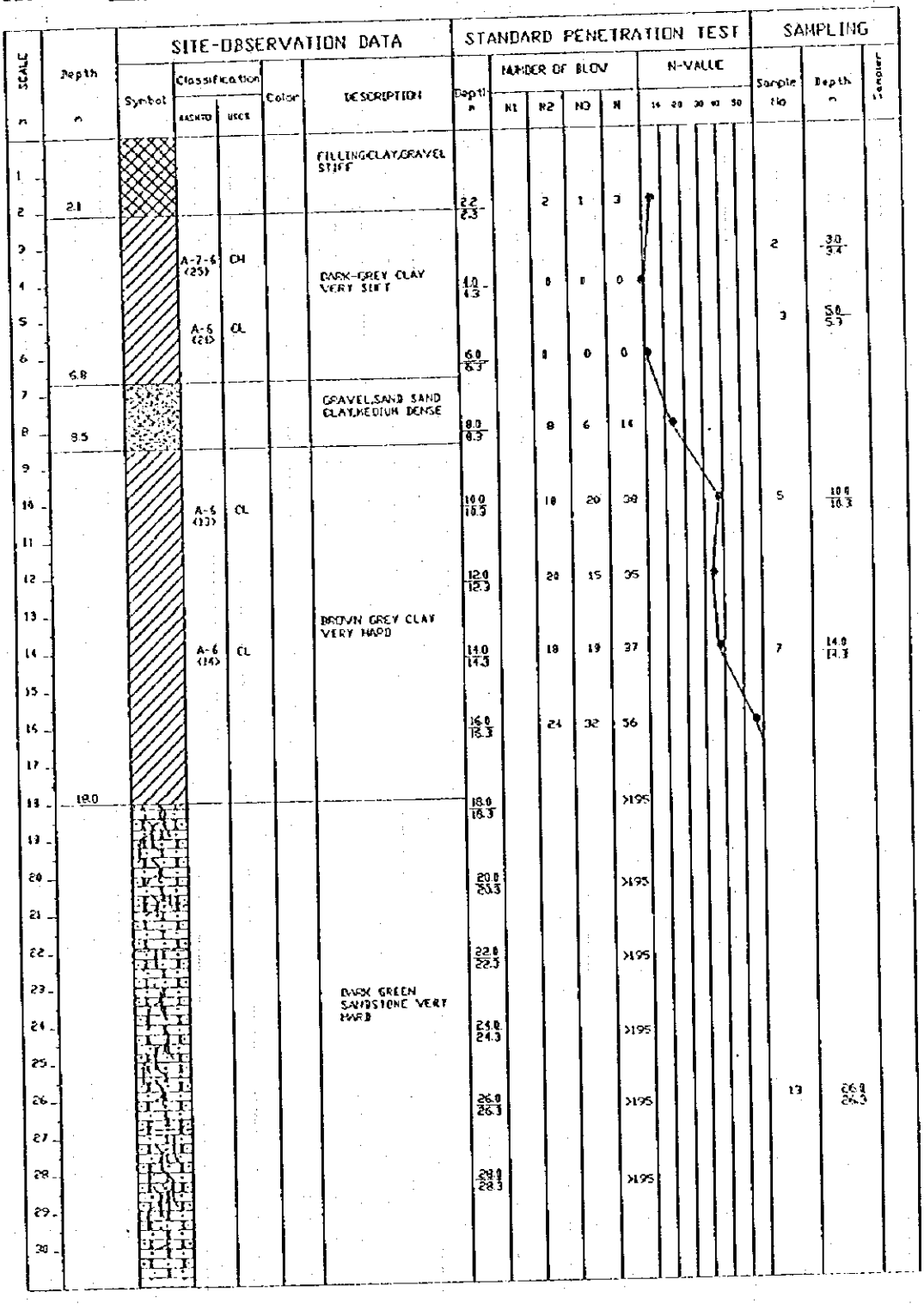
LOCATION PHA LAI BRIDGE BOREHOLE No: B6(Continue) WATER G.L. -0.6 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (6)

ALTITUDE Datum (+5.5) m COMPLETE DATE September 30th,1995

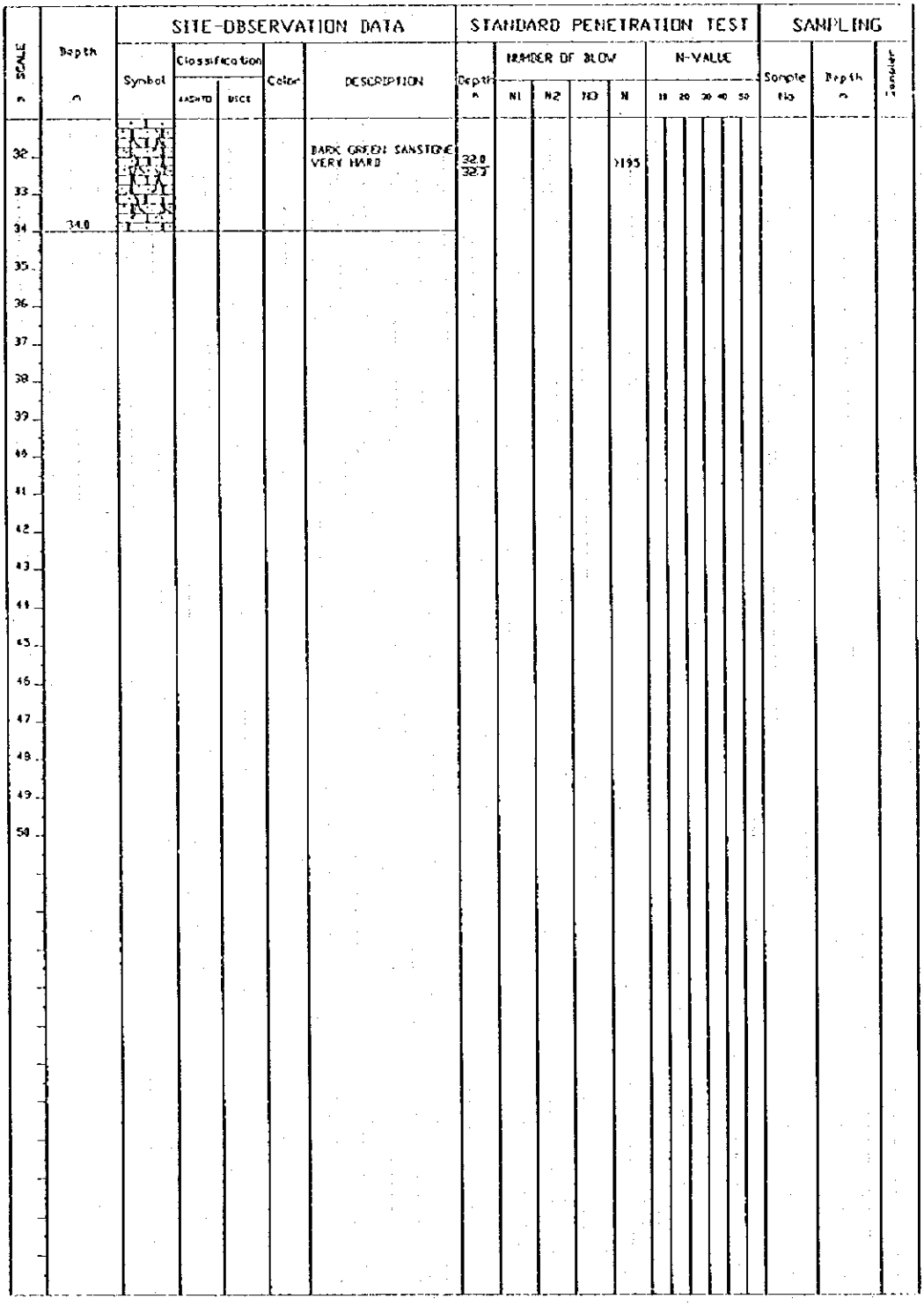
LOCATION HONG GAI BRIDGE BOREHOLE No. B7 WATER G.L. +0.5 m.



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (7)

ALTITUDE Datum (+5.5) m COMPLETE DATE Setember 30th 1995

LOCATION HONG GAI BRIDGE BOREHOLE No. BZ(Continue) WATER G.L. -0.5 m

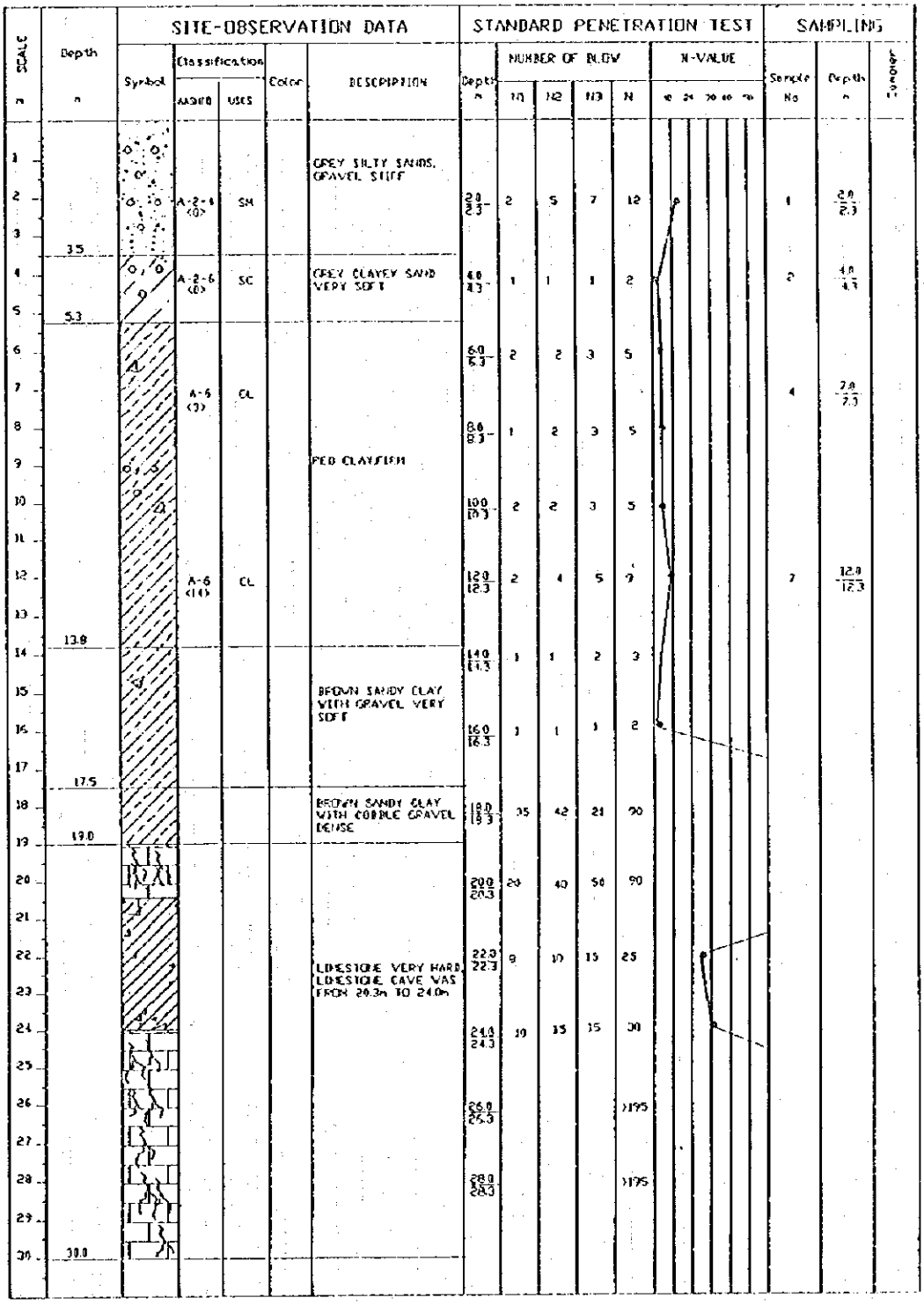


HIGHWAY NO. 18 IMPROVEMENT

Appendix A - 6.1 Boring Logs (7)

ALTITUDE Datum (+2.3) m COMPLETE DATE September 11th 1995

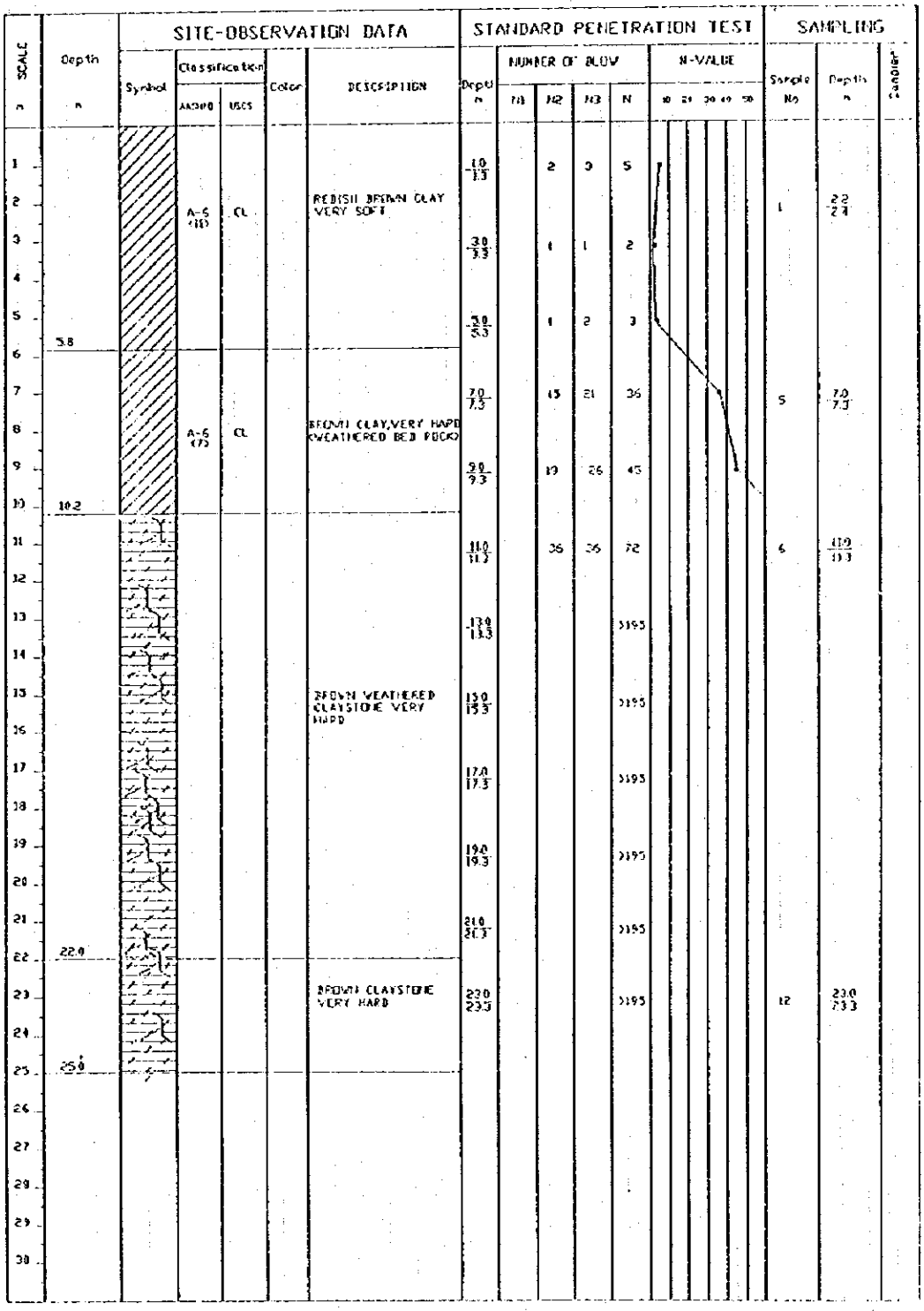
LOCATION CAN PHA BRIDGE BOREHOLE No: B8 WATER GL: +1.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (8)

ALTITUDE Datun O.O m COMPLETE DATE September 26th 19??

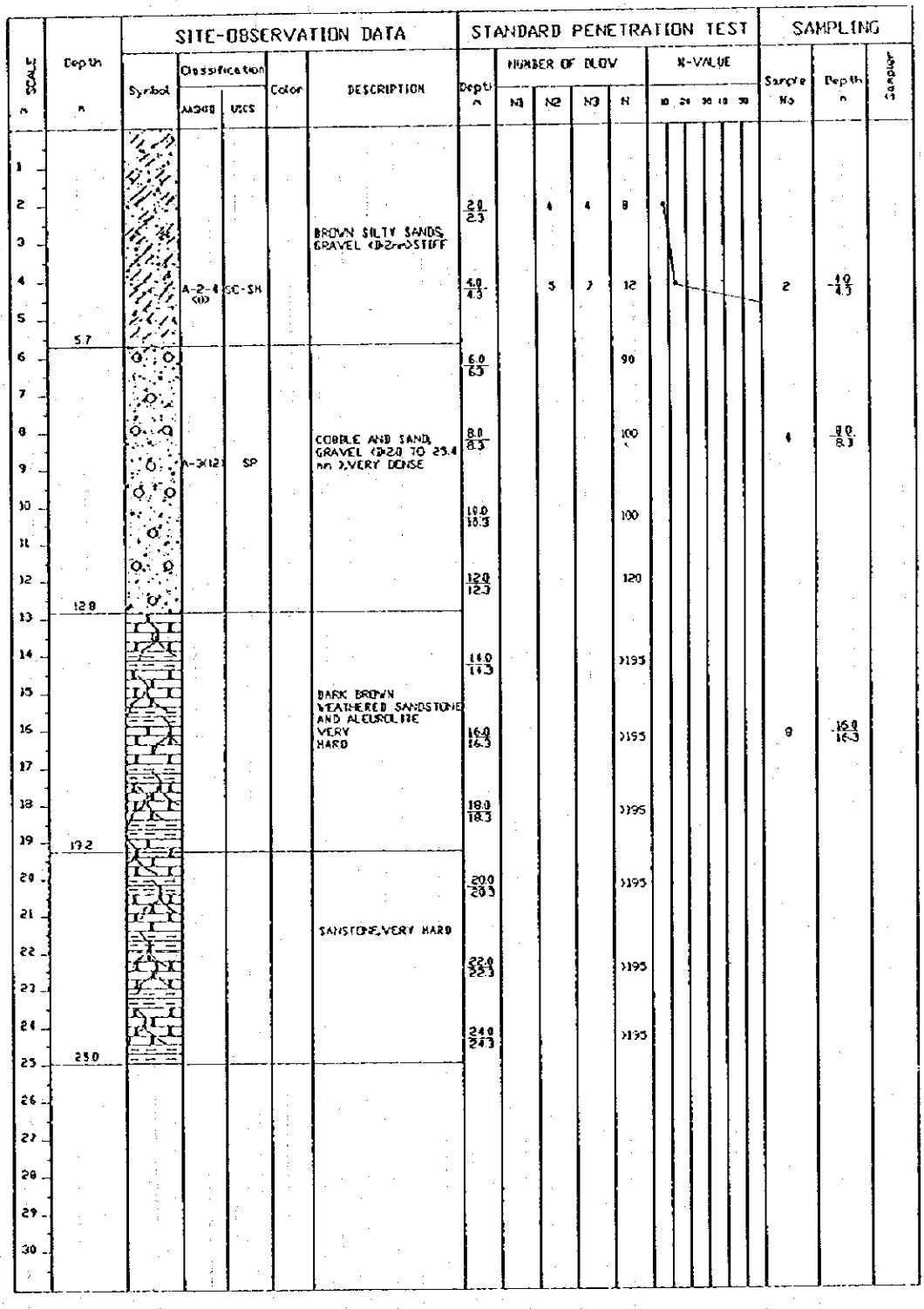
LOCATION BA CHE BRIDGE BOREHOLE No: B9 WATER GL: m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (9)

ALTITUDE Datum(0.0): m COMPLETE DATE September 5th 1995

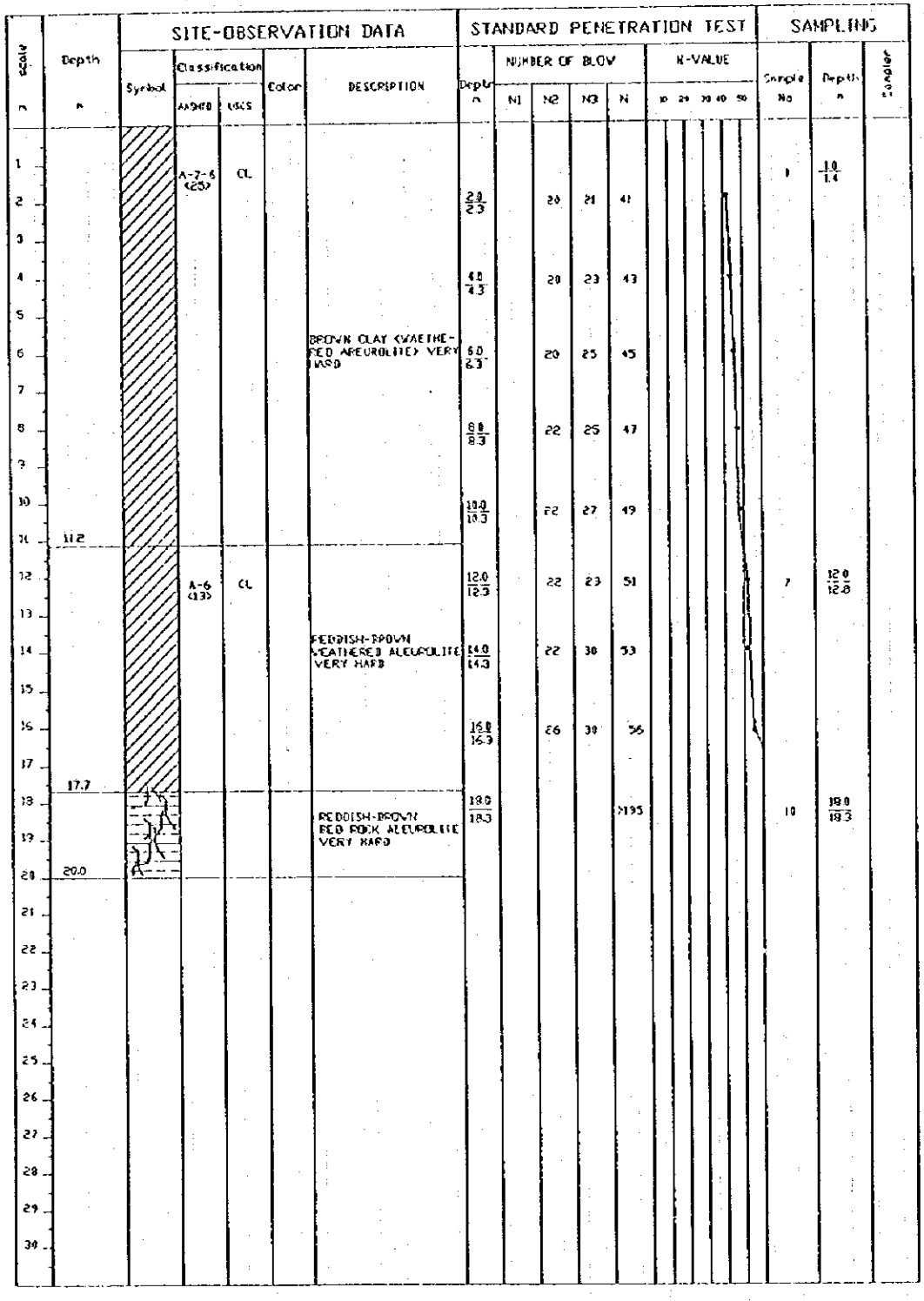
LOCATION TIEN YEN BRIDGE BOREHOLE No: B10 WATER GL - 6.4 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (10)

ALTITUDE Datum (+12.6) m COMPLETE DATE September 29th 1975

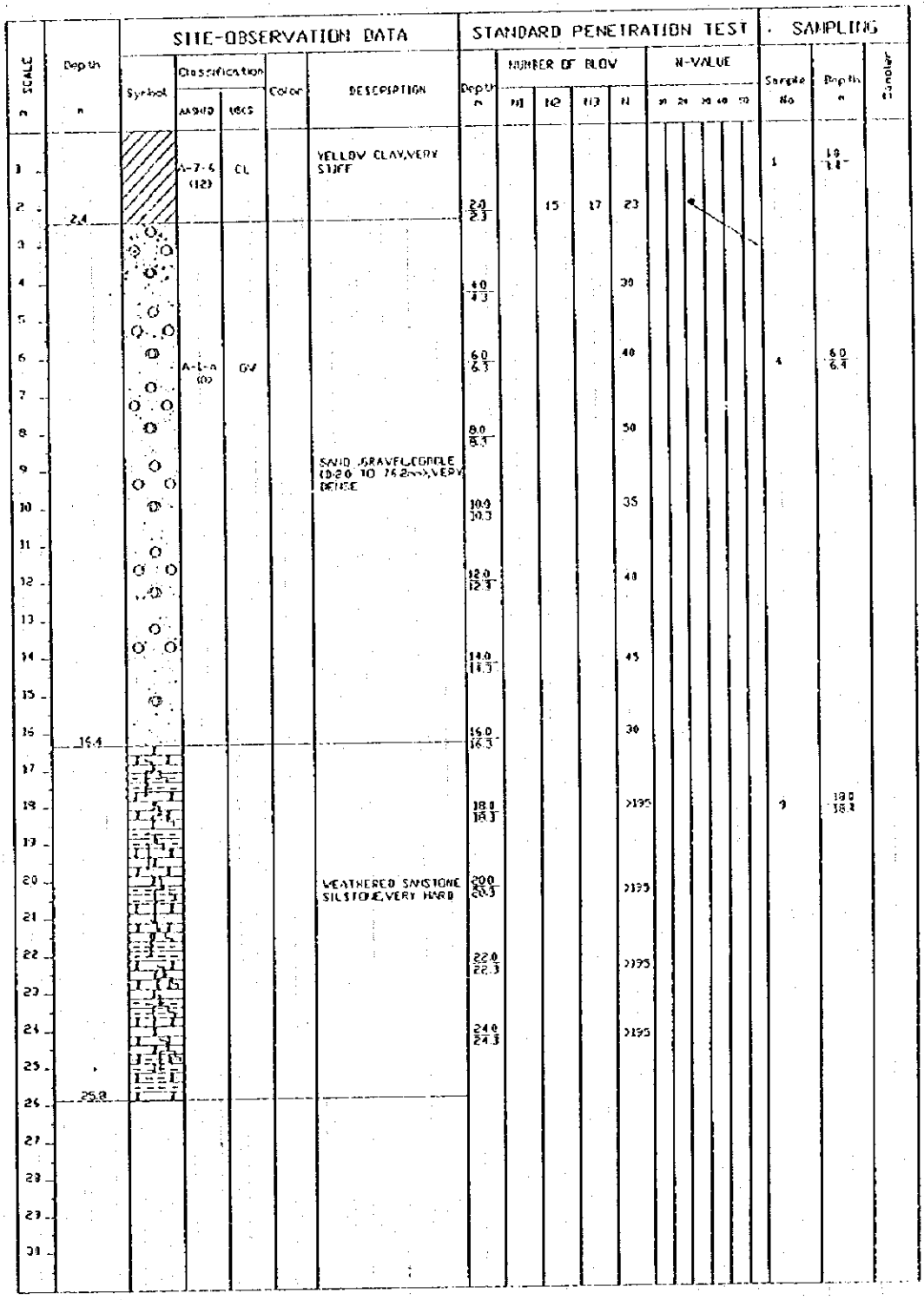
LOCATION DAM HA BRIDGE BOREHOLE No. B11 WATER GL: -5.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (11)

ALTITUDE Datum(CO)= m COMPLETE DATE September 14th, 1[illegible]

LOCATION HA COI BRIDGE BOREHOLE No. B12 WATER GL.-1.0 m

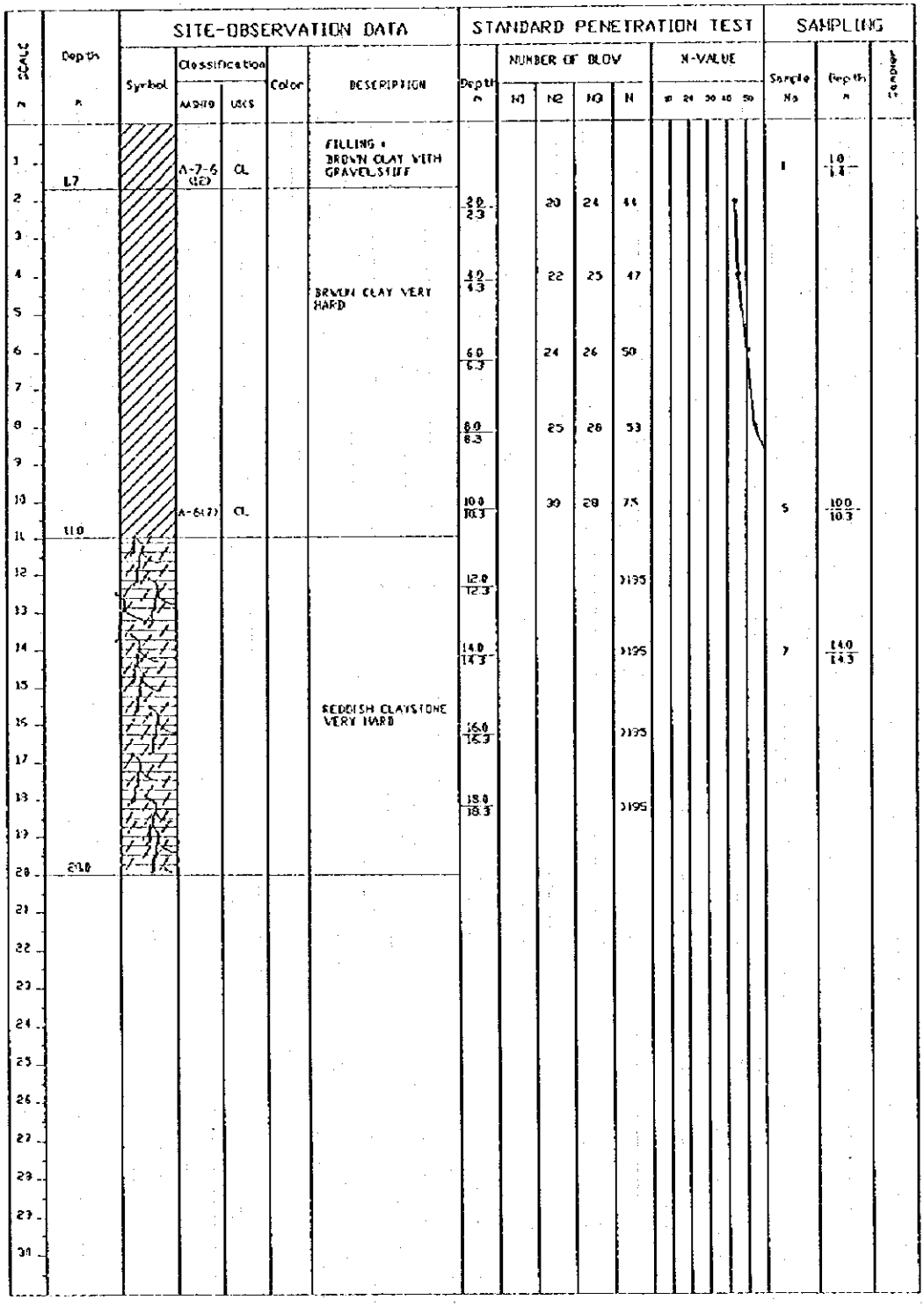


HIGHWAY NO. 18 IMPROVEMENT

Appendix A - 6.1 Boring Logs (12)

ALTITUDE Datum (+3.0) m COMPLETE DATE September 26th, 19[illegible]

LOCATION KINH KOONG BRIDGE BOREHOLE No. B13 WATER GL: 0.0 m



HIGHWAY NO. 18 IMPROVEMENT	Appendix A - 6.1 Boring Logs (13)