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The Northern Delta Transport Development Project (NDTDP)

Environmental Assessment Framework

APPENDIX IIc

Ports and Ferry Boats Stages,Corridor 3 Phase 2

Ministry of Transport, Vietnam Inland Waterway Administration (VIWA), Project Management Unit of Waterways (PMU-W)

22 February 2008

9R6212.21

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Abbreviations and acronyms

AADT	Annual Average Daily Traffic
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BBDT	Benkelman Bean Deflection Test
CEA	Cost-effectiveness Analysis
DP	Displaced Person (or Project-affected Person, PAP)
DWT	Deadweight tonnage
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMDP	Ethnic Minority Development Plan (or Indigenous People's Development Plan, IPDP)
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
FS	Feasibility Study
GDP	Gross National Product
GIS	Geographic Information System
GOV	Government of Vietnam
GPS	Global Positioning System
GSO	General Statistics Office
HCMC	Ho Chi Minh City
HDM4	Highway Development and Management Software Version 4
ICD	Inland Clearance Depot
IMF	International Monetary Fund
IPDP	Indigenous People's Development Plan (or Ethnic Minority Development Plan, EMDP)
IWPM	Inland Waterways and Port Modernization Project
IWT	Inland Waterway Transport
IWTC	Inland Waterways Transport Cost Model
JBIC	Japanese Bank for International Cooperation
LAD	Least Available Depth
MARD	Ministry of Agriculture and Rural Development
MMTRR	Multimodal Transport Regulatory Review
MOT	Ministry of Transport
MRC	Mekong River Commission
MT	Multimodal Transport
MTIDP	Mekong Transport Infrastructure Development Project
MTO	Multimodal Transport Operator

NH	National Highway
NDTDP	Northern Delta Transport Development Project
NLF	National Logistic Forum
NPV	Net Present Value
NWTC	Northern Waterway Transport Corporation
O-D	Origin-Destination
PAP	Project-affected Person (or Displaced Person, DP)
PC	People's Committee
PCU	Passenger Car Unit
PDLC	Physical Distribution and Logistics Centre
PDOT	Provincial Department of Transport
PIANC	International Navigation Association
PIP	Project Implementation Plan
PMU1	Project Management Unit No. 1
PMU-W	Project Management Unit – Waterways
PPC	Provincial People's Committee
PPMU	Provincial Project Management Unit
PRA	Participatory Rapid Appraisal
PSP	Private Sector Participation
QCP	Quality Control Plan
RAP	Resettlement Action Plan
RC	Resettlement Committee
RED	Roads Economic Decision Model
RNIP	Road Network Improvement Project
RPF	Resettlement Policy Framework
RRMU7	Regional Road Management Unit No. 7
SA	Social Assessment
SOE	State-owned Enterprise
SWTC	Southern Waterway Transport Corporation
TD	Technical Design
TEU	Twenty-foot Equivalent Unit
TOR	Terms of Reference

UNCTAD	United Nations Commission on Trade and Development
UNDP	United Nations Development Programme
USD	United States Dollars
VAT	Value-added Tax
VIRESS	Vietnam Registry
VITRANSS	Vietnam National Transport Strategy Study
VIWA	Vietnam Inland Waterway Administration
VLSS	Vietnam Living Standard Survey
VND	Vietnamese Dong
VNMC	Vietnam National Mekong Committee
VOC	Vehicle Operating Cost
VRA	Vietnam Road Administration
VWD	Vehicle Weight & Dimensions
WB	World Bank
WTO	World Trade Organization
3PLs	Third Party Logistics Providers

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Introduction

The Ministry of Transport (MOT) of the Government of Viet Nam is responsible for the planning, design, construction, maintenance and operation of all major modes of transport in Viet Nam including highways, railways, aviation, and inland waterways. MOT has recently undergone restructuring and separate departments were created for the administration and management of various modes of transport. The Vietnamese Inland Waterway Administration (VIWA) through its Project Management Unit – Waterways (PMU-W) is presently concentrating on the improvement of navigation conditions in both the Red River Delta and the Mekong Delta.

The Northern Delta Transport Development Project (NDTDP) is part of VIWA's efforts to increase efficiency of transport infrastructure in the Northern Delta Region. The NDTDP aims to reduce transport costs and tariffs, raise efficiency of logistics services across different transport modes, assist in building management tools and capacity of VIWA and Provincial Departments of Transport, and develop and strengthen existing frameworks for private sector participation in the provision of infrastructure and related services.

Investments in river ports and landing areas in the three waterway corridors are essential to raise the distribution efficiency of the transport network in the project region. Consequently, this will improve connectivity of the region to the sea ports in the north as well as to central and southern Vietnam.

The inland waterway transportation (IWT) in the Red River Delta is a key infrastructure for industrial bulk carriage, especially for commodities such as construction materials.

Viet Tri Port serves the rapidly developing industrial area around Viet Tri. It is also a nodal point in the multi-modal transport infrastructure connecting the mountainous areas and China with the Red River Delta and the sea. Ninh Phuc Port on the other hand serves the economic development of the southwestern region of the Red River Delta.

The environmental impact assessment (EIA) for the Day Ninh Co River Improvement Project was done on an incremental approach. Initially, regional scanning of the Red River Delta region was done based on existing secondary information and on data provided to the planning team. Subsequently, collection of primary information was conducted which included collection of samples in the field, laboratory analysis of samples (water, sediment, soil, benthos, plankton) and visual site assessment. Significant information was also gathered from published researches on the Red River Delta that is available in the worldwide web.

Policy, legal and administrative framework

The mandate of the Government of Vietnam in enforcing environmental regulations emanates from its 1986 Constitution which states that *"State organs, units of the armed forces, economic and social bodies, and all individuals must abide by State regulations on the rational use of natural wealth and on environmental protection"*

The most relevant policies of the Government of Vietnam for environmental impact assessment include the Law on Environmental Protection (LEP); Decree No. 80/2006/NĐ-CP which detailed guidelines on implementation of some articles of the LEP; Decision No. 81/2006/NĐ-CP which provides penalty for environmental protection; and Circular No. 08/2006/TT-BTNMT which contains the guidelines on Strategic Environmental Assessment (SEA), Environmental Impact Assessment (EIA) and Commitment for Environmental Protection (CEP).

Projects that are subject to strategic environment assessment (SEA) reports include strategies and plans on national socio-economic development at the national or provincial level. The agency responsible for building a national strategic project must prepare and submit a strategic environment assessment report to the relevant appraisal body

Article 18.1 of the new Environment Law provides a list of the projects that are required to conduct environmental impact assessment (EIA). These include projects of national importance such as urban area development projects, large scale projects for exploitation of natural resources, and projects for the development of IZs, HTZs and EPZs. While projects that are required to submit strategic environmental

Pursuant to Article 24 of the Environment Law, projects that are not subject to the compulsory environment impact assessment reports must provide an undertaking to protect the environment. The contents of the undertaking must include: (i) the project site; (ii) the form and scale of production, trading and services, materials and raw materials used for the project; (iii) likely waste to be produced from the project; and (iv) an undertaking to apply measures to minimise and treat waste and comply with the laws on environment protection. The undertaking must be registered with the local district People's Committee where the project is located before commencement of the project

Other relevant laws include the law on mineral resources, law on forest protection and development, land law, law on water resource and the Vietnamese standards for the environment quality. In the absence of Vietnamese standards, pollution standards of other countries, e.g. Dutch Soil Pollution Standards are used as the basis for evaluating the results obtained for this EIA.

The World Bank safeguards operational policies that are relevant to the NDTDP are:

The World Bank's Operating Procedure (OP) 4.01 contains the Bank's policy requiring projects proposed for the Bank's financing to conduct environmental assessment to ensure their environmental sustainability and to improve decision making. This operating policy enumerates the different environmental assessment instruments (depending on the project) that maybe submitted in order to comply with the Bank's requirement. This Operational Policy statement was updated in March 2007 to reflect issuance of **OP/BP** 8.00, *Rapid Response to Crises and Emergencies*. The Bank may exempt a project from any of the requirement of this policy if it would prevent the effective and timely achievement of the objectives of an emergency operation.

The Bank recognizes conservation of natural habitats as one of the measures needed to protect and enhance the environment for long-term sustainable development. OP 4.04 contains the Bank's position and conditions on projects located within or projects that may impact on important natural habitats.

The Bank's recognizes the importance of physical cultural resources as sources of valuable scientific and historical information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices. The Bank's policy on physical cultural resources is contained in OP 4.11.

OP 4.12 contains the Bank's policy on involuntary resettlement as a consequence of development projects. The policy contains the World Bank's procedures for management and compensation for project affected households subject to involuntary resettlement when a Resettlement Action Plan (RAP) is required to be prepared. This includes process for determining eligibility to benefits by affected persons, the required planning instruments and resettlement instruments. Triggers for OP 4.12 include: involuntary taking of land or other assets; and when the involuntary taking of land or other assets results in adverse impacts on the livelihood of displaced persons.

The Bank's policy on indigenous peoples is contained in OP 4.10. This policy is part of the Bank's mission of reducing poverty and sustainable development by ensuring that the development process fully respects the dignity, human rights, economies, and cultures of Indigenous Peoples. The policy sets the procedure and requirements for project proposed for Bank financing that affects Indigenous Peoples. The process calls for screening, social assessment and the preparation of Indigenous Peoples Plan.

Project description

Ports

The Government of Vietnam, as part of its strategic plan of promoting economic growth and poverty reduction in the country, has on-going efforts to rehabilitate/ develop the inland waterways of the Red River Delta. Among the projects recommended for Phase 2 of the NDTDP are ports and the ferry boats stages. Thirteen ports have been identified with two priority ports for piloting. These ports are Viet Tri Port in the province of Phu Tho and Ninh Phuc Port in the province of Ninh Binh. For ferry boat stages, two (2) stages per province are proposed for Phase 2.

River ports as a basic part of the inland waterway transport system region are under the management of either the public or private sectors. Most public ports are managed and operated by the Ministry of Transport or the provinces, cities and state or province-owned corporations. The state-owned ports are being managed by several ministries, like the Ministry of Industry and Trade (coal and power cargo operations) or the Ministry of Construction (cement cargo operations). Private ports can be considered as landing stages. Based on available information, although considerable cargo handling occurs along the river banks at privately owned landing stages, the main part of the inter-provincial (long haul) cargo is handled at the public sector ports. Viet Tri port not only serves the rapidly developing industrial area around Viet Tri, but also is a nodal point in the (multi-modal) transport infrastructure connecting the mountainous areas and China with the Red River Delta and the sea. Ninh Phuc Port on the other hand supports the economic development requirement of the southwestern region of the Red River Delta.

Viet Tri Port was built in 1965 and is under the jurisdiction of Phu tho province. It is perfectly situated along the Lo River as a nodal point in intermodal transport.

Built in 1992, Ninh Phuc Port is located at Ninh Binh province. It is situated along the Day River (60 km from the sea) just downstream of the railway bridge and serves as a center of the intermodal transport. The port was designed to accommodate 1,000 DWT vessels. The actual available depth in front of the port is 2.5 m during the dry season

Ninh Binh Port consists of 2 areas viz. the old "Ninh Binh port with 4 berths" 3 of which is used for unloading, and the rest is for loading in to barges and the newly built Ninh Phuc port with 2 berths. Access to sea is via the Day River which is, apart from some small stretches, a perfectly navigable fairway with a LAD of 3.5 m along its route. The port has the road access from Ninh Binh via Nho Quan, Man Duc to Son La, Moc Chau.

The port has a capacity of 1 million tons per year, however, at present, only 300,000 tons is handled (70,000 ton coal unloaded, 50,000 to cement unloaded, 50,000 tons pyrite, 50,000 tons apatite arriving by rail and transferred to vessel, 20,000 tons phosphate, limestone, gravel etc).

Ferry Boat Stages

Like river ports, ferry crossing stages comprise the inland water transport infrastructure system of the Red River delta (excluding ferry crossing stages managed by road transport sector). They are river side platforms established for ferry boats and their passengers in getting to the other side of the river. At times, they are also used for cargo loading and unloading. Its operation must be under management and is classified by law. The activities of ferry stages for passenger are an integrated element of social life and one part of the transport system chain in general, and rural transport system chain in particular.

The passenger river crossing stages on the waterways of Northern Delta are scattered throughout the region and were built according to the Decision on Investment Approval No 2825/QD-BGTVT dated 22 September 2004. They can be located in the following provinces:

- 11 provinces, cities of Red river Delta, namely: Hanoi, Ha Tay, Hai Phong, Vinh Phuc, Bac Ninh, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh and Ninh Binh.
- 7 adjacent provinces namely: Phu Tho, Bac Giang, Yen Bai, Thai Nguyen, Quang Ninh, Tuyen Quang and Lao Cai.

According to the IWT management survey in 18 provinces of the project area, there are 890 FCS's with 1086 vessels and 1026 navigators working on them. Information gathered regarding FCS's are as follows:

Corridor 3
Corridor 3 is about 178 km long connecting Ha Noi with Day (Corridor 3b) and / or Lach Giang Corridor 3a) estuary. This corridor is designed for Class II but due to the many shoals in the Corridor part of the corridor can only used for Class III. Near Hanoi bridges have insufficient vertical clearance during high water levels on the red river. Corridor should be able to handle sea-river vessels for transport between Hanoi and Ho Chi Minh City and maybe China. However, the river mouths at Lach Giang and Day River are among the main constraints. Ships with a limited draught can only enter the rivers during high tide. Both river mouths are subject to sedimentation limiting the accessibility.

Project need

Ports are vital to all economic activities in the IWT system. They are the hub for the movement and handling of important goods and produce for distribution to key markets. To prove that they are cost-effective, they should have the capacity to handle higher value goods (time-sensitive) efficiently for investments to be worthwhile. Current port infrastructures and facilities in the Red River delta, including Viet tri and Ninh Phuc ports are deficient in environmental management and operationally inadequate to meet the designed capacity volume.
Ferry crossings are important component of the inland waterways systems of northern Vietnam. It is used for moving people and cargoes across the wateways.

Project components

The recommended improvements for ports include additional quay, warehouses, paved open yards, covered coal storage facilities, drainage system, waste reception facilities. For ferry boat stages the possible improvements are berths, waiting houses, lighting and navigational aids. The project focuses on improving port infrastructures of Viet tri and Ninh phuc ports. In particular, improvement activities include civil works, i.e., dredging, construction of berths, facilities, inner roads and engineering designs of two ports.

Improvements of Corridor 3 will include installation of groins in Mom Ro, bank protection in Lac Quan, bend correction in Mom Ro, dredging in Mom Ro section and aids to navigation throughtout Corridor 3.

Project investments

The investment costs for river ports, landing stages and ferry boat stages are enumerated in the following table.

Item / Sub-Project	Total Cost Million US$
Ports – Ninh Phuc and Viet Tri	6.43
Ferry Boat Stages	5.07
Corridor 3	10.96
Total	00 19

Ninh with annual rainfall of 2000 – 2400 mm and rainy days of 130-160 days. The lowest rainfall in the study region occurs in the districts of Haiduong, Hung Yen and Dong Trieu district in Quang Ninh with annual rainfall of 1200 - 1600mm. rainfall is evenly distributed in other areas of the study region.

Special weather phenomena

Special weather phenomena affecting the northern region of Vietnam include storms, hoarfrost, fog, drizzle and thunderstorms. The coastal area from Quang Ninh to Ninh Binh is most susceptible to storms. On the average, 3 to 5 storms traverse North Vietnam's plain annually. Heavy rains are usually associated with storms which threaten transport facilities and operation. The storm season is usually from June through October with 40% of the storms occurring between the months of July and August. Fog usually appears in coastal areas, particularly islands and high mounts. Drizzle is a common phenomenon in winter, particularly in March. Thunderstorms usually occur at the beginning of the rainy season with strong winds, heavy rains, thunders and lightning.

Air quality

Ambient air quality in Vietnam is reported to be deteriorating partly due to the use of dirty fuel and the increasing number of motorized vehicles. Industries are among the stationary sources of air pollution in Vietnam. Widespread construction is also among the causes of increased levels of suspended particulates in the atmosphere.

Air quality measurements done for the NDTDP indicate that one-hour levels of SO2, NO2, TSP and CO are still within the Vietnamese Ambient Air Quality Standard. The obtained values are probably typical of rural areas in Vietnam.

Dusty condition in some river ports was noted during the site surveys. This is attributed to the lack of maintenance of port roadways which are covered with spilled soil and fine dust materials. This condition poses health hazards not only to port workers but also to people residing along the access roads. Ambient air quality sampling done in December 2007 shows that air quality in the ports of Viet Tri and Ninh Phuc are within Vietnamese standards. Noise levels are also within standard for residential areas.

Topography and geology

The topography of the study region is relatively flat, slightly sloping towards the coast in the NW-SE direction. The general altitude is low, about 2-3 m from Hung Yen to the south and 1-2 m in Thai Binh and Ninh Binh. The frequently flooded regions in Ha Nam, Nam Dinh and Ninh Binh have elevations of only 0.6 to 1m ASL. Dike systems of the Red River transect the inland region. Low mountains and hills with elevations of 50 m to 100 m are scattered from Nho Quan (Ninh Binh) to Kimbang (Ha Nam).

The Red River Delta was developed over a Cenozoic depression. It is filled up with Tertiary sediments up to 5,000 meters thick, which are overlain by 250 m thick Quaternary sediments and topped by a 30 m to 60 m thick deposit of Holocene sediments.

Soils of the Red River Delta

Ten soil groups have been mapped in the Red River Delta. Seven soil groups are cultivated. Soil quality analysis done for the NDTDP indicates that concentration of heavy metals is low. In some sites however, cadmium concentration is equal to the Dutch reference value while concentrations of mercury is higher than the reference value in some sites. Oil was also determined to be present in some sites, mostly in existing ports and landing areas. The pH values of the soil samples are neutral indicating that acid sulfate soils is not a concern in the project area.

Mineral resources

Major mines are located in the study region. Resources include coal, non-metallic minerals, various metal deposits (bauxite, iron, mercury, antimony and titanium), alluvial minerals, natural gas, mineral water and clay deposits. Clay is of particular importance to the NDTDP because it is

a vital material for the management of contaminated sediments. It is also a cheap alternative to geotextiles.

The Red River system

The Red River system has a total basin area of 143,700 km^2, including that of the Da River. It is the largest river system in northern Vietnam. More than 50% of the catchment area is within the territory of China and Laos. The main drainage channel of the Red River extends for about 1,130km flowing southwards to the Gulf of Tonkin. The laterite soils abundant in the mountainous upper reaches of Yunnan, China gives the characteristic red color of the river. The middle reaches of the Red River flows in a straight southeasterly valley that is controlled by a major geologic structure, the Red River Fault. The 255 km long lower reaches of the Red River comprises the triangular Red River Delta plain that is bounded by limestone cliffs to the north and south.

The width of the Red River varies from more than a kilometer at the segment below the Lo River confluence to about 200m as it approaches the coastline. Width of the distributary branches varies from 100m to 500m. Active meandering of the Red River as indicated by the ancient meanders, buried abandoned river channels and outlines of oxbows is discernible in aerial photos and satellite imageries. Recently, active meandering has been controlled by an extensive network of protective dikes. Some serious meanders still exist that provide hazards to navigation. Straightening of these meanders is one of the recommendations in the NDTDP for river improvement.

Mean discharge as measured in Son Tay is 3,640 m^3/sec. This is equivalent to a mean annual discharge of 114 km^3 with about 74% flowing during the rainy season. River flow declines to 430 m^3/sec during the dry months. Brackish water penetrates about 22km inland of the tributaries during the dry months.

There are a number of estimates of the modern day sedimentation rate of the Red River. It is estimated that the annual discharge of the Red River is about 125 million ton sediments and 70 million ton dissolved matters into coastal zone *(Pho, 1984* cited in Thanh et al., undated). New land is continuously being created at a rate of about 100 meter a year through the deposition of sediments supplied by the rivers (Haskoning 2003).

Other tributaries of the Red River system including the Thai Binh River system and Nhue Day River system are discussed in the EIA.

Water temperature of the Red River varies from 27-30°C during the summer months to 24-26°C during the winter months. The difference in surface and bottom water temperature is around 1°C. The pH values range from 8.0 to 8.5 while suspended sediment concentrations can reach more than 2,000mg/L.

Results of the water sampling and analysis done for the EIA of the NDTDP indicate that pH value in all sites is neutral, salinity gradually increases from Viet Tri to the estuary area and signs of organic pollution are indicated by the high concentrations of dissolved oxygen and biochemical oxygen demand. BOD values in all sites exceeded the Vietnamese standard for A water source. Organic pollution loading is highest in Nam Dinh port, Hongvan port, Nhuthuy landing site and Chuphan Ferry.

Concentrations of NH_4^+, NO_3^- and total N are high although still lower than the maximum permissible limit of the Vietnamese Standard for Surface Water (TCVN 5942:1995, Source A). But the concentration of nutrients is high enough to cause eutrophication in stagnant water. Concentration of total phosphorus (P) is also high in some sampling sites.

Concentrations of phenols and heavy metals in the rivers of the Northern Delta region are much lower than the Vietnamese standard for surface water. However, oil contamination is significant in some sampling sites. This is attributed to oily wastes from boats.

Assessment of the results of the analysis of water samples from selected sites in the study region indicate good water condition in the upstream section of the Red River where DO is high and BOD is low. Spatial correlations for phosphates and nitrates indicate increasing concentrations in the downstream sections which is attributed to the dense residential and industrial areas especially in Hai Phong and Hai Duong.

Increasing concentrations of suspended sediments was observed from the upstream to the downstream sections of the Red River. This is inferred to be due to the active bank erosion and the rampant dredging in Duong River. Among the heavy metals found in sediments, only arsenic showed a distinct declining trend from the headwater to the downstream segment of the Red River system.
River sediment analysis done by the Vietnam National Center for Natural Science and Technology for heavy metals, calcium carbonate, pesticides and organic materials indicate that the heavy metals are below the Dutch Reference Concentration, except for cadmium which showed light exceedance. The same results were obtained for samples collected during the November and December 2007 sampling. Slight exceedance noted in cadmium and mercury. As for soil, no indications of acidic soil were noted in the samples collected. Acidity of soil samples are all neutral. Oil contamination of soil in some ports is evident with the detection of oil in the soil samples.

Landforms in the coastal areas include tidal flats, beaches, beach ridges, mangroves, marshes, tributaries and tidal channels. The prominent features in the coastal areas of the Red River delta are karst islands formation in Halong Bay in the northeastern most corner of the Red River delta. An extensive mangrove swamp that has been converted to shrimp ponds are found along the coast of Halong Bay southwards to Bach Dang estuary. Mangrove swamps also occur in the Do Son-Thai Binh estuary. Southwards, from Van Uc to Thai Binh estuary, the shrimp ponds are fringed by a belt of reforested mangrove.

The mouth of Red River or Ba Lat is an extensive formation of tidal mudflats. The mudflats have been cleared of vegetation and are now mainly used for aquaculture.

The shoreline is generally straight southwards of the Ba Lat estuary being protected by sea dikes. This shoreline terminates at the Lach Giang estuary and the Day River Estuary. Mudflats have formed at the mouth of the Day River. These mudflats are still vegetated by mangroves and mangrove associated plant species. Active deposition is taking place at the mouth of Day River, causing the seaward progradation of the river mouth.

Shoreline accretion in the coastal areas of the Red River Delta occurs at a rate of 25m per year with a maximum rate of 120m per year in some areas. Erosion is the predominant process in some sections of the coast, notably Cat Hai and Hai Hau. Shoreline retreat occurs at a rate of 4.5m to 13 m per year.

Flow patterns in the Gulf of Tonkin are dominated by the tidal and monsoon currents. Tidal regime is diurnal with a range of 4m in the north to 2m in the south. The tidal range at the mouth of the Ba Lat varies from 0.5 m during neap tide to 2.5 m during spring tide. The Gulf of Tonkin is connected to the South China Sea which has strongly seasonally varying residual currents forced by the monsoonal wind patterns.

Wind velocities during the dry season are higher than during the wet season, generating higher waves (significant wave height Hs around 1.4 m) in the Gulf of Tonkin relative to the wet season (Hs below 1 m). However, the most pronounced seasonal difference is probably the frequency of occurrence of significant wave heights: Hs is up to 3 m during 10% of time in the dry season whereas Hs is only 2 m during 10% of time in the wet season. It is noteworthy that the most sediment is supplied to the Gulf of Tonkin when wave energy is low.

Biological status of the Red River Delta

Natural forests in the project region and peripheral areas are found in mountains and hills in the provinces of Phu Tho, Vinh Phuc, Ha Tay, Ninh Binh, Quang Ninh, and Hai Duong. The prevailing plant types in the higher altitudes are tropical wet evergreen forest; semi-deciduous forest with dry

and rainy seasons; and forest on limestone mountains. Vegetation in the lower elevations consist of low mountain subtropical wet evergreen forest, coniferous – broad-leaved forest, forest on limestone mountains and on granite mountains. One important terrestrial ecosystem present in the Red River Delta region is the lowland rain forest. WWF delineated the extent of this ecosystem from the freshwater swamp forests of the Red River Valley south along the north-central coast of Vietnam to the region south of Tam Ky. This ecosystem is reported to be seriously degraded with less than 10 percent of the native vegetation remaining. The climatic condition that prevails in this ecosystem characterized by high rainfall and short dry season produced conditions that once supported diverse wet evergreen forests. Although much of the ecosystem's biodiversity has been lost, it still harbors several mammals and birds of conservation significance.

The predominant terrestrial ecosystem in the Red River Delta is the agro-ecosystem with much of the land area converted to agricultural use and settlements. Paddy rice cultivation is the most dominant agricultural feature in the low lying areas of the delta. Crops cultivated in the region include rice, corn, cassava, sweet potato, banana and sugar cane.

The phytoplankton community of the Red River Delta has a diverse species composition including 183 species dominated by Diatomae which make up 86.1% of total number of species. Phytoplankton development changes with the seasons, with phytoplankton population declining rapidly during the flood peak months and increasing during the dry season. In July-August, the phytoplankton density ranges from 800 to 362,000 cells/m^3 with mean biomass of 130 g/m^3. Phytoplankton develops extensively in the mouth of the Red River in waters shallower than 20m. Phytoplankton biomass and density increases when the tide is high and decreases when the tides fall.

The biomass of zoobenthic animals used as food by other species varies over a wide range from 4 - 96 g/m^3 in the dry season and 5.9 - 11.5 g/m^3 in the wet season (Dang Ngoc Thanh *et al.*, 1991). Zoobenthic community in the tidal mud flats includes 130 species.

A total of 233 fish species belonging to 71 families have been identified in the estuary of the Red River Delta. The fish fauna of this area may be divided into four ecological groups (a) freshwater, (b) euryhaline-marine (c) true estuarine and (d) regularly anadromous migrants.

The fish survey done by the *Phan Mach, Institute of Ecology and Biological Resources in December 2007* describes the fish species that occur in the waterways of Corridor 1 such as the Red River, Cau River and Thai Binh River. About 53 fish species were identified at the Day and Nhue basin while 89 fish species belonging to 6 orders and 20 families have been recorded in the Cau river basin. Along Red River from Viet Tri to the estuary, about 64 fish species have been identified, 12 species of which are cultured. Three fish species of the Red River are listed in the Vietnam Red Book (2000): *Clupanodon Thrissa* (Linnaeus, 1758) (Vulnerable - level), *Squaliobarbus curriculus* (Threatened - level), *Hemibagrius elongatus* (Giinther) (Vulnerable - level). 62 fish species have been identified in the Thai Binh River from Pha Lai to the estuary. 50 species are naturally occurring while the rest are cultured.

Spawning season of the aquatic species in the Red River Delta region is not totally known. Reproductive season of the more important species, namely *Squaliobarbus curriculus* starts from late April to early August. Other fauna such as freshwater shrimps and crabs coincide with the monsoon season.

Limited coastal vegetation (mangroves) occur in the coastal areas of the region. Mangrove stands flourish in places where conditions are favorable for mangrove development.
No corals are present along the coast of the Red River Delta region.

A number of protected areas are located along the coastline of the Red River Delta. These include the Cucphuong National Park (wet tropical forest) occurring in the provinces of Ninh Binh, Hoa Binh and Thanh Hoa; Catba Biosphere Reserve, a tropical evergreen forest; and the Cucphuong National Park with rich species composition, mostly rare and precious ones. The protected areas that are of importance to the NDTDP include the Nghia Hung Proposed Nature

Reserve, Xuan Thuy National Park, Tien Hai Nature Reserve, and the Thai Thuy Proposed Nature Reserve.

Natural disasters and environmental incidents

Natural disasters that occur in the region include storms and tropical low pressures, flood and water logging, sedimentation, erosion and landslide, drought and hot temperature and earthquakes. However, earthquake hazard in the project is low.

Socio-economic conditions

The project site accounts for a major part of the Northern Delta which includes Quangninh and Vinhphuc provinces to the northeast and the province Phutho to the northwest. This region is the center of economic, cultural and social development of northern Vietnam. The region has a population of 13 million.

The Northern Delta region has experienced rapid urban development during the last decade. The urban population has increased by 35% as of 2006. A number of towns have been upgraded to cities. Urbanization has created favorable conditions for socio-economic development but it has also imposed heavy pressures on the environment.

In terms of transport, the Northern Delta region has the most developed transport network when compared to other regions in Vietnam. This is a major boost to development.

Economic activities in the region include agriculture, fishery and forestry. Major agricultural crops include rice, corn, vegetables and fruits. Cattle and poultry raising is also among the major agricultural activities in the region. Aquaculture and capture fishery are well developed in the coastal regions. Forestry is an important economic sector in Hatay, Vinhphuc, Phutho and some districts of Haiphong, Ninhbinh, and Quangninh. Nevertheless, both the area and quality of forests (mountain forests and mangrove forests) are declining, indicating the general decline in quality of the environment.

Dominant land uses in the Red River delta are agricultural, built up and industrial.

Aside from fishing and transport, one of the major uses of river water is for irrigation. A number of pumping stations have been established in different sections of the rivers in Corridor 1.

Historic, natural and cultural resources are present in the region. These include ancient pagodas, temples and ancient port towns. Historic sites and sites of traditional festivals are also present. Ancient architectures, artifacts, pagodas and temples are found in almost all provinces.

Prediction and assessment of environmental impacts of the port projects

The summary matrix of impacts of the improvement works at the Viet Tri and Ninh Phuc Ports is presented in the following table:

Environmental Components	Polarity	Magnitude	Duration	Description of Impacts
Air Quality	N	Minor	ST	Construction: Noise and emissions from construction equipment and fugitive dust,
	N	Major	LT	Operations: Noise and emission from vessels, trucks; Fugitive dust from cargo handling, hauling; rock / ore crushing; noise from crusher in Viet Tri
Geology & Topography				
Topography / morphology	O			Construction & operations, no impact
Erosion & Deposition	N	Minor	ST	Construction can induce erosion
	O			Operations, no impacts on erosion
Sediment Transport	O			Construction – No impact
	O			Operations – No impact
Stream Sediment Quality	N	Minor	ST	Construction – Impacts may come from spillage of construction materials, waste water;
	N	Minor	ST	Operations – spillage of cargo, leachate, waste water may affect stream sediment quality I
Soil and Soil Quality	N	Minor	ST	Construction – Impacts may come from spillage of construction materials, contaminants may include heavy metals, oil;
	N	Minor	LT	Operations – spillage of cargo, leachate, waste water may contaminate soil
Water Resources				
Hydrology / Hydrodynamics	O			Construction and operations of ports and ferry boat stages will not have significant impacts on hydrology.
Surface Water Quality	N	Minor	ST	Construction – pile driving may cause turbidity; spillage of construction materials may cause turbidity, oil, heavy metals.
	N	Major	LT	Operations – water quality can be affected by leachate from stockpile, spillage of cargo, disposal of cargo residue. Possible pollutants include oil, nutrients; bacteriological, heavy metals; Propeller wash during periods of low water may cause resuspension of sediments.
Groundwater (Water Table)	O			Construction is not anticipated to affect water table
	O			No significant impact on water table during operations
Groundwater Quality	N	Minor	ST	Construction – percolation of wastewater may pollute shallow groundwater
	N	Minor	LT	Operations may have same impact on shallow groundwater.
Ecology & Biological Resources				
Protected Terrestrial Habitat	O			No significant impacts
Protected Terrestrial Plants and Animals	O			No significant impacts
Aquatic Flora & Fauna	N	Minor	ST/LT	Distrubance during construction and operations
Important Aquatic/Wetlands Habitats	O			No direct impact
Socio-Cultural				
Land Use	N	Minor	ST	Construction in Viet Tri and Ninh Phuc will not have significant impacts on adjoining land uses. Construction of ferry boat stages may affect
	N	Minor	LT	Operations of ports will not have direct impacts on adjoining land uses. Operations of ferry landing stages may have some impacts on adjoining land uses.
Livelihood Opportunities	p	Minor	ST	Construction may offer some temporary jobs
	P	Minor	LT	Operations may also offer some jobs for residents of some host community

Environmental Components	Polarity	Magnitude	Duration	Description of Impacts
Occupational & Public Health & Safety	N	Minor	ST	Construction – workers maybe exposed to hazards of heavy lifting, heat, ergonometric stress, noise, fugitive dust; water hazards; health hazards due to crowded accommodation in construction camp
	N	Mnor	LT	Operations – workers maybe exposed to hazards of heavy lifting, heat, ergonometric stress, noise, fugitive dust; water hazards; threat of HIV aids vessel crew maybe carriers

O – No impact
N - Negative
P-Positive

Framework Environmental Management Plan

The framework environmental management plan is summarized in the following matrix.

Summary Matrix of the Framework Environmental Management Plan
Construction Stage

Discipline/ Envl Component	Impacts	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Air Quality	Increased noise level; Emission from heavy equipment; Generation of fugitive dust	Proper maintenance of equipment; Limit noisy activities during daytime hours; Trucks hauling construction materials should be covered; Limit speed; Suppression of dust with water	Monitor that diesel fuelled equipment used are properly maintained & complies with emissions standards Dust emission management Visual observation for suspended particulate (dust)	Equipment service records; Emission tests; Dust emission management plan Presence/absence of dust in the atmosphere	Contractors with approval / acceptance by DONRE Contractor	Before engagement of contractor; Annual Daily for the duration of construction	Cost is part of the project management cost Cost part of construction management	Presentation of service records should be part of conditions of contract; Implementation of EMP part of Contractor's TOR
Soils and Soils Quality	Contamination due to spillage of fuel, lubricant, leachate of construction waste dump	Observe best practices in handling fuel; Proper solid and wastewater management	Monitor the adoption of good practices; Monitor the adoption of waste management program Soil quality monitoring	Checklist for monitoring; Waste management program Pb, Cd, Hg, As, Cr, Fe, Al	Preparation of plan and program by Contractor with approval of DONRE Independent Monitoring Contractor	Before start of work; Random checking by DONRE Prior to start of work and once after completion, plus 1 contingent sampling round if confirmation needed	5 sites/port, cost of VND490,000 per sample for a total cost of VND 7,350,000 per port	Preparation of detailed environmental management plan should be included in the Contractor's condition of contract

Discipline/ Envt Component	Impact/s	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Stream Sediment Quality	Construction may have adverse impact on stream sediment through spillage	Adoption of best practices for port construction Proper solid and wastewater management	Monitoring of sediment quality, 1 upstream of port and one downstream. Visual monitoring of waste management practices	pH, Pb, Cd, Hg, As, Cr, Fe, Al	Independent Monitoring Contractor	Once prior to construction, once after completion; one contingent sampling episode.	Total cost VND 490,000 x 2 stations x 3 sampling episodes = VND VND 2,940,000 per port	Part of environmental management plan for Ports
Surface Water Quality	Construction may have adverse impact on surface water quality through spillage of construction wastes, oil, fuel, etc.	Adoption of best practices for port construction Proper solid and wastewater management	Monitor compliance best practices Monitoring of water quality Visual monitoring of waste management practices	Visual monitoring of compliance & checklist method TDS, Suspended sediment, pH, Pb, C, Hg, As, Cr, Fe, Al; Phytoplankton, zooplankton and benthos	Contractor Independent Monitoring Consultant under supervision of DONRE	Visual monitoring continuing Bi-annual, low flow season and wet season. First sampling before construction	No additional cost, part of construction management 4 samples @VND1.728 million/sample = VND7.12 million	Implementation of EMP part of Contractor's TOR
Occupational Health & Safety	Exposure to construction hazards, noise, heat, ergonomic stress	Orientation PPEs First Aid stations Assignment of safety officer; Trained emergency first responded	Monitoring of compliance	Safety Guidelines; Availability and usage of equipment and safety personnel	Preparation of guidelines by Contractor under supervision of DONRE	Daily monitoring	Part of Construction management cost	Preparation and implementation of Health and Safety Plan should be part of Contractor's TOR.
Public Health	Construction may create hazardous conditions for local residents;	Provide ample warnings; Conduct consultations	Monitoring of HSE practices	HSE guidelines and plans	Plan to be prepared by Contractor, supervision by DONRE	Frequent random checks	Part of Construction management cost	HSE part of Contractors TOR

Summary matrix of framework environmental management plan, operations stage

Discipline/ Envi Component	Impact/s	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Air Quality	Fugitive Dust & Coal SPM emission and Noise	Site clean up; Use proper loading &unloading equipment to minimize coal drop; Maintenance of equipment; Impose speed limit Bagging of break bulk cargoes (e.g. sulfur)	Monitor compliance	Site clean up plan; Actual clean up; Equipment emissions test; Maintenance record	Port Authority / owner supervision by by DONRE	Continuing	Cost is part of the port management cost	EMP integrated in port management;
Soils and Soils Quality	Contamination due to spillage of fuel, lubricant, leachate of construction waste dump; Leachate;	Observe best practices in handling fuel; Proper solid and wastewater management	Monitor adoption of good practices; adoption of waste management program	Checklist for monitoring; Waste management program Annual monitoring of soil quality	Preparation of plan and program by Port Owner with approval of DONRE	Continuing and Random checking	Cost is part of the port management cost	Preparation of detailed environmental management plan should be included in the Contractor's condition of contract
Stream Sediment Quality	Operations may have n may have adverse impact on stream sediment through spillage; Leachate	Adoption of best practices for port construction Proper solid and wastewater management	Monitoring of sediment quality, 1 upstream of port and one downstream. Visual monitoring of waste management practices	pH, Pb, Cd, Hg, As, Cr, Fe, Al	Independent Monitoring Consultant under supervision of DONRE	Annual, first is before construction	Total cost VND 490,000x2 = VND 980,000, analysis only	Part of environmental management plan for Ports

Discipline/ Envi Component	Impact/s	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Surface Water Quality	Ports operations may have adverse impact on surface water quality through spillage of construction wastes, oil, fuel, ; leachate; ship discharge of oil waste; sewage,etc.	Roofed storage for coal; Port waste reception facilities; Proper waste management	Monitoring of water quality Monitoring of compliance with EMP	TDS, Suspended sediment, pH, Pb, Cd, Hg, As, Cr, Fe, Al; Port Envi management plan	Plan preparation by port owner; Independent Monitoring Consultant under supervision of DONRE	Bi-annual, low flow season and wet season. First sampling before construction	4 samples @VND1.728 million/sample = VND7.12 million	
Occupational Health & Safety	Exposure to hazards, noise, heat, ergonomic stress	Orientation PPEs First Aid stations Assignment of safety officer; Trained emergency first responded	Monitoring of compliance	Safety Guidelines; Availability and usage of equipment and safety personnel	Preparation of guidelines by Port operator under supervision of DONRE	Continuing Random checks	Part of Construction management cost	Include in Contractor's contract.
Public Health	Operations may create hazardous conditions for local residents;	Provide ample warnings; Conduct consultations	Monitoring of HSE practices	HSE guidelines and plans	Plan to be prepared by Port owner, supervision by DONRE	Continuing Random checks	Part of Construction management cost	

Environmental Monitoring

At present, in Vietnam, the Department of Environmental Protection (NEPA) within MONRE is responsible for the national-wide environmental monitoring. A National Monitoring System set up by the former MOSTE in 1994, involved the various environmental research centres. These centres carry out monitoring of air and water quality and solid wastes in the selected areas and submit reports to NEPA. At provincial level, Department of Natural Resources and Environment (DONRE) is responsible for environmental management, including environmental monitoring which is referred to as *external monitoring*.

For the NDTDP, the PMU-W is responsible for undertaking internal environmental monitoring during pre-construction, construction and operation stages. The results of the internal environmental monitoring are regularly submitted to the Ministry of Transport, DONREs of the related provinces or MONRE for review.

Two types of environmental monitoring are to be implemented in the NDTDP. These are the site audit and environmental quality monitoring.

- Site Audit

Site audit mainly involves the evaluation of the implementation and effectiveness of the mitigation measures. This is conducted by the PMU or its contractor during the pre-construction, construction and operation stages.

- Environmental Quality Monitoring

The environmental quality monitoring involves the testing, analysis and evaluation of selected environmental indicators. Environmental quality and compliance with set standards are assessed by comparing results of monitoring data with relelvant Vietnamese Standards for the Environment

The organizations involved in environmental monitoring are

- Independent Monitoring Consultant (IMC).
- Contractors
- Governmental Environmental Management Agencies (DONREs).

The independent monitoring consultant (IMC) will be engaged by the Project Management Unit of MOT. The role of the IMC is to monitor the implementation of the EMP. The IMC will submit its environmental monitoring report every 3 months to MOT and WB.

Regular monitoring of RAP implementation will be conducted by PMU and by the International Donor (WB), as well as by an independent external monitoring agency.

Internal Monitoring

The Resettlement Department of PMU-W, with the assistance of supervision consultant teams, will be responsible for internal monitoring of RAP implementation.

- *Monitoring Indicators*

The main monitoring indicators are:

- Payment of compensation to PAPs in various categories, according to the compensation policy described in the RAP,
- Public information dissemination and consultation procedures
- Adherence to grievance procedures,
- Resettlement site location, design, site construction and plot allocation
- House construction, technical assistance, payment of subsistence and shifting allowances as described in the RAP,
- Employment generation through project implementation and priority of PAP for the options offered,
- Provision of training and credit availability,

- Co-ordination and completion of resettlement activities and commencement of civil works.

The staff of PMU-W will carry out the internal monitoring activities. They will collect information every month from the Provincial Resettlement Committees (PRCs) and District Resettlement Committees DRCs. A database of resettlement, monitoring information about the project will be maintained and updated every month. PMU-W will submit to WB and Governmental authority a monitoring report on the progress of implementation of the RAP every six month.

The monitoring for occupational health and safety should be done regularly. The monitoring should cover:

- Compliance by contractor with occupational health and safety plan:
- Adherence by workers with the safety guidelines
- Use of PPE by workers, including floatation devices by those working in water
- Presence of emergency first responder
- Availability of first aid station in construction site;
- Reported number of accidents or incidents involving lost time
- The monitoring shall be implemented by PMU-W environmental staff.

Capacity Building for Environmental Management

Environmental management of inland waterway projects is a relatively new task for Vietnam Transport Sector. As such, it is essential that a capacity building for environmental management be undertaken prior to project implementation. Staff who will be involved in the implementation of the EMP should undergo training. The objective of the training is to familiarize the management staff with environmental management and procedures for environmental monitoring and reporting. The training can be conducted by one of the environmental centers involved in environmental impact assessment and environmental management.

The training will include the following components:

a. Training for DONRE staffs

The training will cover, among others, the following subject matters:

- The Environmental Management Program for Ports
- Environmental issues related with port management
- Environmental Regulations and Standards of Vietnam
- Environmental monitoring methods and procedures.
- Environmental Reporting – report preparation, interpretation of laboratory results

b. Training for Construction Engineers

The following training programs will be provided for engineers of the constructors.

- Labour Safety: Regular training on safety issues related to the riverworks and dredging;
- Environmental management Plan of the Project: Orientation of engineering staff on the environmental management plan for NDTDP Ports Management.
- Monitoring and reporting of EMP: The training will include the methodology for site observation and reporting of monitoring results.

Public disclosure

Public disclosure has been carried out during the feasibility study stage. This was done through focus group discussions with stakeholders likely to be affected, consultations with port administrators and with the broad stakeholders through the workshops conducted during the inception stage, interim stage and final stage of the feasibility study.

1 INTRODUCTION

1.1 Background of the Northern Delta Transport Development Project (NDTDP)

The Ministry of Transport (MOT) of the Government of Viet Nam is responsible for planning, design, construction, maintenance and operation of all major modes of transport in Viet Nam: highways, railways, aviation, and inland waterways. MOT has recently undergone a restructuring creating individual and separate modal departments responsible for the administration and management of the various modes of transport, and functional departments responsible for the state-wide administration and management of planning, investment, finance, institutional development, and associated science and technology.

Presently, MOT is concentrating through the Vietnamese Inland Waterway Administration (VIWA) and Project Management Unit Waterways (PMU-W) on the improvement of the navigation conditions in both the Mekong Delta and the Red River Delta. Major national inland waterway related works have been tendered by PMU-W through both national and international competitive bidding. Within the scope of the Northern Delta Transport Development Project (NDTDP) being financed by the International Development Association PMU-W has appointed the Consultants to prepare Feasibility Studies and Preliminary Designs (similar to Basic Designs) for the Project.

1.2 Objectives of the NDTDP

The objectives of *the Northern Delta Transport Development Project* is to support sustainable economic growth and inclusive development in the Northern Delta Region by increasing the efficiency of transport infrastructure in the Northern Delta Region in an integrated and safe manner by means of multi-modal transport. The Project will improve the supply chain efficiency for production, distribution and trade and will also provide better and safer access for the poor to the main supply corridors. The specific Project objectives are:

- to reduce transport costs/tariffs and improve service quality from points of production to local markets or points of export through improvements in the inland waterway and connecting road systems;
- to raise the efficiency of logistics services across different transport modes;
- to assist in building the management tools and capacity of VIWA and Provincial Departments of Transport (PdoT) in the effective exercise of their responsibilities under the 2004 Law on Inland Waterways;
- to develop/strengthen existing frameworks for private sector participation in the provision of infrastructure and services associated with provincial ports, landing stages and logistics centres.

1.3 Proposed Other Packages Phase 2

This framework covers the Phase 2 investment packages for ports and landing stages, ferry boat stages, and improvement of Corridor 3. The environmental assessment of the other Phase 2 investment package for the Day-Ninh Co River Mouth Improvement is presented in a separate volume. The description of the investment packages in Phase 2 are:

1.3.1 Ports and landing stages

Most ports in the project region are in poor conditions and require rehabilitation / development of facilities and stream lining of port management operations. The Upgrading of ports is one of the key improvement activities that has been identified in the NDTDP. Thirteen ports have been identified for improvement. Among these, the Ports of Viet Tri and Ninh Phuc have been chosen as the pilot ports. Improvements being considered are construction of warehouses, quays, open yards, coal storage, sewer and drainage system and waste reception facilities

1.3.1 Ferry Crossings and Landing Stages

The feasibility assessment, based on economic, technical, environmental criteria and stakeholder preferences, has concluded that investment in the improvement of ferry crossings

and landing stages will be most beneficial in terms of attaining the objectives of the NDTDP. Thus, in line with the current economic plan of the government, sections of the main waterways of the Red River delta, including its interconnecting infrastructures, such as, ferry crossing stages will be included in the investment program under the NDTDP.

Like river ports, ferry crossing stages comprise the inland water transport infrastructure system of the Red River delta (excluding ferry crossing stages managed by road transport sector). They are river side platforms established for ferry boats and their passengers in getting to the other side of the river. At times, they are also used for cargo loading and unloading.

The recommendation for Phase 2 is the improvement of two ferry boats stages per province.

1.3.2 Corridor 3 Improvements

The proposed improvements for Corridor 3 in Phase 2 include the development of groin fields, bank protection in Lac Quan, dredging of Mom Ro and the connection of Lach Giang to NInh Puc.and the installation of navigation aids in Red River, Nam Dinh River and Day River.

1.4 Study Methodology and Data Sources

The environmental assessment framework was conducted on an incremental approach to provide the optimum support to planning and feasibility study. A regional scanning of the Red River Delta was initially conducted based on secondary literatures and environmental information was provided to the planning team. The information generated was part of the basis for the environmental screening of specific components and their alternatives. Subsequently, a follow-up collection of primary data, i.e. sampling and laboratory analysis and site inspection, were conducted for the selected project components.

The secondary sources of information include project documents and published researches and reports on the Red River Delta. Among these are:

- Sourcebook of existing and proposed protected areas in Vietnam by Birdlife International, World Bank, Royal Netherlands Embassy and the Ministry of Agriculture and Rual Development (MARD) 2004, 2nd ed.
- Red River Delta Master Plan by Binnie & Partners, Snowy Mountains Engineering Corp Ltd. AACM International Pty Ltd. And Delft Hydraulics, 1995. . UNEP, Government of Vietnam, MOSTE
- Red River Waterways Project Vietnam TA No. 2615-VIE by Haskoning Consulting Engineers and Architects and Delft Hydraulics, 1998. . Gov Socialist Republic of Vietnam, MOT, VIWA.
- Day River-Ninh Co River Mouth Improvement Project – Vietnam by Haskoning Nederland BV Coastal and Rivers, 2003. Ministry of Transportation, PMU Waterways
- Northern Delta Transport Development Project. Consultancy Services for Feasibility Study and Preliminary Engineering Design. Inception Report by Royal Haskoning, SMEC and Center of VAPO 2007. , MOT, VIWA, PMU-Waterways
- ALMEC, 2006 Northern Region Comprehensive Transport Strategy Study

Numerous researches on environment related topics regarding the Red River Delta were also accessed in the world wide web.

Primary data collection consisted of collection of water samples, soil samples, stream sediment samples, collection of selected specimens for identification, air quality and noise measurement. The primary data collection was done in November and December 2007 by the Environment Protection Centre (VESDEC) of the Vietnam Environment and Sustainable Development Institute (VESDI). Chemical analysis of the water, soil and stream sediment samples were done by the Institute of Chemistry of the National Academy of Sciences and Technology. The list and description of sampling locations are attached to this report as **Appendix 1**.

Parameters analyzed are the following:

- ***Water quality*** (20 parameters): Temperature, pH, salinity, TDS, turbidity, SS, DO, Fe, BOD_5, NH_4^+, NO_3^-, total N, total P, Zn, Cr, Cd, As, oil, phenols and total coliform.
- ***Soil quality*** (9 parameters): pH, Al, Fe, As, Pb, Cd, Cr, Hg and total oil.
- ***Sediment quality*** (10 parameters): pH, Al, Fe, As, Cd, Pb, Cr, Hg, pesticides (at some sites) and grain sizes.
- ***Air quality*** (9 parameters): Temperature, humidity, wind speed, CO, SO_2, NO_2, TSP, PM_{10}, Pb.
- ***Noise*** (dBA)
- ***Vibration***: L_x, L_y, L_z (dBA)
- ***Aquatic organisms*** (3 parameters): phytoplanktons, zooplanktons, benthic animals
- ***Fish*** data provided by Institute of Ecology and Biological Resources (IEBR) based on their 2007 surveys.
- ***Flora***: Listing of vegetation species at each sampling sites.

Air quality, noise and vibration tests were done by the SINTEP. The parameters measured include :

- Temperature
- Wind speed
- Total suspended particulate (TSP)
- Particulate Matter 10 (PM10)
- Sulfur dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Carbon Monoxide (CO)
- Noise
- Vibration

A GIS database has been created for the storage and to facilitate the analysis information. Environmental data (i.e. water quality, soil quality, stream sediment quality and air quality) were assessed by comparing with the standards set by the Government of Vietnam and with standards set by globally recognized institutions and governments such as the Dutch Standard for Sediment Pollutants.

For a better understanding of the environmental condition and how it varies with time and space, basic statistical and spatial analyses were done when data sets allow.

Consultations were also conducted as part of data collection and in compliance with procedural requirements. Among the consulted stakeholders were the port authorities / management, the provincial DONREs and the stakeholders that will likely be directly affected by the various components of the project.

1.5 Purpose and Structure of this Volume

This volume contains the environmental assessment framework of the Phase 2 investment package, except for the Ninh Co River Mouth Improvement, the EIA of which is contained in a different volume. The environmental impact assessment was conducted to ensure the environmental sustainability of the project and its components as well as to fulfill the environmental permitting requirements of the Government of Vietnam and the lending institution.

The contents of this volume are:

Chapter 1- Introduction, this section

Chapter 2- An outline of environment related policies, legal and administrative framework pertinent to the waterways improvement project.

Chapter 3- The description of the waterway improvement sub-projects to be undertaken under the NDTDP

Chapter 4 – The existing environmental condition of the study region and specific work sites

Chapter 5 – Typical Impacts of Various Stages of port and ferry boat stages construction and operations

Chapter 6 – Analysis of the various alternatives considered by the NDTDP

Chapter 7 – Typical Impacts

Chapter 8- The Framework for Environmental Management, containing recommendations and strategies for avoidance, mitigation and rehabilitation and monitoring measures

Chapter 9- Disclosure and public involvement and consultations

Chapter 10 – Listing of references used in the study

Chapter 11 – Attachments and appendices

2 LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1 Vietnamese Policy in Environmental Impact Assessment (EIA)

At present, the most relevant environmental policies of Vietnam for environmental assessment are as follows:

2.1.1 Law on Environmental Protection (LEP)

The LEP was approved by the National Assembly on November, 29, 2005 and issued on December 12, 2005 through Order No.29/2005/L/CTN by the State President and enacted on July 01, 2006. The LEP is made up of 15 chapters, 136 articles, including Chapter III which contains the guidelines for environment assessment (SEA articles 14, 15, 16, 17), environment impact assessment (EIA articles 18, 19,20, 21, 22 23) and commitment in environmental protection (CEP, articles 24, 25, 26, 27).

Decree No. 80/2006/NĐ-CP dated August 9, 2006, detailed guidelines in implementation of some articles of the LEP.

This decision includes 3 chapters, 25 articles, of which 12 articles of the chapter I are guidelines for SEA, EIA and CEP: This decision lists the inter-sectoral, inter-provincial projects and EIA reports that are under the jurisdiction of the Ministry of Natural Resources and Environment (MONRE). According to this Decree the projects that are required to conduct EIA are: (1) Road projects of class IV with length of over 50km; and (2) the construction and rehabilitation of river or sea ports for ships of 1,000 DWT and over. The EIA reports for these types of projects should be approved by MONRE, the provincial people committee or MOT. Transport projects of lower capacities are required to prepare CEP for appraisal by the district People Committee.

The following sections give an overview of the SEA, EIA and CEP (after Hilaf Hong Duc (http://www.vilaf.com/index.asp?progid=50003&cateID=EDC3D673-C29E-C598-6145-0759F43E23D0).

- *Strategic Environment Assessment Reports*

Projects that are subject to strategic environment assessment reports include strategies and plans on national socio-economic development at the national or provincial level. The agency responsible for building a national strategic project must prepare and submit a strategic environment assessment report to the relevant appraisal body.

The appraisal is one of the grounds for approving the project. A strategic environment assessment report must include the following contents:

i. general descriptions of the objectives, size and features of the project;
ii. descriptions of the natural, economic, social and environmental conditions of the project;
iii. a prediction of possible negative effects on the environment;
iv. sources of data and appraisal methods; and
v. proposed solutions and directions for the implementation of the project.

The MONRE is responsible for forming a Strategic Environment Assessment Report Appraisal Board with regard to projects belonging to the authority of the National Assembly, the Government and or Prime Minister. The relevant ministries have a responsibility to form Strategic Environment Assessment Report Appraisal Boards with regard to the projects under their respective authority. Provincial People's Committees are responsible for forming Strategic Environment Assessment Report Appraisal Boards with regard to the projects under their respective authority or provincial People's Councils' authority.

- *Environmental Impact Assessment Reports*

Article 18.1 of the new Environment Law provides a list of the projects that are required to conduct environmental impact assessment. These include projects of national importance such as urban area development projects, large scale projects for exploitation of natural resources, and projects for the development of IZs, HTZs and EPZs. Appendix I of Decree 80 implementing the Law on Environment dated 9 August 2006 ("**Decree 80**") provides a more comprehensive list of projects requiring environmental impact assessment reports, including all telecommunications infrastructure construction projects, projects on building and repairing ships and projects on exploitation of oil and gas.

The environmental impact assessment report must be made filed together with the feasibility study of the project. The contents of an environment impact assessment report must include project specifications, operational technology of the project, measures to minimise negative effects on the environment, an undertaking to apply environment protection measures during the construction and operation phases, and opinions of the local commune People's Committee and the population community where the project is carried out. These opinions may be in agreement or disagreement with the project from an environmental protection perspective and must be set forth in the report for the relevant appraising body's consideration.

To obtain the opinion of the community, the project owner has to send a document containing brief contents of the project, environmental impact of the project, measures to minimize such impacts to the People's Committee and National Front Committee at commune level. A dialogue may be launched if required by the People's Committee or the National Front Committee.

An environmental assessment report may be appraised by an appraisal board or an environment assessment service agency. The MONRE is responsible for providing the conditions and guidelines for environment service agencies. The MONRE is authorised to form the environment impact assessment report appraisal board, or select an environment impact assessment service agency in respect of projects belonging to the authority of the National Assembly, the Government or the Prime Minister or inter-provincial or inter-ministerial projects. Other ministries are authorised to form environment impact assessment boards or select environment impact assessment service agencies with regard to projects under their respective authority. Provincial People's Committees are responsible for forming environment impact assessment report appraisal boards, or selecting environment impact assessment report appraisal service agencies with regard to the projects under their respective authority and provincial People's Committee's authority.

The agency organising the appraisal has to inform the project owner about the appraisal result within 3 days of receiving such a result from the appraisal council or the appraisal service agency.

- *Environment Protection Undertaking*

Pursuant to Article 24 of the Environment Law, projects that are not subject to the compulsory environment impact assessment reports must provide an undertaking to protect the environment. The contents of the undertaking must include: (i) the project site; (ii) the form and scale of production, trading and services, materials and raw materials used for the project; (iii) likely waste to be produced from the project; and (iv) an undertaking to apply measures to minimise and treat waste and comply with the laws on environment protection. The undertaking must be registered with the local district People's Committee where the project is located before commencement of the project.

Appendix 4 in this Circular gives the structure and content of an EIA report.

The other relevant regulations are:

- Law on Mineral Resources, approved by the National Assembly on March 20, 1996.
- Law on Forest Protection and Development (1992, revised in 2004)
- Land Law, approved on November 26, 2003 by the National Assembly.
- Law on Water Resource, approved on May 20, 1998, by the National Assembly.

- Law on Forest Protection and Development (1992, revised in 2004)

2.1.2 Decree 81/2006/NĐ-CP of the Government

This Decree prescribes the penalty for the violation of environmental regulations. Chapter I describes the general provisions for penalties, Article 9 of Chapter II describes the penalties for violating the EIA regulation and strategic environmental assessment. Project owners can be fined for not conducting an EIA and for not implementing mitigation measures contained in the approved EIA report.

2.1.3 Vietnamese Standards for the Environment (TCVN)

The Vietnamese Standards for the Environment were published by the former Ministry of Science, Technology and Environment (MOSTE) in 1995, 2000, 2001, 2002 and by the Ministry of Science and Technology (MOSTE) in 2006. The environmental standards include standards for air, water, soil and noise. In general, the list of biophysical parameters is broad enough such that most monitoring programmes can employ the standards as basis for evaluation. However, in the absence of standards such as sediment quality, it is a common practice for ODA projects to use standards from other countries or international organisations.

The relevant Vietnamese standards ared:
- Ambient Air Quality Standard (TCVN 5937-2005) and TCVN 5938 - 2005
- Surface Water Quality Standard (TCVN 5942-1995)
- Acoustic Standard (TCVN 5949-1998)
- Fresh Water Quality for Protection of Aquatic Life (TCVN 6774-2000)

- Domestic Wastewater Standard (TCVN 6772-2000)
- Irrigation Water Quality Standard (TCVN 6773-2000)
- Industrial Effluent Standard (TCVN 5945-2005)
- Permissible Noise Level for vehicles (TCVN 5948-1999)
- Vibration and Shock Standards created by Construction and Industry (*TCVN 6962 - 2001*)
- Soil Quality Standard – Permissible Limits of Pesticides in Soils

2.1.4 Vietnamese Administrative Set Up in Environmental Management

From 2002, the Government of Vietnam has established the administrative and institutional set-up for environmental management. The institutions responsible for environmental management are the following:

- *Ministry of Natural Resources and Environment (MONRE)*

A Prime Ministerial Decision established MONRE on November 11, 2002. MONRE merges numerous departments.

- *Department of Environmental Impact Assessment Appraisal*

This Department is under MONRE. As stated in Decree 91/2002/ND-CP, the Department's function is: *To appraise environmental impact assessment reports of projects and of business and production establishments.*

The Department of EIA Appraisal of MONRE is responsible for organizing EIA Committee for approving SEA, EIA reports guided by the government (Decision N 80/2006/ NĐ – CP).

- *Sectoral Ministries*

According to the LEP (2005) the sectoral ministries are responsible for the environmental management of activities within their sectors. The ministries' responsibilities include the review and approval of EIA reports of the sectoral development projects. For examples, the Ministry of Transport is responsible for approving development projects guided by the Government (Decision 80/2006/ND-CP).

- *Provincial People Committees (PCs)*

Provincial PCs have responsibilities in environmental management in their territories. Accordingly, PCs have functions of reviewing and approving EIA reports for the development project guided by the Government (Decision N 80/2006/ NĐ – CP) in their territories.

- *District PCs*

District PCs have function in reviewing and appraisal CEP reports for the development projects guided by the Government (Decision N80/2006/NĐ – CP) in their territories.

- Provincial Departments of Natural Resources and Environment (DONRE):

In each provincial DONRE there is an Environmental Management Division (EMD). The EMD is responsible for supporting the PC in environmental management in accordance with the LEP and related laws and regulations. Hence, it is DONRE - and in particular, it's EMD - that will likely play a key regulatory role in environmental monitoring during project construction and operation of the NDTDP.

In case that the project will be divided into many sub-projects, each sub-project will have separate EIA or CEP reports, provincial DONREs or District DONREs, respectively, will organise committees for approving each EIA or CEP reports.

2.2 EIA Review and Approval Process

The following is the current standard procedure for environmental review and appraisal in Vietnam:

a) The project owner undertakes EIA study with or without an assistance of consultants.

b) A full EIA study should be conducted during the feasibility study (FS) stage of the project. Content and structure of an EIA report should be in accordance to the *Appendix 4* of the Circular 08/2006/TT – BTNMT of MONRE

c) The project owner submits seven (7) sets of EIA reports together with a letter requesting for the review and approval of the EIA report together with one (1) copy of Feasibility Study Report of the proposed project to the relevant agencies (Department of EIA Appraisal of MONRE or provincial People Committee or Ministry of Transport.

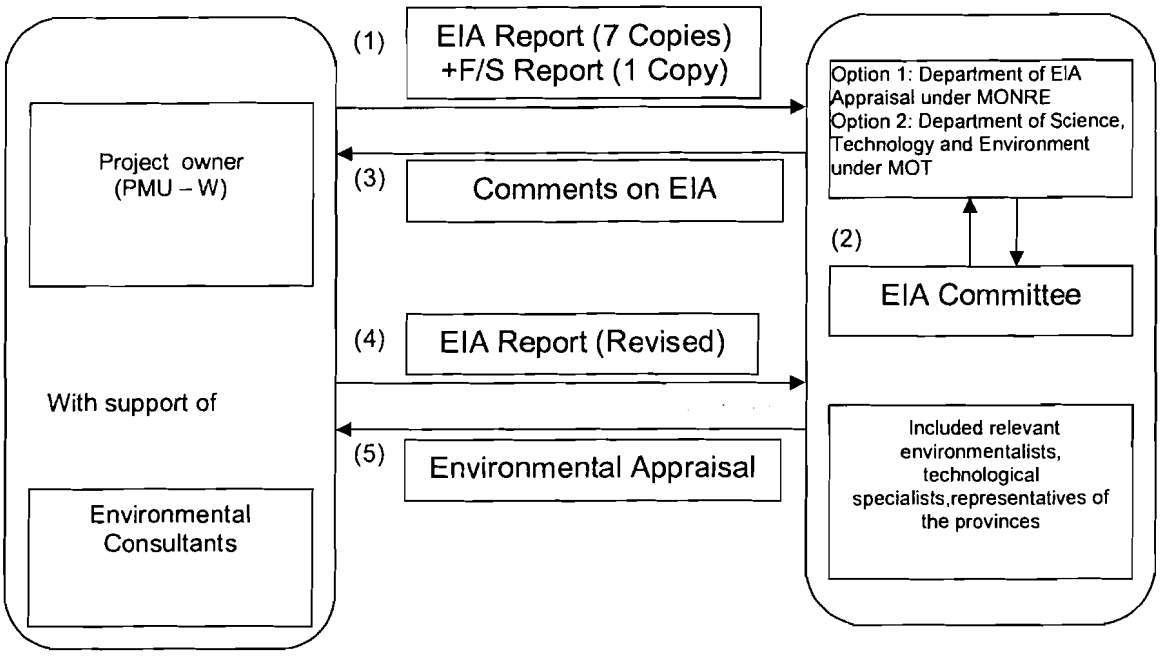
d) After receiving all EIA and F/S reports the relevant environmental authority organizes a Committee, consisting of environmental specialists and technological experts, representatives of Department of Natural Resource and Environment (DONRE) of the concerned provinces for appraisal of the EIA report.

e) The comments and views of the Committee on the EIA report are given to the project owner.

f) The project owner conduct additional studies to clarify all required items of the Committee and revises the report in response to the comments raised by the Committee.

g) An Environmental Approval Paper will be issued after the reception of the revised EIA report, which met the requirements of the Appraisal Committee.

The procedure of EIA for this project is presented in the following figure.



2.3 World Bank Social and Environmental Safeguards Policies

The World Bank safeguards operational policies that are relevant to the NDTDP are:

2.3.1 OP 4.01 (January 1999) -Environmental Impact Assessment:

The World Bank's Operating Procedure (OP) 4.01 contains the Bank's policy requiring projects proposed for the Bank's financing to conduct environmental assessment to ensure their environmental sustainability and to improve decision making. This operating policy enumerates the different environmental assessment instruments (depending on the project) that maybe submitted in order to comply with the Bank's requirement. OP4.01 also defines the basis for the environmental screening of the projects for the purpose of determining the appropriate extent and type of the environmental assessment. Further, the operating policy stipulates the Bank's requirement for institutional capacity building to be included in the project if the borrower has inadequate legal and technical capacity to implement the EA related functions. The need for public consultation, disclosure and conditions for implementation are likewise contained in OP4.01.

This Operational Policy statement was updated in March 2007 to reflect issuance of **OP/BP** 8.00, *Rapid Response to Crises and Emergencies.* The Bank may exempt a project from any of the requirement of this policy if it would prevent the effective and timely achievement of the objectives of an emergency operation.

2.3.2 OP 4.04-(June 2001) Natural Habitats:

The Bank recognizes conservation of natural habitats as one of the measures needed to protect and enhance the environment for long-term sustainable development. OP 4.04 contains the Bank's position and conditions on projects located within or projects that may impact on important natural habitats.

2.3.3 OP 4.11 (July 2006) Physical Cultural Resources

This policy expresses the Bank's recognition of the importance of physical cultural resources as sources of valuable scientific and historical information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices.

As such, the policy contains the Bank's recommendation on how the physical resources can be protected from project impacts and managed within the context of the environmental assessment. Also, the operating policy contains the Bank's conditions for consultation and disclosure and emergency operations under OP 8.00.

2.3.4 OP 4.12 – (Dec 2001) Involuntary Resettlement

OP 4.12 contains the Bank's policy on involuntary resettlement as a consequence of development projects. The policy contains the World Bank's procedures for management and compensation for project affected households subject to involuntary resettlement when a Resettlement Action Plan (RAP) is required to be prepared. This includes process for determining eligibility to benefits by affected persons, the required planning instruments and resettlement instruments. Triggers for OP 4.12 include: involuntary taking of land or other assets; and when the involuntary taking of land or other assets results in adverse impacts on the livelihood of displaced persons.

2.3.5 OP 4.10 – (July 2005) Indigenous Peoples

This policy is part of the Bank's mission of reducing poverty and sustainable development by ensuring that the development process fully respects the dignity, human rights, economies, and cultures of Indigenous Peoples. The policy sets the procedure and requirements for project proposed for Bank financing that affects Indigenous Peoples. The process calls for screening, social assessment and the preparation of Indigenous Peoples Plan.

3 PROJECT DESCRIPTION

3.1 Overview

3.1.1 Ports and Landing Stages

Thirteen priority ports have been identified for improvement and two have been chosen for piloting. The two ports are Viet Tri Port in Phu Tho province and the Ninh Phuc Port in the province of Ninh Binh. The identified priority ports are enumerated in **Table 3-1**. Improvements being considered are construction of berths, open yards, jetties, pavements and provision of the cargo handling equipment.

Table 3-1. Short List of Ports in Corridor 1 and Corridor 2

Name of River Port	Province	Type	Throughput 2005 (tons)
Nhu Thuy	Vinh Phuc	Conventional	40,000
Viet Tri	Phu Tho	Cargo	800,000
Vinh Thinh	Vinh Phuc	Conventional	90,000
Chu Phan	Vinh Phuc	Conventional	90,000
Son Tay	Ha Tay	Conventional	130,000
Hong Van	Ha Tay	Native Port	75,000
Dap Cau (including Alu)	Bac Ninh	Native Port	0
Kenh Vang	Bac Ninh	Conv.	100,000
Phu Dong	Ha Noi	Native	0
Khuyen Luong	Ha Noi	Cargo	245,000
Short List of Ports for Improvement Corridor 2			
Cong Cau	Hai Duong	Native Port	265,000
Thai Binh	Thai Binh	Passenger Port	50,000
Ninh Phuc (+Ninh Binh)	Ninh Binh	Cargo Port	1,250,000

The objectives of the pilot port projects are to demonstrate how to:

- Increase capacity
- Improve operations
- Improve port administration and management
- Include sound environmental management
- Develop sustainable cost recovery and finance mechanisms
- Apply lessons learned in the future river port development projects

3.1.2 Ferry Boat Stages

Like river ports, ferry crossing stages comprise the inland water transport infrastructure system of the Red River delta (excluding ferry crossing stages managed by road transport sector). They are river side platforms established for ferry boats and their passengers in getting to the other side of the river. At times, they are also used for cargo loading and unloading. Its operation must be under management and is classified by law. The activities of ferry stages for passenger are an integrated element of social life and one part of the transport system chain in general, and rural transport system chain in particular.

3.1.3 Corridor 3 Waterways Improvement

Corridor 3 is a vital connection for vessels sailing from the south going into the ports of Ninh Phuc and other inland ports along the Red River. With the improvement of the Ninh Phuc River mouth, improvement of the upper sections have to be undertaken to optimize the usage of the corridor. The proposed investment for improvement are dredging , bend improvement, groins fields and bank protection. Installations of navigational aids all throughout Corridor 3 are likewise proposed to implement restrictions where physical improvements to the waterways cannot be undertaken due to constraints

3.2 Description of Existing Conditions of Ports, Ferry Landings and Corridor 3 Waterways

3.2.1 Prioity Ports

Red River delta region is comprised by an extensive river network wherein a sizable number river ports lined the main waterways. Of the total number of ports, 14 ports are considered main ports (for cargoes and passengers), 14 are native ports and 13 are specialized ports (for coal, petroleum, cement and thermo-electric industries). Among the main cargo ports are Hanoi, Khuyen Luong, Viet Tri, Nihn Binh, Ninh Phuc, Hoa Bihn and Da Phuc ports.

River ports as a basic part of the inland waterway transport system of the region are under the management of either the public or private sectors. Most public ports are managed and operated by the Ministry of Transport or the provinces, cities and state or province-owned corporations. Meanwhile, the state-owned ports are being managed by several ministries, like the Ministry of Industry and Trade (coal and power cargo operations) or the Ministry of Construction (cement cargo operations). Since late 1990s, most MOT-owned ports are no longer being operated by VIWA, but by self-controlled enterprises. VIWA itself, however, remains responsible for the port infrastructure planning.

Private ports can be considered as landing stages. Based on available information, although considerable cargo handling occurs along the river banks at privately owned landing stages, the main part of the inter-provincial (long haul) cargo is handled at the public sector ports.

Viet tri Port

Viet Tri Port was built in 1965 and is under the jurisdiction of Phu tho province. It is perfectly situated along the Lo River as a nodal point in intermodal transport. (**Figure 3-1**). The port is connected to the railway system and has excellent road connection and ample space available for expansion.

The principal river ports in the north including Viet Tri, used to be under VIWA control but since January 1997 waterway management (construction, rehabilitation, maintenance/ dredging), transport, river port operations and shipyards have been "unbundled". The river ports are now under NWTC, with the exemption of Ninh Binh, which is still under VIWA.

Viet Tri port not only serves the rapidly developing industrial area around Viet Tri, but also is a nodal point in the (multi-modal) transport infrastructure connecting the mountainous areas and China with the Red River Delta and the sea. Ninh Phuc Port on the other hand supports the economic development requirement of the southwestern region of the Red River Delta.

Ninh Phuc port

Built in 1992, Ninh Phuc Port is located at Ninh Binh province. It is situated along the Day River (60 km from the sea) just downstream of the railway bridge and serves as a center of the intermodal transport. The port is connected to the railways and has an excellent road connection (Highway No. 1). The land it occupies is quite limited for an expansion plan.

Ninh Binh Port consists of 2 areas viz. the old "Ninh Binh port with 4 berths" 3 of which is used for unloading, and the rest is for loading in to barges and the newly built Ninh Phuc port with 2 berths. The total length of the berth is 270 m. The berths were designed with chained cranes with hooks to handle cargo of 3 ton/m and therefore it is impossible to lift heavy cargo. According to the plan, in order to achieve 1.0 to 1.3 million tons/year, it is necessary to build one more berth with length of 162 m and 2 berths of 78 m in the upstream of 2 existing berths of Ninh Phuc port. The port has a plan to procure handling facilities; however, it depends on the volume of cargo through the port in the coming time. The following commodities are reported to be of concern for the port:

- Cement (production at existing Bim Son plant of 1.4 million tons per year which is envisaged to grow up to 2.8 million tons and new plant Tam Diep 1.5 million tons per year;
- Cement bags amount to some 300,000 tonne/year;
- Coal for the coal fired power station in Ninh Binh of 0.6 million tons per year;
- Other commodities amounting up to approximately 1.2 million tons per year (fertilizer, rice);
- Rock and gravel from the quarries which are operated n the area.

Until only recently there were 2 berths (80 m) present which was mainly used for the handling of coal from 200 ton barges. Actual depth is reported to be 6 m on average.

A first stage development of the port consisting of a bulk handling berth has been finalized only 9 months ago and it was reported that it has a designed capacity of 2.5 million tons per year. The port authority, which falls under the responsibility of MoT (being independent to VIWA since 1997), operates 20 cranes of 25 tons and 2 cranes of 60 tons capacity. Furthermore they operate some 100 trucks of approx. 15 tons capacity each, the latter mainly used for transport of the coal to the power station.

Access to sea is via the Day River which is, apart from some small stretches, a perfectly navigable fairway with a LAD of 3.5 m along its route. The width of the river varies from approx. 500 m at some 30 km from Ninh Binh port to approx. 200 m near the port. The accessibility at the river mouth, however, is the major problem due to siltation of the access channel. Larger ships may only enter during high tide. It is reported that the said accessibility jeopardizes further development of the Ninh Binh Port.

The port has the road access from Ninh Binh via Nho Quan, Man Duc to Son La, Moc Chau. If the cargo is transported via port, it will be possible to add and replace the cargo flow via Hanoi to Son La, Moc Chau through the road No.6. If the Day river mouth will be improved vessels of 600 to 1,000 tonne can call the port. Furthermore the port needs to increase its capability and in order to lift heavy cargo, the berths should be improved.

The port has plans for future expansion. Existing plans are related to rehabilitation of the port infrastructure and renovation of the handling equipment. The port was designed to accommodate 1,000 DWT vessels. The actual available depth in front of the port is 2.5 m during the dry season.

The port has a capacity of 1 million tons per year, however, at present, only 300,000 tons is handled (70,000 ton coal unloaded, 50,000 to cement unloaded, 50,000 tons pyrite, 50,000 tons apatite arriving by rail and transferred to vessel, 20,000 tons phosphate, limestone, gravel etc). Working below its capacity can be accounted to strict competitions with other transport modes and the poor condition of its facilities and handling equipment. Rehabilitation and upgrading of its infrastructure and equipment will eventually increase its chances to achieve a throughput of 600,000 tons/year.

The following photographs show the condition of the priority ports.

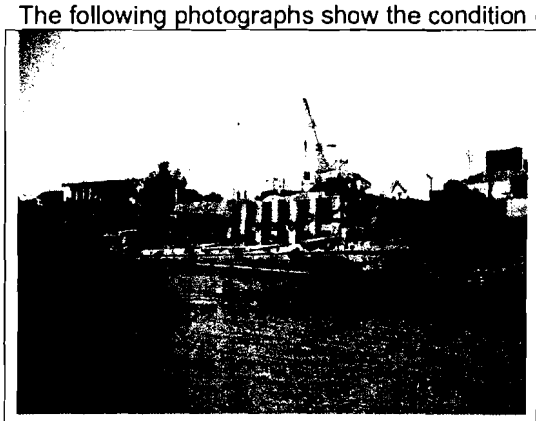


Photo 3-1. One of the quays of Viet Tri

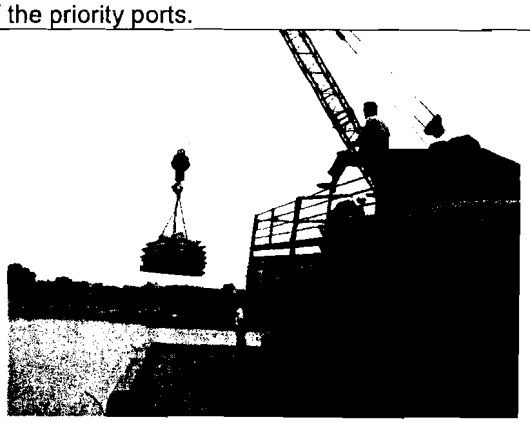


Photo 3-2. Cargo unloading at Viet Tri

Photo 3-3. Bridge along NH1 near Ninh Phuc

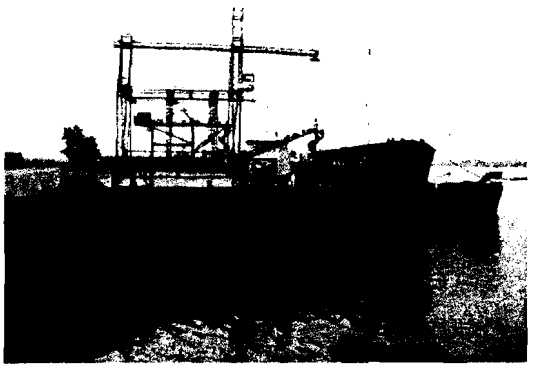


Photo 3-4. One of the quays of Ninh Phuc

3.2.2 Ferry Boat Stages

The passenger river crossing stages on the waterways of Northern Delta are scattered throughout the region and were built according to the Decision on Investment Approval No 2825/QD-BGTVT dated 22 September 2004. They can be located in 11 provinces, specifically in the Red river Delta cities of Hanoi, Ha Tay, Hai Phong, Vinh Phuc, Bac Ninh, Hai Duong, Hung Yen, Ha Nam, Nam Dinh, Thai Binh and Ninh Binh. These are also present in 7 adjacent provinces namely: Phu Tho, Bac Giang, Yen Bai, Thai Nguyen, Quang Ninh, Tuyen Quang and Lao Cai.

According to the IWT management survey in 18 provinces of the project area, there are 890 FCS's with 1086 vessels and 1026 navigators working on them. Information gathered regarding FCS's are as follows:

- The total number of stages: 890;
- The total number of vessels /boats: 1086 units, out of which 1017 private-owned;
- Operation permits issued for 267 stages, that makes 64,7%;
- Registration for operation of vessels/boat: 772 units that makes 71,1%;
- Certificates for vessels/boats navigators/drivers: 712 persons out of total 1036 persons, that makes 68.7%.

3.2.3 Corridor 3

Corridor 3 is about 178 km long connecting Ha Noi with Day (Corridor 3b) and / or Lach Giang Corridor 3a) estuary. This corridor is designed for Class II but due to the many shoals in the Corridor part of the corridor can only used for Class III. Near Hanoi bridges have insufficient vertical clearance during high water levels on the red river. Corridor should be able to handle sea-river vessels for transport between Hanoi and Ho Chi Minh City and maybe China. However, the river mouths at Lach Giang and Day River are among the main constraints. Ships with a limited draught can only enter the rivers during high tide. Both river mouths are subject to sedimentation limiting the accessibility.

The location of these proposed investments are shown in **Figure 3-1**

3.3 Project Need

3.3.1 Port improvement

Ports are vital to all economic activities in the IWT system. They are the hub for the movement and handling of important goods and produce for distribution to key markets. One important condition for ports to prove their capacity as being a cost-effective transport mode, it is important that higher value goods (time-sensitive) be handled efficiently. Over the years, a number of ports in the region have improved their cargo handling operations and service time of vessels to increase their capacity volume, making investment worthwhile.

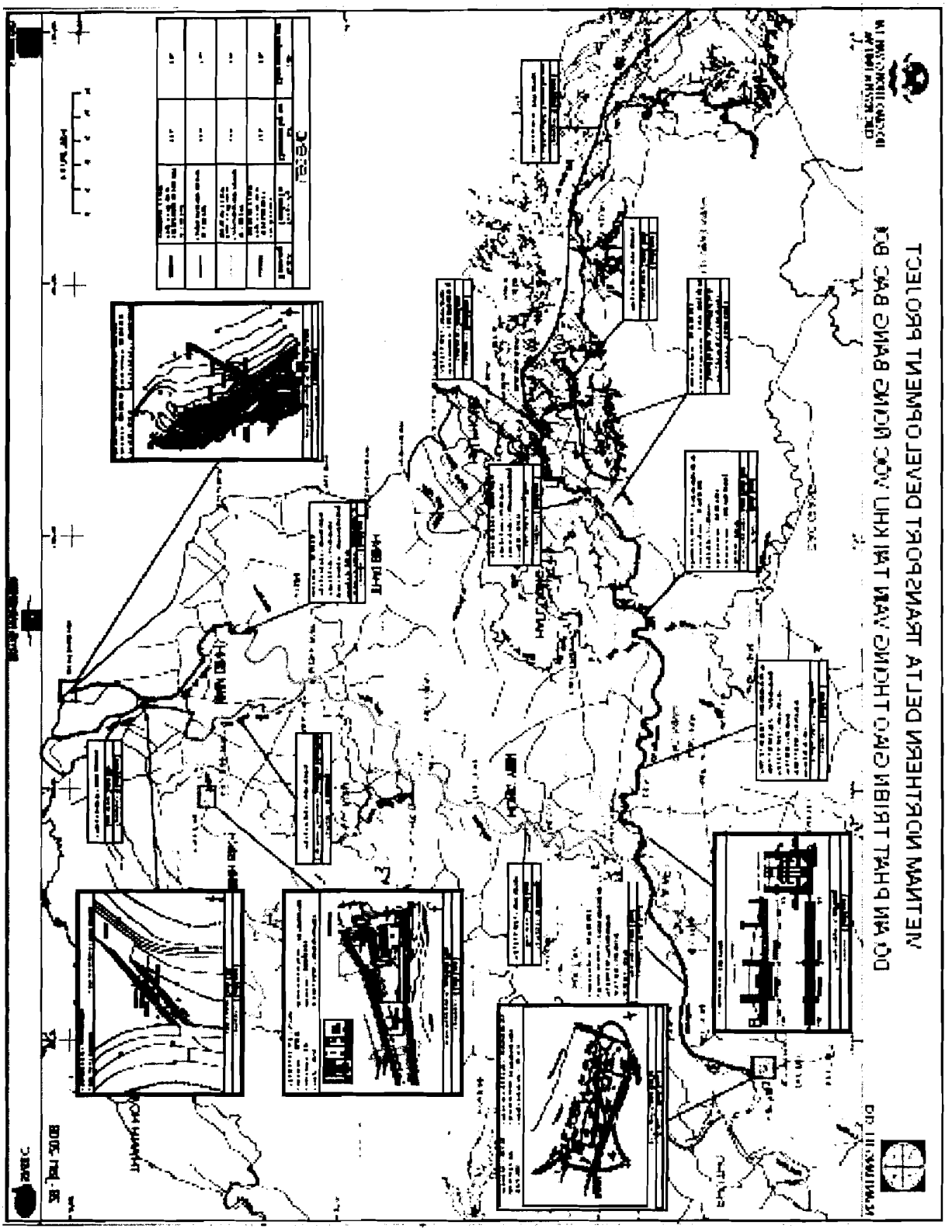


Figure 3-1 The investment package for Phase 1 and Phase 2 NDTDP

Improvement/ development in the waterways would raise the pace and efficiency of the IWT resulting to an increasing demand of cargo handling at ports. Large cargo ports like Vet Tri, would have to accommodate the rapid cargo flow. At present, Vet Tri has deficiencies in its infrastructure and handling equipment that need to be improved/ procured. Likewise, realigning of port operations and management is also required. Enhancement will fully strengthen the capacity of Vet Tri port. The ports need to be improved to be able to handle the projected cargo-volumes presented in **Table 3-5.** The improvements of the ports should take into account the expected growth in the first 10 years.

Table 3-2 Throughput for ports requiring improvements (tons/year)

	PORT	2006	2010	2020
1	Ha Bac (Dap Cau and A Lu)	215,000	--------	500,000
2	Chu Phan	80,000	--------	500,000
	Vinh Thinh	--------	--------	
3	Hong Van	98,000		300,000
4	Son Tay	123,600	--------	400,000
5	Nhu Thuy	40,000	--------	300,000
6	Kenh Vang (new)	--------	--------	300,000
7	Viet Tri	620,000	1,100,000	1,500,000
8	Phu Dong (new)	----------	----------	1,300,000

3.3.2 Ferry Stages Improvement

For years, investments have been set for construction of transport system and step by step, the road network is being upgraded. However, there is no sufficient condition to build crossing river bridge in intersection between roads and waterways, in spite of the big demand of people to travel between two river sides. This is one great concern which has impacted the whole transport network.

A solution to this problem is the construction of river ferry boat stages that will last for years. However, most of the activities are spontaneous and management is insufficient

3.4 Proposed Investments

3.4.1 Priority Ports

The proposed investments for the two ports are enumerated in the following table:

Table 3-3. Proposed Investments in Priority Ports

Viet Tri Port		
Proposed Investments	**Number**	**Area / Dimension**
New Structures		
Quay	4	20mx16.5m
Warehouse	2	36mx18m
Coal Storage	1	100m x 30m
Waste Reception Area	1	30 sq m
Drainage Sewer		500 m
For Improvement		
Open yards	4	100m x 60m
Inner Road		15,000 sq m
Ninh Phuc Port		
Proposed Investments	**Number**	**Area / Dimension**
Quay	1	40m x 13m
Warehouse	1	120mx32m
Open Yard	1	10,300 sq m
Waste Reception Area	1	30 sq m
Drainage Sewer		600 m

Design Basis

The design basis for the proposed investments is briefly presented in the following sections.

Berths

The berth-length is determined by the annual throughput of the port by crane. For purpose of the design an 8 - 14 ton crane has been adopted. The production rate of such a mobile crane is approximately 25 tons/hour. Assuming 330 working days per year including 10% down time and preventive maintenance, 8 operating hours per day the capacity of one crane can be determined.

The design length is 72 m. based on the cargo throughputs, said annual crane throughput and allowing a minimum of 5 m for maneuvering total berth lengths can be determined for each of the ports. Typical values for:

- No of cranes per berth;
- Shift duration;
- Average load factor of barges;
- Operational days

Adopted values are based on the earlier presented assessment of the exiting port operation and sound engineering judgment.

The berth length is probably an overestimation of what is presently required because of the large maneuvering space per berth (5 - 10m). This is especially true if the barges are loaded / unloaded per convoy and not per barge, which is a preferable mode of operation since it reduces the handling time. This extra reserve is however justified to cope with peak-demands; furthermore it makes moderate future expansion possible, without investing in civil works. It is remarked that the capacities (and consequent berth-length) as presented are based on daylight operation of the port only.

Storage area

The required storage area is largely determined by the dwell-time of the commodities at the port-site. Since the flow of goods is more or less constant throughout the year, transport requirements are well predictable and can be planned well in advance. As a result the dwell times can be kept to a minimum of say 2.5 days. Assuming further 330 working days per year, 70% effective use of space, 2.0 tonne/m2 storage-capacity and a peak-factor 1.2, total storage areas can be calculated.

Other Port Facilities

The following port facilities will be constructed and improved:

- Drainage and sewer system;
- Open yards;
- Inner roads

Waste Reception Facilities

The existing port regulations prohibit ship waste to be dumped in the port area, but none of the surveyed ports has ship waste receiving facilities. As a result, the ship waste (solid and liquid) is illegally disposed of along the inland waterways or at sea. In each of the ports oil receipt facilities are required. Basically there are two possibilities to handle oil from ships calling at the port viz.: a vessel collecting oil from the ships at each of the ports and subsequently delivering the waste to a central spot for further treatment; a storage area in each of the ports which is regularly emptied.

In addition, solid waste reception facilities for oily / hazardous wastes and non-hazardous wastes shall be provided in each port.

The layout and location of these proposed investments are shown in **Figures 3-2** and **3-3**

3.4.2 Ferry Boat Stages

Construction of stages must be in accordance with the Transport Master Development Plan and the Strategy. Prior to operation, technical information on appropriate location, size of stages, local topography, engineering geology and hydrology must be obtained.

The following improvements are proposed for each class of ferry boat stages:

For stages in area affected by tides:
Class 1
- Berth on slope bank coincident with access road, of 3m wide , slope i=12-15%. Structure constructed by concrete blocs M250 of 12cm thickness, dimensions 3 4m. The sub-grade is of macadam, thickness 15cm. Soil foundation compacted with K>0,95.
- The foot of berth is made of riprap cages with both sides strengthened by stone kerb.
- Marking board placed on pole of 6.5m high.

Class 2
- Berth on slope bank coincident with access road, of 3,5m wide, slope i=12-15%. Paved by concrete blocs M 250 and 15 cm thickness, block dimensions 3,5 4m. Macadam sub-grade of 15 cm thickness, on compacted soil foundation k>0,95.
- The foot of berth is made of rip-rap cages with both sides strengthened by stone kerb.
- Waiting house of 35m2 in area, dimensions 3,8 9,2m. Steel frame structure, galvanized steel roof.
- Navigation marking post is made of steel tube D120 of 6,5m high.

Class 3
- Berth on slope bank coincident with access road, of 3,5m wide, of 1,5m shoulder, slope i=12-15%. Pavement is of concrete blocs M250, thickness 18cm, block dimensions 3,5 4m, on macadam sub-grade of 20cm thickness.
- Waiting house of 48 m2, dimensions 4,8 10m. Steel frame structure, zinc galvanized steel roof.
- Navigation marking post is made of steel tube D120 of 6,5m high.

Besides on the stages of class 3 there are also 4 lighting posts with halogen lamp.

For stages in area affected by flood
The technical solution for stages of this type is similar to the stages in area affected by tides. However, they will be completed with approach way from the trunk road to the berth.
The parameters of pavement of approach way are the same as for berth. The structure of approach way is likely as follows:

Stage class 1:
The average length of approach way shall be 100m and width of 3m. Riprap kerb on both sides. The structure presents like:
- The top cover is of standard bitumen 3,5kg/m2 and 8 cm thickness.
- Aggregate lager of 15 cm thickness
- Compacted soil foundation with K>0,95

Stage class 2:
The average length of approach way is of 100m, width of 3,5m with riprap kerb on both sides. The structure presents like:
- the top cover is of standard bitumen 3,5 kg/m2 and 8 cm thickness.
- Aggregate layer of 15 cm thickness.
- Compacted soil foundation with K>0,95.

Stage class 3:
The average length of approach way is of 100m, width of 3,5m with riprap kerb. The structure presents like:
- The top cover is of standard bitumen 3,5kg/m2 and 8 cm thickness.
- Aggregate layer of 20 cm thickness.
- Compacted soil foundation with K>0,95.

3.4.3 Corridor 3 Improvements

The proposed improvement works for Corridor 3 (Hanoi-Lach Giang/Ninh Phuc) are the following:

a. Groins at Mom Ro (Km126-134)
b. Bank protection at Lac Quan (Km145-147)
c. Bend Correction at Mom Ro (Km126-134)
d. Dredging Works (Km126-134)
e. Aids to navigation, whole corridor

Natural constraints and sustainability of solutions are the considerations in the design of the improvements of Corridor 3. Groins have been preferred over dredging to minimize dredging and its associated impacts. Improvement of the sharp bends in Dao Nam Dinh River river will likely have significant impacts on the MARD dikes. Instead of upgrading the bend, waterway restrictions will be implementd by means of aids to navigation. Bridge upgrading will also have significant socio-economic impacts, again restrictions will be implemented by navigational aids. In the Mom Ro section, desired bend radius will not be obtained. Improvement will be done as much as possible and restrictions will be implemented.

3.5 Cost of Investments

The total cost of investment for these projects is US$22.46 million. Breakdown of cost is enumerated in the following table

Table 3-4 Estimate of the total cost of Investment for ports, ferry stages and Corridor 3 Improvement

Item / Sub-Project	Total Cost Million US$
Ports – Ninh Phuc and Viet Tri	6.43
Ferry Boat Stages	5.07
Corridor 3	10.96
Total	22.46

Figure 3-1. Layout of Viet Tri Port and the location of the proposed investments

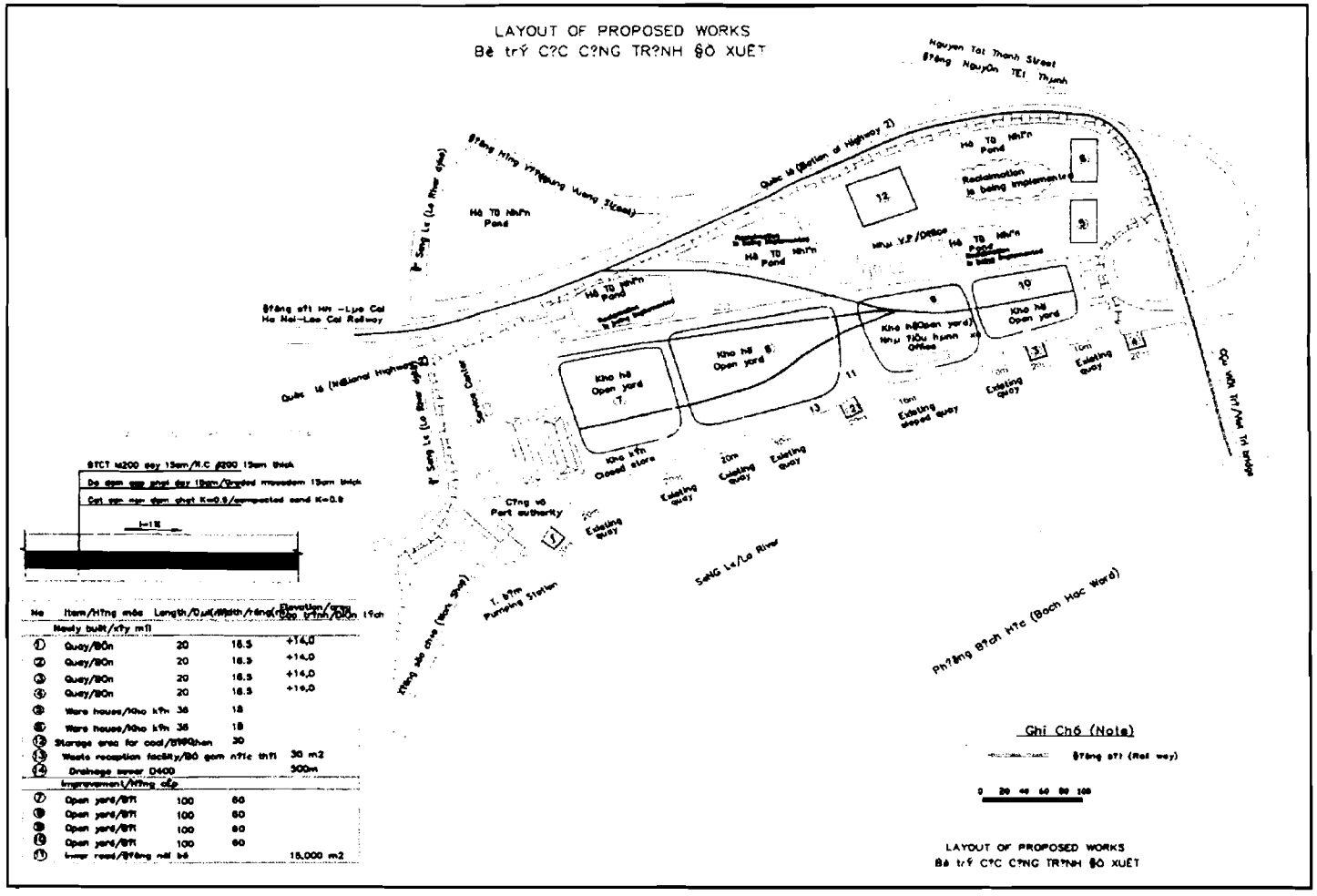
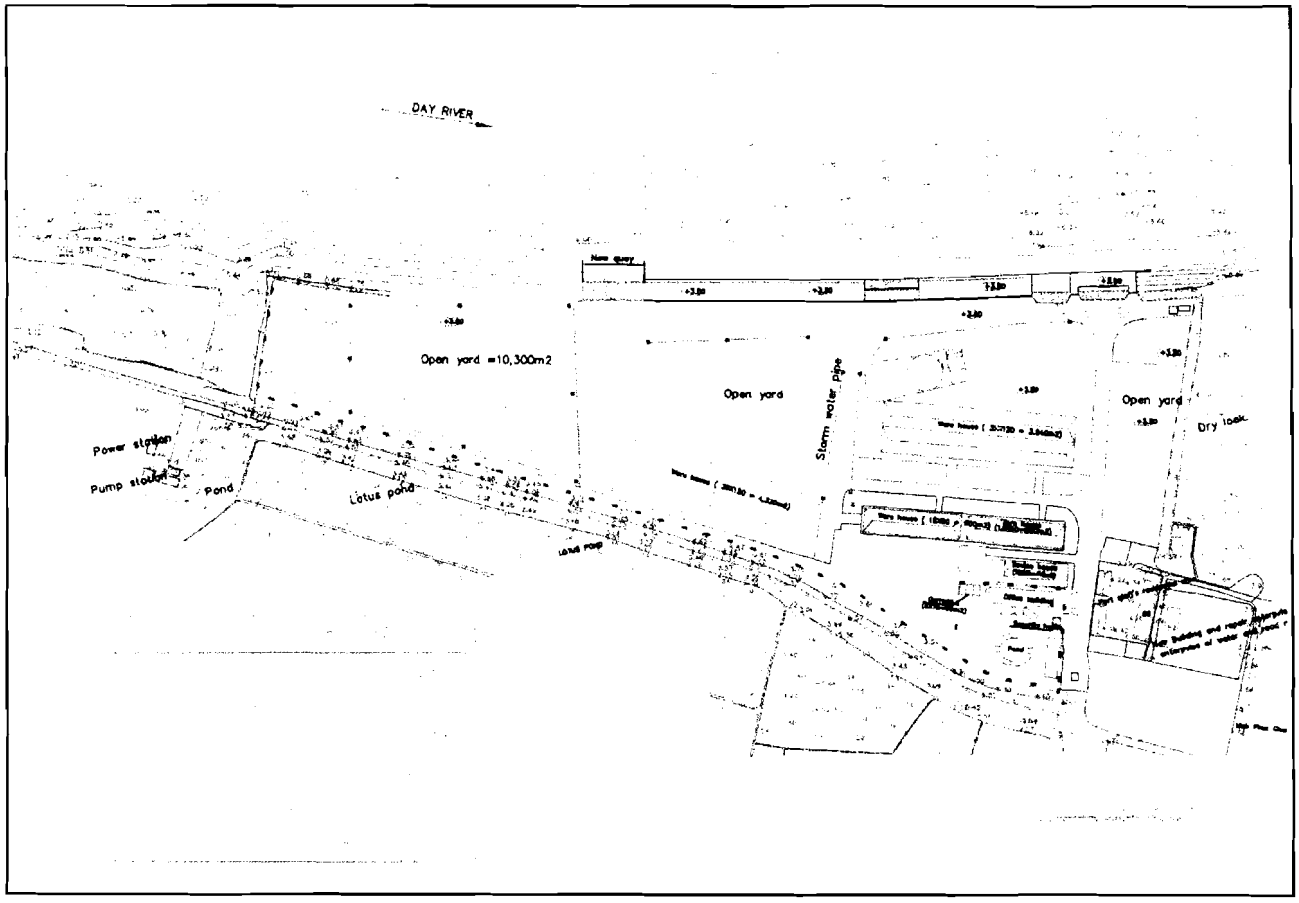


Figure 3-2. Layout of Ninh Phuc Port and the proposed investments

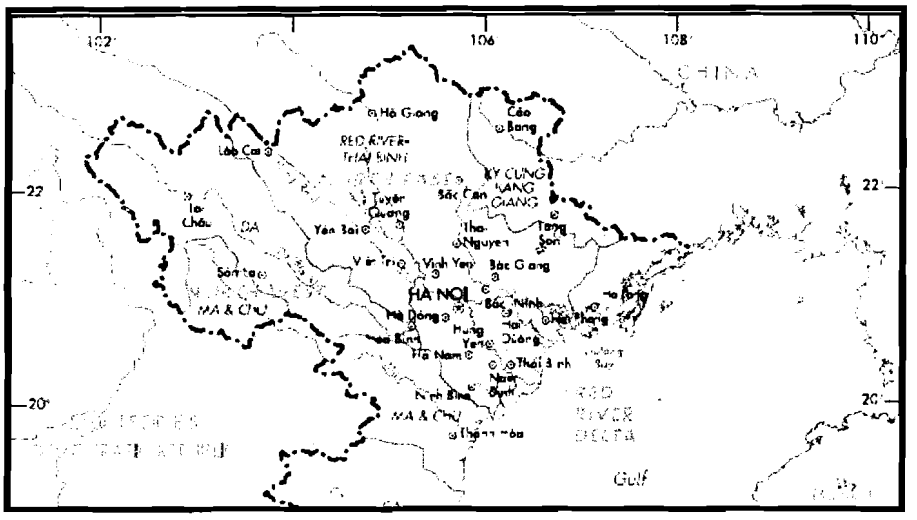


4 EXISTING ENVIRONMENTAL CONDITION

4.1 Location

The project region (**Figure 4-1**) of the Northern Delta Transport Development Project (NDTDP) covers 13 provinces and cities including Phu Tho in the northern sector and Ninh Binh in the southern part of the delta.

Figure 4-1 . Coverage of the NDTDP Study Region



The NDTDP project region has been subdivided into three planning corridors. The provinces traversed by each corridor are enumerated in **Table 4-1**.

Table 4-1. Provinces traversed by the different corridors

Corridor 1: Viet Tri – Ha Noi - Pha Lai - Hai Phong - Quang Ninh	Corridor 2: Ning Binh - Hai Phong - Quang Ninh	Corridor 3: Ha Noi – Day / Lach Giang
Phu Tho	Ninh Binh	Ha Noi
Vinh Phuc	Nam Dinh	Ha Tay
Ha Tay	Thai Binh	Hung Yen
Ha Noi	Hung Yen	Ha Nam
Bac Ninh	Hai Duong	Thai Binh
Hai Duong	Hai Phong	Nam Dinh
Hai Phong	Quang Ning	
Quang Ninh		

The Viet Tri Port of Phu Tho Province belongs to Corridor 1 and the Ninh Phuc Port of Ninh Binh belongs to Corridor 2.

4.2 Overview of the Physical Environment

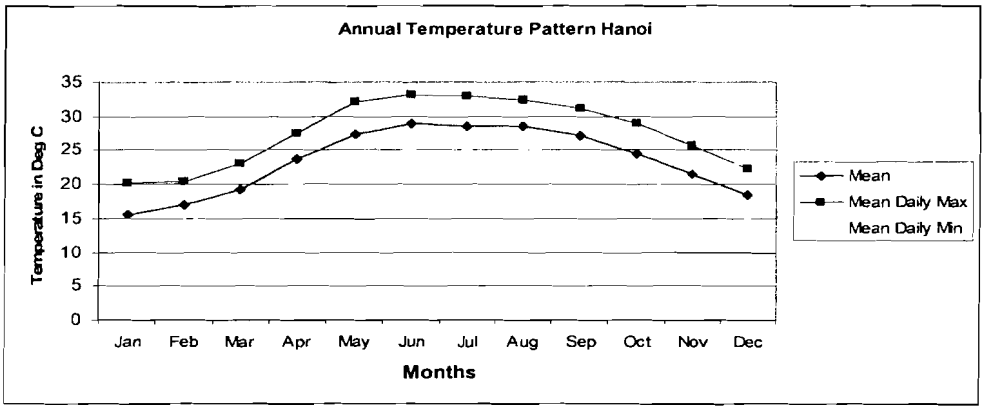
4.2.1 Climate

The climate that prevails in the region of Vietnam, including the Red River Delta is tropical to sub-tropical. The cooling of northern region of Vietnam during the winter months (December to February or March) is caused by northeast monsoon winds emanating from the edge of the

Tibetan Plateau into Vietnam (Stirling et al., 2006). The graph shown in **Figure 4-2** below shows the average monthly temperature variation in Hanoi. The winter climate in the north is cold enough to interfere with year-round rice cultivation. The winter monsoon is devoid of moisture (see **Figure 4-3**) hence dry season prevails in the northern region during the winter season.

Towards the end of winter a condition of almost incessant drizzling rain persists in the lowland. This precedes the onset of the warm southwest monsoon winds which prevails during the rainy season from April to October. The southwest monsoon carries with it a lot of moisture and typhoons. Climatic data shows that an average of 15 typhoons affect the Red River Delta every 10 years (Nguyen Duc Ngu et al., 1992, cited in Binnie et al., 1995).

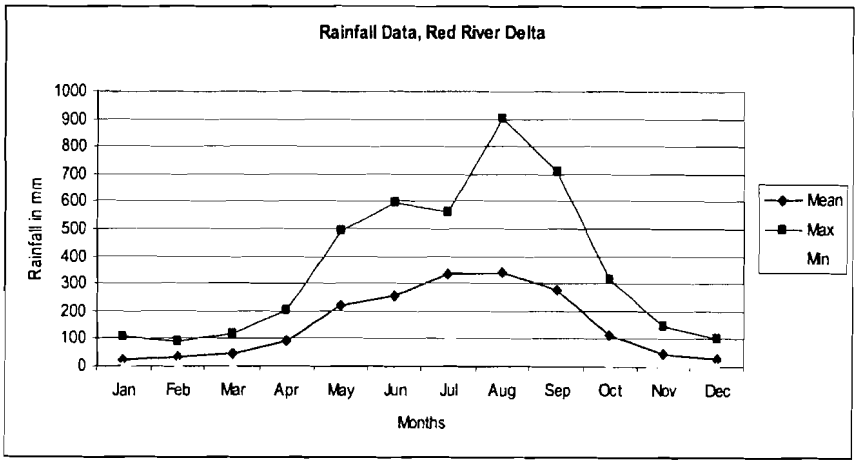
Figure 4-2. Average Monthly Temperature



After, Binnie et al. 1995. Red River Delta Master Plan

The highest rainfall within the study region is experienced in the coastal areas of Quang Ninh with annual rainfall of 2000 – 2400 mm and rainy days of 130-160 days. The average of rainy days is 90-120 per year and the highest rainfall in a day was recorded at 422.5 mm (Tienyen, 03 September 1973). The lowest rainfall in the study region occurs in the districts of Haiduong, Hung Yen and Dong Trieu district in Quang Ninh with annual rainfall of 1200 - 1600mm. In other places in the study region, rainfall is evenly distributed with an average of 1,600-2,000 mm over 110-160 rainy days per year. The highest rainfall in this particular region was recorded at 490.5 mm (Phulien, 22 September 1927). Rainfall generally declines towards the winter season.

Figure 4-3. Rainfall Data of the Red River Delta



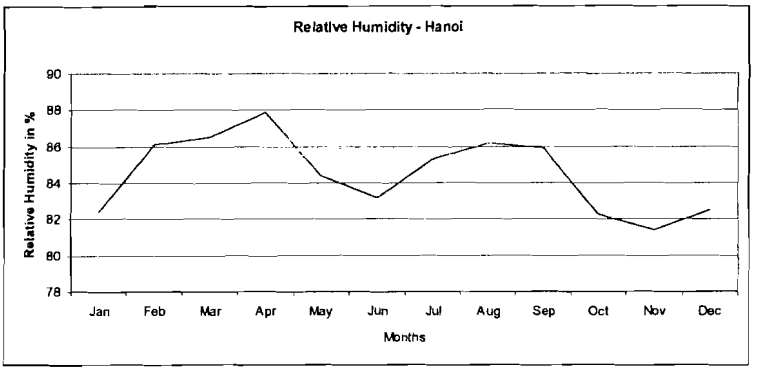
After, Binnie et al. 1995. Red River Delta Master Plan

The annual average relative humidity in the project region ranges from 82 to 86%. The dry season sets at the beginning of winter with relative humidity falling to 76-77% (November and December) in coastal areas and rarely to 80% in plains. The highest relative humidity occurs in March averaging 90-92%.

The content of salt in the air in coastal region is high. It is highest during the dry season (winter and spring) and declines in the rainy season. In Thai Binh – Ninh Binh, the salt content in the air within an area of 5 km from the coastline is 1.5 to 2.5 mg/m^3.

The plot of the monthly average of relative humidity based on readings from the Hanoi weather station is shown in **Figure 4-4.**

Figure 4-4. Monthly Average Humidity, Hanoi



After, Binnie et al. 1995. Red River Delta Master Plan

The annual average of evaporation in the study region is lowest in Phulien (698 mm) and Phutho (762 mm) compared to annual average evaporation of 800-1.000 mm in other inland regions. The coastal areas have higher evaporation than the inland. The annual average evaporation in the coastal areas of Doson – Haiphong is 1,138 mm and 1,250 mm in Kim Son – Ninh Binh.

As described by Thanh et al.(undated), during the NE monsoon during October - April, the NE and N wind reaches an average of 3 - 4m/s. These winds that blow parallel to the direction of coast reach a frequency of 70 - 80% from December - January. During the SW monsoon which prevails during the period of May -September, the average speed of wind is from 4 to 5m/s with the prevailing wind direction of SE, S and E. Every year, the Red River Delta is under the influence of 2 - 5 typhoons occurring from June – September. During such condition, the wind speed reaches 45 - 50m/s. Typhoons that coincided with the spring tide caused very destructive storm surge that ravaged the coastal areas. Under this condition the sea level can rise up to 5 - 6m with very strong waves that can breach the sea dikes.

This extreme condition needs to be considered in the design of the offshore structures such as the bypass canal and breakwaters at the Day and Ninh Co River mouths.

4.2.2 Special weather phenomena

There are special weather phenomena that occur from time to time in the northern region of Vietnam. These can be extreme weather conditions that can severely affect lives and properties and infrastructures including ports and waterways. The coastal area from Quang Ninh to Ninh Binh is most susceptible to storms. Quang Ninh for instance, experiences one of the highest frequencies of storm in Vietnam. On the average, 3 to 5 storms traverse North Vietnam's plain annually. Heavy rains are usually associated with storms which threaten transport facilities and operation. The storm season is usually from June through October with 40% of the storms occurring between the months of July and August. But storms can also occur outside of these months. Recently storms have been experienced in September and October. For instance, the 5th storm in 2007 hit Ninh Binh in late September. The floods brought about by the typhoon caused severe damage over a wide area.

With winter colder than the rest of the region, some places in Quang Ninh, Phu Tho and Vinh Phuc may experience hoarfrost. On average, hoarfrost occurs in Mongcai in 0.5 days per year and in Hoa Binh in 0.9 days per year.

Fog usually appears in coastal areas, particularly islands and high mounts. The highest number of foggy days is found at Phulien at 38.3 days, Coto island: 9.8 days, compared wit 20 to 30 days in other regions. The month with much fog is March. In provinces of the Red River Delta, fog rarely appears (10-20 days per year), and usually in winter, if any.

Drizzle is a common phenomenon in winter, particularly in March. The average number of days of drizzle in the whole region is 6.0 to 43.1 days per year. The highest number of drizzly days occurs in Hung Yen. In general, the occurrence of drizzle is less in islands, e.g. Coto 11.3 days and Bach Longvy: 6.0 days.

Thunderstorms usually occur at the beginning of the rainy season with strong winds, heavy rains, thunders and lightning. The average number of days of thunderstorm is lowest at Bach Longvy Island at 23.2 days/year and it is highest in midland provinces at 77.0 days per year.

4.2.3 Air Quality

Air quality measurements were done in major ports including both Viet Tri and Ninh Phuc Ports December 2007. The results of the air quality measurements are enumerated in **Table 4-2**.

It can be gleaned from **Table 4-2** that at present, 1h – average concentration of SO_2, NO_2, CO, in both ports are well within the permissible limits of 0.35, 0.20 and 30 mg/m^3, respectively, set by the Vietnam Standard for Ambient Air Quality. Concentration of (TSP) and PM10 are also well within the permissible limits. The values obtained are probably typical of rural areas in Vietnam.

The dusty condition of some of river ports was not detected by the instrument measurement. It has been noted during the site surveys that dusty conditions in some of the ports prevail due the lack of maintenance. This situation poses health hazards not only to the port works but also to the people residing along the port access road. The following photographs illustrate the problem:

Photo 4-1. Dusty road in Viet Tri Port

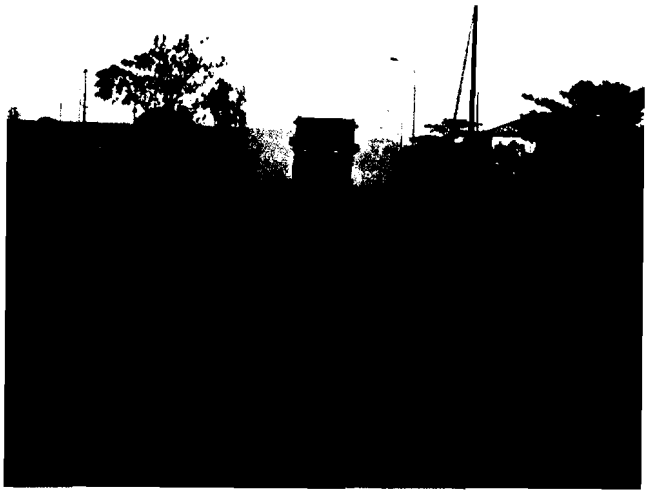


Table 4-2. Air Quality Measurements, December 2007 NDTDP

N	Site Location	T °C	R. Humidity (%)	Wind speed (m/s)	TSP Mg/m^3	PM10 mg/m^3	SO_2 mg/m^3	NO_2 mg/m^3	CO mg/m^3	Noise dBA	Vibration dBA		
											L_X	L_Y	L_Z
1.	Phudong Port - Gialam – Hanoi city	18.5	80	3.0	0.16	0.05				6..8	32.8	30.1	39.3
2.	Kenh Vang Port - Luongtai – Bacninh	19.5	75	2.5	0.19	0.10	0.181	0.035	1.024	60.2	27.4	29.9	36.6
3.	Cong Cau Port - Tuky commune. Haiduong	22	75	1.5	0.04	0.02	0.057	0.053	1.035	56.8	25.9	22.8	31.5
4.	In front of High School Ninh Giang – Ninh Giang – Haiduong Province	21.5	74	1.2	0.03	0.01	0.158	0.061	0.256	67.5	21.0	20.3	36.4
5.	On the road 17A. beside Ninh Giang People Committee – Haiduong province	21.0	70	1.5	0.01	0.01	0.109	0.025	0.512	53.7	20.0	21.1	30.7
6.	Haiphong port – Haiphong city	19.2	75	2.0	0.07	0.03	0.257	0.038	1.041	61.1	43.9	48.7	32.0
7.	Location:Thaibinh Port - Thaibinh province	18.5	85	1.8	0.18	0.05	0.206	0.023	0.768	68.7	30.2	31.3	46.6
8	Namdinh Port - Nam Dinh province	20.0	85	1.8	0.09	0.03	0.193	0.022	0.504	58.8	21.2	22.1	30.9
9	Dong An - Nghia Lac - Nghia Hung - Nam Dinh Province	20.5	80	1.5	0.27	0.11	0.286	0.092	0.760	65.6	39.1	43.5	44.4
10	Ninh Phuc Port - Ninh Binh Province	21.2	78	2.1	0.13	0.05	0.202	0.026	0.258	60.3	21.6	22.4	21.7
11	Hong Van Port - Hong Van - Thuong Tin District - Ha Tay Province	19.5	81	1.2	002	0.01	0.237	0.047	0.763	75.8	69.9	69.1	64.5
12	Sontay Port – Sontay city – Hatay Province	20.0	75	1.5	0.01	0.01	0.118	0.028	0.531	67.4	23.5	25.2	38.3
13	Nhuthuy landing site – Nhuthuy – Lapthach – Vinhphuc province	21.5	78	1.2	..01	0.01	0.095	0.024	0.259	54.4	24.7	24.1	32.2
14	Viettri Port – Viettri City – Phutho Province	24.3	75	1.8	0.12	0.03	0.161	0053	0.266	52.4	28.9	31.9	25.1
15	TCVN 5937 : 2005				0.3	-	0.35	0.20	30	60			
Source: VESDEC – SINTEP. Dec. 2007										TCVN 5949:1998			

Note: - Sampling duration: 60 minute

- The Vietnamese Standard (TCVN 5937 - 2005) for PM10 (24h average) is 0.15 mg/m^3.
- The Vietnamese Standard for Noise at residential. administrative area = 60dBA in day time (6 am – 6 pm) at mixed residential and commercial area = 75 dBA in day time.
- The Vietnamese Standard for vibration caused by construction activity at residential. administrative area = 75 dB (7 am – 7 pm)

For the protection of environmental health as well as public and occupational health, basic housekeeping and maintenance need to be implemented in the NDTDP ports. Noise could likewise be a concern in the relatively big ports of the NDTDP region. It is noted during the site visit that the ports are not only used for shipping and receiving cargoes. Facilities for crushing coal and iron ores are noted to be present. **Photo 4-2** shows one of the crushers in Viet Tri Port used for diminution of iron ores prior to shipping to China.

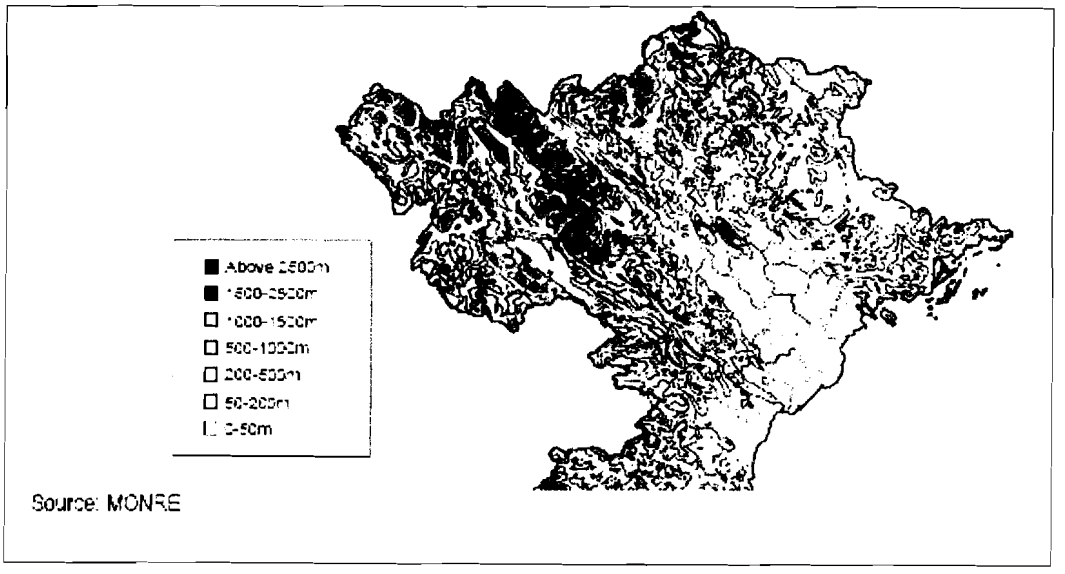
Results of air quality measurements done in Dec 2007 show that the ambient air quality in the ports of Viet Tri and Ninh Puc are within the existing standards. Even the noise level during the sampling is well within the noise standards for residential areas.

Photo 4-2. Ore Crusher and stockpile of iron ore in Viet Tri Port

4.2.3 Topography and Geology

The topography of the study region is relatively flat, slightly sloping towards the coast in the NW-SE direction. The general altitude is low, about 2-3 m from Hung Yen to the south and 1-2 m in Thai Binh and Ninh Binh. The frequently flooded regions in Ha Nam, Nam Dinh and Ninh Binh have elevations of only 0.6 to 1m ASL. The inland region is transected by dike systems along the Red River and branches into independent segments with coastwise stretches on sand dunes. Low mountains and hills with elevations of 50 m to 100 m are scattered from Nho Quan (Ninh Binh) to Kimbang (Ha Nam). The topography of the study region is shown **Figure 4-5**.

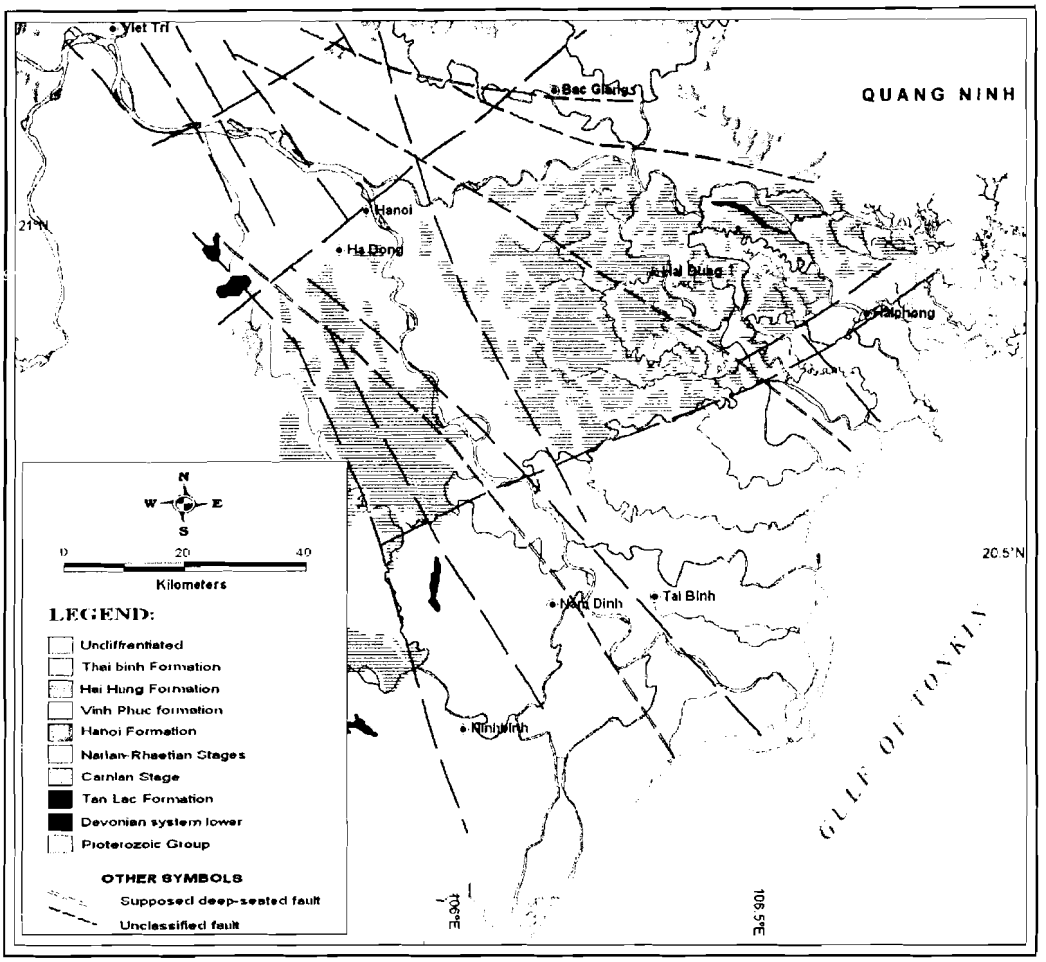
Figure 4-5. Topographic Map of the Study Region



The Red River Delta was developed over a Cenozoic depression. It is filled up with Tertiary sediments up to to a thickness of about 5,000 m, Quaternary sediments up to 250 m thick and overlain by a 30 m to 60 m thick deposit of Holocene sediments *(Tiep, 1994 cited in Thanh)*.

The geologic map of the Red River Delta is shown in **Figure 4-6** (adopted from the Geology and Mineral Resources Map of Vietnam, Dept of Geology and Minerals of Vietnam, 2001).

Figure 4-6. Geologic Map of the NDTDP Study Region



It can be gleaned from the geologic map that both Viet Tri and Ninh Phuc and Mom Ro in Nam Dinh province are underlain by the Upper Holocene Thai Binh Formation. This formation is young, less than 10,000 years old. It is composed of 6 origin types, the fluvio-marine, marshy marine, fluvial sediments, fluvio-marshy sediments, marine sediments and marine eolian sediments. This reflects the oscillation of sea level and its influence in the delta formation during this geologic time.

The engineering implication of such geologic environment is the presence of a thick sequence of varying /alternating layers of unconsolidated sediments with organic content such as clayey sediments, silty sediments, sandy clays and the likes.

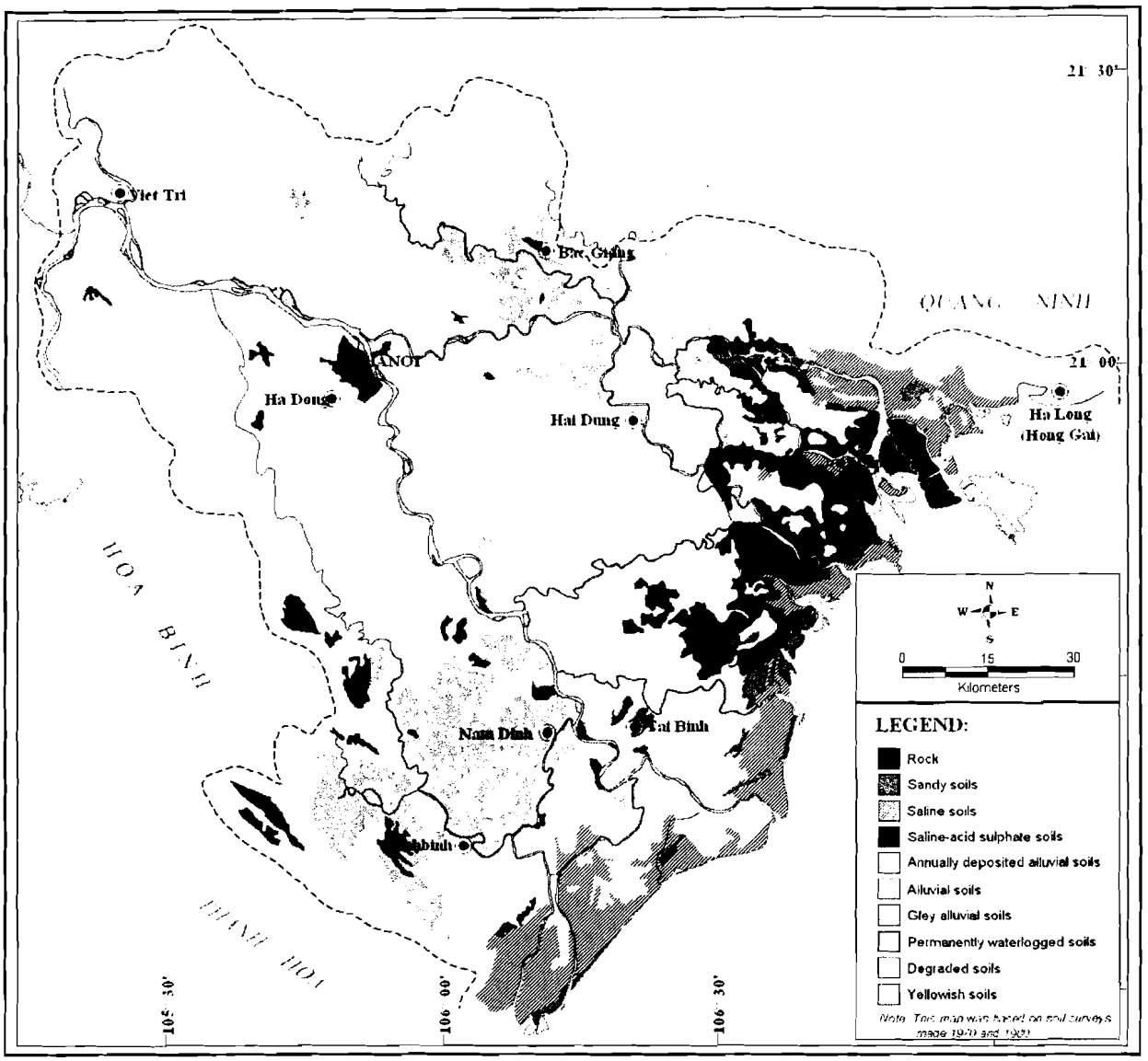
4.2.4 Soils

Ten soil groups have been mapped in the Red River Delta. According to the Red River Delta Master Plan (1995), Seven of these are cultivated and these groups are marine sandy soils, saline soils, acid sulphate soils, alluvial soils, water-logged soil, degraded soils, and yellowish-red soils.

The soil of Ninh Binh is classified as saline soils, while the soil in Viet Tri is alluvial soil.

The distribution of the different soil types in the Red River Delta is shown in **Figure 4-7**.

Figure 4-7. Soil Map of the NDTDP Study Region



Soil Quality

Soils sampling was conducted in selected ports including Viet Tri and Ninh Phuc Ports. The results of the soil analysis are shown in **Table 4-3**. The results of the analysis are compared with the Dutch Standards for Soil and Sediment Pollutants. As shown by the result, the concentration of heavy metals (As. Pb. Cr) are all below the Dutch Reference Concentration. But oil has been determined to be present in soil samples collected from both ports.

The pH values of soil samples collected from all sites (pH values of 6.78 – 7.18) are neutral. It indicates that acid sulphate soils may not be a concern in the project area.

Table 4-3. Soil Quality, priority Ports including Viet Tri and Ninh Phuc

	Sampling Sites	pH	Al (%)	Fe (%)	As (mg/kg)	Pb (mg/g)	Cd (mg/kg)	Cr (mg/kg)	Hg (mg/kg)	Oil (mg/kg)
CORRIDOR 1	VT1 Nhuy Thuy	6.78	10.25	4.8307	6.40	40.79	0.63	86.47	0.26	ND
	VT2 – Viet Tri Port	7.15	8.91	4.2025	7.15	43.42	0.56	64.64	0.20	8.0
	VT2 –Viet Tri Lake	6.94	8.64	4.2675	5.15	64.47	0.42	71.49	0.34	23.0
	VT4-Vinh Tuong Ferry	7.13	9.72	4.3108	13.80	76.32	1.12	69.78	0.27	ND
	VT5-Chu Phan Ferry	7.09	7.02	3.4660	12.42	78.95	0.70	70.21	0.30	8.0
	VT7- Phu Dong	7.19	7.56	4.1050	11.41	60.53	0.35	70.21	0.17	12.0
	VT10 Kenh Vang Port	7.13	7.83	3.2927	11.13	57.89	0.21	65.07	0.34	10.0
CORR 2	VT28 Dinh Quang Port	6.98	8.10	2.9025	11.18	36.25	0.32	45.26	0.15	12.0
	VT25 Tan Deh Bridge	7.02	8.02	4.2580	15.21	71.24	0.34	65.20	0.14	6.0
	VT12 Cong Cau Port	7.18	7.83	3.4335	11.50	55.26	0.56	65.92	0.32	ND
CORRIDOR 3	VT16 Hanoi Port	7.00	7.83	4.4107	16.45	68.75	0.65	69.23	0.14	ND
	VT17 Hong Van Port	7.06	7.52	3.4826	13.22	50.27	0.31	68.20	0.21	6.0
	VT19 Cao Xa, Hung Yen	7.26	7.83	4.0630	10.98	62.54	0.42	61.10	0.18	ND
	VT24-Tra Ly R	7.04	8.10	4.0115	16.35	73.75	0.82	74.15	0.20	27.0
	VT31-Lach Tray R	6.90	5.94	2.8108	12.71	28.75	0.32	41.17	0.13	ND
	VT32-Lach Tray R,	7.15	8.91	3.6826	11.76	71.05	0.56	68.07	0.21	ND
	VT33 Luoc R, Quyn Lam Ferry	7.01	9.18	3.3610	14.22	66.25	0.82	67.89	0.10	15.0
Dutch Standard (Reference value)					29	85	0.80	100	0.3	

4.3 The Red River System

4.3.1 Geography

The Red River has a total basin area is 143,700 km^2, including that of the Da River. More than 50% of the catchment area is within the territory of China and Laos. The main drainage channel of the Red River extends for about 1,130 kilometers flowing southwards to the Gulf of Tonkin. Among its headwater tributaries are the Lo River, which originates from China's Yunnan Province and the Da River. The Da River is located in Northwest Vietnam and it forms the border between the Lai Châu and Điện Biên Provinces. The Da joins the Red River in Phú Thọ Province. The laterite soils abundance in its mountainous upper reaches in Yunnan, China, give the river its characteristic red color (van Maren 2004). The middle reaches of the Red River flows along a straight southeasterly valley that is controlled by a major geologic structure, the Red River Fault. The 255 km long lower reach of the Red River comprises the triangular Red River Delta plain, bounded by limestone cliffs to the North and South. The gradient of the Red River decreases to

$5.9X10^{-5}$ (Gourou, 1936) downstream of the delta apex at Son Tay (Fig. 2.1), after which the river branches into a number of distributaries and discharges into the Gulf of Tonkin.

The width of the Red River varies from more than a kilometer at the segment below the Lo R Confluence to about 200 meters as it approaches the coastline. For the distributary branches such as the Luoc R, Duong R, Kinh Thai, the river width varies from less than 500 meters to about 100 meters.

The length of Red River from this point to the Balat Estuary in Nam Dinh is about 238 km. Downstream of the Da-Red River confluence are two major distributary rivers consisting of the Duong R and the Luoc R. The Duong River branches out from Red River in the general area of Hanoi. Its drainage channel meanders towards the westerly direction for 64 kilometers and then joins up with Thai Binh River. Thai Binh is the major river system draining the hilly southern region of Bac Giang. From this point, Duong R bifurcates into Thai Binh and Kinh Thay R. Further downstream Kinh Thay branches out into two tidal rivers, the Da Bach-Bac Giang. Thai Binh R on the other hand flows further southwards branching out into several tidal inlets including the Van Uc River and ultimately draining into the Cat Hai Estuary.

Louc River, the other distributary of the Red River has a channel length of 72 km. It branches out in the general area of Hung Yen and its channel meanders in the west-northwest direction. it joins with tidal rivers of Van Uc and Lach Tray.

Downstream of the Luoc confluence, the Day-Nam Dinh River distributary branches out flowing in the southerly direction. It joins Day River at about 25 kms from the coastline. Day River empties into the Nghia Hung Estuary. Further downstream of the Dao-Red River confluence, the ultimate distributary branches out. This is the Ninh Co River which flows southwards and ultimately drains into the Nghia Hung Estuary. Its mouth is separated from the Day River by a distance of about 10 km.

The Red River and its tributaries are wide with bottom sediments consisting of silt and fine sand. The river width can reach as wide as 1 km or moreThe banks of the river are alluvial materials, about 3 to 4 meters high. Bank erosion is evident in some sections. Present day river meandering has been controlled with the construction of an extensive network of dikes. But ancient meander belts and abandoned river channels are still evident from maps and satellite imageries.

4.3.2 Hydrology and Sedimentation of Red River

Vu Trung Than et al. (undated) reported that the Red River drainage system is the largest in North Vietnam. Its mean discharge as measured in Son Tay is 3,640 m^3/sec, equivalent to a mean annual discharge of 114 km^3. It is estimated that about 74% of this gross discharge flows during the rainy season from June to October. Peak discharge during rainy season is placed at 30,000m^3/sec. As a consequence, salinity of the estuary is substantially reduced and when such condition prevails, a tongue of fresh water may extend as far as 30 kms into the Gulf of Tonkin.

But during the dry months from November to May, the river flow declines to 430 m^3/sec. During this season, brackish water (salinity of 10 PSU) penetrates the various tributaries up to about 22 km inland. The more saline water (30 to 31 PSU) approaches the coastline with 1.5 to 2.5 PSU/km gradients. Salinity differences between surface water and the bottom are marked. The mixing of fresh and marine waters is hastened by tidal action.

The average annual flow distribution in the Red River system is presented in **Table 4-4**.

Table 4-4. Discharge at Selected Stations

Unit	Red River at Son Tay	Red River at Hanoi	Duong at Thuong Cat	Luoc River (estimate)	Tra Ly River (estimate)	Day River (estimate)	Ninh Co River (estimate)
m^3/s	3,560	2,710	880	350	350	650	200
%	100	75	25	10	10	18	6

Sedimentation

There are a number of estimates of the sedimentation rate of the Red River. It is estimated that the annual discharge of the Red River is about 125 million ton sediments and 70 million ton dissolved matters into coastal zone *(Pho, 1984* cited inThanh et al., undated).

Bulk of the sediment is carried off during river discharges between 7000 to 8000 m^3/sec. This situation according to van Maren (2004) occurs 15 to 16 days per year. Large floods transport large quantities of sediment, but occur only once every few years. Less than 4% of the total sediment load is transported during the dry season (discharges below 2000 m^3/sec).

The estimate of sediment delivery made by Haskoning is presented in **Table 4-5** below. The sediment output of tributaries Ninh Co River and Day River have also been estimated and presented in **Table 4-5.**

Table 4-5. Estimated sediment discharge at the river mouths

River	Estimated sediment output (million tons/year)
Red River	114
Ninh Co River	5
Day River	25

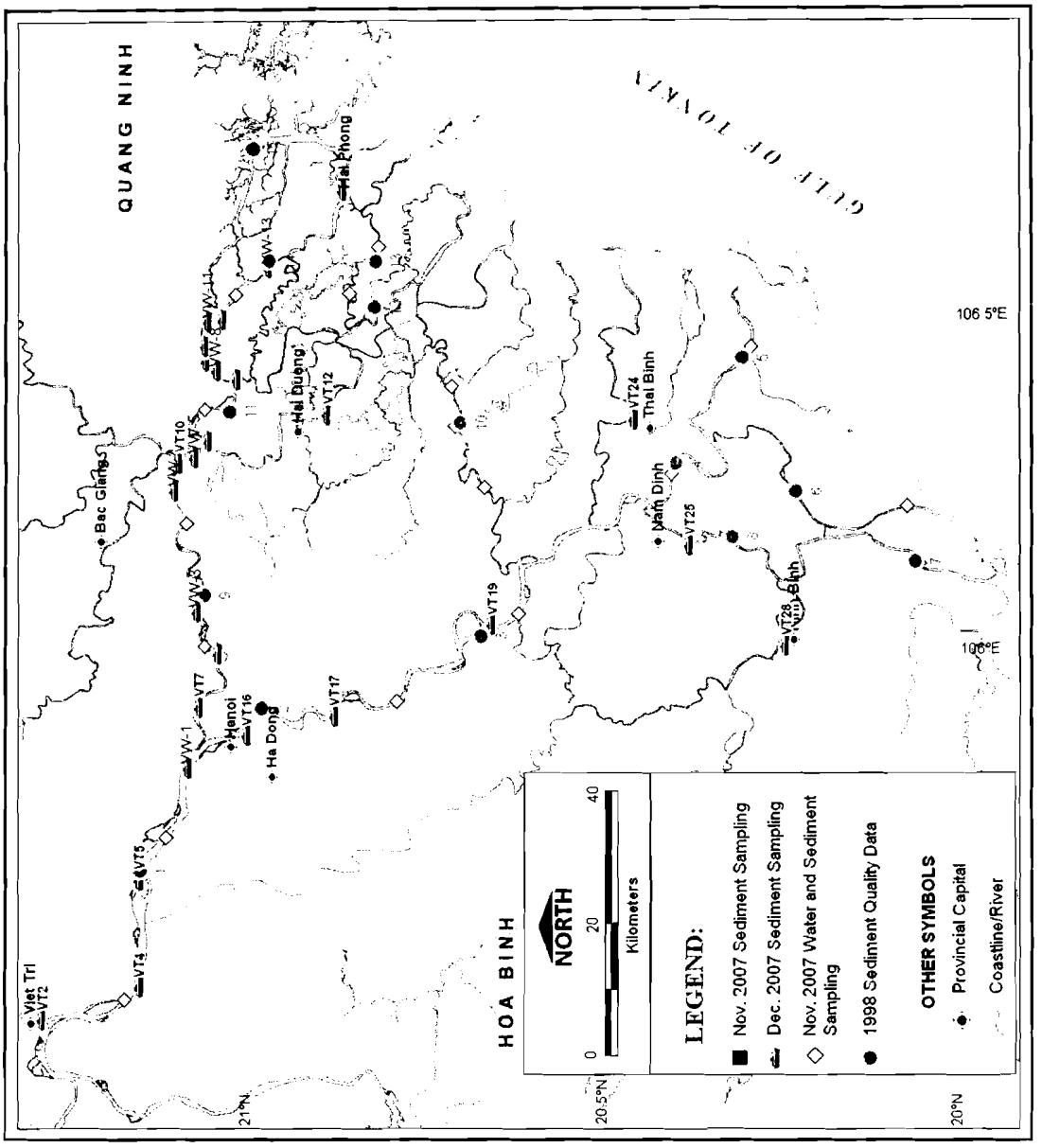
Source: Haskoning 2003

4.3.3 Water Quality

Secondary data on surface water quality is available for certain sections of the Red River and its tributaries. The secondary data on the quality of Red River and its tributaries reported high suspended sediment concentrations which can reach more than 2,000 mg/l. It is reported that the Red River in Hanoi for instance has an annual average of about 847 mg/l which is very much higher than the standard of 80 mg/l.

For the purpose of this EIA, the NDTDP conducted water sampling and analysis of various rivers of the Red River Delta that are within the project region. Water samples were collected from all the priority ports identified by the NDTDP (**Figure 4-8**). The results of the analysis are shown in **Tables 4-6** and **4-7.**

Figure 4-8. Sample Location Map



SMEC ROYAL HASKONING [redacted]

Table 4-6. Water Quality, Nov and Dec 2007 Sampling

Sampling sites	River	Temp. (°C)	pH	TDS (mg/L)	Turbidity (NTU)	SS (mg/L)	DO (mg/L)	BOD_5 (mg/L)	NH_4^+ (mg/L)	Total N (mg/L)	NO_3^- (mg/L)	Total P (mg/L)	Total oil (mg/L)	Phenol (µg/L)	Coliform (MPN/100mL)
CORRIDOR 1															
VT1	Lo R	21	7.2	139	16	24	6.4	13	0.401	2.235	1.024	0.391	ND	0.124	7100
VT2 Port	Viet Tri Port	22	7.3	140	36	52	6.3	9	0.154	1.931	0.828	0.359	0.30	ND	1600
VT2 Lake	Viet Tri Lake	21	7.4	147	6	12	6.4	8	0.132	0.586	0.622	0.407	0.16	0.146	1200
VT4	Red R	21	7.4	139	40	60	6.4	7	0.477	1.435	0.782	0.407	ND	ND	4500
VT5	Red R	22	7.3	131	38	58	6.2	14	0.578	1.044	1.016	0.342	0.34	0.115	2300
VT6	Red R	22	7.4	138	42	62	6.3	12	0.567	1.226	0.986	0.374	ND	ND	5800
VT7	Duong R	21	7.2	140	36	54	5.8	5	0.797	1.215	1.124	0.359	0.26	0.123	1900
VT10	Duong R	21	7.3	144	44	56	5.5	4	0.631	1.616	1.312	0.586	0.20	0.115	4800
VW 11	Kinh Thay		7.1	150	48	60	5.8	10	0.218	2.169	1.712	1.635	ND	ND	1,500
VW 13	Kinh Thay		7.1	175	33	45	5.3	5	0.242	3.678	2.536	2.059	0.12	ND	700
VW 15	Han R		7.2	255	55	75	4.5	5	0.316	9.155	4.722	1.467	0.15	ND	800
CORRIDOR 2															
VT28	Ninh Phuc	21	7.6	264	42	56	4.4	9	0.672	1.692	1.322	0.456	0.68	ND	5200
VT25	Red/Day	22	7.2	230	38	52	3.8	18	0.688	2.541	1.917	0.087	ND	ND	2700
VT12	Louc R	22	7.0	145	28	34	4.8	8	0.683	1.934	1.546	0.668	ND	ND	3000
CORRIDOR 3															
VT16	Red R	22	7.4	152	46	64	4.0	6	0.679	2.505	2.015	0.108	0.22	ND	1300
VT17	Red R	21	7.3	157	42	58	4.1	15	0.871	2.274	1.844	0.101	ND	ND	1600
VT19	Red R	20	7.4	163	50	62	4.2	7	0.592	2.824	2.124	0.101	ND	ND	2600
VT24	Thai Binh	21	7.0	180	18	24	3.7	8	0.756	1.882	1.276	0.087	0.04	ND	1500
VT34	L Giang Estuary		7.8	18,500	19	25	6.2	10	0.352	7.357	3.968	0.328	ND	ND	900
TCVN 5942 – 1995	**B**	**-**	**5.5-9**	**-**	**-**	**80**	**≥2**	**<25**	**1**	**15**	**-**	**-**	**0.3**	**20**	**10.000**
	A		**6 - 8,5**	**-**	**-**	**20**	**≥ 6**	**< 4**	**0.05**	**10**	**-**	**-**	**0**	**1**	**5.000**

Table 4-7. Concentration of heavy metals in river water, Nov & Dec 2007 sampling

Sampling Sites	River	Fe (mg/L)	Zn (mg/L)	Cd (µg/L)	Total Cr (µg/L)	As (µg/L)
			CORRIDOR 1			
VT1	Lo R	0.026	0.031	0.25	4.15	13.20
VT2 – Port	Viet Tri Port	0.028	0.042	0.30	3.98	18.97
VT2 - Lake	Viet Tri Lake	0.031	0.037	0.18	3.74	22.23
VT4	Red R	0.785	0.038	0.27	4.21	5.51
VT5	Red R	1.571	0.053	0.31	5.01	8.09
VT6	Red R	2.722	0.040	0.28	3.92	9.96
VT7	Duong R	0.968	0.039	0.22	3.45	7.59
VT10	Duong R	3.743	0.032	0.34	3.64	12.55
VW11	Kinh Thay	0.336	0.031	0.26	3.18	15.37
VW13	Kinh Thay	0.985	0.035	0.30	3.29	16.09
VW15	Han R	0.649	0.029	0.28	2.89	10.03
			CORRIDOR 2			
VT28	Ninh Phuc Port	1.111	0.024	0.33	4.17	14.64
VT25	Red/Day	0.694	0.044	0.35	4.24	6.23
VT12	Louc R	0.419	0.043	0.39	4.17	2.74
			CORRIDOR 3			
VT16	Red R	0.778	0.036	0.31	3.85	9.56
VT17	Red R	1.972	0.043	0.39	3.21	10.39
VT19	Red R	1.639	0.057	0.28	4.01	5.63
VT24	Thai Binh	1.889	0.051	0.40	3.76	6.61
VT34	L Giang Estuary	0.325	.033	.35	3.05	12.05
TCVN 5942-1995	B	2	2	20	Cr (III): 1000 µg/L Cr (VI): 50 µg/L	100
	A	1	1	1	Cr (III): 100 µg/L Cr (VI): 50 µg/L	0.05

Briefly, the results of this 2007 analysis can be described as follows:

pH value: pH values at all sites are neutral, varying from 7.0 to 7.6, meeting the Vietnamese Standard for Water Source A of Surface water (TCVN 5942 - 1995)

Salinity (total dissolved solids - TDS): Salinity show gradual increase from Viet Tri (VT1, VT2) to the estuary area (VT 25, VT 28-Ninh Phuc Port). The relatively low salinity even in the estuary is attributed to the fact that the 2007 sampling was timed at the end of flood season. .

Organic pollution: Organic pollution of river water is indicated by the concentration of dissolved oxygen (DO) and biochemical oxygen demand (BOD_5^{20}). Organic pollution is evident: at all sites, values of BOD_5^{20} exceed the Vietnamese Standard (TCVN 5942:1995) for the A water source (water for domestic use, BOD standard of $\leq$4 mg/L). However, water quality meets the TCVN 5942:1995 standard for the B water source (not for domestic use, BOD limit of $\leq$25 mg/L).

The organic pollution loading is highest (DO in lowest, BOD is highest) at VT25 (Nam Dinh port), VT17 (Hong Van port), VT1 (Nhu Thuy landing site) and VT5 (Chu Phan Ferry). Aside from ferry landings, the sites are densely populated. In addition, the elevated BOD observed during this sampling period could be a natural seasonal variation since sampling was done at the end of the flood season.

Oil contamination: Oil contamination is detected in some sites such as VT2 – Viet Tri port, VT5 – Chuphan Ferry and VT28 – Ninhphuc port. The oil content in Viet Tri exceeds the Vietnamese Standard (TCVN 5942:1995) for Source B. Oil contamination is interpreted to be due to oily water discharges from boats.

Toxic chemical contamination: the chemical as phenols and heavy metals (Cd, Cr, As) may be considered as toxic ones. But its concentration in both ports are much lower than the Vietnamese Standard for Surface water (Source A).

Bacteriological contamination: Contents of total coliform (1,600 – 5,200 MPN/100 ml) are rather high at both sites but they are still comply with the TCVN 5942:1995 for Source A (5,000 MPN/100mL) and Source B in some sites

Nutrient pollution: Concentrations of NH_4^+, NO_3^- and total N are high, although still lower than the maximum permissible limit of the Vietnamese Standard for Surface Water (TCVN 5942:1995, Source A). But the concentration of nutrients is high enough to cause eutrophication in stagnant water. Concentration of total phosphorus (P) is also high in some sampling sites. Some studies have indicated that concentrations of total N $\geq$ 0.5 mg/L, total P $\geq$ 0,1 mg/L can lead to eutrophication in stagnant waters.

4.3.4 Sediment Quality

River sediment analysis has previously been done in the Red River and its tributaries. The analysis was done in 1998 by the Vietnam National Center for Natural Science and Technology. The analytes included heavy metals, calcium carbonate, pesticides and organic materials and mineral oil. The results of the analysis are presented in T**able 4-8**. The concentrations of deleterious elements are generally lower than the Dutch Reference Concentration, except for cadmium which showed slight exceedance of the Dutch reference number.

Recent sediment sampling and analysis was conducted by the NDTDP and the result of the November 2007 analysis is shown in **Table 4-9.** Current analytical results (**Table 4-10**) show similar patterns with the 1998 sampling. The concentrations of heavy metals in stream sediments are well below the reference values set by the Dutch Standard for Sediment Pollutants except for Cd. Cadmium in most of the sediment samples showed slight exceedance of the Dutch Reference Concentration. Other heavy metals that showed slight exceedance are mercury and lead. The exceedance is way below the Intervention Values.

Pesticide (Persistent Organchlorines) concentrations in sediment samples collected in 2007 are much lower than the reference value in the Dutch Standard for Soil and Sediment Disposal. This is quite contrary to the result of the 1998 sampling which showed relatively higher concentrations of pesticides (**Table 4-8**). The laboratory report of the 1998 analysis should be accessed to confirm the reported concentration.

Table 4-8. 1998 Analysis of Sediments from Red River and Tributaries.

Source: MOTC, VIWA, ADB, Haskoning, Delft Hydraulics, 1998. Red River Waterways Project, Vietnam, TA No. 2615-VIE

Parameters	Unit	Dutch Ref No	S-1 Red C-1	S-2 Red R C-1	S-3 Red R C-3	S-4 Red R C-3	S-5 Red R	S-6 Ninh Co R C-3	S-7 Day R C-3	S-8 Day R C-3	S-9 Duong R C-1	S-10 Duong R C-2	S-11 Kinh Thai C-1	S-12 Van Uc R	S-13 Han R C-1	S-14 Lach Tray	S-15 Da Bach R
Lead	mg/kg	85	6	9.5	12	15.25	14.5	14.75	30	24.5	20.5	23.5	30.25	26	45.5	30.5	36.75
Cadmium	mg/kg	0.8	0.329	0.575	0.775	1.15	1.3	1.5	1.85	1.775	1.35	1.975	1.575	1.65	1.925	1.85	1.725
Copper	mg/kg	36	15.5	18.75	19.25	21.15	20.75	23.5	29.75	19.25	26.75	28.5	25.75	23	51.25	26	28.35
Zinc	mg/kg	140	27	26.75	28	30.75	28.5	30.5	58.5	44.75	26.25	29	24.75	25.25	68.5	30.5	33.45
Nickel	mg/kg	35	24.5	21	22.5	22	22	21.25	31.5	20.5	18	16.75	13.75	14.75	35.45	14.5	13.45
Chromium	mg/kg	100	51	55	48	81	56	41	88	62.5	46	36	60.5	34	93	65	70
Mercury	mg/kg	0.3	0.023	0.025	0.02	0.033	0.02	0.028	0.041	0.028	0.027	0.015	0.016	0.02	0.055	0.023	0.02
Arsenic	mg/kg	29	0.265	0.21	0.291	0.265	0.1	0.267	0.494	0.398	0.159	0.155	0.35	0.174	0.515	0.174	0.215
Calcium Carbonate	%		0.5	0.4	0.5	0.4	0.4	0.4	0.75	0.5	0.4	0.2	0.5	0.2	0.75	0.6	0.5
Pesticides																	
Lindane	Ppb	.05	0.47	0.9	0.62	0.6	0.57	0.35	0.45	0.48	0.44	1.18	0.29	ND	0.15	ND	ND
Aldrin	Ppb	.06	17.98	15.38	10.4	9.29	10.9	7.74	7.86	17.87	13.76	37.93	8.17	18.22	12.43	14.09	10.53
DDD	Ppb	10	5.65	4.6	4.25	2.43	7.66	1.61	2.57	3.83	4.46	ND	0.95	2.51	3.09	ND	ND
Endrin	Ppb	.04	ND	ND	2.82	ND	ND	2.2	3.48	ND	ND	ND	ND	5.95	3.97	ND	ND
DDE	Ppb	10	56.38	57.06	14.9	14.73	37.56	22.8	34.86	52.2	11.41	13.12	31.19	31.18	28.1	6.9	6.9
DDT	Ppb	10	38.07	31.03	13.11	11.2	28.84	12.33	12.26	5.06	7.51	4.07	5.01	5.09	5.85	ND	ND
HCB	Ppb		0.26	0.14	0.22	0.09	0.25	0.09	0.34	0.13	0.2	0.26	ND	0.12	0.35	ND	ND
Organic Materials																	
Organic Materials	%		0	0.1	0.55	0.43	0	0.25	2.73	0	0	0.36	0	0	2.1	0.25	0.33
Mineral Oils	mg/kg	50	2.3	2.1	4.4	4.1	2.2	4.2	184.3	2.4	42.5	2	32.3	18.1	190	2.2	50.3

Table 4-9. Stream Sediment Quality of Rivers of Corridor 1, Nov and Dec 2007

Sta. #	River / Dredge Area	pH	Al (mg/kg)	Fe (mg/kg)	As (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Hg (mg/kg)	Oil (mg/kg)
VT1		7.36	10.44	41623.24	9.68	0.47	49.62	67.14	0.17	ND
VT2	Viet Tri Port	7.22	5.94	35201.76	12.43	0.98	51.32	56.08	0.46	ND
VT2	Viet Tri Lake	7.21	5.46	37431.21	11.26	1.05	53.19	62.21	0.15	ND
VT3	Red R	7.21	9.18	45491.50	16.36	1.02	69.74	68.92	0.24	ND
VT4	Red R	7.22	9.45	42675.36	15.58	0.26	110.53	71.06	0.21	ND
VT5	Red R	7.35	10.80	39642.60	16.32	1.46	106.58	75.34	0.32	ND
VT6	Red R	7.50	5.67	29569.48	10.89	1,13	34.21	59.50	0.41	ND
VW 1	Red R	7.25	3.037	19950.00	7.25	.65	29.33	17.562	0.15	
VT7	Doung R	7.61	6.48	30435.98	11.73	1.32	47.37	58.22	0.12	ND
VW2	Duong R/Trung Mau									
VT8	Duong R	7.56	6.21	36826.46	9.24	0.76	39.47	57.36	0.25	ND
VW3	Duong R/Den/Nhgia Chi									
VT9	Duong R	7.66	6.48	21121.06	8.32	0.42	31.58	52.23	0.62	ND
VW4	Duong R/Chi Ni/Dai Lai									
VT10	Duong R	7.51	9.18	36501.52	13.07	0.92	76.32	66.78	0.15	ND
VW 5	Thai Binh /Than shoal	7.16	2.885	16450.00	6.08	.40	26.45	19.386		
VW 6	Kinh Thani R /Lau Keh	7.46	3.240	17150.00	6.85	.75	27.62	26.764	0.25	
VT11	Kinh Thai	7.60	7.63	39317.66	9.39	0.38	64.47	69.35	0.23	ND
VW 7	Kinh ThaiKM18	7.09	3.240	18560.00	7.56	**0.89**	28.550	22.487	0.18	
VW8	Kinh Thai/Tien Xa									
VW 9	Kinh Thai/Km24-25	7.10	2.970	26250	8.78	**0.95**	28.588	28.568	0.25	
VW10	Kinh Thai/Ken Giang									
VW 11	Kinh Thai /Ben Trieu	7.14	7.560	57040.00	11.88	0.3	67.97	42.726	0.20	
VW12	Kinh Thai /Kinh Chu									
VT13	Kinh Thai /Nhat Shoal	7.51	8.10	35743.33	9.67	0.51	75.00	68.07	0.34	ND
VW13	Han R									
VW 14	Han R	7.16	8.370	54220.00	12.56	0.65	64.56	38.272	0.15	
VW 15	Han R	7.10	7.155	47950.00	10.42	1.05	52.35	46.868	0.2	
VT12	Thani Binh	7.49	9.45	38776.09	10.76	0.66	90.79	73.20	0.62	ND
	Dutch Standard (Reference value)				**29**	**0.80**	**85**	**100**	**0.3**	
	Dutch Intervention Value				**55**	**12**	**530**	**380**	**10**	

Note: Yellow shaded Rows- represent sediment quality from proposed dredging areas in Corridor 1

Table 4-10. Analysis of Stream Sediments, Corridor 2 & 3, Nov and Dec 2007

Sta. #	River / Dredge Area	pH	Al (mg/kg)	Fe (mg/kg)	As (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Hg (mg/kg)	Oil (mg/kg)
CORRIDOR 2										
VT28	Vinh Phuc Port	7.42	9.45	32115.36	6.22	0.28	33.75	42.19	0.61	ND
VT25	Day/Red R	7.56	9.45	34201.48	11.39	0.79	65.00	66.03	ND	ND
VT23	Luoc R	7.33	9.72	42922.33	11.92	0.94	81.25	85.46	0.33	ND
VT22	Luoc R	7.50	9.13	41256.41	10.21	0.79	70.24	71.48	0.19	ND
VT21	Luoc R	7.28	10.53	48291.73	12.01	0.82	71.38	75.13	0.28	ND
VT14	Lach Tray	7.57	9.18	38667.78	12.54	1.82	82.89	68.92	0.28	ND
VT15	Lach Tray	7.51	8.91	38992.72	12.29	0.84	77.63	70.63	0.37	ND
CORRIDOR 3										
VT16	Red R	7.30	6.48	34811.24	9.90	0.65	50.00	54.58	0.29	30.00
VT17	Red R	7.46	6.08	31254.12	13.24	1.28	36.42	64.10	0.53	ND
VT18	Red R	7.38	5.87	32869.68	14.01	0.97	37.98	58.71	0.42	ND
VT19	Red R	7.32	7.56	31000.15	11.27	1.05	58.75	49.26	0.24	ND
VT20	Red R	7.41	6.06	33215.38	15.17	1.25	60.45	50.30	0.35	ND
VT24	Thai Binh	7.57	8.91	37227.11	8.78	0.39	75.00	70.26	0.16	ND
VT26	Red R	ND	ND	ND	ND	ND	ND	ND	ND	48.00
VT27	Red R	7.51	10.26	47491.45	14.66	1.51	83.75	86.34	0.57	ND
VT29	Day R	7.53	6.75	30642.24	5.21	0.73	31.25	41.67	0.22	ND
VT30	Ninh Co R									
VW 34	Lach Giang Est	6.83	3.510	19620.00	8.05	1.15	30.65	22.424	0.32	
	Dutch Standard (Reference value)				29	0.80	85	100	0.3	
	Dutch Intervention Value				55	12	530	380	10	

4.3.5 Coastal Geomorphology

The tidal flats, beaches, beach ridges, mangrove marshes, tributaries and tidal channels are the landforms in the coastal area. The delta front is a gentle plain and the bottom sediments are pinkish brown consisting of fine silt and clay.

The prominent features of the coastline of the Red River Delta are karst islands formation in Halong Bay in the northeastern most corner of the Red River Delta. Along the coast of Halong southwards to Bach Dang estuary is an extensive mangrove swamp which has now been converted into shrimp ponds. The same condition prevails in the Do Son-Thai Binh estuary. Southwards, from Van Uc to Thai Binh estuary, the shrimp ponds are fringed by a belt of reforested mangrove.

Further south of the Thai Binh estuary is the Ba Lat estuary at the mouth of the Red River. The mouth of Red River or Ba Lat is an extensive formation of tidal mudflats. The mudflats closest to the mainland are now cleared of mangrove vegetation and are now used for aquaculture.

A significant stand of mangrove is still present in the outer mudflats. A strand of sandbar, approximately 14 kilometers long has formed at the northern side of the estuary and a southern sand bar of about 11 km long fringes the mudflats south of the mouth of Ba Lat River. Active deposition at the mouth of Ba Lat River is causing the progradation of this part of the coast of Red River Delta.

Southwards from the Ba Lat Estuary, the shoreline is generally straight being protected by a system of sea dike. This shoreline terminates at the Lach Giang estuary and the Day River Estuary. Mudflats have formed at the mouth of the Day River. These mudflats are still vegetated by mangroves and mangrove associated plant species. Active deposition is taking place at the mouth of Day River, causing the seaward progradation of the river mouth.

4.4 Biological Status of the Red River Delta

4.4.1 Terrestrial Ecosystems

- Important Terrestrial Ecosystems

Natural forests within the project region and peripheral areas are distributed in mountains and hills in the provinces of Phu Tho, Vinh Phuc, Ha Tay, Ninh Binh, Quang Ninh, and Hai Duong. From the altitude of 700m upwards the prevailing forest types are: tropical wet evergreen forest; semi-deciduous forest with dry and rainy seasons; and forest on limestone mountains. In the regions with elevation lower than 700m, forest types may include low mountain subtropical wet evergreen forest, coniferous – broad-leaved forest, forest on limestone mountains and on granite mountains.

Forests in the basin of the Da River (Hatay, Phutho) have the species composition typical for the Northwest of Vietnam, being rich and abundant with valuable wood (*Pentace tonkinensis, Chukrasia tabularis, Garninia fragraeoides, etc*) and medicinal plants *(Bulbous aralia, Polygonum multiflorum, etc.*). Quangninh province currently has 150,000 ha of forest with the dominance of semi-deciduous and deciduous forests and with precious wood such as *Garnicia fragraeoides, Pachudia cochinchinensis, Pinus merkusiana* and some subtropical species such as *Castanea vulgaris and Castania, etc.*

The groups of high values include anise, cinnamon in Quangninh, elemi and pine in Hoabinh; The oil containing group including *Vernicia montana* is found in Nammau, Binhlieu, Tienyen and Mongcai (Quangninh); many precious woods are gathered in Halung forest (Hoanhbo); The fast growing species includes *Castania, canarium, Liquidambar, etc.* in Chilinh (Haiduong); the group of medicinal and edible trees is also diverse.

One important terrestrial ecosystems present in the Red River Delta region is the lowland rain forest. WWF (http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0141_full.html) delineated the extent of this ecosystem from the freshwater swamp forests of the Red River Valley south along the north-central coast of Vietnam to the region south of Tam Ky. This

ecosystem is reported to be seriously degraded with less than 10 percent of the native vegetation remains. The among the remaining patches of this ecosystem is best preserved in the Cuc Phuong and Pu Mat National Parks. At Cuc Phuong, 1,800 vascular plant species have been described for a small area with limited topographic diversity.

The climatic condition that prevails in this ecosystem characterized by high rainfall and short dry season produced conditions that once supported diverse wet evergreen forests. Primary wet evergreen forest consists of a dense, three-tiered canopy reaching 25-35 m and occasionally 45 m height in undisturbed sites. The upper canopy is dominated by a species of *Hopea, Castanopsis hystrix,* and *Madhuca pasquieri.* The fan palm *Livistona saribus* is a common subcanopy species in small gaps.

Although much of the ecosystem's biodiversity has been lost, it still harbors several mammals and birds of conservation significance, including the Owston's banded civet (*Hemigalus owstoni*), white-cheeked gibbon (*Hylobates leucogenys*), red-shanked douc langur (*Pygathrix nemaeus*), and Francois's leaf monkey (*Semnopithecus francoisi*). One endemic bat species is found here (*Paracoelops megalotis*l). There are more than 300 bird species in this ecoregion, including three near-endemic and one endemic species (**Table 4-11**).

Table 4-11. Endemic and Near-Endemic Bird Species

Family	Common Name	Species
Phasianidae	Annam partridge*	*Arborophila merlini**
Phasianidae	Edwards's pheasant	*Lophura edwardsi*
Timaliidae	Short-tailed scimitar-babbler	*Jabouilleia danjoui*
Timaliidae	Grey-faced tit-babbler	*Macronous kelleyi*

4.4.2 Aquatic Flora & Fauna Red River Delta

The main source of secondary information on the aquatic flora and fauna of the Red River Delta is the study by Vung Trung Than et al. (1987).

Phytoplankton

Phytoplankton are the most important primary producers. The foundation of the food web, they transform light and nutrients into energy for herbivores such as zooplankton which, in turn, support higher trophic levels. Phytoplankton grows best in low velocity waters with warm temperatures and high nutrient availability, particularly phosphorus. Phytoplankton growth is generally limited in stream or riverine systems, which have much greater flow velocities. A relative increase in species diversity or richness under unchanged conditions is taken as an indicator of of improving water quality condition. Conversely, the preponderance of a certain species like the blue green algae is an indicator of poor water quality. To evaluate the importance of phytoplankton as a food source, the volume or quantity of algae available for consumption is often the most critical parameter to be considered. For this reason,phytoplankton data is typically expressed in terms of chlorophyll *a* concentration (g/L) overall biovolume (i.e., m^3/mL), or population densities (i.e., cells/mL) as well as species composition (USACE 2002)

The phytoplankton community of the Red River Delta has a diverse species composition including 183 species (**Appendix 12**) dominated by Diatomae, which make up 86.1% of total species. Some genera with numerous species are *Chaetoceros* (28 species), *Coscinodiscus* (18), *Rhizosolenia* (14), *Ceratium* (9), *Navicula* (8), and *Melosira* (6).*Skeletonema costatum* and some representatives of *Pennateae* are often abundant in the upper regions of the estuary where salinity is below 15 0/00.

According to Vu Trung Tang, in terms of the annual cycle, phytoplankton development changes between two seasons: declining rapidly during flood peak months (July - August) and increasing in the dry season. In July-August, the phytoplankton density ranges from 800 to 362,000 cells/m^3 and the mean biomass is 130 g/m^3. Later (October - November) phytoplankton explodes in number, reaching a mean density of 973,000 cells/m^3 and a mean biomass of 470 g/m^3. At the end of the dry season, the phytoplankton development decreases

slightly, as a function of a decline in nutrients in the estuary, to a mean density of 368,000 cells/m^3 and biomass of 309 g/m^3. Frequently, phytoplankton develops intensively near the Red River mouth in waters shallower than 20 m where it is controlled by tidal action. Phytoplankton density and biomass increase when the tide is high and decrease when the tide falls, reaching extremes at the times of highest and lowest tides (**Appendix 12**).

The sampling conducted by the NDTDP, the analysis of the results of the 14 samples, 66 species are recorded belonging to 4 algae phyla: Cyanobacteria, Chlorophyta, Bacillariophyta and Euglenophyta (**Appendix 12**). The number of algal species mentioned above is not enough to reflect the phytoplankton composition in the nature. Of the the phytoplankton present, Bacillariophyta is most abundant (33 species). The number of Euglenophyta is the least at 9 species. The structure of algae composition is different from each other of the rivers: the Red river at Hung Yen has the most abundant species composition (31 species), the main component of river flora mainly is Bacillariophyta while in lake at Viet Tri, *Microcystis aeruginosa* (a toxic blue algae species belonging to Cyanobacteria) is existing.

Density of phytoplankton of all rivers in the Red River Delta in November is rather low. Density fluctuated from approximately 2,000 to over 4,000 individuals/L. Of all the sites sampled, algal density is highest in Viet Tri Lake (4,795 ind/L).In quantitative composition, multi-cell algae of genera *Oscillatoria, Lyngbia* (Cyanobacteria) and *Spyrogira* (Chlorophyta) are the most dominant.

Zooplankton community

The Bac Bo estuarine area supports a rich and diverse zooplankton. A total of 185 species have been recorded, including Copepoda (107 species), Cladeocera (14), Siphonophora (8),Chaetognatha (8), Amphipoda (6), Tunicata (6), Protozoa (5), Ostracoda (4), Pteropoda - Heteropoda (3), Rotatoria (2), Cumacea (2), Sergestinae (1), Euphausidae (1) and Nauplius (18). Like the phytoplankton, the zooplankton is divided into three ecological groups, (a) freshwater, (b) estuarine, (c)euryhaline-marine. Fresh water fauna often appears in the upper parts of the estuary and is abundant in number, especially the wet season and at times of neap tide. Contrastingly, euryhaline-marine fauna occurs near the end of the estuary, is richest near Spring tide and in the dry season.

Zooplankton density and biomass vary between 6,130 - 15,500 individuals/m^3 and 240 - 370 g/m^3 respectively. Lowest values are in flood months, but high values are in the dry season (Khuc Ngoc Cam, 1975; Nguyen Van Khoi et al, 1980), especially at times of highest tide and during the period from midnight to 5-6:00 am.

Zoobenthos community

The biomass of zoobenthic animals used as food by other species varies over a wide range from 4 - 96 g/m^3 in the dry season and 5.9 - 11.5 g/m^3 in the wet season (Dang Ngoc Thanh *et al.*, 1991).

Zoobenthic community in the tidal mud flats includes 130 species, representing some principal groups such as Polychaeta (34 species), Gastropoda (16), Bivalvia (23), Macrura (17) Brachyura (38). Many of these species are economically important, for example *Ostrea, Meretrix, Aloides, Macta, Netica, Sanguillaria, Penaeus, Metapenaeus, Palaemon, Scylla, Portunus*, etc.

Fish fauna

According to Vung Trung Tang (1987), a total of 233 fish species have been identified in the estuary of the Red River Delta belonging to 71 families and 18 fish orders. The families with numerous species are Carangidae (11 species), Cynoglossidae (14), Gobiidae (13), Leiognathidae (11), Sciaenidae (11), Teterodontidae (11), Clupeidae (9), Engraulidae (9) and Mugilidae (6). Some fresh water fish of the families Cyprinidae and Bagridae often occur in water with a salinity below 10-12 PSU in the upper regions of the estuary. The representatives of some Priacanthidae, Pomacentridae, Chaetodontidae are frequently found near coral reefs and some offshore juvenile fish also penetrate estuaries for feeding such as Elasmobranchia, Exocoetus, Sphyraena, Formio, Stromatoidae, Scombridae.

Despite the mixed origin, estuarine fish fauna of the Bac Bo Delta are related to the Tonkin Gulf fish fauna. Most representatives originated from tropical seas and have adapted to high salinity fluctuations occurring in the estuary (Vu Trung Tang *et al.*, 1987).

The fish fauna of this area may be divided into four ecological groups (a) freshwater, (b) euryhaline-marine (c) true estuarine and (d) regularly anadromous migrants such as *Clupando theissa* and *Hilsa reveesii.*

4.4.3 Fish

The fish survey done by the *Phan Mach, Institute of Ecology and Biological Resources, in December. 2007* describes the fish species that occur in the Red River and its distributaries. The descriptions are as follows:

Nhue and Day river

About 53 fish species were identified at the Day and Nhue basin. Most of them belong to Carp spp. The species having high economic value are: *Cyprivius carpio, Carasius auratus, Pinibartus caldwelli, Anthorhodeus dayeus, A. Tonkinensis.*

In this river basin there is one of 33 inland water fish species recorded in the Vietnam Red Book (2000). It is *Squaliobartus Curiculus* (T - level) (C¸ chµy in Vietnamese).

Cau River

89 fish species of 6 orders, 20 families have been recorded in the Cauriver basin. Most of them are native ones, only *Trichogaster Trichopterus, Oreocronis niloticus and O.mossambicu* are exotic (from other countries). Most of species belong to carp family (50% of the total species number). Two species are listed in the Vietnam Red Book (2000): *Onlychostoma laticeps* (Vulnerable) (C¸ SØnh in Vietnamese) and *Squaliobarbus curiculus (*Threatened). Twelve of the fish species in Cau River are cultured.

Red River

Along Red River from Viet Tri to the estuary about 64 fish species have been identified of these 12 species are cultured. Three fish species of the Red River are listed in the Vietnam Red Book (2000): *Clupanodon Thrissa* (Linnaeus, 1758) (Vulnerable - level), *Squaliobarbus curriculus (*Threatened - level), *Hemibagrius elongatus* (Giinther) (Vulnerable - level).

Thai Binh river

Sixty-two species have been recorded in this river from Pha Lai to the estuary. Fifty (50) are naturally occurring and 12 are cultured. Two species are listed in the Vietnam Red Book (2000): *Clupanodon Thrissa* (Linnaeus, 1758) (Vulnerable - level) and *Squaliobarbus curriculus* (Threatened - level).

Photo 4-3. *Hemiculter leusisculus* one of the euryhaline fishes of the Red River	**Photo 4-4** *Varuna litterata*, brackish water crab caught in Kinh Thay River
d	

The list of fish species of the Red River Delta is attached as **Appendix 21.**

Seasonality of Some Biologic Processes in the Red River

The spawning season of the various aquatic fauna of the Red River Delta is not totally known. However, for some of the important species such as the *Squaliobarbus curriculus* the reproductive season starts from late April to early August, with the best season from May to July (Long Huang Gua, 2004) While other fauna such as freshwater crabs and shrimps coincide with the monsoon season. This is presumed to be due to the availability of increased of habitat (e.g inundated floodplain) for hatchlings in large rivers swollen by monsoonal rains (Dudgeon, 2000). **Table 4-12** summarizes the known seasonal processes of some aquatic life of the Red River Delta.

Table 4-12. Matrix of season and documented seasonality of biological processes of some freshwater aquatic life of Red River

Biologic Processes	J	F	M	A	M	J	J	A	S	O	N	D
Rainy Season/Flood												
Peak Zooplankton												
Peak density & biomass phytoplankton												
Peak density & biomass Zoobenthos												
Reproductive season, *Squaliobarbus curriculus* (Long Huang Gua et al. 2004)												
Reproductive Season freshwater shrimps & crabs (Dudgeon 2000)												

4.4.4 Mangrove Ecosystems of the Red River Delta

Dykes have been constructed along most part of the river system and coastline of the Northern Delta for protection against flooding. Only a narrow strip of inter-tidal sand or mud flat beyond the dykes, except near river mouths where deposition is very active and mud flats and sandy islands are expanding due to influx of sediment. Several sandy islands evolved due to accretion including the islands that now make up the Xuan Thuy Nature Reserve. Coastal vegetations, i.e. mangrove are represented by small shrub like trees, apparently an adaptation to the prevailing harsh environment, e.g. climatic conditions. Mangrove replanting along the coast of the Red River delta covers about 7,400 hectares of plantations of *Kandelia candel.* While exotic species *Casuarina equisetifolia* is planted on sandy beaches and dunes.

In places where conditions are favorable for mangrove development, i.e. sheltered, presence of large portion of freshwater and sediments the mangrove stands flourish. This is true for the stretch of the coastline from Do Son Cape to the northern bank of Van Uc River where mangrove communities consist of *Sonneratia caseolaris* and associated mangrove species *Aegiceras corniculatum* and *Acanthus ilicifolius.* In some areas Cyperus malaccenis replaces the *Acanthus ilicifolius* or grows in mixed stands. Prevalent shrimp pond construction has severely reduced the area covered by *Sonneratia.*

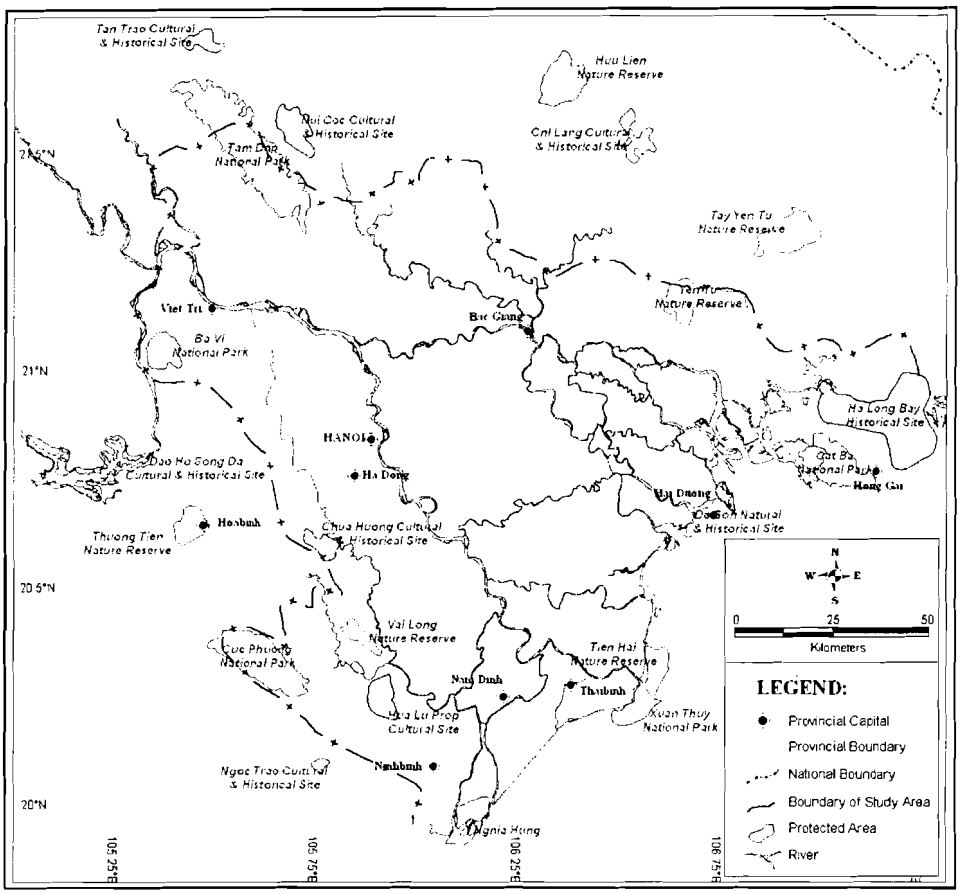
In areas where accretion is very active such as the coastline from Van Uc estuary to Lach Troung, the area is open, flat with large swamps and rich in alluvium. The area is exposed to storms and hence not suitable to mangrove growth except in the estuaries of Ninh Co and Tra Ly rivers. Mangrove and mangrove associated species in this area include *Aegiceras corniculatum, Acanthus ilicifolius, Kandelia candel Sonneratia caseolaris.*

In swamps where low salinities prevail the following plant species are present: *Cyperus stolononiferus; C. malaccencis, C. tegitiformis, Scirpus aff. Runcoides; Phragmites karka; Myriphyllum spicatum ; Najas kingii; N. indica; Paspalum vaginatum.*

4.5 Protected Areas - Biodiversity Protection and Conservation

The Vietnamese Government has put in place biodiversity conservation program. As part of this program it has declared protected areas. A number of the protected areas are located along the coastal zone of the Red River Delta. The locations of these protected areas are shown in **Figure 4-9.** A brief discussion of some of the more prominent protected areas in the study region is presented in the following sections.

Figure 4-9. Protected Areas in the Red River Delta



4.5.1 Cucphuong National Park

This protected area straddles 3 provinces, namely Ninh Binh, Hoa Binh and Thanh Hoa, has typical features of wet tropical forests. It is influenced by monsoon with 3 wood layers , 1 shrub layer and 1 forest floor. The 35-40m high wood layer includes *Parashorea, Ficus retusa, Dracontomelum duperreamum, Sapindus oocarpus, Amoora gitantea, etc.* The 30 m high wood layer includes Castanopsis, etc. In thin broad-leaved forests in limestone mountains of Tamdiep, Hoalu and Giavien, etc. there are wood species such as *Pentace tonkinensis, Chukrasia tabularis, Garninia fragraeoides, etc.* and species of Orchidaceae, Dioscoreaceae, Nephrolepsidaceae, etc. The species composition is very diverse. In primeval forests more than 2,000 species of 221 families, 987 branches are observed. Forests on limestone mountains have 1,937 species, 229 families of 4 orders.

The protected area has 60 species of wild animals, 4 entomophagous species, 18 dermoptera species, 1 manis species, 3 primate species, 15 rodent species, 15 carnivorous species, 4 artiodactyl species with rare and precious species such as Pyganthris nemareus L., Panthera pardus, Selenarctos thibetanus, Antelope, deer, Capreolus capreolus, Herpestes, Mustella. One hundred forty (140) bird species are known to inhabit the park, including the noteworthy species such as Pavo muticus imperator, Lophura diardi, nightingale, Motacilla flava flava.

Therty-six (36) reptile species including Gecko gecko L., Varanus nebulotus, Morelia, Bungarus, Ancistrodon conotortrix, Tropidomotus natrix and 20 amphibian species, mostly toad and frog have also been identified..

4.5.2 Catba National Park

The Catba Biosphere Reserve includes 13,200 ha of forests (accounting for 60% of the surface area of the island). That is tropical evergreen rain forest. Forests on limestone mountain sides have wood trees such as *Allospondias lakonensis*, Proteas. Particularly, in the pure forest at Trungtrang the precious and rare *Nageia fleury* is found. The total number of vegetation species observed in Catba is 839, belonging to 498 branches, 169 families (Tran Ngoc Ninh, 1997).

This protected area has have 38 mammal species of 9 phyla, 17 families with rare and specious ones such as *Trachypithecus francoisi poliocephalus, Macaca artoides, Macaca mulata, Felis bengalensis, and Panthera pardus, etc.*

Presently forests are shrinking in acreage, wood reserve and biodiversity as a result of overexploitation, not to say annual fire as well as shifting and wandering custom of some ethnic minorities.

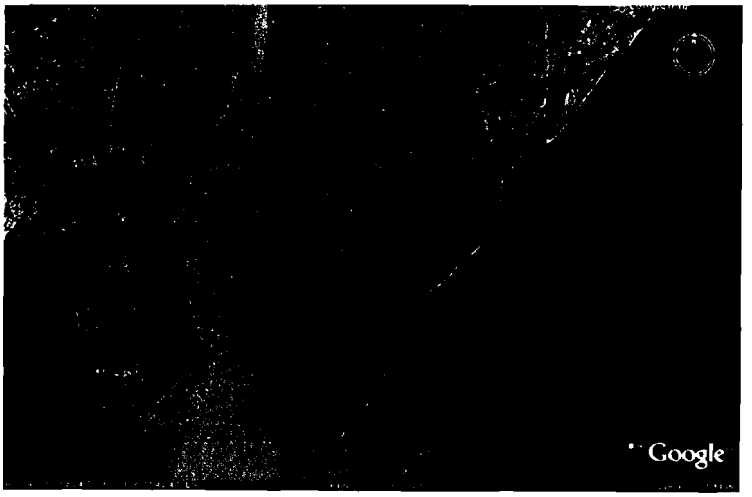
But the protected areas that are of concern to the NDTDP are the wetland protected areas found along the coastal zone of the Red River Delta. These protected areas are presented in the following sections. The source of information is the Sourcebook of Existing Protected Areas in Vietnam, 2nd edition.

4.5.3 Nghia Hung Proposed Nature Reserve

The site covers 12 km of coastline, bordered by Day River to the west and by Ninh Co River to the east. Landforms include sandy beaches, dunes and salt marsh. Aquaculture ponds are found to the west. Outside the main dyke, there is an intertidal area of about 3,400 hectares. Offshore, about 5 kms away are two small sandy islands covering 25 ha. One island support dunes while the other supports a salt marsh. Nghia Hung supports 13 different habitats and is one of the most diverse areas in the coastal zone of the Red River Delta

It supports a number of globally threatened or near-threatened waterbird species such as the Spotted Greenshank, Asian Dowitcher, Spoonbilled Sandpiper, Chinese Egret and Black faced Spoonbill among others. It qualifies as an Important Bird Area.

Figure 4-10. The imagery gives a bird's eye-view of the Ngiah Hung Proposed Nature Reserve in the Estuarine of the Day and Ninh Co Rivers.



4.5.4 Xuan Thuy National Park

This protected area is located in the province of Nam Dinh . It has a total area of about 7,100 hectares. It was decreed by Government as a protected area on 05 Sept 1994

Xuan Thuy National Park is located in the coastal zone of the Red River Delta, at the mouth of the main channel of the Red River, known as Ba Lat River. Site consists of 3 islands. The largest is occupied by aquacultural ponds, the second contains mangrove and well as coastal marshes and a small aquaculture pond. The 3rd island is still accreting because of active deposition. Maximum elevation of the protected area is 3 m asl. It Supports 14 habitat types, both natural and man-made ones. Habitat types with highest biodiversity values are the undisturbed mudflats and natural mangroves, dominated by *Kandelia candel.*

This is an important winter staging area for migratory waterbirds. Eight species of globally threatened and near threatened birds regularly occur in the protected area. Xuan Thuy supports the largest wintering population of Black-faced Spoonbill in Vietnam. Xuan thuy qualifies as an Important Bird Area.

4.5.5 Tien Hai Nature Reserve

This protected area is located in the province of Thai Binh. The protected area occupies an area of about 12,500 hectares. It was decreed as a protected area on 05 September 1994. the nature reserve is located at the mouth of the Red River, immediately north of Xuan Thuy. It consists of 2 sandy islands, Vanh Island with an area of 2,000 ha and Thuy which has an area of 50 ha. Vanh Island is separated from mainland by a deep channel. The banks of Vanh are covered by mangrove, most of which is enclosed by ponds. It supports 12 habitat types, most important are sand dunes, reedbed and mangrove. Intertidal mudflats are important habitat for feeding shorebirds. This reserve forms the nNorthern extension of Xuan Thuy Nature Reserve.

Figure 4-11. Overview of the Xuan Thuy National Park and the Tien Hai Nature Reserve

4.1.1 Thai Thuy Proposed Nature Reserve

This proposed nature reserve is located in the province of Thai Binh and occupies an area of 13,696 hectares. It is bordered by Tra Ly River to the south and by the Thai Binh

River to the north. The proposed reserve is bisected by the Diem Ho River. To the south of Thai Binh River mouth are extensive areas of mudflats. To the west are salt pans and adjacent to Tra Ly is a region of aquaculture ponds. It contains the largest remaining tract of old-growth mangrove forest in the Red River Delta. About 400 hectares of natural mangrove forest dominated by *Sonneratia caseolaris* remains at Thai Thuy. Most of the mangrove forest consists of plantation of *Kandelia candel*. The mangrove plantation is about 2,888 ha.

The proposed reserve supports 4 main habitat types and it supports several globally threatened and near threatened waterbird species over winter and on passage.

4.6 Natural Disasters and Environmental Incidents

4.6.1 Storms and tropical Low Pressures

According to statistics from 1980 to 1997, 26 storms have affected the provinces in the Northern Delta. The highest wind speed experienced during such condition was greater than 50m/s during the occurrence of Typhoon Wendy in 9 September 1968. During the of 1996 to 1999, the number of storms and tropical low pressures declined with 12 occurrences in 1996, 5 in 1997 and none in 1998 and 1999 as influenced by El Nino phenomenon The second storm in 1997 caused heavy rain and strong wind that affected almost all the provinces in the region. Wind was measured at 25 m/s with gusts of over 26 m/s to 35m/s. In 2007, 3 storms hit the coastal provinces of Ninh Bbin and Nam Dinh.

4.6.2 Flood and Water-Logging

Historical data shows that in the second half of the last century, floods of the Red River are more severe and with shorter return-periods. Floods in 1971 1945, 1969 and 1996 have the peaks of 14.8m, 13.22m and 13.38m, respectively. That is higher or equal to the usual flood level of 13.6m in Hanoi. The 1971 flood, with return period of 200-250 years and the 1945 flood with return period of 100 year are among the big floods. These floods are almost equivalent to 1,000 year floods with flow rates of rate of 45,000-51,000m3/s. This flow rate is 1.19-1.35 times the flow rate of the in 1971 flood as measured at Son Tay.

Most regions in the Northern Delta are protected by dikes but elevations of the dikes vary. When dikes are overtopped by floodwater, the areas must be drained by pumping. During the 4th storm in 1996, although the wind is of grade 9 to 10 only, a storm surge occurred which almost overtopped the dikes of Hai Phong, Thai Binh, Nam Dinh. Overtopping and breaching of the dikes will have disastrous consequences on the economy of the region.

In 1998, heavy rain and rising water flew over and broke the dike of Dabac district, sweeping away many houses and schools at Tienyen (Quangninh). About 1000 meter of the sea dike was breached and damaged causing extreme traffic jams. Recently (1995-1999), flash floods frequently occurred at Tanlac district, (Hoabinh) with higher frequency and worse destruction. The regions of Nhovien and Nhoquan (Ninhbinh) have been damaged by flash floods of the Hoanglong River. Particularly, the flood in early October 2007 caused water logging over thousands of hectare and houses in districts of Nhoquan and Giavien NinhBinh province.

Two provinces, Hanam and Namdinh, have very low elevations and are therefore prone to inundation. At present, the dike system and the Hoabinh hydroelectric dam have reduced the hazards of flooding in these provinces in the North Vietnam's Plain.

4.6.3 Sedimentation, Erosion and Land Slide

Natural processes and human activities have altered the conditions of the watersheds. Deforestation of the headwaters has shortened the concentration period of run-off, hastening erosion and sedimentation.

The Hoa Binh reservoir has basically changed the hydrological and hydraulic conditions of the river. Trapping of sediment in the reservoir has caused sediment starvation in river sections below the dam. As a consequence, erosion of the river bed is taking place. In Da River,

depth of river bed erosion is 6.5m right behind the dike. An erosion depth of 4.5m has affected 5 km of the river. While river bed erosion with depth of 2.1 m has affected a distance of 11-12km. The erosion of the river bed has induced bank erosion, threatening the dike sections of Hoa Binh town.

Threats of erosion persist in Thinhland town where more than six million cubic meters of soil has been eroded. The state of erosion and landslide in the regions is as follows:

- *Hungyen Province:* in the period of 1991-1998, the Red River caused landslide of 112 ha at Lamson ward (Hungyen town). The Red River dike section at Maidong commune has suffered a rift of 190m in length, 0.5-0.18m in width. In the Luoc River dike, the rift is 600m long and 0.03-0.05m wide. In 1998, functional state bodies invested at least 1 billion dong to repair the rifts and prevent erosion in Hungyen;
- *Ninhbinh Province:* Landslide occurred in the mountainous areas of Tamdiep, Nhoquan, Giavien, Thuy. Bank erosion is present in Van River in Ninh Binh town;
- *Hai Duong Province:* Break of Thanhong, Thanhha dikes in 1996;
- *Riverside dike of the Thaibinh River* is low, small with weak bases. Safety is threatened by incidents of long inundation at alarming degrees of 2 or 3.

4.6.4 Drought and Hot Temperature

The most recent drought occurred from March to late May 2003. Hoabinh hydroelectric plant ceased operations and thousands of hectares of crops were destroyed. The water shortage affected a large proportion of the population.

4.6.5 Earthquake

Earthquake hazard in the project site is low. The 1983 earthquake was measured at intensity 3-4 on the Richter scale and the April, 30, 2007 earthquake felt in Hanoi has an intensity of 3 based on the Richter scale.

4.7 Socio-Economic Conditions

The project site accounts for a major part of the Northern Delta which includes Quangninh and Vinhphuc provinces to the northeast and the province Phutho to the northwest. This region is the center of economic, cultural and social development of northern Vietnam. This region has a population of 13 million representing 15.5% of Vietnam's total population. This region contributes 15% annually to the country's GDP. In recent years (2001 – 2007) these provinces have enjoyed high economic growth rate of 8-12% per year, according to reports by the provinces. As a result of industrialization and urbanization, a large area of farming land and forests has been converted into urban or residential land. Some information of economic growth of the provinces is outlined below.

4.7.1 Industrial Development

In the period of 2001 – 2006, the industrial growth of provinces in the study region was 15 – 30%, higher than the national average. But industrial growth was higher in Hanoi, and provinces of Quangninh, Haiphong, Hungyen, Haiduong, Vinhphuc which experienced growth rate of over 20% per year. The industrial GDP accounted for over 40%. Meanwhile, the economy of the provinces of Thaibinh, Ninhbinh, Hatay Namdinh, Phutho, Hanam are still generally agricultural based.

The favorable conditions for Industrialization has served as the impetus for the development and expansion of industrial parks in cities, districts and towns of Campha, Halong, Uongbi, Dongtrieu (Quangninh povince), Thuynguyen, Anduong, Kienthuy, Anhai (Haiphong), Haiduong city, Chilinh, Namsach, Camgiang (Haiduong province), Myhao, Vanlam (Hungyen province), Dongvan, Phuly (Hanam province), Giavien, Tamdiep, Ninhbinh city (Ninhbinh province), Namdinh city (Namdinh province), Thaibinh city (Thaibinh province), Luongson (Hoabinh province), Viettri city (Phutho province), Vinhyen city, Phucyen town (Vinhphuc province), Hadong city, and Hoaiduc (Hatay province).

Ninh Binh

In Ninh Binh, a number of industrial zones have been declared. Among these is the Ninh Phuc Industrial zone which will be located in the Hoa Lu District and Khan P10, Highway 1A and the Ninh Phuc Port. hun commune in Yen Kanh district. This IZ has a land area of 350 hectares and will be located close to Ninh Phuc Port. The IZ is expected to hose a nitrogen fertilizer plan, manufacturing, assembling, mechanics industry and processing industry.

The other industrial zone right near the center of NInh Binh is the Southern Indusrtial Complex of Ninh Binh Town. It is expecting to host manufacturing, repair and assembly plant, cleaning and processing industry.

Other industrial areas are spread in other parts of the province which are planned to accommodate a wide range of industry from agro-industrial to food processing, clothing and textile, manufacture of handicrafts, dimension stone and the like.

Pho Tho

One of Phu Tho's main produce is tea. At present there are 7 tea processing factories in the province. In 1997 the province's processed tea product amounted to 8000 tons jointly produced by various tea processing companies such as Phu Ben Tea Joint Venture (with Belgium), CTC tea factory with Indian equipment. Phu Tho needs to expand and build up additional tea factories to produce and export 14,000 tons/year.

Other agro-forestry and foodstuff processing industry consist of: sugar, liquor beer, natural water, sodium glutamate, husked rice and maize and frozen meat. There is a plan to increase meat processing capacity to 12000 tons/year of pork and beef.

There are two textile factories in the province with capacity of 75 mil. meters of cloths/year and five garment enterprises. Viet Tri leather industry employs 2000 workers with capacity of 1 mil. pairs/year.

4.7.2 Urbanization

The project region has experienced rapid urban development during the last decade. The urban population increased to more than 35% as of 2006, higher than the nation's average of 24% for 1995. A number of towns have been upgraded to cities (including Thaibinh, Hoabinh, Ninhbinh, Haiduong, Hadong and Vinhyen as of 1995).Urbanization creates favorable conditions for socio – economic growth but also imposes heavy pressures on the environment.

4.7.3 Transport

The project area has the most developed traffic network when compared with other regions in Vietnam. This is a major boost to industrial development.

Inland road

The existing road system links all communes to centers of districts and provinces. The main national roads include:

- National Road 2: linking Hanoi with the Northeast and the Northwest regions.
- National Road 5: linking Haiphong ports with Haiduong, Hungyen and Hanoi city.
- National Road 18: linking Mongcai border gate with Halong city and Haiduong and Bacninh.
- National Road 10: linking coastal provinces, namely Quangninh, Haiphong, Thaibinh, Namdinh, and Ninhbinh provinces.
- National Road1: linking Southern provinces with Hanoi city.
- National Road 21: linking Hanam, Namdinh with coastal districts of Namdinh provinces.
- National Road 6: linking provinces in the Northwest region with Hanoi.

Railways

In the project area there are has 3 railways: the North-South, the Hanoi – Haiphong and the Hanoi – Quangninh and Hanoi – Laocai.

Waterways

The Northern Delta hosts the largest ports in North Vietnam and also the hub of international transport. The biggest ports include Cua Ong, Cai Lan (Quangninh), Dinh Vu, and Chua Ve (Haiphong).

Airways

Two international airports are located in the study region. These are the Noibai (Hanoi) and Catbi (Haiphong) and some military airports.

4.7.4 Agriculture, Forestry and Fishery

Agriculture, forestry and fishery are among the economic activities in the project region. The agricultural areas in the Northern provinces are Hungyen, Haiduong, Namdinh, Thaibinh, Ninhbinh, and Hanam. Major agricultural crops include rice, maize, vegetable and fruits. Cattle and poultry-raising are among the major agricultural industries of the region.

In the coastal provinces of Quangninh, Haiphong, Thaibinh, Namdinh, and Ninhbinh, aquaculture and capture fishery are well developed. In the period of 2001 – 2006, the growth rate of agriculture is 3 – 4% per year, and fishery 4 – 8% per year.

Forestry is an important economic sector in Hatay, Vinhphuc, Phutho and some districts of Haiphong, Ninhbinh, and Quangninh. Nevertheless, both the area and quality of forests (mountain forests and mangrove forests) are declining, indicating the general decline in quality of the environment.

4.7.5 Land Use Around Viet Tri Port and Vinh Phuc Port

Viet Tri Port

A bird's eye view of the port and its surroundings are shown in the following Google Earth Imagery. shows the land uses around the port. It can be appreciated from the imagery that the port is located at the periphery of the town center. The land use in the general area is a mixture of residential, commercial and industrial use. The imagery shows the numerous lakes in the area around the port.

Photo 4-5. Bird's eye view of Viet Tri

The north eastern side of the port is bound by the north approach of the Viet Tri Bridge. While to the south west is the port area is bound by a small shipyard and some residential houses. The view of this as seen from the river is shown in the following photo.

Photo 4-6. The land use at the south western boundary of Viet Tri Port

Ninh Phuc Port

Similar to Viet Tri Port, Ninh Phuc Port is located very close to the urban center of Ninh Binh. Presently, adjoining the port area is a reclamation that will be develop as an industrial zone. Beside the port is a ship building and repair facility. The photo below shows the reclamation area adjoining the port. While the following photo shows the ship repair and building facility right beside the port.

Photo 4-7. Reclamation beside the Port of Ninh Phuc

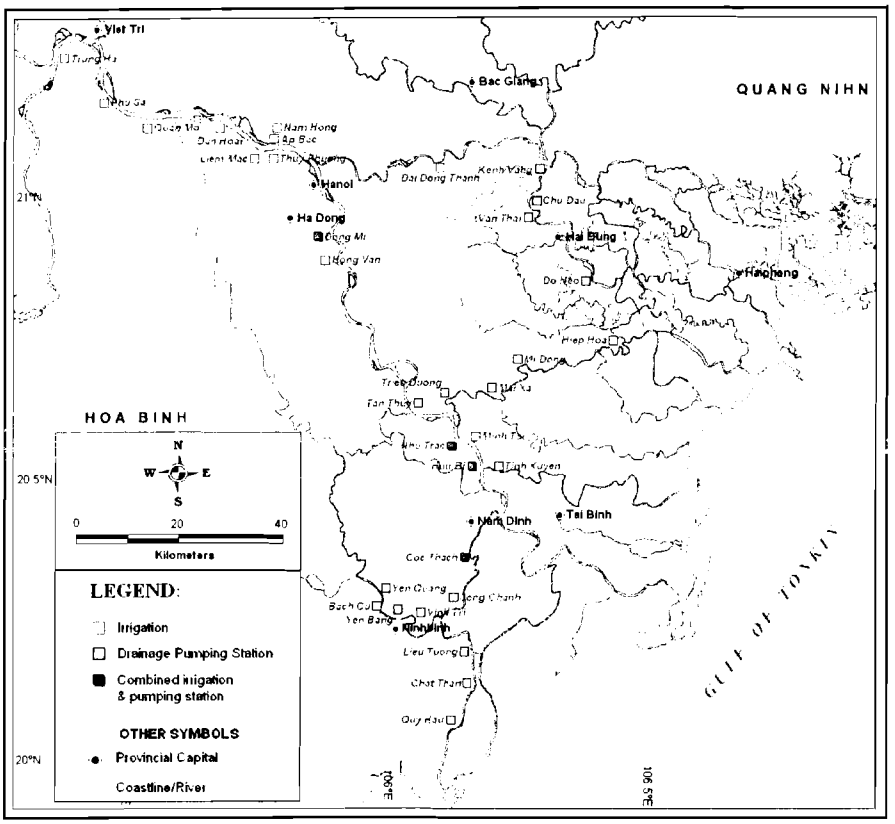
Photo 4-8. Ship yard beside Ninh Phuc Port

4.7.6 Red River as Source of Irrigation Water

Aside from fishing and transport, one of the major uses of the river water is for irrigation. A number of pumping stations have been established in different the rivers within the project region **Figure 4-12** shows the location of pumping stations in the Red River Delta while Photo 4-22 shows one of the stations.

Photo 4-9. One of the pumping stations upstream of the Red River

Figure 4-12. Pumping stations located along the river of the Red River Delta



4.7.7 Historical and Natural and Cultural Resources

There are a number of historical heritages in the study region. Among these are the Conson pagoda, Kiepbac temple (Hai Duong), the ancient port town and Hien town, the temple of Pham Ngu Lao (Hung Yen), Keo pagoda (Thaibinh), relics of Saint Nguyen, Dichlong pagoda and cavern, the temple to King Dinh Tien Hoang, Loson pagoda, Hoalu cavern, Baidinh mount and pagoda, Phatdiem Stone Church (Ninhbinh). Alongside the coast of Haiphong – Quangninh are historic sites and sites of traditional festivals such as the Bachdang gate, Yentu pagoda, Cuaong temple, etc. In almost all provinces there are heritage resources of ancient architectures and artifacts, pagodas, temples. The resources that are within the project site are summarized below.

Phu Tho

Phu Tho has rich cultural resources and is considered as the ancestral land of Vietnam. The Den Hung (Hung Temple) Remains is related to the legend about 18 Hung Kings who built Van Lang State, the Ancient Vietnam, with Phong Chau as the capital. There are numerous archaeological sites like Son Vi, Dong Dau, Lang Ca and many pagodas, temples, tombs around Nghia Linh Mountain which indicate that Phong Chau used to be cultural center of ancient Vietnamese. Phu Tho is also home to many festivals including Bach Hac, Chu Hoa, and most venerated is Den Hung Festival. This festival is held every 10th day of the 3rd lunar month timed with annual anniversary of the Kings Hung. It is now a great ceremonial festival. Other tourists destinations in the province include the Xuan Son National Park and Ao Chau Pond which are scenic spots frequented by tourists.

Ninh Binh

Ninh Binh is equally rich in historical and cultural assets. One of which is the Hoa Lu Ancient Royal capital. This is the ancient capital for 41 years (968-1009) with 12 years spent under the Dinh Dynasty beginning with King Le Dai Hanh.

A relatively recent cultural heritage is the Phat Diem Cathedral which was built in 1875-1898 in Luu Phuong cimmune, Kim Son district, 120km from Hanoi. The cathedral covering an area of 8ha consists of various structures. The largest structure is the cathedral proper which was built in 1891. Phat Diem Cathedral is an architectural complex that combines the traditional pagoda architecture of Vietnam and the Gothic style of Christian architecture.

Bich Dong is natural heritage. It is a grotto located in the Ngu Hanh Son mountain range, in Dam hamlet, Minh Hai commune, Hoa Lu district. It is known as the "the Second Most Beautiful Grotto in Vietnam". Another natural attraction is the Tam Coc consisting of 3 grottoes adorned with stalactites and stalagmites in different shapes and colours.

But the most popular natural heritage in NInh Binh is the Cuc Phuong National Park. The National Park lies between the provinces Ninh Binh, Hoa Binh and Thanh Hoa. It covers an are of 25,000 ha, three-quarters of which is limestone mountains with a height ranging from 300m to 600m above sea level. This primeval tropical forest was discovered in 1960, and it was turned into a national park two years later. Cuc Phuong is famous for dozens of picturesque caves. The most interesting of them is Dong Nguoi xua (Ancient Man Cave) where stone tools of pre-historic humans were found. The National Park is home to some 2,000 species of flora. Some rare wood trees of the Parashorea and Dracontomelum families are about 1,000 years old and from 50m to 70m high. In particular Cuc Phuong boasts at least 50 varieties of orchid. Many of which are fragrant all the year round. The National Park is also home to 262 species of animals, birds and reptiles, including elephants, tigers, deer, flying squirrels, flying lizards, and boas.

5 TYPICAL ENVIRONMENTAL IMPACTS

5.1 Typical Environmental Impacts Ports

5.1.1 Preconstruction Stage

Ports

The activities during the pre-construction stage include:

- Detailed design
- Detailed survey
- Clearing of construction sites within the ports

No significant impacts are expected during the pre-construction stage, except for impacts that may be caused by the clearing of construction sites within the ports. The clearing will include removal of old pavements of the open yards. This will generate noise and dust and will produce waste construction materials including concrete rubbles. Fugitive dust is expected to deteriorate air quality in the port areas during clearing due to the presence of dusts on the roads.

No significant impacts on biological resources since the improvements in both Viet Tri and Ninh Phuc are confined within the existing port facilities which are devoid of any significant vegetation communities.

As for social impacts, no resettlement impacts are predicted during pre-construction since work will be confined within the existing port facilities. Social impacts during the preconstruction stage may emanate from the entry of construction workers into the community. The presence of a large construction workers in the project area may cause a range of adverse impacts. Poor hygiene in construction workers camps may cause diseases not only for workers but also the general community. Transmission of communicable diseases, including STDs, between workers and into the general community may occur and conflicts between construction workers and the local communities may occur.

The presence of a large number of construction workers may generate increased pressure on basic services in the project area, including water supply.

These impacts however will be short term and may prevail only during the pre construction until the construction stage.

Ferry Boat Stages

Similar to the ports, no significant impacts are expected during the pre-construction stage of the ferry boat stages.

But social impacts of the ferry boat stages is uncertain at this stage since final selection of the ferry boat stages is yet to be done.

Corridor 3 Improvement

No Significant impacts are predicted as well for the pre-construction stage of Corridor 3 Improvement.

5.1.2 Typical Impacts Associated with Construction Stage

a. Impacts on Air Quality

Ports

During construction stage, the impacts on air quality and noise will emanate from the operations of construction equipment and fugitive dust from stockpile and handling of construction materials, earth movement and construction activities. The noise is more of an occupational health concern. The impact of noise on human communities outside the ports of Viet Tri is mitigated by a number of factors:

- The port occupies a large areas and residential houses are located at the periphery of the port
- The port is bound by dikes;
- Roads fringe the port area, adding distance to receptors.

The same condition prevails in the port of Ninh Phuc. The port is bound by a dike in its frontage and by two channels on both sides of the property. The channel on the east side is the slipway of a ship building facility.

The impact on noise and emissions associated with construction is rated to be minor, negative and of temporary in nature.

The kind of noise levels that the workers will likely be exposed to are enumerated in **Table 5-1**.

At the moment, fugitive dust is a major concern in Viet Tri and the Ninh Phuc Port due to the accumulation of very fine dust on the roads of the ports. The dust is re-suspended whenever a vehicle drives through the road. The impact of this on the air quality was not detected during the air quality sampling done in December 2007 because of the intermittent activities and considering that sampling was only for an hour. But during construction with activities specially during the dry season, this may pose health hazards to workers.

The construction can have cumulative impact on air quality. This impact on air quality is negative, minor, short term

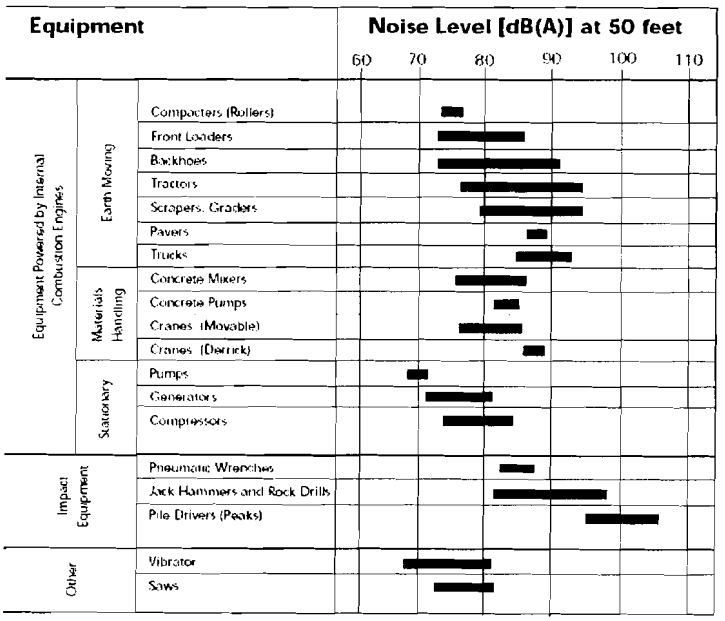
Ferry Boat Stages

The impacts on air quality and noise will be comparatively more significant for ferry boat stages. As observed, ferry boat stages are usually fringed by residences and some stores, hence receptors are likely present around the ferry boat stages.

Corridor 3 Improvement

The activities of Corridor 3 improvement that will generate emissions and noise are the dredging and construction of groins and river bank protection since these will require the use of heavy equipment. But considering the wide dimension of the river in Mom Ro, noise generated by the dredge will not be a nuisance to the community on the bank. However, construction activities on the banks may cause some nuisance noise to the community.

Table 5-1. Noise levels of selected construction equipment



Note: Based on limited available data samples
Source: U.S. Environmental Protection Agency

b. Impacts on Soil and Soil Quality

Ports

Impacts on soil and soil quality during construction will emanate from spillage of pollutants, oil, lubricant and fuel. The chemical analysis of soil samples from the ports of Ninh Phuc (VT-28 is already showing signs of oil contamination and this is presumed to be from oil spillage. Oil concentration in soil sample from Vinh Phuc Port is 0.16 mg/kg.
The impact of soil contamination during construction is negative, short term and could be of long term duration.

Ferry Boat Stages

The same impact on soil and soil quality can be expected during the construction of ferry boat stages.

Corridor 3 Improvement

Threats to soil contamination in Corridor 3 waterways improvement is likely associated with the bank protection work and groins construction. These activities will require the use of staging areas and stockpiles area for construction materials. Impact is negative, minor and short term.

c. Impacts on Erosion and Deposition

Ports

The construction activities will have minor impact on these geologic processes. The ports of Viet Tri and Ninh Phuc are already constructed and with bank protection. This impact is likely to be a concern in other ports where bank trimming will have to be done.

Ferry Boat Stages

The construction of ferry boat stages will be associated with some degree of erosion because of the construction of the ramp, part of which will be below water level. Some erosion may occur during construction of the ramp but this is relatively minor and temporary in duration.

Corridor 3 Improvement

Works in Corridor 3 that will likely cause erosion of banks during construction are the dredging, the bend improvement in Mom Ro and bank protection in Lac Quan. Bare banks will be exposed to flowing water which will induce some erosion.

d. Impacts on Natural Sediment Transport

Ports

Construction of ports will not have impact on sediment transport

Ferry Boat Stages

Construction of ferry boat stages will not have any impact on sediment transport

Corridor 3 Improvement

Groins construction will have the most significant impact on sediment transport. This is the purpose of the groin. It will constrict flow and consequently increase flow velocity which in turn will increase the sediment transport capacity of the river. This is a positive impact.

e. Impacts on Hydrodynamics / Hydrology

Ports

The port improvement works will only have localized impact on river flow with the construction of the new quay. The impact will likely be confined close the bank. This impact is considered minor, negative, Long term.

Ferry Boat Stages

The construction of the ferry boat stages on hydrodynamic characteristics of the river will be minimal.

Corridor 3 Improvement

Of the components of Corridor 3 improvement, groins will have the most significant impact on hydrodynamic characteristic of the river. Since this is the desired effect, this is considered a positive impact. The condition will prevail within the groin fields.

f. Impacts on Stream Sediment Quality

Ports

The contamination of stream sediment during construction may occur through spillage of construction materials, e.g. cement, fuel and lubricant. This impact is considered minor, negative and short term duration.

Ferry Boat Stages

Impacts on stream sediment quality during construction of ferry boat stages is likely similar to impacts of the ports.

Corridor 3 Improvement

The significant source of impacts on stream sediment quality during dredging of Corridor is the disposal of contaminated sediment in other parts of the river.

g. Impacts on Surface Water Quality

Ports

During construction, pollution of surface water in the area of the port may occur due to spillage of construction materials such as cement mix, construction materials, fuel, lubricants, solvents and other toxic substances.

Discharges of wash water from maintenance areas can also contribute to pollution of surface water during construction. This impact is considered negative, minor and short term

Ferry Boat Stages

Similar impacts may occur during the construction of ferry boat stages.

Corridor 3 Improvement

Resuspension of pollutants, e.g. heavy metals into the water column during dredging and bend cutting may cause the pollution of the surface water. In addition, spillage from other activities like construction of groins and bank protection may also contribute to pollution of the surface water during construction.

h. Impacts on Terrestrial Ecosystem

Construction of ports and ferry boat stages and Corridor 3 improvement will not have significant impacts on the terrestrial ecosystem. The river banks of Corridor 3 and sites of the ports and ferry boat stages are either cultivated or built-up. Wegetation found in the site are mostly common species.

i. Impacts on Aquatic Ecosystem

Ports

Pile driving will be done for the new quays. This can cause some disturbance near the bank. Considering the current level of activities in the port, this will be a cumulative impact on aquatic life, but not significant. The new piles may offer shelter to fish and other aquatic life.

Ferry Boat Stages

Construction of ferry boat stages will have minimal impacts on aquatic life.

Corridor 3 Improvement

Dredging and construction of groynes will have significant impacts on aquatic life. Dredging and construction of the groynes will smother bentic communities. But in the long term, the conditions that will prevail at the toes of the groynes will be favorable for aquatic organisms, including fish life. This is a positive impact with possibly long term duration.

j. Social Impacts

Ports

The most significant social impacts of the improvements in Phase 2 is acquisition of land. The improvement of the priority ports of Viet Tri and Ninh Phuc will not require land acquisition since the improvements will be confined within the existing port area. However, improvements in other ports might require acquisition of land.

Ferry Boat Stages

The priority ferry boat stages for improvement have not yet been identified and so requirement for land acquisition is uncertain at this point.

Corridor 3 Improvement

It is also uncertain how much land needs to be acquired for the improvement of Corridor 3. The bend improvement and bank protection might require land acquisition as is the case in Corridor 1.

k. Impacts on Occupational Health and Safety

The impacts on occupational health and safety of all the activities in Phase 2 will be similar in nature. Occupational hazards during construction include:

- Exposure to hazards of operating heavy equipment
- Exposure to hazards of heavy lifting
- Exposure to heat and fumes;
- Exposure to hazards of drowning;
- Exposure to health hazards due to crowded condition in construction camp;
- Exposure to ergonomic stress

l. impacts on Pulblic Health and safety

Construction in operation ports and ferry stages may cause unsafe condition for vessels, crews and ferry passengers.

5.1.3 Impacts Associated with Operations

a. Impacts on Air Quality, Noise and Vibration

Ports

Currently, aside from fugitive dust, noise and vibrations are a concern in Viet Tri port due to the operations of rock crusher. Noise level of rock crushers is 90 to 100 dB(A) (Down and Stocks, 1977) as measured from operator's position. Operators need to be properly protected from exposure to such noise levels.

Cargo handling and hauling is also a main source of fugitive dust. This is a concern for cargoes such as coal, ores, construction materials and cement.

In the port of Ninh Phuc, fugitive dusts from the port and the large reclamation area right next to the port can be a concern in the short to moderate term or until the reclaimed land has been developed.

Impacts on air quality and noise is negative and possibly a major impact of long term duration.

b. Impact on Soils and Soil Quality

Ports

During operations stage, a potential source of soil contamination is spillage of oil and other cargo materials that can be leached, such as coal and metallic ores, like and iron and pyrite ores. Persistent and long term infiltration of leachate from these materials can cause acidity and heavy metal contamination of soil. As noted during the site inspection, spillage is a concern during unloading of break bulk cargo such as coal. In addition, due to lack of maintenance, drainage lines seemed to be clogged by spilled materials, causing drainwater to overflow into the roads. The leachate from these spilled materials can percolate and affect the shallow groundwater. This impact is rated minor to moderate, negative, long term duration.

Situations like the one depicted in the following photo of Viet Tri Port can lead to environmental consequences such as increased coal dusts, leaching of spilled coal and overall pollution of the port area.

Photo 5-1. Viet Tri Port showing coal stockpile.

c. Impacts on Stream Sediment Quality

Ports

The pathway for contaminating the stream sediments is the same as the pathway for contaminating soils. River sediments can be contaminated by spillage of cargoes and heavily polluted run-off water. This impact can be a major negative impact that is of long term duration.

During periods of low water, propeller wash of vessels can re-suspend stream sediments causing high turbidity and re-suspension of pollutants if present.

d. Impacts on Surface Water Quality

Ports

Sources of pollution on the surface water quality during the operational stage include:

- Discharge of oily water by vessels
- Improperly disposal of oily waste
- Improper disposal of solid waste by the port and the vessels
- Improper disposal of cargo residue
- Discharge of sewage water by the port facility;
- Leachate from stockpiled cargoes.

It was observed that although there are laws banning disposal of waste into bodies of water, all the ports visited have no waste reception facilities. This impact during operations is rated as a potential major impact with a long term duration.

e. Impacts on Groundwater Quality

Ports

The contamination of the groundwater may from the same sources as the ones mentioned in the preceding section. If contaminated water or leachate is allowed to percolate into the ground, there is a possibility that contamination of of the shallow groundwater can occur. Pollutants may include nutrients, oil, heavy metals, sediments. This impact can be a major negative impact.

f. Impacts on Aquatic Organisms

Corridor 3 Improvements

The presence of the groynes is expected to have long term benefit to the aquatic life. Experience in other rivers where groynes have been installed reported that turbulent flow at the toe of the groynes is beneficial to aquatic life. The same situation is predicted to occur in Corridor 3.

g. Impacts on Occupational and Public Health and Safety

Ports

During operations stage the occupational hazards are exposure to hazards of operating heavy equipment, heavy lifting, heat and fumes and ergonometric stress. Threats of HIV aids can also be a concern both for port workers and the host community.

The summary of the impacts assessment during the construction stage is presented in the following table:

Table 5-2 Summary of Typical Impacts During construction

Environmental Components		N Polarity	Magnitude	Duration	Description of Impacts
Air Quality	**Ports**	**N**	Minor	ST	Construction: Noise and emissions from construction equipment and fugitive dust,
	Ferry	**N**	Minor	ST	
	Corridor 3		Minor	ST	
Geology & Topography					
Soil Quality	**Ports**	**N**	Minor	ST	Construction & operations, no impact
	Ferry	**N**	Minor	ST	
	Corridor 3	**N**	Minor	St	
Erosion & Deposition	**Ports**	**N**	Minor	ST	Minimal in Viet Tri and NInh Phuc, but could be relatively significant in others
	Ferry	**N**	Mnor	ST	
	Corridor 3	**N**	Minor	LT	Construction of groynes will enhance erosion
Sediment Transport	**Ports**	**0**			
	Ferry	**0**			
	Corridor 3	**P**	Minor-Moderate	LT	Groynes will enhance sediment transport
Stream Sediment Quality	**Port**	**N**	Minor	ST	Impacts may come from spillage of construction materials, waste water;
	Ferry	**N**	Minor	ST	Impacts may come from spillage of construction materials, waste water;
	Corridor 3	**N**	Minor	ST	Remobilization of pollutants because of dredging.
Water Resources					
Hydrology / Hydrodynamics	**Ports**	**N**	Mnor	LT	New quay's piers may induce local alteration
	Ferry Landing	**O**			
	Corridor 3	**P**	Moderate	LT	Desired results is enhanced streamflow velolcity
Surface Water Quality	**Ports**	**N**	Minor	ST	Spillage of construction materials may cause turbidity, oil, heavy metals.
	Ferry	**N**	Minor	ST	Same impact as ports
	Corridor 3		Minor - Moderate	ST	Resuspension of pollutants in sediment
Groundwater (Water Table)	**Ports**	**0**			Construction is not anticipated to affect water table
	Ferry	**0**			Construction is not anticipated to affect water table
	Corridor 3	**0**			
Groundwater Quality	**Ports**	**N**	Minor	ST	Construction – percolation of wastewater may pollute shallow groundwater
	Ferry	**N**	Minor	ST	
	Corridor 3	**0**			
Ecology & Biological Resources					
Protected Terrestrial Habitat	**Ports**	**O**			No significant impacts
	Ferry	**O**			
	Corridor 3	**O**			
Protected Terrestrial Plants	**Ports**	**O**			No significant impacts

Environmental Components		N Polarity	Magnitude	Duration	Description of Impacts
and Animals	**Ferry**	**O**			
	Corridor 3	**O**			
Aquatic Flora & Fauna	**Ports**	**N**	Minor	ST/LT	Distrubance during construction and operations
	Ferry	**N**	Minor	ST/LT	Distrubance during construction and operations
	Corridor 3	**P**	Minor	LT	
Important Aquatic/Wetlands Habitats	**O**				No direct impact
Socio-Cultural					
Social Impact	**Ports**	**Unk**			It is uncertain if other ports will induce change in land use
	Ferry	**Unk**			Uncertain if improvement of ferry stages will acquire and change land use
	Corridor 3	**N**			
Occupational & Public Health & Safety	**Ports, Ferry and Corridor 3**		Minor	ST	Construction – workers maybe exposed to hazards of heavy lifting, heat, ergonometric stress, noise, fugitive dust; water hazards; health hazards due to crowded accommodation in construction camp

5. ANALYSIS OF ALTERNATIVES

6.1. Without the Project Scenario

"No new action" is always an alternative and often it compares favorably in a purely economic analysis. However, there can also be significant non-economic impacts from such an approach which makes a straightforward evaluation more difficult. The present ferry crossings, ports and ferry boat stages can be maintained and used without any new action. The "no new action" alternative means that passengers and cargoes will have to bear the risk of unsafe water transport system. In addition, it is uncertain how well can the present facilities accommodate the projected increase in number of users that is expected as the economy of the Red River Delta improves. The other question is how the present facilities will be able to cope with the growing demand for enhanced environmental management. The same situation confronts the other ports for Phase 2. Without any improvement in environmental management, the ports contribution to degradation of the Red River system will parallel the increase in river traffic brought about by the growing demand for river transport. The increase in demand within the near future is a certainty given the robust economic growth of the country during the last few years. The presence of oil in some of the soil samples collected from some ports of the Red River Delta are indicators of pollution coming from the river boat traffic. Contamination can worsen if no interventions are implemented in the near future.

"No new action" preserves the existing status quo of environmental impact versus benefit, whatever that balance maybe. "It will mean foregoing the economic and environmental benefits that are expected to be derived from improving the ports, the ferry boat stages and waterways.

6.2 Environmental Considerations in Selection of Alternatives

The selection of alternatives for improvements of Corridor 3 has taken into consideration social and environmental factors. Sustainability of solution is the main factor in the decision to construct groins in some bottlenecks of Corridor 3 instead of dredging. By constructing the groynes, the need for maintenance dredging is minimized which consequently minimizes the adverse impacts of dredging.

Because of the considerable impact on the dikes, which are vital hazard mitigation infrastructures, bend improvement in Dao Nam Dinh will not be implemented, instead, waterway restrictions will be applied through aids to navigation.

To avoid the social impacts associated lifting of bridges in Corridor 3, restrictions will be imposed instead through aids to navigation.

7. FRAMEWORK ENVIRONMENTAL MANAGEMENT PLAN

This section contains the Framework Environmental Action Plan (EAP) for Phase 2 of the Northern Delta Transport Development Project. This is intended to provide the guidance in the development of the specific EMPs for Phase 2 priority ports and ferry landing stages.

The Framework EMP contains the following information for ports and ferry boat stages:

- Summary of typical environmental impacts that could occur as a result of project activities
- Identification of feasible mitigation measures
- Identification of suggested monitoring indicators including responsibilities and cost or implementation
- Overview of environment-related institutional arrangements for the project
- Overview of environmental monitoring and reporting requirements for the project

7.2 Impacts Management Strategies

There are several strategies to mitigate major negative impacts. The following strategies were employed for this report (in order of priority):

Avoid the impact. To "avoid" means to be able to change some aspect of the project design, construction, or operation such that the impact no longer occurs (e.g., changing the alignment of a road so it avoids a national park).

Minimize the impact. To "minimize" means to implement measures that will reduce impacts to acceptable levels (e.g., ensuring that construction equipment meets TCVN industrial emission standards).

Mitigate the impact. To "rectify" means to allow an impact to occur, and then afterwards take measures to rehabilitate the environment to a level whereby the impact is within acceptable limits (e.g., filling in used limed pits as part of construction clean-up).

Compensate for the impact. To "compensate" means to allow the impact to occur, then afterwards provide non-monetary compensation (first priority) or monetary compensation (second priority) for losses created by the impact (e.g., if a farmer must be resettled, the first compensation priority is to provide replacement land and housing. If replacement land and housing cannot be provided, the replacement value of losses should be calculated and provided to the farmer.).

7.3 Construction Stage

7.3.1 Impacts due to emissions and noise

The environmental management strategy for emissions and noise is basically through minimization of the source of the impact. This can be achieved by requiring that all the equipment supplied for the project complies with the Vietnamese Government standard for vehicle emission (TCVN 5939-2005). The Project Owner or its CSM contractor can require equipment supplier to submit service records of the equipment and results of emission testing.

As for stationary sources of noise and emissions such as concrete batching plants, these facilities should be located at least 200 meters from residential areas in order to comply with TCVN 5949 – 1998. In addition, plant emission will have to comply with the Vietnam Standard for Air Emission (TCVN-5939-2005). Otherwise, plant will have to to install emission control equipment

Scheduling of noisy construction activities during day time hours of 7 am to 6 pm is another way by which noise impacts are minimized.

Noise generated by construction activities should be mitigated so that the following noise limits will be attained in various receptor area.

Table 7-1. TCVN 5949 – 1998

No	Area	Period of time		
		From 6h-18h	From 18h-22h	From 22h-6h
1	Areas needed special low noise Hospitals Libraries Sanatoria Kindergartens, schools)	50	45	40
2	Residential area: (Hotels, administration offices) Houses, apartment houses, etc	60	55	50
3	Commercial and service areas	75	70	50

7.3.2 Control of Fugitive Dust

Impacts on fugitive dust during construction can be minimized. One way is by cleaning the ports' roads of accumulated dust. Imposing speed limits on construction vehicles is another good practice which can minimize fugitive dust. Covering of construction materials during transport will also help minimize fugitive dust. As for managing bare areas during the dry season, dust suppression by watering is the most common method.

To protect local residents from impacts of fugitive dusts, stockpile areas for construction materials should be located away from residential areas.

7.3.3 Impacts on soil quality due to spillage of fuel and lubricants

This impact can be avoided by not storing or conducting equipment maintenance work in the construction site. However, if storage of fuel and lubricant on site is necessary, avoidance of the impact can be achieved by having a proper fuel and lubricant depot on site. Fuel depot should be provided an impervious floor to keep spilled fuel from contaminating the soils. Observing good practices in handling fuel and filling up vehicles should contribute in minimizing fuel spillage. Proper disposal of used lubricant and oily wastes are other measures in minimizing impacts on soil contamination.

7.3.4 Impacts on surface water quality during construction

Degradation of surface water quality during construction can be minimized by implementing environmental management strategies cited in the management of soil contamination. In addition, negative impacts on river water quality can be further minimized by preventing contaminated run off. This can be achieved by proper disposal of cargo residue or spilled cargoes that have been cleaned up prior to construction. The cargo residue of coal for instance should be disposed of in sanitary landfill.

Proper management of construction wastes will also help minimize contaminated run-off. Construction wastes should be managed to minimize the volume and to prevent prolonged holding in the construction site. Segregation of wastes should be observed and that toxic waste materials should be handled properly. The discarded asbestos roofing materials in Viet Tri should be disposed of in compliance with existing guidelines. These should be disposed in authorized facilities.

In case housing is provided for construction crew, this will have to be provided with proper sanitation facilities such as a sewer system and septic tanks.

Proper stockpiling of construction materials should also be done to prevent silted run-off. During the rainy season, the stockpile of construction materials such as sand or soil fill materials should be covered or bunded to prevent silted run-off.

In case dewatering of excavation has to be done, heavily silted water should not be directly discharged into the river. It should either be passed through a siltation pond or allowed to flow into a vegetated ground to allow silt to settle.

7.3.5 Impacts on Land Acquisition

In case of land acquisition, this should be done in accordance with existing legal framework governing land acquisition, compensation and resettlement in Vietnam.

In case of temporary acquisition of land for use as construction staging area or for stockpiling of construction materials, the impacts should be mitigated by restoring the land to its original condition prior to handing back to the user.

7.3.6 Social Impacts due to presence of construction workers from outside

To minimize the impacts of temporary increase on public services, temporary housing, possible social conflicts between construction crew and local residents, hiring of members of the host community should be prioritized. In case construction crew from outside temporary housing should be provided.

7.3.7 Impacts on Public Health and Safety

Strategy for managing impacts on public health and safety should be avoidance of impacts. The construction site should be off limits to the general public. The construction site should be secured by fencing to control entry into the work site. Warning signs should be conspicuously displayed to warn the public of the on-going construction. Speed limits shall be imposed on construction vehicles when traversing residential areas.

To prevent spread of communicable diseases among construction crew and local residents, health screening of construction crews should be done.

7.3.8 Impacts on Occupational Health and Safety

Management strategy of impacts on occupational health and safety shall be avoidance. To protect and keep workers safe, the following shall be implemented:

- Workers shall be given orientation on safety procedures on job site;
- They shall be provided with personal protection equipment such as hard hat, safety shoes, ear plugs, masks when necessary, gloves and googles;
- A first aid station with a trained emergency first responder shall be provided in the construction site;
- A safety officer shall be designated to enforce safety regulations in the construction site;
- Workers shall be provided with ample clean water;
- Hygiene facilities shall be available in construction site;
- An emergency warning system shall be instituted to protect workers from site emergencies and natural hazards.
- Evacuation plan for extreme emergency conditions shall be formulated.

7.4 Operations Stage

7.4.1 Emissions and noise

Minimization of impacts shall be the environmental management strategy that shall be adopted for noise and emissions impact The vehicles and equipment used in port operations should be properly maintained with particular attention to exhaust and noise muffler. Vehicles and equipment should be tested for emission annually. The vehicles will have to comply with the Vietnamese Government standard for vehicle emission (TCVN 5939-2005). Prior to

deployment, the equipment owner will have to submit service records of the equipment and results of emission testing.

7.4.2 Fugitive Dust

Generation of fugitive dust shall be avoided and minimized through the following means:

a. Regular clean up of the roads of spilled cargoes;

b. Covering of all trucks hauling cargoes of coal, cement, construction materials and others that can cause dust emission.

c. To control coal SPM the following measures should be adopted as per IFC (2007) guidelines:

- Use of loading and unloading equipment to minimize the height of coal drop to the stockpile;
- Use of water spray systems and/or polymer coatings to reduce the formation of fugitive dust from coal storage (e.g.on stockpiles) as feasible
- Bagging of break bulk cargoes

7.4.3 Impacts on soil quality due to spillage of cargoes

The environmental management for this impact shall be minimization and avoidance. Environmental management for fugitive dust applies as well to management of impacts on soil contamination.

7.4.4 Impacts on Surface Water Quality

Impacts on surface water during port operations shall be minimized by the following measures:

- Leachate Control

Control of leachate formation is essential for Ninh Phuc and Viet Tri because these ports handle large volumes of coal and metallic ores capable of generating acidic leachate. To prevent and control leachate from coal stock pile in the ports of the NDTDP and to control fugitive dust, ports should have covered / roofed storage areas for coal. This will help reduce moisture of of coal, prevent fugitive dust, minimize spillages and minimize the need for treatment of run-off. The coal storage area is preferably a portal frame building with GI sheet roofing and half height containment wall to confine the coal.

The use of roofed coal storage area will not only have environmental benefit, but financial benefit as well as indicated by the experience of the Viet Tri Paper Company.

For other metallic ores like pyrite ore and iron ore (sulphide mineral bearing) these should be covered during the rainy season.

- Management of Oily Bilge Water

Part of the investment for Viet Tri Port and Ninh Phuc Port shall be reception facilities for oily bilge water. A tank and pump shall be stationed in the port so vessels can discharge their bilge water efficiently. The tank shall be collected regularly by a waste contractor for treatment and disposal.

- Management of Ship Solid waste and Hazardous Waste (e.g. oil stained waste)

Separate waste bins shall be provided port side. One bin for solid wastes and one bin for oil stained wastes. The bins shall be collected by the a waste contractor for disposal in the landfill.

- Sewage Management

Sewage from the port buildings shall be treated through a septic tank.

7.4.5 Aesthetics and Environmental Enhancement

To improve environmental quality, aesthetics and to provide buffers for noise, dust emissions it is recommended that trees be planted along the ports perimeter. There are a number of suitable reforestation tree species available like *Casuarina sp* that thrives well in the region.

7.4.6 Health and Safety Aspects

- Occupational Health

Workers will be exposed to ergonomic stress, hazards of operating heavy equipment, exposed to heat and high noise level. Further, the workers will be exposed to overhead conditions, such as working underwater in flowing and low visibility water condition. They will also be exposed to hazards of heavy lifting. To protect and keep workers safe, the following shall be implemented:

- Workers shall be given orientation on safety procedures on job site;
- They shall be provided with personal protection equipment such as hard hat, safety shoes, ear plugs, masks when necessary, gloves and googles;
- A first aid station with a trained emergency first responder shall be provided in the construction site;
- A safety officer shall be designated to enforce safety regulations in the construction site;
- Workers shall be provided with ample clean water;
- Hygiene facilities shall be available in construction site;
- An emergency warning system shall be instituted to protect workers from site emergencies and natural hazards.
- Evacuation plan for extreme emergency conditions shall be formulated.

For safe storage, coal piles should be piled so as to prevent or minimize the likelihood of combustion, through:

- Compacting coal piles to reduce the amount of air within the pile,
- Minimize coal storage times,
- Avoiding placement of coal piles above heat sources such as steam lines or manholes,
- Constructing coal storage structures with noncombustible materials,
- Designing coal storage structures to minimize the surface areas on which coal dust can settle and providing dust removal systems, and
- Continuous monitoring for hot spots (ignited coal) using temperature detection system. When a hot spot is detected, the ignited coal should be removed.
- Access should be provided for firefighting;

- Public Health and Safety

Protection of public health and safety should not be neglected. For this purpose the following shall be adopted:

- Construction site shall be off-limits to non-workers, warning signs shall be prominently posted along the site periphery;
- Traffic signs and other warning signs shall be posted conspicuously outside the port to warn people..
- Health screening will be done for workers to prevent spread of disease to the host community and among workers.

- Waste Management

For protection of public health and safety, more than anything else, the port should practice proper solid waste management. It shall optimize the reduction of waste, recycling and re-use of waste. Wastes generated by the port, including oily wastes and cargo residue shall be disposed in an authorized disposal site.

According to reports, Ninh Binh has an operating government funded sanitary landfill. The port authorities should seek the permission of the People's Committee of Ninh Binh to dispose port wastes into this facility.

Viet Tri on the other hand has two simple landfills that can possibly accommodate the wastes of the Viet Tri Port.

Proper management of construction waste shall also be observed. Waste minimization, recycling and reuse shall be the waste management strategy. Residuals shall be hauled off to the sanitary landfill.

7.5 Environmental Monitoring

7.5.1 Institutional Responsibilities for Environmental Monitoring and Reporting

At present, in Vietnam, the Department of Environmental Protection (NEPA) within MONRE is responsible for the national-wide environmental monitoring. A National Monitoring System set up by the former MOSTE in 1994, involved the various environmental research centres. These centres carry out monitoring of air and water quality and solid wastes in the selected areas and submit reports to NEPA. Annually, MONRE prepares "Annual Report on the State of Environment of Vietnam" based on environmental monitoring and socio-economic data. This report is presented to the Government. According to the Law and Government Decision, projects and/or companies which may have environmental problems may carry out appropriate monitoring programs during the project construction and operation under the arrangement of *"internal monitoring"*.

At provincial level, Department of Natural Resources and Environment (DONRE) is responsible for environmental management, including environmental monitoring which is referred to as *external monitoring*.

For the NDTDP, the PMU-W is responsible for undertaking internal environmental monitoring during pre-construction, construction and operation stages. The results of the internal environmental monitoring are regularly submitted to the Ministry of Transport, DONREs of the related provinces or MONRE for review.

7.5.2 Organization of Environmental Monitoring

Two types of environmental monitoring are to be implemented in the NDTDP. These are the site audit and environmental quality monitoring.

- Site Audit

Site audit mainly involves the evaluation of the implementation and effectiveness of the mitigation measures. This is conducted by the PMU or its contractor during the pre-construction, construction and operation stages.

- Environmental Quality Monitoring

The environmental quality monitoring involves the testing, analysis and evaluation of selected environmental indicators. Environmental quality and compliance with set standards are assessed by comparing results of monitoring data with relelvant Vietnamese Standards for the Environment

Agencies Involved in Environmental Monitoring Programs

The organizations involved in environmental monitoring are

- Independent Monitoring Consultant (IMC).
- Contractors
- Governmental Environmental Management Agencies (DONREs).

The independent monitoring consultant (IMC) will be engaged by the Project Management Unit of MOT. The role of the IMC is to monitor the implementation of the EMP. The IMC will submit its environmental monitoring report every 3 months to MOT and WB.

General responsibilities of the IMC are:

a. Conduct observation at the project area and assess the following aspects:

- Status of implementation of safety measures (signboards, restricted zone, fences, isolation etc.) in the construction phase.
- Status of installation of sanitary facilities at worker camps and construction sites.
- Status of waste management in the construction phase and operation phase.
- Public consultation in environmental problems produced by the project.

b. Conduct field sampling and submit samples to the laboratory for analysis

7.5.3 Environmental Quality Monitoring

Monitoring Requirement for Construction Phase

The environmental monitoring shall be carried out in two stages. The first stage shall be site audit, checklist assisted. The monitoring shall be based on visual inspection, inspection of records and interview of key informants. Instrumental / quantitative shall only be used if there are reported exceedances.

The monitoring shall be done by the Contractor under the supervision of DONRE who has jurisdiction over environmental management of provincial ports.

Monitoring for Operations

- Air Quality Monitoring

Due to the low concentrations of pollutants in the ambient air of the project sites of NDTDP, air quality will be limited to sites where there are human communities (receptors) near the port.

Monitoring will be limited to noise and suspended particulate matter (dust). The occurrence of nuisance noise and increased TSP in the atmosphere will be occasional rather than a continuous event, such that instrumental monitoring may not detect exceedance. As such alternative method shall be key informant interview. Key informants from the nearby communities shall be identified and these people shall be interviewed on a regular basis to detect any exceedance or nuisance.

The monitoring shall be done on a monthly frequency.

This constitutes as part of site audit and the monitoring should be done by the Contractor under the supervision of the DONRE.

The cost of this monitoring is subsumed in the operational cost of the Contractor.

- Surface Water Quality Monitoring

Monitoring of surface water quality during operations shall be done twice a year. Sampling location shall be one upstream of the port and one downstream of the port. The monitoring will be done by the Contractor under the supervision of the DONRE.

Parameters to be monitored are:

Parameters for Monitoring

Temperature	NO_3^-
pH	Total N
C	Total P
Salinity	Zn
Turbidity	Cr
SS	Cd
DO	Oil
Fe	As
BOD_5	Phenol
NH_4^+	Total Coliform

Cost of analysis per sample is VND1,780,000 per sample with 2 sampling points and twice a year sampling, the total annual cost is VND 7.12 million or about US$445.00

- Stream Sediment Quality Monitoring

Monitoring of sediment shall be done annually, during the dry season. Two sampling stations are to be maintained at the same sites as the surface water quality monitoring.

The parameters to be monitored are pH, Al, Fe, As, Cd, Pb, Cr and Hg. Cost of analysis per sample is VND490,000 and for 2 stations a year, the total cost per year is VND980,000 or about US$ 70.00.

7.6 Monitoring for Social Impacts - Monitoring of Resettlement Action Plan

Regular monitoring of RAP implementation will be conducted by PMU and by the International Donor (WB), as well as by an independent external monitoring agency.

Internal Monitoring

The Resettlement Department of PMU-W with the assistance of supervision consultant teams, will be responsible for internal monitoring of RAP implementation.

- *Monitoring Indicators*

The main monitoring indicators are:

- Payment of compensation to PAPs in various categories, according to the compensation policy described in the RAP,
- Public information dissemination and consultation procedures
- Adherence to grievance procedures,
- Resettlement site location, design, site construction and plot allocation
- House construction, technical assistance, payment of subsistence and shifting allowances as described in the RAP,
- Employment generation through project implementation and priority of PAP for the options offered,
- Provision of training and credit availability,
- Co-ordination and completion of resettlement activities and commencement of civil works.

Staff for Conducting Internal Monitoring

The staff of PMU-W will carry out the internal monitoring activities. They will collect information every month from the Provincial Resettlement Committees (PRCs) and District Resettlement Committees DRCs. A database of resettlement, monitoring information about the project will be maintained and updated every month.

- *Reporting*

PMU-W will submit to WB and Governmental authority a monitoring report on the progress of implementation of the RAP every six month.

Monitoring for Impacts on Occupational Health & Safety

The monitoring for occupational health and safety should be done regularly. The monitoring should cover:

- Compliance by contractor with occupational health and safety plan:
- Adherence by workers with the safety guidelines
- Use of PPE by workers, including floatation devices by those working in water
- Presence of emergency first responder
- Availability of first aid station in construction site;
- Reported number of accidents or incidents involving lost time
- The monitoring shall be implemented by PMU-W environmental staff.

7.7 Capacity Building for Environmental Management

Environmental management of inland waterway projects is a relatively new task for Vietnam Transport Sector. As such, it is essential that a capacity building for environmental management be undertaken prior to project implementation. Staff who will be involved in the implementation of the EMP should undergo training. The objective of the training is to familiarize the management staff with environmental management and procedures for environmental monitoring and reporting. The training can be conducted by one of the environmental centers involved in environmental impact assessment and environmental management.

The training will include the following components:

a. Training for DONRE staffs

The training will cover, among others, the following subject matters:

- The Environmental Management Program for Ports
- Environmental issues related with port management
- Environmental Regulations and Standards of Vietnam
- Environmental monitoring methods and procedures.
- Environmental Reporting – report preparation, interpretation of laboratory results

b. Training for Construction Engineers

The following training programs will be provided for engineers of the constructors.

- Labour Safety: Regular training on safety issues related to the riverworks and dredging;
- Environmental management Plan of the Project: Orientation of engineering staff on the environmental management plan for NDTDP Ports Management.
- Monitoring and reporting of EMP: The training will include the methodology for site observation and reporting of monitoring results.

Cost for the training activities is estimated in **Table 7-2**.

Table 7-2. Estimated Cost for Training Activities (Ninh Phuc and Viet Tri)

No	Training	Items	Estimation	Cost (VND)
1	Training for DONRE staffs (in the Pre-Construction phase)	3 above mentioned topics of training	20 people * 3 days * document preparation	25,000,000 (lump - sum)
2	Safety training (in the Construction phase)	Consultant's manpower requirement	1/2 man-month (local expert)	8,000,000
		Perdiem for 40 participants	40 people x 1days x 300,000 VND/day	18,000,000
		Other expenditures: classroom, stationery...	lump-sum	5,000,000
3	Training on environmental protection related to inland water (in the Construction phase)	Consultant's manpower requirement	1/2 man-month	8,000,000
		Per diem for 40 participants	40 people x 1days x 300,000 VND/day	12,000,000
		Other expenditures: classroom, stationery...	lump-sum	5,000,000
4	Training on environmental monitoring and reporting (in the Construction phase)	Consultant's manpower requirement	1/2 man-month	8,000,000
		Per diem for 30 participants	30 people x 1days x 300,000 VND/day	9,000,000
		Other expenditures: classroom, stationery...	lump-sum	5,000,000
	Total			**97,000,000**

7.8 Stakeholders' Responsibilities

The responsibilities and participation of the different stakeholders are enumerated in the following table:

Party	Responsibilities
Ministry of Transport (MOT)	MOT is Project owner, responsible for project management including overall environmental management. To carry out overall environment management, within MOT an Environment Management Section will be set up. The Section is in charge of guiding and supervising implementation of the EMP for this project and other project.
Project Management Unit (PMU-W)	PMU within MOT is responsible for project implementation. PMU-W responsibilities include: - Overall planning, management and monitoring of the environmental management. - Ensuring that all environmental protection and mitigation measures of environmental impacts are carried out in accordance with policies regulations on environment and other relevant laws. - Coordinating with provincial people Committees in environmental management activities. - Organizing training courses for local staff and contractor's teams on mitigation measures and safety methods (professional experts on environment shall be involved). - Carrying out internal monitoring and supervising independent monitoring, which will be contracted with other consulting services of the project. - Supervising and providing budget for monitoring activities. - Reporting on environmental information to MOT and WB. - Implement changes or adjustments according to MONRE recommendation to protect the environment according to Vietnam's standards, laws, and regulations.
Consultants	The consultant should conduct several project tasks, including: - Detailed Design - Updating of RAP and EIA report. - Preparation of bidding documents. - Carry out some EMP tasks (environmental monitoring etc.) and assist PMU-W with environmental issues during construction.
Contractors	The Contractors will be selected by PMU-W. Their responsibilities include construction / dredging works and comply with environmental management plan and guidelines stipulated in the EIA and EMP. This includes: - Implement mitigation measures; - Ensuring safety of construction workers and local people during construction. - Following Vietnam and WB policies on environmental protection during construction.
Independent Monitoring Consultant (IMC)	Independent monitoring consultant for the EMP implementation will be engaged by PMU-W to conduct the monitoring programs in 3 stages of the project. The budget for the IMC will be provided by PMU.
Ministry of Natural Resources and Environment (MONRE)	MONRE is responsible for state management on environmental issues. As part of this responsibility, MONRE will review the EIA report. During EMP implementation, MONRE requires DONREs of the related provinces to act as external regulators. Their duties will include: - Monitoring the implementation of mitigation measures for construction and operation stages. - Assess effectiveness of recommended mitigating measures in minimizing the adverse impacts.
People's Committees of 10 provinces	At provincial level the PCs will mandate the DONREs to coordinate with the MONRE on the supervision of the implementation of the environmental management plans during and after construction phase.
Project Affected	PAHs will directly participate in the PMU-W's survey programs on affected

Party	Responsibilities
Households (PAHs)	households. Through these surveys they will: 1) have the opportunity to express their requirements and concerns to the above institutions; 2) provide input to the method and units of compensation. After compensation is complete, PAHs are responsible for cooperating with the contractors to clear relevant sites in a timely manner. In order to ensure that PAHs are well informed on the project, local authorities will provide PAHs with basic knowledge on project-related activities, and the negative and positive impacts on the natural/social environment. PAHs will be able to have a role in monitoring the environmental effects of the project and the EMP performance of the contractor. PAHs will also be consulted during the project in relation to relevant environment issues. PAHs will be allowed to bring legal action to an appropriate court if the PAH considers its claim for participation or information is ignored, groundlessly refused, or if information provided by local authorities is inadequate.

Summary of Environmental Management Plan – Construction Phase Priority Ports, Ninh Phuc & Viet Tri Ports

Discipline/ Envl Component	Impact/s	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Air Quality	Increased noise level; Emission from heavy equipment; Generation of fugitive dust	Proper maintenance of equipment; Limit noisy activities during daytime hours; Trucks hauling construction materials should be covered; Limit speed; Suppression of dust with water	Monitor that diesel fuelled equipment used are properly maintained & complies with emissions standards Dust emission management Visual observation for suspended particulate (dust)	Equipment service records; Emission tests; Dust emission management plan Presence/absence of dust in the atmosphere	Contractors with approval / acceptance by DONRE Contractor	Before engagement of contractor; Annual Daily for the duration of construction	Cost is part of the project management cost Cost part of construction management	Presentation of service records should be part of conditions of contract; Implementation of EMP part of Contractor's TOR
Soils and Soils Quality	Contamination due to spillage of fuel, lubricant, leachate of construction waste dump	Observe best practices in handling fuel; Proper solid and wastewater management	Monitor the adoption of good practices; Monitor the adoption of waste management program Soil quality monitoring	Checklist for monitoring; Waste management program Pb, Cd, Hg, As, Cr, Fe, Al	Preparation of plan and program by Contractor with approval of DONRE Independent Monitoring Contractor	Before start of work; Random checking by DONRE Prior to start of work and once after completion, plus 1 contingent sampling round if confirmation needed	5 sites/port, cost of VND490,000 per sample for a total cost of VND 7,350,000 per port	Preparation of detailed environmental management plan should be included in the Contractor's condition of contract

Discipline/ Envt Component	Impacts	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Stream Sediment Quality	Construction may have adverse impact on stream sediment through spillage	Adoption of best practices for port construction Proper solid and wastewater management	Monitoring of sediment quality, 1 upstream of port and one downstream. Visual monitoring of waste management practices	pH, Pb, Cd, Hg, As, Cr, Fe, Al	Independent Monitoring Contractor	Once prior to construction, once after completion; one contingent sampling episode.	Total cost VND 490,000 x 2 stations x 3 sampling episodes = VND VND 2,940,000 per port	Part of environmental management plan for Ports
Surface Water Quality	Construction may have adverse impact on surface water quality through spillage of construction wastes, oil, fuel, etc.	Adoption of best practices for port construction Proper solid and wastewater management	Monitor compliance best practices Monitoring of water quality Visual monitoring of waste management practices	Visual monitoring of compliance & checklist method TDS, Suspended sediment, pH, Pb, C, Hg, As, Cr, Fe, Al; Phytoplankton, zooplankton and benthos	Contractor Independent Monitoring Consultant under supervision of DONRE	Visual monitoring continuing Bi-annual, low flow season and wet season. First sampling before construction	No additional cost, part of construction management 4 samples @VND1.728 million/sample = VND7.12 million	Implementation of EMP part of Contractor's TOR
Occupational Health & Safety	Exposure to construction hazards, noise, heat, ergonomic stress	Orientation PPEs First Aid stations Assignment of safety officer; Trained emergency first responded	Monitoring of compliance	Safety Guidelines; Availability and usage of equipment and safety personnel	Preparation of guidelines by Contractor under supervision of DONRE	Daily monitoring	Part of Construction management cost	Preparation and implementation of Health and Safety Plan should be part of Contractor's TOR.
Public Health	Construction may create hazardous conditions for local residents;	Provide ample warnings; Conduct consultations	Monitoring of HSE practices	HSE guidelines and plans	Plan to be prepared by Contractor, supervision by DONRE	Frequent random checks	Part of Construction management cost	HSE part of Contractors TOR

Summary of Environmental Management Plan – Operation's Phase Priority Ports, Ninh Phuc & Viet Tri Ports

Discipline/ Envt Component	Impacts	Mitigation	Monitoring	Indicators	Responsible Entity	Frequency & Timing	Cost of Monitoring	Implementation Scheme
Air Quality	Fugitive Dust & Coal SPM emission and Noise	Site clean up; Use proper loading &unloading equipment to minimize coal drop; Maintenance of equipment; Impose speed limit Bagging of break bulk cargoes (e.g. sulfur)	Monitor compliance	Site clean up plan; Actual clean up; Equipment emissions test; Maintenance record	Port Authority / owner supervision by by DONRE	Continuing	Cost is part of the port management cost	EMP integrated in port management;
Soils and Soils Quality	Contamination due to spillage of fuel, lubricant, leachate of construction waste dump; Leachate;	Observe best practices in handling fuel; Proper solid and wastewater management	Monitor adoption of good practices; adoption of waste management program	Checklist for monitoring; Waste management program Annual monitoring of soil quality	Preparation of plan and program by Port Owner with approval of DONRE	Continuing and Random checking	Cost is part of the port management cost	Preparation of detailed environmental management plan should be included in the Contractor's condition of contract
Stream Sediment Quality	Operations may have n may have adverse impact on stream sediment through spillage; Leachate	Adoption of best practices for port construction Proper solid and wastewater management	Monitoring of sediment quality, 1 upstream of port and one downstream. Visual monitoring of waste management practices	pH, Pb, Cd, Hg, As, Cr, Fe, Al	Independent Monitoring Consultant under supervision of DONRE	Annual, first is before construction	Total cost VND 490,000x2 = VND 980,000, analysis only	Part of environmental management plan for Ports

EMP Construction Phase - Continuation

Component	Impacts	Mitigation	Monitoring	Standard	Entity	Timing	Monitoring	Scheme
Surface Water Quality	Operations may have adverse impact on surface water quality through spillage of construction wastes, oil, fuel, ; leachate; ship discharge of oil waste; sewage,etc.	Roofed storage for coal; Port waste reception facilities; Proper waste management	Monitoring of water quality Monitoring of compliance with EMP	TDS, Suspended sediment, pH, Pb, Cd, Hg, As, Cr, Fe, Al; Port Envi management plan	Plan preparation by port owner; Independent Monitoring Consultant under supervision of DONRE	Bi-annual, low flow season and wet season. First sampling before construction	4 samples @VND1.728 million/sample = VND7.12 million	
Occupational Health & Safety	Exposure to hazards, noise, heat, ergonomic stress	Orientation PPEs First Aid stations Assignment of safety officer; Trained emergency first responded	Monitoring of compliance	Safety Guidelines; Availability and usage of equipment and safety personnel	Preparation of guidelines by Port operator under supervision of DONRE	Continuing Random checks	Part of Construction management cost	Include in Contractor's contract.
Public Health	Operations may create hazardous conditions for local residents;	Provide ample warnings; Conduct consultations	Monitoring of HSE practices	HSE guidelines and plans	Plan to be prepared by Port owner, supervision by DONRE	Continuing Random checks	Part of Construction management cost	

8. PUBLIC DISCLOSURE

8.1. Consultations with Stakeholder Groups

Consultations have been facilitated to date on the broad range of Project related issues primarily via Focus Group Discussions with a variety of stakeholder groups as follows:

- Project Affected Women and Men (Mixed Groups and Groups involving either just women or men), including a range of possibly severely affected displaced persons.
- People identified as being poor or vulnerable including female-headed households, the elderly and people intellectually or physically impaired.
- Mass organizations including the Fatherland Front, Vietnam Women's Union, Farmers' Association, Veterans Association, and Youth Organization.
- Local business owners ranging from smaller enterprises employing up to 5 people through to medium-sized enterprises of more than 200 employees
- Small traders, especially market-based women, and trading intermediaries that link farmers with markets
- Owners and operators of both waterways and road transport ranging from owners or operators of small minibuses through to owners or operators of large barges.
- Provincial, district and commune officials, especially those tasked with managing physical infrastructure within their jurisdiction.
- Civil society groups including NGOs and local religious organizations with a presence in or possession of knowledge relating to the specific socio-economic characteristics of the Project area.

To date 280 people (including 170 women) in have participated in these consultations and by the 30th of December it is intended that consultations will be undertaken with another 220 people. This figure does not include DP who will be consulted during the preparation of the RAP. All people who have been identified as potentially affected DP will be consulted in relation to the parameters of the Project, their entitlements and design preferences.

8.2 Consultation with Transport Officials / Port Operators

Extensive public consultation has been conducted throughout the various phases of the feasibility study to gauge the perception of key stakeholders. The primary focus of consultations with ports operators include the Provincial Department of Transport Officials and various Officials, Provincial Department of Transport Officials and port authorities from the following provinces:

Hung Yen
- Mr. Quan: Director of Hung Yen PDOT
- Mr. Nha: Vice Director of Hung Yen PDOT
- Mr. Nu: Chief of Planning and Technical Department.

Nam Dinh
- Mr Khinh: Vice Director of Nam Dinh PDOT
- Mr Mich: Chief of Planning and Technical Department

Ninh Binh
- Vice Director of Ninh Binh PDOT
- Mr Khanh: Chief of Planning and Technical Department

Hai Duong

- Mr Thang, Vice Director of Hai Duong PDOT
- Mr Phuong, Chief of Planning and Technical Department
- Mr Hiep, Deputy Chief of Traffic Management Department

Vinh Phuc

- Mr Minh, Vice Director of Vinh Phuc PDOT
- Mr Luong, Chief of Planning and Traffic Management Department

Phu Tho
- Mr Long, Officer of Planning Department PDOT

Viet Tri Port
- Mr Khanh, Director of Viet Tri Port
- Mr Chinh, Vice Director of Viet Tri Port
- Mr Thang, Deputy Director of Business Development

8.3 Formal Consultations / Workshops

Formal consultations have also been conducted for the NDTDP. The method used for the consultation is workshop. Three formal workshops have been conducted and these are the Inception Workshop (August 2007), the Interim Workshop, (December 2007) and the Final Workshop (January 28, 2008). The workshops were attended by the Ministry of Transport, Vietnam Inland Waterways Administration (VIWA), the Provincial Peoples' Committee, the port administrators, the World Bank and the consultants.

Photo 8-1. NDTDP Final Workshop, January 28, 2008, Melia Hotel.

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10 APPENDICES

Appendix 1: Location of the sampling sites and studied environmental components

Appendix 2: Water Quality of the river in the Northern Delta Nov.2007

Appendix 3: Concentration of heavy metals in water of the rivers in the Northern Delta, Nov.2007

Appendix 4: Soil Contamination at the study sites, Nov.2007

Appendix 5: Sediment Quality at the study area, Nov.2007

Appendix 6: Pesticide Contamination in Sediment at the study area, Nov.2007

Appendix 7: Water Quality of the river in the Northern Delta, Dec. 2007

Appendix 8: Heavy metal contamination river water, Dec. 2007

Appendix 9: Sediment contamination in the study area, Dec. 2007

Appendix 10: Grain sizes of the collected sediment sample, Dec. 2007

Appendix 11: The Present air quality, noise, vibration and microclimate at the study site

Appendix 12. List of recorded species of phytoplankton at some rivers in the Red River Basin in Nov., 2007

Appendix 13. Quantitative density of phytoplankton at the sampling sites

Appendix 14. List of zooplankton species composition recorded in rivers in the red river delta on November 2007

Appendix 15. Density Distribution of Zooplankton

Appendix 16. Zoo-benthos species composition recorded in rivers in the red river delta in Nov., 2007

Appendix 17: Individual quantity of zoobenthos groups at rivers in the Red River Delta (Nov.2007)

Appendix 18: Biomass of zoobenthos groups at rivers in the red river delta (Nov., 2007)

Appendix 19. Individual quantity of benthos species (Nov.,2007)

Appendix 20: Biomass of zoobenthos species (Nov.,2007)

Appendix 21. Fish of the Red River and Thai Binh River Basins

Appendix 22. List of Vegetation –NDTDP- Project Area, November 2007

Appendix 1: Location of the sampling sites and studied environmental components

	Location	Coordinate	Studied Components					
			Water	Soil	Sediment	Noise	Vibration	Aquatic organisms
VT1	Nhu Thuy landing site – Nhu Thuy – Lap Thach – Vinh Phuc province	21°19'47,4" 105°26'35,2"	X	X	X	X	X	X
VT2-Port	Viet Tri Port – Viet Tri city – Phu Tho Province	21°17'56,3" 105°26'36,6"	X	X	X	X	X	X
VT2-Lake	Viet Tri Lake – Viettri city – Phu Tho province	21°18'07,8" 105°26'05,5"	X	X	X			X
VT3	Vinh Tuong – Vinh Phuc province	21°15'08,6" 105°26'56,8"			X			
VT4	Sontay Port –Sontay city – Ha Tay province	21°09'36,5" 105°30'53,9"	X	X	X	X	X	X
VT5	Chu Phan Ferry – Vinh Phuc province	21°09'34,3" 105°38'49,1"	X	X	X			X
VT6	Hong Ha Commune – Dan Phuong District – Ha Tay province	21°09'52,9" 105°38'02,8"			X			
VT7	Phu Dong landing site – Sai Dong District – Ha Noi City	21°02'41,2" 105°57'34,0"	X	X	X	X	X	X
VT8	Trung Mau Commune – Gia Lam District- Ha Noi City	21°04'02,0" 105°59'48,5"			X			
VT9	Dai La Commune – Gia Binh District – Bac Ninh Province	21°06'00,2" 106°12'06,1"			X			
VT10	Kenh Vang Port – Luongtai District – Bac Ninh Province	21°06'58,0" 106°14'43,7"	X	X	X	X	X	X
VT11	Nam Tan Commune – Nam Sach District – Hung Yen Province	21°04'56,9" 106°19'19,9"			X			
VT12	Cong Cau Port – Hai Duong City – Hai Duong Province	20°54'46,2" 106°20'34,9"	X	X	X	X	X	X
VT13	Hiep Son Commune – Kinh Mon District – Hai Duong Povince	20°59'28,3" 106°23'21,2"			X			
VT14	Truong Tho – An Lao District – Hai Phong City	20°50'50,8" 106°33'52,0"			X			
VT15	Truong Son – An Lao District – Hai Phong City	20°51'26,0" 106°32'47,6"			X			
VT16	Ha Noi Port – Ha Noi City	20°00'28,0" 105°52'13,2"	X	X	X			X
VT17	Hong Van port – Thuong Tin District – Ha Tay Province	20°48'44,0" 105°54'54,8"	X	X	X	X	X	X

	Location	Coordinate	Studied Components					
			Water	Soil	Sediment	Noise	Vibration	Aquatic organisms
VT18	Thong Nhat – Thuong Tin District – Ha Ttay Province	20°48'44,0" 105°54'54,8"			X			
VT19	Cao Xa – Hung Yen Province	20°40'53,8" 106°02'13,1"	X	X	X			X
VT20	Quang Chau – Hung Yen town – Hung Yen Province	20°37'08,7" 106°02'59,6"			X			
VT21	An Khe – Quynh Phu District –Thai Binh Province	20°42'53,1" 106°23'41,1"			X			
VT22	Que ferry – Quynh Hoa Commune – Quynh Phu District – Thaibinh Province	20°41'55,5" 106°19'15,0"			X			
VT23	Viet Yen – Diep Nong Commune – Hung Ha District –Thai Binh Province	20°39'37,9" 106°14'04,5"			X			
VT24	Thai Binh Port – Thai Binh City – Thai Binh Province	20°27'31,9" 106°20'34,8"	X	X	X	X	X	X
VT25	Nam Dinh Port – Nam Dinh City – Nam Dinh Province	20°26'26,9" 106°12'53,8"	X	X	X	X	X	X
VT26	Nam Phong – Nam Dinh Province	20°25'49,1" 106°12'16,2"			X			
VT27	Giao Thuy – Ngo Dong – Xuan Thuy District – Nam Dinh Province	20°17'55,4" 106°25'51,5"			X			
VT28	Ninh Phuc Port – Ninh Binh City – Ninh Binh Province	20°15'03,3" 106°00'06,1"	X	X	X	X	X	X
VT29	Quan Lieu – Nghia Hung District – Nam Dinh Province	20°11'27,3" 106°11'47,3"			X	X	X	
VT30	Quan Khu – Nghia Hung District – Nam Dinh Province	20°11'33,4" 106°11'00,6"			X			
VT31	Bat Trang – An Lao District – Hai Phong City	20°51'09,7" 106°30'05,0"		X				
VT32	Trung Lap – Vinh Bao District – Hai Phong City	20°43'28,2" 106°27'53,1"		X				
VT33	Quynh Lam – Quynh Phu District – Thai Binh Province	20°41'56,8" 106°16'07,1"		X				
VT34	Lach Giang Estuary – Nam Dinh Province	20°01684'	X	X				
VT35	In front of High School Ninh Gianh – Hai Duong Province	106°20362'				X	X	
VT36	On the road 17A – Ninh Giang – Hai Duong Province					X	X	
VT37	Hai Phong port – Hai Phong City		X		X	X	X	

	Location	Coordinate	Studied Components					
			Water	Soil	Sediment	Noise	Vibration	Aquatic organisms
Location of sampling in 1.12.2007 by boat								
VW1	Duong River	$21^0$09747' $105^0$8215'			X			
VW2	Duong River	$21^0$04553' $105^0$99461'			X			
VW3	Duong River	$21^0$08213' $106^0$0746'			X			

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Hanoi. December 31 , 2007

Analytical methods USED FOR The NDTD PROJECT
(WATER, SOIL, SEDIMENT SAMPLES COLLECTED BY VESDEC TEAM IN NOV. , DEC, 2007
)

PARAMETERS	METHODS	INSTRUMENTS FOR DETERMINATION
pH	TCVN 6492:1999 US EPA 1501	pH meter Metrohm
BOD	APHA 5210B TCVN 6001:1995	VELP Scientifica
COD	APHA 5220 TCVN 6186:1996	Cintra 40 UV-Visible Spectrometer /GBC Scientific Equipment Pty Ltd / Australia and USA
CN-	apha 4500	Cintra 40 UV-Visible Spectrometer /GBC Scientific Equipment Pty Ltd / Australia and USA
Phenol	APHA 5530 C	idem
NH_4	APHA 4500 TCVN 5988-95	idem
NO_3	APHA 4500 TCVN 6180-96	idem
ΣN	APHA 4500 N	idem
ΣP	APHA 4500 P TCVN 6202-96	idem
Pb, Zn, Cr, Fe Cd, Al	APHA 3113	AAS Perkin – Elmer 3300 USA
As, Hg	APHA 3114, 3112	AAS Perkin – Elmer 3300 /MHS-10 - USA
Pesticides Organochloride	apha 6630 B	HP 5890, HP 6890 GC/ECD – USA
Oil total	apha 5200	Cintra 40, UV-Visible Spectrometer Australia
Coliform	Tcvn 4584-88	ESCO LAMINAR Flow Cabinet

Conducted by a Team of Ass. Prof. , Dr. Le Lan Anh

Signature

Assoc. Prof. Le Lan Anh
Department of Analytical Science and Technology

Air Quality Measurement

Parameter	Measurement/ analysis equipment
Humidity	Humidity Meter SK – 80 TRA (Japan)
Noise	Noise Meter ONO SOKKI (Japan)
Dust	Dust detector KANOMAX (Japan)
SO_2	TESTO 350/XL (Germany)
NO_2	TESTO 350/XL (Germany)
CO	TESTO 350/XL (Germany)
Wind speed	Wind speed meter D – 79853 (Germany)

Appendix 2: Water Quality of the river in the Northern Delta Nov.2007

No	Sampling sites		Temp. (^{0}C)	pH	TDS (mg/L)	Turbidity (NTU)	SS (mg/L)	DO (mg/L)	BOD_5 (mg/L)	NH_4^+ (mg/L)	Total N (mg/L)	NO_3^- (mg/L)	Total P (mg/L)	Total oil (mg/L)	Phenol (µg/L)	Coliform (MPN/100mL)
1	VT1		21	7.2	139	16	24	6.4	13	0.401	2.235	1.024	0.391	ND	0.124	7100
2	VT2 – Port		22	7.3	140	36	52	6.3	9	0.154	1.931	0.828	0.359	0.30	ND	1600
3	VT2 - Lake		21	7.4	147	6	12	6.4	8	0.132	0.586	0.622	0.407	0.16	0.146	1200
4	VT4		21	7.4	139	40	60	6.4	7	0.477	1.435	0.782	0.407	ND	ND	4500
5	VT5		22	7.3	131	38	58	6.2	14	0.578	1.044	1.016	0.342	0.34	0.115	2300
6	VT6		22	7.4	138	42	62	6.3	12	0.567	1.226	0.986	0.374	ND	ND	5800
7	VT7		21	7.2	140	36	54	5.8	5	0.797	1.215	1.124	0.359	0.26	0.123	1900
8	VT10		21	7.3	144	44	56	5.5	4	0.631	1.616	1.312	0.586	0.20	0.115	4800
9	VT12		22	7.0	145	28	34	4.8	8	0.683	1.934	1.546	0.668	ND	ND	3000
10	VT16		22	7.4	152	46	64	4.0	6	0.679	2.505	2.015	0.108	0.22	ND	1300
11	VT17		21	7.3	157	42	58	4.1	15	0.871	2.274	1.844	0.101	ND	ND	1600
12	VT19		20	7.4	163	50	62	4.2	7	0.592	2.824	2.124	0.101	ND	ND	2600
13	VT24		21	7.0	180	18	24	3.7	8	0.756	1.882	1.276	0.087	0.04	ND	1500
14	VT25		22	7.2	230	38	52	3.8	18	0.688	2.541	1.917	0.087	ND	ND	2700
15	VT28		21	7.6	264	42	56	4.4	9	0.672	1.692	1.322	0.456	0.68	ND	5200
TCVN 5942 – 1995		**B**	**-**	**5.5-9**	**-**	**-**	**80**	**≥2**	**<25**	**1**	**15**	**-**	**-**	**0.3**	**20**	**10.000**
		A		**6 - 8,5**	**-**	**-**	**20**	**≥ 6**	**< 4**	**0,05**	**10**	**-**	**-**	**0**	**1**	**5.000**

Appendix 3: Concentration of heavy metals in water of the rivers in the Northern Delta, Nov.2007

No	Sampling sites		Fe (mg/L)	Zn (mg/L)	Cd (µg/L)	Total Cr (µg/L)	As (µg/L)
1	VT1		0.026	0.031	0.25	4.15	13.20
2	VT2 – Port		0.028	0.042	0.30	3.98	18.97
3	VT2 - Lake		0.031	0.037	0.18	3.74	22.23
4	VT4		0.785	0.038	0.27	4.21	5.51
5	VT5		1.571	0.053	0.31	5.01	8.09
6	VT6		2.722	0.040	0.28	3.92	9.96
7	VT7		0.968	0.039	0.22	3.45	7.59
8	VT10		3.743	0.032	0.34	3.64	12.55
9	VT11		0.336	0.031	0.26	3.18	15.37
10	VT12		0.419	0.043	0.39	4.17	2.74
11	VT 13		0.985	0.035	0.30	3.29	16.09
12	VT 15		0.649	0.029	0.28	2.89	10.03
13	VT16		0.778	0.036	0.31	3.85	9.56
14	VT17		1.972	0.043	0.39	3.21	10.39
15	VT19		1.639	0.057	0.28	4.01	5.63
16	VT24		1.889	0.051	0.40	3.76	6.61
17	VT25		0.694	0.044	0.35	4.24	6.23
18	VT28		1.111	0.024	0.33	4.17	14.64
TCVN 5942-1995		**B**	**2**	**2**	**20**	**Cr (III): 1000 µg/L Cr (VI): 50 µg/L**	**100**
		A	**1**	**1**	**0,01**	**Cr (III): 100 µg/L Cr (VI): 50 µg/L**	**0,05**

Appendix 4: Soil Contamination at the study sites, Nov.2007

N	Sampling sites	pH (H_2O)	Al (%)	Fe (%)	As (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Hg (mg/kg)	Oil (mg/kg)
1	VT1	6.78	10.25	4.8307	6.40	40.79	0.63	86.47	0.26	ND
2	VT2 – Port	7.15	8.91	4.2025	7.15	43.42	0.56	64.64	0.20	8.0
3	VT2 - Lake	6.94	8.64	4.2675	5.15	64.47	0.42	71.49	0.34	23.0
4	VT4	7.13	9.72	4.3108	13.80	76.32	1.12	69.78	0.27	ND
5	VT5	7.09	7.02	3.4660	12.42	78.95	0.70	70.21	0.30	8.0
6	VT7	7.19	7.56	4.1050	11.41	60.53	0.35	70.21	0.17	12.0
7	VT10	7.13	7.83	3.2927	11.13	57.89	0.21	65.07	0.34	10.0
8	VT12	7.18	7.83	3.4335	11.50	55.26	0.56	65.92	0.32	ND
9	VT16	7.00	7.83	4.4107	16.45	68.75	0.65	69.23	0.14	ND
10	VT17	7.06	7.52	3.4826	13.22	50.27	0.31	68.20	0.21	6.0
11	VT19	7.26	7.83	4.0630	10.98	62.54	0.42	61.10	0.18	ND
12	VT24	7.04	8.10	4.0115	16.35	73.75	0.82	74.15	0.20	27.0
13	VT25	7.02	8.02	4.2580	15.21	71.24	0.34	65.20	0.14	6.0
14	VT28	6.98	8.10	2.9025	11.18	36.25	0.32	45.26	0.15	12.0
15	VT31	6.90	5.94	2.8108	12.71	28.75	0.32	41.17	0.13	ND
16	VT32	7.15	8.91	3.6826	11.76	71.05	0.56	68.07	0.21	ND
17	VT33	7.01	9.18	3.3610	14.22	66.25	0.82	67.89	0.10	15.0
Dutch Standard (Reference value)					29	85	0.80	100	0.3	

Appendix 5: Sediment Quality NDTDP study area, Nov.2007

N	Sampling sites	pH	Al (mg/kg)	Fe (mg/kg)	As (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cr (mg/kg)	Hg (mg/kg)	Oil (mg/kg)
1	VT1	7.36	10.44	41623.24	9.68	0.47	49.62	67.14	0.17	ND
2	VT2 – Port	7.22	5.94	35201.76	12.43	0.98	51.32	56.08	0.46	ND
3	VT2 – Lake	7.21	5.46	37431.21	11.26	1.05	53.19	62.21	0.15	ND
4	VT3	7.21	9.18	45491.50	16.36	1.02	69.74	68.92	0.24	ND
5	VT4	7.22	9.45	42675.36	15.58	0.26	110.53	71.06	0.21	ND
6	VT5	7.35	10.80	39642.60	16.32	1.46	106.58	75.34	0.32	ND
7	VT6	7.50	5.67	29569.48	10.89	1,13	34.21	59.50	0.41	ND
8	VT7	7.61	6.48	30435.98	11.73	1.32	47.37	58.22	0.12	ND
9	VT8	7.56	6.21	36826.46	9.24	0.76	39.47	57.36	0.25	ND
10	VT9	7.66	6.48	21121.06	8.32	0.42	31.58	52.23	0.62	ND
11	VT10	7.51	9.18	36501.52	13.07	0.92	76.32	66.78	0.15	ND
12	VT11	7.60	7.63	39317.66	9.39	0.38	64.47	69.35	0.23	ND
13	VT12	7.49	9.45	38776.09	10.76	0.66	90.79	73.20	0.62	ND
14	VT13	7.51	8.10	35743.33	9.67	0.51	75.00	68.07	0.34	ND
15	VT14	7.57	9.18	38667.78	12.54	1.82	82.89	68.92	0.28	ND
16	VT15	7.51	8.91	38992.72	12.29	0.84	77.63	70.63	0.37	ND
17	VT16	7.30	6.48	34811.24	9.90	0.65	50.00	54.58	0.29	30.00
18	VT17	7.46	6.08	31254.12	13.24	1.28	36.42	64.10	0.53	ND
19	VT18	7.38	5.87	32869.68	14.01	0.97	37.98	58.71	0.42	ND
20	VT19	7.32	7.56	31000.15	11.27	1.05	58.75	49.26	0.24	ND
21	VT20	7.41	6.06	33215.38	15.17	1.25	60.45	50.30	0.35	ND
22	VT21	7.28	10.53	48291.73	12.01	0.82	71.38	75.13	0.28	ND
23	VT22	7.50	9.13	41256.41	10.21	0.79	70.24	71.48	0.19	ND
24	VT23	7.33	9.72	42922.33	11.92	0.94	81.25	85.46	0.33	ND
25	VT24	7.57	8.91	37227.11	8.78	0.39	75.00	70.26	0.16	ND
26	VT25	7.56	9.45	34201.48	11.39	0.79	65.00	66.03	ND	ND
27	VT26	ND	ND	ND	ND	ND	ND	ND	ND	48.00
28	VT27	7.51	10.26	47491.45	14.66	1.51	83.75	86.34	0.57	ND
29	VT28	7.42	9.45	32115.36	6.22	0.28	33.75	42.19	0.61	ND
30	VT29	7.53	6.75	30642.24	5.21	0.73	31.25	41.67	0.22	ND
31	VT 30	7.3	7.75	38624.42	6.12	0.57	29.52	37.76	0.19	ND

Appendix 6: Pesticide Concentration in Sediments of the NDTDP study area, Nov.2007

N	Pesticide (Organo-chlorines)	Analytical Method	Unit	Result				
				VT4	VT10	VT12	VT15	VT30
1	Alfa-BHC	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
2	Gamma-BHC	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
3	Beta-BHC	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
4	Delta-BHC	EPA8081A	µg/Kg	1.1	0.5	0.5	0.5	0.8
5	Heptachlor	EPA8081A	µg/Kg	0.5	< 0.4	0. 4	0.2	0.5
6	Aldrine	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
7	Heptachlorepoxide	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
8	α- Chlordan	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
9	β- Chlordan	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
10	4,4'-DDE	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
11	Endosulfan 1	EPA8081A	µg/Kg	0. 3	< 0.1	0. 1	0.2	<0.1
12	Dieldrine	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
13	Endrine	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
14	4,4'-DDD	EPA8081A	µg/Kg	< 0.1	< 0.1	0. 3	< 0.1	< 0.1
15	Endosulfan 2	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
16	4,4'-DDT	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
17	Methoxylchlor	EPA8081A	µg/Kg	0.3	0.5	0.8	0.5	0.6
18	Endirn aldehyde	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
19	Endosulfan sulfate	EPA8081A	µg/Kg	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

1. *Analysis of all collected water, soil and sediment samples was conducted in the analytical laboratory of the Institute of Chemistry – National Academy of Sciences and Technology, November 2007*
2. *ND: non detectable*
3. *Location of sampling sites: see Table 3.8.*

Appendix 7: Water Quality of the rivers in the Northern Delta, Dec. 2007

N	Sampling sites	pH	TDS (mg/L)	Turbidity (NTU)	SS (mg/L)	DO (mg/L)	BOD_5 (mg/L)	NH_4^+ (mg/L)	Total N (mg/L)	NO_3^- (mg/L)	Total P (mg/L)	Total oil (mg/L)	Phenol (µg/L)	Coliform (MPN /100mL)
1	VW 11	7.1	150	48	60	5.8	10	0.218	2.169	1.712	1.635	ND	ND	1,500
2	VW 13	7.1	175	33	45	5.3	5	0.242	3.678	2.536	2.059	0.12	ND	700
3	VW 15	7.2	255	55	75	4.5	5	0.316	9.155	4.722	1.467	0.15	ND	800
4	VT 34	7.8	18,500	19	25	6.2	10	0.352	7.357	3.968	0.328	ND	ND	900

Appendix 8: Heavy metal contamination river water, Dec. 2007

N	Sampling site	Cd (µg/l)	Cr (µg/l)	Zn (mg/l)	Fe (mg/l)	As (µg/l)
1	11	0.26	3.18	0.031	0.336	15.37
2	13	0.30	3.29	0.035	0.985	16.09
3	15	0.28	2.89	0.029	0.649	10.03
4	VT 34	0.35	3.05	0.033	0.325	12.05

Appendix 9: Sediment contamination in the study area, Dec. 2007

N	Sampling Site	Cr (mg/kg)	Pb (mg/kg)	Fe (%)	Cd (mg/kg)	As (mg/kg)	Al (%)	Hg (mg/kg)	pH
1	VW 1	17.562	29.33	1.995	0.65	7.25	3.037	0.15	7.25
2	VW 3	27.652	32.45	2.595	0.55	8.25	4.307	0.23	7.52
3	VW 5	19.386	26.45	1.645	0.4	6.08	2.885	0.10	7.16
4	VW 6	26.764	27.62	1.715	0.75	6.85	3.240	0.25	7.46
5	VW 7	22.487	28.55	1.856	0.89	7.56	3.240	0.18	7.09
6	VW 8	31.836	25.64	1.964	0.45	7.25	3.585	0.19	7.25
7	VW 9	28.568	36.25	2.625	0.95	8.78	2.970	0.25	7.10
8	VW 11	42.726	67.97	5.704	0.3	11.88	7.560	0.20	7.14
9	VW 14	38.272	64.56	5.422	0.65	12.56	8.370	0.15	7.16
10	VW 15	46.868	52.35	4.795	1.05	10.42	7.155	0.2	7.10
11	VW 34	22.424	30.65	1.962	1.15	8.05	3.510	0.32	6.83

Appendix 10: Grain sizes of the collected sediment sample, Dec. 2007

TT	Site	Coarse Sand (%)	Fine Sand (%)	Clay (%)	Limon (%)
1	VT 16	11.67	76.99	5.82	5.52
2	VT 19	0.12	91.06	4.86	3.96
3	VT 23	4.11	63.69	8.16	24.04
4	VT 24	0.16	61.22	6.18	32.44
5	VT 25	0.49	74.45	2.56	22.50
6	VT 27	0.09	52.45	9.94	37.52
7	VT 28	5.30	67.50	11.00	16.20
8	VT 29	5.28	85.52	4.38	4.72
9	VT 5	64.00	32.22	1.98	1.80
10	VT 11	0.79	41.01	18.52	39.68
11	VT 1	65.75	28.80	2.15	3.30
12	VT 2 - port	61.20	35.15	2.40	1.25
13	VT 4	25.10	66.05	4.50	4.35
14	VT 12	10.50	70.55	7.85	11.10

Notes: - VW 5 and VW 11: collected in December 2007

- Other samples: collected in November 2007

Appendix 11: The air quality, noise, vibration and microclimate at the study site

N	Site Location	T (°C)	R. Humidity (%)	Wind speed (m/s)	TSP mg/m³	PM10 mg/m³	SO_2 mg/m³	NO_2 mg/m³	CO mg/m³	Noise dBA	Vibration dBA		
											L_X	L_Y	L_Z
1.	Phu Dong Port – Gia Lam – Hanoi city	18.5	80	3,0	0,16	0.05				67,8	32,8	30,1	39,3
2.	Kenh Vang Port – Luong Tai – Bac Ninh Province	19.5	75	2.5	0,19	0.10	0,181	0,035	1,024	60,2	27,4	29,9	36,6
3.	Cong Cau Port - Tuky commune, Haiduong Provine	22,2	75	1.5	0,04	0.02	0,057	0,053	1,035	56,8	25,9	22,8	31,5
4.	In front of High School Ninh Giang – Ninh Giang – Hai Duong Province	21.5	74	1.2	0,03	0.01	0,158	0,061	0,256	67,5	21,0	20,3	36,4
5.	On the road 17A, beside Ninh Giang People Committee – Hai Duong province	21.0	70	1.5	0,01	0.01	0,109	0,025	0,512	53,7	20,0	21,1	30,7
6.	Hai Phong port – Haiphong city	19.2	75	2.0	0,07	0.03	0,257	0,038	1.041	61,1	43,9	48,7	32,0
7.	Thai Binh Port - Thaibinh province	18.5	85	1.8	0,18	0.05	0,206	0,023	0,768	68,7	30,2	31,3	46,6
8	Nam Dinh Port - Nam Dinh province	20.0	85	1.8	0,09	0.03	0,193	0,022	0,504	58,8	21,2	22,1	30,9
9	Dong An - Nghia Lac - Nghia Hung - Nam Dinh Province	20.5	80	1.5	0,27	0.11	0,286	0,092	0,760	65,6	39,1	43,5	44,4
10	Ninh Phuc Port - Ninh Binh Province	21.2	78	2.1	0,13	0.05	0,202	0,026	0,258	60,3	21,6	22,4	21,7
11	Hong Van Port - Hong Van - Thuong Tin District - Ha Tay Province	19.5	81	1.2	0,02	0.01	0,237	0,047	0,763	75,8	69,9	69,1	64,5
12	Sontay Port – Sontay city – Hatay Province	20.0	75	1.5	0,01	0.01	0,118	0,028	0,531	67,4	23,5	25,2	38,3
13	Nhu Thuy landing site – Nhu Thuy – Lap Thach – Vinh Phuc province	21.5	78	1.2	0,01	0.01	0,095	0,024	0,259	54,4	24,7	24,1	32,2
14	Viet Tri Port – Viet Tri City – Phu Tho Province	24.3	75	1.8	0,12	0.03	0,161	0,053	0,266	52,4	28,9	31,9	25,1
15	TCVN 5937 : 2005				0.3	-	0.35	0.20	30	60 TCVN 5949:1998			

Source: ***VESDEC – SINTEP, Dec, 2007***

- *Sampling duration: 60 minute*
- *The Vietnamese Standard (TCVN 5937 - 2005) for PM10 (24h average) is 0.15 mg/m³.*
- *The Vietnamese Standard for Noise at residential, administrative area = 60dBA in day time (6 am – 6 pm) at mixed residential and commercial area = 75 dBA in day time.*
- *The Vietnamese Standard for vibration caused by construction activity at residential, administrative area = 75 dB (7 am – 7 pm)*

Appendix 12. List of recorded species of phytoplankton at some rivers in the Red River Basin in Nov., 2007

No.	Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Phylum BACILLARIOPHYTA														
	Order Discinales														
	Family Coscinodiscaceae														
1	*Melosira varians* Ag														
2	*Melosira granulata* Ralfs	+	+	+	+	+	+	+			+		+		+
3	*Melosira granulata var. angutissima*		+	+								+			
4	*Melosira islandica*				+	+	+	+			+				+
5	*Melosira distans* Kutzing		+										+		
6	*Cyclotella stelligera*		+		+	+	+	+			+				+
	Family Achnanthaceae														
7	*Cocconeis placentula Ehr*		+	+								+	+		
	Family Fragilariaceae														
8	*Synedra acus* Kutz		+		+	+	+	+	+	+	+	+	+	+	+
9	*Synedra. ulna (Mitzsch)* Ehr.		+		+	+	+	+	+	+	+		+	+	+
10	*Synedra ulna (Nitzsch) Ehr var biceps (kg)* Schonf.		+							+			+		
11	*Fragillaria. virescens* Ralfs.											+			
12	*Fragillaria construens* Grunow												+		
	Family Tabelariaceae														
13	*Diatoma elongatum Ehr*	+		+	+	+	+	+		+	+		+		+
	Family Naviculaceae														
14	*Navicula radiosa*		+												
15	*Navicula placentula Grun*	+		+	+	+	+	+	+	+	+	+	+	+	
16	*Navicula placentula fo. lanceolata*		+	+	+					+		+	+		
17	*Navicula placentula f. rostrata*	+		+						+					
18	*Navicula. gracillis* Ehr	+		+											
19	*Navicula. gastrum*	+		+											
20	*Amphora hendeyi*		+			+	+	+			+		+		+
21	*Cymbella turgida* Clever			+			+				+	+			
22	*Cymbella. naviculiformis*			+						+		+			
23	*Cymbella. parva* Clever		+												
24	*Cymbella ventricosa* Kutz		+	+											
25	*Cymbella. tumida*			+						+			+		

No.	Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14
26	*Gomphonema sphaerophorum* Ehr	+	+	+						+			+		
27	*Gomphonema. olivaceum* Ehr	+	+	+	+	+	+	+		+	+				+
28	*Gyrosigma attenuatum*		+		+	+	+	+			+				+
	Family Nitzschiaceae														
29	*Nitzschia recta Hantsch*			+	+	+	+	+	+	+	+	+	+	+	+
30	*Nitzschia. filiformis Hust.*				+	+	+	+			+		+		+
31	*Nitzschia. philippinarum Ehr*			+						+		+			
32	*Nitzschia. nianensis*								+			+		+	
	Family Surirellaceae														
33	*Surirella robusta Ehr*				+	+	+	+	+		+			+	+
	Phylum CHLOROPHYTA														
	Order Chlorococcales														
	Family Hydrodictyaceae														
34	*Pediastrum. simplex var. simplex*								+					+	
35	*Schroederia Setigera (Schroder)* Lemm											+			
36	*Tetraedron gracille (Reinsch)* Hansg								+			+		+	
	Family Scenedesmaceae														
37	*Crucigenia tetrapedia (Kirchner)* W&G West					+	+	+			+				+
38	*Crucigenia. rectangularis*											+			
39	*Scenedesmus. obiquus*								+			+		+	
40	*Scenedesmus. ellipsoideus* Chodat								+			+		+	
	Order Zygnematales														
	Family Zygnemataceae														
41	*Spirogyra ionia*	+		+								+	+		
42	*Spirogyra. prolifica*	+		+									+		
	Family Mesotaeniaceae														
43	*Gonatozygon aculeatum Hast.*											+			
	Family Desmidisceae														
44	*Closterium. moniliferum (Bory)* Ehr											+			
45	*Closterium. porectum*				+	+	+	+			+				+
46	*Cosmarium sportella* Ehr											+			
	Order Ulotrichales														
	Family Ulotricaceae														

No.	Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14
47	*Ulothrix zonata (Schmide)* Bohlin	+	+	+						+					
	Phylum CYANOBACTERIA														
	Order Chroococcales														
	Family Chroococcaceae														
48	*Mycrosystis aeruginosa*	+		+											
	Bộ Nostocales														
	Family Nostocaceae														
49	*Anabaena viguieri*											+			
	Family Oscillatoriaceae														
50	*Lyngbya putealis*								+					+	
51	*Lyngbya birgei* G.M.S.Smith								+			+		+	
52	*Oscilllatoria limosa Ag*		+	+	+	+	+	+		+	+	+	+		+
53	*Oscilllatoria. planetomica*														
54	*Oscilllatoria. formosa* Bory		+	+	+	+	+	+			+		+		+
55	*Oscilllatoria. princeps*	+		+						+			+		
56	*Spirulina princeps* W& G.S.West				+	+	+	+			+				+
57	*Phormidium. tenue*											+			
	Phylum EUGLENOPHYTA														
	Order Euglenales														
	Family Euglenaceae														
58	*Euglena acus* Ehr			+	+	+	+	+			+	+			+
59	*Euglena. gaumei*					+	+	+			+				+
60	*Euglena. hemichromata*				+							+			
61	*Euglena. caudata*											+			
62	*Euglena. rostifera nsp.*				+			+							
63	*Leptocylyndrus wangi*											+			
64	*Phacus. longicauda*											+			
65	*Phacus. acuminatus*											+			
66	*Strombomonas. fluviatilis var. ettlii*											+			
		13	19	25	20	20	12	21	12	16	21	31	20	12	19

Source: VESDEC and IEBR, Nov.2007

Appendix 13. Quantitative density of phytoplankton at the sampling sites

No.	Sampling locations	Density (cell/l)				
		Total density	Bacillario-phyta	Chlorophyta	Cyanobac-teria	Euglено-phyta
1	Nhu Thuy Port	3,798	964 (25)	737 (19)	2,097 (56)	0
2	Viet Tri Port	2,494	1,701 (69)	283 (11)	510 (20)	0
3	Viet Tri Lake	4,705	1,757 (37)	794 (17)	2,041 (44)	113 (2)
4	Sontay Port	2,834	1,417 (50)	113 (4)	1,134 (40)	170 (6)
5	Chu Phan Port	2,778	1,474 (53)	283 (10)	907 (33)	113 (4)
6	Phu Dong Port	1,928	397 (21)	1,021 (53)	510 (26)	0
7	Kenh Vang Port	2,664	1,474 (55)	283 (11)	737 (28)	170 (6)
8	Cong Cau Port	1,928	397 (21)	1,021 (53)	510 (26)	0
9	Hanoi Port	2,438	1,531 (62)	283 (12)	624 (26)	0
10	Hong Van Port	3,004	1,587 (53)	283 (9)	1,020 (34)	114 (4)
11	Hung Yen Port	2,721	1,361 (51)	283 (10)	964 (35)	113 (4)
12	Nam Dinh Port	2,948	1,701 (58)	510 (17)	737 (25)	0
13	Thai Binh Port	1,928	397 (21)	1,021 (53)	510 (26)	0
14	Ninh Phuc Port	2,721	1,361 (51)	283 (10)	964 (35)	113 (4)

Note: value in bracket show percent rate (percentage)

Appendix 14. List of zooplankton species composition recorded in rivers in the red river delta on November 2007

No	Taxon	Nhu Thuy Port	Viet Tri Port	Viet Tri Lake	Sontay Port	Chu Phan Port	Phu Dong Port	Kenh Vang Port	Cong Cau Port	Hanoi Port	Hong Van Port	Hung Yen Port	Thai Binh Port	Nam Dinh Port	Ninh Phuc Port
	Phylum Arthropoda														
	Class CRUSTACEA														
	Subclass COPEPODA														
	Order Calanoida														
	Family Diaptomidae														
1	*Mongolodiaptomus birulai* (Rylop)	+		+	+	+	+	+	+	+	+	+	+	+	+
2	*Phyllodiaptomus tunguidus* Shen et Tai	+	+	+	+	+	+	+	+	+	+	+	+	+	
3	*Neodiaptomus handeli* (Brehm)											+	+	+	
	Family Paracalanidae														
4	*Paracalanus crassirostris Dahl**														+
	Order Cyclopoida														
	Family Cyclopidae														
5	*Mesocyclops leuckarti* (Claus)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
6	*Microcyclops varicans* (Sars)	+	+	+	+		+	+	+	+	+	+	+	+	+
7	*Thermocyclops hyalinus* (Rehberg)		+	+	+	+	+	+		+	+	+		+	+
8	*Thermocyclops taihokuensis* (Harada)					+	+				+				
9	*Eucyclops serrulatus* (Fischer)									+	+				
10	*Limnoithona sinensis* (Burckhardt)														+
	Subclass BRANCHIOPODA														
	Order Cladocera														
	Family Bosminidae														
11	*Bosmina longirostris* (O. F. Muller)							+							+
12	*Bosminopsis deitersi* Richard	+	+	+											+
	Family Sididae														
13	*Diaphanosoma sarsi* Richard			+	+	+	+	+	+	+	+		+	+	+
14	*Diaphanosoma excisum* Sars	+	+					+				+			
15	*Diaphanosoma leuchtenbergianum* Fischer		+	+	+		+		+	+	+				+

	Family Daphniidae														
16	*Moinodaphnia macleayii* (King)				+				+				+		+
17	*Moina dubia* de Guerne et Richard	+	+	+	+	+	+	+	+	+	+	+	+	+	+
18	*Daphnia lumholtzi* Sars		+	+											
	Family Chydoridae														
19	*Euryalona orientalis* (Daday)										+				
	Phylum NEMATHELMINTHES														
	Class ROTATORIA														
	Order Monogononta														
	Family Asplanchnidae														
20	*Asplanchna sieboldi* (Leydig)		+	+	+	+	+	+	+	+	+	+	+		+
	Family Brachionidae														
21	*Brachionus quadridentatus Hermann*			+											
22	*B. falcatus* Zacharias								+						
23	*B. calyciflorus* Pallas			+		+									
24	*Platyias quadricornis* (Ehrenberg)			+											
	Others														
25	Insecta larvae		+	+	+	+	+	+		+	+	+	+	+	
26	crustacean lavae	+	+	+	+		+		+		+		+	+	+
27	Amphipoda										+				
	Total	**9**	**12**	**16**	**12**	**10**	**12**	**11**	**11**	**11**	**15**	**11**	**11**	**10**	**15**

Note: * : Brackish water species

Appendix 15. Density Distribution of Zooplankton

Zooplankton group / Locations	Copepoda Ind./m^3 (%)	Cladocera Ind./m^3 (%)	Rotatoria Ind./m^3 (%)	Total density con/m^3
Nhu Thuy Port	72 (63)	42 (37)	0 (0)	114
Viet Tri Port	66 (38)	96 (55)	12 (7)	174
Viet Tri Lake	1950 (53)	1260 (34)	480 (13)	3,690
Sontay Port	360 (71)	90 (18)	60 (12)	510
Chu Phan Port	180 (67)	60 (22)	30 (11)	270
Phu Dong Port	456 (87)	48 (9)	18 (4)	522
Kenh Vang Port	570 (73)	180 (23)	30 (4)	780
Cong Cau Port	96 (55)	54 (31)	24 (14)	174
Hanoi Port	540 (91)	36 (6)	20 (3)	596
Hong an Port	648 (92)	42 (6)	18 (3)	708
Hung Yen Port	492 (92)	24(4)	18 (3)	534
Nam Dinh Port	828 (93)	48 (5)	12 (1)	888
Thai Binh Port	564 (97)	18 (3)	0 (0)	582
Ninh Phuc Port	126 (46)	144 (52)	6 (2)	276

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Appendix 16. Zoo-benthos species composition recorded in rivers in the red river delta in Nov., 2007

No.	Taxon	Nhu Thuy Port	Viet Tri Port	Viet Tri Lake	Son Tay Port	Chu Phan Port	Phu Dong Port	Kenh Vang Port	Cog Ccau Port	Ha Noi Port	Hong Van Port	Hung Yen Port	Thai Binh Port	Nam Dinh Port	Ninh Phuc Port
	Phylum Mollusca														
	I. Class Bivalvia														
	1. Family Corbiculidae														
1	*Corbicula bocourti* Morlet								+		+				
2	*Corbicula messageri* Bav.et.Dautz	+											+		
3	*Corbicula moreletiana* (Prime)	+					+					+	+		+
	2. Family Solennidae														
4	*Pharella sp.**														+
	3. Họ Mytilidae														
5	*Limnoperna siamensis* (Morelet)		+						+						+
	4. Family Unionidae														
6	*Nodularia douglasiae crassidens* Hass						+								
	II. Lớp Thân mềm Chân bụng-Gastropoda														
	5. Family Ampullariidae														
7	*Pomacea canaliculata* (Lamarck)														+
	6. Family Bithyniidae														
8	*Bithynia fuchssiana*														+
9	*Parafossarulus striatulus* (Benson)														+
10	*Allocinma longicornis* (Benson)														+
	7. Family Planorbidae														
11	*Hippeutis umbilicalis* (Benson)							+							
	8. Family Stenothyridae														

12	*Stenothyra messageri* Bavey et Dautzenberg														+
	9. Family Thiaridae														
13	*Melanoides tuberculatus* (Muller)			+					+	+					+
14	*Tarebia granifera* (Lamarck)									+					
15	*Thiara scabra* (Muller)									+					
	10. Family Viviparidae														
16	*Angulyagra boettgeri* (Heude)			+											+
17	*Angulyagra polyzonata* (Frauenfeld)		+												
18	*Sinotaia aeruginosa* (Reeve)			+											
	Phylum Arthropoda														
	III. Class Crustacea														
	Order DECAPODA														
	Suborder MACRURA														
	11. Family Palaemonidae														
19	*Macrobrachium hainanense* Parisi		+	+	+	+	+	+	+	+	+				
	Suborder BRACHYURA														
	12. Family Grapsidae														
20	*Sesarma sp.**								+						
	Total	2	3	4	1	1	3	2	5	4	2	1	2	1	10

Note: * : brackish water species

Appendix 17: Individual quantity of zoobenthos groups at rivers in the Red River Delta (Nov.2007)

Locations	Zoobenthos groups			
	Bivalvia	Gastropoda	Crustacea	Total
Nhu Thuy Port	4			4
Viet Tri Port		3	2	5
Viet Tri Lake		22	9	31
Sontay Port			6	6
Chu Phan Port			3	3
Phu Dong Port	2		1	3
Kenh Vang Port		1	1	2
Cong Cau Port	1	3	2	6
Hanoi Port		188	4	192
Hong Van Port	1		2	3
Hung Yen Port	1			1
Nam Dinh Port	8			8
Thai Binh Port	0	0	0	0
Ninh Phuc Port	15	10		25
Total	**32**	**227**	**30**	**289**

Appendix 18: Biomass of zoobenthos groups in the Red River delta (Nov., 2007)

Trạm	Zoobenthos groups			
	Bivalvia	Gastropoda	Crustacea	Total (g)
Nhuthuy Port	2.5			2.5
Viettri Port		1.5	0.3	1.8
Viettri Lake		16.8	0.9	17.7
Sontay Port			0.5	0.5
Chuphan Port			0.2	0.2
Phudong Port	6.4		0.6	7
Kenhvang Port		0.01	1	1.01
Congcau Port	0.7	0.9	0.21	1.81
Hanoi Port		54.3	0.9	55.2
Hongvan Port	0.9		3	3.9
Hungyen Port	0.2			0.2
Namdinh Port	2.2			2.2
Thaibinh Port	0	0	0	0
Ninhphuc Port	25.6	7.42		33.02
Total (g)	**32**	**227**	**30**	**289**

Appendix 19. Individual quantity of benthos species (Nov.,2007)

Species	Locations														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Allocinma longicornis														1	1
Angulyagra boettgeri			2											1	3
Angulyagra polyzonata		1													1
Bithynia fuchsiana														2	2

Species	Locations														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Corbicula bocourti								1		1					2
Corbicula messageri	3											1			4
Corbicula moreletiana	1					1					1	7		13	23
Hippeutis umbilicalis							1								1
Limnoperna siamensis		2						2						1	5
Macrobrachium hainanense		2	9	6	3	1	1	1	4	2					29
Melanoides tuberculatus			2					1	9					1	13
Nodularia douglasiae crassidens						1									1
Parafossarulus striatulus														1	1
Pharella sp.														2	2
Pomacea canaliculata														1	1
Sesarma sp.								1							1
Sinotaia aeruginosa			18												18
Stenothyra messageri														2	2
Tarebia granifera									99						99
Thiara scabra									80						80
Total	**4**	**5**	**31**	**6**	**3**	**3**	**2**	**6**	**192**	**3**	**1**	**8**	**0**	**25**	**289**

Appendix 20: Biomass of zoobenthos species (Nov.,2007)

Species	Locations														Total (g)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Allocinma longicornis														1	0.5
Angulyagra boettgeri			2											1	3
Angulyagra polyzonata		1													1
Bithynia fuchsiana														0	0.3
Corbicula bocourti								1		1					1.6
Corbicula messageri	1											1			1.7
Corbicula moreletiana	1					1					0	2		25	29.4
Hippeutis umbilicalis							0								0.01
Limnoperna siamensis		1						0						0	1.3
Macrobrachium hainanense		0	1	1	0	1	1	0	0.9	3					7.41
Melanoides tuberculatus			3					1	2.3					0	5.6
Nodularia douglasiae crassidens						6									5.6
Parafossarulus striatulus														1	0.6
Pharella sp.														0	0.2
Pomacea canaliculata														4	4.1
Sesarma sp.								0							0.2
Sinotaia aeruginosa			13												12.5
Stenothyra messageri														0	0.02
Tarebia granifera									38						37.8
Thiara scabra									14						14.2
Total (g)	3	2	18	1	0	7	1	2	55	4	0	2	0	33	127.04

Appendix 21. Fish of the Red River and Thaibinh River Basins

Adapted from Phan Mach, Institute of Ecology and Biological Resources, Dec. 2007

N	Vienamese Name	Scientific Names	Nhuệ R	Cầu River	Red River	Thái - bình R	Note
	Bộ cá Trích	**Clupeiformes**					
	Họ cá lành canh	**Engraulidae**					
1	Cá lành canh	*Coilia grayii* Richardson	+	+	+	+	Economic
	C. Mßi cê hoa	*Clupanodon thrissa* (Linnaeus, 1758) **Red Book (V)**			+	+	Economic
	Họ cá Ngần	**Salangidae**					
2	Cá Ngần to	*Salanx chinensis* (Osbeck)	+	+	+	+	
	Bộ cá Chép Mỡ	**Characiformes**					
	Ho Characid	**Charracidae**					
3	Cá chim trắng nước ngọt	*Colosoma brachypomum* **	+	+	+	+	
	Bộ cá Chép	**Cypriniformes**					
	Họ Chép	**Cyprinidae**					
4	Cá Mại	*Rasbora cephalotaenia* (Bleeker, 1852)		+	+	+	
5	Cá Cháo	*Opsariichthys bidens* Gunther, 1873		+	+	+	
6	Cá Lòng tong	*Opsariichthys hieni* Tu		+	+	+	
7	Cá Trắm đen	*Mylopharyngodon piceus* (Rich.)	+	+	+	+	
8	Cá Trắm cỏ (trắm trắng)	*Ctenopharyngodon idellus* (C&V)* *	+	+	+	+	
9	Cá Măng	*Elopichthys bambusa* (Rich)		+			
10	Cá Nhồng Măng	*Luciobrama macrocephalus* (Lac.)		+	+	+	
11	Cá Trắm đen	*Mylopharyngodon piceus* (Rich)		+	+	+	
12	Cá Chày	*Squaliobarbus curriculus* (Rich., 1846) **Red Book (T)**	+	+	+	+	
13	Cá Ngão gù	*Culter flavipinnis* Tirant, 1883	+	+	+	+	
14	Cá Thiểu	*Cultrichthys erythropterus* (Basilewsky)	+	+	+	+	
15	Cá Mương	*Hemiculter leucisculus* (Bas., 1853)	+	+	+	+	Economic
16	Cá Dầu hồ	*Toxabramis hotayensi* Hao *nov. sp*		+	+		
17	Cá vền dài	*Megalobrama terminalis* (Richardson,1846)	+	+	+	+	Economic
18	Cá vền	*M. skolkovii* Dybowsky,1872		+	+	+	
19	Cá dầu mỏng	*Pseudohemiculter dispar* (Peters,1880)		+	+	+	
20	Cá Mại bạc	*Rasborinus formosae* Oshima, 1920 (Metzia)		+	+	+	
21	Cá Mại sọc	*R. lineatus* Pellegrin, 1907 (Metzia)	+	+	+	+	
	Cá Mại	*R. cephalotaenia steineri* (N&P)	+				

N	Vienamese Name	Scientific Names	Nhuệ R	Cầu River	Red River	Thái - bình R	Note
22	Cá mần	*Xenocypris davidi* Bleeker, 1871		+			
23	Cá Nhàng bạc	*Xenocypris argentea* Gunther,1868		+	+	+	
24	Cá Đục ngộ	*Hemibarbus medius* Yue, 1995		+			
25	Cá Đục chấm râu	*Microphysogobio labeoides* (N.& P., 1927)		+	+	+	
26	Cá Đục chấm mõm ngắn	*M. yunanensis* (Yao & Young, 1977)		+			
27	Cá Đục đanh chấm mõm dài	*M. vietnamica* Yen,1978		+			
28	Cá Đục đanh đốm	*Saurogobio dabryi* Bleeker,1871		+			
29	Cá Đục trắng	*Squalidus chankaensis* (Dybowsky, 1827)		+			
30	Cá Đục râu	*Gobiobotia kolleri* (Ban. & Nal., 1966)		+			
31	Cá Thè be râu	*Acheilognathus barbatulus* (Gun., 1873)		+	+	+	
32	Cá Thè be thường	*A. tonkinensis* (Vaillant, 1892)	+	+	+	+	
33	Cá Bướm chấm	*Rhodeus ocellatus* (Kner, 1876)	+	+			
34	Cá Bướm giả	*R. vietnamensis* Yen, 1978		+			
35	Cá Dầm	*Puntius brevis* (Bleeker, 1850)	+	+	+	+	
36	Cá Đòng đong	*Capoeta semifasciolata* (Gunther,1868)	+	+	+	+	
37	Cá Chày đất	*Spinibarbus hollandi* (Oshima, 1919)		+	+	+	
38	Cá Bỗng	*S. denticulatus* (Oshima,1926)		+	+	+	Economic
39	Cá Sinh	*Onychostoma gerlachi* (Sauvager & Dobry,1874)		+	+	+	Economic
40	Cá Sinh gai	*O. laticeps* (Gunther, 1896) **Red Book (V)**		+			
41	Cá Mọm	*S. acanthopterus* (Fowler,1934)		+			
42	Cá gỗ	*Neolissochilus blanci* Pell. & Fa., 1940		+			
43	Cá trôi ấn	*Labeo rohita* (Hamilton)**	+	+	+	+	
44	Cá mrigan	*Cirrhinus mrigala***	+	+	+	+	
45	Cá Trôi	*Cirrhinus molitorella* (Cuv.& Val., 1842)**	+	+	+	+	
46	Cá Dầm đất	*Osteochilus salsburyi* (N. & P., 1927)	+	+	+	+	
47	Cá Đo	*Garra pingi* (Tchang, 1929)		+			
48	Cá Sứt mũi	*G. bourreti* (Pellegrin, 1828)		+			
49	Cá Mè hoa	*Hypophthalmichthys nobilis* (Rich,1845)**	+	+	+	+	
50	Cá Mè trắng	*Hypophthalmichthys molitrix* (Valiennes,1844)**	+	+	+	+	
51	Cá Rưng	*Carrasioides cantonensis cantonensis* (Heincke)	+	+	+	+	
52	Cá Diếc	*Carassius auratus* (Linnaeus, 1758)	+	+	+	+	
53	Cá Chép	*Cyprinus carpio* (Linnaeus, 1758)**	+	+	+	+	
54	Cá Chèn	*C. melanes* (Yen,1978)		+			
55	Cá tép dầu	*Ichskauina macrolepis hainamensis* (N&P)	+	+	+	+	
	Họ chạch	**Cobitidae**					
56	Cá Chạch bùn	*Misgurnus anguillicaudatus* (Can.,1842)	+	+	+	+	Economic

N	Vienamese Name	Scientific Names	Nhuệ R	Cầu River	Red River	Thái - bình R	Note
57	Chạch đá	*Barbatula fasciolatus* (N&P)	+				
58	Chạch đá đuôi đỏ	*B. caudofurea* (Yen)	+				
59	Cá Chạch hoa	*Cobitis cf. sinensis* (S & D,1874)		+	+	+	
60	Cá Chạch hoa	*C. yeni* Tu, 1986		+			
	Bộ cá nheo	**Siluriformes**					
	Họ lăng	**Bagridae**					
61	Cá Lăng	*Hemibagrus elongatus* (Giinther) **Red Book (V)**			+		
62	Cá Bò	*Pelteobagrus fulvidraco* (Rich., 1846)	+	+			
63	Cá Mịt	*P. virgatus* (Oshima, 1926)		+			
64	Cá Mịt tròn	*Elteobagrus kyphus* Yen,1978	+	+			
	Họ cá Ngạnh	**Cranoglanididae**					
65	Cá Ngạnh	*Cranoglanis henrici* (Vaillant,1893)		+	+	+	
	Họ nheo	**Siluridae**					
66	Cá Nheo	*Silurus asotus* Linnaeus, 1758	+	+	+	+	
67	Cá Thèo	*S. cochinchinensis* (Val., 1840)	+	+	+	+	
	Họ trê	**Clariidae**					
68	Cá Trê trắng	*Clarias batrachus* (Linnaeus, 1758)		+	+	+	Economic
69	Cá Trê đen	*Clarias fuscus* (Lacepede)	+	+	+	+	Economic
70	Cá Trê vàng	*Clarias macrocephalus* Gunther, 1864		+	+	+	
71	Cá Trê lai (trê Phi)	*Clarias gariepinus* (Burchell, 1815)**	+	+	+	+	
	Bộ mang tấm	**Synbranchiformes**					
	Họ lươn	**Synbranchidae**					
72	Lươn	*Monopterus albus* (Zuiew, 1703)	+	+	+	+	Economic
	Họ chạch sông	**Mastacembelidae**					
73	Cá Chạch sông	*Mastacembelus armatus* Lacepede, 1800	+	+	+	+	
	Họ bống trắng	**Gobiidae**					
74	Cá Bống đá	*Rhynogobius giurinus* (Rutte,1897)	+	+	+	+	
75	Cá Bống đá khe	*R. leavelli* (Herre, 1935)		+			
76	Cá Bống cát	*Glossogobius giuris* (Hamilton, 1822)	+	+	+	+	
77	Cá Bống mắu mắt	*G. biocellatus* (C. & V.,1837)		+			
	Họ Bống đen	**Eleotridae**					
78	Cá Bống suối đen tối	*Eleotris fusca* Bloch & Schneider, 1801	+	+	+		
79	Cá Bống mọi	*E. melanosoma* Bleeker, 1852		+		+	
80	Cá Bống đen nhỏ	*E. oxycephala* Tem. & Schl., 1845	+	+	+	+	
81	Cá Bống suối đầu ngắn	*Philypnus chalneersi* (N. & P., 1927)		+			
	Bộ cá vược	**Perciformes**					

N	Vienamese Name	Scientific Names	Nhuệ R	Cầu River	Red River	Thái - bình R	Note
	Họ Rô phi	**Cichlidae**					
82	Cá Rô phi vằn	*Oreochromis niloticus* (Linnaeus, 1758) **	+	+	+	+	
83	Cá Rô phi đen	*O. mossambicus* Peters, 1880 **	+	+	+	+	
84	Cá Rô phi đỏ	*Oreochromis niloticus* & *O. aureus***		+	+	+	
	Họ cá Mú	**Pereichthyidae**					
85	Cá Rô mo thường	*Coreoperca whiteheadi* (Boul., 1869)	+				
	Họ rô đồng	**Anabantidae**					
86	Cá Rô đồng	*Anabas testudineus* (Bloch, 1722)	+	+	+	+	Economic
	Họ cá cờ	**Osphronemidae**					
87	Cá cờ	*Macropodus opercularis* (L., 1788)	+	+	+	+	
	Họ sặc	**Belontidae**					
88	Cá Sặc bướm	*Trichogaster trichopterus* (Pallas, 1770)	+	+	+	+	
	Họ chuối	**Channidae**					
89	Cá Xộp	*Channa striata* (Bloch, 1793)	+	+	+	+	Economic
90	Cá Chuối suối	*Ch. orientalis* (Ham. & Bloch, 1822)	+	+			
91	Cá Chuối hoa	*Ch. maculatus* (Lacepede)	+	+			
92	Cá Trèo đồi	*Ch. asiatica* (Linaeus)	+				
	Bộ cá Sóc	**Cyprinodontiformes**					
	Họ sóc	**Adrianichthyidae**					
93	Cá Sóc	*Oryzias sinensis* (Chen & Uwa., 1989)		+	+	+	
94	Cá sóc	*O. latipes*	+	+			
	Họ cá bơn	**Bothidae**					
95	Cá Bơn	*Tephrinectes sinensis* (Lacepede, 1802)	+				
			53	89	64	62	

Notes : Species: cultured species

English names

Vietnamese name	English name	***Scientific name***
Bộ cá thát lát		*Osteoglossiformes*
Họ cá thát lát	Featherbacks	*Notopteridae*
Cá that lác (+)	Bronze featherback	*Notopterus notopterus (Pallas, 1780)*
Cá còm - (++)	*Clown featherback*	*Notopterus chitala (Hamilton - Buchanan, 1822)*
Bộ Cá Chình	Eels **	*Anguilliformes*
Họ Chình	Freshwater eels	*Anguillidae*
Cá chình (+++)	Giant mottled eel	*Anguilla marmorata Quoy & Gaimard, 1824*
Bộ cá chép	Minnows and Carps	*Cypriniformes*
Họ chép	Minnows and Carps	*Cyprinidae*
Trắm cỏ (++)	Grass carp	*Ctenopharyngodon idellus (Cuvier & Valenciennes, 1844)*
Cá măng	Yellow cheek (++)	*Elopichthys sp*
Cá chày mắt đỏ	Barbel chub (+) (++)	*Squaliobarbus curriculus (Richardson, 1846)*
Cá mương	Sharp belly (+)	*Hemiculter leucisculus (Basilewsky, 1855)*
Cá thiểu = cá ngão = ngô	Predatory carp (+) (++) (+++)	*Culter flavipinnis Tirant, 1883*
Trôi ấn độ	Rohu (+)	*Labeo rohita (Hamilton, 1822)*
Cá Trôi trắng	Vietnamese mud carp (++)	*Cirrhina molitorella (Valencienes, 1844)*
Mè trắng VN (+)	Vietnamese silver carp	*Hypophthalmichthys harmandi Sauvage,1844*
Cá Rưng=cá nhưng	(++) (+++)	*Carassioides acuminatus (Richardson, 1846*
Cá diếc (+)	Crucian carp (++) (+++)	*Carassius auratus gibelio (Bloch, 1783)*
Cá chép (+)	Common carp (++) (+++)	*Cyprinus carpio Linnaeus, 1758*
Cá mại cá sỉnh (++)	Laticep carp	*Onychostoma spp*
Cá dộp (cá Bỗng)	Denti carp (++)	*Spinibarbichthys denticulatus Oshima, 1926*
Cá xả lửa (*cá hỏa*)= *ho lieng=cá ruuồng*	Tonkin carp (+++)	*Labeo tonkinensis Pellegrin & Chevey, 1936*
Cá niên	(+)	*Onychostoma ovale Pellegrin & Chevey, 1936*
	(+)	*Onychostoma ovalis rhomboides Tang, 1942*

Cá lúi sọc	Bony lipped barb (++)	*Osteochilus schlegeli (Bleeker, 1851)*
Cá Cận (+)	Chinese barb (++)	*Puntius semifasciolatus*
Cá sóc (trà sóc)	*Jullien's golden, price carp (+)*	*Probarbus jullieni (Sauvage, 1880)*
Cá sứt môi	Vietnamese mud carp (+++)	*Garra poilanei*
Cá cóc (++)	Soldier river barb	*Cyclocheilichthys enoplos (Bleeker, 1850)*
Cá nun =Nu=Nung=rầm xanh (++)	Lemas carp	*Bangana lemassoni (Pellegrin & Chevey, 1936) Altigena lemassoni Pellegrin et Chevey, 1936*
Cá Cầy	??	*Cyclocheilichthys furcatus Sontirat, 1985*
	??	*Cyclocheilichthys repasson (Bleeker, 1853)*
Dền =dềnh =vền (+)	*Black amur bream*	*Sinibrama affinis (Vaillant, 1892) Megalobrama terminalis (Richardson, 1845)*
Cá mát=mác 2 loài	*(++)*	*Onychostoma ovale Pellegrin & Chevey, 1936 cá niên*
		Onychostoma ovalis rhomboides Tang, 1942 cá niên
Cá Khóa	*(++)*	*Tor stracheyi (Day, 1871)*
Cá trèn (+, ++)	*Butter catfish***	*Ompok bimaculatus (Bloch, 1797)*
Họ cá bám đá	River Loaches **	*Balitoridae*
Cá bám đá		*Sewellia lineolata Valenciennes, 1842*
Họ Chạch (+++)	Loaches	*Cobitidae*
Họ Lăng	Bagrid catfishes	*Bagridae*
Cá lăng chấm (+++)	Spotted catfish **	*Hemibagrus elongatus (Gunther, 1864)*
Họ Cá Ngạnh	Cranoglanids **	*Cranoglanididae*
Cá Ngạnh (++ và +++)	Cranoglanidid catfish	*Cranoglanis henrici (Vaillant, 1893)*
	Cranoglanidid	*Cranoglanis bouderius (Richardson, 1896)*
		Cranoglanis sinensis Peters, 1880
Họ Chiên	Sisorid catfishes **	*Sisoridae*
Cá Chiên (+++)	Giant bagarius, Goonch	*Bagarius yarreli Sykes, 1838*
		Pseudecheneis sulcatus (McClelland, 1842
Họ Trê	Breathing catfishes **	*Clariidae*

Cá Trê đen (+++)	Black catfish	*Clarias fuscus (Lacepede, 1803)*
Họ cá Úc		*Arridae*
Cá núc (cá úc) (+++)	Giant catfish **	*Arius thalassinus (Ruppell, 1835)*
		Cranoglanis henrici (Vaillant, 1893) ???
	Swamp eels and Spiny eels **	*Synbranchiformes Flutidae*
Họ lươn		
	Swamp eels **	*Synbranchidae*
lươn (+++)	Swamp eel	*Monopterus albus (Zuiew, 1793)*
		Fluta alba (Zuiew, 1793)
Họ chạch sông	Spiny eels **	*Mastacembelidae*
Con chạchchạch lá tre(+++)	*Peacock eel***	*Mastacembelus taeniagaster (Fowler, 1935) Mastacembelus aculeatus (Block, 1878)*
cá lấu=láu=Cá láo cá chạch bông (+++)	Zing - Zang eel **	*Mastacembelus taeniagaster (Fowler, 1935) Mastacembelus armatus (Lacepede, 1800)*
Cá chạch bùn (+++)	Loach	*Misgurnus anguillicaudatus (Cantor, 1842)*
Họ Bống	Gobies (+++)	*Gobiidae*
Cá Bống tượng (bống mú) (++)	*Sand goby, Marbled sleeper*	*Oxyeleotris marmorata (Bleeker, 1852)*
Cá bống cát (++)	Ganetic tank goby	*Glossogobius giuris (Hamilton, 1822)*
Họ cá Rô Phi họ cá vược		*Cichlidae*
Rô Phi đen (++)	Mozambique cichlid	*Oreochromis mossambicus (Peters, 1852)*
Họ cá rô	Climbing perches (++) (+++)	*Anabantidae*
	Common climbing perch	*Anabas testudineus (Bloch1792)*
cá rô đồng (++)	anabas	
Họ đối	Mullets	*Mugilidae*
Đối (++)	Blue tailed mullet (++) (+++)	*Liza seheli* (Forsskal, 1775)
Họ cá Tra		*Pangasiidae*
Cá bông lau (++ và +++)		*Pangasius krempfi*
Họ cá vược		*Cichlidae*
Cá mõm heo-mõm trâu=	(+++)	*Bangana lemassoni (Pellegrin & Chevey, 1936)*
Họ chuối cá quả	Snakeheads (+++)	*Channidae Ophiocephalidae*
Cá trầu (cá chuối hoa) (++)	Snake - head mullet	*Ophiocephalus maculatus (Lacépède, 1802)*
Họ nheo		*Siluridae*
Cá leo	Walla catfish **	*Wallagonia attu (Schneider, 1801)*

Cá niết=cá thèn=cá chèn cá trèn bầu	*sheatfish ** Butter catfish*	*Pterocryptis cochinchinensis (Valenciennes, 1840) Ompok bimaculatus (Bloch, 1797)*
Họ cá Vược		*Cichlidae*
Cá vược = dược cá chẽm (++)	White seabass, Giant seaperch, Siver seaperch (++)	*Lates calcarifer (Bloch, 1790)*
Họ khác khong rõ	Other species (do not have official Vietnamese names)	
Chạt=chạc=cháo=quạc	(++)	*Opsariichthys bidens Gunther, 1873*
Cá sặc vện (hường vện) (+++)- Họ rô biển/Nandidae	Gangetic leaffish (++)	*Nandus nandus (Hamilton, 1822)*
Cá còm - (++) Họ thát lác/Notopteridae	*Bronze featherback () Clown featherback*	*Notopterus notopterus (Pallas, 1769) Notopterus chitala (Hamilton - Buchanan, 1822)*
sặc rằn - Họ cá sặc/Belontiidae	*Snake skin gourami (++)*	*Trichogaster. trichopterus (Pallas, 1770)*

Appendix 22. List of Vegetation –NDTDP- Project Area, November 2007

No	Location	English Name	Latin Name
1	**Location 1:** Lo river at Cao Phong, Triệu Đề - Lập Thạch – Vĩnh Phúc Province (VT1) **Coordinate** 21°19'47,4" 105°26'35,2"	Corn	Zea mays L.
		bamboo	Bambusa arundinacea
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Weed	Saccharnm spontaneum L.
		China tree	Melia azdarach
		Datura	Datura motel L.
		Manioc	Manihot esculunta crantz
		Kudzu	Pueraria Montana
		Brush	
2	**Location 2:** Lo river at Việt Trì – Phú Thọ Province (VT 2 Port) **Coordinate:** 21°17'56,3"105°26'36,6"	Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Burweed	Sida sp.
		Ecalyptus	Eucalyptus sp
		Khaya Senegal	
		Brush	
3	**Location 2:** Lo river at Việt Trì Lake – Phú Thọ Province (VT 2 lake) **Coordinate:** 21°18'07,8" 105°26'05,5"	Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Wild cotton	Gossyplium sp
		Sensitive plant	Mimosa pudiea
		Wild pineapple	Pandanus sp
		Brush	
4	**Location 3**: Lo river at Vĩnh Tường – Vĩnh Phúc Province (VT 3) **Coordinate:** 21°15'08,6" 105°26'56,8"	Corn	Zea mays L.
		Manioc	Manihot esculunta crantz
		Bamboo	Bambusa arundinacea
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
5	**Location 4:** Red River at Vĩnh Tường Ferry – Vĩnh Tường – Vĩnh Phúc Province (VT 4) **Coordinate:** 21°09'36,5" 105°30'53,9"	Bamboo	Bambusa arundinacea
		Corn	Zea mays L.
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		China tree	Melia azdarach
		Ecalyptus	Eucalyptus sp
		Mulberry	Morus alloa L.
		Banana	Musa paradisiacal L.
6	**Location 5:** Red river at Chu Phan Ferry – Vĩnh Phúc Province (VT 5) **Coodinate:** 21°09'34,3" 105°38'49,1"	Sweet-potato	Ipomoea batas (L.) poir
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Corn	Zea mays L.
		Banana	Musa paradisiacal L.
		Bamboo	Bambusa arundinacea
		Brush	
7	**Location 6:** Red river at Liên Hà, Đan Phượng, Vĩnh Phúc Province (VT 6)	Banana	Musa paradisiacal L.
			Canavalia sp
		Corn	Zea mays L.
		Apple	Rhamnacea
		Burmuda grass	Cynodon dactylon (L.) Pers.

No	Location	English Name	Latin Name
	Coordinate:	Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
	21^{0}09'52,9"	Weed	Saccharnm spontaneum L.
	105^{0}38'02,8"	Manioc	Manihot esculunta crantz
		pumpship	Cucurlita dactylon (L.) pers.
		Cockscomb	Celosia agentea L.
			Muntingia calabura
8	**Location 7**: Đuống river at Phù Đổng – Sài Đồng – Hà Nội City (VT 7)	Corn	Zea mays L.
		Banana	Musa paradisiacal L.
		Manioc	Manihot esculunta crantz
	Coordinate:	Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
	21^{0}02'41,2"	Weed	Saccharnm spontaneum L.
	105^{0}57'34,0"		
9	**Location** 8: Đuống river at Làn Small village, Trung Mầu Commune – Gia Lâm District – Hà Nội City (VT 8)	Corn	Zea mays L.
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Fern	Polypodiophyta
	Coordinate:		
	21^{0}04'02,0"		
	105^{0}59'48,5"		
10	**Location 9:** Đuống river at Đại La – Gia Bình – Bắc Ninh Province (VT 9)	China tree	Melia azdarach
		Corn	Zea mays L.
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
	Coordinate:	Weed	Saccharnm spontaneum L.
		Fern	Polypodiophyta
	21^{0}06'00,2"	Bamboo	Bambusa arundinacea
	106^{0}12'06,1"	Sensitive plant	Mimosa pudiea
11	**Location 10:** Đuống river - Kênh Vang port – Hải Dương Province (VT 10)	Bamboo	Bambusa arundinacea
		Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Sensitive plant	Mimosa pudiea
	Coordinate:	Papaw	Caryca papaya L.
		Soybean	Canavalia sga
	21^{0}06'58,0"		Muntingia calabura
	106^{0}14'43,7"		Khaya Senegal
12	**Location 11:** Kinh Thay river at Nam Tân – Nam Sách – Hưng Yên Province (VT 11)	Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Corn	Zea mays L.
	Coordinate:	Bamboo	Bambusa arundinacea
		Banana	Musa paradisiacal L.
	21^{0}04'56,9"	Mulberry	Morus alloa L.
	106^{0}19'19,9"		Khaya Senegal
		Sensitive plant	Mimosa pudiea
		Brush	
13	**Location 12:** Thai Binh river at Cống Câu port – Hải Dương City (VT 12		Ficus hispida
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
	Coordinate:	Weed	Saccharnm spontaneum L.
	20^{0}54'46,2"	Water hyacinth	Eichornia crassipes
	106^{0}20'34,9"	Apple	Rhamnacea

No	Location	English Name	Latin Name
		Brush	
14	**Location 13:** Kinh Thay river at Hiệp Sơn – Kinh Môn – Hải Dương (VT 13) **Coordinate:** 20°'59'28,3" 106°23'21,2"	Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Ecalyptus	Eucalyptus sp
		Guava	Psidium guajcus
		Longan	Dimocarpus longan
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Water hyacinth	Eichornia crassipes
15	**Location 14:** Lach Tray river at Trường Thọ - An Lão – Hải Phòng City (VT 14) **Coordinate:** 20°'50'50,8" 106°33'52,0"	Corn	Zea mays L.
		Ecalyptus	Eucalyptus sp
		Guava	Psidium guajcus
		Longan	Dimocarpus longan
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Water hyacinth	Eichornia crassipes
16	**Location 15:** Lach Tray river at Liễu Giai Small Village – An Lão – Hải Phòng City (VT 15) **Coordinate:** 20°'51'26,0" 106°32'47,6"	Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
		Apple	Rhamnacea
		Banana	Musa paradisiacal L.
		Mango	Mangifera indie
		Malabar almond	Terminalia Catappa L
		Guava	Psidium guajcus
			Muntingia calabura
		Water hyacinth	Eichornia crassipes
17	**Location 16**: Red river at Ha Noi Port – Ha Noi City (VT 16) **Coordinate:** 20°00'28,0" 105°52'13,2"		Coloeasia sp
			Ficus hispida
		Casuarina	Casuarina equiseti folia
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
18	**Location 17:** Red river at Hồng Vân Port – Văn Giang – Hưng Yên Province (VT 17) Coordinate: 20°48'44,0" 105°54'54,8"	Ecalyptus	Eucalyptus sp
		Malabar almond	Terminalia Catappa L
		Sensitive plant	Mimosa pudiea
		fig	Ficus racemosa
			Ficus hispida
		China tree	Melia azdarach
		Corn	Zea mays L.
		Banana	Musa paradisiacal L.
		Bamboo	Bambusa arundinacea
19	**Location 18:** Red river at Tân Châu Ferry – Hưng Yên Province (VT 18) **Coordinate:** 20°'48'44,0" 105°54'54,8"	China tree	Melia azdarach
		Apple	Rhamnacea
		Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Ecalyptus	Eucalyptus sp
			Khaya Senegal
			Muntingia calabura
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.

No	Location	English Name	Latin Name
		Weed	Saccharnm spontaneum L.
20	**Location 19:** Red river at Cao xá – Hưng Yên Province (VT 19) **Coordinate:** 20^0'40'53,8" $106^0$02'13,1"	Corn	Zea mays L.
		China tree	Melia azdarach
		Sweet-potato	Ipomoea batas (L.) poir
		Longan	Dimocarpus longan
		Banana	Musa paradisiacal L.
		Brush	
		Catus	Eupluorbia antia
		Wild pineapple	Pandanus sp
		Ecalyptus	Eucalyptus sp
		Malabar almond	Terminalia Catappa L
		Sensitive plant	Mimosa pudiea
21	**Location 20:** Red river Be small village – Quảng Châu Commune – Hưng Yên Town – Hưng Yên Province (VT 20) Coordinate: 20^0'37'08,7" $106^0$02'59,6"	Mulberry	Morus alloa L.
		Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Fern	Polypodiophyta
			Coloeasia sp
		Ecalyptus	Eucalyptus sp
		China tree	Melia azdarach
		Wild pineapple	Pandanus sp
		Sweet-potato	Ipomoea batas (L.) poir
		Wild pineapple	Pandanus sp
		Ecalyptus	Eucalyptus sp
		Malabar almond	Terminalia Catappa L
		Sensitive plant	Mimosa pudiea
22	**Location 21:** Luoc river at An Khê –Quỳnh Phụ - Thái Bình Province (VT 21) **Coordinate:** 20^0'42'53,1" $106^0$23'41,1"	Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Bamboo	Bambusa arundinacea
		China tree	Melia azdarach
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
23	**Location 22:** Luoc river at Đò Quế - xã Quỳnh Hoa –Quỳnh Phụ - Thái Bình Province (VT 22) **Coordinate:** 20^0'41'55,5" $106^0$19'15,0"	Banana	Musa paradisiacal L.
		Bamboo	Bambusa arundinacea
		China tree	Melia azdarach
		Corn	Zea mays L.
		Burmuda grass	Cynodon dactylon (L.) Pers.
			Muntingia calabura
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
24	**Location 23:** Luoc river at Việt Yên – Điệp nông – Hưng Hà - Thái Bình Province (VT 23) **Coordinate:** 20^0'39'37,9" $106^0$14'04,5"	Corn	Zea mays L.
		Ecalyptus	Eucalyptus sp
		Bamboo	Bambusa arundinacea
		Sugar cane	Saccharum officianarum L.
		China tree	Melia azdarach
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
25	**Location 24:** Tra Ly river at Thái Bình Port – Thái Bình	Apple	Rhamnacea
		fig	Ficus racemosa
		Ecalyptus	Eucalyptus sp

No	Location	English Name	Latin Name
	Province (VT 24) **Coordinate:** 20^0'27'31,9" $106^0$20'34,8"	Brush	
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon aciculatus (Rety.) Trin.
26	**Location 25:** Red river at old ferry of Tân Đệ bridge - Nam Định Province (VT 25) **Coordinate:** 20^0'26'26,9" $106^0$12'53,8"	China tree	Melia azdarach
		Banana	Musa paradisiacal L.
		Flamboyant	Delmin regia
		Indian taro	Alocasia odora (Rosela) C.Kocle
		Papaya	Carica papaya L.
		Bamboo	Bambusa arundinacea
		Bamboo	Bambusa arundinacea
		Ecalyptus	Eucalyptus sp
			Amaranthus
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon aciculatus (Rety.) Trin.
		Weed	Saccharum spontaneum L.
27	**Location 26:** Red river at Nam Phong Confluence – Nam Định Province (VT 26) **Coordinate:** 20^0'25'49,1" $106^0$12'16,2"	Corn	Zea mays L.
		Sensitive plant	Mimosa pudica
		Wild pineapple	Pandanus sp
			Ficus hispida
			Coloeasia sp
		Banana	Musa paradisiacal L.
		Perilla	Perilla frutescen
		Ecalyptus	Eucalyptus sp
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
28	**Location 27:** Day river at Ngô Đồng – Xuân Thủy – Nam Định Province (VT 27) **Coordinate:** 20^0'17'55,4" $106^0$25'51,5"	Casuarina	Casuarina equiseti folia
		Wild pineapple	Pandanus sp
		Bamboo	Bambusa arundinacea
		Apple	Rhamnacea
		China tree	Melia azdarach
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
29	**Location 28:** Day river at Đình Quang Port – Ninh Bình Province (VT 28) **Coordinate:** 20^0'15'03,3" $106^0$00'06,1"	Wild pineapple	Pandanus sp
		Water hyacinth	Eichornia crassipes
		Ecalyptus	Eucalyptus sp
		Brush	Khaya Senegal
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
30	**Location 29:** Day river at Quần Liêu small village - Nghĩa Hưng – Nam Định Province (VT 29) **Coordinate:** 20^0'11'27,3" $106^0$11'47,3"	Bamboo	Bambusa arundinacea
		China tree	Melia azdarach
		fig	Ficus racemosa
			Ficus hispida
			Khaya Senegal
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.

No	Location	English Name	Latin Name
31	**Location 30:** Ninh Co river at Quần Khu small village - Nghĩa Sơn – nghĩa Hưng – Nam Định Province (VT 30) **Coordinate:** 20°11'33,4" 106°11'00,6"	Tropical fruit similar to lichee	Baccourea ramiflcra lour
		Bamboo	Bambusa arundinacea
		China tree	Melia azdarach
		Sargasso	Paederig cousi
			Momordica coclim clinemis (Lour) Spreng
		Banana	Musa paradisiacal L.
		Casuarina	Casuarina equiseti folia
		Loopah	Liyfa cylindrica
		Pomelo	Citrus grandis (L.) oslo
		Longan	Dimocarpus longan
32	**Location 31:** Lach Tray river at Bát Trang – An Lão – Hải Phòng City (VT 31) **Coordinate:** 20°51'09,7" 106°30'05,0"	Corn	Zea mays L.
		Banana	Musa paradisiacal L.
		Bamboo	Bambusa arundinacea
		Longan	Dimocarpus longan
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
33	**Location 32:** Lach Tray river at Trung lập – Vĩnh Bảo – Hải Phòng City (VT 32) Coordinate: 20°43'28,2" 106°27'53,1"	Ecalyptus	Eucalyptus sp
		Catus	Eupluorbia antia
		Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Bamboo	Bambusa arundinacea
		Water hyacinth	Eichornia crassipes
		Sensitive plant	Mimosa pudiea
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.
34	**Location 33:** Luoc river at Quỳnh Lâm Ferry – Quỳnh Lâm – Quỳnh Phụ - Thái Bình province (VT 33) Coordinate: 20°41'56,8" 106°16'07,1"	Banana	Musa paradisiacal L.
		Corn	Zea mays L.
		Bamboo	Bambusa arundinacea
		Malabar almond	Terminalia Catappa L
		Spinach	Ipmoea aqua
		Guava	Psidium guajcus
		Manioc	Manihot esculunta crantz
		Kudzu	Pueraria Montana
		Brush	
		Burmuda grass	Cynodon dactylon (L.) Pers.
		Chrysopogon	Chrysopogon acculatus (Rety.) Trin.
		Weed	Saccharnm spontaneum L.

Notes: - Latin names of the recorded vegetation species provided by Dr. Nguyen Khac Khoi, professor and senior botanist of the Vietnam Academy of Natural Sciences & Technology