THE SOCIALIST REPUBLIC OF VIETNAM
MINISTRY OF TRANSPORT
PROJECT MANAGEMENT UNIT OF WATERWAYS

World Bank

NORTHERN DELTA TRANSPORT DEVELOPMENT PROJECT (NDTDP)

CORRIDOR 3
Day – Ninh Co junction Canal and crossing bridge (DNC)

ESIA
Environment and Social Impact Assessment – Vol 1

CNR ENGINEERING In association with VIPO

August 2016

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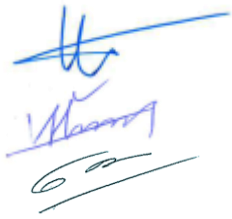
Done by :	F.PRESSIAT (CNR) PHAM ANH TUAN (VIPO) HA VIET HUNG (VIPO)	February 2016	
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

General Abbreviations

CEO:	Contractor Environmental Officer
CNR:	Compagnie Nationale Du Rhône
CSC:	Construction Supervision Consultant
CST:	Construction Supervision Team
DMDP:	Dredged Materials Disposal Plan
DONRE:	Department of Natural Resources and Environment
ESIA:	Environment and Social Impact Assessment
EMP:	Environmental Management Plan
HSO:	Health and Safety Officer
MDTIDP:	Mekong Delta Transport Infrastructure Development Project
MOH:	Ministry of Health
MONRE:	Ministry of Natural Resources and Environment
MOT:	Ministry of Transport
NDSO:	Nam Dinh Statistics Office
NDTDP:	Northern Delta Transport Development Project
NBSO:	Ninh Binh Statistics Office
NGO:	Non-governmental Organization
RRD:	Red River Delta
SEMP:	Site Environmental Management Plan
SEO:	Supervising Environmental Officers
OP:	Operational Policy
PEO:	Project Environmental Officer
PMU-W:	Project Management Unit of Waterways
PPC:	People Committee
QCVN:	National Technical Regulation
TCVN:	Vietnamese Standard
TOR:	Terms of Reference
UNICEF:	United Nations International Children's Emergency Fund
VIWA:	Vietnam Inland Waterways Agency
VIPO:	VIPO Trading and Investment Consultant JSC.
WB:	World Bank
WHO:	World Health Organization

Technical Abbreviations

AAS:	Atomic absorption spectroscopy
BOD:	Biological Oxygen Demand
COD:	Chemical Oxygen Demand
DO:	Dissolved oxygen (mg/L)
DWT:	Dead Weight Tonnage
EC:	Electric conductivity (µS/cm; mS/cm)
ICP-MS:	Inductively coupled plasma mass spectrometry - Mass Spectrometry
IC:	Ion chromatography
GC:	Gas chromatography
m bgl:	Meter below ground level
m asl:	Meter above modern sea level
N, S, E, W:	North, South, East, West
NO_x:	Nitrogen Oxides
PM:	Particle matters
SD:	Sediment
SS:	Surface Soil
SW:	Surface water
TDS:	Total dissolved solids (mg/L)
TOC:	Total organic carbon (mg/L)
TSS:	Total Suspended Solids
TSP:	Total Suspended Particulates
UW:	Underground water
UV-VIS:	Ultra Violet-Visible Spectrometer

General comment: Further chemical abbreviations are based on the nomenclature if the International Union of Pure and Applied Chemistry.

1. INTRODUCTION

1.1. PROJECT BACKGROUND THE NORTHERN DELTA TRANSPORT DEVELOPMENT PROJECT

According to statistical data, the share of waterway transport accounts for 67% of total transport performance in the Northern Delta area of Vietnam, equivalent to 17,500,000 tons of goods per year. Inland waterway transported goods include rice, timber, cement, coal, building materials, and fertilizer. It can be seen that the volume of shipped cargo is huge and the kind of cargo is diversified. However, the inland waterway transport condition in Northern Delta region is relatively weak and does not meet the demand of trade and economic developments as shown in the following aspects:

- There are “black spots” of potential risks of waterway collision and accidents;
- Folded turning corners with curved radius of less than 550m, vessels passing through this area must slow down so it leads to the increase of time and transport costs.
- Waterway sections are too small and narrow to circulate in two-ways may cause waterway traffic congestion.
- The flow is not deep enough to limit the circulation of means of waterway transport with high weight.

From the condition above, the Prime Minister has issued a decision No. 16/2000/QD-Ttg dated February 3rd 2000 on "master plan of river transport development in Vietnam until 2020" and a decision No. 13/2008/QD-BGTVT dated June 8th 2008 on "Approving adjustments and supplements of the master plan of inland waterways transport development in Vietnam by 2020."

Northern Delta Transport Development Project (NDTDP) belongs to the master plan inland waterways transport development in Vietnam until 2020.

NDTDP received the investment decision No. 883/QD-BGTVT dated April 4th 2008 of Minister of Transport. NDTDP consists of 3 components as follows:

- Component A: Multimodal Transport Corridor Investments
- Component B: Ferry boat stages
- Institutional support to MOT, VIWA and provinces.

Client of Component A and C is Vietnam Inland Waterway Administration.

Component A includes improvements of waterway corridor flow No.1 from Viet Tri to Hai Phong, corridor No.2 from Quang Ninh to Ninh Binh and corridor 3 from Hanoi to Day River Estuary to form a transport network serving for socio-economic development of Northern Delta region.

Waterway Corridor 3 (in short Corridor 3) is a sub-component of component A and will be implemented in the phase II of project. Corridor 3 begins from Red river through Hanoi to Nam Dinh province dividing into 2 branches sailing from Day and Ninh Co river to Lach Giang estuary (see picture below).

Figure 1: Map of general location

Corridor 3 passes through Hanoi, Ninh Binh and Nam Dinh.

The project purposes are to invest training; improvement and upgrade of reach the standard of channel class II and upgrade 2 main ports namely Viet Tri (Phu Tho) and Ninh Phuc (Ninh Binh).

The project's initial scope concerned:

- Viet Tri port modernization,
- Mom Ro deviation channel and bend correction;
- Do Bui bend correction;
- Ninh Phuc port modernization;
- A connecting canal and lock ship between Day River and Ninh Co River;
- A bridge over DNC canal;
- A Channel access from the sea to the estuary and breakwaters in the Ninh Co estuary (Lach Giang estuary);
- Support marine through supplementing, repairing and improving aids to navigation in Red river, Day River and Ninh Co River;

The Corridor 3 project was accepted and the ESIA + EMP + RAP approved by WB and MONRE by 2013. The construction phases started by 2013 (land clearance) and were achieved between 2014 and 2015 for:

- Viet Tri port;
- Mom Ro ;
- Do Bui;
- Ninh Phuc Port;
- Lach Giang estuary;
- Navigation aids steps of the project.

The construction of DNC canal and ship lock was delayed due to the lengthy duration of discussions between MOT, Province, Districts and Communes for the type of bridge (mobile or fix) and for its air clearance. The alternative for the bridge over DNC canal to have a fixed bridge of 15 m air clearance and this was approved by MOT in the letter No.14457/BGTVT-KHĐT dated 14/11/2014.

This phase of the project includes:

- Construction of DNC canal and ship lock following 2013 detailed design;
- Construction of crossing bridge with 15 m of air clearance following 2015 preliminary design;
- Construction of the access road following 2015 preliminary design.

1.2. SCOPE OF PREPARING A REPORT ON ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

This phase of the project concerns the construction of a canal, a ship lock and a crossing bridge permitting the transfer between Day and Ninh Co river of ships over 1.000DWT and construction of bank protections with a length of over 1.000m thus according to the guideline in Item 23, Item 32 of Annex II of Decree No. 18/2015/NĐ-CP of Vietnamese regulation, the project must prepare an ESIA. An ESIA is also required under WB regulations.

The DNC Detailed Design was prepared between 2012 and 2013. The ESIA of the project was submitted to the World Bank and MONRE in 2013.

The DNC project construction was approved in 2013 by World Bank and by MONRE (MONRE Letter No. 2485/QD-BTNMT dated 11 December 2013).

At this time the choice of the bridge design and air clearance was not already made by MOT and the construction of DNC canal, ship lock and bridge was delayed.

Besides, according to Vietnamese regulation (Letter No. 126/TCMT-TD dated 21 January 2016 of MONRE), no ESIA is necessary for the bridge portion of the DNC canal sub-project.

The present report is an update of the 2013 ESIA, previously approved by WB and MONRE, including the evaluation of the additional impacts of the crossing bridge based on the December 2015 preliminary design of the bridge.

1.3. OBJECTIVES OF THE NDTDP

A feasibility study and preliminary engineering designs for the Northern Delta Transport Development Project (NDTDP) was approved in 2008[1] including 3 components and several subcomponents as follows:

➔ ***Component A: Multimodal Transport Corridor Investments***

Subcomponent A1. Improvements of two National waterway corridors:

(i) east-west northern corridor between Viet Tri and Quang Ninh; and

(ii) north-south western corridor between Hanoi and Ninh Co River estuary.

Subcomponent A2. Improvements to Ninh Co River Estuary and an inter-connecting canal between the Day and Ninh Co Rivers with a navigation lock

Subcomponent A3. Improvements to Provincial Ports

Subcomponent A4. Pilot Maintenance Contracts

➔ ***Component B: Investments in small ferry boat stages***

➔ ***Component C: Institutional support to MOT, VIWA and provinces*.**

Corridor 3 consists of:

- A coastal channel in Lach Giang estuary,
- Several different river sections including Ninh Co and Red rivers from the sea to Hanoi,
- A connecting canal between Ninh Co and Day rivers (the focus of this ESIA),
- Bend correction works at Mom Ro and Do Bui,
- Ninh Phuc and Viet Tri ports improvement.

The overall length of Corridor 3 is 183 km. The required hydrographical and topographical surveys undertaken between 2012-2013 and updated for the DNC canal area in 2015-2016 cover the inland waterways and the Lach Giang estuary.

The Corridor 3 portion of the Project is expected to increase the capacity of the inland waterways transport system to meet growing transport demands and support economic development by reducing transport costs for both producers and consumers. After improvement the waterway will allow:

- 3000 DWT (Dead Weight Tonnage) from Lach Giang estuary to the bifurcation point of the Day river and Dao Nam Dinh river – River mouth section 1;

[1] Northern Delta Transport Development Project – Feasibility Study and Preliminary Engineering Design – Final report, March 2008, SMEC, Royal Haskoning and centre of VAPO

- 3000 DWT and barges 4X400 Tones from the bifurcation point of the Day river and the Dao Nam Dinh river to Ninh Phuc port – River mouth section 2;
- 1050 DWT and barges 4x400 Tones from Hanoi port to the bifurcation point of the Red river and Ninh Co River (sector of Mom Ro). – Corridor 3 – section 1;
- 3000 DWT for the Ninh Co River – Corridor 3 – section 2.

The main design choices and considerations for Corridor 3 are:

The 4 x 400 ton barges are expected to sail from Ninh Phuc port to Hanoi port, on the Dao Nam Dinh River and the Red river. The maximum sea river vessel considered capable of sailing all the way to Hanoi has a capacity up to 1050 DWT. The 3000 DWT sea river vessel will sail to Ninh Phuc port, but will not continue to Hanoi.

The upgrading of the corridor 3 has already entailed dredging; bend corrections, bank protection, shoal regulation and provision of aids to navigation.

What is now required is the construction of an inter-connecting canal between the Day and Ninh Co rivers for 4x400 ton barge convoys and self-propelled sea-river ships and vessels up to 3000 DWT in capacity, including a ship lock and a fixed-span bridge through the new canal, plus access roads to the bridge.

1.4. PURPOSE AND STRUCTURE OF THE REPORT

Purpose: This ESIA concerns the updated project of DNC canal, ship lock, and bridge and road access. It will describe the actual conditions (environment and social economic) of all the project areas, describe the projects, evaluate the impacts, propose mitigation means, implement an Environmental Management Plan and report the public consultation results.

Structure of the Report: The report is divided in 2 volumes:

Volume 1: ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT (ESIA)

Part 1:

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK
PROJECT DESCRIPTION
NATURAL, ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

Part 2:

ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT
METHODS TO AVOID, REDUCE OR COMPENSATE NEGATIVE IMPACTS
PUBLIC CONSULTATION

Volume 2: EMP - ENVIRONMENTAL MANAGEMENT PLAN

2. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

2.1. VIETNAMESE POLICY IN ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

**** Pursuant to law***

a. The laws on environment

- Law on biodiversity No. 20/2008/QH12 dated 13 November 2008.
- Law on water resources No. 17/2012/QH13 dated 21 June 2012.
- Law on environmental protection No. 55/2014/QH13 dated 23 June 2014.
- Law on labor No. 10/2012/QH13 dated 18 June 2012.
- Law on cultural heritages No. 28/2001/QH10 dated 29 June 2001.
- Decree No. 179/2013/ND-CP prescribes the penalty for the violation of environmental regulations.
- Decree No. 127/2014/ND-CP dated 31 December 2014 on prescribed conditions of organization and operation of environmental monitoring services.
- Decree No. 18/2015/ND-CP dated 14 February 2015 on strategic environmental assessment, environmental impact assessment, and environmental protection commitment.
- Decree No. 19/2015/ND-CP dated 14 February 2015 detailing and guiding the implementation of some articles of the Law on Environmental Protection.
- Circular No. 27/2015/TT-BTNMT dated 29 May 2015 on strategic environmental assessment, environmental impact assessment, and environmental protection commitment.
- Decree No. 35/2015/ND-CP dated 13 April 2014 on management and use of rice-farming land.
- Decree No. 38/2015/ND-CP dated 24 April 2015 on management of waste and discarded materials and detailed provisions of some articles of Decree No. 59/2007/ND-CP dated 9 April 2007.
- Circular No. 28/2011/TT-BTNMT of the Ministry of Natural Resources and Environment dated 01/8/2011 stipulated technical process of environmental monitoring ambient air and noise.
- Circular No. 29/2011/TT-BTNMT of the Ministry of Natural Resources and Environment dated 01/8/2011 regulating the environmental monitoring techniques continental surface water.
- Circular No. 30/2011/TT-BTNMT of the Ministry of Natural Resources and Environment dated 01/8/2011 stipulated technical process of environmental monitoring groundwater.
- Circular No. 31/2011/TT-BTNMT of the Ministry of Natural Resources and Environment dated 01/8/2011 stipulated technical process of environmental monitoring sea water (including sediment and marine organisms).
- Circular No. 33/2011/TT-BTNMT of the Ministry of Natural Resources and Environment dated 01/8/2011 stipulated technical process of environmental monitoring of land.
- Decision No. 22/2006/QĐ-BTNMT on 18/12/2006 of the Minister of Natural Resources of the mandatory environmental ISO.
- Decision No. 26/12/2006 23/QD-BTNMT on the list of hazardous wastes.
- Decree No. 127/2014/ND-CP dated 31 December 2014 of the Government on regulating the requirements applicable to environmental monitoring service activities

b. The relevant legislation

- Law on inland waterway transport No. 23/2004/QH11 dated 15 June 2004 and No. 48/2014/QH13 dated 17 June 2014 on amending and supplementing a number of articles of law on inland waterway transport No. 23/2004/QH11.
- Law on dyke No. 79/2006/QH11 dated 29 November 2006.
- Law on road traffic No. 23/2008/QH12 dated 13 November 2008.
- Decree No. 15/2013/ND-CP dated 06 February 2013 on management of construction quality.
- Law on land No. 45/2013/QH13 dated 29 November 2013.
- Law on construction No. 50/2014/QH13 dated 18 June 2014.
- Decree No. 43/2014/ND-CP dated 15 May 2014 detailing a number of articles of the land law.
- Decree No. 47/2014/ND-CP dated 15 May 2014 on compensation, support and resettlement upon land recovery by the State.
- Decree No. 32/2015/ND-CP dated 25 March 2015 on management of construction costs.
- Decree No. 59/2015/ND-CP dated 18 June 2015 on construction project management.
- Circular No. 13/2007/TT-BXD dated 31 December 2007 guiding a number of articles of Decree No. 59/2007/ND-CP dated 09 April 2007 on the management of solid waste.
- Circular No. 14/2009/TT-BTNMT dated 01 October 2009 of the Ministry of Natural Resources and Environment Detailed regulations on compensation, support, resettlement and procedures of land acquisition, traffic leased land.
- Circular No. 13/2012/TT-BGTVT on amending and supplementing a number of articles of Decree 09/2010/TT-BGTVT on guiding environmental protection in developing transport infrastructure.
- Document No. 1665/TTg-CN dated 17 October 2006 of the Prime Minister on the implementation of the land acquisition and construction of transportation projects;
- Decision No. 16/2008/QD-BTNMT dated 31 December 2008 promulgates national technical standards for the Environment.
- Decision No. 883/QD-BGTVT dated 04 April 2008 on approving investment Transport Development Project River Delta region using loans from the World Bank (Project WB6).
- Decision No. 14457/BGTVT-KHDT dated 14 November 2014 on approving adjustment basic design of bridge DNC, WB6 project.

*** The standards and regulations applicable**

- TCVN 6663-14:2000 (ISO 5667-14:1998): Water quality - Guidance on quality assurance of environmental water sampling and handling
- TCVN 6663-1:2011 (ISO 5667-1:2006): Water quality - Sampling - Guidance on the design of sampling programs and techniques.
- TCVN 6663-3:2008 (ISO 5667-3:2003): Water quality. Sampling. Part 3: Guidance on the preservation and handling of water samples.
- TCVN 6663-6:2008 (ISO 5667-6:2005): Water quality. Sampling. Part 6: Guidance on sampling of rivers and streams.
- TCVN 6663-11:2011 (ISO 5667-11:2009): Guidance on sampling of underground water.
- TCVN 5998-1995 (ISO 5667-9:1992): Guidance on sampling from marine waters.

- TCVN 6663-13:2000 (ISO 5667-13:1993): Water quality. Sampling. Part 13: Guidance on the sampling of water, wastewater and related sludge.
- TCVN 6663-15:2004 (ISO 5667-15:1999): Water quality. Sampling. Part 15: Guidance on preservation and handling of sludge and sediment samples.
- ISO 5667-12, 1995: Water quality. Sampling. Part 12: Guidance on sampling of bottom sediments.
- ISO 5667-19, 2004: Water quality. Sampling. Part 19: Guidance on sampling of marine sediments.
- TCVN 5297-1995: Soil quality-Sampling. General requirements.
- 22 TCN 259-2000: The process of geological exploration works
- TCVN 7538-2:2005 (ISO 10381-2:2002) Soil quality-Sampling. Part 2: Guidance on sampling techniques.
- TCVN 5973-1995: Air Quality. Stratified sampling method for assessment of ambient air quality.
- TCVN 5754-1993: Work place air. Methods for determination of mass concentration of toxic gases and vapors. General sampling methods.
- TCVN 6399-1998 (ISO 1996-2:1987): Acoustics. Description and measurement of environmental noise Part 2: Acquisition of data pertinent to land use.
- QCVN 01:2009/BTNMT - National technical regulation on drinking water quality.
- QCVN 02:2009/BTNMT - National technical regulation on domestic water quality.
- QCVN 03-MT:2015/BTNMT - National technical regulation on the permissible limits of heavy metals in the soil.
- QCVN 04:2008/BTNMT - National technical regulation on chemical residues in soil and plant protection.
- QCVN 05:2013/BTNMT - National Technical Regulation on ambient air quality.
- QCVN 06:2009/BTNMT - National technical regulation on hazardous substances in the ambient air.
- QCVN 07:2009/BTNMT - National technical regulation on hazardous waste thresholds.
- QCVN 08-MT:2015/BTNMT - National technical regulation on surface water quality.
- QCVN 09-MT:2015/BTNMT - National technical regulation on underground water quality.
- QCVN 10-MT:2015/BTNMT - National technical regulation on coastal water quality.
- QCVN 14:2008/BTNMT - National technical regulation on domestic wastewater.
- QCVN 15:2008/BTNMT - National technical regulation on the pesticide residues in the soils.
- QCVN 26:2010/BTNMT - National technical regulation on noise.
- QCVN 27:2010/BTNMT - National technical regulation on vibration.
- QCVN 38:2011/BTNMT – National technical regulation on surface water quality for protection of aquatic lifes.
- QCVN 39:2011/BTNMT – National technical regulation on surface water quality for irrigated agriculture.
- QCVN 40:2011/BTNMT - National technical regulation on industrial wastewater quality.
- QCVN 43:2012/BTNMT-National technical regulation on sediment quality.
- The New Dutch list: Dutch standards prescribed parameters of pollution in soil and sediment.

- **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 Minister 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 ESIA Appraisal of MONRE is responsible for organizing ESIA Committee for approving SEA, ESIA reports guided by the government (Decree No. 80/2006/ ND-CP).

• **Sectorial Ministries**: According to the LEP (2005) the sectorial ministries are responsible for the environmental management of activities within their sectors. The ministries' responsibilities include the review and approval of ESIA reports of the sectorial development projects. For examples, the Ministry of Transport is responsible for approving development projects guided by the Government (Decree No. 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 ESIA reports for the development project guided by the Government (Decree No. 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 (Decree No. 80/2006/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 ESIA or CEP reports, provincial DONREs or District DONREs, respectively, will organize committees for approving each ESIA or CEP reports.

2.2. WORLD BANK SOCIAL AND ENVIRONMENTAL SAFEGUARDS POLICIES

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

- ***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 ESIA related functions.

To comply with OP 4.01, an ESIA including an EMP has been prepared during the preparation of the NDTDP to cover phase 1 proposed investment including Corridor 1 and the two ports. ESIA for Phase 2 investments, this report, is prepared for Corridor 3 during the implementation phase of the NDTDP. Lessons learnt from phase 1 ESIA and implementation will be incorporated into this report.

- 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. The NDTDP will not affect any known important natural habitat or protected area. Nevertheless, OP 4.04 is triggered OP4.04 is triggered as considerable dredging under the project will have an impact on aquatic biodiversity.

To mitigate possible impacts on aquatic life, the Project will adopt the following approach insofar as possible:

Dredging close to the bank and in wetlands (the most important places for aquatic life) and on spawning areas will be carried out between October to May, avoiding the peak of biological activity during the flood/rainy season.

The disposal sites for excavated and dredged materials will be managed following adaptive methods - reducing the release of Total Suspended Solids by sedimentation in temporary ponds and through the frequent monitoring of surface and ground water quality.

Construction of the DNC canal will eliminate a length of 250 m of riverbank on the Day River side and 650 m of riverbank on the Ninh Co River side. However, this impact will be mitigated by the project's adoption of an innovative ecological engineering approach which will enhance biodiversity and protect against the effect of waves and erosion on the river banks and adjoining wetland, creating and/or restoring approximately 9 ha of aquatic and wetland habitats— an area 18 times greater than the lost habitat.

- 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. The NDTDP will not affect any Indigenous People thus OP4.10 is not triggered.

- 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 potential impacts of proposed project on physical resources can be avoided or minimized. As the NDTDP investment will lead to relocation of a small temple for bend correction, OP 4.11 is triggered. Extensive public consultation has been conducted with local community regarding the relocation of this temple and a plan for rebuilt has been developed base on the result of public consultation.

- 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.

- EHS Guidelines:

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards.

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them.

2.3. MATERIALS AND DATA SOURCE

2.3.1. Provided by the client

- ***Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix Ia: Social Assessment – Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix Ib: Resettlement Plan for Corridor 1 – Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix Ic: Resettlement Plan for Ninh Co River mouth – Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix IIa: Environmental And Social Impact Assessment for Corridor 1 – Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix IIb: Environmental And Social Impact Assessment for Ninh Co River Mouth Improvement – Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix IIc: Environmental assessment framework Ports, Ferry boat stages and Corridor 3– Feasibility Study and Preliminary Design*** – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;
- ***Appendix III: Institutional Analysis and Recommendations*** – Feasibility Study and Preliminary Design – Final Report of Northern Delta Transport Development Project made by Consultant Association of Royal Haskoning, SMEC and VAPO Center in March 2008;

- ***NDTDP Corridor 3*** – ESIA – EN version approved by WB - April 2013
- ***NDTDP Corridor 3*** – ESIA – VN version approved by MONREMONRE – December 2013

2.3.2. Provided by the consultant

Material sources prepared by the Consultants for the Project:

- Topographical Survey (2013 + update 2015)
- Bathymetric survey (2013)
- Engineering geological report
- Hydrological study Report
- Ninh Co River mouth morphological expertise
- Social survey (2013 + update 2015)
- Environmental survey (2013 + update 2015)

2.4. APPLIED METHOD IN ESIA

Different activities were undertaken to accomplish the task on Environmental And Social Impact Assessment specifically in the evaluation of the potential impacts (positive or negative, temporary or permanent, general or local) of the project.

To identify adverse effects, economical and feasible mitigation measures were identified with the assistance of Consultants. The major methods used in the conduct of ESIA and to come up with the ESIA Report are listed below:

Screening method: Screening is the initial step of the ESIA process. It identifies proposals that require an ESIA and excludes those that do not. All proposed projects should be screened to determine whether or not they must be subject to an ESIA.

Establishing an environmental baseline: As the reference point for impact prediction and evaluation, baseline information has a critical role in the technical quality of ESIA work. Baseline data can be collected through field surveys or from secondary sources and focused only on impacts being investigated. The Vietnam current regulations are strictly followed in sampling and analyses of samples. This phase, in particular, may be limited by the time and resource constraints that are placed on an ESIA Study.

Review of alternatives: The identification and comparison of alternatives are central to the application of ESIA as a creative, problem-solving process. It is applied primarily to find better ways to avoid and minimize adverse impacts while still realizing project objectives. Also, the consideration of alternatives can point to creative opportunities for environmental enhancement, community development and project savings.

Environment/project interactions: The primary focus of ESIA is on predicting project/ environment relationships in terms of cause and effect. Other aspects of this relationship should not be overlooked. The aim of ESIA is to assess the impacts of a proposed development. In certain cases, the environment can affect the construction or operation of a project. Some strategies being used in the impact analysis are presented as follows:

Systematic sequential approach (SSA) provides a proven approach to "thinking through" the causal chain: activity - changes - impacts - mitigation.

Environmental matrix method: This method combines listing development activities with listing vulnerable environmental factors in a matrix. Development activities are on vertical axis and environmental factors are on horizontal axis or vice versa. This method shows causal relation of various factors at the same time.

Spatial analysis methods allow for the presentation of the spatial pattern of environmental impacts through map overlays. GIS is routinely used for analyzing and displaying spatial impacts.

Rapid assessment techniques allow for quick estimation of releases of pollutants to the environment and to identify the type of pollution control to be used and estimate its effectiveness in reducing the level of pollutant. This allows for an estimate of the release to the environment to be made.

Public involvement and consultation: Public involvement is a cornerstone of the ESIA process. People are an integral part of the environment, and the significant social impacts of a proposal are analyzed as an integral part of an ESIA study (or a companion report). All proposals that are subject to an ESIA are likely to have social, economic or health impacts. Social survey is conducted through interview using a questionnaire. It is prepared and administered to gather public perception on the project and its impacts. The results of the social survey are presented to the people through open forums. A public consultation is held to identify the actions needed to resolve raised issues.

Determining risk: Impact prediction is made in the context of uncertainty and risk. These characteristics need to be understood in order to frame the approach to ESIA. ESIA is based on the premise that project-related environmental impacts can be predicted.

Evaluation of impact significance: Evaluation of the significance of potential impacts takes place throughout the ESIA process, beginning with screening. Also, it should be applied as a formal test of the residual impact once mitigation has been taken into account.

Mitigation means and Environmental Management Plan (EMP): Mitigation is the practical phase of the ESIA process. It is concerned with preventing or remedying the adverse impacts and optimizing the environmental and social benefits of a proposal. The aim of mitigation should be to deal first with significant adverse impacts and to realize opportunities for environmental gains and benefits. Once these have been addressed, attention can be turned to impacts that are adverse but not considered to be significant.

2.5. ESIA TEAM STUDY

Study Team/Members		Position/Expertise	Tasks
Project Investor (PMU-W)			
1	Mr. Nguyen Van Thuong	Waterway and Port Engineer	Head of Project Management
2	Ms. Nguyen Thi Thanh	Environmental Engineer	Engineer
2	Mr. Nguyen Cao Anh	Environmental Engineer	Engineer
Consultant (Compagnie Nationale du Rhône / IMDC / TRACTEBEL)			
1	Mr. Sinou Jean CNR	Team Leader Senior Hydraulic Engineer	Team Leader/ Engineer
2	Mr Bard Jean Paul CNR	Vice Team Leader Senior Hydraulic Engineer	Hydraulic Engineer
3	Mr Delphin-Poulat Gilles CNR	Waterway Expert Senior Civil works Engineer	DNC canal + ship lock design Dredged and excavated material from DNC
4	Mr Toro Fernando Mr Bayard Pierre IMDC	River mouth experts Senior Hydraulic Enginners	Hydrological modeling
5	Mr Romain Granjon	Geotechnical expert	DNC geotechnical
6	Mr Patrick Gernigon Mr Ali Remadi TRACTEBEL	Road and bridge expert Road and Bridge engineer	DNC Road and Bridge
7	Mr Pressiat Franck CNR	Senior Environment Engineer	ESIA, EMP, DMDP Environmental monitoring Social assessment
Sub-Contractor 1 (VIPO)			
1	Mr Pham Anh Tuan	Environment Engineer	ESIA, EMP, DMDP Environmental monitoring
2	Mr Ha Viet Hung	Social/Resettlement Expert	Resettlement Action Plan Handling of Social/ Resettlement Concerns
3	Mr Bui Vu Hiep	Environment Engineer	1st ESIA Corridor 3 - 2013 – VN Version
4	Mr. Nguyen Van Cuong	Senior Soils/ Materials Engineer	Engineer
5	Mr. Bui Duc Binh	Road engineer	Road and bridge design
Other Sub-Contractors			
1	Institute of Chemistry	Laboratory of chemistry	Physical and chemical analysis soil, sediment, water, underground water, fishes, vegetation
2	Application Environmental Geology Center	Laboratory of chemistry	
3	Institute of Tropical Architecture	Laboratory of chemistry	
4	Mr Trinh Quang Phap	Red River Delta Ecosystem specialist	Fishes and vegetation inventories
5	Mr Vu Van Tri	Road and bridge expert	Road and bridge Design

3. PROJECT DESCRIPTION

3.1. OVERVIEW

3.1.1. Project Name

Name of the project*: **Northern Delta Transport Development Project – Waterway Corridor 3***.

For convenience, "waterway corridor 3" is referred to as "corridor 3" or "the project" in this report.

3.1.2. Project Investor

Investor: ***Ministry of Transport***

Represented by ***Project Management Unit of Waterways (PMU-W).***

General Director: Mr. Le Huy Thang

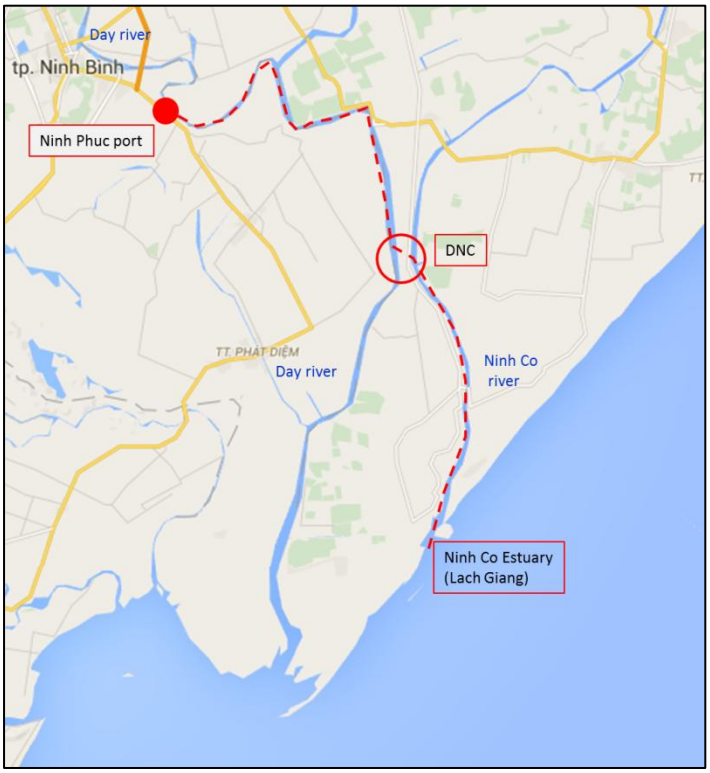
Address: 6th Floor, Thang Long PMU building, Linh Nam ward, Hoang Mai district, Hanoi

Telephone: 04 39747633 Fax: 04 39747637;

Project Management Unit of Waterways is under Ministry of Transport and responsible to the Client for project professional issues such as bidding document preparation, bidding review, environmental and social impact assessment (ESIA) report preparation.

3.2. PROJECT GEOGRAPHICAL LOCATIONS

The actual inland waterway crossing the Red River delta from North to South covers 180 km from Hanoi (km 0) to Lach Giang (km 180). It traverses the Red River from Hanoi (km 0) to upstream Mom Ro Curve (km 125.000) and, downstream, the Ninh Co River from Mom Ro (km 125) to Lach Giang (km 180).



The corridor from Lach Giang to Hanoi can be used for commercial navigation and is designed for Class II but due to the many shoals in the Corridor, part of it can only use for Class III. Near Hanoi bridges have insufficient vertical clearance during high water levels on the red river. However, the Day and Ninh Co river mouth 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.

Figure 2: Location of Corridor 3 from Lach Giang to Ninh Phuc port

The DNC canal will permit the junction between Day and Ninh Co rivers, permitting boats coming from the sea by Ninh Co river mouth to join the Day river upstream the sedimented part of the river, and then join the industrial ports located in the Day river or continue to Hanoi using the day river, with less length and better navigation conditions.

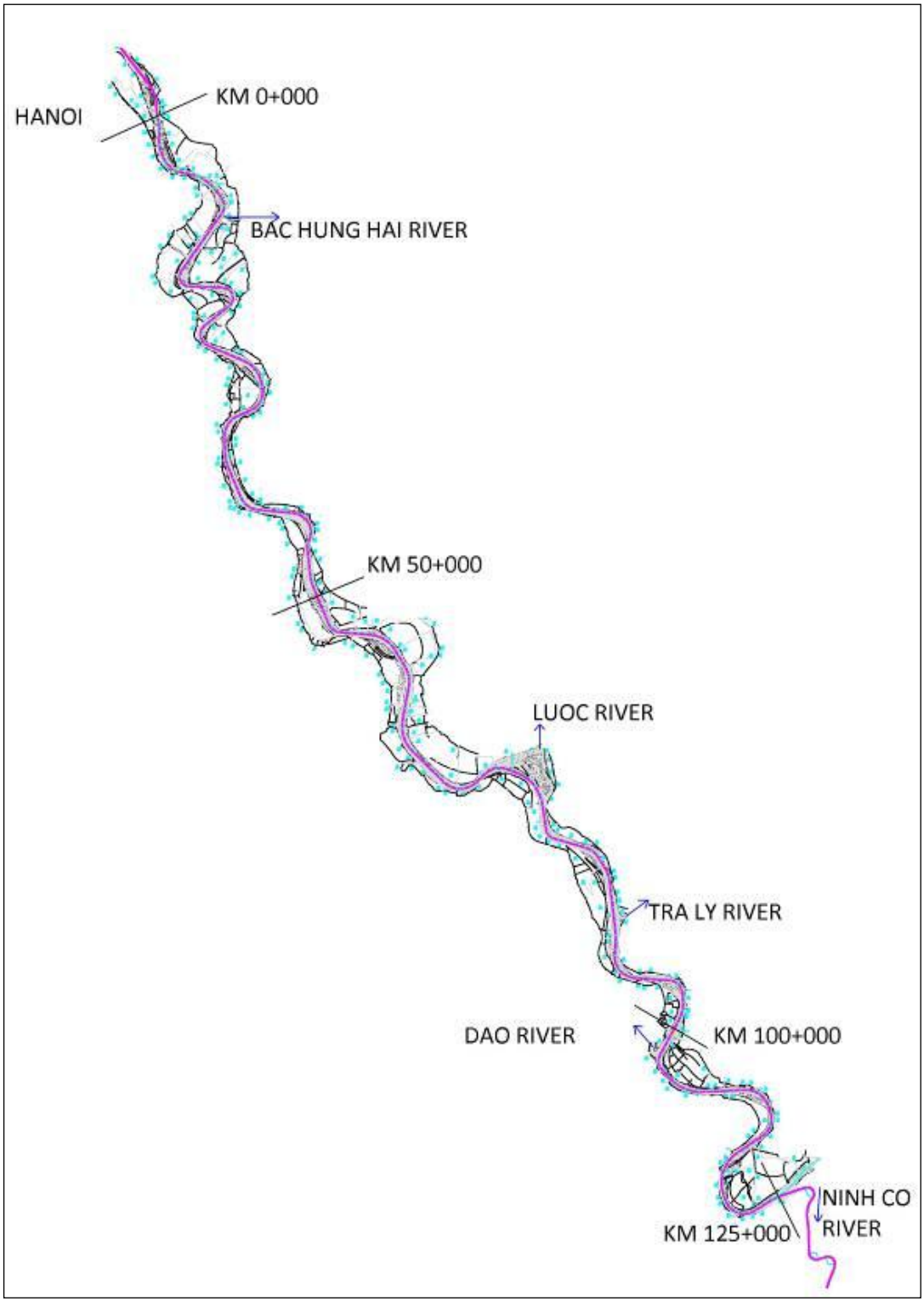


Figure 3: Map of actual Inland water way from Hanoi to Mom Ro (Red River section)

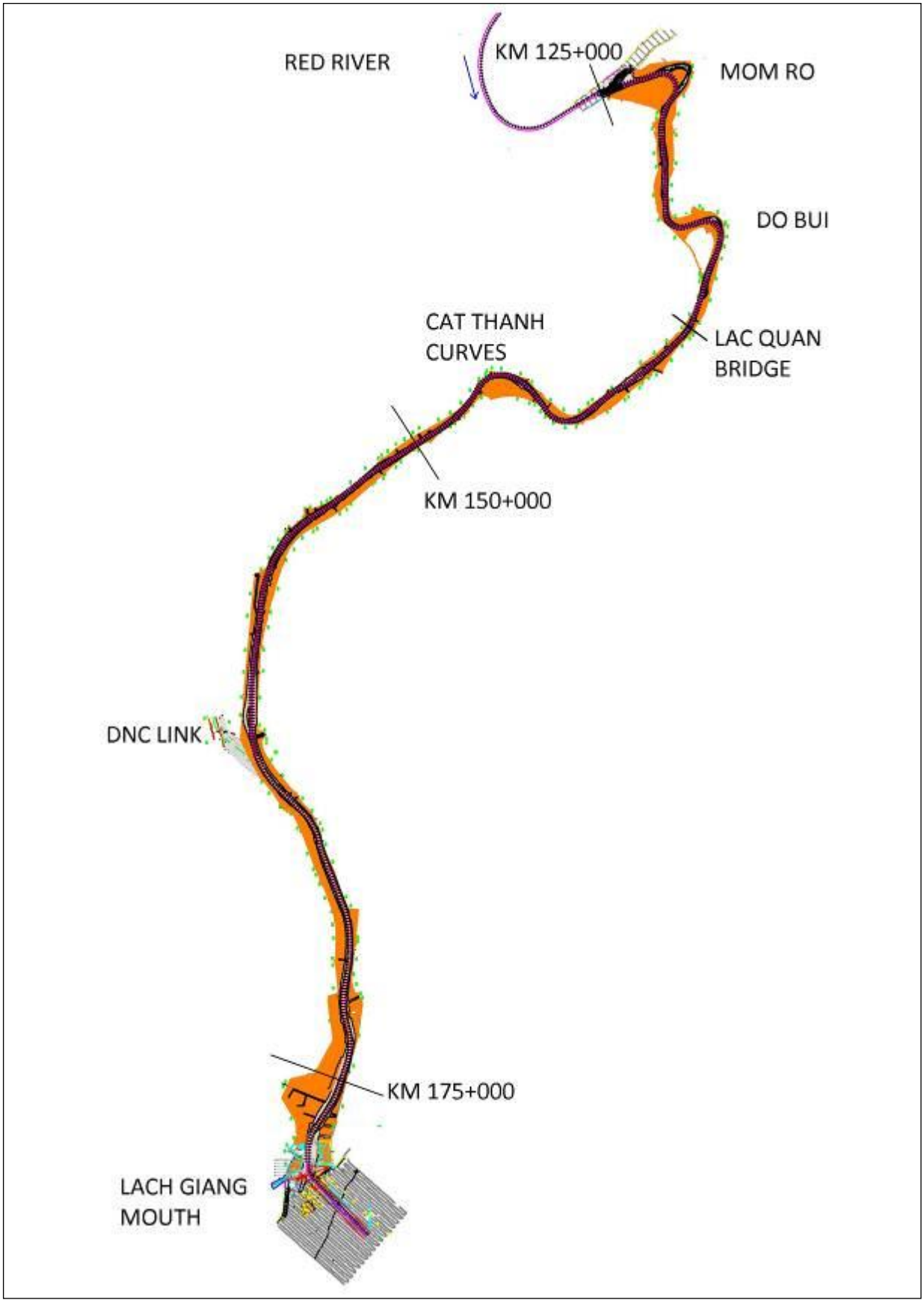


Figure 4: Map of actual Inland water way from Mom Ro to Lach Giang (Ninh Co River section)

3.3. SCOPE OF INVESTMENTS

The remaining project activity consists of the Construction of a connecting canal from Day River to Ninh Co River (DNC canal) including a ship lock in the middle of the canal and the relocation of the existing road and a bridge to cross the Ship lock.

The other Project investment activities have already been studied and constructed between 2012 and 2015. They are now operating:

1. Waterway corridor 3 (Hanoi – Lach Giang) from Lach Giang estuary through Ninh Co river, Red river to Hanoi: training work and improvement and upgrade of channel to reach the channel class I;

3. Construction of an access channel and breakwaters in Lach Giang estuary to permit 2.000DWT vessels to access from the sea to the Ninh Co river and join Ninh Binh Port. The 3.000DWT vessels can be able to use it during high tide or with load reducing;

4. Modernization of Viet Tri Port by construction of 1 berth of 600 T, warehouse, stockyard, conveyor, inner road, drainage system, runoff water treatment, anti-dust equipment, etc.;

5. Modernization of Ninh Phuc port by construction of 1 berth of 3.000DWT, warehouse, stockyard, conveyor, inner road, drainage system, runoff water treatment, anti-dust equipment.

3.4. PROJECT LOCATION

The project area is located in Northern Vietnam and concerns a part of the Inland Waterway of the Red River Delta, from Hanoi to the sea. The DNC project specifically concerns the Ninh Co River and the Day and Dao rivers.

The initial Corridor 3 project was divided in 6 sites, located in the boundary of 3 provinces:

- Nam Dinh province,
- Ninh Binh province
- Phu Tho province.

The project was implemented in 06 following areas:

Table 1: Project sites

Situation	Project site	Province	Commune
Finished	Mom Ro (Km126-131)	Nam Dinh	An Vinh village, Truc Chinh commune, Truc Ninh district, Nam Dinh province
Finished	Do Bui (Km134-138)		Lo Xuyen village, Phuong Dinh commune, Xuan Truong district, Nam Dinh province.
Studies on going	**Day Ninh Co connecting canal DNC (Km164-167)**		**Nghia Son and Nghia Lac communes, Nghia Hung district, Nam Dinh province**
Finished	Lach Giang estuary (Km180-181)		Thinh Long town, Hai Hau district, Nam Dinh province
Finished	Ninh Phuc port	Ninh Binh	Bich Dao ward, Ninh Binh town, Ninh Binh province
Finished	Viet Tri port	Viet Tri	Ben Got ward, Viet Tri city, Phu Tho province

The remaining construction project (DNC) concerns only 1 province (Nam Dinh).

Overview of the project sites is shown in Figures 5 and 6.

Figure 5: General location map of Corridor 3

Figure 6: Overview of project sites include in corridor 3

(Green = done - Yellow = to build)

3.5. PROJECT COMPONENTS

The following paragraph is a synthesis of the project components which are detailed in the Detailed Design Reports (DDR). This chapter presents the location of each project site and explains the purpose of the works. The projects are illustrated by a synthetic drawing for each area. The technical drawings are available in the Detail Design Reports.

The projects components are summarized in the following table:

Table 2: Synthesis of projects components

Project Area	Main purpose	Works	Excavated/dredged materials management and quantities	
DNC	Link 2 rivers	Connecting canal Ship lock Dredging Bend cutting Bridge and road	Reuse of clay by bricks factories Use of all the "non-clay" materials for agricultural soils improvement by communes Remaining soil/clay/sand can be evacuate to existing Lach Giang's southern disposal area	Ship lock: 300 000 m3 Day side: 636 000 m3 Ninh Co side: 613 000 m3 Road + Bridge : 11 700 m3 Total: 1 561 000 m3

3.5.1. Description of Navigation Channel characteristic

The channel along the Red River from Hanoi to Red / Ninh Co junction is designed following the standard dimensions of Class I and the standard dimensions calculated for the design fleet : 1050 DWT self-propelled vessel (ship B) and 4x400 DWT pushed convoy (ship C). All the calculation is available in the Part III of the Detailed Design Report.

The channel is 125 km long from km 0+000 to km 125+000. Km 0+000 is located at Chuong Duong Bridge in Hanoi. Km 125+000 is located at Red / Ninh Co junction.

<u>Channel dimensions</u>

The typical cross sections of the channel are presented in the following figure 7.

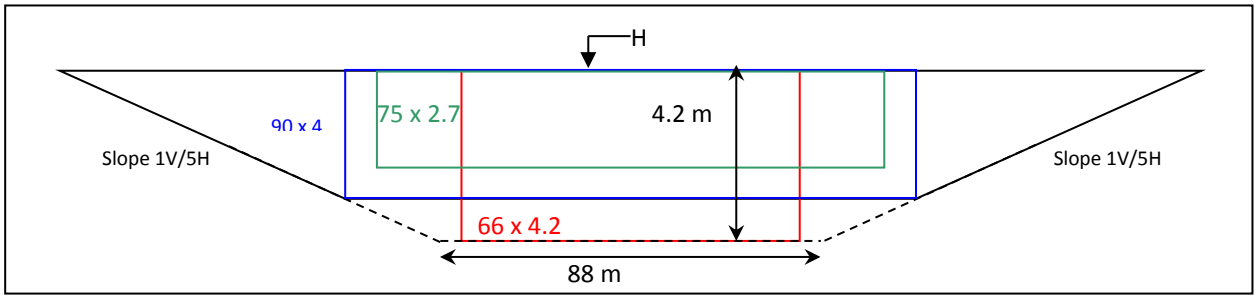


Figure 7: Typical cross section of the channel from Hanoi to Red / Ninh Co junction and from Ninh Co junction to DNC canal

Legend:

Blue rectangle 90 x 4 = Class I. Green rectangle 75 x 2.7 = C-C combination

Red rectangle 66 x 4.2 = B-C combination

The minimum dimensions required by the standards are a width of 88 m at depth 4.2 m, with slopes at 1V/5H. **The consultant proposes a standard width of 90 m at depth 4.2 m, with slopes at 1V/5H,** which allows the navigation rectangle of Class I and navigation rectangles for B-B, B-C and C-C combinations

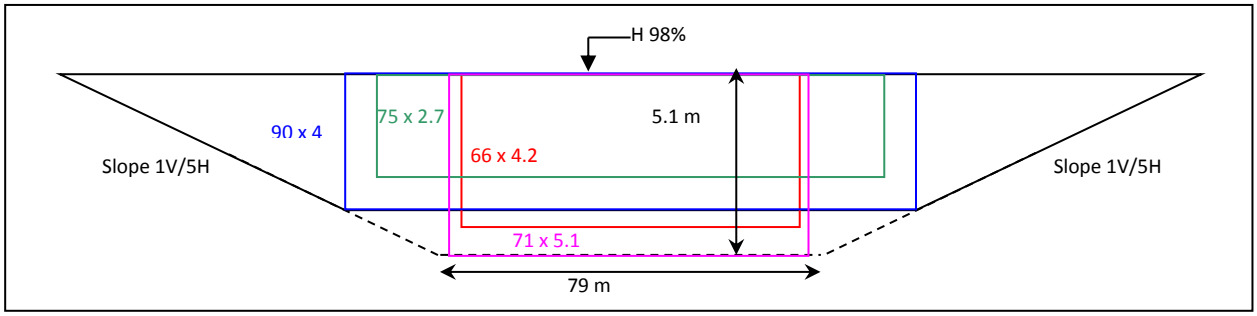


Figure 8: Typical cross section of the channel from DNC Canal to Lach Giang River Mouth

Legend:

Blue rectangle 90 x 4 = Class I Green rectangle 75 x 2.7 = C-C combination

Red rectangle 66 x 4.2 = B-C combination Pink rectangle 71 x 5.1 = A-C combination

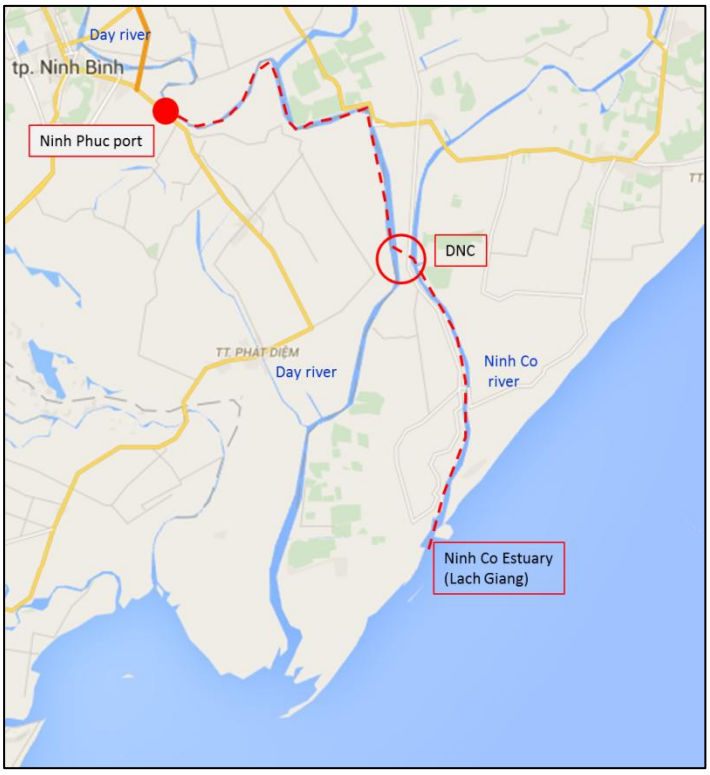
The dimensions of rectangle A-A (3000 DWT light loaded) are 63 x 5.1 and dimensions of rectangle D-D (2000 DWT full loaded) are 69x5.1, so these rectangles are included inside the A-C rectangle.

The minimum dimensions required by the standards are a width of 79 m at depth 5.1 m, with slopes at 1V/5H. **The consultant proposes a standard width of 80 m at depth 5.1 m, with slopes at 1V/5H,** which allows the navigation rectangle of Class I and navigation rectangles for B-B, B-C and C-C combinations.

3.5.2. Day River – Ninh Co River (DNC) Connecting Canal - km 164-165

The work items at this project site aims mainly at allowing the sea-river boats until 3000 DWT to link the Ninh Phuc port by using the works planned on the Ninh Co mouth (Lach Giang). This service requires to build-up a link between the Ninh Co River and the Day River is created. This link is located in the place where both rivers are the closest.

Considering the heads between both rivers which could achieve 1m in current conditions, this connection must be equipped with a lock.



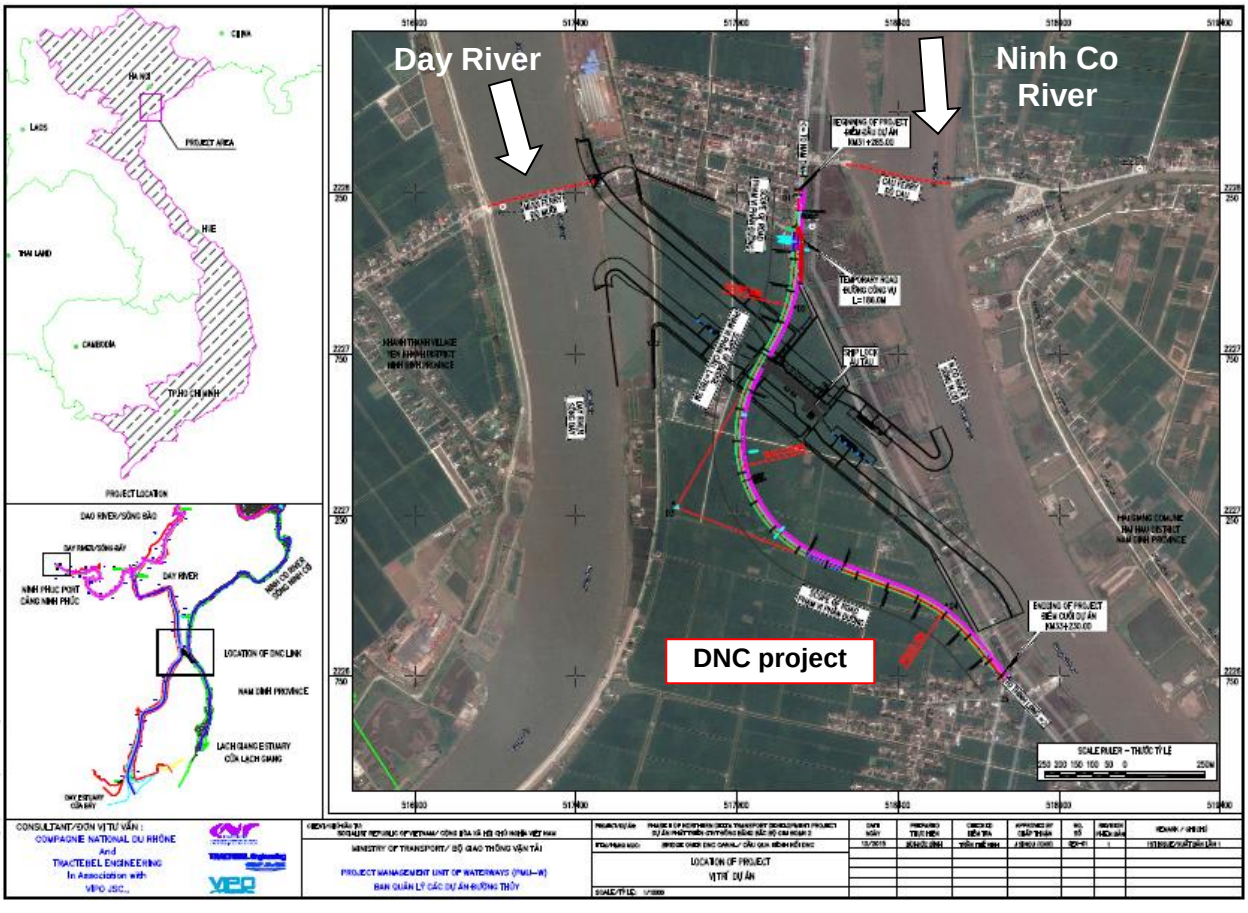


Figure 9: Satellite view from DNC area and project

The connection being on the network of waterways of class I (Classification TCVN 5664), it has to allow also the transit of the pushed convoys 4 X 400 T.

In the 1st phase, only boats of 2 000 DWT (Draft of 4.5 m) or 3 000 DWT half loaded are expected, but the conception of the lock has to take into account the final objective of transit of boats of 3 000 DWT full loaded (Draft 5.0 m).

Channels on both sides of the lock which can be constructed for 2000 DWT by taking into account a margin for silting. In a second step, these stretches will be dredged to allow 3000 DWT full loads to use this channel.

The project aims mainly at allowing the sea-river boats of up to 3 000 DWT capacity to link up with the Ninh Phuc port by using the works planned on the Ninh Co mouth (Lach Giang).

According to the canal design, the ship lock connecting Day and Ninh Co rivers will cut through the provincial road DT490 (from Km32-Km33). In order to allow road traffic to pass the navigation lock a bridge has to be constructed.

b. Surrounding sensitive receptors

The project area is lined:

- In the North, by the main street of the village of Do Muoi;
- In the South at the Day side, by the hamlet of the church.
- In the middle: a cemetery near the road on the Ninh Co side.

The area around the DNC project is flat with an average elevation of (+0,50 m). The central part is protected by the main dykes which lines Day and Ninh Co rivers. The use is mainly agricultural (rice). An old brick factory pond (not used any more) is located on the Day River side. Grounds outside of main dykes are protected by lower dykes against the tide marling.

The provincial road TL490C is adjacent to the Ninh Co dyke.

A Christian church and 2 cemeteries are located very close to the project area. **The project has been adapted from Feasibility study design to ensure that the works do not destroy or affect access to these cultural and religious heritage sites.**

The 2015 updating field campaigns identified 14 tombs (4 brick tombs and 10 soil tombs) that are located in the construction area of the canal.

Figure 10: Consultant checking tombs location at DNC area

There are different networks (electrical power lines, optic fiber and irrigation system) identified during Detail Design study. The project integrates all of these constraints and allows protecting or relocating and limiting the impacts of the residents.

The project is located in an agricultural area but very close to small cities with many surrounding houses. The first design presented as part of the feasibility study would have destroyed many houses (> 80 houses) and gardens on Day and Ninh Co rivers. The detailed design phase has allowed for modification of this initial design, and will reduce the impact on houses and gardens to 30 houses relocated and gardens affected, for which compensation will be paid in line with World Bank OP 4.12 - Involuntary Resettlement.

c. DNC Canal scope of work

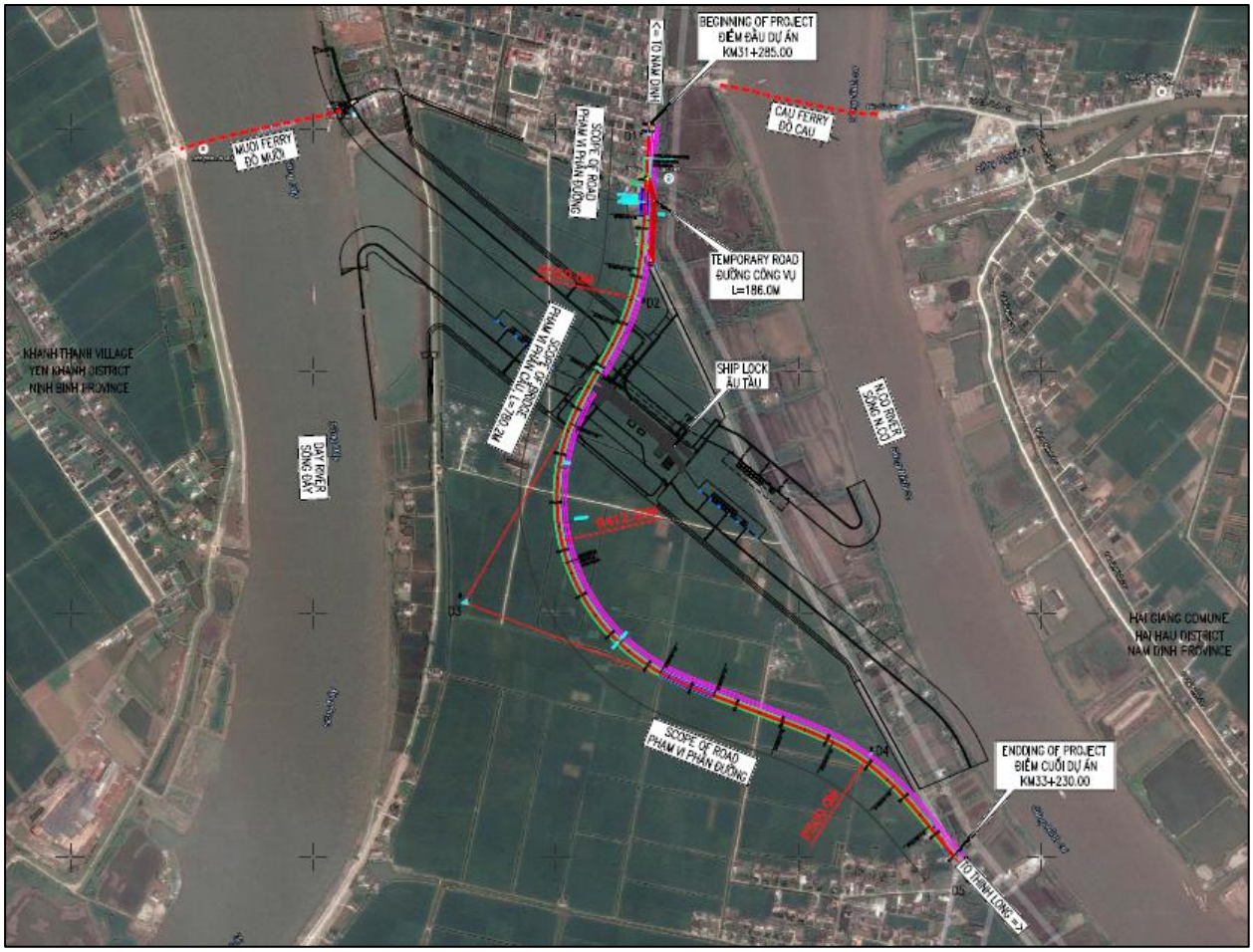


Figure 11 : Project site at DNC Canal

In Day- Ninh Co connecting canal, there are 4 items to build:

- Connecting canal (1 at Ninh Co side and 1 at Day side);
- 1 Ship lock (+ extension possibility for a 2nd ship lock in the future);
- Lifting quay;
- Road restoration and New bridge to maintain road traffic.

DNC project main quantities

Table 3 : Amount and scope of items at DNC Canal

Item	Unit	Scope	Amount	Note
Connecting canal	Lock gate	gate	1	Dimension 9.2 m width x 7.8 m depth, Open and close two side door with angle of 45^0
	Lock ship	lock	1	Dimension: 160 m Length x 15 m Width x 5.5 Depth
	Drainage system	System	1	-
	Yards for ship	Yard	2	200m in length
	Lock operation house	house	1	
	Dredging/Excavations	m^3	1,561,000	For ship lock chamber and canal
Road	General dimension			1195 m length x 12 m width
	Excavation / soil removal	m3	11 700	10 765 m3 for removal of not suitable soil below the road embankment The rest = excavation before concrete bridge piles/piers
	Soil filing / embankment	m3	27 800	Embankment of the road
Bridge	General dimension	780 m length x 12 m width x 19.05 m maximum high Air clearance max : 15 m for 5% highest water levels		
	Abutments		2	
	Piles/piers on ship lock		3	15 m high
	Ground Piles/piers		15	2 m to 15 m high

DNC ship lock and canal description

The useful length of 160 m corresponds to the simultaneous lockage of a boat of 1 050 DWT (56.2 m) and of other one of the 3 000 DWT (90.0 m). The length of both boats in 146 m leaves
A margin of 14 m has been left for spaces between boats and gates which is sufficient. Considering the necessity of making cross pushed convoys class I of a width of 15.2 m, the width of the lock is enlarged to 17 m.

The hydraulic levels led to consider a uniform sill level on the whole lock. The maximum draught of the project boats of project being 5.0 m and the low level exceeded 98 % of time being (-0.80),
The level (-7.00) leaving a clearance under keel of 1.20 m is retained.
The wall top level takes into account the hydraulic closure against the floods.

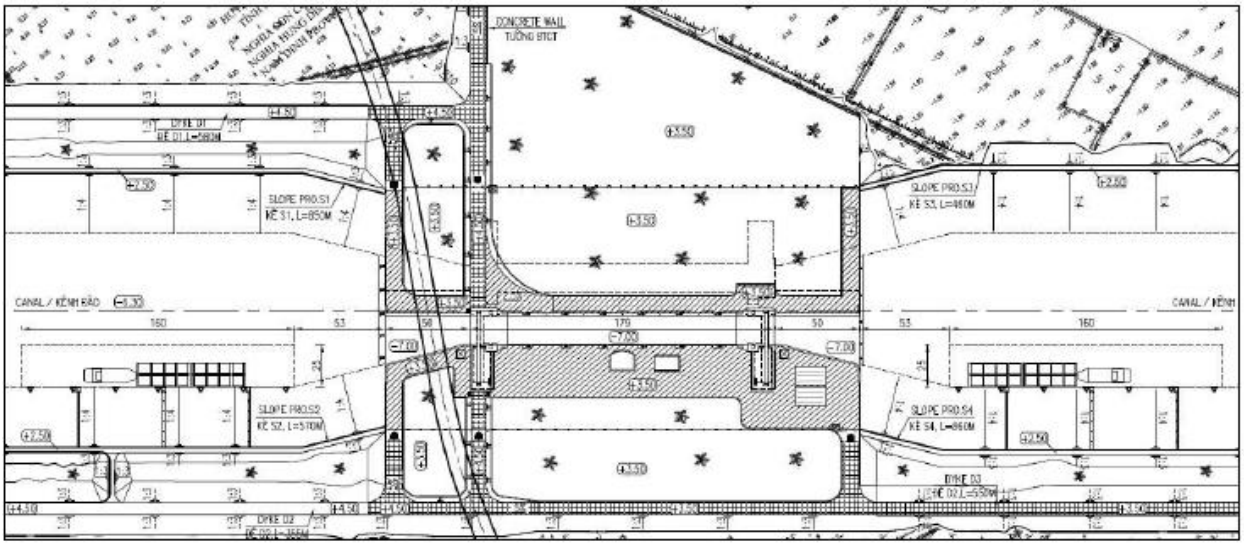


Figure 12 : General Plan View of ship-lock

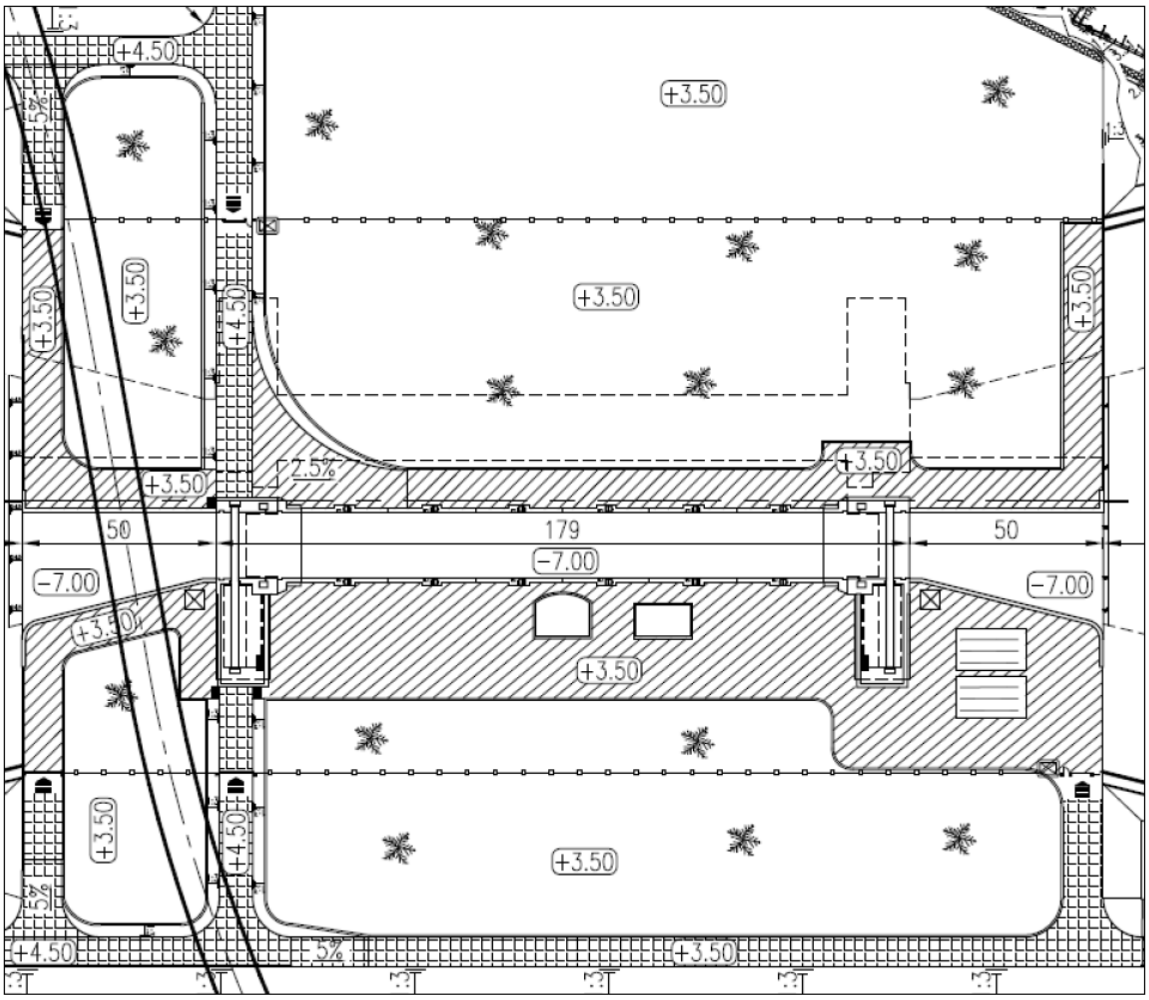


Figure 13 : Detailed Plan View of ship-lock

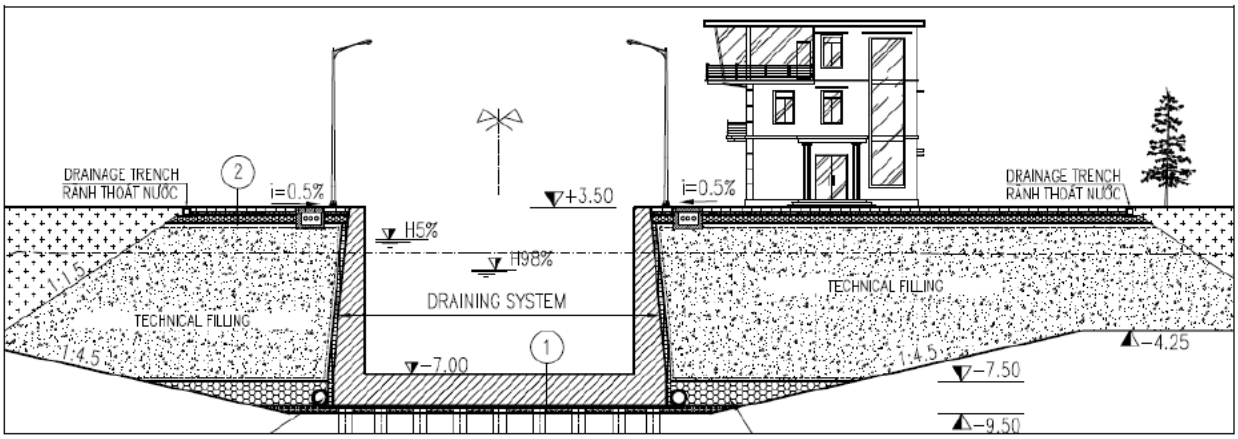


Figure 14 : Section view of ship-lock

Channel bottom levels

For the short term (2 000 DWT), the draught to be considered is 4.60 m. We take into account a clearance under keel of 90 cm, so a depth at 5.50 m. This depth will also allow the half loaded ships to sail from Lach Giang mouth to Ninh Phuc Port, using the DNC canal.

For the long term (3 000 DWT), we consider a draught of 5.00m and a depth of 6.00 m (clearance under keel of 100 cm).

An additional margin of 40 cm should be kept for sedimentation. The bank protections will be set to fit both requirements.

The following table gives the bottom levels for each side:

	H98%	Short term (2000 DWT) – 4,6 m			Long term (3000DWT) – 5,0m			Bank protections	
		Depth	level	+ margin	Depth	level	+ margin	Depth	level
Day side	(-0,4)	5,5	(-5,9)	(-6,3)	6,00	(-6,4)	(-6,8)	6.4	(-6,8)
Ninh Co Side	(-0,8)		(-6,3)	(-6,7)		(-6,8)	(-7,2)		(-7,2)

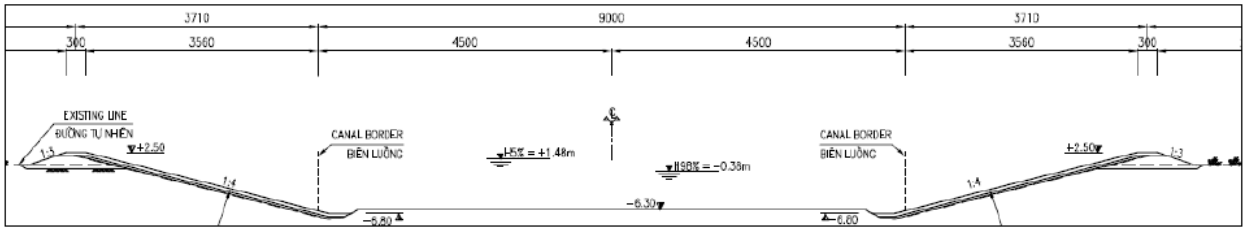


Figure 15 : Channel section view

Banks and dykes

Banks (in green on the figure below) in clearing of the channel are planned with a slope in 1:4 in the part where the works are realized in dry conditions.
The bank is prolonged by the new secondary dykes until the level (2.50), this one protecting the dyke against high levels of tide.

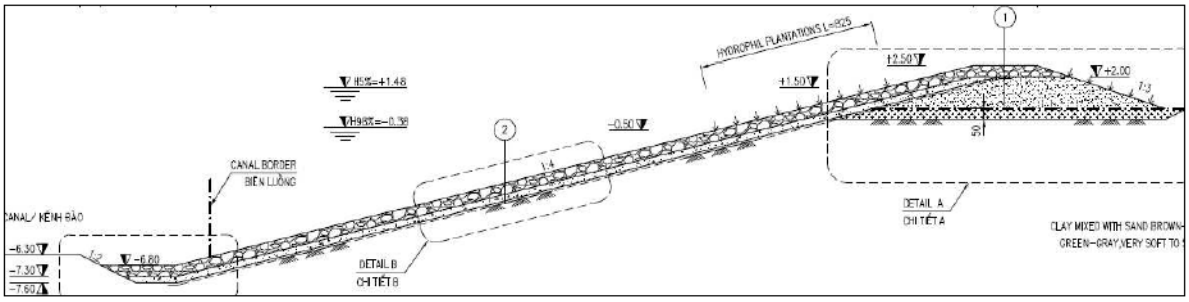


Figure 16 : Bank protection section view

	Bottom level	Bank heights	Bank lenght	Lenght at the North side	Length at the south side
Day side	(-6,80)	7,3 m	29.2 m	900 m	600 m
Ninh co side	(-7,20)	7,7 m	30.8 m	600 m	800 m

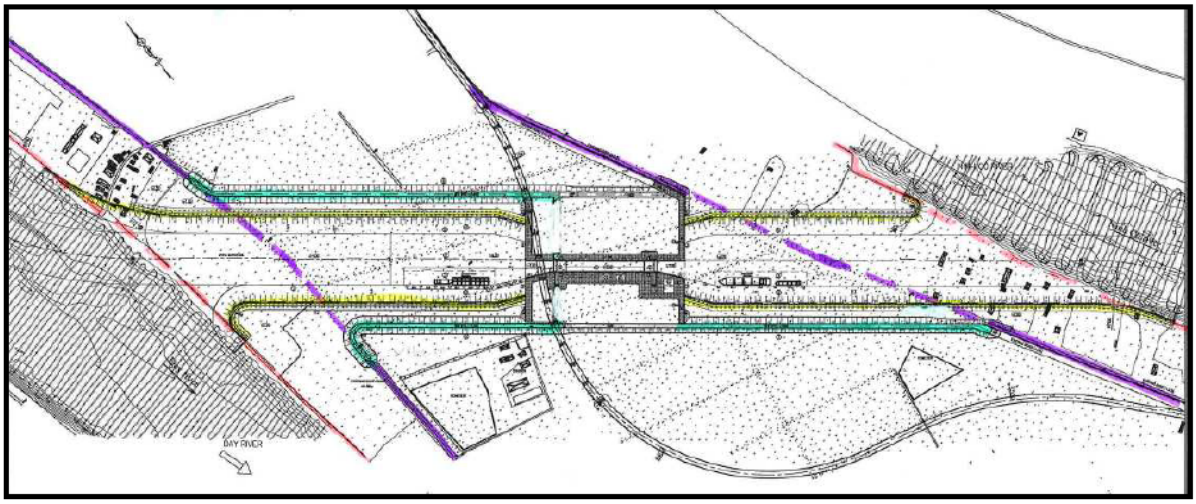


Figure 17 : *Banks and dikes plan view*

Secondary dykes (existing secondary dykes in pink and new in yellow on the figure below)

The main dykes leave outside important flooded areas. These areas are nevertheless protected from high levels of tide and from current high flow by secondary dykes (in pink on figure above) following the river to the level (+2.50). These secondary dykes will also be restored.

Lengthes to be built	North	South
Day side	800m	500m
Ninh co side	400m	800m

Main dykes

The project area is protected from the floods by main dykes (MARD) following rivers (mauve on figure above).
In this sector, the height of dikes varies weakly around:

- (+4.50) at the Day side
- (+3.50) at the Ninh Co side

The opening of the channel requires to recreate new dykes along the channel and to close them on the platform of the lock (with raising up to the head at the Day side)

Lengthes to be built	North	South
Day side (+4.50)	600m	400m
Ninh co side (+3.50)	500m	-

The main dykes have on top a width 7.50 m and the slopes are planned in 1:3. In the upstream, the dyke is protected from channel waters by a security berm at the natural ground level (+0.50).

These dykes have to resist a hydraulic pressure corresponding to the difference between their top level and a downstream level which we shall take at (0.00), the average groundwater level.

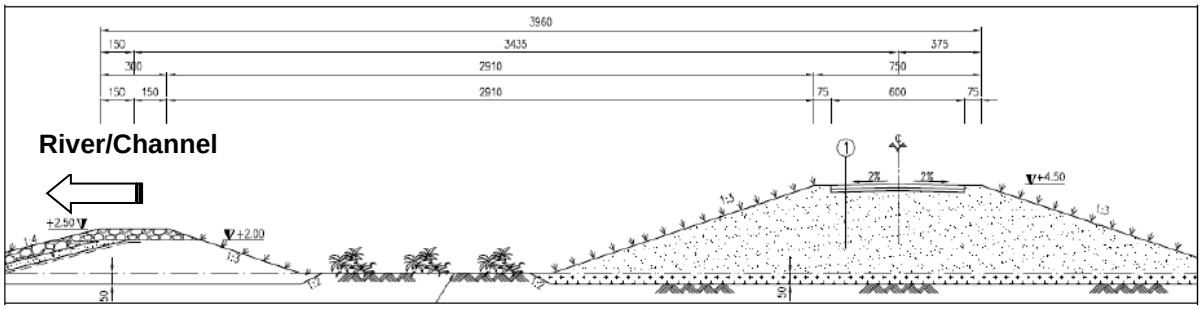


Figure 18 : Primary and secondary dikes section view

Banks protection design

Banks in clearing of the channel are planned with a slope in 1:4 in the part where the works will be realized in dry conditions. The bank is prolonged by the secondary dyke until the level (2.50), this one protecting the berm of the dyke of the tide movements.

The bank protections have to resist the effects:

- Waves due to the wind and to the passage of boats by weakening them;
- Disturbances caused by jet flow

The amortization requires a rough surface and the protection must be able to adapt itself to the deformations of the ground support. We suggest retaining the solution of a rip-rap protection on all the height of the bank.
The top close to the stretch of water will be filled with materials and planted by Vetiver or adapted local plants.

The outer spaces include essentially:

- Areas located around the platforms at the North side (~30 000 m ²) and at the Southside (~10 000 m ²).

At this stage, it is planned to fill them until the level (+3,50) and to plant trees.

- The slopes behind the secondary dykes : Width 6m on 2 500 m → 15 000 m²
- The horizontal berm in front of the dykes at the existent ground level (+0.50) in front of the dykes. These areas with a 10m width are protected from high levels of tide and from current high flow by the new secondary dykes to the level (+2.50). Width 10m on 1 500 m → 15 000 m².
- The slopes of the dykes: Width 2x12m at the Day side and 2x9m at the Ninh co side. Width 42m on 1 500 m → 63 000 m²

For this 3 areas (~93 000 m²), at this stage, it is planned hydrophyl plantation in the continuity of the top of banks.

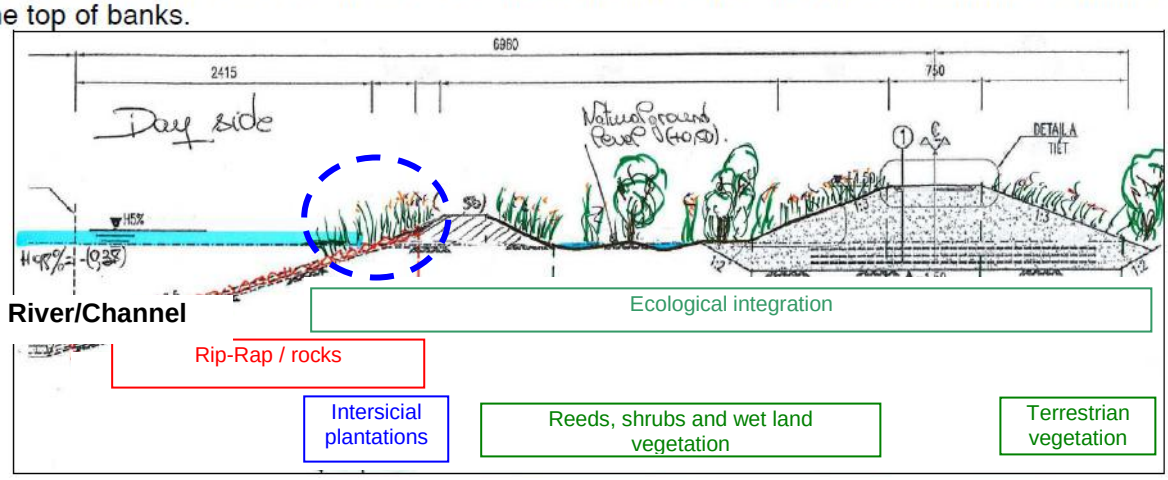


Figure 19 : Mixed bank protection + ecological integration – section view

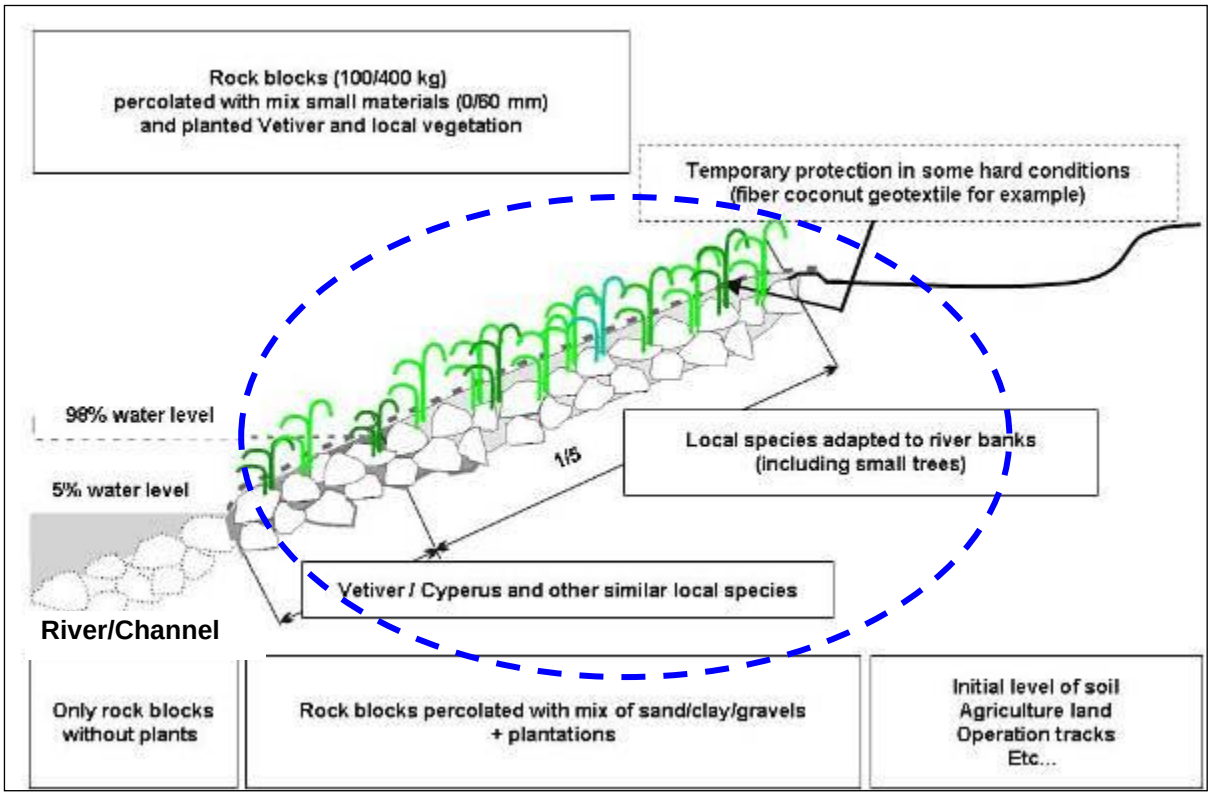


Figure 20 : Mixed bank protection - detailed section view

Operating hours

The lock of DNC canal is open 24h/24, 7 days 7 and about 350 days per year. A couple of weeks are devoted to maintenance of the lock, during which navigation is completely stopped. This(ese) period(s) is(are) utilized to repair the mechanical parts, concrete structures, etc. The lock is open day and night because the traffic on the DNC channel is linked to the tides, as the lock is close to the sea access.

Staff

The DNC lock is operated by a lock keeper. The keeper opens and closes barrier systems, gates, and sluices for insuring the emptying or the filling of the lock and traffic of boats. It also switches the traffic lights to indicate to the boats they can enter or exit the lock.

It communicates with the boats' crews using a VHF radio, in a predefined channel (e.g. channel 22 - around 157 to 160MHz reserved for sea or river radio communications).

To ensure the service 24h/24, the lockkeepers' team consists of 6 persons.

Lock maintenance is provided by a team of 2 mechanical technicians, and 3 electrical-and-control-systems technicians.

Each technician of the team insures one-week-long 24h/24 on-call duty.

A lad is present only during working hours of the week.

A guard is present at working hours (from 5am to 21h). 2 people have this function. The operation staffs also include a secretary and a manager. The manager of the team can be joined 24h/24 in case of major event.

Safety and security issues are addressed in detail in Chapter 7.

Road and bridge description

The chapter has been prepared with the parts of the preliminary design drawings and report available by December, 25th 2015.

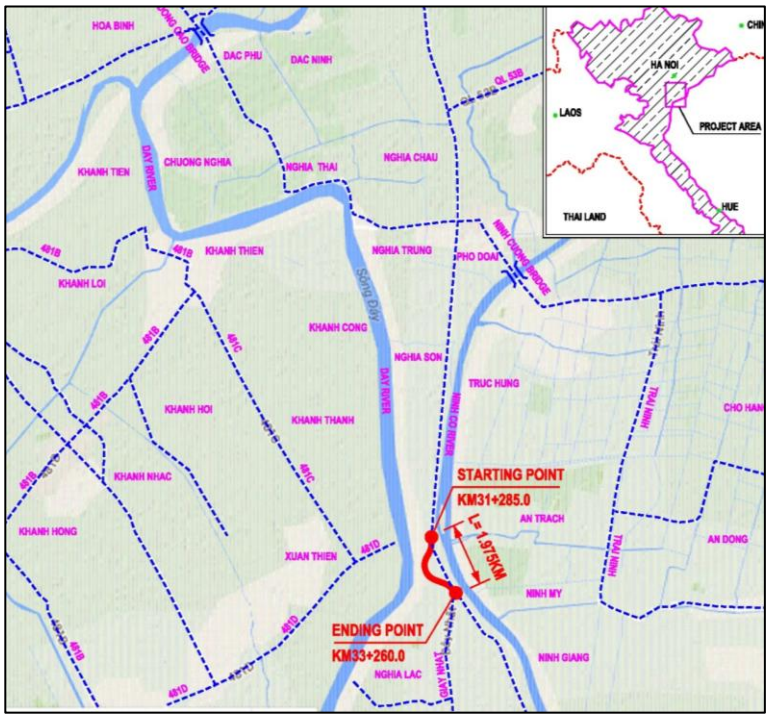


Figure 21 : Location Map of Day-Ninh Co (DNC) bridge

The area starts from Muoi Village, Nghia Son Commune (nears the junction with Muoi Ferry road) to Day Nhat T-junction, Nghia Lac Commune. The length of bridge and approach road is 1975m (bridge: 780.2 m, approach roads: 1194.8 m). The DNC Bridge will be crossing though 2 communes Nghia Son and Nghia Lac, Nghia Hung District, Nam Dinh province.

The start point and end point of DNC bridge project section as follows:

- Start Point: Km31+285;
- End Point: Km 33+260.

Objective of the DNC Bridge

- The goal of the project is to allow smooth flow road traffic passing though canal to compensate for the construction of the DNC canal;
- Future developments are also considered as this section of the highway will be a part of large travel capacity, high technical standards, and improvement to 4 lanes highway of the main connecting axis which facilitate economic development of the provinces of Nam Dinh;
- The objective is also to meet the Nam Dinh province's future development of trunk road connecting Gie-Ninh Binh expressway and (future) North-South Coastal Expressway,

particularly with regards to facilitating and improving to coastal area industry development.

Scope of DNC detailed design works

The scope of DNC Bridge Detailed Design works has the following characteristics:

1. Spatial Scope -Construction area: Nghia Son & Nghia Lac Commune, Nghia Hung District, Nam Dinh Province -Starting point: KM31+285 -Ending point: KM33+260, Length 1,975m;

2. Approach Road Class: Class III as described in TCVN 4054-2005. Design speed is 80 km/h. -Typical cross-section is as follows: Cross section width: 12 m, in details as following: Carriageway: 2 x 3.5 m = 7.0 m (2 motorized lanes), Shoulder: 2 x 2.5m = 5 m (Paved: 2 x 2 m = 4 m, unpaved shoulder: 2 x 0.5 m = 1 m);

3. Bridge 1 fixed bridge of 780 m long, which cross ship lock with navigation clearance 15m;

4. Total project length = approach roads (1195 m) + bridge (780 m): 1975m.

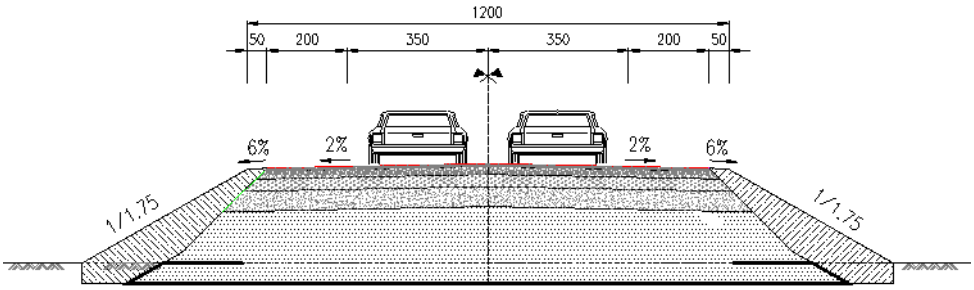


Figure 22 : Typical of DNC cross section of approach road

- Road Design: Road Class III (Flat terrain, TCVN 4054-2005), design speed: 80km/h, Cross section width: 12m; Approach road: 1,248 m;
- Bridge Design: Design Load for 2 lanes of HL93 (22TCN272-2005); Overall width: 12m; Navigation's clearance of 15m, type: Fix Bridge, span diagram 18x40m, Girder shape: Super T beam, bridge's length: 720m long;
- In phase 1: Construction of 02-lane highway with first component of bridge (under financed of this project);
- Possible option in a second phase 2: Construction of another 02-lane highway with second component of bridge (will be financed by local government);

Geometric criteria:

- Approach road and bridge: The highway geometric criteria follows Highway Specifications for Design-TCVN 4054-2005, Road Class III (Flat terrain), with design speed 80km/h as follows:
    - Min horizontal curve radius (With isc =8%) : 250m;
    - Normal horizontal curve radius (With isc = 5%) : 400m;
    - Horizontal curve radius without super elevation : 2500m;
    - Stopping sight distance : 100m;
    - Min crest curve radius : 4000m;
    - Min sag curve radius : 2000m;
    - Max longitudinal gradient 5%;
- Pavement:
    - Carriageway: uses existing pavement structure of DT490;
    - Paved shoulders, applies same structure as carriageway's pavement.

Design:

- Design horizontal alignment is taken at left side of planned centerline of DT490 for the option of second component of road DT490 will be widening to right side of existing DT490;
- Horizontal alignment has 3 horizontal curves: with relevant design radius as follow 500m, 400m, 550m;Alignment starts from Km31+285 and ending atKm33+253 (DT490), design length 1968m.

Vertical Alignment

Design vertical alignment is taken at left side of planned centerline of DT490 for the option of second component of road DT490 will be widening to right side of existing DT490;

Vertical alignment has 3 curves: with relevant vertical design radius as follow 2000m, 4000m, 2000m; Total design length 1968m, details as follows:

- One (2) crest curve radius: 4000m;
- Two sag curve radius: 2000m;
- Design longitudinal gradient 5%;

Highway road

As taking account to the current situation, Grade III (Flat) road has designed as 2 lanes highway, design speed 80km/h; Cross section width of 12m as follows:

- Carriageway 2 x 3.5m = 7.0m;
- Paved shoulders 2 x 2.0m = 4.0m;
- Unpaved shoulder 2 x 0.5m = 1.0m.

In planned, Grade I (Flat) road has planned as 6 lanes highway the design speed 120km/h; Cross section width of 33m as follows:

- Carriageway 6 x 3.75m = 22.5m;
- Median 1.50m;
- Safety strip (closest to median) 2 x 0.75m = 4.0m;
- Safety trip (grassing curb) 2 x 3.0m = 6.0m;
- Unpaved Shoulder 2 x 0.75m = 1.5m;
- Proposed Cross section width as 12m for approach road.

Cross section of project complies with the Letter No. 962/TB-BGTVT dated 22/9/2015 from the Ministry of Transport on agreement of scale of DNC bridge scale is Road class III (flat), will be the same as proposal in previous study as follows:

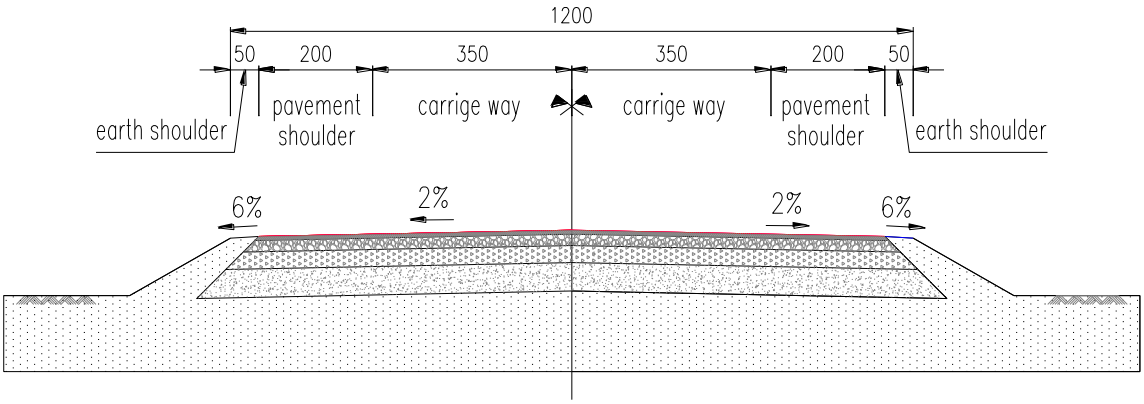


Figure 23 : Typical design of DNC road cross section

Embankment

- Embankment fill material: Fine and/or coast sand;
- The fill slope of the embankment is selected to be 1/1.5;
- Depends on height, the embankment may be filled directly dredging surface organic soil, sand piles or supporting slab.

Bridge

Overall bridge Cross section has selected based on criteria:

- Ensure the standard of current road class Bridge width >= Road width = 12m;
- Ensure the future road: the current road (will be upgraded to class I, flat-TCVN4054-2005) the bridge width is proposed B=12.25 m as follows:
  - Carriageway 3 x 3.75m = 11.25m;
  - Parapet 2 x 0.5m = 1.0m.

Completion stage: Build one more bridge with B=12.25m parallel to the existing bridge to ensure total bridge width will meet with future requirements.

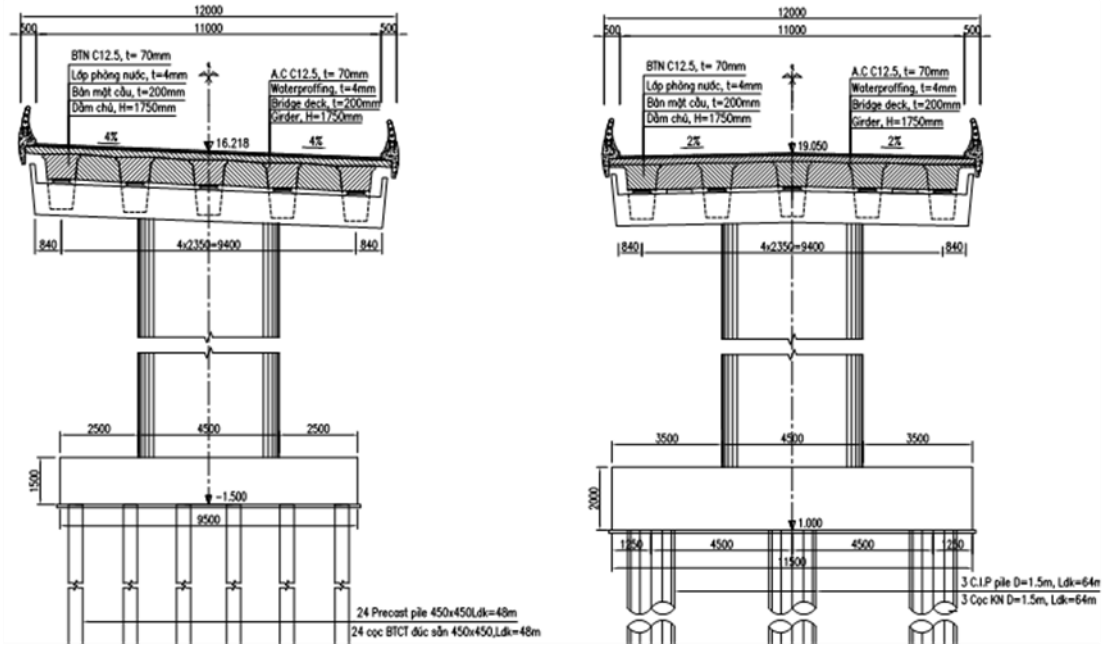


Figure 24 : Typical design of DNC bridge cross section

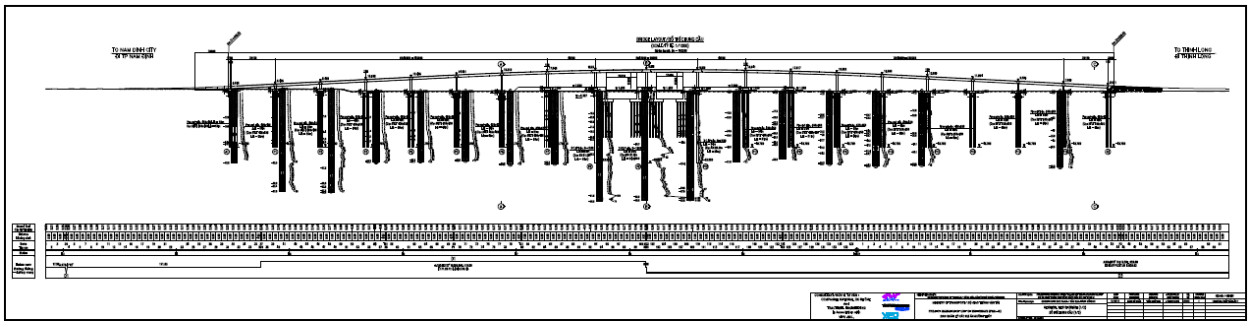


Figure 25 : Typical design of DNC bridge longitudinal cross section

A total of 18 piers will be constructed: 15 piers (9.5 x 5.5 m of basement section) on the ground and 3 piers (11.5 x 2.3 m of basement section) on the ship lock.

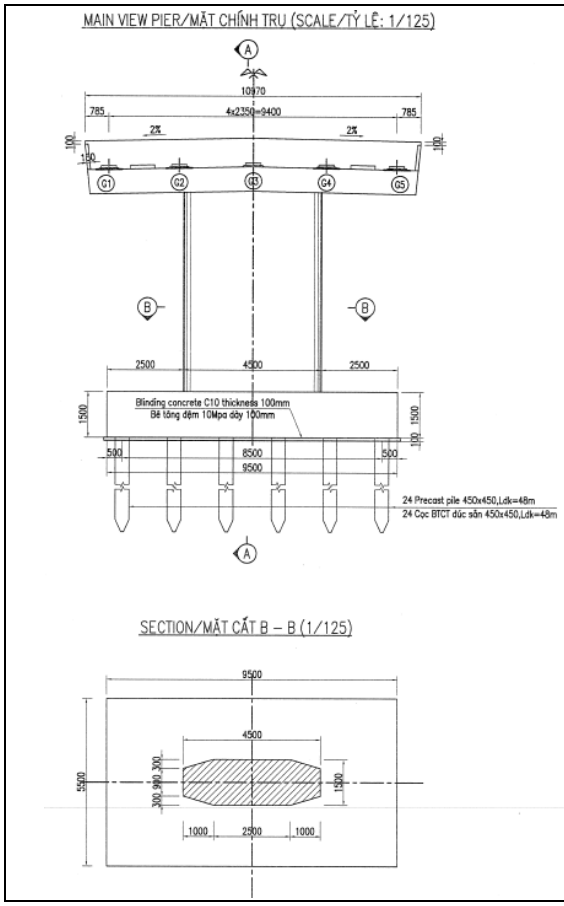


Figure 26 : Typical design of Ground piles

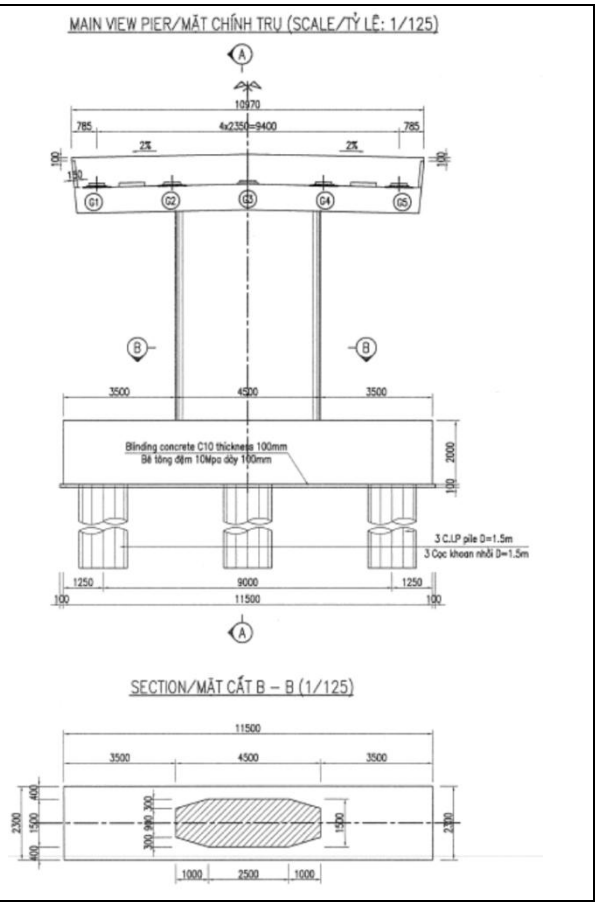


Figure 27 : Typical design of Ship lock piles

Ferry access road

The ferry access cross road will be modified along 50 m because the new main road will be 90 cm higher than the existing one.

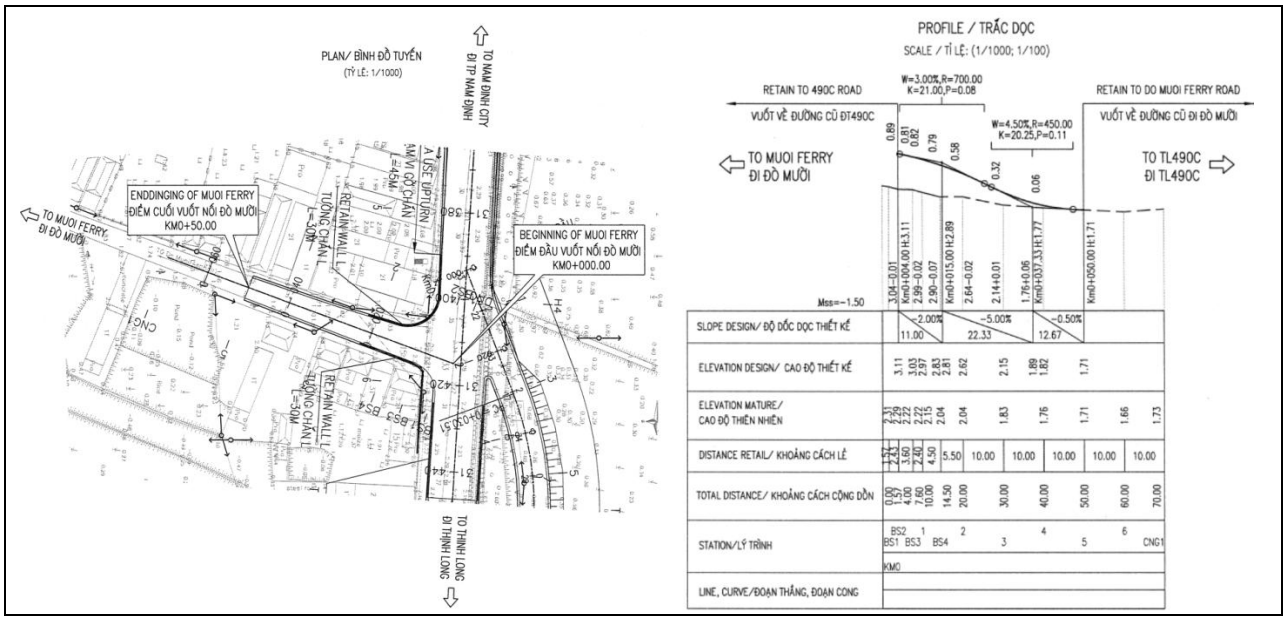


Figure 28 : Design of ferry crossroad access layout and longitudinal profile

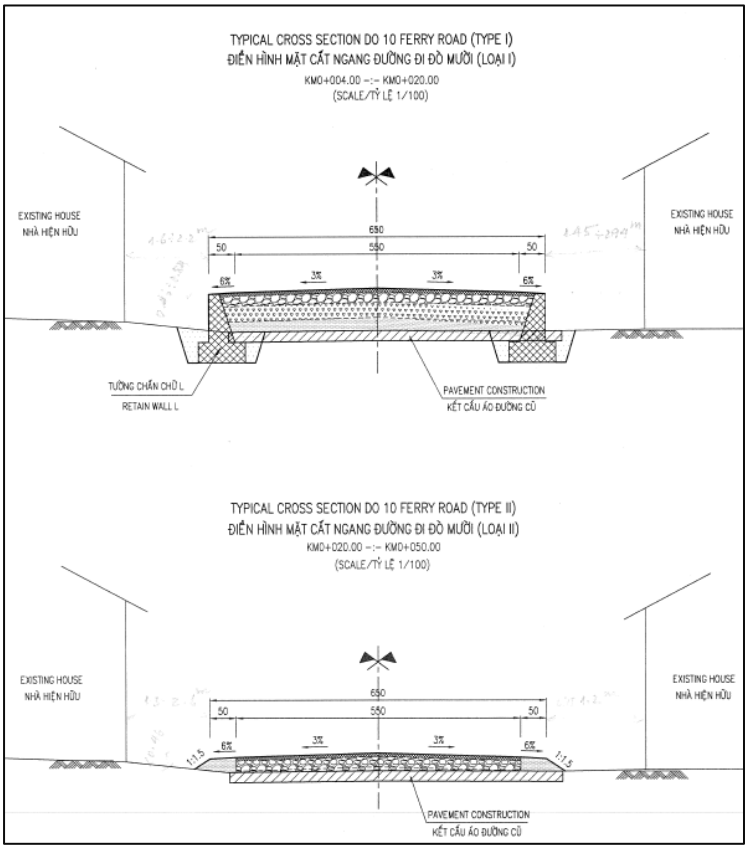


Figure 29 : Design of Ferry crossroad cross section

Temporary junction road during construction phase

A temporary road will be necessary during the road and bridge construction phase to permit the access of the remaining part of the existing road.

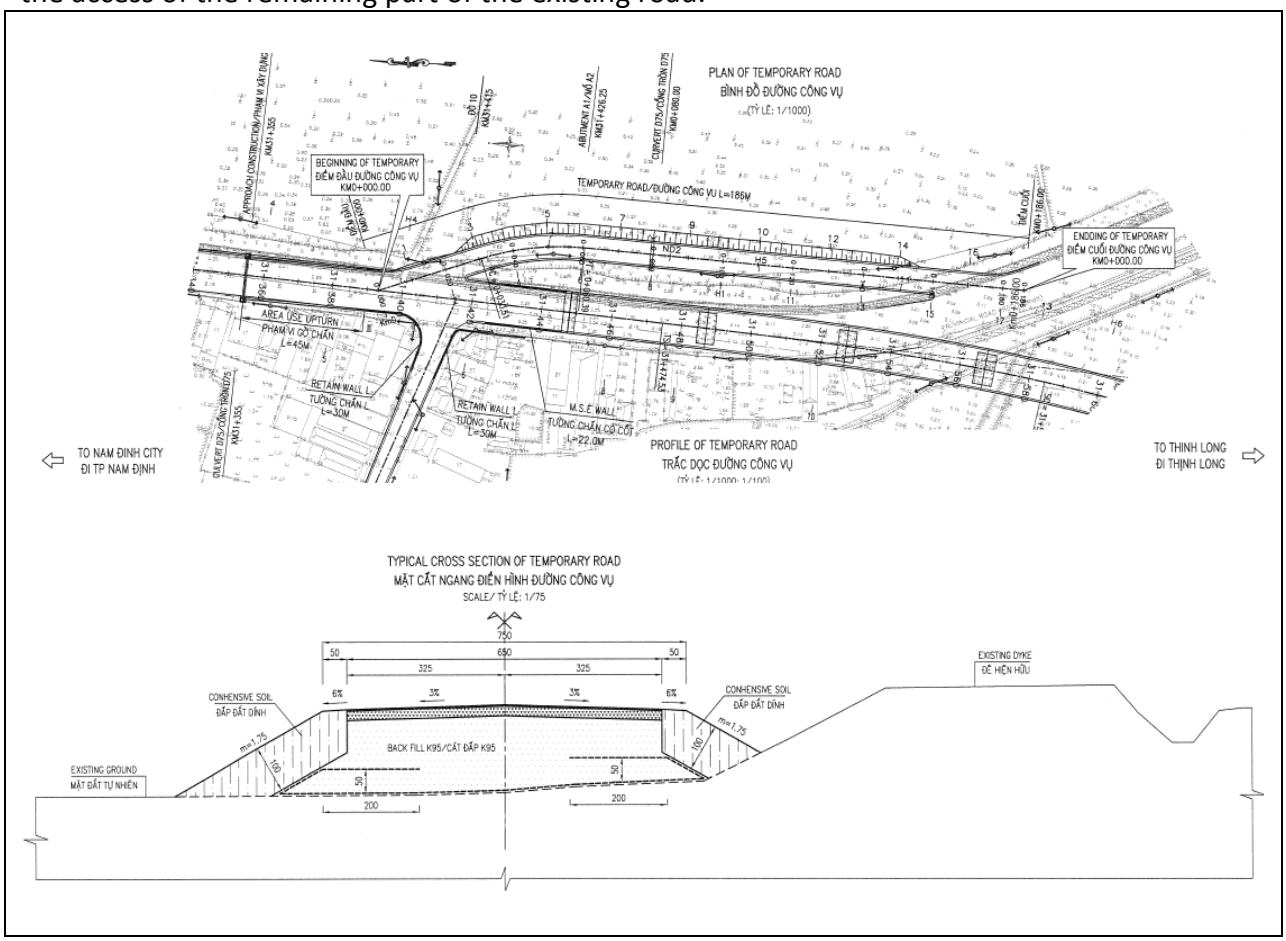


Figure 30 : Layout and cross section of the temporary road at Northern road junction

DNC earthworks and disposal areas

The volume of excavation for the channel at each side and the lock pit is about 1.3 Mm3

For the channel, the stability calculation (See Calculation report) shows:

- The slope has to be 1:4
- A procedure of construction is necessary to assure the stability during the implementation of the protections of banks and the secondary dykes

Procedure of construction:

- 1st phase: implementation of ripraps until the middle of slope
- 2nd phase: Partial water filling of the canal, until the level (-4.0).
- 3rd phase: Completion of banks protection until the top level (+0.5)
- 4ème phase: Water filling until the level (-2.0).
- 5ème phase: Secondary dyke erection. Before the water level increased at the level (-1.0)

For the lock pit, the stability calculation (See Calculation report) shows the necessity of the following design:

- First excavation to the level (-1) –thickness around 1.5m - on a 15m width.
- Excavation to the level (-4.25)with 1:4.5 slope
- Berm of 10m width
- Excavation to the level (– 9.00) with 1:4.5 slope

The main part of the works will be realized in dry conditions:
- Shielded behind the main dykes ((+4.50) at the Day side and (3.50) at the Ninh Co side) for the erection of the lock, the mooring areas and a part of the canal
- After closure of the new main dykes on the lock, shielded behind the secondary dykes (+2.50) for the part of the canal included between main and secondary dykes.

We can consider the following main phases:

- Phase 1: Main excavation between the main dykes - Volume ~ 590 000 m3

- Phase 2: New main Dykes connected with the lock. Removal of the old main dykes and enlargement of the excavation (Volume ~ 500 000 m3) sheltered from secondary dikes for realization of the protections in dry conditions.

- Phase 3: Removal of the secondary dikes and dredging (Volume ~ 210 000 m3) - Underwater realization of the protections.
Considering the impermeability of soils, it isn't planned to have ground waters to evacuate from the pit. On the other hand a pumping device will be necessary to evacuate rainwater.

Under the DNC canal sub-project a total of 1,561,315 m^3 will be excavated or dredged, the bulk of which—1,549,000 m^3—will be excavated or dredged for the Canal and Ship-lock construction. The earthworks for the associated bridge and approach road will mobilize 11,700 m^3 of excavation and 27,800 m^3 of soil filling.

There are 3 existing disposal sites in the project area, including 2 sites located at 2 brick factories, namely Duc Lam and Dong Bang, and the third site being the Lach Giang Southern disposal area. All 3 sites have been approved by MONRE and have obtained the required authorization to operate as such for the purposes of the DNC canal sub-project. The Lach Giang site was included under the NDTDP project ESIA for the Lach Giang works, which was also approved by MONRE. The project proposes using these 3 existing sites to store dredging/excavating materials of DNC canal construction.

Current Status of Disposal Sites

- Lach Giang disposal site: one disposal area in the Southern section of the complex with the purpose of casuarina plantation (financed by the Project) was built to store dredging materials in the Lach Giang bypass access channel sub-project. Although the Lach Giang sub-project was finished, the site has not been fully filled up as per its designed capacity due to lack of soil. At the moment, it can store from 700,000 to 1,300,000 m^3. After it is fully filled up, the Contractor will be responsible to plant casuarina. The site's surrounding area is the sea and it is located far away—1500m—from the nearest residential areas (see figure below).

- Duc Lam and Dong Bang brick factories: the land for disposal sites belongs to the factories. The land is borrowed from communes to produce bricks. Surrounding area is far away 500m from residential areas. Currently, these areas have been used for storing materials to make brick.

All 3 proposed sites have been duly approved and authorized by MONRE.

Environment Impact of disposal sites:

The impacts due to the construction of disposal sites include the dust, odor, and gases generated by dredged sludge, landscape, improper disposal of contaminated excavated materials to the designated disposal site, garbage disposal from surrounding areas; the risks that the disposal sites be used by local people as domestic dumpsite and waste from other construction works nearby; and land subsidence risk at disposal sites during construction.

In order to mitigate environmental impacts caused by disposing dredging materials into the disposal sites, the disposal sites have been designed and designated to avoid impacts on the surrounding environment. Specifically:

- Lach Giang's Southern Disposal area at the Ninh Co Estuary is a 30 ha area with capacity of 700,000 to 1,300,000 m^3. The disposal site is only for materials which contain heavy metal and pesticides level for agricultural land lower than Vietnamese technical regulation QCVN 03-MT:2015/BTNMT and QCVN 15:2008/BTNMT.
- Duc Lam brick factory disposal site has the total area of 25 ha with capacity of 1,150,000 m^3. From the geotechnical survey, this site will accept only clay materials (0-4m from surface) from DNC project.
- Dong Bang brick factory disposal site has the total area of 25 ha with capacity of 900,000 m^3.
- Impact on land subsidence and erosion by formation of disposal sites. For the 3 chosen disposal sites, the geological survey has confirmed a relatively firm and stable foundation. The dredged materials will be disposed at low-lying areas of the sites to the existing elevation of the surrounding area. Therefore, the risk of land subsidence and erosion is low and unlikely. For disposal sites in the brick factories, it will be constructed to the maximum elevation less than 1m than the dike. The risk of erosion should therefore be carefully taken into account in design and construction methods.

- Transport of dredged material to these sites will have potential impacts on sensitive receptors as these activities will create dust, noise, limited access and nuisance, especially for religious, educational and healthcare institutions. A list of those sensitive receptors is shown in Chapter 6 and relevant mitigation measures are presented in Chapter 7.

Uses of the excavated and dredged soil may include:

1. Direct reuse on site for the road construction will absorb 27,800 m^3;
2. Direct reuse by brick factory will absorb 200,000 m^3;
3. The major part of the remaining materials could be temporarily stored for later reuse for bricks production (up to 400,000 m^3) and/or for agricultural lands raising (up to 600,000 m^3) as requested by communes. With 600,000 m^3 of excavated materials requested by communes, the project should make sure that these do not go to small scale brick production units (back-ward technology).
4. If necessary the remaining material (up to 1,300,000 m^3) can be transferred by boat and disposed at Lach Giang's Southern Disposal area at the Ninh Co Estuary.
5. The total disposal areas capacity is 3,350,000 m^3 and is much larger in scope than is needed (approximately 1,500,000 m^3), allowing for a choice of the most suitable and least impacting disposal alternatives.

Even if testing demonstrates that the actual conditions of soil and sediments don't identify any toxic contamination, it is critical to have a management plan for dredging activities, to ensure that any sludge containing toxic materials is removed, transported, and disposed of safely. Any sludge containing heavy metals or other toxic substances exceeding permitted standards will be disposed of in lined, sealed landfill sites, and nearby sensitive receptors will be taken into consideration

In the vicinity of the construction sites 2 major disposal areas are already selected:

a) A major disposal area is available: ***Lach Giang's Southern Disposal area*** in the Ninh Co river mouth estuary. This area, built under the NDTDP project, can be used to store up to 700,000 to 1,300,000 m^3 of soil and sediments. This site is located 16 km (by boat) from the DNC construction site.

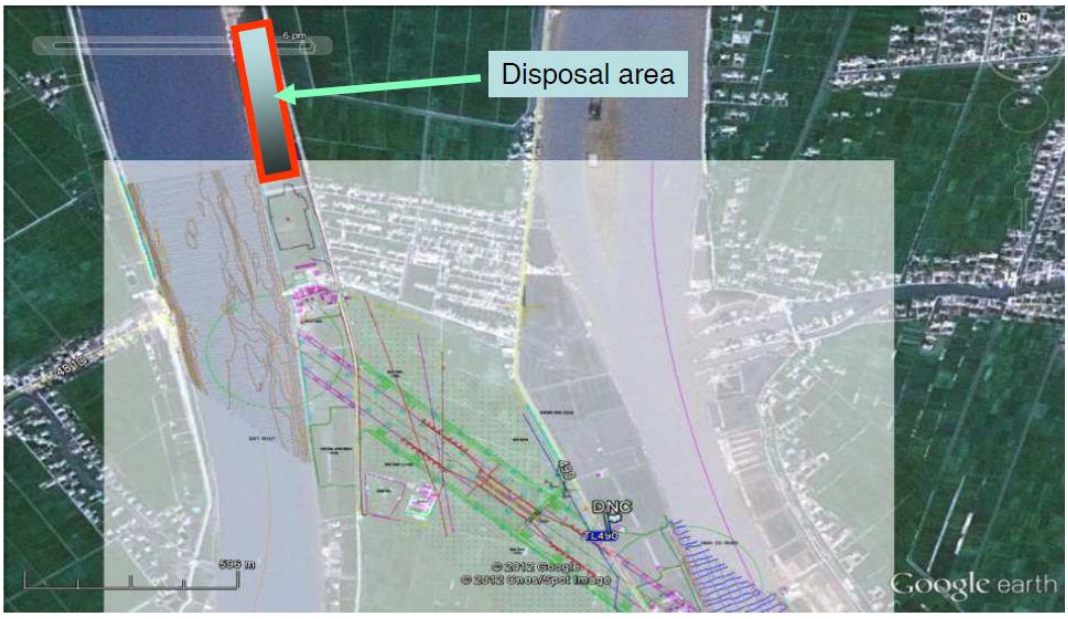
a) Lach Giang Southern Disposal Area (Thinh Long commune)

Total surface: 30 ha **Distance**: About 16 km from Do Muoi

Receiving quantity: 700,000 to 1,300,000 m^3 **Existing work**: Disposal area to be filled

Can accept all dredging soil and sediment

b) Soil disposal area of Duc Lam brick factory on the left side of the Day River for temporary storage of clay to reused for bricks production. The total capacity is 1,150,000 m^3 over 25 ha of surface. From the geotechnical survey, this site will accept only clay materials from DNC project. The maximum quantity to be disposed on this site is estimated about 400,000 m^3;



a) Duc Lam brick factory:

- **Total Surface area:** 25 ha
- **Receiving quantity:** 1,150,000 m^3 (only receive soil from Day river and from 0-4 m)
- **Distance:** about 1 km from Do Muoi
- **Purpose:** to make brick
- **Existing works:** Duc Lam brick fact. near Day river (capacity: 300 m^3/day)

c) Dong Bang brick factory for storage of clay, sand and sediments to be reused for bricks production and later constructions managed by the commune. The total capacity is 900,000 m^3 over 25 ha of surface. The maximum quantity to be disposed on this site is estimated about 400 to 600,000 m^3.

b) Nghia Lac commune:

- **Total Surface area:** 28 ha
- **Receiving quantity:** 900,000 m^3 (can receive all dredging soil & sediment)
- **Distance:** about 3-4 km from Do Muoi
- **Existing works:** Dong Bang brick fact. (capacity: 200 m^3/day), agricultural land & aquaculture near NC river

Table 4- Detailed Construction Equipment Requirements

Equipment Type	Capacity	Minimum Number required					
		Mom Ro	Do Bui	DNC	Viet Tri	Ninh Phuc	Lach Giang
Cutter suction	with minimum of 900 HP	3	3	2	0	0	2
Backhoe Dredger	<1,5m^3	2	1	2	1	1	2
Bulldozer	140 HP	2	2	4	1	1	1
Roller	16 tons	0	0	4	1	1	0
Truck	7 tons	5	3	0	2	2	10
Motor Grader	108 HP	0	0	1	1	1	0
Concrete mixer	250 liters	2	2	0	0	0	0
Concrete batching	60 m3/h	0	1	0	0	0	0
Concrete batching	120 m3/h	0	0	2	1	1	1
Barge	200 T	1	1	1	1	1	10
Barge	400 T	3	3	1	1	1	5
Crane	16 tons	1	1	2	1	1	2
Crane	25 tons	1	1	2	2	1	2
Crane	100 tons	0	0	0	0	0	1
Crane	150 tons	0	0	0	0	0	1
Piling driving machine	2,5 tons (weight of the dynamic part)	0 / 2	2	3	1	1	0
Excavator	2.3 m^3	2	2	2	1	1	1
Electric generator	50 Kw	1	1	1	1	1	1
Pump	0.4-1 Kw	2	2	2	0	0	0
Laboratory		1	1	1	1	1	1

Table 5- Detailed Construction Manpower Requirements

Position	Minimum Number required					
	Mom Ro	Do Bui	DNC	Viet Tri	Ninh Phuc	Lach Giang
Contract Manager	1	1	1	1	1	1
Administrative Manager	1	1	2	1	1	1
Quality Control Manager [QC Manager]	1	1	1	1	1	1
Quantity Engineer [or Quantity Surveyor] or equivalent	1	1	1	1	1	1
Safety Person	1	1	2	1	1	1
Dredging master	1	1	1	1	1	1
Spoil relocation area master	1	1	1	0	0	1
Land Excavation and works master	1	1	1	1	1	1
Materials Engineer	1	1	1	1	1	9
Environmental Management Officer [EMO]	1	1	1	1	1	9
Shop Drawing Engineer / Surveyor	2	2	2	1	1	9
Workers	30	30	100	30	30	100
Total	42	42	114	40	40	135

4. NATURAL, ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

4.1. GEOGRAPHICAL AND GEOLOGICAL CONDITIONS

4.1.1. Geography

All the projects for Corridor 3 - excepted Viet Tri Port - are located in the Red River (also call Song Hong in Vietnamese) Delta.

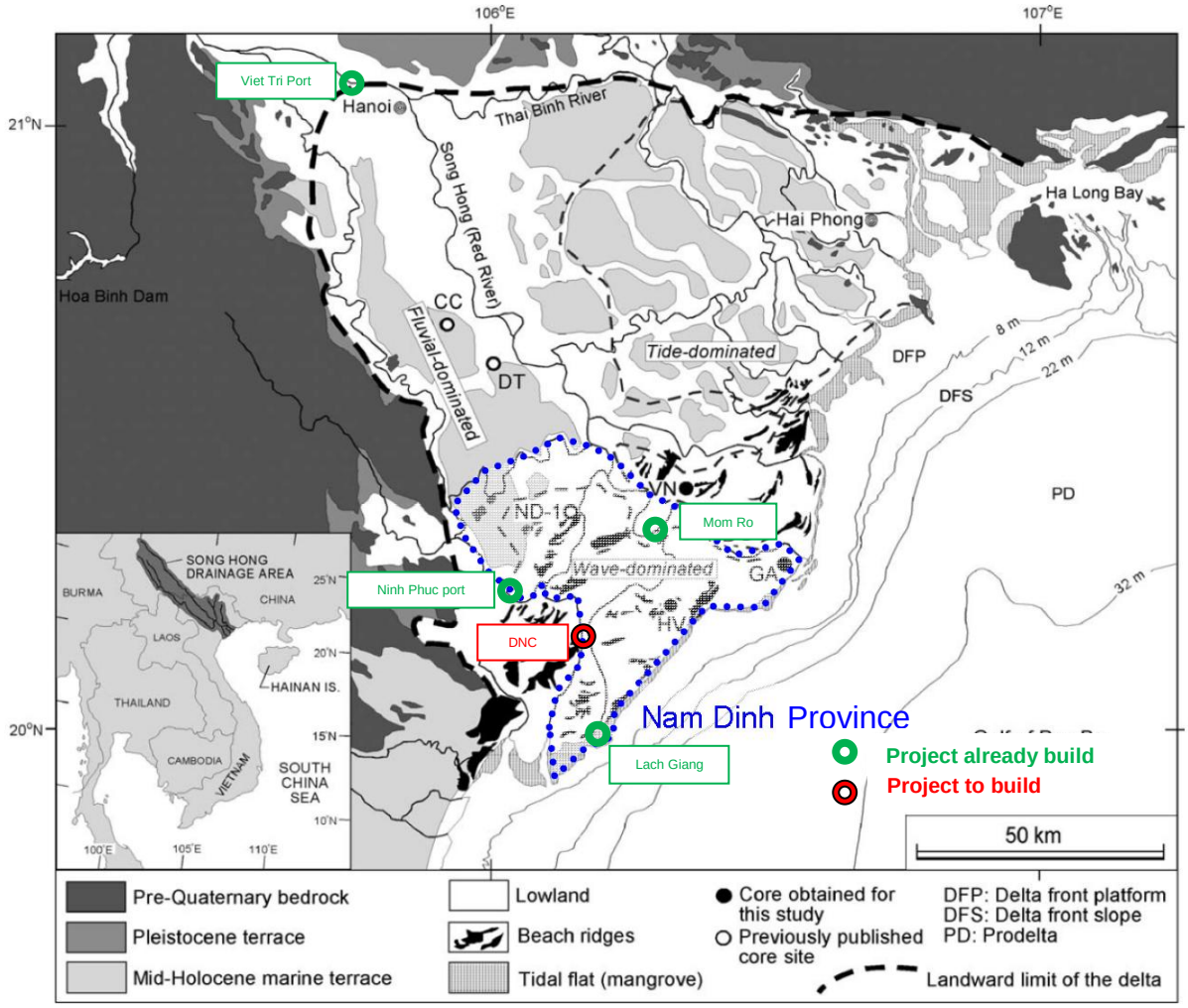


Figure 31 : Red river delta and location of projects area for Corridor 3

(Source: Assessment of Groundwater Resources in Nam Dinh Province – 2011)

The Red River is about 1,200 km long, originates in the mountains of Yunnan Province in China and enters Vietnam close to the Laos border. It has two main tributaries, the Song Lo, also called the Lo River or the Clear River, and the Song Da, also called the (Black River) which contributes to the high water volume of the Red River.

Viet Tri Port is located upstream on the Lo River, the last important Red River Tributary's before the Red River Delta. All the other projects sites are located in the Red River Delta (RRD) and are located within the boundaries of include in Nam Dinh and Ninh Binh provinces. They concern Day-Dao rivers confluence, Day River and Ninh Co River. **The DNC project includes the Day River on the right side and the Ninh Co River on the left side.**

Table 6: Rivers concerned by the DNC project

Project areas	Lo River	Dao River	Day River	Ninh Co River
DNC canal			**X**	**X**

Nam Dinh province is covered with a dense surface water network consisting of natural rivers and artificial channels with a general flow direction from NW to SE. The channel network is increasing in density towards the coastal Nam Dinh area and has crucial relevance for irrigation of paddy fields and other agricultural areas with river water as well as discharge of sewage and waste waters to the sea.

The Day River follows the W-shaped border of Nam Dinh with 400-500 m width and 45 km length, coming from the Triassic limestone recharge area in Ninh Binh province.

Four major rivers are located within or at the border of Nam Dinh province, the Red River along the NW border of Nam Dinh with his river mouth at the Ba Lat estuary, the Dao River connecting the Red and the Day Rivers (SW border of Nam Dinh) and the Ninh Co River with its river mouth to the sea at Lach Giang estuary.

From Nam Dinh city to the Red River mouth, the Red River bed has 54 km lengths and is estimated to be 400–500 m wide and about 10-15 m deep.

The geography of the study area indicates that the total basin area is 143,700km2, including 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 1,130km 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 Dien Bien Provinces. The Da River 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 south-easterly valley that is controlled by a major geologic structure, the Red River Fault.

The entire delta region, backed by the steep rises of the forested highlands, is no more than three meters above sea level, and much of it is one meter or less. The area is subject to frequent flooding; at some places the high-water mark of floods is fourteen meters above the surrounding countryside. For centuries flood control has been an integral part of the delta's culture and economy. An extensive system of dikes and canals has been built to contain the Red River and to irrigate the rich rice-growing delta. Modeled on that of China, this ancient system has sustained a highly concentrated population and has made double-cropping wet-rice cultivation possible throughout about half the region.

The width of the Red River varies from more than a kilometer at the segment below the Lo River Confluence to about 200 meters as it approaches the coastline.

Evidence of active meandering in the past is indicated by ancient meanders, buried abandoned river channels and outlines of oxbows are discernible in aerial photos and satellite imageries.

However, present day meandering has been controlled by the extensive network of protective dikes. Large mid-channel shoals, elongated shoals parallel to the river course and occasional islands are among the depositional feature of the river. Active deposition of sediment within the channel has caused shallowing which severely limits navigation in some sections of the river system.

Active bank erosion is occurring in certain sections of the Red River Delta contributing to the river's sediment load.

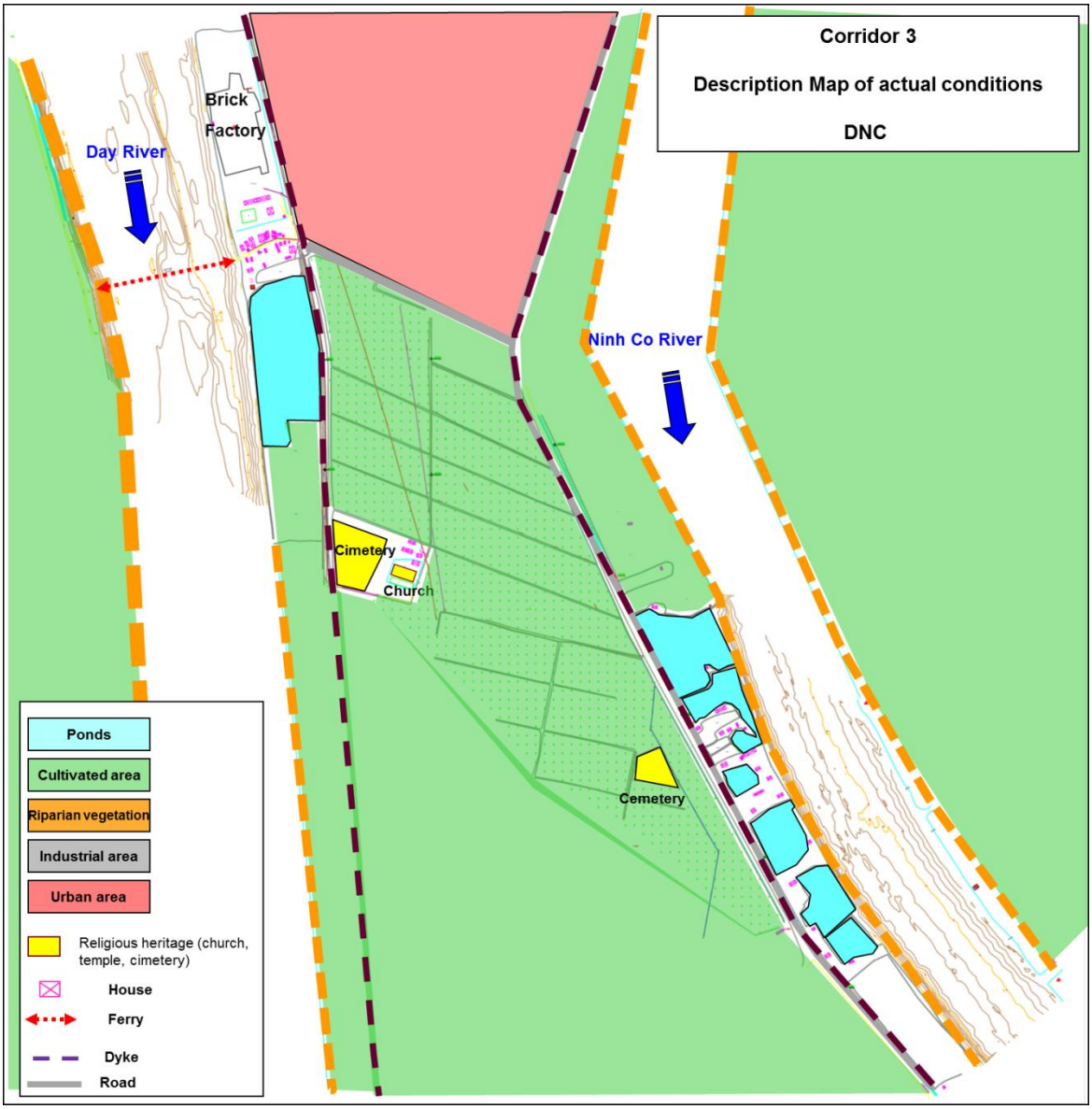


Figure 32 : DNC aera actual condition map – land occupation

4.1.2. Geology

The geologic map where the project sites are located is shown in Figure 33 below.

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

The pre-cenozoic basement of the NW trending Red River basin began to subside in Neocene time, initiated by the strong uplift of the Proto-Himalayan mountain chain. High erosion rates resulted in the mobilization of huge amounts of material, which was collected by the tributaries of the major receiving river systems and transported to the Gulf of Tonkin; recent erosion rates reach approximately 130 Million tons of sediments per year (TANABE et al. 2003b). During millions of years, deposition and accumulation at the river mouth in combination with ongoing subsidence of the Red River basin finally resulted in the formation of the huge River Delta complex.

The axis of the Red River basin is marked by the Red River fault which splits into two branches the northeaster Song Chay fault, and the south-western Song Hong (Red River) fault (SEARLE 2006). These two faults bound the Ailao Shan–Red River shear zone.

The central basin axis contains more than 3 km of Neocene sediments along a narrow 30-50 km wide graben (MATHERS et al. 1996; MATHERS et al.1999). The graben is thought to have subsided totally about 6 km over the last 50 million years resulting in a maximum long-term subsidence rate of the 0.12 mm/a (MATHERS et al. 1996) of the central part of the basin.

The river course and the narrow drainage area are regulated by the NW–SE aligned Red River fault system.

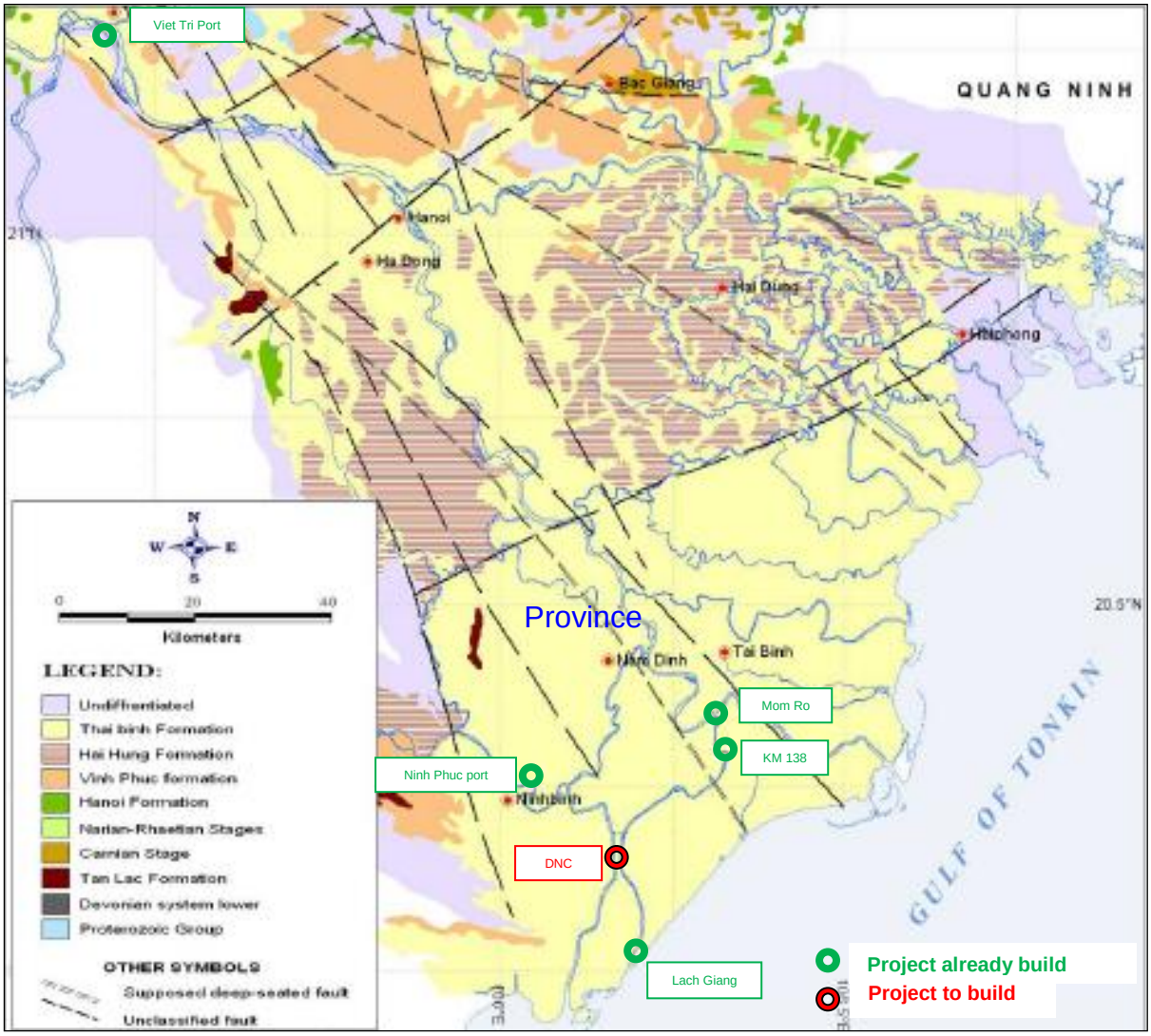


Figure 33: Geologic Map of the Corridor 3 Study Area

(Source: Geology and Mineral Resources Map of the Department of Geology and Minerals of Vietnam)

The typical geologic formations on the study area are:

Proterozoic Group -This group consists of very old (2,600 to 570 million years before preset) crystalline and metamorphic rocks. This could be considered as the basement of the Red River Delta.

Lower Devonian - This formation consists mainly of white-gray, brown gray sandstone, siltstone, clay shale and grit stone with local interbeds of limestone and sericite schist. This formation is about 400 million years old before present.

Carnian Stage (Upper Triassic) – This is characterized by fine grained red continental sediments grading upward to medium and coarsed grained sediments, then more or less carbonate sediment. This formation is about 220 million years old.

Norian-Rhaetian Stage – Van Lang Formation, this consists of quartz conglomerate and grit stone, medium-grained, medium to thick bedded sandstone, violetish-gray clay shale with some interbeds

of grit stone, bearing plant remains. Upper part is composed of dark gray siltstone, gray sandstone interbedded with black-gray coaly shale.

Hanoi Formation – This formation is less than two (2) million years old. This consists of two (2) origin types, the fluvial sediments and the fluviproluvial sediments. The former consists of coarse grained beds composed of pebble, grit intercalated with some sand and silt with thickness of more or less two (2) meters. The latter is made up of quartz pebble, granule, sand mixed with some silt.

Vinh Phuc Formation – Upper Pleistocene, this formation is less than a million years old. This formation is composed of two (2) origin types, fluvio marine and marine sediments.

Hai Hung Formation – Lower-Middle Holocene, this is very young formation in the geological sense. This is about 11,000 calendar years old. It is made up of four (4) origin types, the fluvio-marine sediments, marine marshy sediments, marine sediments and the Lacustrine-marshy sediments.

Thai Binh Formation – Upper Holocene, this formation is younger still, less than 10,000 years old. It is composed of six (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 during this geologic time.

Undifferentiated Quaternary – this is the youngest formation composed of unconsolidated sediments occurring in rivers.

As indicated in the geologic map, the project area traverses predominantly the young geologic formation of the Thai Binh Formation. Given the varying depositional environment, sediment characteristics can vary from clay to sand to mixtures of clay-sand-silt of varying proportions.

Susumu et al. (2006) described the deltaic evolution during the Holocene based on the results of drill cores obtained from the Red River Delta. Their interpretation of the cores indicated that during the past 9000 years, Song Hong's sediments filled the incised valleys and with rapid advancement of the river mouth. The river mouth advanced towards the gulf and the delta went through a series of morphological evolution, from funnel-shaped (9 – 6 cal. Kyr BP) to straight (6 – 2 cal. kyr BP) and finally to lobate (2 – 0 cal. kyr BP). The morphological change is presumed to be influenced by the shift in hydrologic condition from a tide dominated bay-head setting to a wave-influenced open-coast setting. The authors inferred that cessation of the sea-level rise at 6 cal. kyr BP had little influence in the change of river mouth morphology because the pro-gradation rate decelerated from 22 to 4 m/yr, instead of accelerating at that time. Further, it was interpreted by the authors that the river-mouth morpho-dynamic change from straight to lobate was largely caused by an increase in the Song Hong sediment discharge from 17 – 27 (9 – 2 cal. kyr BP) to 49 million t/yr (2 – 0 cal. kyr BP) as a result of anthropogenic deforestation along the upper reaches of the Song Hong (Susumu Tanabe et al., 2006).

This interpretation is supported by the results of the palynological study done in the Red River Delta. Pollen records showed intensified human activities after 3340 cal. yr BP as indicated in the records by large quantities of cultivated Gramineae taxa, possibly including the main wet rice species*, Oryza sativa*, secondary forest, and other upland cultivated plants (Zhen Li et al., 2006).

Authors estimate that fault movements are considered to be minor at least since the late Miocene. RANGIN et al. (1995, in SEARLE 2006) suggested minimal or no post-Pliocene displacement based on offshore seismic data from the extension of the Red River fault into the Gulf of Tonkin. SEARLE 2006 estimates that left-lateral shearing along the Red River fault in North Vietnam initiated around 21 Ma and ended at 5.5 Ma.

Geomorphology of the RRD plain can be divided into wave-, tide-, and fluvial-dominated systems on the basis of surface topography and hydraulic processes. Except for the Red River bank area, large parts of the geomorphology of Nam Dinh is supposed to be wave-dominated.

4.2. METEOROLOGICAL CHARACTERISTICS

The corridor 3 study area is characterized has a subtropical monsoon climate with a pronounced maritime influence. The humidity reaches over 80% throughout the year. This typical North Vietnamese climate dominates the microclimate of Nam Dinh province with bit cooler temperatures and a higher humidity in the vicinity to the sea. The average annual rainfall is 1600-1800 mm, 85% of which occurs during the rainy season (April to October). The heaviest rainfall occurs from July to September, causing extensive flooding in the delta due to the overflow of riverbanks. The prevailing winds are north and east in winter, and south and southeast in summer. From June to the end of September, the coast of the Red River delta is regularly affected by typhoons, which give rise to strong winds, heavy rainfall and storm surges, accompanied by high waves. The winters are cool and dry, with mean monthly temperatures varying from 16.3 to 20.9°C. During the winter or dry season (November - April), the monsoon winds usually blow from the northeast along the China coast and across the Gulf of Tonkin, picking up considerable moisture. Consequently the winter season in most parts of the country is relatively dry in comparison to the rainy or summer season. Lowest daily average temperatures are met in January and February with 10 to 13°C and average humidity can be "relatively low" with ~94% (November-December), but also reach highest average humidity with up to 98% (January- March). The monthly average rainfall varies between 86.9 and 118 mm. Fine drizzle is frequent in early spring, after which temperatures rise rapidly to a maximum of 40°C in May. The summers are warm and humid, with average temperatures varying from 27°C to 29°C. The south-westerly summer monsoon from May to October is associated with hot temperatures and heavy rain falls. Maximum daily average air temperature occurs generally in June and July varying from 29 to 31°C. The lowest relative humidity is 86.5% and the highest relative humidity is up to 92% in July, while the monthly average rainfall lies between 87.1 within 427.6 mm.

- Average temperature of year : 24° C,
- Annual rainfall average from 1100 to 1800 mm.
- Average humidity is relatively high of year: 83 - 85 %.

Table 7: Air quality analysis in Ninh Co /Day River area – 06-11/02/2012 (CNR/VIPO)

Sample name	Unit	QCVN	Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
Sampling area			DNC canal				
Sample symbol			6-A28	6-A34	6-A35	6-A36	6-A37
Coordinates			20°8.579' 106°10.525'	20°8.779' 106°10.152'	20°8.099' 106°10.238'	20°8.018' 106°10.695'	20°7.646' 106°10.836'
Sampling time			9h00	10h00	11h20	10h30	11h30
Sampling date			11/2/2012	10/2/2012	10/2/2012	11/2/2012	11/2/2012
Weather at the sampling time			Cloudy	Cloudy	Cloudy	Cloudy	Cloudy
Temperature	oC		18.5	18.4	17.5	18.6	18.7
Humidity	%		85.50	85.65	84.90	91.30	80.25
Wind speed	m/s		0.90	0.90	0.95	2.45	1.20
Wind direction			NE	NE	NE	NE	NE
Noise	dBA	70(a)	68.8	59.5	51.7	61.8	58.7
Vibration	dB	75(b)	52	52	52	52	52
TSP	ug/m3	300(c)	76	36	40	51	73
PM10	ug/m3	-	37	20	26	24	34
Pb	ug/m3	-	<0.1	<0.1	<0.1	<0.1	<0.1
SO2	ug/m3	350(c)	83	40	52	46	41
CO	ug/m3	30000(c)	7200	5800	5100	4900	5200
NOx	ug/m3	200(c)	67	46	60	42	45
VOCs	ug/m3	-	21	18	20	19	21

An update of baseline pollutant emissions, noise, and vibration data was carried out in December 2015. The results below confirm the previous data assessment, undertaken in February 2012.

- The average noise during one hour fluctuates from 60.1 to 65.4 dBA. It meets the allowable limit as per National Technical Specification QCVN 26:2010/BTNMT on the noise in regular areas from 6 am to 9 pm.
- The average vibration during one hour fluctuates from 51.7 to 68.8 dB which meets the allowable limit as per National Technical Specification QCVN 27:2010/BTNMT on the vibration in constructed areas from 6 am to 9 pm.
- The total suspended particulates (TSP) during 1hour fluctuate from 36 to 76 ug/m^3 which is within the allowable limit as per National Technical Specification on surrounding air quality QCVN 05:2009/BTNMT.
- The average SO_2 content during 1hour fluctuates from 40 to 83 ug/m^3. It meets the allowable limit as per National Technical Specification on surrounding air quality QCVN 05:2009/BTNMT
- The average CO content during 1hour fluctuates from 4900 to 7200 ug/m^3 which meets QCVN 05:2009/BTNMT
- The average NO_x content during 1hour which fluctuates from 42 to 67 ug/m^3 meets QCVN 05:2009/BTNMT
- The average VOCs content during one hour fluctuates from 18 to 21 ug/m^3 which meets QCVN 05:2009/BTNMT

It can be judged that the air environment quality in project site at the survey time is good. The concentration of pollutants in surrounding air is within the allowable limit of Vietnamese specifications on environment.

Table 8: Air quality analysis in Ninh Co /Day River area – 09/12/2015 (CNR/VIPO)

Client: VIPO Trading and Investment Consultant Joint Stock Company **Project: Northern Delta Transport Development Project (NDTDP)**		
Sample: Ambient air, noise, vibration		**Symbols**: A1, A2, A3, A4
Date:	Sampling date: 09/12/2015 Analyzing date: 09 - 18/12/2015	**Analysts**: Eng. Nguyen Manh Tu Eng. Vu Ba Hai
Sampling location: DNC connecting canal bridge project **Address:** Nghia Son + Nghia Lac commune – Nghia Hung district – Nam Dinh province		

Sampling Locations

No.	Code	Sampling positions	Sampling time	Coordinate
1	A1	At starting point of the project from residential area + 200m to the North	10h00	20. 14198° N 106.17488° E
2	A2	At starting point of the project Km31+285	10h35	20. 13976° N 106.17486° E
3	A3	At Cathedral parish of Han family	13h00	20. 13554° N 106.17251° E
4	A4	At ending point of the project km33+260	11h00	20. 12836° N 106.18164° E

Analysis Results

No.	Parameter	Unit	A1	A2	A3	A4	QCVN 05:2013/ BTNMT	QCVN 26:2010/ BTNMT	QCVN 27:2010/ BTNMT	QCVN 06:2009/ BTNMT
1	TSP	µg /m3	20.3	20.8	21.8	21.6	300			
2	CO	µg /m3	2854	2894	2814	2879	30000			
3	NO2	µg /m3	87	88	85	86	200			
4	SO2	µg /m3	121	122	123	119	350			
5	VOCs	µg /m3	34	33	31	35	-			5000
6	Noise Leq	dBA	62.1	60.1	65.4	65.1	-	70		
7	Vibration	dB	62.4	63.8	60.8	62.5	-	-	75	

4.3. HYDROLOGIC CHARACTERISTICS

The water discharge of the Red River varies strongly in terms of the season. The discharge at Ha Noi station reaches a maximum in July–August (about 23 000 m^3/s) and a minimum during the dry season in January to May with typically 700 m^3/s (TANABE et al. 2003). The maximum measured discharge (within the validated span of values) in Hanoi has a value of 14 800 m^3/s recorded on the 20th of August 1996. The minimum measured discharge has a value of 387 m^3/s and was recorded on the 12th of February 2008.

Maximum flow rate has been observed in August with 14 800 $m^{3/}s$; lowest flow rate can be almost zero (no flow) in December and January, yearly average is 387 m^3/s. Although the downstream part of the river is tidal influenced, salinity monitoring has shown that total salinity is generally <1g/l (NGUYEN VAN DO 1996a). Thus, the fresh-salt water boundary is estimated to be close (20 km) to the sea, which can be explained by a high hydraulic gradient and flow rate of the river. The high hydraulic gradient is caused by a W tributary of the Day River, the Boi River, who is discharging a large mountainous area in the NW of Nam Dinh Province.

Table 9 : Estimation of sediment delivery (Haskoning, 2003).

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

Source: Haskoning 2003

New land is continuously being created at a rate of about 100 meters a year through the deposition of sediments supplied by the rivers (Haskoning 2003). The information on sedimentation rate and longshore sediment transport are key inputs in the technical feasibility analysis of the river mouth improvement options for Ninh Co River and Day River.

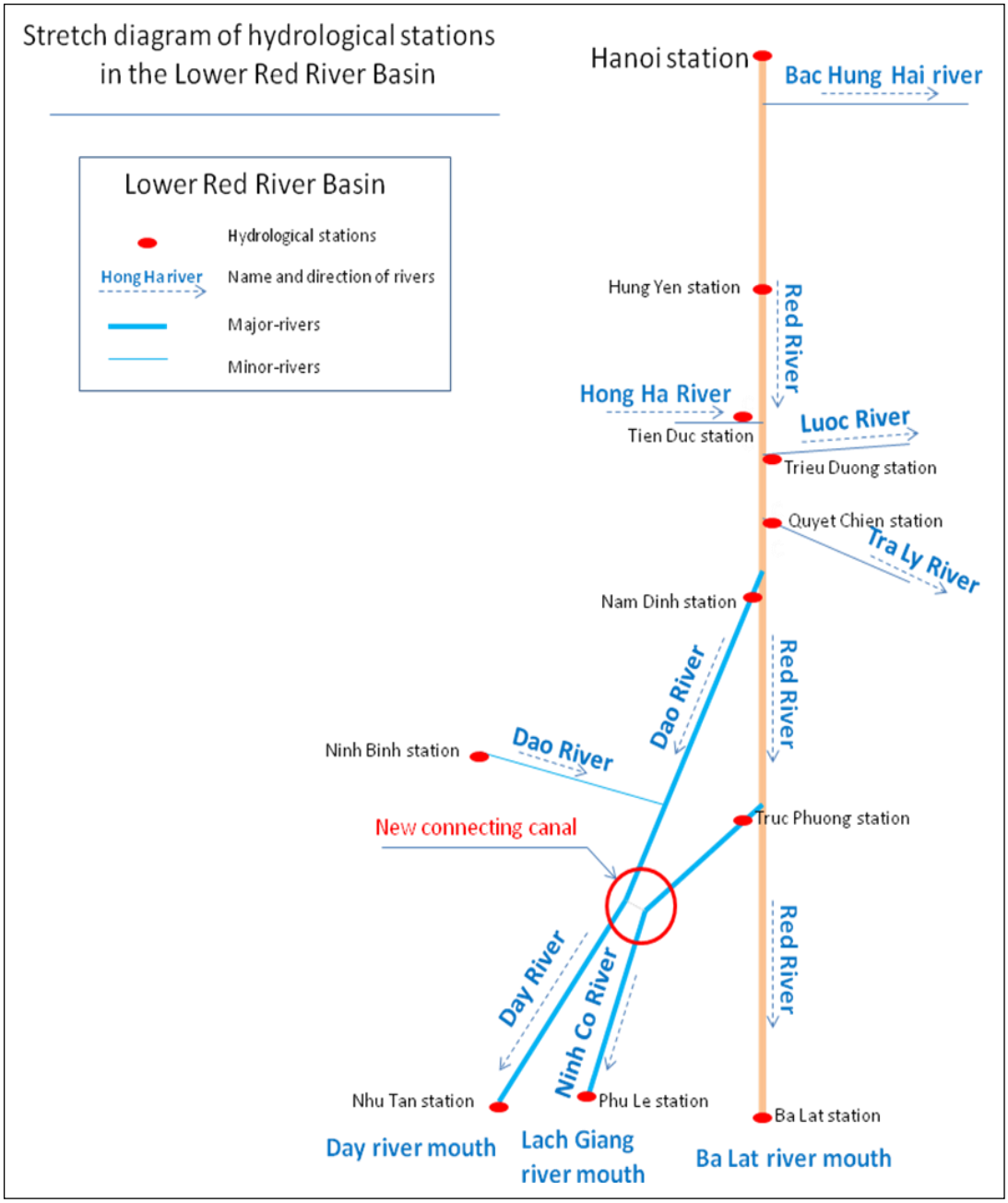


Figure 34 : Location of the hydrological stations

4.3.1. Red River, Ninh Co River and Day River in Ninh Binh Province

Red River:

The available dataset at Hanoi consists of water levels measurements from 1991 to 2010. Water levels were delivered in hourly time series and maximum and minimum values for each year.

95% of the time water levels at Hanoi are higher than 154 cm
5% of the time water levels are higher than 995 cm.

The discharge at Hanoi is higher than 757 m^3/s in 95% of the time and higher than 8570 m^3/s in 5% of the time (data of 1991-1992 + 1995-1996 + 1999-2000).

The extreme yearly maximum and minimum discharges were selected to create the input data set for determining the design discharge for the return period of 20 years using several theoretical extreme values probabilistic laws.

Table 10 : Gumbel laws.

Return period = 20 years	GUMBEL law	GAUSS law	PEARSON III law
High Discharge	15 220 m3/s	14 720 m3/s	
Low Discharge		378 m3/s	

Ninh Co River:

- Upstream:

Truc Phuong station is located upstream of the Ninh Co River, close to the bifurcation with the Red River. The distance along the Ninh Co River between this station and the coast is about 60 km.

+ Water level (data from 1991 to the end of 2010): The maximum measured water level is 314 cm (recorded on the 23rd of August 1996). The minimum measured water level is -94 cm (recorded on the 5th of March 2005). There are 95% of the time water levels at Truc Phuong are higher than -36 cm and 5% of the time water levels are higher than 171 cm.

The distribution function of the tidal high and low water levels at Truc Phuong: 95% of the time the low water level is higher than -63 cm and 5% of the high water levels is than 195 cm.

Water level for a return period of 20 years at TRUC PHUONG station:

HWL (5 %) = 300 cm

LWL (95 %) = - 90 cm

+ Flow discharges (data from 2001 to 2010): The maximum measured discharge in Truc Phuong has a value of 990 m^3/s recorded on the 12th of August 2008. The minimum measured discharge has a value of -226 m^3/s and was recorded on the 9th of April 2008. The discharge at Truc Phuong is higher than -68.8 m^3/s in 95% of the time and higher than 503 m^3/s in 5% of the time.

Discharges for a return period of 20 years at TRUC PHUONG station:

HWL (5 %) = 1 100 m3/s

LWL (95 %) = - 240 m3/s

+ Velocity (data from 1996-2010): 95% of the time velocity at Truc Phuong is higher than -0.056 m/s and 5% of the time water levels are higher than 0.375 m/s.

- Downstream:

Phu Le station is located at the mouth of the Ninh Co River (Lach Giang), 6.5 km upstream from the coast. Only water levels were delivered for this station (data from 1991 to 2010).

The maximum measured water level is 258 cm (recorded on the 26th of September 2005). The minimum measured water level is -134 cm (recorded on the 2nd of January 1991).

The distribution function of the hourly water level at Phu Le: 95% of the time hourly water levels at Phu Le are higher than -78 cm and 5% of the time hourly water levels are higher than 119 cm.

Water level for a return period of 20 years at PHU LE station:
HWL (5 %) = 225 cm
LWL (95 %) = - 128 cm

4.3.2. Dao River in Ninh Binh Province

*** Nam Dinh station:**

Nam Dinh station is located upstream in the Dao River close to the bifurcation with the Red River.

+ Water level (data for the period 1967-1982 and 1991-2009): The maximum measured water level is 537 cm (recorded on the 22nd of August 1971). The minimum measured water level is -48 cm (recorded on the 13th of April 1970 and on the 27th of March 1974). 95% of the time water levels at Nam Dinh are higher than 8 cm and 5% of the time water levels are higher than 300 cm.

Water level for a return period of 20 years at NAM DINH station:
HWL (5 %) = 480 cm
LWL (95 %) = - 50 cm

*** Ninh Binh station:**

Ninh Binh station is located along the Day River, about 13.5 km upstream of the confluence of the Day and Dao Rivers.

+ Water level (data for the period 1967-1982): The maximum measured water level is 321 cm (recorded on the 25th and 26th of July 1980). The minimum measured water level is -47 cm (recorded on the 11th of March 1977). 95% of the time water levels at Ninh Binh are higher than -4 cm and 5% of the time water levels are higher than 194 cm.

Water level for a return period of 20 years at NINH BINH station:

HWL (5 %) = 342 cm
LWL (95 %) = - 50 cm

*** Doc Bo station:**

Doc Bo station is located on the Day River, close to the bifurcation with the Dao River.

+ Water level (data for the period 1967-1982): The maximum measured water level is 322 cm (recorded on the 23rd of August 1971). The minimum measured water level is -50 cm (recorded on the 13th of April 1970). 95% of the time water levels at Doc Bo are higher than -6 cm and 5% of the time water levels are higher than 181 cm.

Water level for a return period of 20 years at DOC BO station:
HWL (5 %) = 280 cm
LWL (95 %) = - 63 cm

*** Nhu Tan station:** Nhu Tan station is located at the mouth of the Day River, 4 km upstream the sea.

+ Water level (data for the period 1967-1982): The maximum measured water level is 245 cm (recorded on the 18th of July 1971). The minimum measured water level is -140 cm (recorded on the 25th of May 1971). 95% of the time water levels at Nhu Tan are higher than -57 cm and 5% of the time water levels are higher than 103 cm.

Water level for a return period of 20 years at Nhu Tan station:

HWL (5 %) = 220 cm

LWL (95 %) = - 100 cm

4.3.3. Day and Ninh Co rivers close to DNC

The characteristics values at each side of DNC canal have been computed:

- at DNC canal, side Ninh Co river (X = 10,09 km), from linear interpolation between characteristic levels calculated at PHU LE (X = 0 km) and TRUC PHUONG (X=39,09 km). So $H_{DNC/NCO} = H_{PLE} + \frac{H_{TPH} - H_{PLE}}{X_{TRP} - X_{PLE}} \times (X_{DNC} - X_{PLE})$

- at DNC canal, side Day river (X = 23,95 km), from hourly water levels. These hourly water levels have been calculated by linear interpolation between hourly water levels measured at NHU TAN (X = 0 km) and DOC BO (X= 42,6 km). So $H_{DNC/DAY} = H_{NTH} + \frac{H_{DBO} - H_{NTH}}{X_{DBO} - X_{NTH}} \times (X_{DNC} - X_{NTH})$

Table 11 : Summarized characteristics water values (cm) computed from the 4 stations and DNC canal.

	X - km	Min	98%	95%	Mean	10 %	5 %	4 %	2 %	Max
NINH CO river PHU LE station (PLE) WL cm period (1991-2010)	X = 0	-134	-91	-78	21	100	119	125	135	258
NINH CO river DNC canal (DNC) WL cm period (1991-2010)	X = 10,09	-124	-80	-67	32	112	132	139	152	272
NINH CO river TRUC PHUONG station (TPH) WL cm period (1991-2010)	X = 39,09	-94	-50	-36	65	147	171	181	200	314
DAY river NHU TAN station (NTH): WL cm period (1967-1982)	X = 0	-140	-67	-57	22	87	103	106	117	245
DAY river DNC canal (DNC) WL cm period (1967-1982)	X = 23,95	-53	-24	-14	53	**132**	**148**	**152**	166	280
DAY river DOC BO station (DBO) WL cm period (1967-1982)	X = 42,6	-28	6	16	78	180	203	210	228	344

Remarks:

1) At DNC canal: Characteristic water levels of Day river are higher than characteristic water levels of Ninh Co river. The main reasons are that: i) the length of Day river between DNC canal and the mouth is higher than the linear of Ninh Co river between DNC canal and Lach Giang, ii) the discharge of Day river is higher than the discharge of Ninh Co river.

2) For the navigation under the bridge, air clearance = 15 m. The level of the bridge at the location of the rectangle of navigation must be higher than reference water level H5% (1,48 mND) + 15 m = 16,48 mND

The table below gives, per year, the number of hours and days during the water level is higher than H5%:

date	hours	days	hours / day
31/12/67 23:00	143	31	4.61
31/12/68 23:00	493	75	6.57
31/12/69 23:00	397	47	8.45
31/12/70 23:00	414	68	6.09
31/12/71 23:00	1244	113	11.01
31/12/72 23:00	348	62	5.61
31/12/73 23:00	895	105	8.52
31/12/74 23:00	148	34	4.35
31/12/75 23:00	219	41	5.34
31/12/76 23:00	29	11	2.64
31/12/77 23:00	141	26	5.42
31/12/78 23:00	640	78	8.21
31/12/79 23:00	411	54	7.61
31/12/80 23:00	680	67	10.15
31/12/81 23:00	307	66	4.65
31/12/82 23:00	354	56	6.32
total	6863	934	
moyen	429	58	7.35

In average per year, 7 hours/day during 58 days. So, the vessels can pass always under the bridge but, during 58 days/year, the vessels are obliged to wait during 7 hours /day.

3) The new road must be higher than reference water level H4% (1,52 mND).

4.3.4. Ninh Co River Mouth area

Phu Le station is located at the mouth of the Ninh Co River (Lach Giang), 6.5 km upstream from the coast.

+ Water level (data from 1991 to 2010): The maximum measured water level is 258 cm (recorded on the 26th of September 2005). The minimum measured water level is -134 cm (recorded on the 2nd of January 1991). 95% of the time hourly water levels at Phu Le are higher than -78 cm and 5% of the time hourly water levels are higher than 119 cm.

Water level for a return period of 20 years at PHU LE station:

HWL (5 %) = 225 cm

LWL (95 %) = - 128 cm

4.4. TOPOGRAPHIC CHARACTERISTICS

Survey area is between Day and Ninh Co river dikes; distance from river bank to dyke is short so there are no substantial structures. Most of the sensitive receptors in the survey area brick kilns and houses. There are many fields to grow vegetables and some dyke sections to cultivate bamboo for landslide control mitigation measures.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Rice fields outside of the dyke – Day River side</td><td>Rice fields outside of the dyke – Ninh Co River side</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Rice fields between the dykes – Day River side
At the back view of the church</td><td>Road and dyke on Ninh Co River side</td></tr>
</table>

4.5. GEOTECHNICAL CHARACTERISTICS OF SOILS

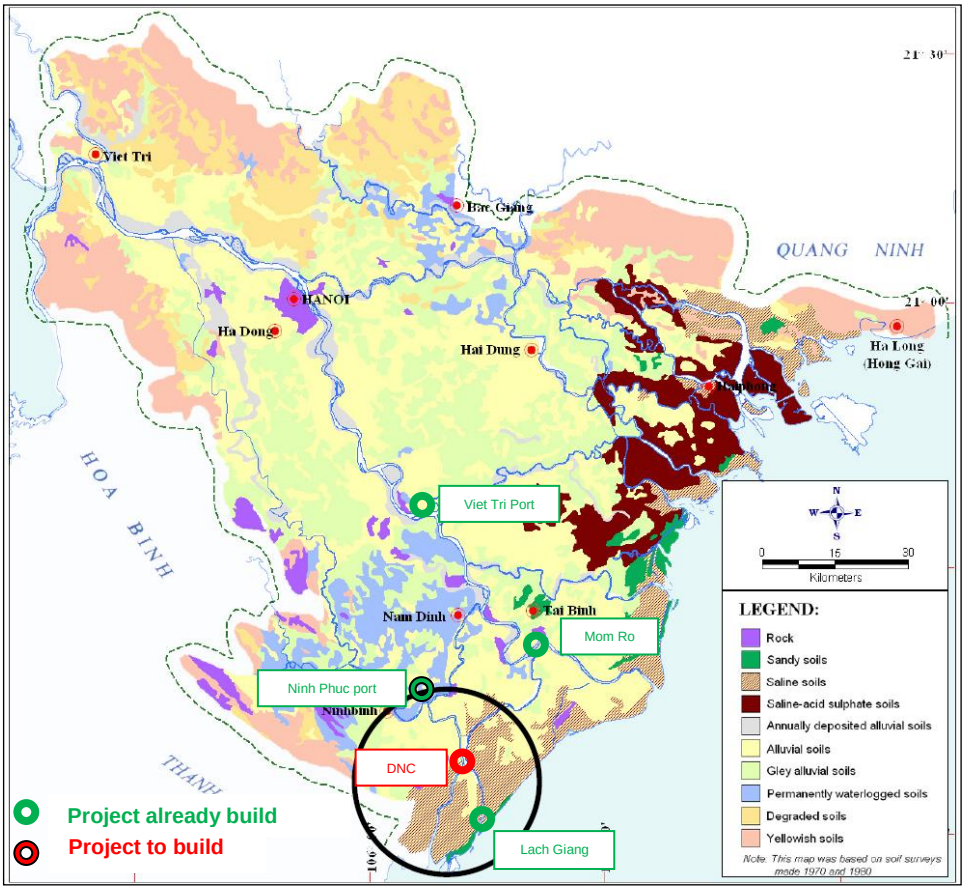


Figure 35 : Soils group in Red River Delta (Red River Master Plan – 1995)

The distribution of the different soil types in the Red River Delta is shown in figure 35. Ten (10) soil groups have been mapped in the Red River Delta. According to the Red River Delta Master Plan (1995), seven (7) of these are cultivated and these groups are marine sandy soils, saline soils, acid sulfate soils, alluvial soils, water-logged soil, degraded soils, and yellowish-red soils.

Based on this soil map, soil types along the project stretch are annually deposited, alluvial soils in the upper and lower reaches.

Stratum characteristics have a strongly influence on existed form, water- bearing capacity as well as the formation of the chemical composition of groundwater. The Northern Delta is constituted mainly by Cenozoic sediments, in which the Neocene sediment is located in deep and exposed only at the edge places, and Quaternary sediment is on the ground-surface. The Cenozoic is composed of three sub-formation: lower sub-formation; middle sub-formation (Miocene) including Phong Chau formation (N_1pc), Phu Cu formation ($N_{1-2}pc$) and Tien Hung formation ($N_{1-3}th$); upper formation including Vinh Bao formation (N_2vb), Le Chi formation (Q_1lc), Hanoi formation ($Q_{1-2-3}hn$), Hai Hung formation ($Q_2^{1-2}hh$) and Thai Binh formation ($Q_{2-3}tb$).

The Quaternary systems have the following characteristics:

***Le Chi formation (Q_1lc):** widely distributed in Hanoi basin at depth from 65-70 to 90 meters or less. Main components are of gravel, sand, gravel mixed with clay, grey colored with complex origin, derived mainly are fluvial or mixed fluvial-marine origin. The average thickness is from 10 to 20 meters.

***Hanoi formation ($Q_{1-2-3}hn$)**: widely distributed on the plains, exposed at the edge and the rest is completely covered.

Exposed area in western, north-western, and northern are form of river platform with height from 7-10m to 20meters at Hiep Hoa (Bac Giang), Lam Thao (Phu Tho) etc... Formation is composed mainly of cobbles, gravels, grits, and sands with thickness of 3-5m.

Covered area is observed through boreholes in provinces such as Hanoi, Hai Duong, Hung Yen, Thai Binh, Nam Dinh, and Ninh Binh within from 2-3m to 30-40m in depth. The main components are sand, gravel, pebble. The thickness of the formation increases from northwest to southeast: from 3m in the west and northwest to 90m in central, eastern and south-eastern plains.

In this formation, the composition of coarse grain with high percentage of 50-70% together with big thickness create an aquifer with water- bearing from medium to rich.

***Vinh Phuc formation ($Q_{1-3}vp$):** Widely distributed and often founded with two types of sections:

A section of exposed area at provinces Vinh Phuc, Bac Giang, at the edge of northeast and southwest plains. In these places there are no Holocene sediments. There are two types of section in exposed area. The sediment of fluvial origin ($aQ_{1-3b}vp$): the lower part is of medium to coarse grained sand mixed with gravel and grit. The upper part is of silty clay mixed with sand, clayey sand variegated colored, 5-38m thickness. These sediments have good water-bearing. Sediment of fluvial-marshy origin ($albQ_{1-3b}vp$) is distributed on the narrow area in Soc Son, Yen Phong. These sediments have poor water-bearing.

A section at cover area: It consists of two parts from bottom to top. The lower part mainly of fine-medium grained sand mixed with silt clay, 10-40m thickness. The upper part mainly of silt clay mixed sand grey, whitish-grey variegated colored. Main origin is fluvial-marine sediments. The average thickness is of 5-15m. The lower part of section is of silt clay, classifying on waterproof layer separating the major aquifers qh and qd. In places this layer is absent, both qh and qp aquifer hydraulic relationship with each other, directly generate circulation between them. At sea-shore areas, where the clay layer is thick, well shielded, so qp aquifer is protected from the influence of the intrusion of salt water during marine transgression Frandri.

***The Hai Hung formation (Q_2^{1-2} *hh*):** exposed in large areas of provinces Hai Duong, Hung Yen. At provinces Thai Binh, Nam Dinh, Ha Nam...this is distributed at 5-25m in depth. The origin of these sediments is as follows:

+ Sediments of fluvial origin ($aQ_2^{1-2}hh$): distributed along river banks in north-eastern and north-western plains. The main components are of sand, silt sand.

+Sediments of lake-marshy origin (lbQ): distributed in Viet Tri, Hoai Duc (Hanoi), lower are of peat mixed with silt clay dark colored, upper are of clay, silty clay grey colored, rich vegetable humus

+Sediments of fluvial-marine origin ($amQ_2^{1-2}hh$): distributed from southern Hanoi, Thuong Tin to sea-shore. Lower are of sand, sand mixed with silty clay, upper are of sandy silt, clayey silt intercalated with vegetable humus

+Sediments of marine-marshy ($mbQ_2^{1-2}hh$): distributed at the edge of plains such as Ninh Binh, Hai Phong, Kinh Mon, etc. Main components are clayey silts, sandy silt bearing vegetable humus and thin peat lenses, 3-5m thick.

+Sediments of marine ($mQ_{2-}^{1-2}hh$): distributed in Hai Hung, a part of provinces Ha Nam, Ninh Binh, Hai Phong. Main components are of silty clay, clay grey, whitish grey colored, 2-20m thick. The components of sediment formation are sand, silty sand with well water-bearing to create a water-bearing layer qh1. The component of sediment formation is fine grained having poor water-bearing creating a discontinuous waterproof layer between two water-bearing layer qh1 and qh2.

***Thai Binh formation (Q_{2-3}*tb*) :**

-Lower Sub-formation (Q_{2-3}tb1): consists of types as follows:

+Fluvial sediments (aQ_{2-3}tb1); distributed along existing rivers. Main components are sand, silty sand; somewhere is clayey silt, 0.5-10m of thickness.

+Sediments of fluvial-marine (amQ_{2-3}tb1): distributed in provinces Hai Phong, Thai Binh, Ha nam. Main components are of sand, sand mixed with clayey silt intercalated with shell fragments, 5-15m thick.

+Marine sediments (mQ_{2-3}tb1): distributed in sea-shore areas. Main component is sand with thickness of 0.5-5m

+Sediments of marshy-marine (bmQ_{2-3}tb1): distributed in provinces Ha Nam, Ninh Binh. Main components are sandy silt mixed vegetable humus and peat, 1-5m thick.

The thickness of lower sub-formation is of 17-26m.

-Upper sub-formation (Q_{2-3}tb2): consists of types as follows:

+Fluvial sediment (aQ_{2-3}tb2): consists of river-bed and out of dyke sediments. Main components are sand, silty with clayey silt.

+Sediment of fluvial-marshy-marine (amQ_{2-3}tb2): distributed in sea-shore area. Main components are sand, clayey silt, sandy silt with brown-grey, grey colored.

+Sediment of fluvial-lake-marshy ($albQ_{2-3}$tb2); distributed in northern Nam dinh, Ly Nhan district, a small of in Thai Thuy, Vinh Bao. Main components are of clayey silt mixed with vegetable humus, intercalated with pear lenses.

***Marine sediment ($mQ_{2-3}tb2$):** distributed in existing sea-shore areas and is sand ridges lying parallel with sea-shore that having a height of 0.5-3.5m. Main component is fine sand.

The average thickness of sub-formation is 13-20m. The water-bearing formations that to create water-bearing is layer qh2.

4.5.1. Ninh Binh Province

+ Layer 1: Lean clay with sand, very soft, thickness of layer changes from 8.9m to 12.8m is layer low bearing capacity.

+ Layer 2: Poorly graded sand, loose, drilling depth in to layer from 0.9m to 2.20m, but bottom elevation of layer has not been defined, is layer low capacity.

The above experimental results and analysis show that soil layers in the survey areas are layers with the condition from very weak to good.

For auxiliary construction works, such as management house, lock and bank protections, geotechnical conditions should be carefully considered to have the most accurate analysis for the location of foundation using the appropriate type of foundation.

During the design and selection of foundation solution, the geotechnical conditions should be considered and carefully analyzed so that the construction works will be stable ensuring the Project's economic efficiency, sustainability, and safety.

4.6. PHYSICAL-CHEMICAL CHARACTERISTICS OF SOILS

4.6.1. General description

The distribution of the different soil types in the Red River Delta is shown in Figure 4-5. It can be gathered from the map that the soil type in the Day-Ninh Co project site is saline soil. It was observed during the site inspection that saline water is allowed to enter the harvested rice paddies (Fig. 36).

Figure 36: Harvested rice paddies with saline water

The presence of barnacles in the sluice gate along the paddy dike indicates that brackish water is constantly present in this area (Fig.37).

Figure 37 : Barnacles on the sluice gate near the rice paddy indicate constant presence of saline water

The surface and deep soil samples taken in surveyed areas are agricultural soils. Thus we apply the specification QCVN 03:2008 and the Dutch Standards for Soil and Sediment Pollutants as the basis to evaluate the soil quality.

The initial analysis by Royal Haskoning conducted in 2007 (ESIA – FS study) revealed presence of heavy metals with concentrations below Dutch standards. Only mercury (Hg) exceeded (0.34 mg/kg) Dutch standards for reference value (0.30 mg/kg) but remained lower than the Dutch standard intervention value. A sampling/analyzing campaign has been carried out by CNR-VIPO in February 2012 on surface and deep soils. An updated survey has been implemented in December 2015 on surface soils to cover the possible impacts of the existing road relocation and the future bridge.

In "*Arsenic contents and physicochemical properties of agricultural soils from the Red River Delta*", Nguyen Minh PHUONG and al explain that: « *The Red River is the biggest river system in the north of Vietnam. While mountainous topography dominates in the upper river basin, the delta plain is built up by alluvial soils, including fluvial and marine deposits (Haruyama et al. 2006). According to the Vietnamese soil classification (Vietnam soil map) and other previous studies, fluvisols dominate the Red River Delta (Trinh and Wada 2004), although other soil types such as Ferralsols, found in soils around the world (6.0 mg kg–1; Bowen 1979) or the average As contents in Fluvisols in Vietnam (7.06 mg kg–1; Tran and Tran 2002). Furthermore, approximately 72% (paddy) and 83% (upland) of the surface soils and approximately 56% (paddy) and 50% (upland) of the subsurface soils exceeded As levels of 12 mg kg, the maximum allowable limit in Vietnamese agricultural soils enacted in the Vietnamese standard limitation for soil*"

4.6.2. Surface soils

The surface soil samples taken in surveyed areas are agricultural soils. Thus we apply the specification QCVN 03:2008/BTNMT and QCVN 15:2008/BTNMT as the basis to evaluate the soil quality.

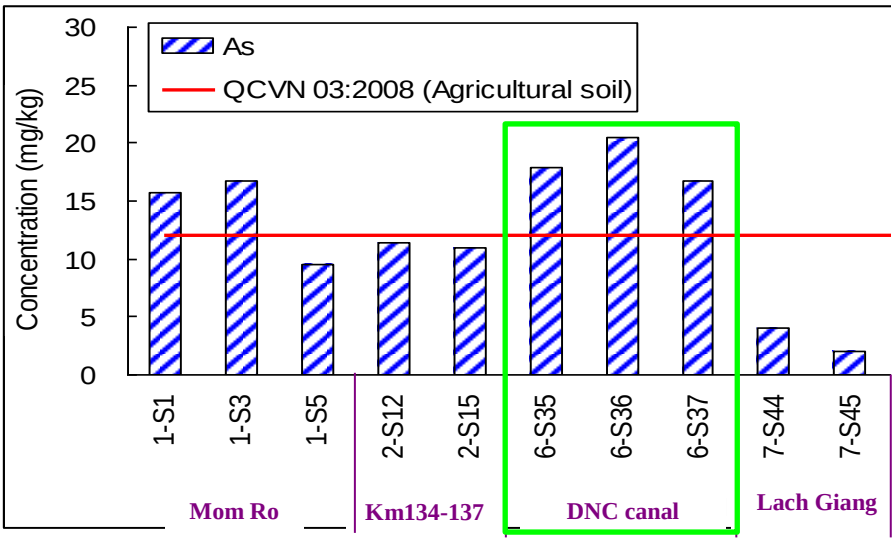


Figure 38 : Arsenic (As) content of the surface soil samples at the surveyed areas - 2012

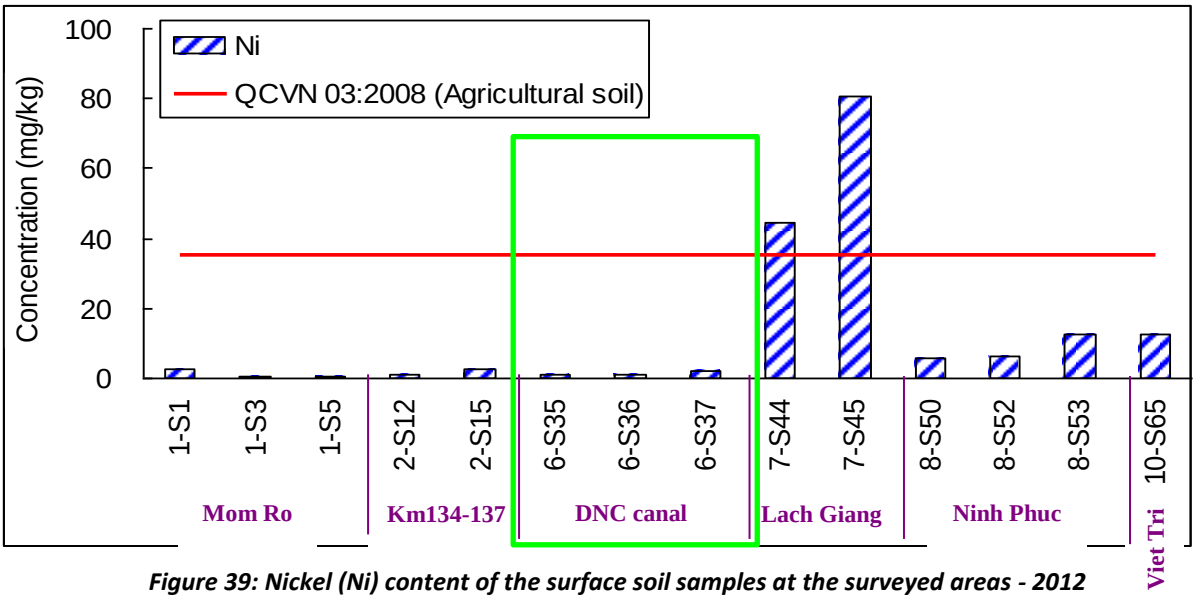


Figure 39: Nickel (Ni) content of the surface soil samples at the surveyed areas - 2012

The updating of the project concerns the road relocation and the construction of the new bridge. This phase will impact the surface soil. The surface soil samples (0.20 & 0.50 cm) taken in surveyed areas are agricultural soils. Thus we apply the specification QCVN 03:2008/BTNMT as the basis to evaluate the soil quality.

These analyses confirm the results from 2012:

- According to the analysis results, pH which is in the range of 7.1 to 7.3 is normal value.

- The metal indicators are lower than the Vietnamese and Dutch permitted specification. For heavy metals, the dredging/excavating of surface soil from 0-50 cm can be used as cultivation soil.
- Petroleum hydrocarbons and pesticides are present but with low and acceptable concentrations.

Table 12 : Results of Surface soils monitoring campaign – December 2015 – CNR-VIPO.

Sampling Locations

No.	Code	Sampling positions	Sampling Time	Coordinate
1	S1-1	Soil at starting point of the project; depth of 0.2m to the north	09/12/2015 10h35	20. 13954° N 106.17470° E
2	S1-2	Soil at starting point of the project depth of 0.5m to the north	09/12/2015 10h40	20.13954° N 106.17470° E
3	S2-1	Soil near Cathedral parish of Han family; depth of 0.2m km31 + 285	09/12/2015 10h50	20. 13551° N 106.17259° E
4	S2-2	Soil near Cathedral parish of Han family; depth of 0.5m km31 + 285	09/12/2015 10h55	20. 13551° N 106.17259° E
5	S3-1	Soil at ending point of the project; depth of 0.2m km33+260	09/12/2015 11h20	20. 12776° N 106.18110° E
6	S3-2	Soil at ending point of the project; depth of 0.2m km33+260	09/12/2015 11h25	20. 12776° N 106.18110° E

Analysis Results

No.	Parameter	Unit	Soil sample at the depth of 0.2m			Soil sample at the depth of 0.5m			QCVN 03:2008/ BTNMT	Dutch standard
			S1-1	S2-1	S3-1	S1-2	S2-2	S3-2		
1	pH	-	7.2	7.1	7.3	7.2	7.1	7.3	-	
2	Humidity	%	85	86	84	85	86	84	-	
3	Salinity	‰	-	-	-	0.10	0.12	0.11	-	
4	Acidity	%	-	-	-	0.00011	0.00013	0.00012	-	
5	TOC	mg/kg	31,043	31,051	31,052	-	-	-	-	
6	Al	mg/kg	60,753	60,487	60,547	60,571	60,561	60,563	-	
7	As	mg/kg	7.3	8.4	8.1	7.5	7.4	7.3	12	
8	Cd	mg/kg	0.31	0.32	0.34	0.25	0.23	0.21	2	
9	Cu	mg/kg	3.22	3.26	3.21	3.21	3.25	3.17	50	
10	Cr	mg/kg	51.27	50.37	51.45	49.08	51.12	50.31	-	100
11	Ni	mg/kg	1.68	1.58	1.57	2.26	2.56	2.76	-	35
12	Pb	mg/kg	4.21	3.92	3.98	3.97	3.97	3.97	70	
13	Hg	mg/kg	0.12	0.11	0.12	0.11	0.13	0.12	-	0.3
14	Zn	mg/kg	8.35	8.15	8.16	8.34	7.16	8.11	200	
15	Fe	mg/kg	29,408	29,317	29,304	29,364	29,401	29,375	-	
16	Petroleum hydrocarbons	mg/kg	8.13	8.12	8.16	-	-	-	-	
17	Pesticides	µg/kg	0.32	0.36	0.35	-	-	-	-	

No.	Parameter	Unit	Soil sample at the depth of 0.2m			Soil sample at the depth of 0.5m			QCVN 03:2008/ BTNMT	Dutch standard
			S1-1	S2-1	S3-1	S1-2	S2-2	S3-2		
1	pH	-	7.2	7.1	7.3	7.2	7.1	7.3	-	
2	Humidity	%	85	86	84	85	86	84	-	
3	Salinity	‰	-	-	-	0.10	0.12	0.11	-	
4	Acidity	%	-	-	-	0.00011	0.00013	0.00012	-	
	(Chlorinate)									

4.6.3. Deep soils

In order to allow ships of under 1000 DWT to go easily from Lach Giang estuary to Ha Noi port and in turn; ships of under 3000 DWT to go from Ninh Co through Day river to Ninh Phuc port and in turn, the project needs to expand the curve radius in Mom Ro river; conduct bank correction in Km134-137 in Ninh Co river, build Day – Ninh Co canal and dredge Lach Giang estuary. With above- mentioned purposes, the project needs to dredge a great number of agriculture land with the average depth of 6m. Evaluation of deep soil sample quality should be undertaken in order to manage the environmental impact in this area.

A result of deep soil sample from 2012 is shown in Figs. above and below.

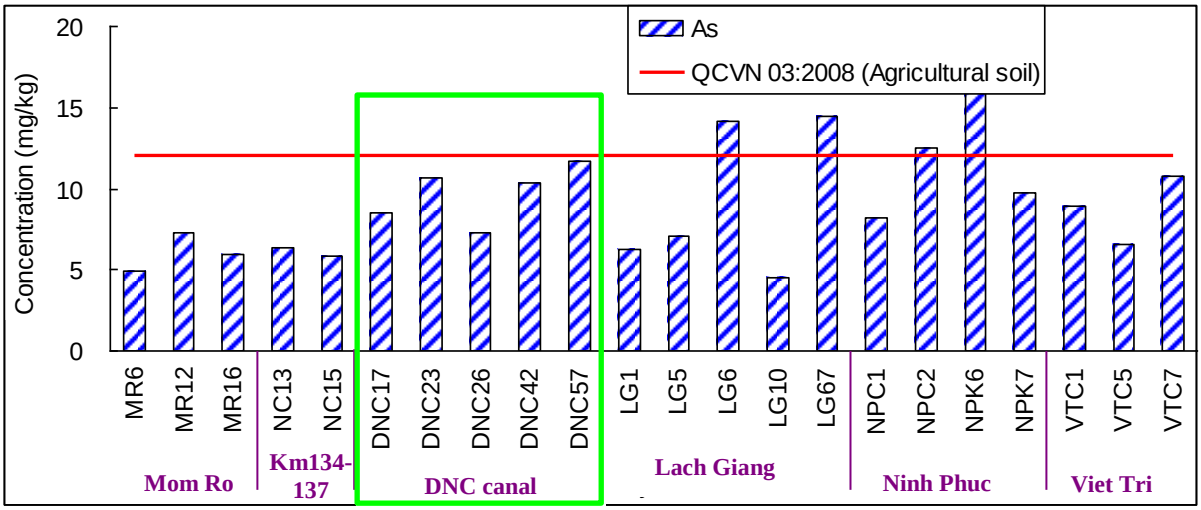


Figure 40 : Arsenic (As) content of the deep soil samples at the surveyed areas - 2012

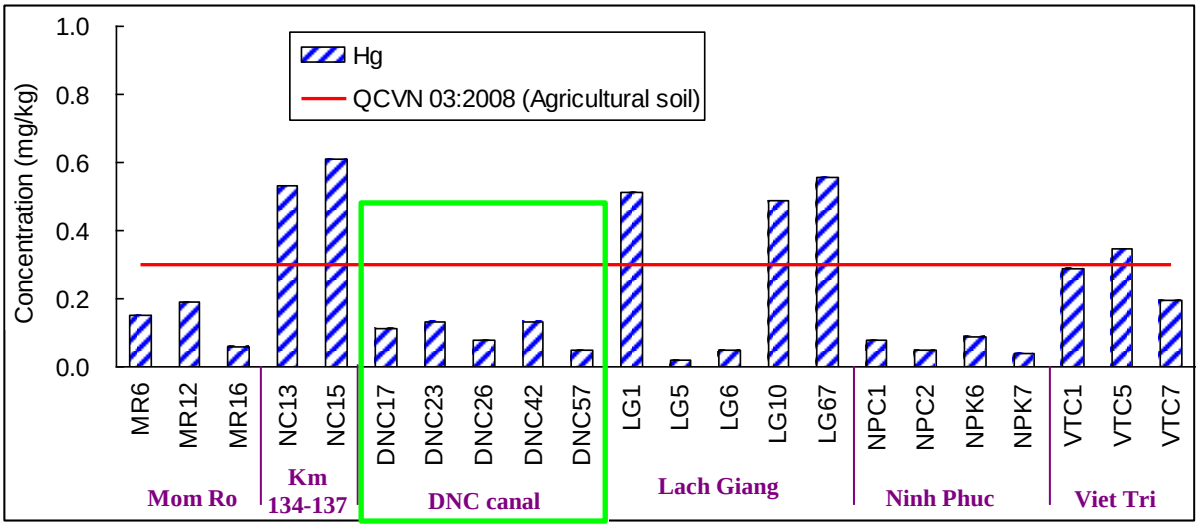


Figure 41 : Mercury (Hg) content of the deep soil samples at the surveyed areas - 2012

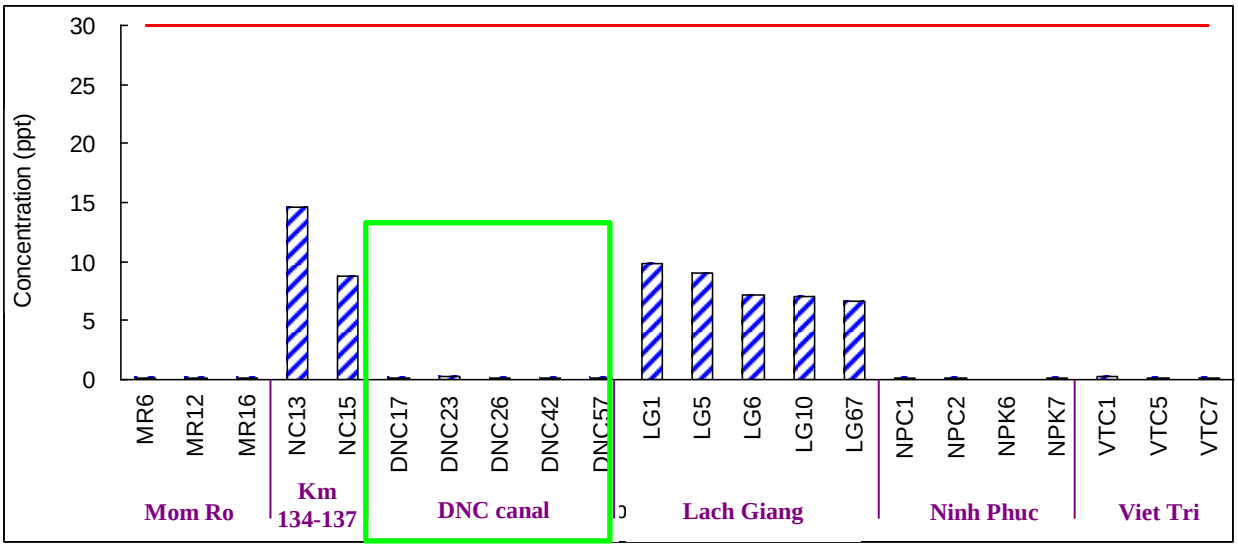


Figure 42 : Mercury (Hg) content of the deep soil samples at the surveyed areas - 2012

From the analyzed result it can be seen that metal contents are lower than the allowable specification.

Through analysis of results of salt at the time of the survey showed that deep soil in these areas ranged from 0.05 to 14.66 ‰, the highest in the Km134-137 area (from 8.81 to 14.66 ‰). According to geological classification, soil salinity is a soil that contains soluble salt content greater than 3% by weight of dry soil. Therefore, soil depths in these areas at the time of the survey are not saline.

4.6.4. Sulfate soil

Sulfate soils are soils formed in coastal plain regions had so much decay organisms release sulfur (S). Sulfur combines with iron (Fe) in sediment form:

FeS_2: $Fe + S \rightarrow FeS_2$

When exposed to air FeS_2 can quickly form sulfuric acid through the reaction:

$4FeS_2 + O_2 + 14H_2O \rightarrow 4Fe(OH)_3 + 8SO_4^{2-} + 16H^+$

Formed acid sulfuric absorbs in to surrounding environment causing damage of concrete and steel structure. Besides, it can dissolve metals such as iron, aluminum, zinc, manganese, and copper in the soil. Therefore, water with low pH often contains toxic metals.

In this project, we evaluate sulfate soil in the Lach Giang estuary area and DNC connecting channel (this is the area to dig a channel length of about 1500 m, 180 m long, 6 m deep dredged soil mass should very large). The sulfate soil sample is also the deep soils samples are analyzed 03 indicators are more acidic, wet oxidation and dry titration. The results showed in the table below that:

- The acidity in the survey area ranged from 6.30 to 8.35. The acidity at the DNC is higher than in Lach Giang. Thus, deep soil samples in these areas are not acidic soils.
- The wet oxidation (organic carbon) in DNC area is higher than Lach Giang estuary average 51 times.
- The dry titration is the standard measure CO_2 born after 1.125 days of incubation on dry soil.

This method means that the determination of total organic carbon in the soil dry decomposed by microorganisms.

Table 13 : Sampling and preservation methods used during the monitoring campaigns - 2012

No.	Sample symbol	pH	Wet oxidation (% Carbon)	Dry Titration (% CO_2)	Dry Titration (% Carbon)
	DNC17	7.00	0.0150	0.269	0.0734
	DNC23	6.50	0.0260	0.553	0.1508
	DNC26	6.30	0.0460	0.662	0.1805

Sulfate soil phenomenon does not occur in the survey area as a result of acid ranges from about 6:30 to 8:35.

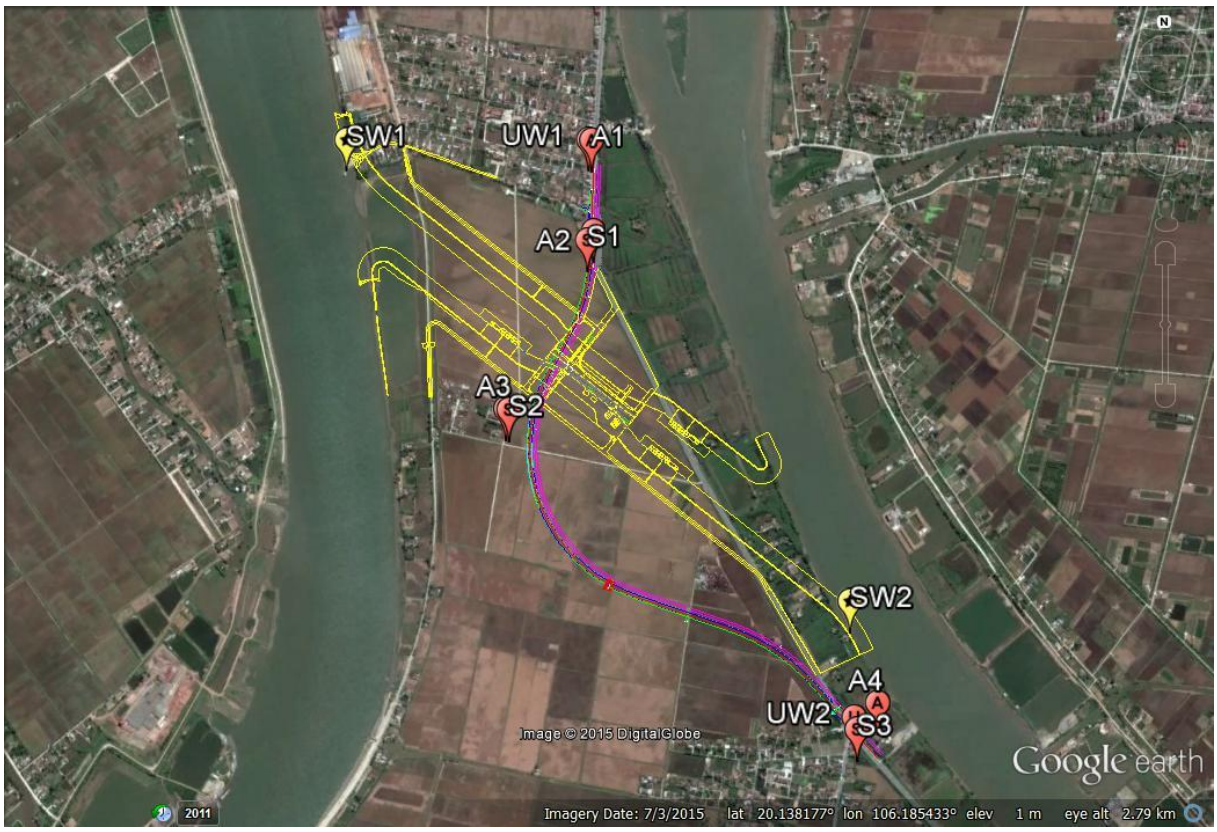


Figure 43 : 2015 Monitoring map

The Red River Delta System

Red river Delta is covered with a dense surface water network consisting of natural rivers and artificial channels with a general flow direction from NW to SE. The channel network increases in density towards the coastal Nam Dinh area and has crucial relevance for irrigation of paddy fields and other agricultural areas with river water as well as discharge of sewage and waste waters to the sea.

The Red River Delta is formed by many distributaries from Hanoi to Gulf of Tonkin.

Nam Dinh Province is formed by four major rivers located within/or at the border of the Province:

* The Red River along the NW border of Nam Dinh with his river mouth at the Ba Lat Estuary,
* The Dao River connecting the Red and the Day Rivers (SW border of Nam Dinh)
* The Ninh Co River with its river mouth to the sea at Lach Giang estuary.

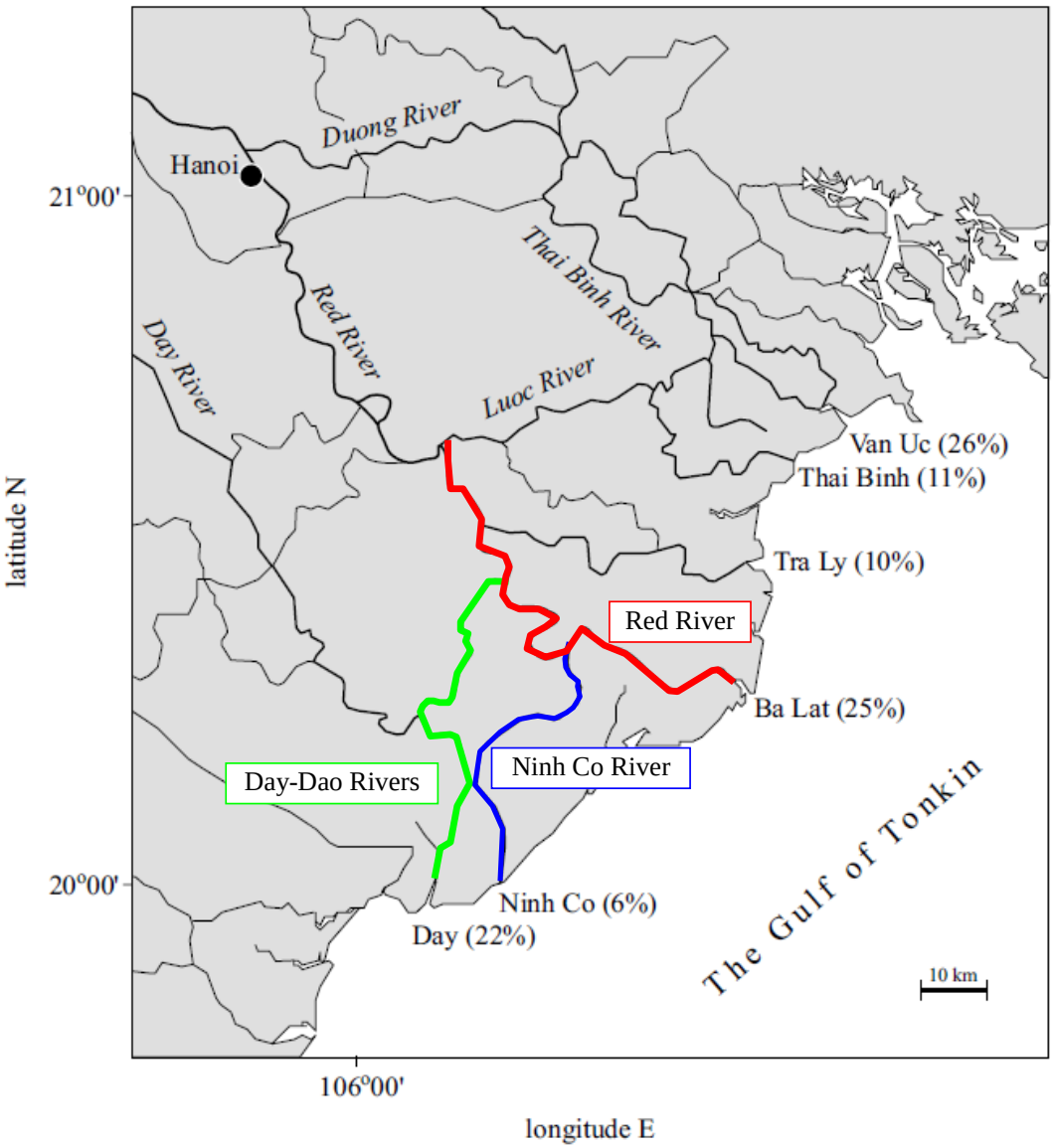


Figure 44 : Red River Delta Rivers Mouths and general layout of the Red River delta with the discharge percentage given for each outlet

(Map source: Z. Pruszak, P. V. Ninh, M. Szmytkiewicz, N.M. Hung, R. Ostrowski -2005)

4.6.5. River system

From Nam Dinh city to the Red River mouth, the Red River bed is 54 km in length and is estimated to be 400–500 m wide and about 10-15 m deep. The water discharge of the Red River varies strongly in terms of the season. The discharge at Hanoi station reaches a maximum in July–August (about 23 000 m3/s) and a minimum during the dry season in January to May with typically 700 m3/s (TANABE et al. 2003). Salinization of the Red River due to tidal fluctuation has been studied first by NGUYEN VAN DO 1996a. During dry season and tidal high stand, elevated salinity has been observed up to 4.5–5 km inland from the Ba Lat estuary. It represents about 25 % of the average discharge.

The Ninh Co River separate from Red River near Mom Ro and goes SW to the Sea. The length from Mom Ro to the sea is about 60 km. The average discharge at the river mouth is about 6% of the total discharge of the Red River upstream Hanoi.

The Day River follows the W border of Nam Dinh with 400-500 m width and 45 km length, coming from the Triassic limestone recharge area in Ninh Binh province. Maximum flow rate has been observed in August with 3110 m^3/s; lowest flow rate can be almost zero (no flow) in December and January, yearly average is 813 m^3/s. Although this river is tidal influenced, salinity monitoring has shown that total salinity is generally <1g/l (NGUYEN VAN DO 1996a). Thus, the fresh-salt water boundary is estimated to be close to the sea, which can be explained by a high hydraulic gradient and flow rate of the river. The high hydraulic gradient is caused by a W tributary of the Day River, the Boi River, who is discharging a large mountainous area in the NW of Nam Dinh Province. The average discharge at the Day river mouth is about 22% of total Discharge upstream Hanoi.

Z. Pruszak (2005) explains that Red River Delta is dominated by a monsoon climate, so its hydrological regime is closely connected with the monsoon seasons. The north-east monsoon, occurring in the dry season, lasts from November to May with about 25% of the total annual discharge and with a minimum volume of approximately 2% in March. The flood season during the south-west monsoon lasts 5 months from June to October and carries 75% of the total annual discharge with the peak in August (21%). The average dry season discharge at the Son Tay hydrological station is 1200 m3 s−1 while during the flood season this figure is 14 000 m3 s−1; the highest ever maximum of 33 600 m3 s−1 was recorded in August 1971

The situation where high water levels during the flood season coincide with spring tides and storm surges is of the utmost importance for the people inhabiting the lower RRD plain. The lower RRD basin can be divided into different areas with various hydrological regimes: the area not affected by tides, the area slightly affected by tides, the area governed both by flood and tides, and the area essentially controlled by the tidal regime.

One of the main hydrological characteristics of the river mouth is the behavior of the river water during the dry and flood seasons. The interface between saline and fresh water depends on the river flow, the tidal cycle and the river morphology. During the dry season, especially in February, March and April, saline intrusions into the Red River via the rivers mouths are significant. The isohaline of 1 PSU during this season may lie more than 20 km upstream in the flood cycle of the spring tide. The situation is reversed during the flood season, when fresh water often spreads a long way out to sea, as far as many kms off the rivers mouths.

4.6.6. Estuarine system

Along the Red River Delta coastline, waves, currents and sea level variations are defined mainly by the monsoon and typhoon regime. The offshore wave climate determined on the basis of a 20-year series of wind speed and direction measurements show that the wave regime in the Gulf of Tonkin is defined primarily by the monsoon wind climate.

Figure 45 : Winds directions during summer and winter seasons

According to the zoning of the tidal parameters in the seas around Vietnam in general and in the Gulf of Tonkin in particular, the tides are diurnal with amplitude variations depending of the locations. In this region, special attention is paid to irregular sea-water level changes during monsoons and typhoons. The high irregular water levels in the estuary are extremely dangerous when typhoon or monsoon surges coincide with a spring tide. They often result in damage to infrastructure, sea and river dyke systems, or at the very least give rise to saline intrusions in the winter season, when the coincidence of winter monsoon surges and spring tides is likely. This is also enforced by the storm surges which appear very often along the western coast of the Gulf of Tonkin.

There is a remarkable trend in the variation of the dominant roles of tide and waves in the northern and southern parts of the Red River mouths. While the river mouths in the north are often tunnel-shaped, because of the prevalence of river and tidal forces, the river mouths in the south are often convex in shape, which is the upshot of the dominant wave forces.

The Red River delta has the typical triangular shape of an accurate type of delta and is influenced rather equally by wave, tidal and fluvial processes. The coastal areas of the delta can, with respect to the prevailing influence, be divided into a northern and a southern region with the boundary near Thai Binh mouth (Mathers et al, 1999).

The northern region is well sheltered against wave motion because of mainland China and Hainan Island in the Tonkin Bay and is therefore mainly dependent on tidal processes. The

northern distributaries develop straight toward the sea and have some resemblance to the shape of a Bird's Foot delta.

The southern region is highly dependent on wave motion because of its exposure to waves with long fetches both from southeast and northeast. Several barriers (sandy ridges and beach-spits) formed "tangentially" to the open sea can be seen in this region, where the intermediate beaches are rather static and mainly serve as carriers of longshore sediment transport. The final form of this beach forming process is showed north of the mouth: a straight tangential ridge, often positioned at a seaward flank of clusters of ridges, i.e. mainly accreted land between the mainland and the beach ridge. The overall form of the river mouth area illustrates the effect of the wave climate leading to divergent longshore sediment transport that produces this typically convex shape.

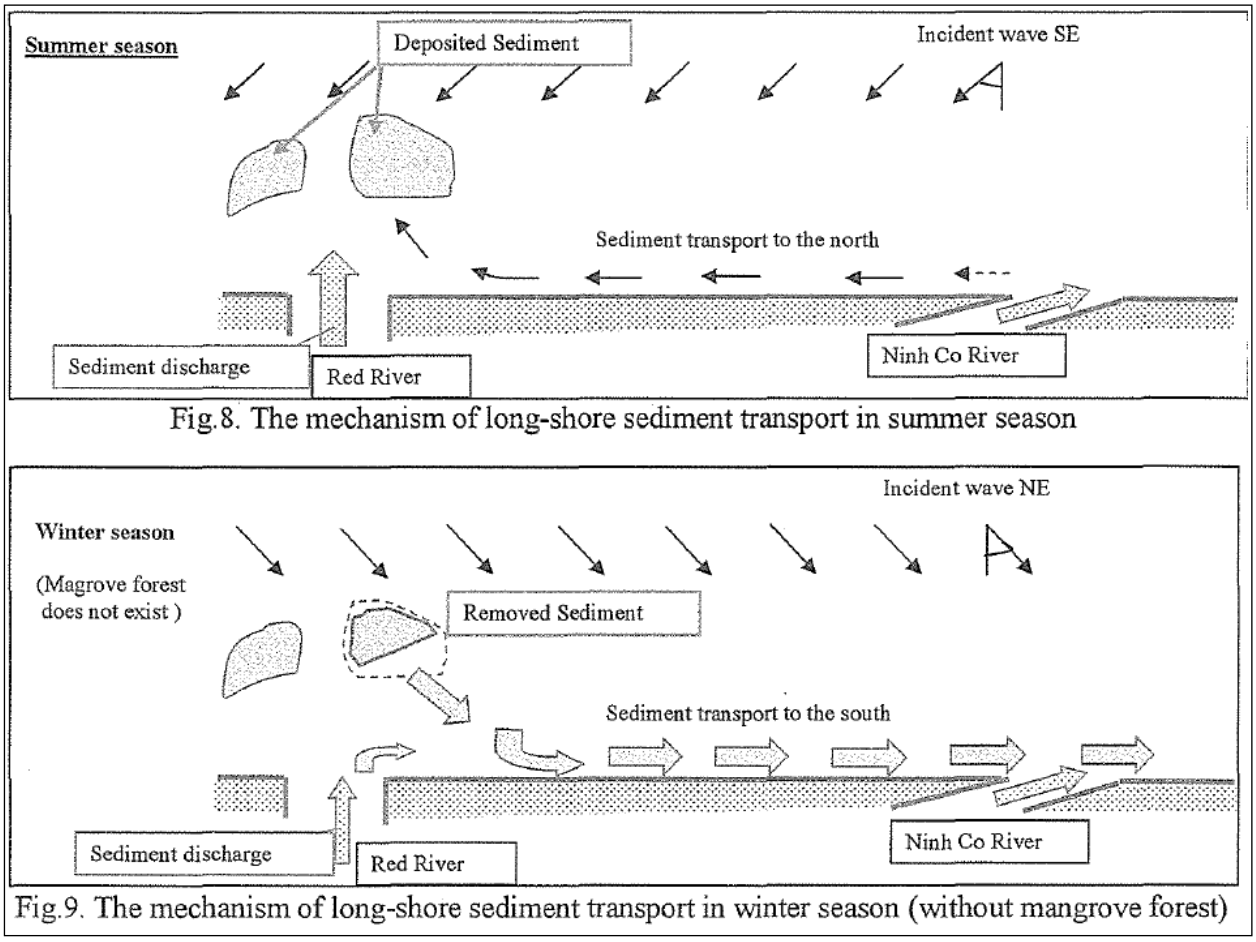


Figure 46 : Mechanism of long-shore sediment transport between Red River Mouth and Ninh Co River Mouth during summer and winter.

(Source: I. Deguchi*, S. Araki * , T. Nakaue* B.T. Vinh* - MONITORING OF THE CHANGE IN COASTAL ENVIRONMENT IN SOUTHERN PART OF RED-RIVER DELTA FROM SATELLITE IMAGES AND THE MECHANISM OF BEACH EROSION)

The sediment transportation along the coast line change during winter and summer season is shown in figure 47.

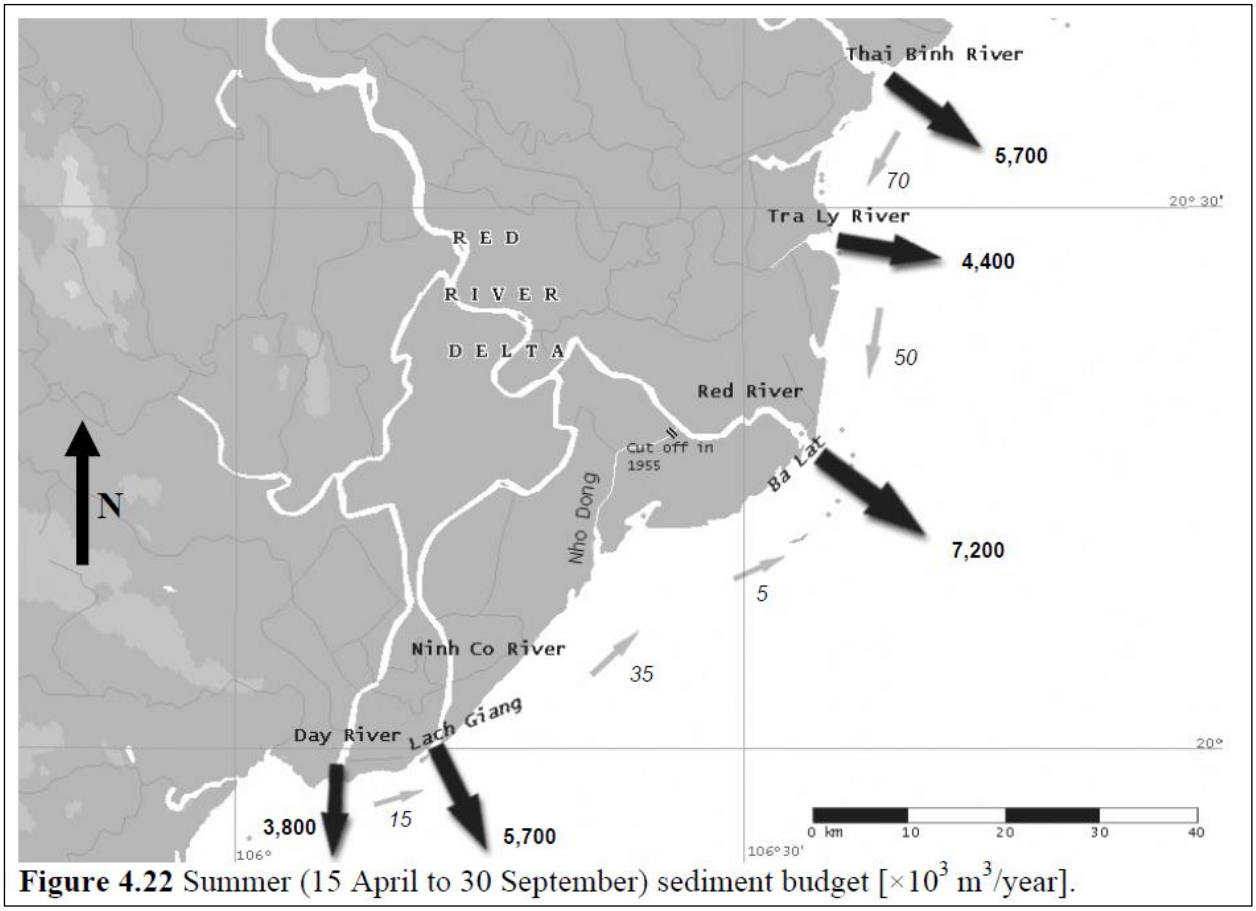


Figure 4.22 Summer (15 April to 30 September) sediment budget [$\times 10^3$ m^3/year].

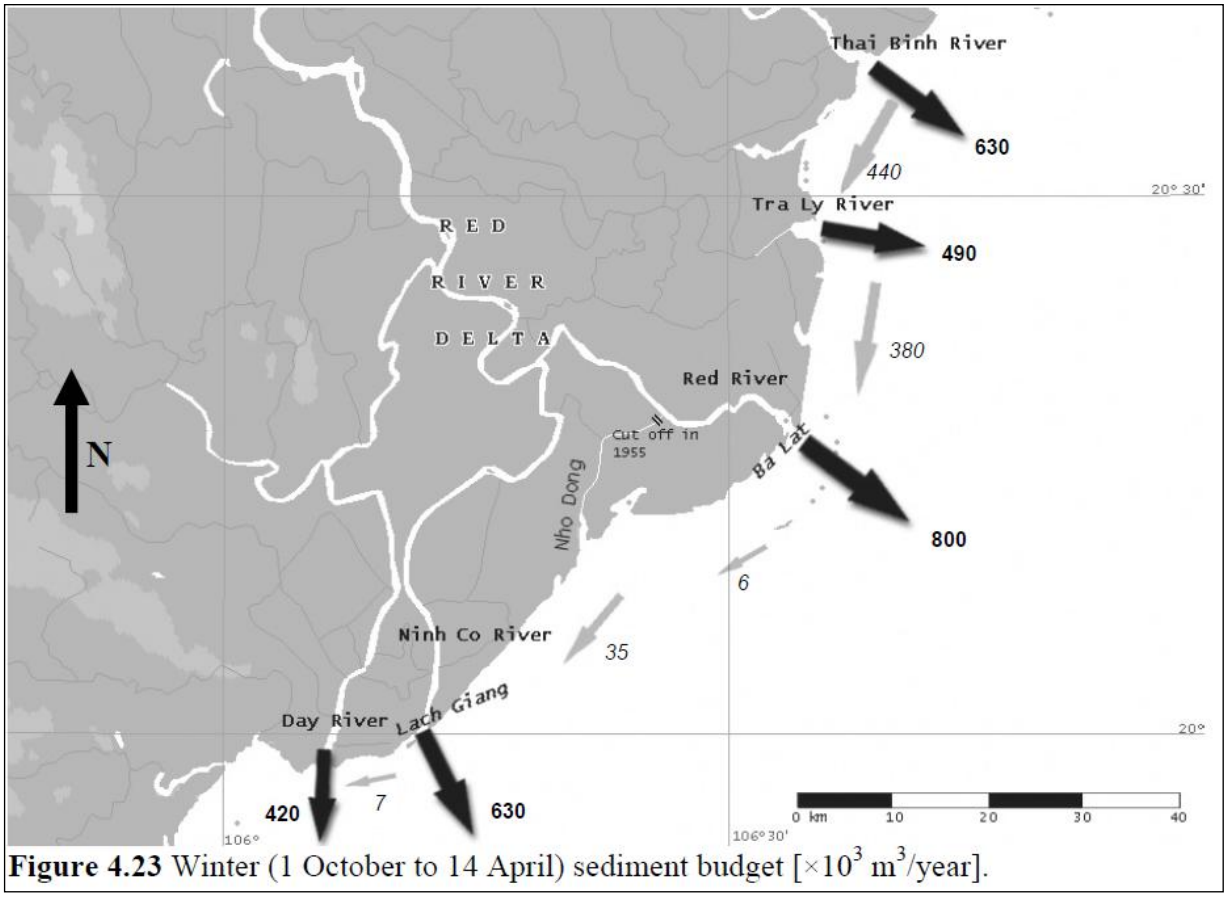


Figure 4.23 Winter (1 October to 14 April) sediment budget [$\times 10^3$ m^3/year].

Figure 47 : Seasonal distribution of sediments along red River Delta Coastline

(Source: Martin Häglund and Pär Svensson – 2002)

Based on lithological data, combined with hydrology, physiography and geology, it is found that there are large variations in the long shore sediment transport along the coast, which is greatly affected by shoreline orientation and wave climate (Zeidler and Nhuan, 1997). The coastline of the Red River delta mainly consists of cohesive material (12 percent sand, 59 percent aleurite and 29 percent clay) which annually is supplied with 72 million tons of sediment. However, most of this river load, over 70 percent, passes through the intertidal plain and vanishes into the sea. The remaining sediment material contributes to the development of the delta. In the summer, the river flows are very high due to the heavy rains. Hence, 80-90% of the sediment discharged through the Red River is transported during June to October (Pruszak, 1998). This heavy sediment load is caused by the rain flushing particles and alluvium to the rivers, as well as erosion of the river banks because of the large flow. Furthermore, at time scales of thousands of years, a predominant cause of shoreline change is a sea level rise, which has had great impact on the littoral process historically, but also the recent development of the Red River delta. Shoreline changes obtained from maps suggest that the Hai Hau erosion started around the beginning of the 20th century, but the erosion rate seems to have decreased during the late 60s (Vinh et al, 1996).

As the mangroves were cut almost everywhere along the coast and because of the increasing number of people living near the coasts, the effects of the typhoons are more severe and cause significantly more erosion than in the past.

Areas with aggradation (i.e.: Day river mouth) and areas with active and very strong erosion (i.e.: Ninh Co river mouth) have been identified during data collection. This is illustrated by fig. 47.

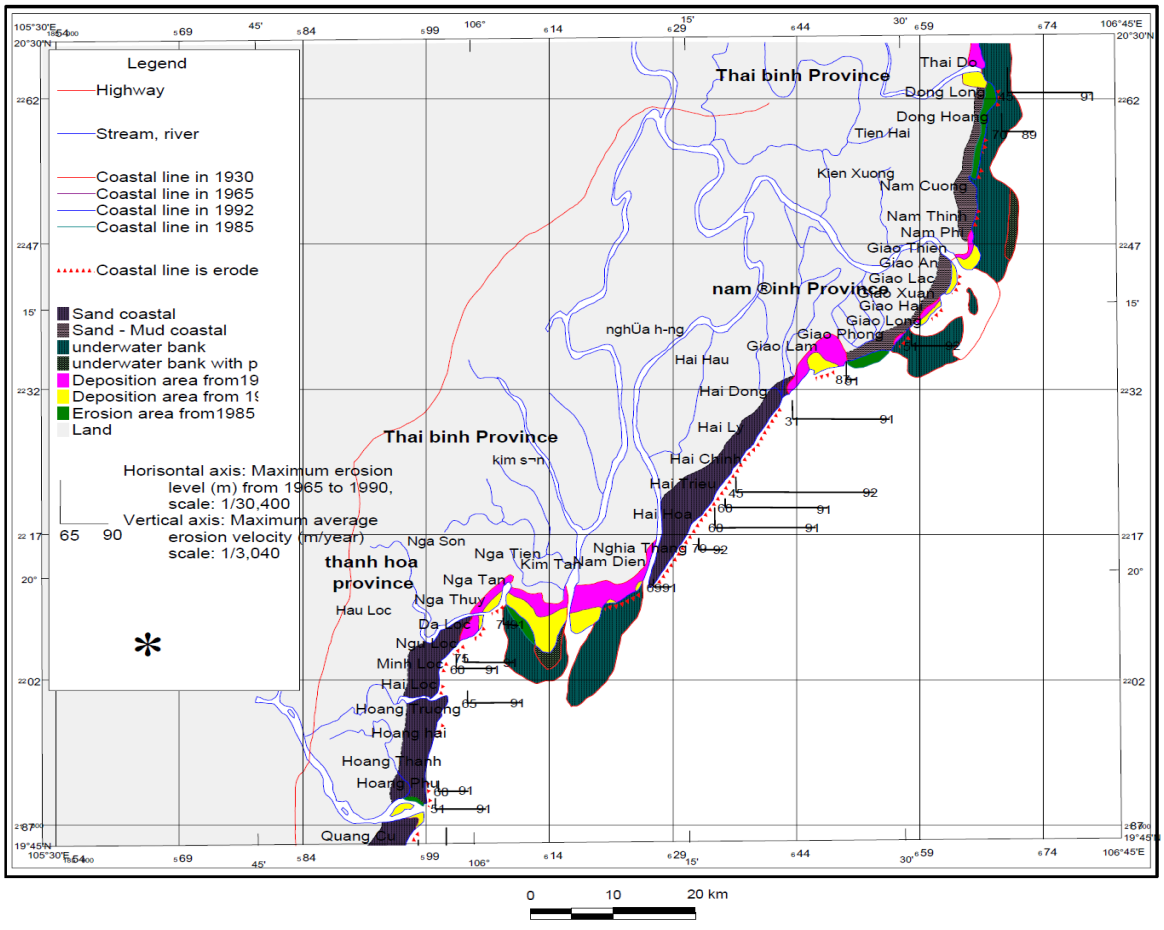


Figure 48 : Shoreline development at Nam Ha province and adjacent coastal areas (Hung, 2001a)

4.6.7. Surface water quality

The initial analysis by Royal Haskoning conducted in 2007 (ESIA – FS study) revealed presence of heavy metals with concentrations below Dutch standards. Only mercury (Hg) exceeded (0.34 mg/kg) Dutch standards for reference value (0.30 mg/kg) but remained lower the Dutch intervention value. A sampling/analyzing campaign has been carried out by CNR-VIPO in February 2012 on surface water. A new updating campaign has been implemented in December 2015 by CNR-VIPO on surface water to cover the possible impacts of the existing road relocation and the future bridge.

pH is the first important parameter needing to be defined at site. Water source with pH > 7 contains many ions of the carbonate and bicarbonate group (because this water runs through many soil and stone layers. The water source with pH < 7 often contains acids ions. This very low pH is harmful to immature fishes and insects. pH in river water depends on many factors such as seasons of the year and hydraulic regime. The pH values of all samples in surveyed locations fluctuate from 7.2 to 7.3 and are within permitted limitation 5.5 ÷ 9 according to QCVN 08:2008/BTNMT (Column B2).

Temperature is one of factors affecting directly the rate of metabolism and growth of creatures living in the water; the rate of photosynthesis; the solubility of oxygen in Water River; creatures and plants sensitive to disease, parasites and toxic substances. The increase or decrease of temperature also has great effect on the water quality. The water temperature depends on the season and time of day. During survey, the temperature is within the limit in consistency with the growth of aquatic species (21.3 ÷ 21.5 ^{o}C).

Conductivity of water relates to the presence of ions in water. The ions are usually salts of metals such as NaCl, KCl, SO_4^{2-}, NO_3^{-},etc. The intrusion of saline water or water pollution effects of high electrical conductivity often related to the toxicity of water-soluble ions.

The survey results show that the electrical conductivity is in 212 ÷ 221 µS/cm for all the freshwater areas. The Vietnam's current specification does not regulate the electrical conductivity in surface water. However, through reference documents it finds that the results of electrical conductivity scope with the natural characteristics of freshwater resources in the Red River Delta.

Table 14 : Results of Surface water monitoring campaign – December 2015 – CNR-VIPO.

Sampling Locations

No.	Code	Sampling positions	Sampling time	Coordinate
1	SW1-1	Surface water of Day river at Pha Muoi wharf; depth of 0.5m	09/12/2015 12h30	20. 14216oN 106. 16857oE
2	SW1-2	Surface water of Day river at Pha Muoi wharf; depth of 1m	09/12/2015 12h40	20. 14216oN 106. 16857oE
3	SW2-1	Surface water of Ninh Co River at the depth of 0.5m	09/12/2015 11h40	20. 13075oN 106. 18105oE
4	SW2-2	Surface water of Ninh Co River at the depth of 1m	09/12/2015 11h45	20. 13075oN 106. 18105oE

Analysis Results: QCVN 08:2008/BTNMT (B2): National technical regulation on surface water quality, applied B2 level - surface water for waterway transportation and other purposes with the requirement of low quality water.

No.	Parameter	Unit	SW1-1	SW1-2	SW2-1	SW2-2	QCVN 08:2008/ BTNMT (B2)
1	Temperature	°C	21.3	21.5	21.4	21.4	-
2	pH	-	7.2	7.3	7.2	7.3	5.5 ÷ 9
3	DO	mgO2/l	4.81	4.87	4.46	4.86	≥ 2
4	Turbidity	NTU	85.2	83.5	88.7	82.8	-
5	Conductivity	µS/cm	219	212	221	218	-
6	Salinity	‰	0.21	0.16	0.19	0.17	-
7	TSS	mg/l	67		61		100
8	TDS	mg/l	136		123		-
9	COD	mg/l	18		16		50
10	BOD5 (20oC)	mg/l	7		5		25
11	Cl-	mg/l	125		123		-
12	F-	mg/l	0.03		0.01		2
13	Al	mg/l	0.04		0.02		-
14	As	mg/l	0.003		0.002		0. 1
15	Cd	mg/l	0.00021		0.00015		0.01

No.	Parameter	Unit	SW1-1	SW1-2	SW2-1	SW2-2	QCVN 08:2008/ BTNMT (B2)
16	Cu	mg/l	0.03		0.02		1
17	Cr6+	mg/l	0.0005		0.0002		0.05
18	Fe	mg/l	0.05		0.02		2
19	Mn	mg/l	0.0015		0.0011		-
20	Ni	mg/l	0.0015		0.0010		0.1
21	Pb	mg/l	0.03		0.01		0.05
22	Hg	mg/l	0.0005		0.00011		0.002
23	Zn	mg/l	0.003		0.002		2
24	NH4+-N	mg/l	0.04		0.02		1
25	NO2—N	mg/l	0.04		0.03		0.05
26	NO3—N	mg/l	2.42		2.14		15
27	Grease and oil	mg/l	0.04		0.01		0.3
28	Fecal Coli	MPN/ l00ml	<0.0001		<0.0001		-
29	Total Coliform	MPN/ 100ml	345		319		10000
30	Pesticides (Chlorinate)	µg/l	0.001		<0.0001		0.03

Total suspended solids (TSS) are factors that reduce water quality. High suspended solids concentration will reduce the self-cleaning ability of river water, cause deposition of pollutants in the river bed. In addition, aluminated soil in suspended solids can also reduce the pH of water and increase the concentration of heavy metals. In some cases, suspended solids contain sediments deposited in the river bed may also release the accumulated pollutants as heavy metals, pesticides, hydrocarbons and micro-organisms into the environment. The natural ranges on Red Delta River are 10 to 200 mg/l during dry season and 300 to 5000 mg/l during wet season. The survey results indicate that TSS concentration is 67 mg/l on Day River (SW1 sample) and 61 mg/l on Ninh Co River (SW2 sample). However, if compared to B2 column which is used for waterway transport the values of TSS in all surveyed area are much lower than the Vietnamese allowable specification (100 mg/l) (Fig. 49).

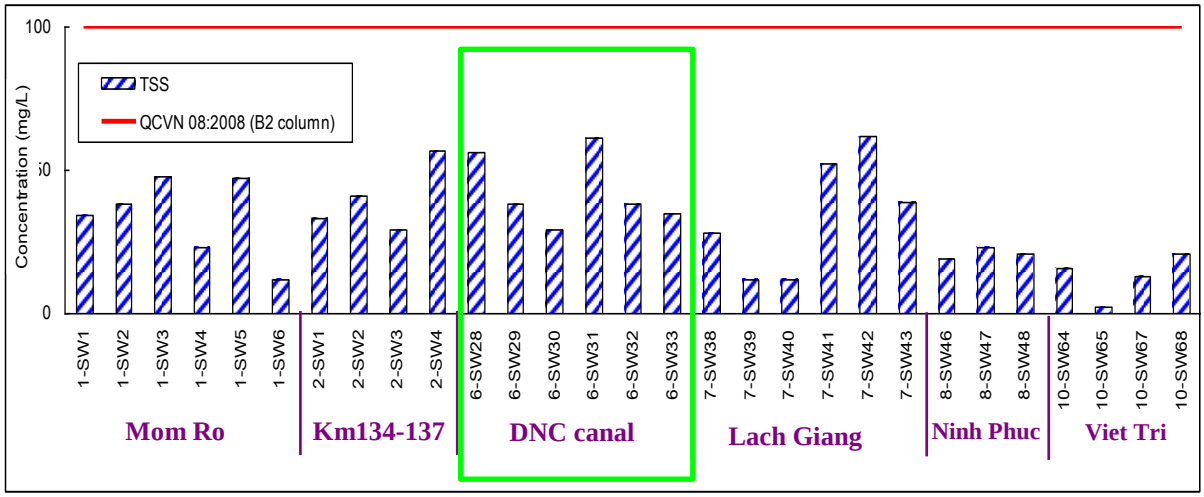


Figure 49 : TSS content of the surface water samples at the surveyed areas

Turbidity of water characterizes colloids, organic matter, alluvium, clay, algae, microorganisms and other suspended particles ... and has linear rate with suspended solids in water. High turbidity will reduce the capability of light transmission in water, affect the photosynthetic capacity of autotrophic organisms in the water and reduce the aesthetic and using water quality. However, turbidity also depends on the flow depth and the depth of the surveyed samples. The higher the turbidity level is the greater contamination is. At the time of survey (December 2015), there is a difference in turbidity between Day river and Ninh Co river. The turbidity of Ninh Co river (82.8-88.7 NTU) is quite similar than the one of Day river (83.5-85.2 NTU). As the sampling campaigns were done in dry season, the Turbidity was naturally low. The literature confirms this and shows that, in wet season, the turbidity values can reach over 1000 to 5000 NTU due to the huge concentrations of suspended materials naturally transported by the river during flood times.

TDS (Total Dissolved Solids) is the total number of charge ions, including minerals, salts or metals existing in a certain volume of water and is usually expressed as a function or $^{o}/_{oo}$ or ppt. TDS is usually taken as the basis for determining the initial level of cleanliness / purity of water. TDS do not include the Total Suspended Solid (TSS). TDS is the sum of inorganic and organic substance (molecular, ionized solids, dissolved solids or suspended micro particles cannot be filtered). Most of TDS are calcium, phosphate, nitrates, sodium, potassium, some toxic industrial substances, pesticides etc.
The analysis results show that TDS in surveyed areas is low in the range of 123-136 mg/l.

Salinity is the total amount of dissolved compounds contained in 1 kg of water. Because the total concentration of major ions (11 ions) accounted for 99.99 suspended minerals, the salinity of sea water can be considered equal to this value. The analysis results show the salinity of rivers is low from 0.16 to 0.21 ‰, normal for freshwater conditions and homogeneous with literature available on these areas.

Dissolved Oxygen (DO) the amount of dissolved oxygen in water necessary for the respiration of aquatic organisms (fish, amphibians, aquatic insects, etc...) and usually is created by the

dissolution from the atmosphere or by photosynthesis of algae. Dissolved oxygen concentration is an important factor to determine the self-cleaning ability of the river. DO in water involve in metabolism; maintain energy for the water microorganisms development, reproduction. DO concentration in water is changing according to seasons, temperature, photosynthetic activities of the water plant and the biodegradation of organic substances in water consumes oxygen. If DO concentration is low, aquatic species will decrease their activities or die. Therefore, DO is an important indicator to evaluate the water pollution in abyss. The survey results show that DO concentration in the measured locations with 1 m higher than water surface fluctuates from 4.46 to 4.81 mg/l. The result shows the measured values meet the Vietnamese allowable specifications ($\geq$ 2 mg O_2/l).

Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD_5) is the necessary amount of oxygen to oxidize chemical compounds in water including organic and inorganic substances. Accordingly, COD is the necessary oxygen to oxidize all chemical substances in water, while BOD is the necessary oxygen to oxidize a part of chemical compounds which are decomposed by microorganisms. The whole amount of oxygen used for the above reactions is taken from Dissolved Oxygen (DO). Therefore, the high demand of chemical oxygen and biological oxygen will reduce DO concentration in water and is harmful to aquatic creatures and the ecosystem in general. Organic, domestic and chemical sewage are factors to create the high values of BOD and COD in water environment.

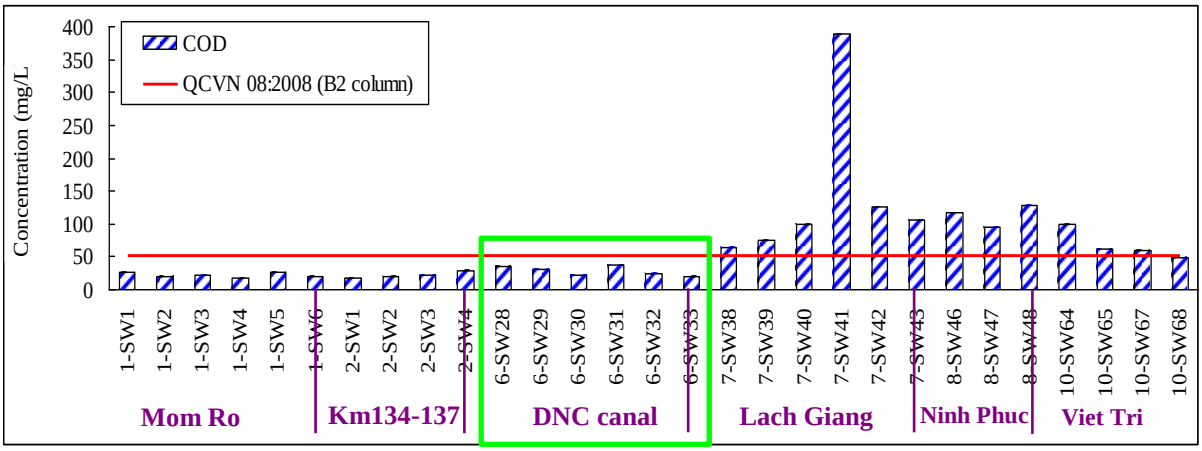


Figure 50 : COD content of the surface water samples at the surveyed areas

From Figs. 50 and 51, it can be seen that COD and BOD5 contents are within QCVN 08:2008/BTNMT (column B2).

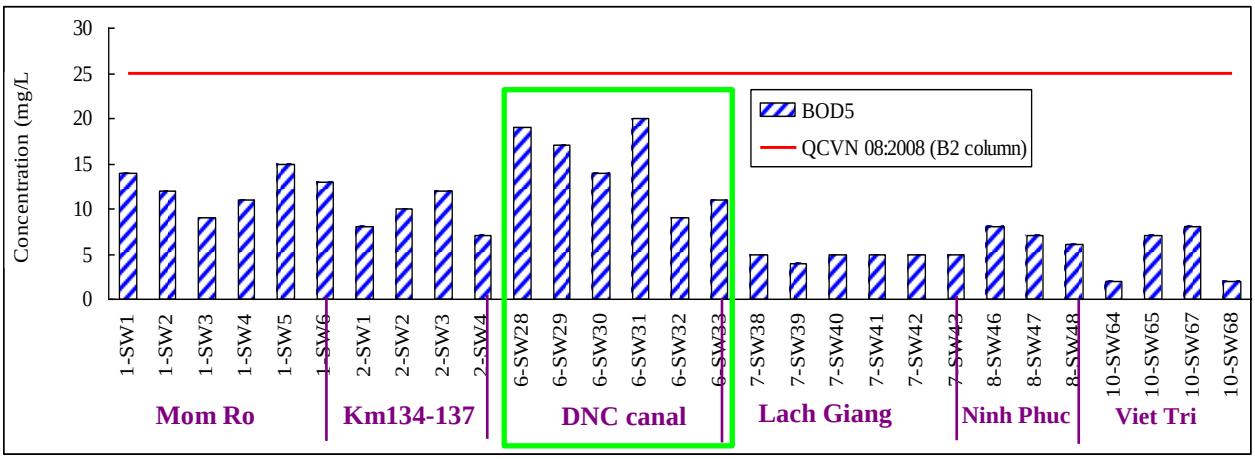


Figure 51 : BOD5 content of the surface water samples at the surveyed areas

Metals often do not involve or less involves in the biochemical process of organisms and often accumulates in their body. Thus, depending of concentrations they can be hazardous elements to living creatures. Water is polluted by heavy metals affecting negatively the habitat of organisms and human. Heavy metals are accumulated in the food chain penetrating to human body. The polluted surface water will spread the polluted substances to underground water, land and other related environment components.

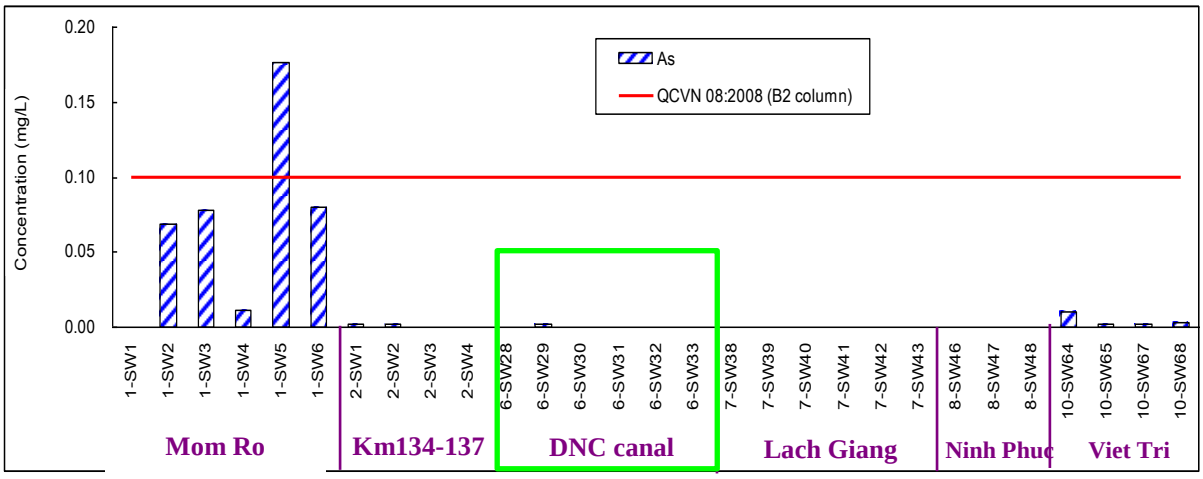


Figure 52 : Arsenic content of the surface water samples at the surveyed areas

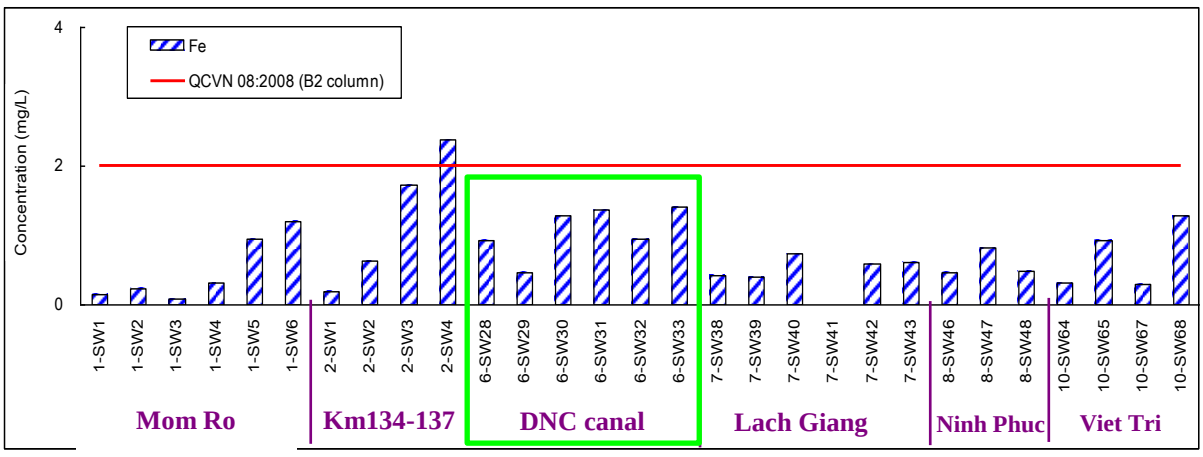


Figure 53 : Iron (Fe) content of the surface water samples at the surveyed areas

Based on the results of analyzing the metal content in water, it can be seen that it is not polluted in surveyed area.

Fluoride (F^-): Weathering of rock and mineral containing fluorine releases fluorine in to underground water, river and stream water to increase gradually the fluorine concentration in water. The surplus or lack of fluorine in soil, water and plant environment affect human health; bone and teeth diseases are the most clearly manifestation. Surface water often contains low fluorine concentration of 0.2 mg/l. When underground water runs through layers of limestone, dolomite, clay, the fluorine content in water is very high up to 8 – 9 mg/l. At the time of survey, F^- contents in sampling areas are much lower than National Specification QCVN 08:2008/BTNMT.

Nitrogen Group: The common form of nitrogen compounds in water is ammonium, nitrite, and nitrate, as a result of decomposition of organic substances or pollution from sewage. In this group, ammonium is the most toxic substance to fish and other aquatic species. Nitrite is formed from the decomposition reaction of organic nitrogen and ammonium with the participation of bacteria. Nitrite is then oxidized to nitrate. In addition, nitrate is also in water because sewage from the chemical industry, the field that use chemical fertilizers, seepage water from disposal area, overflowing rainwater. The presence of nitrogen compounds in the chemical composition of the water shows signs of water pollution. Based on all analysis results, we found that at the time of sampling in all surveyed area, the content of NH_4^+, NO_2^-, NO_3^- is within the Vietnamese allowance specifications.

Pesticides chlorine: Pesticides can seep into groundwater and surface water such as lakes, rivers and streams cause water pollution. However, survey results did not find any pesticide pollution organochlorine group which in the sampled area at the time of the survey.

Microorganism: At the time of sampling, we did not find the pollution of 2 targets Fecal Coli and Total Coliform in surveyed area. The results showed that the total Coliform is much lower than the allowable limit (10000 MPN/100ml).

Conclusion: In general, at the time of the December 2015 survey, surface water quality at survey areas is within QCVN 08:2008/BTNMT (B2 column). However, the project needs to develop a strict supervision program for water surface environment to ensure that the project construction does not increase pollution affecting aquatic life and surface water used for the agricultural production irrigation of local people. Besides quality control of construction equipment during dredge, bend correction and groin construction….such as oil should be not leaked from these equipment during operation; the contractors should control exhaust emission like CO, SO_2, NO_2, Pb……arising from these equipment since when catching rain, they might be accumulated and settled causing pollution for water surface, soil and plants.

4.6.8. Ground water quality

The initial groundwater analyses were implemented by Royal Haskoning in 2007 (ESIA – FS study). A sampling/analyzing campaign has been carried out by CNR-VIPO in February 2012 on underground water. A new updated survey has been undertaken in December 2015 by CNR-VIPO on underground water to cover the possible impacts of the existing road relocation and the future bridge.

According to the survey results, all wells in DNC area have a depth of more than 100m. Thus, during the works performed close to the surface the impact on Ninh Co and Day rivers can be considered as insignificant because the sedimentary layers underground are very low permeability (clays and sandy clays compacted) and do not allow the infiltration of suspended particles. These very fine sediments function as a filter and block the chemical soluted in the water.

Hardness is a measure of overall multivalent cations in the water, more especially calcium and magnesium ions. Surface water often does not have high hardness groundwater. Depending on the hardness of water is divided into the following categories:

Hardness from 0 - 50 mg / l ->	Soft Water
Hardness of 50 - 150mg / l ->	Water somewhat hard
Hardness of 150 - 300mg / l ->	Hard water
Hardness> 300 mg / l ->	Very hard water

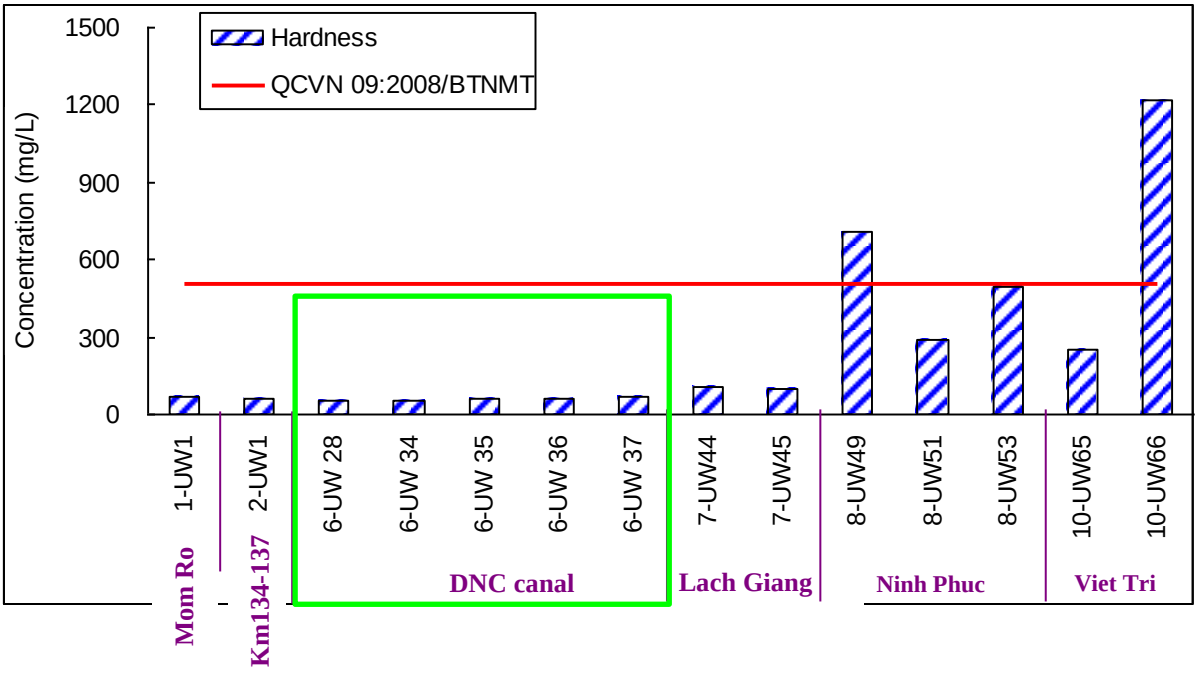


Figure 54 : Hardness content of the underground water samples at the surveyed areas

From Figure 54, it can be seen that the hardness is within the permitted specification (326-354 mg/l) per 500 mg/l as designed in QCVN 09:2008/BTNMT.

Table 15 : Results of underground water monitoring campaign – December 2015 – CNR-VIPO.

Sampling Locations

No.	Code	Sampling positions	Sampling time	Coordinate
1	UW1	Borehole water of Mr. Trinh Van Trang's house - before filtering at the depth of 140m - (Drilling from 2009)	09/12/2015 10h00	20. 14200° N 106.17480° E
2	UW2	Borehole water of Mr. Tran Xuan Ngoi's house - before filtering at the depth of 97m - (Drilling from 1991)	09/12/2015 11h20	20. 12804° N 106.18104° E

Analysis Results: QCVN 09:2008/BTNTM - National technical regulation on underground water quality

No.	Parameters	Unit	UW1	UW2	QCVN 09:2008/BTNMT
1	Temperature	oC	27.4	27.3	-
2	pH	-	7.22	7.23	**5.5 ÷ 8.5**
3	DO	mgO2/l	3.12	3.15	-
4	Turbidity	NTU	31	30	-
5	Conductivity	µS/cm	157	158	-
6	Salinity	‰	0.36	0.34	-
7	Hardness (CaCO3)	mg/l	354	326	**500**
8	TSS	mg/l	623	675	**1500**
9	COD (KMnO4)	mg/l	3.01	3.14	**4**
10	F-	mg/l	0.061	0.062	**1.0**
11	SO42-	mg/l	123	124	**400**
12	Fe	mg/l	6.53	7.13	**5**
13	Mn	mg/l	0.26	0.27	**0.5**
14	Cl-	mg/l	12.34	13.58	**25**
15	Al	mg/l	0.028	0.026	-
16	As	mg/l	0.017	0.015	**0. 05**
17	Cd	mg/l	0.0022	0.0021	**0.005**
18	Cu	mg/l	0.015	0.013	**1**
19	Ni	mg/l	0.001	0.002	-
20	Pb	mg/l	0.0005	0.0004	**0.01**
21	Hg	mg/l	<0.0001	<0.0001	**0.001**
22	Zn	mg/l	0.022	0.020	**3.0**
23	NH4+-N	mg/l	0.033	0.022	**0.1**
24	NO2--N	mg/l	0.013	0.014	**1.0**
25	NO3--N	mg/l	1.04	1.05	**15**
26	Fecal. Coli	MPN/ 100ml	<0.0001	<0.0001	-

No.	Parameters	Unit	UW1	UW2	QCVN 09:2008/BTNMT
27	Total Coliform	MPN/ 100ml	1	2	**3**
28	Pesticides (Chlorinate)	µg/l	<0.0001	<0.0001	-

Total solids: the total solids content is within the permitted specification.

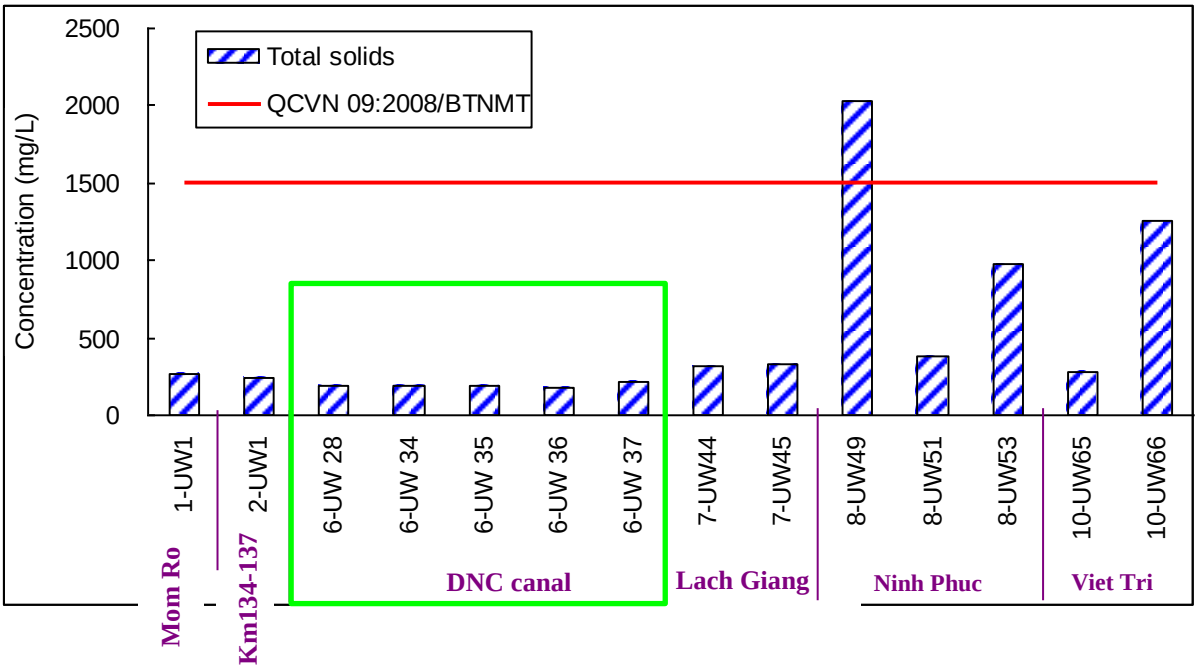


Figure 55 : Total solids content of the underground water samples at the surveyed areas

COD: from the Fig. 56, it can be found that COD content in surveyed areas is within the permitted specification.

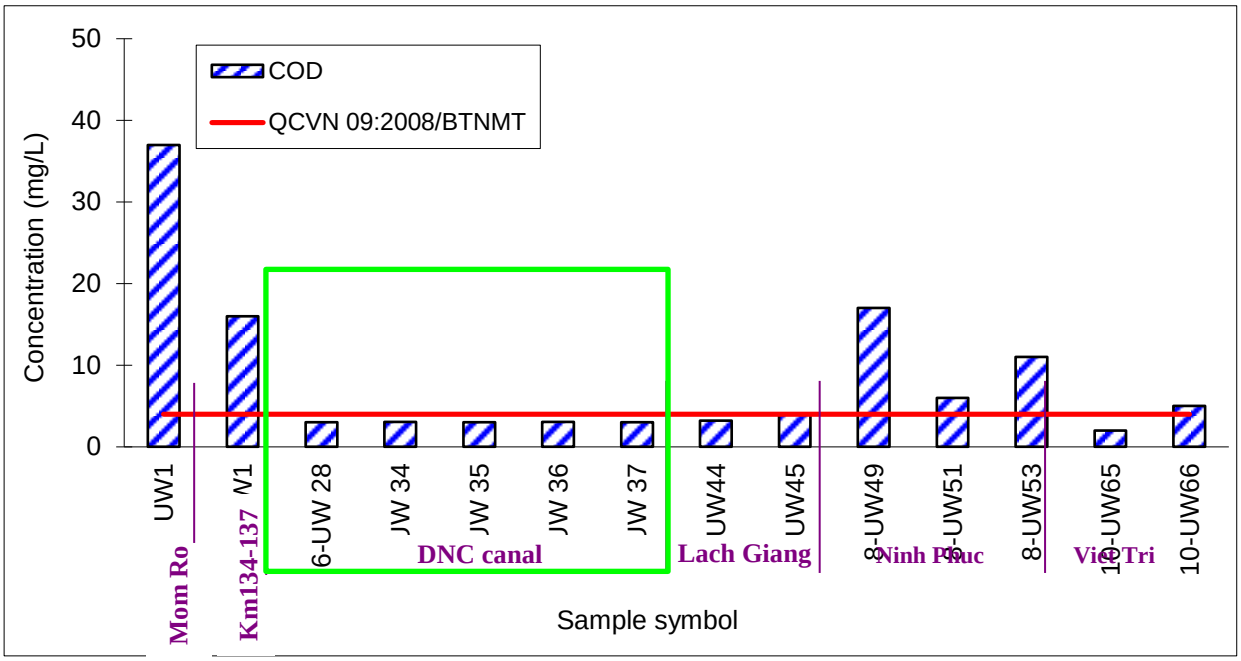


Figure 56 : COD content of the underground water samples at the surveyed areas

SO_4^{2-} content is within the permitted specification.

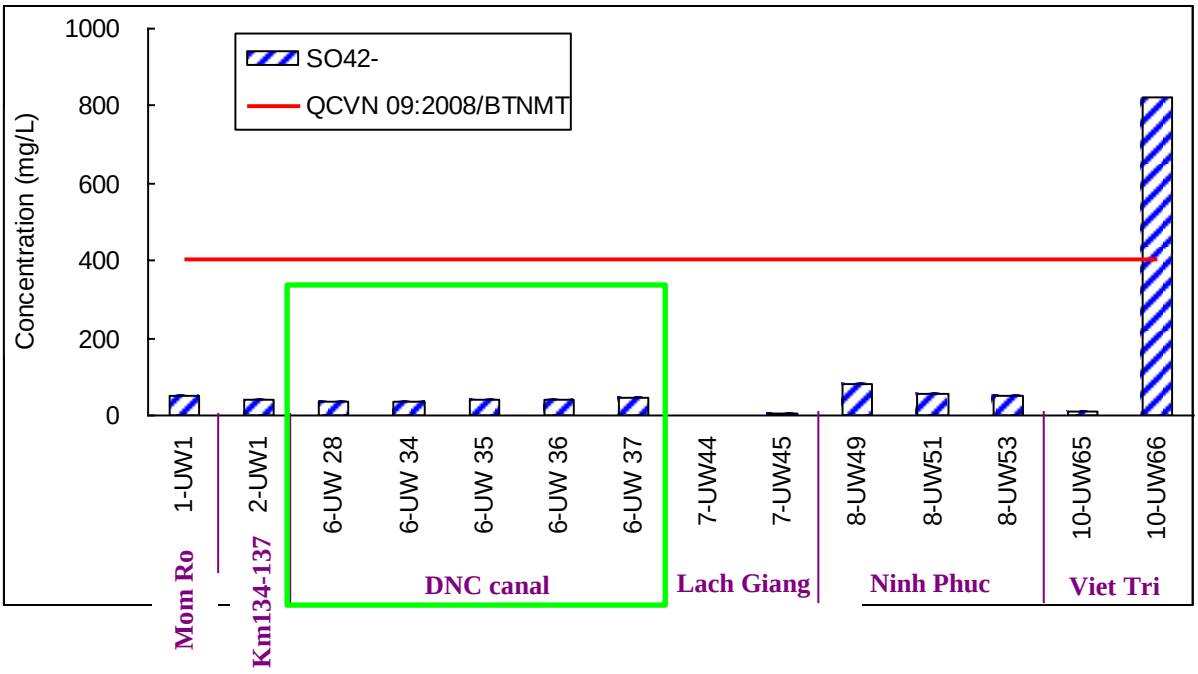


Figure 57 : Sulfate (SO_4^{2-}) content of the underground water samples at the surveyed areas

Chlorine : Water with high chloride content is often caused by the osmosis from the sea water or the pollution from wastes such as zinc, oil exploitation, paper production, water production from the softening process.

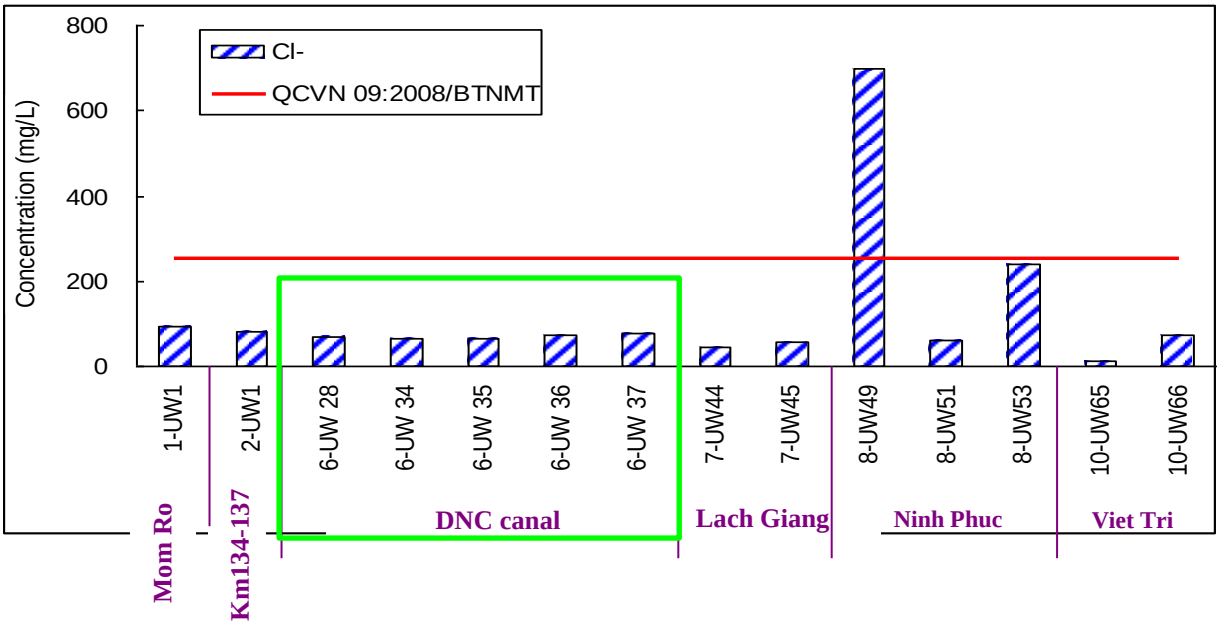


Figure 58 : Chlorine (Cl-) content of the underground water samples at the surveyed areas

In the Fig. 58, we see that the chloride content (one main ion contributes to the salinity of water) in all surveyed areas is below the permitted specification.

*** Metals**

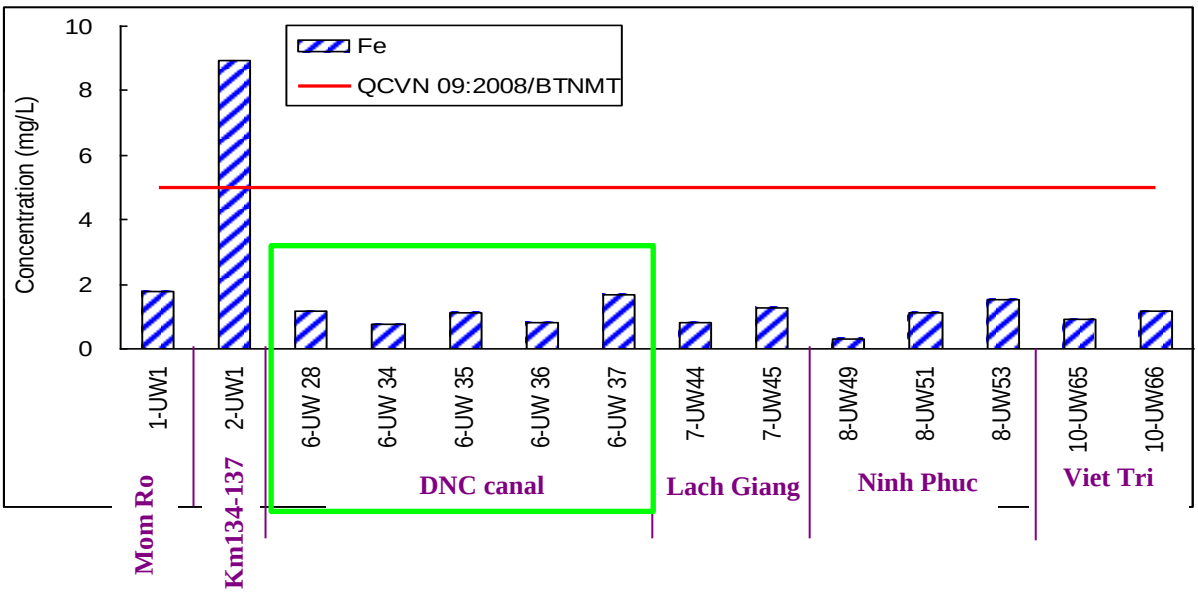


Figure 59 : Iron (Fe) content of the underground water samples at the surveyed areas

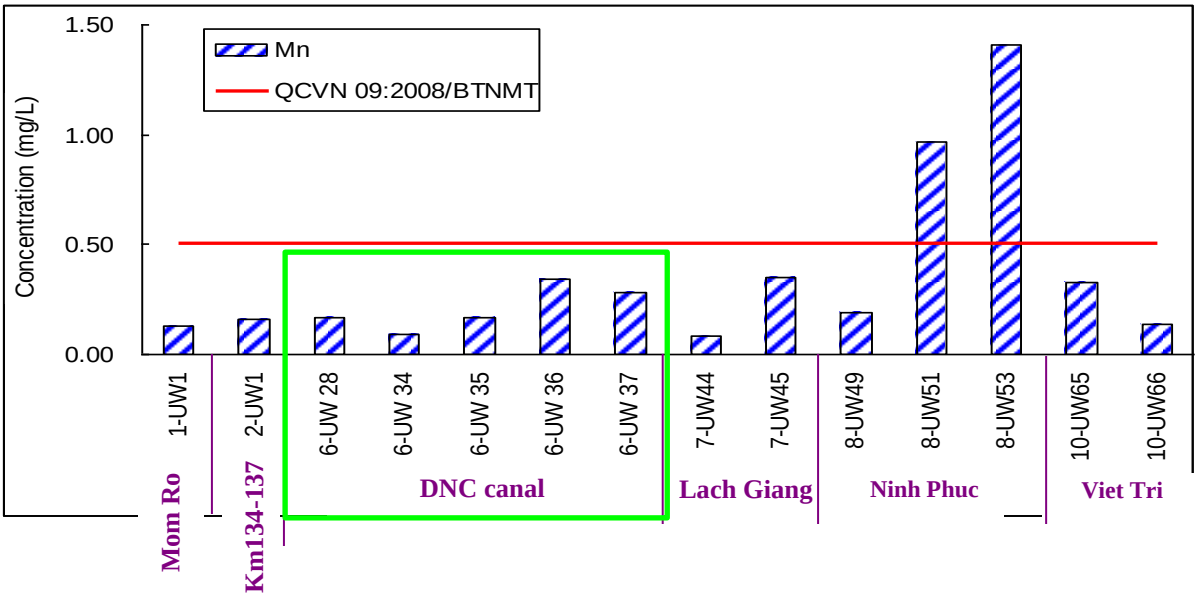


Figure 60 : Manganese (Mn) content of the underground water samples at the surveyed areas

In general, the results of analyzing metals show that the metal content in underground water at the time of survey is lower than the permitted specification..

NH_4^+

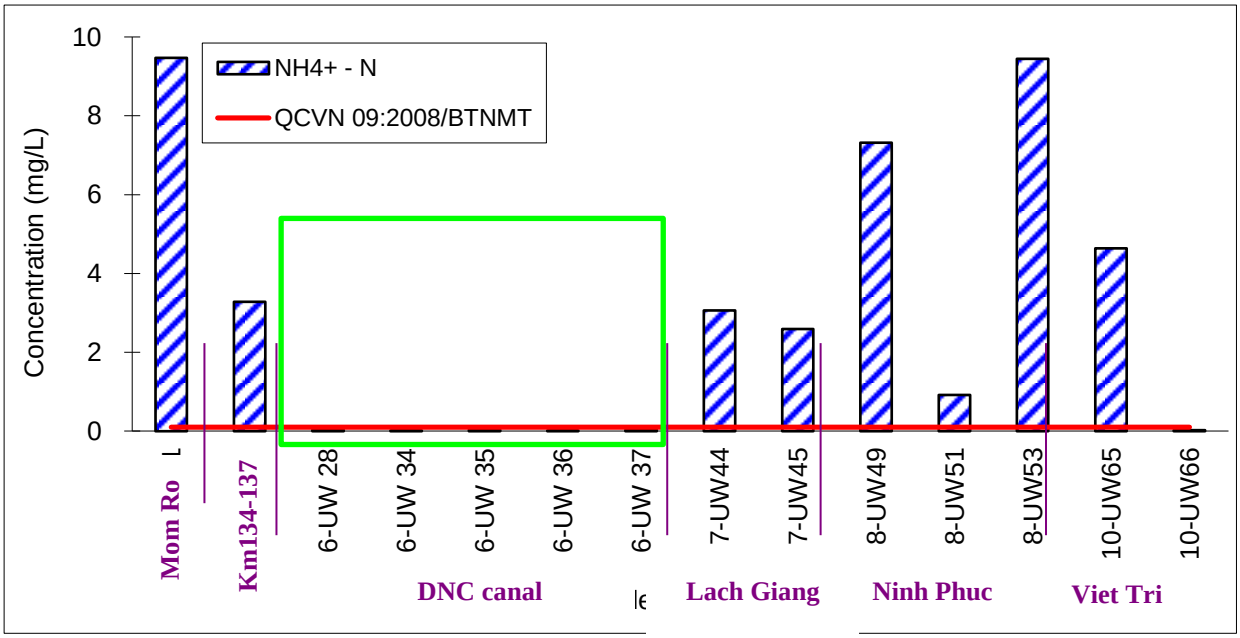


Figure 61 : Ammonium (NH4+-N) content of the underground water samples at the surveyed areas

The ammonia parameter is within the permitted specification.

Microorganism

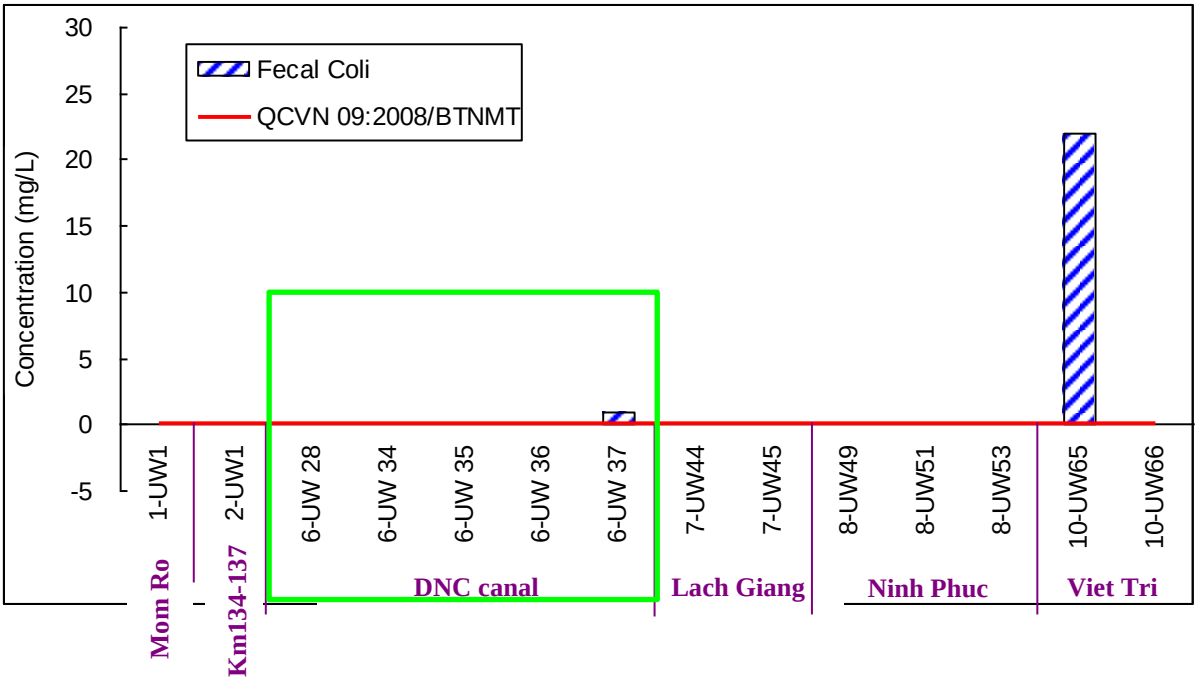


Figure 62 : Fecal Coli content of the underground water samples at the surveyed areas

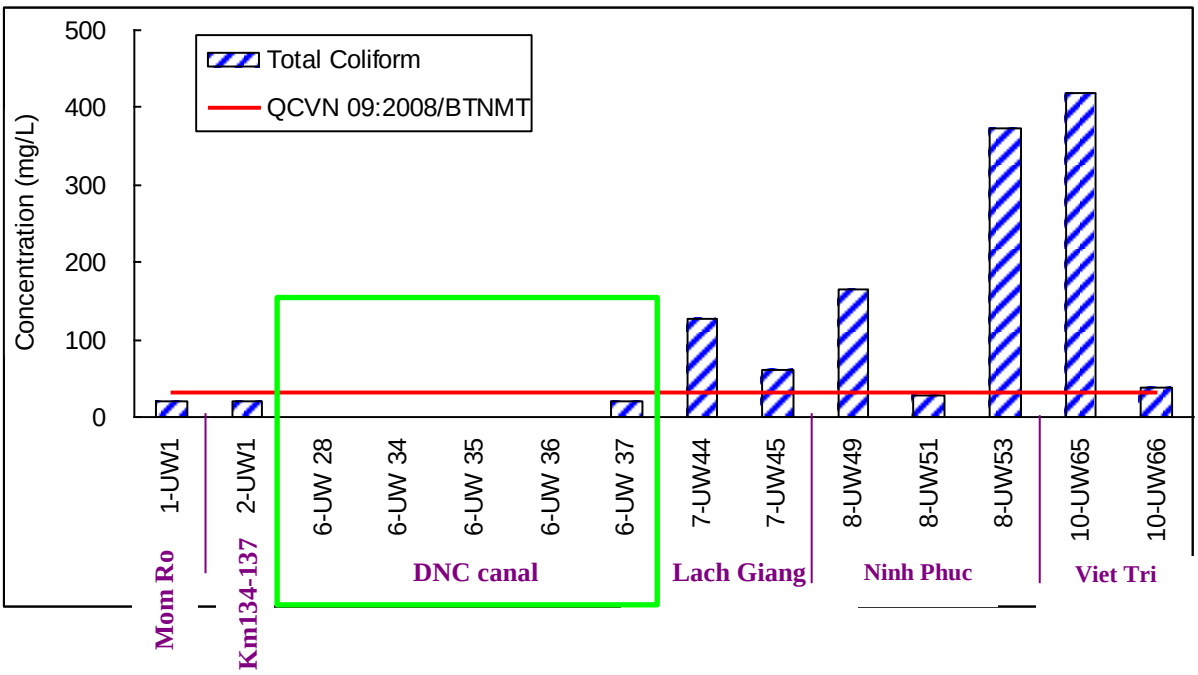


Figure 63 : Total Coliform content of the underground water samples at the surveyed areas

The total Coliform is within the permitted specification.

Organochlorine pesticides

The analysis results show that there is no pollution caused by the organochlorine pesticide at the time of sampling in all surveyed areas.

Conclusion: At the time of sample groundwater quality is good in surveyed areas.

4.6.9. Sediment Quality

During the canal construction, sediment in river bed will be dredged. The evaluation of sediment quality before construction will thus help managers prepare measures during construction. If sediment sample is polluted, necessary and timely measures should be taken to avoid affecting the surrounding environment. The analyses were done in 2012 by CNR-VIPO. The road and bridge will not concern sediment dredging so no updated assessment of sediment quality was necessary.

Sediment plays an important role of water pollution monitor. Heavy metals, pesticides and organic compound with high density often absorb to sediment and then gradually disperse in to water and lastly affect the aquatic system. As for some chemicals, it's difficult to observe them in water but easy to analyze in sandy and silt samples. Hydrocarbon in sediment is stored longer thanks to anaerobic conditions. The sediment samples with symbol of SD (coordinate close to surface water sampling points, 1.5-2.0 m far from the shore) are showed in the figure 64.

According to the Vietnamese standard QCVN 43:2012/BTNMT (National Technical Regulation on Sediment Quality), the results show that all the analytical parameters are lower than permissible standard.

For example, the Cadmium and Mercury contents are much lower than Vietnamese standard (Figs. 64 and 65).

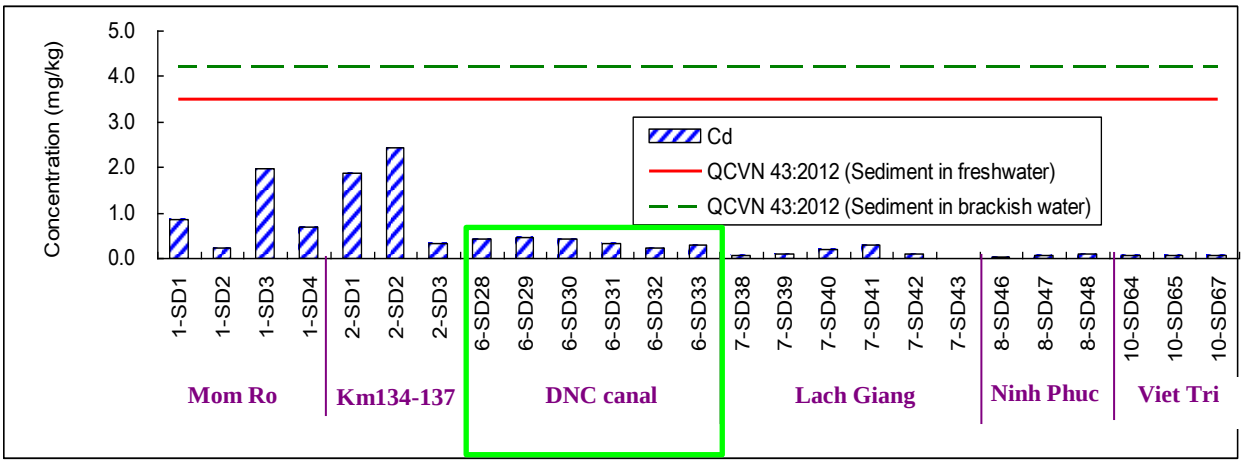


Figure 64 : Cadmium (Cd) content of the sediment samples at the surveyed areas

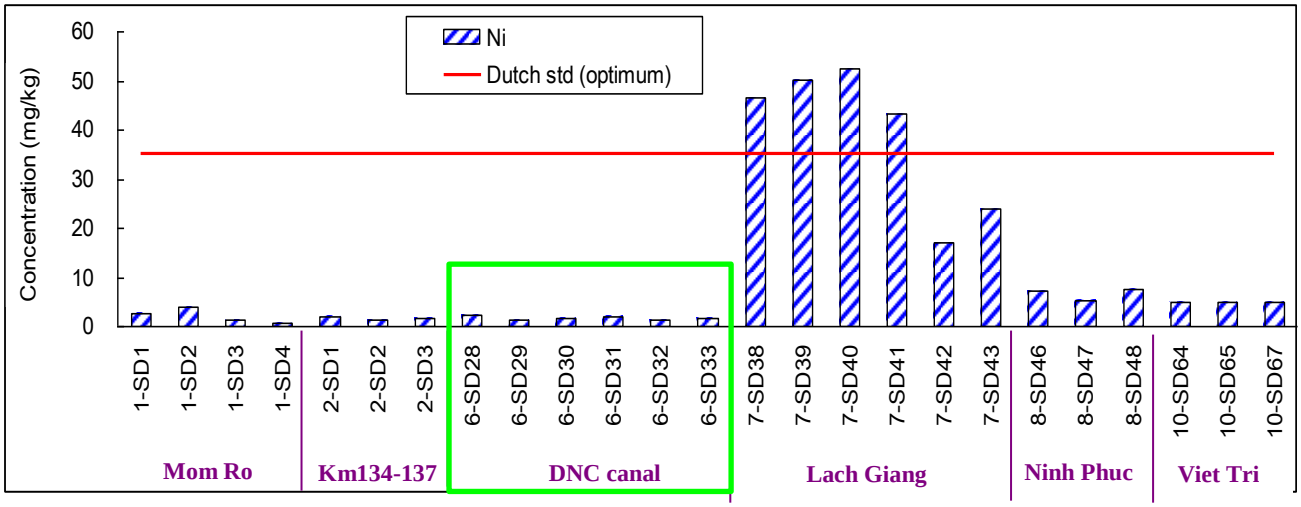


Figure 65 : Nickel (Ni) content of the sediment samples at the surveyed areas

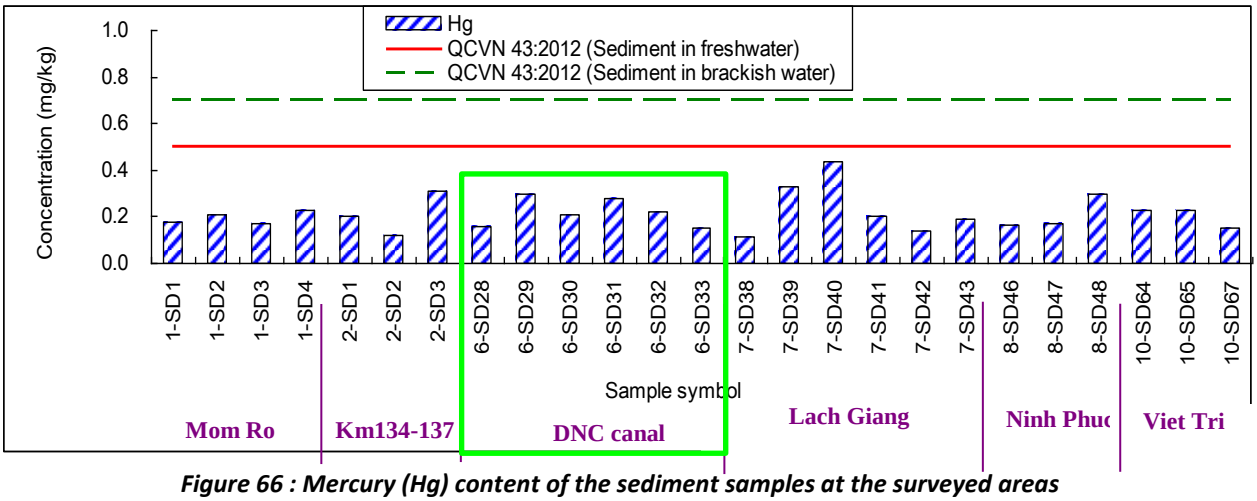


Figure 66 : Mercury (Hg) content of the sediment samples at the surveyed areas

As Vietnam has no specification on sediment quality for Nickel, we refer to Dutch specification as the basis to evaluate. At DNC area, the concentrations of heavy metals are all below the standards.

Conclusion: All analytical parameters of sediment samples in sampling areas at survey time are lower than Vietnamese permissible standard even if compared with Dutch standard.

4.7. BIOLOGICAL STATUS OF THE RED RIVER DELTA

From North to South and from East to West, Vietnam has a diversified eco-system, even within small areas. Research show that there are 95 types of eco-system belonging to 7 types of main terrestrial ecosystems: 39 types of mangrove ecosystems, which include 28 types of natural mangroves and 11artificial mangroves; plus 20 different types of marine ecosystems.

The community composition in Vietnamese ecosystems is diverse and its structure is complex with many classes and sub-species. This characteristic makes the ecosystem diversity in Vietnam much different from other countries in the world. But on the Red River Delta, the human activities are very strong, and most of the land and ponds are totally modified by agriculture, urbanization and transportations networks. On the rivers, navigation is intense and the banks are under the permanent influence of navigation, and during flood, to strong natural disturbing factors. In the delta, the diversity of natural habitats is now very poor and the remaining habitats, fauna and flora communities, totally adapted to these factors.

The remaining ecosystems in the DNC area are faced with heavy anthropogenic presence and interference with ecosystems and are deeply influenced by navigation and huge floods for aquatic ecosystems; and by agriculture and human activities for terrestrial ecosystems. So they are now adapted to these perturbation factors and can be estimated as resilient.

4.7.1. Terrestrial Ecosystems

Natural forests within the project region and peripheral areas are distributed - far from the Red River Delta - in mountains and hills in the provinces of Phu Tho, Vinh Phuc, Ha Tay, Ninh Binh, Quang Ninh, and Hai Duong.

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 area is very far from DNC project and absolutely not concern by any impact from construction or operation in the project.

Far from the project (> 15 km) an IBA (Important Bird Area) was identified by Birds International Association and presented in chapter 4.9. But now the presence of avifauna is very low even in the IBA because of intense illegal hunting and expansion of human population.

4.7.2. Vegetation and aquatic fauna in basin Ninh Co and Day Rivers

Background

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

Phytoplankton community

Phytoplankton is the most important source of primary production.. 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 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 bio volume (i.e., _m³/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 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/m3 and the mean biomass is 130 g/m3. Later (October - November) phytoplankton explodes in number, reaching a mean density of 973,000 cells/m3 and a mean biomass of 470 g/m3. 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/m3 and biomass of 309 g/m3. 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. 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. The number of algal species mentioned above is not enough to reflect the phytoplankton composition in the nature. Of 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/m3 and 240 – 370 g/m3 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.

Zoo benthos community

The biomass of zoo benthic animals used as food by other species varies over a wide range from 4 - 96 g/m3 in the dry season and 5.9 - 11.5 g/m3 in the wet season (Dang Ngoc Thanh et al., 1991). Zoo benthic 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 salinity below 10-12 PSU in the upper regions of the estuary. The representatives of some Priacanthidae, Pomacentridae, and Chaetodontidae are frequently found near coral reefs and some offshore juvenile fish also penetrate estuaries for feeding such as Elasmobranchia, Exocoetus, Sphyraena, Formio, Stromatoidae, and Scombridae.

Despite their 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*.

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. 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 Thriss*a (Linnaeus, 1758) (Vulnerable - level), *Squaliobarbus curriculus (*Threatened - level), *Hemibagrius elongatus* (Giinther) (Vulnerable - level).

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 14-19 summarizes the known seasonal processes of some aquatic life of the Red River Delta.

Table 16: 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)												

Monitoring 2012

An investigation program of vegetation and fishes was organized in February 2012 to characterize the fauna and flora close to the works areas of NDTDP projects, including DNC area. This investigation program had included site investigation and sampling (KV5 and KV6) on DNC area (in and outside of the project limits).

The survey on the status of biological resources are focused on two main objects as vegetation and fish fauna for environmental impact assessment involved dealing with the project "Improving waterway transportation on the Ninh Co and Day River Corridor".

For the above objective the investigation on the status of vegetation and fish resources was conducted from 6th February 2012 until 14th February 2012 at 9 area sites that located throughout the basin-watershed of Red, Ninh Co and Day Rivers belonging to three provinces as Nam Dinh, Ninh Binh and Phu Tho.

Due to the implementation of investigations within the project framework with limited time and funding, the data obtained in this report are only limited in the quantitative aspect that would only provide for preliminary assessment on state of vegetation and fish fauna at the time of survey period and within investigated sites.

Sampling in rainy season was not pertinent for vegetation and not possible for fish fauna considering the limited budget and time available. These 2012 investigations had included general visual observations and sampling on representative sectors of the NDTDP sites projects.

At the DNC area, 2012 investigations have been conducted on the project site as well as on an expanded area on the periphery so as to obtain a fairly accurate picture of the ecological stakes of

the site. For the bridge and road ESIA updating in 2015, no time and budget was provided for new vegetation and fish sampling.

For vegetation, investigations have focused on visual observations of these habitats and associated vegetation. Then representative samples of the flora present in the main habitats (natural or anthropogenic) identified on the site have been done. At the DNC, 2 vegetation samples were carried out on the construction zone and 1 sample in the inner suburbs.

For the fish fauna, habitat characterization and settlement had originally been based solely on the bibliography—documented existing research. The approach envisaged at start of the ESIA in 2011/2012 was to complete this description with a map of suitable habitats for different stages of the life cycles of major fish species. At the DNC and its outskirts, the first observations have shown a very low diversity of aquatic habitats in the riverbed (dry season). In the rainy season, the water level increases and also submerges the floodplain. On these periods, the connection between riverbed and flood plain is done for high flows and very high water levels that make very complex the identification of fish presence during floods.

So as to better identify the main species present (and thus sampling of fish samples on different points on the 2 arms of the river (Day and Ninh Co) was undertaken to try to complete this description of fish wildlife. The sampling was carried out by netting by local fishermen (KV5 and KV6).

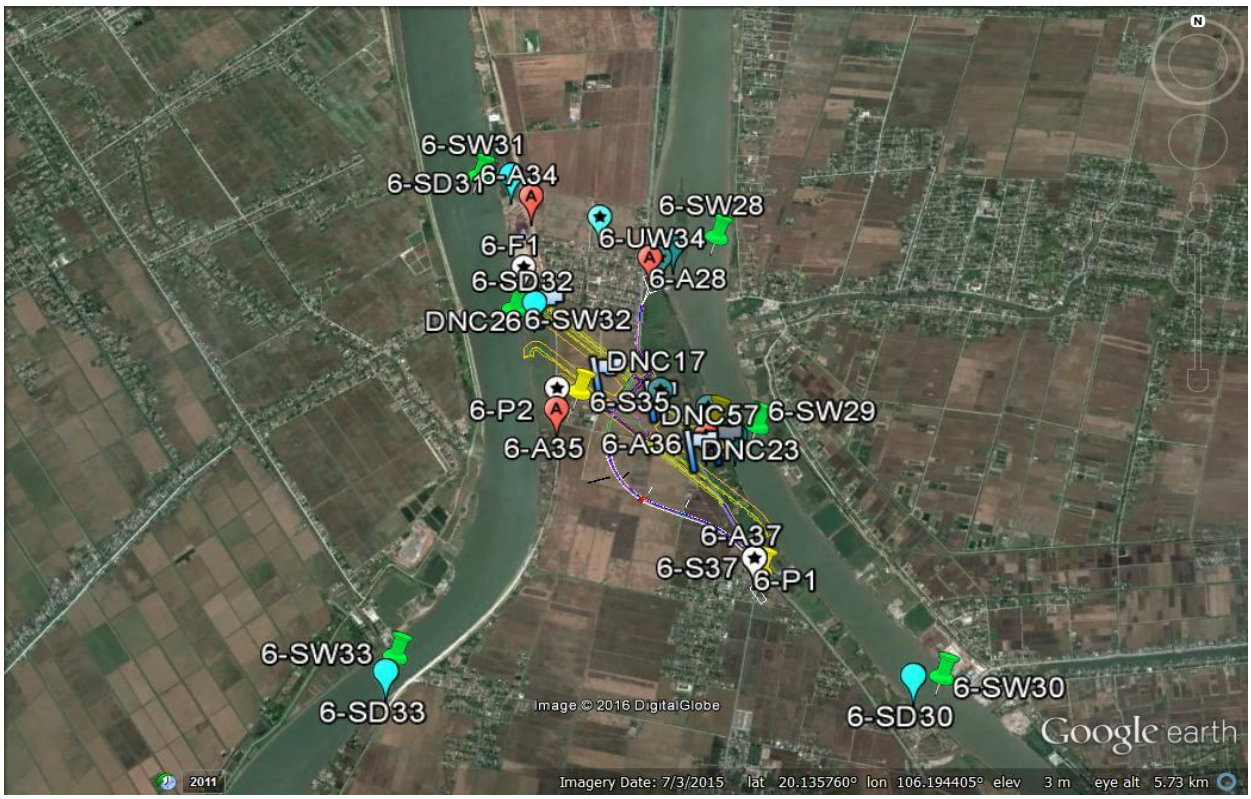
Sampling locations and methods

Location survey includes 9 sampling locations on NDTDP project that presented in table below with local names and their coordinated positions. Sampling points KV5 and KV6ver the DNC area. The sampling points are representative of the existing conditions in the surrounding area.

Table 17: Sampling locations

Investigation areas	Co-ordinates	Localities
KV1 (Mom Ro)	20°20'59" - 106°18'84"	An Vinh, Truc Ninh, ND
KV2 (Km134-137)	20°17'87" - 106°19'60"	Lo Xuyen, Xuan Truong, ND
KV3 (Km142)	20°15'14" - 106°18'50"	Xuan Binh, Xuan Truong, ND
KV4 (Km145-146)	20°14'55" - 106°16'24"	Hai Minh, Hai Hau, ND
KV5 (Km162) - DNC	**20°08'81" - 106°10'67"**	**Nghia Son, Nghia Hung, ND**
KV6 (Km164-166) - DNC	**20°08'12" - 106°10'67"**	**Nghia Hung, ND**
KV7 (Lach Giang)	20°00'55" - 106°12'15"	Thinh Long, ND
KV8 (Ninh Phuc port)	20°15'05" - 106°00'09"	Bich Dao, Ninh Binh
KV10 (Viet Tri port)	21°18'05" - 105°26'45"	Bach Hac, Viet Tri, Phu Tho

A sampling map in DNC area is presented in the figure below:



Note:

A: Ambient Air	SW: Surface water	SD: Sediment	S: Soil
F: Fish	P: Plantation		

Vegetation Investigation:

At each sampling site the investigations were carried out with observation, sampling and taking photograph of the vegetation occurring within 100-200 m distance transversal and along the river, including water bodies, wetlands, gardens, fields on both sides of River. All vegetable plants are presented in the area included wild plants and vegetation crops were collected and identified by common and scientific names. In addition, the interviews to local people on the status of previous and present vegetation were taken. The identification of plant species based on Plant Taxonomy Book (Pham Hoang Ho, 2000).

Fish fauna investigation:

Fish samples collected from each sampling site by fish catching tools of the local fishermen at the river villages. The surveys and sampling were also conducted in the small markets at local villages. In addition, interviews with the fishermen and fish sellers in the market were conducted. The final data were referenced to some previous investigation on the fish fauna in the same areas that available in the database of Institute of Ecology and Biological Resources, VAST, Hanoi. The identification of fish species is conforming to Nguyen Van Hao (2001, 2005) and Kottelat (2001) studies.

Investigation results

Vegetation

The composition of vegetable flora associated with Ninh Yen, Day River riparian's recorded of 48 species, that belonging to 21 families. The number of plant taxa as species, genera, families that reported in the investigated area are listed in Table 16. The species composition of vegetable flora with local, common and scientific names is listed in Table 18. In the investigated basin the domination of vegetation were belonging to the family of Asteraceae, Poaceae and Brassicaceae with 48%, 43% and 17%, respectively. Other plant families were occurred less common with 1-2 genera in each of them. **DNC concerns sample KV-6 at Nghia Hung commune) and KV5 at Nghia Son commune (In figures below.**

Bananas (*Musa* spp.)

Bermuda grass (*Cynodon dactylon)*

Wiregrass (*Eleusine indica)*

Common reed (*Phragmites communis)*

Table 18: Vegetation: Sampling locations and number of samples in 2012

Sampling Sites	Localities	Vegetable Taxa		
		Number of Species	Number of Genera	Number of Families
KV-1	An Vinh, Truc Ninh, Nam Dinh	12	12	8
KV-2	Lo Xuyen, Xuan Truong, Nam Dinh	16	14	9
KV-3	Xuan Binh, Xuan Truong, Nam Dinh	9	9	8
KV-4	Hai Minh, Hai Hau, Nam Dinh	13	11	11
KV-5	**Nghia Son, Nghia Hung, Nam Dinh**	**16**	**15**	**8**
KV-6	**Nghia Hung, Nam Dinh**	**12**	**12**	**8**
KV-7	Thinh Long, Nam Dinh	8	8	8
KV-8	Bich Dao, Ninh Binh	14	13	8
KV-10	Bach Hac, Viet Tri, Phu Tho	14	13	8

Agricultural crops, including 17 species of plant species that included: food crops (rice, maize, peanuts), but at the time of the survey some these crops were not been growth, therefore they should not included in the report; vegetable crops (pumpkin, cabbage, broccoli, kohlrabi, lettuce, corriandrum, knotweed, elephant ear), fruit tree (bananas), medical plants (dandelion, dye-weed, plantain), cottage industrial plants (mulberry, bamboo, papyrus, castor oil, calamus).

Wild plants: includes 30 different plant species belonging to groups of wild weeds, wild chrysanthemum, sensitive plants, water hyacinth, cypress and other gramineous plants. Although wild plants dominate the vegetation along rivers in the survey area, but their density and coverage level is not too high.

In the term of vegetation structure the recorded plants in the investigated area can be classified into some ecosystems:

Agricultural ecosystem: there are rice fields and household gardens that mainly located in the outer dykes and some of them in the inter dykes along the rivers, where local people plant seasonal crops, fruit trees such as rice, corn, beans, green vegetables, bananas). **Most of the DNC project area is covered by agricultural land (> 95 %).**

Starting point of project

Agricultural land

Ending point of project

Do Muoi ferry

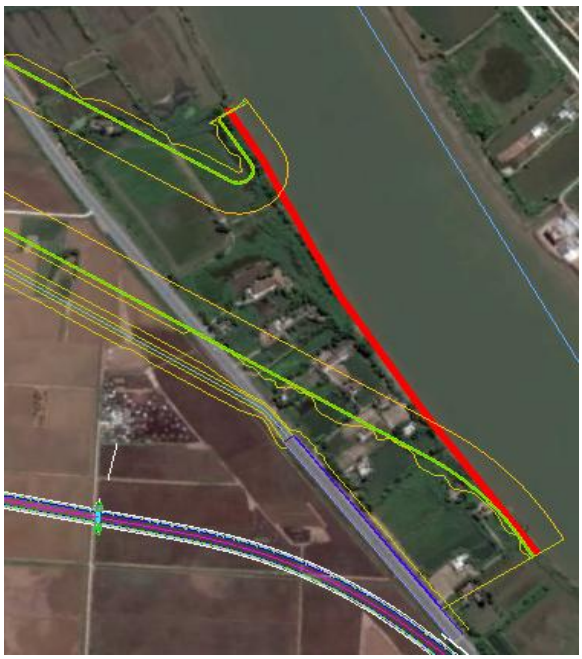
Church in Nghia Lac commune near project

Duc Lam factory in Nghia Son commune

Wetland ecosystem: At KV-6 is an agricultural wetland area with one seasonable rice crop, but between to crops, the area is favorable to the growth of wild plants, predominant among them wild white top weed and gramineous plants, whereas at the adjoining alluvial areas rush and water hyacinth are predominant in permanent flooded areas. In the KV-6 with flooded acreage that is larger than in Ninh Co River presence of many species is noted such as plum-grass (*Saccharum arundinaceum*), reed (*Phragmites communis*), strabismus-grass (*Cyperus difformis*), common-reed (*Sonneratia caseolaris*), rush (*Cyperus* spp.), and mangrove-apple (*Sonneratia caseolaris*), whereas in the upper edge of this area is still dominated by the wild daisy of Asteraceae. **Within the DNC area these habitats are only located on few longitudinal sites, concerning a very narrow (5 to 10 m width) area between agricultural lands and the rivers. Thay mostly concern the Ninh Co river side. These habitats concern less than 20.000 m² along the 3200 m of banks on Day River right bank and Ninh Co River left bank. In the project area this habitat concern 1650 m² on Day river side and 3200 m² on Ninh Co river side.**

The impacts of the DNC canal on the bank eliminate a length of 250 m on Day River side and 650 m on Ninh Co River side ➔ see the 2 pictures below.

Impacted riparian vegetation on Day River side (250 m of cumulated length)

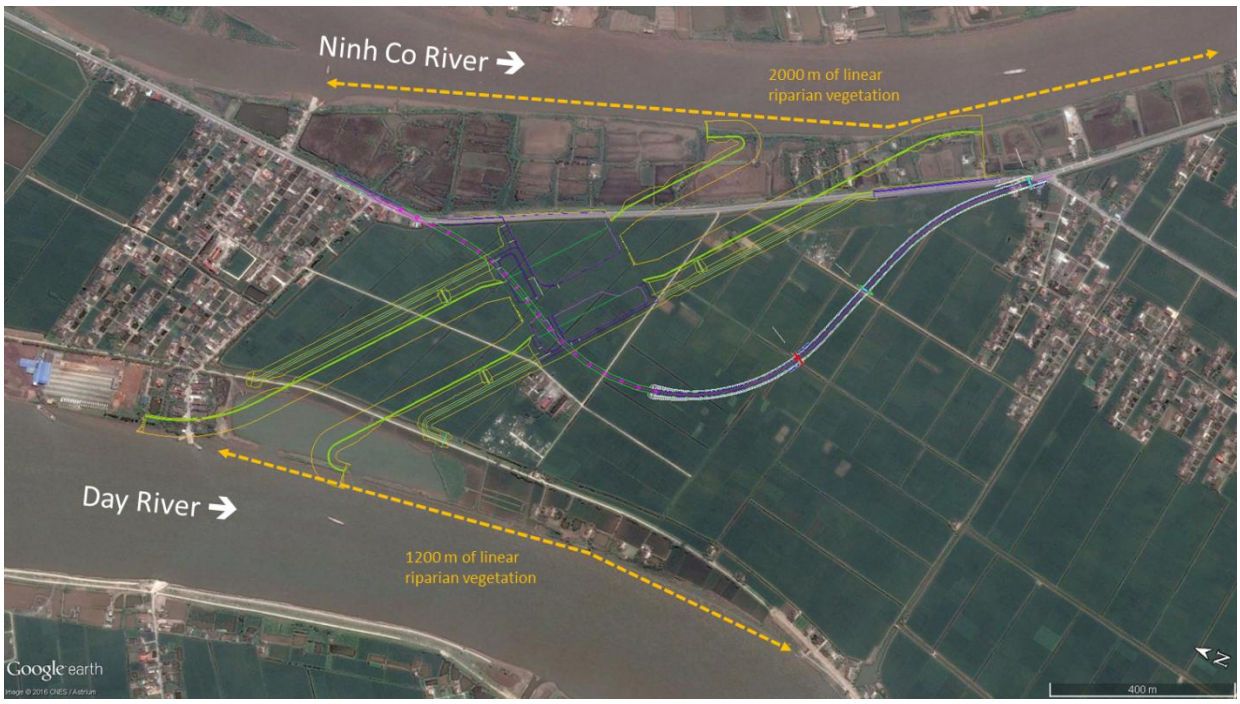


Impacted riparian vegetation on Ninh Co River side (650 m length)

The riparian vegetation is wider and more diversified on Ninh Co river side, but the ecological interest is limited to small birds, insects and reptiles, none of which are threatened or endangered species. Considering the very limited width of this 900 m length of riparian vegetation it represents less than 5.000 m² of destroyed riparian vegetation. The ecological treatment of the canal bank protection will create 90.000 m² (9 ha) of riparian habitats – it will represent 18t times the lost habitats.

Reeds *(Phragmites communis*)

Plum-grass (*Saccharum arundinaceum*)



Vegetation on DNC area

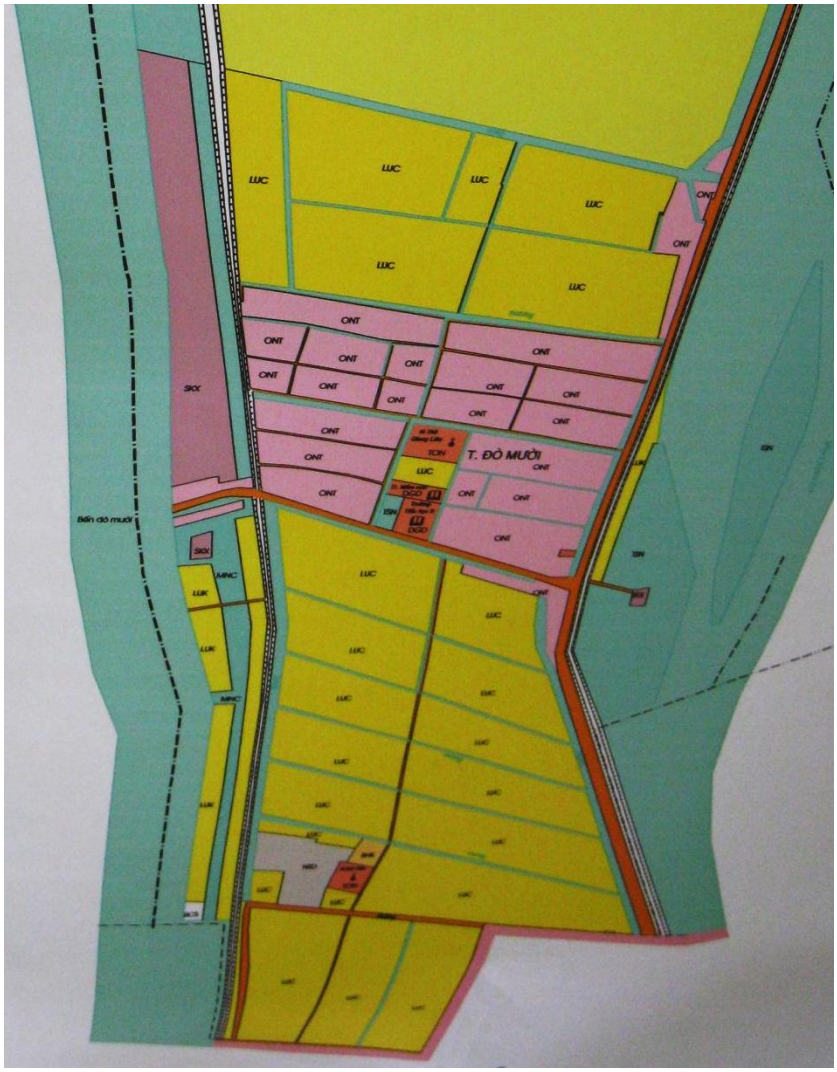
Above from Google Earth April 2015- area during harvesting of "wet" rice fields near the rivers

Below from Google earth July 2015 – area during harvesting of "dry" rice fields between the dykes

Grassland ecosystem: **On DNC area they are located only at the limits between the agricultural lands and the river. Most of the time they are mixed with artificial (anthropic) wetland habitats and represent a very small part of the land occupation.**

Mangrove ecosystem: **This ecosystem is not present at DNC area and concerns only the very lower part of Ninh Co and Day rivers, especially the estuaries.**

In conclusion, the vegetation in the survey areas of the Ninh Co and Day Rivers (DNC project) watershed is mainly grassland and wild shrubs and seasonal annual crops with low economic value (See the agricultural map below). The level of vegetable diversity of the basin-watershed is low and their economic importance is not so much valuable, apart from its use as the ground cover against erosion by Grass may be used for cattle fodder use for livestock, and some wild plant species are used as traditional medicine.



Note:

LUC	***Rice land***
ONT	***Resident land***

Fish fauna

The composition of fish fauna in the survey areas consists of 29 species that belonging to 12 families, 6 orders. The number of fish taxa as species, families and orders that reported in the investigated area are presented in Table17. The species composition of fauna with local, scientific names is listed in Table 19. **The DNC area is covered by 2 survey and sampling sites:**

- **KV-5 - DNC Nghia Son, Nghia Hung, Nam Dinh**
- **KV-6 - DNC Nghia Hung, Nam Dinh**

The majority of fish fauna is indigenous species and only one species as tilapia zebra (*Oreocromis niloticus*) was invasive and not originally indigenous to Vietnam but now it is established in the nature with a relatively common distribution. The fish family with dominant number of species is Cyprinidae with 47% of total species. Almost fish species in these areas has the same origin with the fish fauna in the Red river system, only a few species originated from the Mekong delta and appeared recently such as blue-gourami (*Trichogaster trichopterus*). The fish fauna in the Ninh Co, Day River watershed included 2 groups: culturing fishes in lakes and ponds at local resident villages along rivers. This group is including 9 species as carp, Silver carp, Bigheaded carp, black-carp, grass-carp, mud-carp, Labeo-rohita, zebra-tilapia, mozambique-tilapia. In the flooded season some ponds broken so culturing fish may release into the rivers and living as the natural fishes. Wild fish group consists of 20 species and these often dominated in the watershed. Ecologically, the fish fauna can be separated into two groups: freshwater fish fauna and brackish water fish fauna. Freshwater species are occurred in almost surveyed areas, except KV-7. From total of 29 recorded species, 21 species are belonging to freshwater fauna and 8 species are belonging to marine and brackish water fauna which are typically by Bombay-duck, halfbeak, mackerel, yellowfin seabream, Indian-mackerel and sea-bass. Some of them are widely distributed in both freshwater ecosystems and brackish water ecosystems such as common-carp, sharp-belly, barbel-fish, cranoglanidid and zebra-tilapia.

Table 19: Fishes: Sampling locations and number of samples in 2012

Sampling sites	Localities	Fish taxa			
		Number of Species	Number of Genera	Number of Families	Number of Orders
KV-1	An Vinh, Truc Ninh, Nam Dinh	18	16	6	3
KV-2	Lo Xuyen, Xuan Truong, Nam Dinh	16	14	3	3
KV-3	Xuan Binh, Xuan Truong, Nam Dinh	7	7	2	2
KV-4	Hai Minh, Hai Hau, Nam Dinh	5	5	2	2
KV-5 - DNC	**Nghia Son, Nghia Hung, Nam Dinh**	**16**	**15**	**8**	**4**
KV-6 - DNC	**Nghia Hung, Nam Dinh**	**15**	**14**	**8**	**4**
KV-7	Thinh Long, Nam Dinh	15	15	12	6
KV-8	Bich Dao, Ninh Binh	15	14	4	3
KV-10	Bach Hac, Viet Tri, Phu Tho	11	10	4	3

Cranoglanidid (*Cranoglanis sinenssis*) occurring at five investigated sites (KV-1, KV-2, **KV5, KV6**, KV7)

In term of fish density and productive fishery: Apart from field surveys, the investigations by interviews on the local markets and traditional fishermen indicated that the fish being caught by fishermen is very low. This situation might be due to contaminated environment, but

another cause might be the use by local people of various tools for fishing such as using electric pulses that might be caused the fauna extermination. Currently only very few local people can survive by fishing. . Many fishermen on the rivers have been moved ashore to make a livelihood with other jobs.

In the KV-6 on the Day River, the density of freshwater fish is relatively high and some larger carp is still caught.

Common carp *(Cyprinus carpio*)

Tilapia (*Oreochromis niloticus*)

Sharp belly (*Hemiculter leucisculus)*

Sardine (*Clupanodon thrissa)*

In conclusion, the fish resources in watershed of Ninh Co and Day River have been decreasing for years in both species diversity and productivity. This was confirmed during the survey, when only very few people are living by fishing and even fishermen are now not able to get enough incomes from fishing activity. This reduction of fish diversity and quantities is due to different factors as over fishing, flood and sediment control, sand exploitation and natural habitats reduction and ecosystem's simplification. Due to the paucity and ongoing regression of fish fauna in the red river watershed, the use of fish community as indicator tool for environmental impact assessment is not useful or particularly relevant.

Table 20: Vegetation composition at the investigated locations

No	Vietnamese name	English name	Scientific name	Scientific name of Plant Families	Vietnamese name of Plant Families	Sampling sites							
						1	2	3	4	KV6 DNC	7	8	10
1	Cây bần	Mangrove apple	*Sonneratia caseolaris*	Lythraceae	Bằng lăng					-	-		
2	Bí đỏ	Bumkin	*Cucurbita pepo*	Cucurbitaceae	Bầu bí		-						
3	Cải bắp	Cabbage	*Brassica oleracea*	Brassicaceae	Cải		-		-				
4	Cải xanh	Mustard	*Brassica juncea*	Brassicaceae	Cải		-		-				-
5	Su hào	Kohlrabi	*Brassica oleracea*	Brassicaceae	Cải		-		-				
6	Cải trời	Wild cabbage	*Rorippa indica*	Brassicaceae	Cải							--	
7	Chua me đất (cỏ 3 lá)	Oxalis	*Oxalis corniculata*	Oxalidaceae	Chua me đất						--		
8	Chuối	Bananas	*Musa* spp.	Musaceae	Chuối	-	-	-		-			-
9	Thủy trúc (cỏ lác) 1 nhỏ	Small rush	*Cyperus iria*	Cyperaceae	Cói				-	-			
10	Thủy trúc (cỏ lác) 2 lớn	Large rush	*Cyperus difformis*	Cyperaceae	Cói		-	-					
11	Cúc dại	Wild daisy	*Calotis anamitica*	Asteraceae	Cúc	+	+	+	++	+	-	-	+
12	Cứt lợn	Billygoat weed	*Ageratum conycoides*	Asteraceae	Cúc	--							
13	Cỏ lào	Siam weed	*Chromolaena odorata*	Asteraceae	Cúc		--						--
14	Cúc dại	White top weed	*Parthenium hysterophorus*	Asteraceae	Cúc		--					--	
15	Cúc tần	Indian fleabane	*Pluchea indica*	Asteraceae	Cúc		-	-				--	
16	Rau ngổ	Corriander	*Enydra fluctuans*	Asteraceae	Cúc				-				
17	Cây mây	Rattan	*Calamus tetradactylus*	Asteraceae	Cúc				-				-
18	Bồ công anh	Dendelion	*Taraxacum officinale*	Asteraceae	Cúc							--	
19	Nhọ nồi	Dye-weed	*Eclipta prostrata*	Asteraceae	Cúc	--							
20	Xà lách	Salad	*Lactuca sativa*	Asteraceae	Cúc		-						
21	Dâu tằm	White mulberry	*Morus alba* L.	Moraceae	Dâu tằm		+						
22	Rau má	Indian pennywort	*Centella asiatica*	Apiaceae	Hoa tán	-							
23	Rau mùi	Corriandrum	*Coriandrum sativum*	Apiaceae	Hoa tán		--						
24	Cỏ lá tre	Bamboo leaf	*Lophatherum gracile*	Poaceae	Hòa thảo	+							
25	Cỏ gà	Bermuda grass	*Cynodon dactylon*	Poaceae	Hòa thảo	++	+			+	+		+

No	Vietnamese name	English name	Scientific name	Scientific name of Plant Families	Vietnamese name of Plant Families	Sampling sites							
						1	2	3	4	KV6 DNC	7	8	10
26	Cỏ lá gừng	Carpet grass	*Axonopus compressus*	Poaceae	Hòa thảo							+	
27	Cỏ tranh	Blady grass	*Imperata cylindrical*	Poaceae	Hòa thảo	--				-			-
28	Cỏ mần trầu	Wiregrass	*Eleusine indica*	Poaceae	Hòa thảo	--							
29	Cỏ lau	Plum grass	*Saccharum arundinaceum*	Poaceae	Hòa thảo		+			+			
30	Sậy	Common reed	*Phragmites communis*	Poaceae	Hòa thảo					+			
31	Tre	Bamboo	*Bambusa bambos*	Poaceae	Hòa thảo			-		-		-	-
32	Cỏ cú	Nut grass	*Cyperus rotundus*	Poaceae	Hòa thảo							--	
33	Muống biển	Goat's foot	*Ipomoea pes-caprae*	Convolvulaceae	Khoai lang						-		
34	Bèo tây	Water hyacinth	*Eichhornia crassipes*	Pontederiaceae	Lục bình	-		+	+	+		+	
35	Bông mã đề	Plantain	*Plantago asiatica*	Plantaginaceae	Mã đề	--							
36	Ô rô nước	Bear's breech	*Acanthus ilicifolius*	Acanthaceae	Ô rô						-		
37	Phi lao	Beach she-oak	*Casuarina equisetifolia*	Casuarinaceae	Phi lao			+	+		+		
38	Dương xỉ	Fern	*Cyclosorus* sp.	Thelypteridaceae	Quyết	--			--			--	
39	Cây dăm (nghể)	Knotweed	*Polygonum glabrum*	Polygonaceae	Rau dăm		-		-				
40	Chút chít	Dock	*Rumex wallichii*	Polygonaceae	Rau răm								-
41	Ráy	giant elephant ear	*Alocasia odora*	Araceae	Ráy			-	-				-
42	Khoai nước	Elephant ear	*Colocasia esculenta*	Araceae	Ráy		-			-		-	
43	Cỏ rau	Scurvy weed	*Commelina diffusa*	Commelinaceae	Thài lài	-			-	-		-	
44	Rau sam (cỏ sữa lá nhỏ)	Asthma plant	*Euphorbia thymifolia*	Euphorbiaceae	Thầu dầu			--			--		-
45	Thầu dầu	Castor oil plant	*Ricinus communis*	Euphorbiaceae	Thầu dầu								-
46	Trinh nữ 1	Sensitive plant	*Mimosa pudica* L.	Mimosaceae	Trinh nữ							-	+
47	Trinh nữ 2	Giant sensitive tree	*Mimosa pigra* L.	Mimosaceae	Trinh nữ							-	-
Total:						12	16	9	13	**12**	8	14	14
Estimated % presence: <10% (--); 10<%<25 (-); 25<%<50 (+); 50<%<75 (++); 75% (+++)										DNC			

Table 21: Fish composition at the investigated locations

No	Vietnamese name	English name	Scientific name of Species	Scientific name of Families	Scientific name of Orders	Sampling sites								
						1	2	3	4	5 DNC	6 DNC	7	8	10
1	Cá Khoai	Bombay-duck	*Harpadon nehereus*	Synodontidae	Aulopiformes							+*		
2	Cá kìm	Halfbeak	*Hemirhamphus pusillus*	Hemirhamphidae	Beloniformes							+*		
3	Cá chép	Common carp	*Cyprinus carpio*	Cyprinidae	Cypriniformes	+	+	+	+	+	+*	+	+*	+
4	Cá tép dầu	Oil tinny fish	*Ichskauina macrolepis*	Cyprinidae	Cypriniformes	+	+		+				+*	
5	Cá diếc	Crucian carp	*Carassius gibelio*	Cyprinidae	Cypriniformes	+	+	+	+	+	+		+*	+
6	Cá mương	Sharp belly	*Hemiculter leucisculus*	Cyprinidae	Cypriniformes	+	+	+	+	+	+	+	+*	+
7	Cá mè trắng	Silver carp	*Hypophthalmichthys molitrix*	Cyprinidae	Cypriniformes	+	+							
8	Cá mè hoa	Bigheaded carp	*Hypophthalmichthys nobilis*	Cyprinidae	Cypriniformes	+	+			+	+		+	+
9	Cá chày đất	Barbel fish	*Spinibarbus caldwelli*	Cyprinidae	Cypriniformes	+	+	+		+	+	+	+	
10	Cá trắm đen	Black carp	*Mylopharyngodon piceus*	Cyprinidae	Cypriniformes	+	+			+	+		+	+
11	Cá trắm cỏ	Grass carp	*Ctenopharyngodon idella*	Cyprinidae	Cypriniformes	+		+	+	+	+		+	+
12	Cá rưng	Cardinal fish	*Carasioides cantonensis*	Cyprinidae	Cypriniformes	+	+	+		+	+		+	
13	Cá trôi ấn độ	Labeo rohita (Rohu)	*Labeo rohita*	Cyprinidae	Cypriniformes	+	+			+	+		+*	+
14	Cá trôi	Mud carp	*Cirrhinus molitorella*	Cyprinidae	Cypriniformes	+	+				+		+	+
15	Cá vền	Black amur bream	*Megalobrama terminalis*	Cyprinidae	Cypriniformes							+*		
16	Cá mòi cờ	Sardine	*Clupanodon thrissa*	Clupeidae	Cypriniformes							+*		
17	Cá đối	Bluetailed mullet	*Liza seheli*	Mugilidae	Mugiliformes					+	+	+		
18	Cá rô phi vằn	Tilapia	*Oreochromis niloticus*	Cichlidae	Perciformes	+	+	+	+	+	+	+	+*	+

No	Vietnamese name	English name	Scientific name of Species	Scientific name of Families	Scientific name of Orders	Sampling sites								
						1	2	3	4	5 DNC	6 DNC	7	8	10
19	Cá rô phi đen	Mozambique tilapia	*Oreochromis mossambicus*	Cichlidae	Perciformes	+	+			+	+		+	+
20	Cá sặc bướm	Blue gourami	*Trichogaster trichopterus*	Osphronemidae	Perciformes					+	+	+		
21	Cá thu	Mackerel	*Scomberomiorus guttatus*	Scombridae	Perciformes							+		
22	Cá hanh (tráp)	Yellowfin seabream	*Acanthopagrus latus*	Sparidae	Perciformes						+	+*		
23	Cá bạc má	Indian mackerel	*Rastrelliger kanagurta*	Scombridae	Perciformes							+		
24	Cá vược (chẽm)	Sea-bass	*Lates calcarifer*	Latidae	Perciformes					+	+	+		
25	Cá lăng	Bagrid catfish	*Hemibagrus elongatus*	Bagridae	Siluriformes									+*
26	Cá nheo	Amur catfish	*Silurus asotus*	Siluridae	Siluriformes	+	+			+	+		+	+
27	Cá ngạnh	Cranoglanidid	*Cranoglanis sinenssis*	Cranoglanididae	Siluriformes	+	+			+	+	+		
28	Cá trê đen	Black catfish	*Clarias fuscus*	Clarridae	Siluriformes	+							+	
29	Cá chạch sông	River loach	*Mastacembelus armatus*	Mastacembelidae	Siluriformes	+	+							
Total:						18	16	7	5	**16**	**15**	15	15	11
+) Recorded by fishing craft; *) Collected in survey time										**DNC**	**DNC**			

4.8. PROTECTED AREAS - BIODIVERSITY PROTECTION AND CONSERVATION

The Vietnamese Government has put in place biodiversity conservation programs. 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 67.

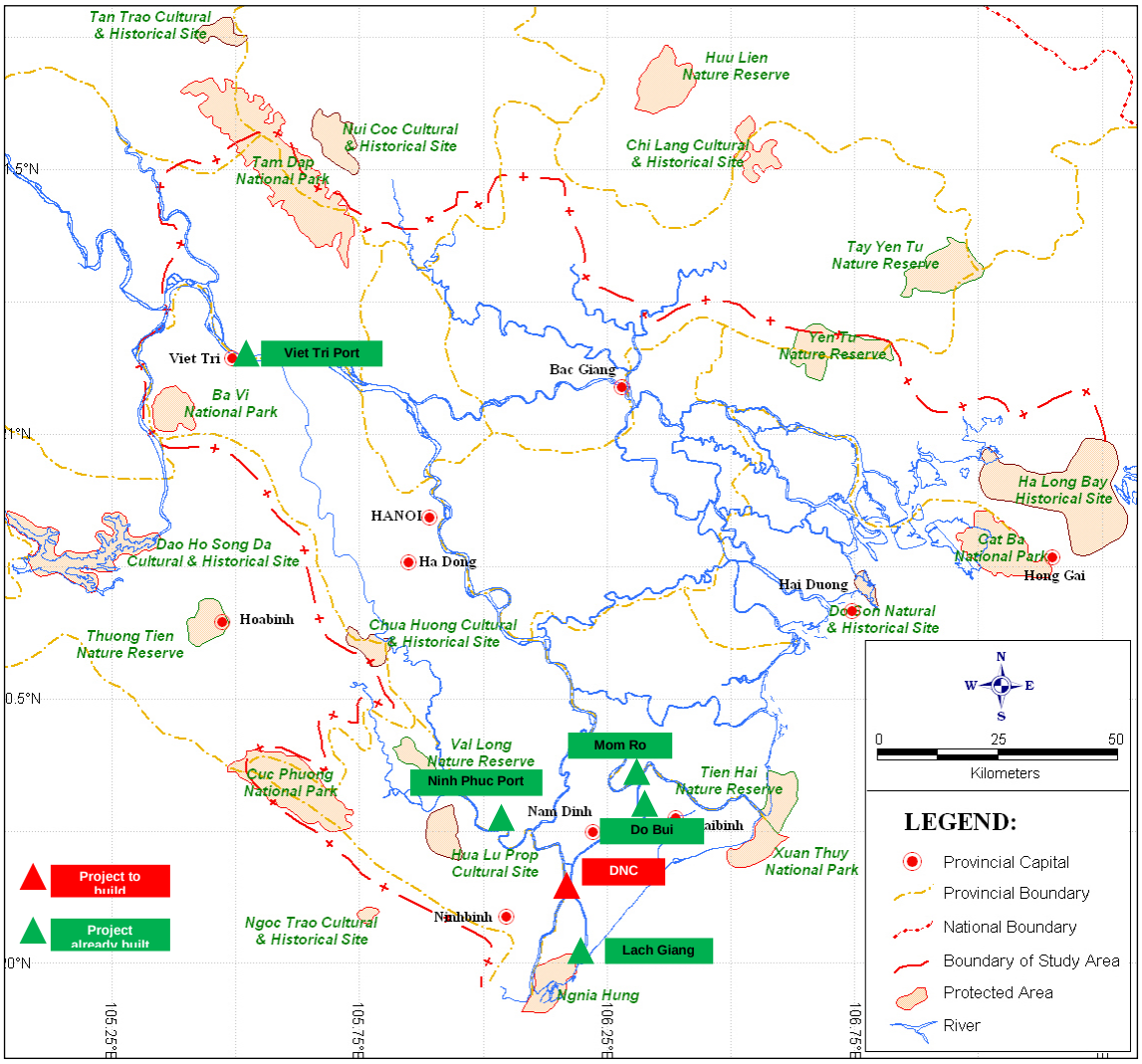


Figure 67: Location of protected areas

The project **is not located in or near any protected area.**

The site of Nghia Hung, located more than 20 km from DNC area, in the south of Nam Dinh province, between Day and Ninh Co estuaries was considered as an IBA (Important Birds Area) and was proposed as a protected area in the 90'. However, the Birdlife International Association conclude that this site does not meet any more the IBA conditions because of high hunting level and many disturbance on this site. Despite, this site has a real potential for breeding/nesting and rehabilitation of avian habitats.

In the 2006 report "Conservation of Key Coastal Wetland Sites in the Red River Delta: an assessment of IBAs 10 years on", Nguyen Duc Tu (Birdlife International Vietnam Program), Le Manh Hung (Institute of Ecology and Biological Resources),Le Trong Trai (Birdlife International Vietnam Program), Ha Quy Quynh and Nguyen Quoc Binh (Institute of Ecology and Biological Resources) and Richard

Thomas (Birdlife International) explain *:"Nghia Hung is located in southern Nam Dinh Province and comprises 12 km of coastline between the Ninh Co estuary in the north and the Day estuary to the south. The main habitats are saltmarsh, sandy beaches and dunes, some of which have been afforested with the exotic Casuarina equisetifolia. Close to the estuaries are mangrove plantations. In recent years there has been rapid development, with the majority of land both inside and outside the Nghia Hung dyke converted into aquaculture ponds. Currently, north of the Day river mouth, a project implemented by Military Zone No.3 is constructing a dyke system to create up to 800 ha for aquaculture development. This project will destroy 10 ha of mangrove plantation, currently under the management of Nghia Hung District FPD (Nguyen Duc Tu and Le Trong Trai 2005). There are two offshore islands, Dong Con Mo and Tay Con Mo*"..

Nghia Hung was proposed as a nature reserve by Birdlife and the Forest Inventory and Planning Institute (FIPI) in 1996. But Nghia Hung is still not listed on any official decree related to the Special-use Forest system. This area was considered as an Important Bird Area (IBA) and referenced as IBA n°VN12. But now the site does not meet the IBA criteria.

The following figures show the location of the IBA VN12 and the DNC project, distant from more than 10 km.

Figure 68 : General Location of IBA in Southern Red River Delta and location of DNC to IBA VN12

4.9. NATURAL DISASTERS AND ENVIRONMENTAL INCIDENTS

4.9.1. 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 Binh and Nam Dinh.

4.9.2. 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 Ninh Binh 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.

From 1989 to 2010, Nam Dinh suffered 26 typhoons and 04 floods. The flood in 2012 caused water logging thousands of houses and hectare. The sea dike was broken; hundreds of field canals has landslide and erased.

4.9.3. 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 Thinh Long 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:

Hung Yen 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;

Ninh Binh 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.

4.9.4. 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.

4.9.5. 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.

4.10. SOCIO-ECONOMIC CONDITIONS

4.10.1. Generality

The NDTDP 3 waterways project site accounts of the Northern Delta which includes for the most part Nam Dinh province, Ninh Binh province for Ninh Phuc Port and for Viet Tri Port, on the north, the province of Phu Tho. **DNC project concerns only Nam Dinh province.**

Table 22: Provinces concerned by NDTDP Corridor 3 waterway projects

Phu Tho	Nam Dinh	Ninh Binh
Viet Tri Port	Mom Ro	Ninh Phuc Port
	Do Bui	
	DNC Canal	
	Lach Giang	

Green: projects already built - Yellow: DNC project to build

Nam Dinh Province:

Nam Dinh province is located in the plains and the northern lands of Vietnam. The province includes the city of Nam Dinh, 90 km southeast of Hanoi. It is surrounded by the provinces of Thai Binh, Ha Nam and Ninh Binh and the East Sea.

Area: 1652 km ²

Population: 1,830,023 people [Nam Dinh statistical Yearbook, 2010]

Density: 1108 people/km²

Nam Dinh province is covered with a large number of lakes and ponds. Rice (most of the agricultural fields), maize, groundnuts, sugar cane, banana trees, mulberry trees are grown in the province"

Figure 69 : Location of Nam Dinh province in Vietnam

There are several traditional craft villages specializing in Wrought iron, copper smelting, wood carving and textile painting. The textile factory in Nam Dinh is the largest of its kind in the North.

Nam Dinh province has great cultural traditions. This is the native land of the kings of the Tran Dynasty (thirteenth-fourteenth centuries) and the famous poet Tu Xuong. Celebrations Pho Minh, The Co, Phu Day are famous. The main attractions of the province include temples Tran, Phu Day, pagodas Keo,

Thien Hanh, Pho Minh Le and Co, Thinh Long Beach and bird parks and Con Ngan Lu, Xuan Thuy National Park. The transport network is very favorable. There railway line north-south Vietnam and the National Highway 21 connecting highway 1A and the Center of the city. In addition, the National Highway 10 connects the county town of Ninh Binh and Thai Binh province, Hai Phong, Quang Ninh; National Highway 38 connects the Hai Duong, Hung Yen, Ha Nam provinces to Nam Dinh city.

4.10.2. Soils and land use

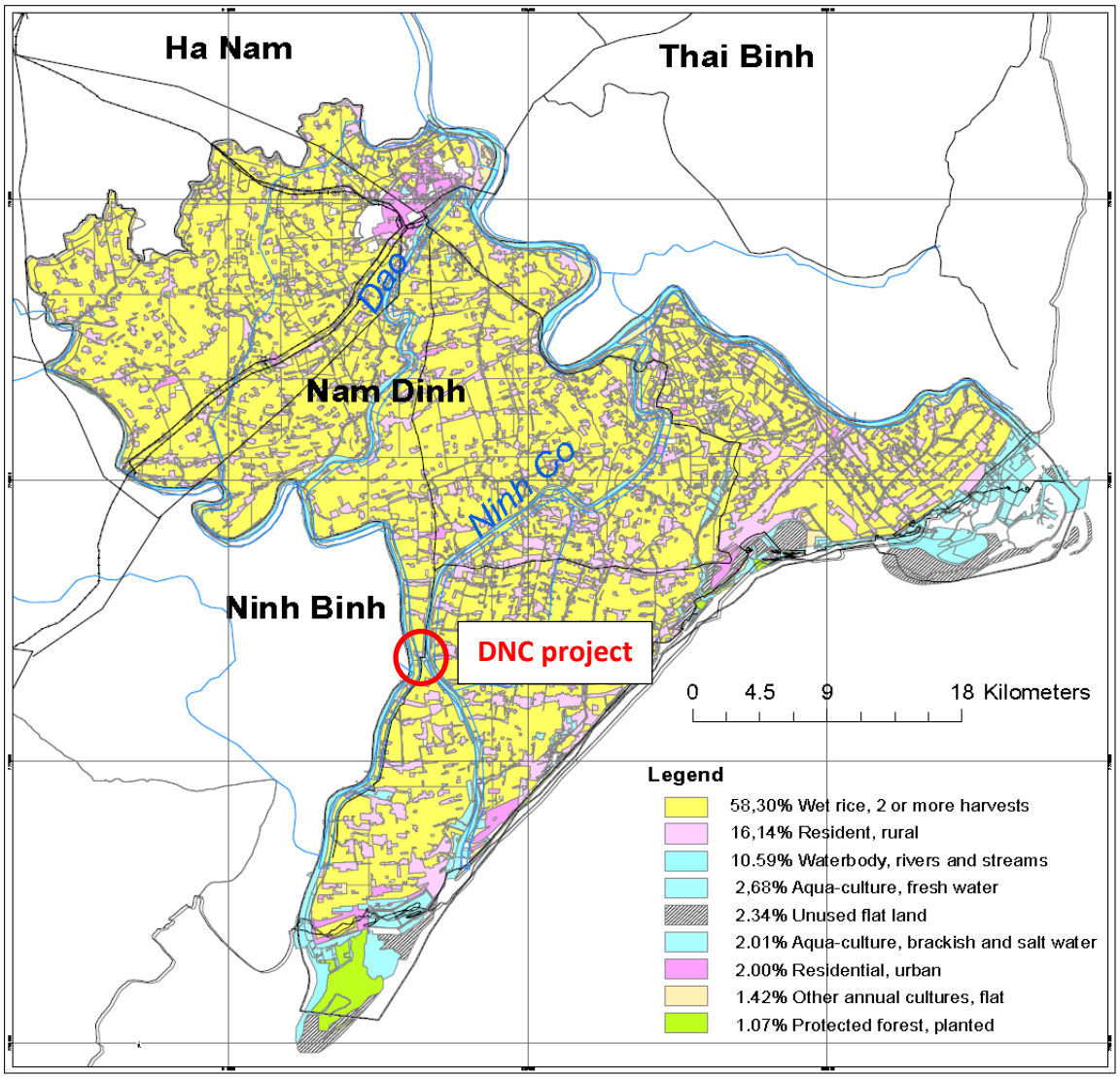


Figure 70 : Land use distribution in Nam Dinh province, status 2007.

Legend lists only land use types covering above one percent of total province area.

(Source: Assessment of Groundwater Resources in Nam Dinh Province – 2011)

The soils of the Red River Delta are generally fertile and have been utilized since ancient times for intense agriculture with predominance of rice paddy cultivation. Traditionally, the repetitive flooding events regularly added nutrient rich silt and clay to large areas of RRD. Dykes and other flood prevention measures result in the increasing use of chemical fertilizers. According to LEHMUSLUOTO 2007 large areas of the RRD including Nam Dinh province are covered with alluvial fluvisols, moreover with saline soils and acid sulphate soils.

Typically for the RRD area, Nam Dinh is basically an agricultural dominated province. Paddy rice with 2 harvests per year represents the predominant crop with more than 58% coverage of the whole area (***Figure 70***). For centuries, flood control has been an integral part of the delta's culture and economy. An extensive system of dykes and canals has been built to irrigate the paddy fields with river water from through to contain the Red and the Dao River.

Furthermore, fish and shrimp aquaculture using fresh and brackish water is widespread with almost 5% area coverage. Other annual crops have only minor relevance with less than 2% coverage. Urban and village area represent about 16 % of the total area. In total about 74 % of the province area is temporarily flooded by paddy irrigation, aquaculture farming and other water bodies which are expected to have relevant impact for the subsurface water balance.

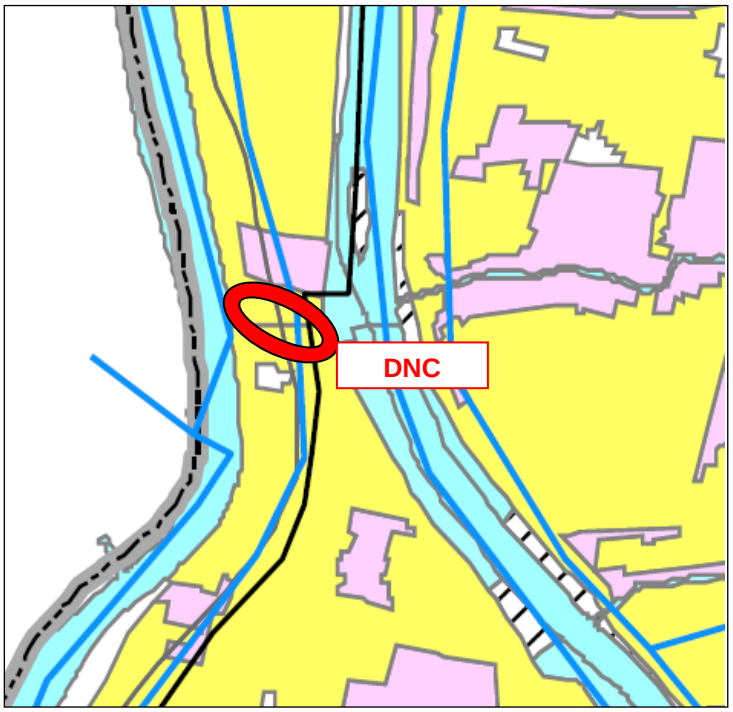


Figure 71 : Land use near DNC

On DNC canal area, land use consists on agriculture (mostly wet rice) with 2 rural resident areas (Nghia Son and Nghia Hung) upstream and downstream of the project.

4.10.3. 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, Hung yen, Haiduong, and 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, and 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).

Nam Dinh province

Industrial manufacture in Nam Dinh province varies in many works such as: textile, foundry mechanical engineering, and key industry of processing. In recent years, processing industry and manufacturing construction materials develop well such as processing of wood, sea food ... Some mining industries are well developing but they are still in small scale.

There are 20 industrial complexes approved by People's Committees of the provinces, 8 complexes occupy 100% land area (Xuan Tien, Xuan Hung complex – Xuan Truong district, Van Chang complex – Nam Truc district, Complex at Co Le town, Cat Thanh town – Truc Ninh district, La Xuyen complex, Yen Xa town – Y Yen district, Nghia Son complex – Nghia Hung district); 2 complexes acquits 90 % land area (Xuan Truong complex in Xuan Truong district, Truc Hung complex in Truc Ninh district)

There are 90 available craft villages which include various activities including textiles and , manufacturing of agricultural tools..

However in the recent year there have been fairly large scale industrial developments in Nam Dinh province. The new industrial zones are newly built or are being planned:

- Hoa Xa processing zone is located in western Nam Dinh city with the area of 326 hectares in which 70% of the area has been constructed. My Trung industrial zone in My Loc district has planned in details for 150 hectares; currently infrastructure construction companies are being looked for and the investment projects are encouraged.
- Vu Ban industrial zone in Vu Ban district is 200 hectares in area.
- Y Yen 1 and 2 industrial zones have the total area of 300 hectares and are under planning process.
- Song Ninh industrial zone in Xuan Truong district has the area of 190 hectares, specialized in ship building and fishery processing.
- Thinh Long industrial zone in Hai Hau district has the area of 70 hectares and specializes in service and processing industry.

Industrial activities help villages economically but pollute the environment with waste of dust, water, and solid waste.

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 Province

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 is located 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 Industrial 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.

The main industries of Ninh Binh provinces are quarry exploitation and cement production. The area of limestone quarry is 12000 hectares with capacity of around tens of millions cubic meter. Moreover, there is ore dolomite, clay and coal. Ninh Binh is the good area to develop building material production using the local available material source.
Ninh Binh is investing for industrial development and at present there is Tam Diep industrial zone in Tam Diep district. This zone has the area of 70 hectares and is targeting to industries such as processing agricultural, forestry and fishery products, food and food processing, textile, footwear, mechanic equipment installation, electricity, animal feed and fertilizer using

Ninh Binh has plans to develop seven industrial zones (Gian Khau, Khanh Phu, Tam Diep, Khanh Cu, Phuc Son, Son Ha, and Xich Tho) and other 22 industrial zones specifically designed for small to medium-sized businesses. Gian Khau, Khanh Phu and Tam Diep industrial zones have attracted 70 projects with a combined investment capital of more than VND30 trillion. Gian Khau Industrial Zone has leased out all of its area, while the occupancy rate in Khanh Phu Industrial Zone has reached 95.4 percent and Tam Diep Industrial Zone 51.5 percent

4.10.4. Urbanization

Urbanization is understood as the migration from rural to urban areas is the focus of more and more people live in urban territories. 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, Hoa Binh,Ninh Binh, Haiduong, Hadong and Vinhyen as of 1995).Urbanization creates favorable conditions for socio – economic growth but also imposes heavy pressures on the environment.

According to the Population and Housing Census in Vietnam in 2009, the rate of urban population in Phu Tho, Ninh Binh and Nam Dinh provinces is below 20%. [Source: General statistics Office, 2011]

4.10.5. 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.

Nghia Hung is a district in the southern province of Nam Dinh. The east of Hai Hau district, Truc Ninh, west Kim Son (Ninh Binh), the South China Sea, north Nam Truc district and Y Yen Nghia Hung is reached in three rivers: Song Dao, Ninh Co, and Day River.

Nghia Hung provincial highways 490, 508 and 493 run through.

MOT and province are working on a new high speed road crossing the future DNC canal. This road is supposed to be constructed in on the same area. Discussions are ongoing between PMU, MOT and Province to include

Fit between the flows of the two rivers is the Ninh Co River and Day River and the dense network of rivers; it is very convenient for the development of waterways.
(Source: Wikipedia)

Currently the main inland waterway in the project area starts from ocean through Ninh Co estuary to Hanoi and through Day estuary to Ninh Binh. This waterway depends on climate condition and tide. Vessel can go through Day Rivers only when the tide rises in the spring. There is an average of 1200 vessels in project site (JICA and Ministry of Transport 2003).

One of destinations for coal and material transporting vessels in Red river delta is Ninh Binh port and cement factories around Ninh Binh port.

Vessels in the river are mainly steel barge, pulling boat, pushing boat and self-propelled barge. The quality of vessels is poor due to the lack of frequent maintenance. A typical fleet of barges includes 4 barges of 200 tons and 1 tractor of 135 HP.

Ninh Binh is an important traffic node from the north to Center and Southern Vietnam.
- Road: In the province of the National Highway 1A and National Highway 10, National Highway 12A, 12B, 59A.
- Railways: North-South railway line runs through the province of Ninh Binh has a length of 19 km with 4 stations (Ninh Binh, Cau Yen, Ghenh and Dong Giao,) facilitate transport of passengers, goods and construction materials .
- Waterways: Ninh Binh has convenient waterway system due to the many large rivers: River Day, Hoang Long River, the Qian, Vac River, and River Van Lang River. There are also major ports: Port Ninh Phuc Ninh Binh port Kim Son, contributed to socio-economic development of the province [Source: http://www.ninhbinh.gov.vn/web/guest/117].

Inland roads

The existing road system links all communes to centers of districts and provinces. The main National roads concerning Corridor 3 projects 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.

DNC canal concerns only the provincial road DT490.

Railways

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

But DNC area is not concern by any railway.

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). All the Red River Delta is covered by an inland waterway network used for commercial but also public transportation.

DNC project covers the Day River and Nin Co River waterways.

Airways

One international airport (Noi Ban Airport - Hanoi) is located in the north-east of Hanoi city. This airport is 40 km far from Viet Tri Port and farer (100 to 150 km) from the other works sites. There is no airport (civil or military) in the close vicinity (< 5 km) from all the working sites.

DNC is not affected by any airport infrastructure and the proposed bridge does not lie on low-flying flight paths.

4.10.6. Agriculture, Forestry and Fishery

Nghia Hung: Rice, potatoes, peanuts, jute, rush, ducks and pigs. Fishing and seafood processing, salt production, shipbuilding as well as a new potential.

Nghia Son: With an area of 9ha located in the area between the village with Clothing manufacturing and Tanneries, Nghia Son industrial zone has attracted the attention of many small and medium investors, had a few active investors in industrial parks, large address the needs of local people working as garment (Taiwan investors), mechanical engineering, furniture and fine art...

With its position as one of the communes adjacent to two major rivers and waterway development potential, Nghia Son has very good development shipbuilding industry, small and medium-sized boat for investors inside and outside the water transport in the business.

A traditional agricultural economy (crop and livestock) with fertile characteristics fed by the two great rivers, Nghia Son is taking advantage of the great advantages in agricultural development. In addition the business is also one waterway traditional industries here.

Ninh Binh province: 20 years ago, the economic structure in Ninh Binh was mainly agriculture - forestry – fishery with the proportion of 62.9 percent, and industrial - construction and services was only 37.0 percent; by 2011, economic structure in Ninh Binh changed qualitatively with the industry - construction and services making up 85 percent, and agriculture - forestry - fishery only 15 percent. Economic growth of Ninh Binh is high compared to other provinces in the country (average 13.0 percent / year) with GDP increasing by 32.91 times over the 20 years. In 1992, exports from Ninh Binh totaled only US$2.5 million; in 2011 they reached US$263.7 million.
[Source: http://vccinews.com/news_detail.asp?news_id=26606].

In recent years, the provincial economy has been growing well. Ninh Binh has transformed its economic structure towards industry and services to increase the contribution of industry and construction and services to the provincial gross domestic product (GDP) to 49 and 36 percent in 2011 respectively, with agriculture, forestry and fisheries declining as a proportion of provincial GDP to 15 percent. The province has tended to form important cultivation centers including high quality rice development in Kim Son, Yen Khanh and Yen Mo. In 2010, Ninh Binh ranked 10th among provinces and cities nationwide in terms of the provincial competitiveness index (PCI).
[Source: http://ven.vn/dynamic-ninh-binh-province_t77c192n27851tn.aspx].

4.10.7. Land Uses along the Banks

The project will permanently recover approximately 726,065 m^2 of land, including 6599 m^2 residential land; 11,853 m^2 of land for garden (mainly used for fruit trees); 657,613 m^2 for planting crops and about 50,000 m^2 of non-agricultural land.

Of 657,613 m^2 planting crops, farmers in Nghia Lac and Nghia Son cultivate rice two time per year (265,567 m^2); people in Truc Chinh rear fish, cultivate peanut & banana (282,420 m^2); people in Phuong Dinh (98,399 m^2) cultivate mulberry, beans and corn while farmers in Xuan Hong only cultivate banana (11,407 m^2).
In Truc Chinh commune, a brick factory uses 50,000 m^2 for brick production.
[Source: Social economic survey].

4.10.8. Mineral Resources

Nam Dinh is rich in construction materials such as building sand, brick clay, puzzolan, while those in the central coastal zone are characterized by limonite placers, facing stone, building stone, art stone. Thermo-mineral sources occur in all coastal provinces and cities (Source: Nguyen Quang Hung et al.)

4.10.9. Irrigation Use of River Water

At present, in all the Corridor 3 project sites local people take water from rivers around these areas for irrigation. In DNC area, as the salinity in the Day River is lower than that in Ninh Co river local

people take water from Day River and discharge in to Ninh Co River for agricultural production. Besides water level in Day river is higher than that in Ninh Co river thus around this area they do not need to use pump.

4.10.10. Historical, Natural and Cultural Resources / Heritages

There are no key historical, natural heritages, or archaeological sites around the Project areas, excepted. With regard to cultural and religious heritages, a church and 2 cemeteries are located near the project area (about 1 km from the site). This church will be only temporarily disturbed by the activity construction phase. Several tombs will need to be relocated. The mitigation plans to reduce these impacts are described in the Chapter 7.

Extensive consultations and focus group discussions were carried out with local authorities at different levels and with representatives from these affected properties to learn their views towards resettlement impacts on the properties and recommendations for mitigating measures, including possible relocation measures.

4.11. SYNTHESIS ON DNC PROJECT AREA

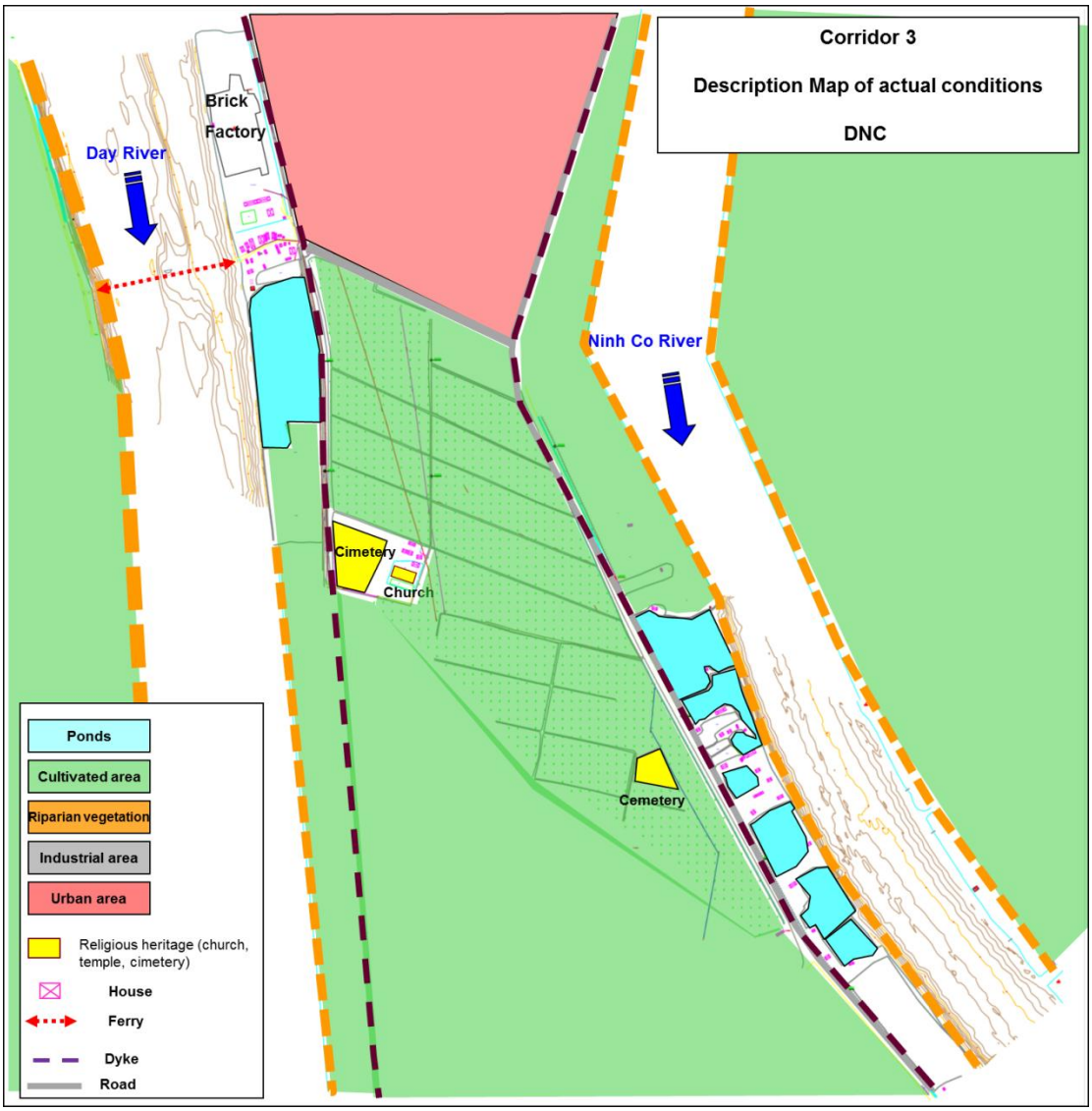


Figure 72 : Actual conditions map at DNC.

Important natural and built environment characteristics within the DNC project area:

- Mostly agricultural land (rice fields + ponds);
- Important urban area Nghia Son on the North of the area;
- Many houses close to Ninh Co River and Day River;
- 1 church and 2 cemeteries identified in the area;
- Day river is fresh water – Ninh Co River is influenced by salinity from the sea with water from fresh to salted depending of the river flow and the tides;
- Level and flow of Ninh Co River + Day River are naturally controlled by level of sea tide;
- 1 ferry upstream on Day river;
- Natural habitats present on reeds area in some ponds;
- 1 industrial brick factory up at Nghia Son commune, on Day side, upstream the DNC junction + many brick factories all along Ninh Co River and Day River;
- Quan lieu canal located 5 km upstream actually permit salted water to enter in Day River from Ninh Co River.

View of Day River (left side) on DNC area

View of Day River and rice fields on DNC area

View of DNC area

View of church and cemetery on DNC area

View of ponds, rice fields and houses on Ninh Co side of DNC

View of Ninh Co River from right side on DNC area + many small old brick factories (not impacted)

5. ALTERNATIVES AND OPTIONS ANALYSIS

Between 2013 and 2015 the projects of Viet Tri port, Ninh Phuc port, Lach Giang channel estuary channel access and Mom Ro + Do Bui bend cutting were built.

The DNC link between Ninh Co and Day rivers is the last improvement needed for the Corridor 3 waterway. It needs to include road relocation and a bridge to cross the new canal.

5.1. WITHOUT THE PROJECT SCENARIO

A general "No new action" scenario has been analyzed for the entire corridor 3 project in the feasibility study. The “without project” scenario is a possible alternative approach 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 actual “no project” scenario will only concern the non-construction of the DNC canal.

A "No new action" scenario at DNC will preserve the existing status of environmental impact versus benefit, whatever the balance might be. “No new action” will mean that coastal shipping, even with the lach Giang estuary channel already built will still be unable to pass from Ninh Co to Day Rivers and so will not permit to connect the sea to the Port of Ninh Binh. The waterway route from the estuary to the Port of Hanoi and their hinterlands will not be reduce because unable to pass by the Day River. A large part of the Coasters will still have to call in on Haiphong and offload the cargo onto IWT vessels.

A “No action” scenario will reduce near to zero the benefits from the already completed 200 Million USD investments on Corridor 3.

The “No New Action «scenario will mean foregoing the economic and environmental benefits that are expected to be derived from improving the Day-Ninh Co Rivers.

A second “No action” concerning the road and bridge can be evaluated: if the canal is built but without road relocation or a crossing bridge, it will isolate the downstream part of the area between Day River, Ninh Co river and the sea. It means that the land connections will be blocked and the population living there will be strongly disturbed. A no action for the road and bridge will block any economic development in this area and, most of all, penalize the actual economic conditions based on agricultural goods. It will also block the industrial development of this area – in opposition with the national and local strategic purposes envisioned.

5.2. ENVIRONMENTAL CONSIDERATIONS IN SELECTION OF ALTERNATIVES FOR DNC

The selection of alternatives for improvements of Corridor 3 has taken into consideration social and environmental factors.

5.2.1. Doors of the lock

The alternative was based on 3 possibilities:

- No lock;
- Lock with gate open most of the time;
- Lock with gate open only when boats.

This channel purpose is too linked Day River to Ninh Co River. But these 2 rivers have different levels because of different flows and different influence of tide. This difference of level (until more than 1 m) will create velocity constraints for navigation with risk of damage to boats or difficulties for navigation in the canal. ➔ A lock is necessary.

The salinity is also very different in Ninh Co River (high influence of salted water) and Day River (low influence of salted water). If the canal was open 24h/24h (as the Quan Lieu Canal 5 km upstream), high flow of salted water from the Ninh Co will enter in the Day River when Ninh Co Level is higher than Day River ➔ a lock with gate opening only when boats need to cross the lock is necessary.

The selected alternative (canal with lock and gate open only when boats need to cross) permit to ensure navigation conditions in the canal and to prevent high flow of salted water to come from the Ninh Co River to the Day River.

For the bridge, the 1st option was a mobile bridge but after 3 years of discussion between Vietnamese authorities, the alternative of a fix bridge with 15 m of air clearance was decided by MOT, following the request of local population, Province and districts, because the future industrial projects planned downstream in this area will need access by road and waterway.

5.2.2. Location of the canal

The initial location of the canal was impacting more than 50 houses, a church and a cemetery.

The Detail Design phase purpose was to propose a location and angles of the canal with the 2 rivers permitting the boats to enter and get of the canal with minimizing the impacts on houses and religious building. The updated design of the project in 2015 identified 2 tombs that need relocation and will be include in the Resettlement Action Plan.

The preliminary design of the road and bridge has also reduced from 12 to 5 the number of houses to be destroyed and relocated.

The surface of lands impacted by the project was estimated in 2013 at 62 ha, but the 2015 updated design, based on the detailed design of the Canal and the preliminary Design of the Road and Bridge reduces the impacted land to 47 ha.

The final design proposed solution to reduce from 62 houses to 30 the number of impacted houses and preserves the church and the cemetery from destruction. 14 tombs will need relocation.

A Christian church and 2 cemeteries are located very close to the project area. The project has been adapted from Feasibility study design to ensure that the works do not destroy or affect access to cultural and religious heritage sites.

These alternatives permit to reduce the quantity of sensitive receptors affected as, reduces the cost of resettlement and helps the project to be accepted by local people.

5.2.3. Concrete bank protection vs. ecological/mix bank protection

For the bank protection, two alternatives were studied by consultant:

- **Alternative 1 consists in classical bank protections** (concrete plots) designed in accordance with Vietnamese standards. The design following Vietnamese standards is overestimating the size of the elements that constitute the protection.

- **Alternative 2 – mixed bank protection, based on ecological protection bank (vegetation) and classical bank protection** (rip rap) is proposed and will permit to improve the environment biodiversity and protect against the effect of waves and erosion. This alternative is not referenced by the Vietnamese standards but it is based on more than 20 years of experience on the Rhône and the Rhine Rivers as on other major waterways in Europe. This kind of ecological protection bank permit plant adapted local plants into the hole into the rip rap and to create friendly habitats for birds, small mammals, reptiles, batrachians, terrestrial and aquatic invertebrates and also fishes. Depending of the choice of vegetation, local people can get some income from harvesting part of the vegetation and also by improvement of fishing due to the better habitats for fishes.

In addition to the ecological interests, the alternative 2 (rip-rap + vegetation protection bank) is much cheaper than the classical concrete plots (see tables below).

The alternative 2 is the proposed solution for most of the bank on DNC canal. It will permit to restoration and creation about 9 ha of aquatic and wetland habitats and will be important for biodiversity and landscape integration of the canal.

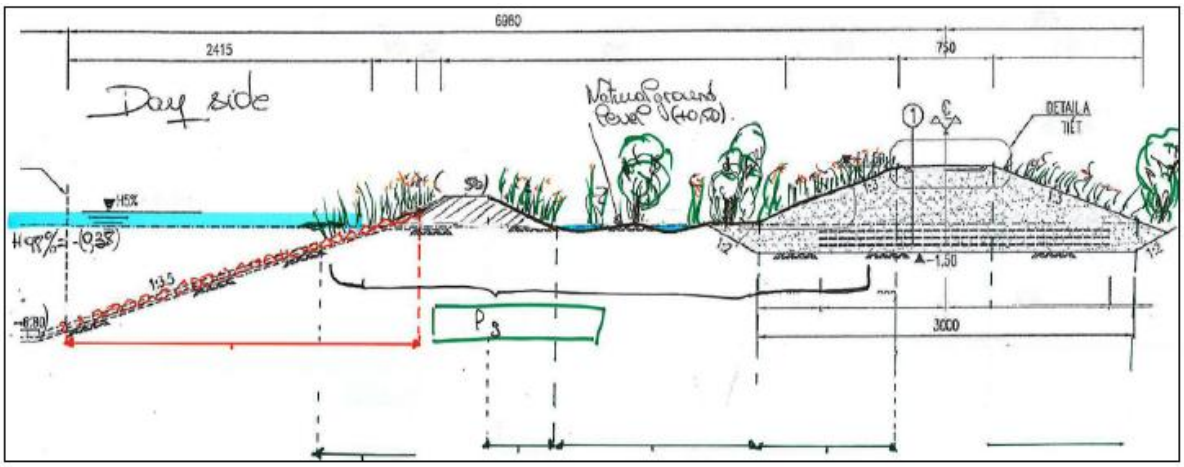


Figure 73 : Cross section of Ecological protection bank proposed for DNC Canal.

Ecological bank protection during construction
(CNR – Rhône river 1998)

Ecological bank protection 1 year after construction
(CNR – Rhône river 1999)

Ecological bank protection 2 year after construction
(CNR – Rhône river 2000)

Figure 74 : Example of ecological bank protection on Rhône River Waterway (CNR – 1998-2000).

6. ENVIRONMENTAL IMPACT ASSESSMENT

6.1. ENVIRONMENTAL IMPACT ASSESSMENT METHOD

The qualitative and quantitative assessment of impacts is based on the intersection of "importance of environmental or social issue «with its sensitivity to the project or to the projects elements studied. The method is summarized as follow:

IMPACT RISK LEVEL				IMPORTANCE / LEVEL OF ENVIRONMENTAL - SOCIAL				
				None	Low	Medium	Strong	Major
SENSIVITY TO PROJECT	NEGATIVE	Major						
		Strong						
		Medium						
		low						
	None							
	POSITIVE	Low						
		Medium						
		Strong						
		Major						

Kind of impact	Level of impact	Cotation	Impact rating
Serious conflict or major deterioration	Major negative impact	-3	
Medium Conflict or medium deterioration	Medium negative impact	-2	
Minor adverse/negative effect or slight deterioration in mild conflict	Minor negative impact	-1	
Insignificant or no impact	No or unsignifiant impact	0	
Minor positive effect, slight improvement	Minor positive impact	+1	
Medium improvement	Medium positive impact	+2	
Significant improvement or removal of serious conflicts	Major positive impact	+3	

Impacts can be:

- Positive or negative;
- Temporary or permanent;
- Local or general.

They are measured on the three phases of projects:

- Preconstruction / preparation;
- Construction;
- Operating and maintaining.

For this analysis we use a reliable methodology for impact assessment based on impact matrices with seven classes which can be included in a multicriteria analysis (MCA) to compare projects or variants.

-3 = Major negative impact

-2 = Medium negative impact

-1 = Minor negative impact

0 = No or insignificant impact

+1 = Minor positive impact

+2 = Medium positive impact

+3 = Major positive impact

We can detail the structure for defining the magnitude and significance of the impacts:

a) No or insignificant Impact (0)

An impact is assessed as "no impact" if it is physically removed in space or time from the environmental component or if the impact is so small as to be un-measurable or insignificant (i.e. negligible).

b) Minor Impact

An impact is assessed as "minor" if it occurs but with low effects or only affecting very low issues and which won't create conflict. A minor impact can be positive (+1) or negative (-1).

c) Medium impact

An impact is assessed as "medium" if it affects an issue but without major effects in intensity, duration or geographical extent. An impact is also identified as medium if it can need local conservation but without conflict of risk of blocking. A medium impact can be positive (+2) or negative (-2).

d) Major Impact

An impact is assessed as "major" if it has the potential to significantly affect an environmental component. A major impact can be positive (+3) or negative (-3). The following criteria will be used to determine whether a given impact is "major":

- spatial scale of the impact (site, local, regional, or national/international);
- time horizon of the impact (short term (0 - 12 months), medium (12 - 36 months), or long term (>3 years);
- magnitude of the change in the environmental component brought about by the activities (small, moderate, large);
- importance to local human populations;
- compliance with the international, national, provincial, or district environmental protection laws, standards, and regulations; and
- Compliance with the WB guidelines, policies, and regulations.

e) Unknown Impact

An impact is assessed as "unknown" if the significance of the effect cannot be predicted for any of the following reasons:

- the nature and location of the activity is uncertain;
- he occurrence of the environmental component within the impact area is uncertain;
- the time scale of the effect is unknown; or
- the spatial scale over which the effect may occur is unknown.

Synthesis on Impacts

The project impacts will be assessed for each project area on the 3 phases (preconstruction / construction / operating) and synthesis forms will be prepared:

- 1 form for preconstruction and construction phases
- 1 form for operating phase.

Then, by the end of the ESIA, the residual (final) impacts will be also evaluated including the mitigation means.

Cumulative Impacts

Apart from the World Bank-financed activities under NDTDP, the Ministry of Transport or other government agencies at the Provincial and local level have no additional existing or planned activities in the Project area that would have a negative cumulative impact on Valuable Ecological Components relevant to Project activities – namely, water quality, aquatic biodiversity, and the quality of life of agricultural communities in the Project area and downstream.

The environmental impact of the DNC Canal Project itself has long term positive environmental impacts. The Project will adopt an innovative ecological engineering approach. A mixed bank protection scheme is proposed for the Project, based on ecological bank protection (vegetation capacity to fix the banks) and classical bank protection (rip rap), which will enhance biodiversity and protect against the effect of waves and erosion on the river banks and adjoining wetland, creating and/or restoring approximately 9 ha of aquatic and wetland habitats— an area 18 times greater than the lost habitat. Moreover, the transfer of a significant portion of dredged/excavated material to Lach Giang's Southern Disposal area will expedite the filling (and subsequent closure) of the disposal site, allowing for the plantation of income generating Casuarina trees on 30 ha of the disposal site.

During the tree maturation period, this will provide favorable habitat for birds and invertebrates. It is anticipated that these ecological approaches to riverbank protection and disposal site closure – in providing examples of cost-effective and environmentally friendly mitigation solutions – will lead to a positive cumulative impact on "green" construction practices in Vietnam.

All sub-projects under the Parent project are already completed and operational. As such, there will be no additional cumulative environmental or social impacts ensuing from these sub- projects.

6.2. SUMMARY OF DNC PROJECT WORKS

The river works to be implemented for the NDTDP Phase 1 are enumerated in Chapter 4. "Project Description". The project will consist of seven locations requiring dredging, excavating, dredged and excavated materials management (disposal, reuse), banks protections, bend cutting, canal, ship lock, crossing bridge and road constructions. The table below summarizes the civil works on ach project area.

Table 23: Synthesis of civil works at DNC project components

Project area	Main pupose	Works	Excavated and dredged materials management and quantities	
DNC	Link 2 rivers by canal	Connecting Canal	Reuse most of the clay and sandy-clay materials by bricks factories; Use part of the "non clay" materials for agricultral soils improvement by communes; Transfert the remaining quantities of material to Lach Giang southern Disposal area	Canal + Shiplock: 1.549.000 m3 Road + Bridge: 11 700 m3
		Shiplock		
		Dredging		
		Bend cutting		
		Bank protections		
		Ecological bank protections		
		Relocation of main road		
		Fix bridge to cross the canal		
		Reconstruction of Ferry Boat stage		

Table 24: Summary of Dredging/Excavation Activities for DNC project

Estimated excavated & dredged volume Day side (place measure)	Estimated excavated & dredged volume Ninh Co side (place measure)	Estimated excavated & dredged volume Shiplock (place measure)	Estimated excavated volume Road and Bridge (place measure)	**Total excavated & dredged materials**	Volume sandy or sandy + clay materials	Total Volume clay materials
m^3	m^4	m^3	m^3	m^3	m^3	m^3
636 050	613 203	300 362	11 700	**1 561 315**	1 161 315	400 000

Direct evacuation to brick factories	Temporary storage of clay for bricks factories	Reused in project area (for road/bridge)	Volume used for agri land raising	Volume transfered to Lach Giang disposal area	Total Volume for disposal sites	Number of Proposed Disposal sites	Surface of Proposed Disposal sites	**Total Capacity of disposal sites**
m^3		m^3	m^3	m^3	m^3		ha	m^3
200 000	200 000	27 800	333 515	1 000 000	1 333 515	3	83	**3 350 000**

Uses of soil disposal materials
100 % of clay reuse by bricks factories or temprary storage to reused by bricks factories.
Communes ask for backfilling of low agricultural areas and improve agricultural production
Remaininig materials transfert to Lach Giang Southern Disposal area

The total dredging and excavation activities represent about 1,561,315 m^3 of materials coming from:

- The major part of this—1,549,000 m^3—will be excavated or dredged for the Canal and Ship-lock construction.
- The earthworks for bridge and road will mobilize 11,700 m^3 of excavation.

The materials evacuation will concern:

1. Direct reuse on site for the road construction (27,800 m^3);
2. Direct reuse by brick factory (200,000 m^3);
3. Major part of the materials (up to 700,000 to 1,300,000 m^3) will be transferred by boat and disposed of at the Lach Giang's Southern Disposal area at the Ninh Co Estuary.
4. The remaining part of the materials could be temporarily stored for later reused for brick production (200,000 to 400,000 m^3) and/or for agricultural land elevation (300,000 to 600,000 m^3) as requested by communes.

The total disposal areas' capacity is 3,350,000 m^3 and is much larger than needed (1,561,315 m^3).

6.3. IMPACTS SCREENING CHECKLIST

As an aid to impact prediction, a general screening matrix of impacts for each phase / part of a project was used for project as shown in table 17. The matrix indicates the environmental component/s that will be affected by each civil works activity. This matrix also focused on specific works for DNC: ship lock, canal & Fixed Bridge + road. The impacts of the 3 phases (pre-construction, construction and operating) are identified by 3 criteria:

- Location : General (G) or Local (L)
- Duration : Permanent (P) or Temporary (T)
- Intensity :

Kind of impact	Level of impact	Rating
Serious conflict or major deterioration	Major negative impact	-3
Medium Conflict or medium deterioration	Medium negative impact	-2
Minor adverse/negative effect or slight deterioration in mild conflict	Minor negative impact	-1
Insignificant or no impact	No or unsignifiant impact	0
Minor positive effect, slight improvement	Minor positive impact	+1
Medium improvement	Medium positive impact	+2
Significant improvement or removal of serious conflicts	Major positive impact	+3

Table 25: Impacts Screening Matrix

Environmental Components	PRECONSTRUCTION PHASE			CONSTRUCTION PHASE											OPERATING PHASE	
	Land aquisitions	Networks relocation (electric lines, water supplies, …)	Transportation means relocations	Dredging	Land Excavating	Temporary soils disposal	Definitive soil disposal	Recoverability of materials	Bend cutting / reprofiling	Bank Protections	Ecological Bank protections	**DNC Ship Lock**	**DNC Fix bridge**	Workers camps	Ship Lock functionment	Fix bridge
Climate & Air Quality																
Air Quality	/	T+L	T+L	T+L	T+L	T+L	P+L	T+L	T+L	T+L	T+L	T+L	T+L	/	P+G	P+L
Noise emission	/	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	P+L
Geology & Topography																
Topography / morphology	/	/	T+L	T+L	P+L	T+L	P+L	T+L	P+L	P+L	P+L	P+L	P+L	T+L	/	/
Soils and Soils Quality	/	/	/	/	P+L	T+L	P+L	T+L	/	T+L	P+L	P+L	P+L	T+L	/	/
Erosion & Deposition	/	/	/	T+G	T+L	T+L	T+L	/	T+L	P+L	P+L	T+L	/	/	T+L	/
Sediment Transport	/	/	/	T+G	T+L	/	P+G	P+G	T+L	P+L	P+L	T+L	/	/	T+L	/
Water Resources																
Hydrology	/	/	/	/	/	/	/	/	/	/	/	T+L	/	/	T+L	/
Surface Water Quality	/	/	/	T+L	T+L	T+L	T+L	T+L	T+L	T+L	P+L	P+L	T+L	T+L	T+L	/
Salinity intrusion	/	/	/	/	/	/	/	/	/	/	/	T+L	/	/	T+L	/
Ground water	/	/	/	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	P+L	T+L	T+L	/	/
Natural Resources																
Mineral resources	/	/	T+L	/	/	/	/	T+L	/	T+L	T+L	T+L	T+L	T+L	/	/
Energies consumsions (fuel…)	/	T+L	T+L	T+L	T+L	T+L	/	T+L	T+L	T+L	T+L	T+L	T+L	T+L	P+G	/
Ecology & Biological Resources																
Terrestrial Habitat and vegetation	/	/	T+L	/	P+L	T/P+L	P+L	/	P+L	P+L	P+L	P+L	P+L	T+L	/	/
Terrestrial Fauna	/	/	T+L	T+L	P+L	T/P+L	P+L	T+L	P+L	P+L	P+L	P+L	P+L	T+L	/	/
Aquatic and wetlands habitat and vegetation	/	/	T+L	T+L	P+L	T/P+L	T/P+L	/	T+L	T+L	P+L	P+L	/	T+L	P+L	/
Aquatic and wetlands fauna	/	/	T+L	T+L	P+L	T/P+L	T/P+L	T+L	T+L	T+L	P+L	P+L	/	T+L	P+L	/
Important Natural Areas	/	/	/	/	/	/	T+L	/	/	/	/	/	/	/	/	/
Socio-Cultural-Economical																
Livehood	T+L	/	T+L	T+L	T+L	T+L	P+L	T+L	T+L	P+L	P+L	P+L	T+L	T+L	P+L	P+L
Employment	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	P+L	T+L
Living conditions	P+L	T+L	T+L	T+L	P+L	T+L	P+L	T+L	P+L	T+L	T+L	P+L	P+L	T+L	P+L	/
Land Use	P+L	T+L	T+L	/	P+L	T+L	P+L	T+L	P+L	P+L	P+L	P+L	P+L	T+L	/	/
Landscape	/	P+L	P+L	T+L	T+L	T+L	P+L	/	P+L	P+L	P+L	P+L	P+L	T+L	/	P+L
Agriculture	P+L	T+L	T+L	/	P+L	T+L	P+L	T+L	P+L	P+L	P+L	P+L	P+L	T+L	/	/
Industries	T+L	T+L	T+L	T+L	T+L	T+L	/	T+L	T/P+L	T+L	T+L	T+L	T+L	T+L	P+G	/
Roads / Tracks	/	T+L	T+L	T+L	T+L	T+L	/	T+L	T/P+L	T+L	T+L	P+L	P+L	T+L	P+G	/
Ferries	/	/	P+L	T+L	/	T+L	/	T+L	T+L	T+L	/	P+L	/	/	P+L	/
Navigation	/	/	/	T+L	/	T+L	/	T+L	T+L	T+L	T+L	T+L	/	/	P+G	/
Historical & Cultural Heritage	/	/	/	/	P+L	/	/	/	P+L	/	/	P+L	P+L	/	/	P+L
Public Health & Safety	/	T+L	T+L	/	T+L	T+L	/	T+L	T+L	T+L	T+L	T+L	T+L	T+L	T+L	/

Potential project impacts in all phases of the project have to be considered. 3 phases are identified:

- Preconstruction / preparation phase;
- Construction phase;
- Operating and maintaining phases.

6.4. IMPACTS DURING THE PRECONSTRUCTION PHASE

Ground preparation for disposal

Pre-construction phase (preparation phase) is the first operational stage of the project where the required works (e.g. surveys, detailed engineering design, land acquisition, final adjustment of the technical means by contractors, etc.) need to be accomplished. The impacts during this phase can be related to:

- Land acquisitions;
- Land clearance and preparation;
- Workers camps building;
- Networks (electrical lines, drinking water distribution networks , wastewater, phone lines, etc.) relocation;
- Roads and tracks relocation;
- Ferries relocation
- Industrial equipment relocation;
- Relocation of historical and religious heritage;

Impacts from land acquisition and relocation of networks, equipment, networks:

It concerns the impacts of selected construction methodology alternatives, such dredging, dumping, disposal sites locations, bank protections, and others. The details are discussed in this chapter.

Impacts of workers camps installation, soils preparation, etc.

Impacts of setting up construction camps arise mainly from sites preparation, transporting of materials such as bamboo, wood, cement, sand, galvanized iron, steel and others. Appropriate specifications of such materials will be used; hence, insignificant quantity of waste materials will be generated. It's very difficult to quantify actually the quantities of material incomes (used) and wastes outcomes (produced) during the construction of all construction camps. A large part of them will be recycled for other purposes.

During the pre-construction period, the main issues to focus will include:

- Impacts of construction methodologies;
- Impacts of site clearance;
- Impacts due to the installation of temporary facilities;
- Impacts of ground preparation activities. This stage includes two (2) items which are ground preparation for disposal and preparation for construction.

Following land acquisition, relocation of some existing infrastructures such as power poles and lines, water intakes, ferry stages etc. and 14 tombs will take place. Such relocation will temporally disrupt access to the existing services related to power supply, water supply/irrigation, waterway transport, places of religious etc. by local community. The relocation works also can also cause safety risks to both workers and local communities.

- Disturbance to local community related to the arrival of the contractor's workers
- Potential groundwater quality degradation in relation to well-drilling at contractor's camps (if any)

Surface for disposal areas

The quantity of materials (soils and sediments) to be generated from dredging, excavation and others earthworks activities determine the size of the disposal areas needed. Sites identified to serve as temporary and/or permanent place for the dredged/excavated materials with the environmental component that will be potentially affected are estimated.

Physical impacts

Two sites initially chosen for disposal areas had very similar physical characteristics (flat areas, and low level under influence of water level) and are close to the river.

Depending of the methodologies to be proposed by the contractors, some small dikes will be built to create to maintain the materials in a closed area. In this case, the physical components of the future disposal areas will be impacted.

The third (but main) disposal area is located 16 km from DNC, at Lach Giang Southern Disposal area. It has a capacity of 1,300,000 m^3 and it is include in the scope of Corridor 3 project. It is already totally separated from the sea by a dyke and it was build has a disposal area.

The preparation phase will not be a significant impact from physical conditions.

Ecological impacts

2 of the disposal areas proposed are agricultural areas or already clay/sand storage areas without ecological interest. The ecological impact of the preparation phase for land disposal area is rather low.

The Lach Giang disposal area is isolated in the sea with no connection to the ground and will permit a disposal activity without ecological impact.

Economic impacts

The situation will be different depending if the actual use of the land is for agriculture or for clay/sand storage.

For agricultural areas: supposing the area occupied by agricultural land used to grow rice, 1 ha of land can yield 7 tons/ year and the price of rice is 5 million VND/ ton. The annual deficit

on the economy is 28 ha x 7 x 5 = 980 million VND/year/ha and it's equivalent to an average annual income of 40 laborers.

For clay and sand storage areas, there is no difference between actual conditions and future conditions because the use of land will be the same ➔ no impact on the economy.

For Southern Disposal Area in Lach Giang, the economic impact can be estimated as positive, because, after filling, the area could be used by province authorities for tree planting (Casuarina) and will permit to allow economic benefits for the local community after 5 to 10 years of trees growing. 1 ha of Casuarina can permit to grow 50 to 200 tons of wood. The average price of Casuarina wood in Vietnam is around 3000 VND/kg.
So 1 ha of Casuarina can bring 125 to 500,000,000 VND (6,000 to 24,000 USD) of benefits from wood selling. In Lach Giang, the available disposal area with new possibilities of plantation will concern 30 ha. So the incomes from wood production after 5 to 10 years can be estimated to 3.75 to 15,000,000,000 VND (180,000 to 720,000 USD). ➔ Even after deducting the manpower cost for plantation and harvesting, the economic impacts are still very positive for local population.

Estimation
of temporary and permantly impacted land
by DNC Canal, shiplock , road and bridge
(based on layout from 15/12/2015)

(houses impacted not included)

N°	Name	Temporary impacted (Construction phase) m²	Permantly impacted (loose) m²
1	Road Construction track	1 000	
2	Construction offices + construction site accesse road	5 500	
3	Construction area / workers camp / concrete plants / concrete laboratory / Parking / facilities	25 500	
4	Storage area	9 600	
5	Road & Bridge Construction track	7 000	
6	Road and Bridge Construction track	4 400	
7	Storage area	480	
8	Canal construction track	5 500	
9	Canal construction track	8 200	
10	Canal construction track	2 600	
11	Delivery quay and port	6 000	
15	Access to main road	2 470	
12	Canal and shiplock		345 859
13	Road & embenkments		21 000
14	North road junction		1 200
16	Bridge piles	1 414	760
	Sub-total	*79 664*	*368 819*
	Total	448 483	

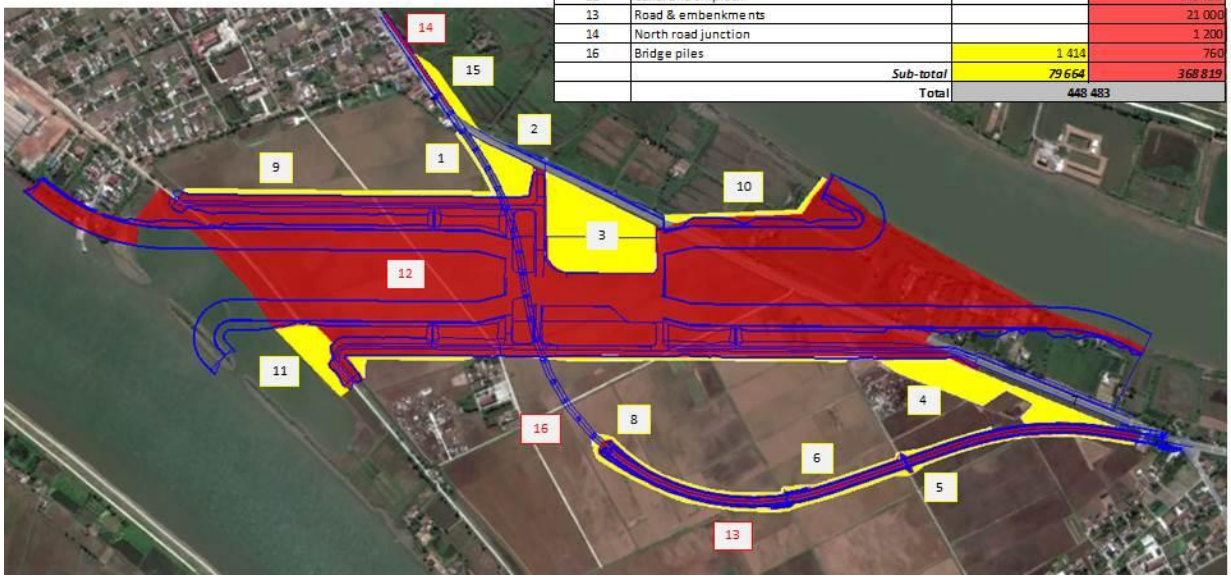


Figure 75 : Surfaces occupied by construction phase (yellow) and by final project (red)

6.5. SOCIAL AND ECONOMIC IMPACTS OF PRECONSTRUCTION PHASE

A social impact assessment, including census, inventory of loss (IOL) and sample socio-economic survey was carried out for affected households, affected land and non-land assets and affected business activities as well. Number of affected households and persons were also identified by the survey. The severity of impact on the affected assets and livelihood of households was also determined. Information on the affected households), members of the affected households, sources of livelihood, income level, and tenure status were also gathered.

a) Affected households

According to IOL, there are 264 households with 1,061 persons to be affected by the project , including 247 HHs are severely affected due to losing more than 20% of agricultural land, 30 HHs have to relocate due to losing residential land and entire houses, and 48 HHs are vulnerable (12 poor HHs and 36 women-headed HHs). No ethnic minority people are found in the project area. Relocated households will be resettled within the project communes so that their social relations are not disrupted and their accessibility to public services are still maintained.

b) Impacts on lands

The total land to be acquired by the project is approximately 450,000 m^2 (45ha), of which, 370,000m^2 (37ha) and 80,000m^2 (8ha) will be permanently and temporarily acquired,

respectively. Of the total 450,000m^2 (45ha), affected agricultural land of households is 321,000 m^2 (32.1ha), residential land of households is 6,915 m^2 (0.7ha), and 120,500 m^2 (12ha) of agriculture land is public land managed by communes. Severely losing agricultural land affects income and livelihoods of 247 households. However, livelihood restoration program will be prepared and implemented for them.

c) Impacts on houses

There are 30 households whose houses are fully affected with total affected area of 2,660m^2 and will have to relocate, and 2 households are partially affected in their houses with a total area of 135 m^2 and do not have to relocate because the remaining part of their houses are usable. All affected houses are Class 4 (semi-permanent).

d) Impacts on other non-land assets

The project will affect 14 tombs (04 brick tombs and 10 soil tombs) at Nghia Lac commune. The tombs will be removed and reburied in the graveyard of the commune. Besides, the project will affect various crops and fruit trees. According to result of IOL, crops and trees are affected as follows: 313,253 m^2 of rice, 3,530 m^2 of maize, 3,366 m^2 of peanut, 800 banana trees and 150 bamboo trees

e) Impact on public facilities

Do Muoi ferry in Nghia Son commune will be temporarily relocated to another site, about 50 m from the original site, to maintain transportation between Nam Dinh and Ninh Binh provinces during project implementation. This temporary relocation of the ferry will not affect any households or vendors on either side of the ferry because they will be able to continue to do business at the new site. The project will build access roads and ferry docks on both sides before relocating the ferry. Therefore, transportation of local people will not be disrupted. The ferry will be restored to its current location after project construction. All costs associated with relocating and restoring the ferry, and all construction thereof, will be borne by the canal contractor, as this will be included under the value of their civil works package.

Two high voltage transmission lines of 110 KV and 35 KV in area of DNC canal at Nghia Son commune, Nghia Hung district, will be also relocated to another area nearby. Relocation of the transmission lines will disrupt temporarily the local power supply, but does not affect the living conditions and production of local residents.

The canal construction will cut across the road No 490 with a section of about 300 m in the area of Nghia Lac and Nghia Son commune. However, it does not disrupt transport activities of residents along the road because the bridge crossing the canal will be built to connect two sides of the canal before breaking the road section.

The canal will cut 260 m of dyke on Day's right bank and 260 m of dyke on the Ninh Co's left bank. Construction of the DNC canal also affects irrigation systems located along Day and Ninh Co Rivers. In the absence of mitigation measures, the change of the irrigation system may disrupt water supply for rice cultivation of local farmers and create a strong impact on cultivation and on local people access to resources. PMU-W has consulted with local authorities and local irrigation agency about mitigation measures and agreed that a new irrigation scheme will be constructed before construction of DNC canal to ensure no impact on cultivation/production of local farmers in terms of irrigation.

The canal construction will also affect some inter-village roads at Nghia Son commune, especially the road connecting some villages of Nghia Son commune to the Church. The

electricity supply for the Church also will undergo impacts. Mitigation measures will be consulted with local people and included in bidding documents.
The canal construction will affect 300m of the underground communication cable along the road No 490. It may disrupt temporary the communication activities of local people however, a temporary cable will be used during relocation of the underground cable to maintain the communication of local people.

6.6. IMPACT DURING CONSTRUCTION PHASE

Social and Economic impacts of construction phase

The scope of work for each diverse location varies and the impacts will be different. To sum up, the proposed construction activities for the DNC construction are as follows:

- Dredging
- Soil excavation
- Soil disposal for excavated and dredged materials
- Bank protection
- Ecological bank protection
- Ship Lock building
- Road relocation
- Fix bridge construction

Comment

Impact of Dredging and Excavating

Of the proposed DNC project works, it is predicted that river dredging and disposal of dredged materials will have the most significant impacts. These activities – if not well managed – can have major impacts on the physical environment, biological environment and socio-economic environment.

The impacts are attributed to extraction of large volume (over 1.5 million cubic meters) of materials, including sediments from dredging and soil from excavations plus disposal of the dredged/excavated materials will require large areas. As such, discussion of the impacts of dredging and excavating is given priority.

Table 25 lists the known impacts of dredging and the time and space relationship of the impacts. It shows that impacts associated with dredging are potentially significant at or near the activity and that severity of impact declines with distance. The impacts of dredging can be considered as local and temporary.

Table 26: General impacts of dredging

Physico-Chemical Impacts	Description of the Impacts
River channel characteristics	Deepening of the channel, removal of shoals and in some sections, widening of the river channels.
	Dredging will improve bankfull capacity of the waterways
Geologic processes	It may hasten bank erosion and deposition; Increased efficiency of sediment transport due to flow improvement.
Water Quality – turbidity due to resuspension of sediments	The most imminent impact on water quality is turbidity which will affect not only the aesthetic quality but other parameters as well. The degree of resuspension of sediments and turbidity from maintenance dredging and disposal depends on four main variables (Pennekamp & Quaak 1990): • the sediments being dredged (size, density and quality of the material), • method of dredging (and disposal), • hydrodynamic regime in the dredging area, i.e.current direction and speed, and • the existing water quality and characteristics (background suspended sediment and turbidity levels). On the other hand, dredging can also result to improvement of water quality in some parts of the river due to restoration of water depth and flow. Near estuaries, dredging can cause migration of salt wedge farther inland.
	Disturbance of the stream sediments can result to the possible resuspension of heavy metals and other persistent pollutants which will make it available to aquatic organisms.
Biological Aspects	Dredging will remove a layer of the substrate material including the benthic organisms inhabiting the substrate. This will affect non-motile organisms since those that are capable of moving will move away from the disturbance. This impact is reversible since once the substrate has stabilized, benthic organisms will again colonize the dredged area. The resuspension of sediments during dredging and disposal may also result in an increase in the levels of organic matter and nutrients available to marine organisms.
	Settlement of these suspended sediments can result in the smothering or blanketing of bottom communities. But because part of the suspended sediments will be carried by the current, settlement will be spread over a wider area.
	High concentration of suspended sediment can threaten juvenile fishes. Suffocation can result with accumulation of silt on gills. Low visibility brought about by high concentration of suspended sediment can also affect feeding of aquatic organisms that depends on sight for feeding.

At the DNC area the quantity of river dredging will be limited (25 % of total quantity) at the entrance of the 2 canal sections on Day River and Ninh Co River sides. The main quantity of excavated materials will concerns agricultural soils (terrestrial excavations – 75 % of total quantity) with no direct links to the rivers, except the transportation by boats to the disposal areas.

a) Impacts on Hydrologic Regime

The rivers modifications are very local (close to the entrances of the canal) and no modification of hydrology is expected due to the construction method which will keep the canal closed until the ship lock construction will be finished. The 2 rivers will not be connected during the construction phase.

b) Impacts on Topography / Morphology

Dredging for the canal connections to Day and Ninh Co Rivers will modify transversal local profiles of the rivers. This will reduce locally water velocity and enlarge river section. That will

modify erosion / deposition conditions. This is a local minor negative impact, due to its localized nature and maybe of term duration.

The sediment budget of the Red River Delta including Day River and Ninh Co River is naturally controlled by erosion of the water shaded and floods occurrence/intensity.

This sediment budget of Red River is deeply modified since 1990 by:

- Large dams building on the upper river = floods occurrence & intensity reduction + sediments coming from upstream blocked by the dams + reduction of the sediment transport capacity downstream the dams;
- Modification of the agricultural means = increasing of very fine sediments from the agricultural lands
- Deforestation = increasing erosion from the water shaded = increase sediments flows to the rivers
- Sand/Clay exploitation = dredging for commercial/construction use of sediments create a deficit of materials in sediment transport.

At DNC the total quantity of dredging and excavation is estimated at 1.561 Million m3. But the total quantity of sediments to dredge in the 2 rivers is limited (400.000 m3). Most of the 2 canals plus ship lock chamber earthworks will be created by excavation, and so will not interfere with the quantity of sediment from the 2 rivers.

The annual flow of sediment transported by Red River is difficult to estimate. Häung and Svenson had estimated (2002) the sediment budget of the different rivers in South Red River Delta (fig 76). We have indicated on this map, the dredged quantities for corridor 3 waterways improvement. The following table summarizes the quantities naturally transported by river and to be dredge from 2012 Detail Design Reports.

Table 27: Natural flow in Day River + Ninh Co River and quantities to dredge from Corridor 3 Detail Design

Quantities of sediments (m3)	Natural annual sediment flow (Pruszak 1998)	Natural annual sediment flow (Häglund & Svensson 2002)	Dredged quantities in river	Dredged quantities in estuary	Total Dredged	Minimum % Dredge/natural flow	Maximum % Dredge/natural flow
Ninh Co River	10 000 000	6 330 000	1 000 000	1 680 000	2 680 000	27%	42%
Day River	12 000 000	5 520 000	156 000	0	156 000	1%	3%
TOTAL	22 000 000	11 850 000	1 156 000	1 680 000	2 836 000	13%	24%

The total dredging for DNC in the rivers (400.00 m3) represents less than 2 % of annual sediment transport by Ninh Co and Day River.

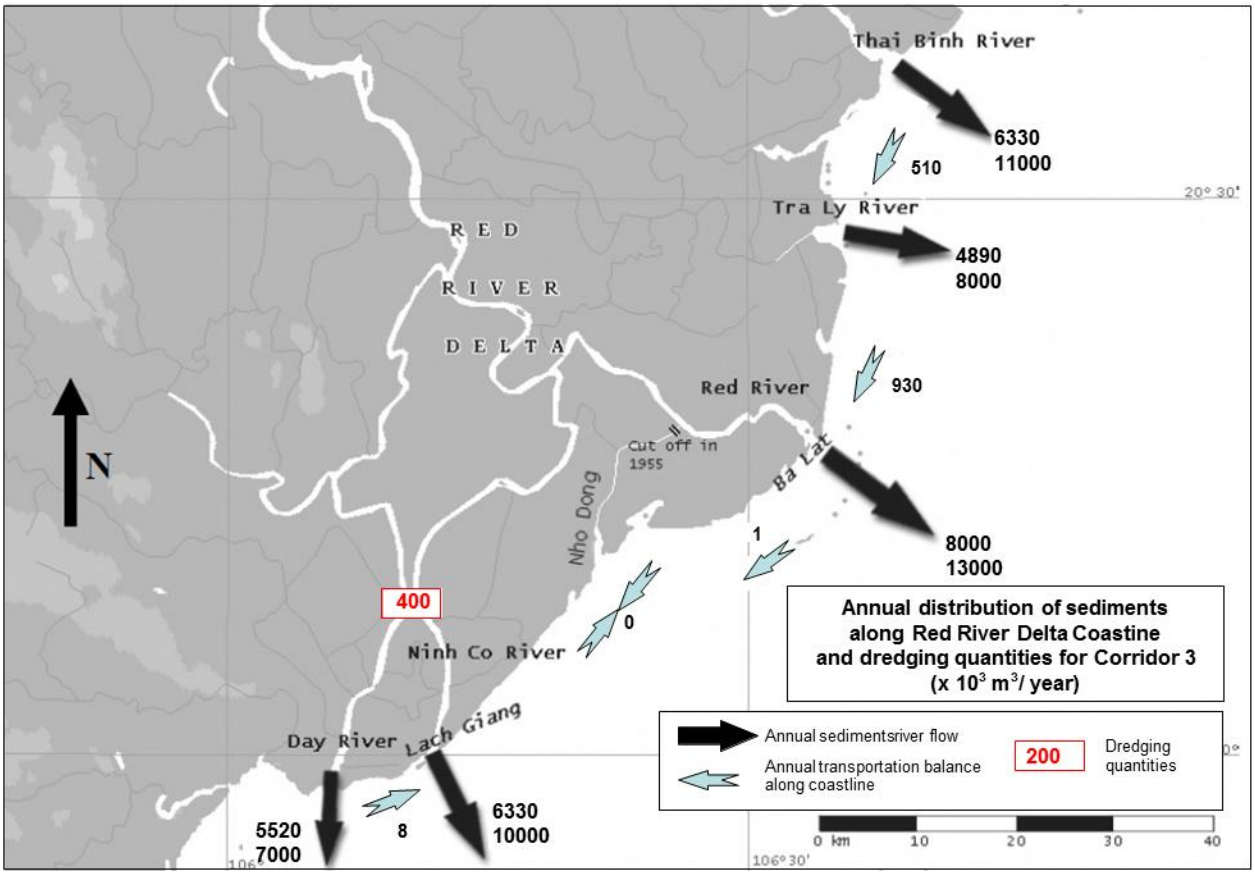


Figure 76: Annual distribution of sediments along red River Delta Coastline and dredging quantities in Day & Ninh Co rivers for DNC project

Even with 2% of the sediment budget of the 2 rivers, the major impact of dredging is mainly due to the export of materials outside the river bed and their subsequent inability to contribute to sediment transport and finally reach the estuary.

This impact will cumulate with the others modifications of amounts of sediments identified since 20 years in Red River.

The impact could be reduced from 3 means:

- Reducing dredging quantities (inside and outside the projects);
- Permitting for main part of the sediment to return to the river (during flood if possible);

Stagger the dredging works over several years so as not to cause a sudden impact hardly controllable. It is noted that a sediment deficit exceeding 5 to 10% of solid natural flow can induce serious environmental and material consequences.

Erosion hazards are strengthened and on medium term, damage to infrastructures (dams, docks, bridges, bank protections, protections in estuarine) are very likely.

The ESIA recommends conducting a comprehensive sediment assessment throughout the course of the Red River from the Hoa Binh dam to estuaries and quantifying current

disturbances on sediment transport in order to compare the potential impacts of dredging provided.

This sediment assessment will enable the authorities in charge of navigation, dikes and control areas of sedimentation and erosion to build a management plan consistent throughout the watershed.

c) Impacts on Water Quality

Turbidity due to sediment re-suspension is the primary impact of dredging on water quality. Increased turbidity and total filterable solids (TFS) can occur below the dredge. The turbidity is highest immediately downstream of the dredge but declines rapidly downstream of the dredge (USACE 1997).

The level of turbidity generated by dredging is partly dependent on the type of dredger used. Experience with hydraulic cutter head shows that maximum concentrations generally remain less than 500mg/L and bottom suspended-sediment plumes are limited to within 500m of the dredge (Havis 1988; LaSalle 1990) (DOER 2000). Mechanical dredging on the other hand can cause much more severe conditions.

Mechanical dredgers generate suspended-sediments through the impact of the bucket on the bottom and withdrawal from the bottom, washing of material out of the bucket as it moves through the water column and above the water surface, and additional loss when the barge is loaded (LaSalle 1990). A suspended-sediment plume associated with clamshell dredging at its maximum concentration (1,100mg/L) may extend up to 1,000m on the bottom (Havis 1988; LaSalle 1990; Collins 1995).(DOER 2000).

Regarding natural TSS concentration of the Red River (50 to 10 000 mg/l) the impacts of dredging is not very high.

The picture below illustrates the natural high level of TSS in Red River during rainy season

Figure 77 : Boat on Red River during rainy season and High TSS concentration

During the dry season TSS concentrations are lower (10 – 100 mg/l) so the impacts of dredging will be more important during the dry period than during the rainy season, but the length of the TSS plume is limited and the impact can be considered as local and temporary.

The sediment quality shows for most of the areas no toxic contamination or a very low contamination level that excludes chemical/toxic contamination to surface water.

For the locations where higher levels of contaminants are identified, the level impact risks because of dredging is very low because the sediments to be dredged are the same as those that would in any event be transported naturally by flooding.

Based on the proposed work, dredging in the rivers will be part of the DNC project limited to the extent possible.

From the experience of Corridor 1 supervision and Corridor 3 construction supervision at Mom Ro, Do Bui and Lach Giang between 2013 and 2015, the dredging does not create a significant impact, regarding of the natural conditions in the Rivers and also because of the limited rate of dredging.

Overall, on the total stretch of Corridor 3, Day River and Ninh Co River are actually permanently disturbed by constant dredging, from maintenance dredging for navigation and from commercial extractions of stream sediment for construction. As observed, water quality degradation occurs sometimes during dredging when overflow occurs when the barges hydraulically unload the dredged material to landing stages along the rivers.

As mentioned earlier, increased turbidity in the river due to dredging is confined within the immediate vicinity of the dredged area. Figure 3 shows the plume dispersion during dredging in the Red River. It can be noted in the photo that the plume does not spread laterally due to the current. It spreads out downstream of the dredge and is effectively diluted.

Figure 78 : Dredging in Red River

Duration of the dredging at DNC will depend of the deadlines of each part of the projects. Dredging are necessary to connect the constructed objects (canal, deviation, bend cutting) to the existing navigation channel. It will also depend on the capacity of the cutter suction dredge that will be used.

The construction phases for the DNC projects area is expected to be completed in 18 to 24 months. The dredging will therefore be spread over the building period.

Use of cutter suction dredges and pumping spoils onto land disposal will minimize the impacts of suspended sediments. Assuming that no overflow is allowed during dredging, source of suspended will be limited to leakage and disturbance of the river bottom with the movement of cutter head. But, impact on increased suspended sediment is enforced by the natural factors of high clay and silt content of the river sediment.

The typical flow velocity of Ninh Co and Day River is dependent of the river flow but also (except for Viet Tri and Nin Phuc ports) by the tide level in the sea. But the average velocity is about 0.5m/sec. Thus, leaked suspended solids will be dispersed and diluted effectively.

Furthermore, the turbidity plume will be confined to a limited area right next and downstream to the dredged area.

The stream sediments from the dredging area in DNC area is compliant with the soil and sediment standard set by QCVN 03:2008/BTNMT (heavy metals) and QCVN 15:2008/BTNMT (pesticide residues).The hazard of re-suspension of contaminants in the water column during dredging is minimal.

Further, the beneficial use of sediments is possible. However, monitoring of sediment during dredging should be done for proper spoils management. Slight exceedances of heavy metals are noted among the collected stream sediments samples.

The impacts of dredging on water quality is rated negative, minor and of short term duration.

For groundwater quality, during the works performed close to the surface the impact on Ninh Co and Day rivers can be considered as insignificant because the sedimentary layers of the underground have very low permeability (clays and sandy clays compacted) and do not allow the infiltration of suspended particles. These very fine sediments function as a filter and block the chemical dissolved in the water.

The impact due to the piling and ground improvement used for the foundations engineering that have to be implemented prior the construction of the Bridge and Ship lock will be carefully considered.

The piles are the columnar elements driven in soils for the foundations of the structures. They have the function of transferring loads through weak, compressible (soft) strata onto competent strata. The driven piles will be implemented for the foundations of the bridge at a

maximum depth of 62 meters and at 52 meters for the ship lock. Some ground stabilization will be done for the enhancement of the properties of weak compressible strata in order to render them competent to carry loads from structures. The penetrative ground improvement methods will be the drainage of the weak compressible soils by placement of vertical drains. The works will be limited to the depth of 15 meters and will have no impact on groundwater.

Besides that, mechanical compaction will be used at ground surface and addition of material to increase locally density is not forecasted in the design. Such a works have no impacts on groundwater.

Based on above, it is then important to consider the potential pollution hazards specially associated to drive piling that could affect the water in the range of the works.

Indeed, the ground works could have the potential to create limited pathways for contaminant migration from the surface to the deep layers, but an unacceptable risk of pollution can only occur in case there is also a source of contamination and a receptor that could be harmed by exposure to those contaminants. This is often termed a Source-Pathway-Receptor (S-P-R) linkage.

Around the site works, for the use of groundwater, the water is pumped through wheel that exist in almost all of the households. The water is used mainly for sanitary use but never serves as drinking water.

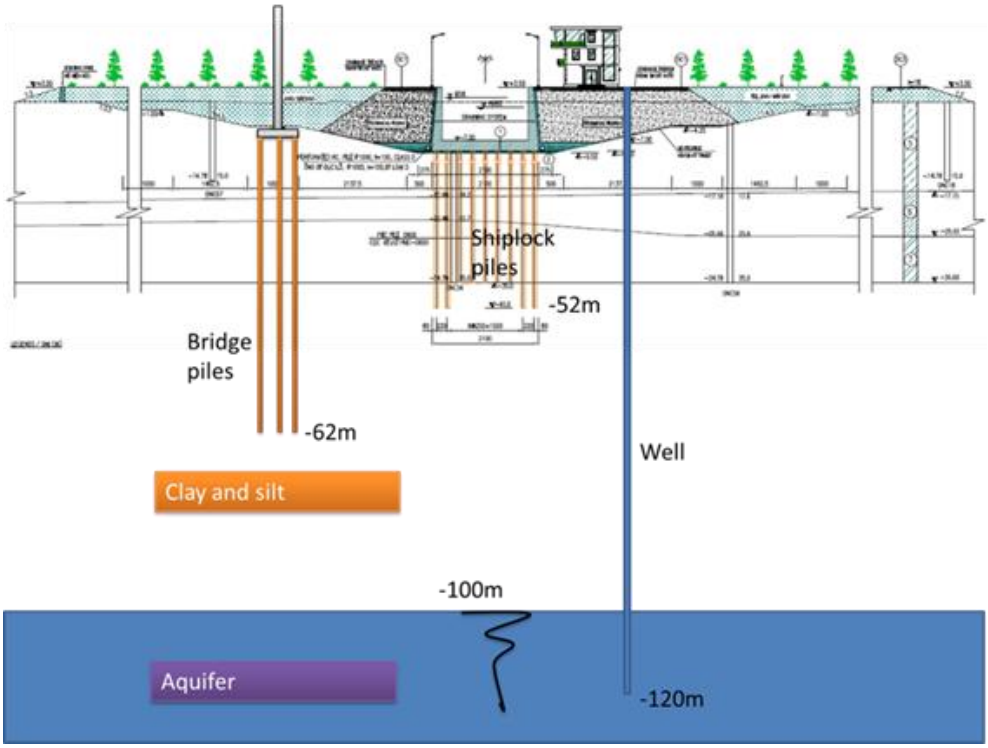
In addition during worksite surveys, some of the wells of the area were visited in order determine hydrogeology and geotechnical parameters. It appears that all of them were driven at more than 100-120 meter depth.

The potential impact of the most deep driven pile is then very low because circulation will be extremely limited by the existence of a 40 meters clay screen of 1.10-7m/s permeability between the bottom of the deepest pile and the aquifer.

Potential risk can thus be summarized as below:

- Are contaminants present on the site and could ground work allow them to migrate, for example as a result of a vehicular accident and oil spill/
- Would pilbreach a low permeability layer or connect two previously discrete aquifers ==> no
- Does the site overlay Major or Minor Aquifer; ==> yes
- Is the site located within a Source Protection Zone; ==> No
- Is groundwater currently of good quality; ==> Yes
- Is the water table shallow or likely to be intersected by piles; ==> No
- Are the geological strata fractured or fissured; Not applicable for soft soil
- Are the works close to a surface water body and could run-off pollute those waters ==> No

Limited Impact of driven piles to Groundwater is described in the figure below:



d) Impacts on Aquatic Life

Dredging can affect aquatic life in a number of ways. The most direct impact is the removal of substrate including the benthic organisms and the smothering of sessile bottom dwelling organisms by dredged materials.

The other source of impacts associated with dredging is the impact of suspended sediments on aquatic life. Numerous researches and experiments have been done in the past on the impacts of suspended sediments. DOER (2000) reviewed these studies and relates the findings to sediment suspension associated with dredging.

In fact the increase of TSS and Turbidity is linked to the granulometry of the sediments and to the methodology of management the sediment dredged.

In Red River Delta (Day and Ninh Co River) the sediments are a mix of sands, silts and clay. They are composed of a fine fraction, easy to resuspended, not cohesive on surface but very cohesive in depth, limiting the intensity of re-suspension. The dredging methodology will use classical materials but the sediments won't be "rejecting" directly to the river like a suction dredge. The sediment will be excavated and send by boats or by pipes to the disposal areas – which are configured to allow settling of the materials and the return of water with lightly loaded TSS to the River.

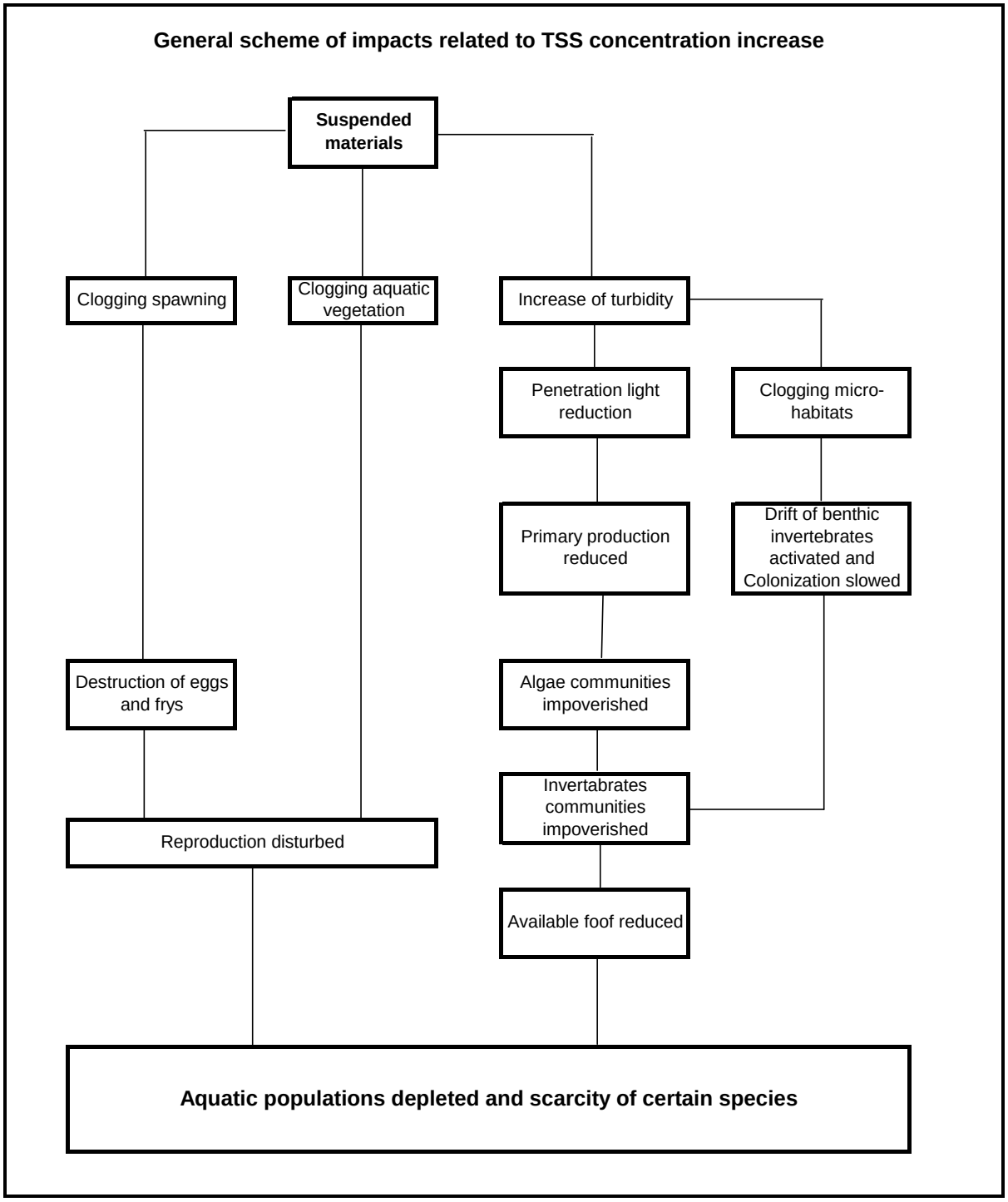


Figure 79: General Scheme of impacts related to TSS concentration increase on aquatic life

Table 28: Time - Space Relationship of Dredging Impacts

	Near-field Environmental Effects (<1km)	Far-field Environmental Effects (>1km)
Short-term Environmental Effects (<1 week)	Dredging Turbidity Smothering/removal of organisms Reduced water quality	Dredging None generally expected
	Disposal Smothering of organisms Turbidity Reduced water quality Acute chemical toxicity	Disposal Offsite movements of chemicals by physical transport
Long-term Environmental Effects (>1 week)	Dredging Disturbance by shipping traffic Removal of contaminated sediment	Dredging None generally expected
	Disposal Altered substrate type Altered community structure Chronic chemical toxicity Bioaccumulation	Disposal Offsite movements of chemicals by physical transport and/or biota migration

The TSS rate close to the dredging zone is about 100 to 500 mg/l of TSS but limited to 10 / 50 m close to the dredge. Downstream, the TSS concentration drops rapidly at rates close to the upstream conditions.

Literature typically considers plume length < 500 m. The elevation of TSS concern a length of 100 to 500 m downstream the dredge. Of course the TSS is more important near the bottom of the river than in surface. The length of TSS plum is also depending of the river velocity and of the lateral dispersion possibility. The slower is the river, the longer is the plum.

To evaluate the risk of impacts, the TSS concentration during dredging must be compared to natural TSS concentrations.

On Red River system, the TSS values are very high during rainy season with natural concentration from 200 to 10 000 mg/l. On the opposite, during dry season, the TSS can be very low (< 50 mg/l).

The impact of dredging will be much more important during dry season and, on the opposite, very low or insignificant during rainy season.

It is also recognized that delta, estuarine and coastal waters experience conditions of high turbidity due to sediment re-suspension caused by floods, storms, tides and currents. It is expected therefore that organisms have behavioral and physiological mechanisms for dealing with this feature of their habitat. The same condition can be said for river habitats where fish

and invertebrates display considerable adaptability to dredging, probably because the streams naturally have substantial seasonal and annual fluctuations (Moyle et al. 1982). These fluctuations, in the form of seasonal flushing flows, can greatly reduce the long term impact of dredging.

Because dredging-related suspended-sediment plumes may differ in scope, timing, duration, and intensity from natural conditions, dredging may create local conditions not typically experienced by resident or transient species (DOER, 2000) – especially during dry season.

On delta areas, species have adapted there life cycle to natural conditions.

Some species need low TSS conditions while others need high TSS value.
On the low Red River – including Delta - some scientists are recently worried about floods and TSS reduction related to the large dams build on the upstream part of the river which block the floods, the sediments and reduce the sediment transport downstream the dams. They notice a relationship between the fall of the natural production of shrimp in estuarine and the reduction of sediment inputs. The high level of sand and clay extractions in the Red River for commercial and construction uses is also a parameter to consider.

Generally, free swimming aquatic fauna like fishes are able to swim away from highly turbid waters. But for those that follow or linger in turbid water, feeding rates of certain species are reduced at a high turbidity level.

This is presumably due to a decrease in the reactive distance of the fish to their planktonic prey (Hecht and van der Lingen 1992 in DOER 2000). Clogging of gills is also known to affect fish in waters with high concentration of suspended sediments.

As for crustacean species, laboratory studies showed that crustaceans are not affected by suspended sediments conditions normally associated with dredging. All mortalities observed in laboratory studies are associated with suspended sediment concentrations of over 10,000 mg/l (DOER 2000), conditions not caused by dredging.

For most of the species living in the Red River Delta, acceptable values of TSS concentrations fluctuate between 10 and 10 000 mg/l.

Of course, the high TSS period is the high water level period and many aquatic organisms can move to lower TSS areas and, for the most sensitive of them, refuge in areas favorable to settling like sea grass, low speed zones, protected areas of the main flow, etc.

The species really sensitive to high TSS value are not adapted to Delta and are not present, or only present during natural low TSS concentration period.

e) Aquatic Life Recovery of Dredged Areas

There are relatively few references on recovery of dredged areas in fresh water. But there is a wealth of information on studies on recovery/ re-colonization of dredged areas in estuaries. For the purposes of this study, experiences in the estuaries are used as references to appreciate the recovery period of dredged areas.

EPA's monitoring of recovery of dredging in a river in Alaska showed that substantial recovery of the diversity of macro-invertebrate occurred after one year (A. M. Prussian et al. 1999). On the Rhône River (France) the recovery survey after dredging show a return to initial biodiversity (including fishes, invertebrates, birds and mammals) from 1 - 3 months to 9 months, frequency-dependent to small-medium floods.

The studies show that the 3 important factors for recovery speed are:

- Quality of the habitats upstream and the transfer possibility (invertebrates drift, fish's circulation, etc.).
- Duration between completion of dredging and first floods;
- Maintaining a favorable habitat for species drifting.

On Red River, even if floods intensity and frequency had been reduced because of the upstream large dams, frequent small and medium floods happen and permit a colonization of dredged areas from upstream.

The lateral recolonization is also very important to consider in Red River Delta. The rivers are very wide and the dredging sections will not cover all the rivers width so large areas of recolonization spots will be preserved.

A review of dredging works in coastal areas world-wide showed that the rates of recovery of benthic communities following dredging in various habitats varied greatly (Nedwell & Elliot 1998; Newell, Seiderer & Hitchcock 1998).

Among the information available on recovery of riverine benthic communities after dredging are the reports by the USACE and USEPA according to the USACE, if the substratum is stable with moderate to low velocities, the area could colonize in less than 5 years.

Some recovery times and habitat types are listed as follows:

Table 29: Recovery Period Observed in Various Dredging Areas

Location	Habitat Types	Recovery time
Coos Bay. Oregon	Disturbed Muds	4 weeks
Rhône River Delta, France	Silts and sands	1 month after flood
Rhône River Delta, France	Gravels and sand	3 to 6 months
Gulf of Cagliari. Sardinia	Channel muds	8 months
Mobile Bay. Alabama	Channel muds	8 months
Goose Creek. Long Island	Lagoon muds	> 11 months
Klaver Bank. North Sea	Sands-gravels	1-2 years
Chesapeake Bay	Muds-sands	18 months
Lowestoft. Norfolk	Gravels	>2 years
Dutch coastal waters	Sands	3 years
Boca Ciega Bay. Florida	Shells-sands	10 years

The general observation is that recovery rates were most rapid in highly disturbed sediments in estuaries that are dominated by opportunistic species. In general, recovery times increase in stable gravel and sand habitats dominated by long-lived components with complex biological interactions controlling community structure.

Experiences in other areas generally agree with the above observation. For instance, the study in polluted estuary in northeastern England showed that recovery of benthic communities will require more than 6 months. (M.P Quigley and J.A. Hall, 1999). A study of a small dredging area (2625 m2) in a similar environment in the harbor of Ceuta in North Africa showed that about 6 months are required for the disturbed area to re-establish a sediment structure and a macro benthic community similar to the undisturbed area (Jose M Guera-Garcia et al.2003).

The recovery of the dredged areas by flora and fauna is under the influence of flood which permits recolonization from upstream as long as the nature of the funds and the hydraulic conditions remain almost the same. In the red river delta this is the case because the dredging will most of all create deeper places but in the same sediments quality with very similar water velocity and habitats conditions.

h) Impacts on Protected Aquatic / Wetland Habitats

The dredging in DNC will not directly affect any protected areas. Wetland protected area is located between Day and Ninh Co Estuary. The other protected wetlands such as Xuan Thuy, Cat Ba and Vin Ha Long are far (> 10 km and more) from the dredging areas.

But, the modification of solid flow due to dredging in the rivers, even in DNC area, could participate to some modifications in the sediment reparation along the coast. From the results of the morphological studies, it's difficult to identify and quantify the possible long term impacts, especially because sediment transport is already heavily modified due to significant changes in the river flows but also by artificial dimensions, increasing sea levels and storms amplification in conjunction with the global climate.

Regular long-term monitoring of coastline would be necessary but it will be very complex to point out the potential impacts of all the sediment budget modification from the different human and natural factors coming from upstream because of the importance of other disturbance factors on the water shaded downstream and on the coast.

f) Impacts on Stream Sediment Quality

Re-suspension of pollutants into the water column during dredging may case contamination of the stream sediments downstream of the dredging area. This risk is considered minimal since sediments of DNC area are uncontaminated based on the results of the sediment analysis and the re-suspended quantities will be rather small. This impact is rated minor, negative and short term duration.

g) Impacts on Air Quality

Impacts of the dredging on air quality will emanate from the operations of diesel fuelled engines. The project will have to comply with QCVN05:2009/BTNMT for emissions of dredging equipment. This impact is rated negative, minor, local and of short term duration.

h) Impacts on Occupational and Public Health and Safety

During dredging operations the workers will be exposed to hazards of operating heavy equipment, noise, heat, ergonomic stress. They will also be exposed to water hazards, such as drowning.

Overall, one of the objectives of the NDTDP is to enhance public safety in water travel. But during the construction stage, dredging can pose hazards to river navigation. The dredge will be an obstruction in the river way. This is a concern both on Ninh Co and Day rivers. Temporary aids to navigation during dredging period will permit to reduce the impacts.. This impact is rated minor, negative, and short to medium term duration.

j) Impacts on Cultural and Historical Resources

The dredging will not have direct impact on Cultural and historical resources of the Red River Delta. These known cultural and historically significant areas are located away from the dredging area of DNC. Only 3 tombs (from 20th and 21st centuries) are located close to the site limits but not concerned by dredging.

k) Impacts on irrigation

Not significant because the water volume only need about 1000 m3 to supply for the ship lock when the boat pass thorough.

Drainage flow in the dry season is 864,000m3 / h in Day River and 216,000m3 in Ninh Co River. Thus, the flow of water lost due to the operation of the ship lock or approximately 0.11 % flow of Day River. The losses are very small compared to the flow of the Day River. Therefore, the impact on water supply in the dry season is not significant.

In flood, the greatest flow of Day River is 5,760,000m3 /h, the Ninh Co River is 1,440,000 m3/h. Such additional water supply for the Ninh Co River due to the operation of the ship lock equivalent of 0.06 % of the water flow Ninh Co River. This additional water flow is very small compared to the ability of Ninh Co River drainage should this impact is not significant.

With such operation mechanisms, the impact on the transfer of water between the two rivers is not significant.

* Level of impact: Negative, not significant, long-term
* Scope of impact: Day - Ninh Co (DNC) area
* Mitigation measures: no

Impact of extracting ground/soils materials

a) Impacts on Topography / Morphology

Construction of the canal and ship lock will remove around 1,500,000 m3 of soil by excavation and dredging. Of 1,500,000 m3, there are around 200,000 m3 of clay which could be used as materials for 2 brick factories located at Nghia Son and Nghia Lac communes as well as materials for fill up the access road to the bridge (around 30,000 m3). The remaining non-clay soil of about 1,270,000 m3 will be used to fill up the Lach Giang's southern disposal area which was prepared to keep dredging/excavation materials during constructing Lach Giang group in phase 1 but it was not enough soil material to fill up to reach attitude as designed for planting tree. Therefore, it is not required to set up new disposal areas in order to keep 1,500,000 m3 of soil mentioned above for this project.

b) Impacts on Water Quality

All the excavation works are done under cofferdam protection which allows separating the excavation area from the river, and protecting the river from huge TSS pollution.

So the excavation phase do not concern aquatic areas excepted on the following points:

Pumping to dewater the excavated areas = return of turbid water to the river. To minimize the TSS and turbidity increasing, and to comply with VN standards for navigated river, mitigation means will have to be organized. The purpose of these mitigations means will be to reduce the TSS concentration by decantation. Of course, the runoff water will be important during rainy season - but natural TSS will be also more important. On the opposite, runoff water will be reduced during dry season as the TSS concentration in the rivers.

A maximum level of TSS or Turbidity authorized to be rejected in the river will have to be fixed – and it could vary depending of the natural TSS/turbidity of the river.

If applying these measures appropriately, the impact of excavation could be rated as negative, moderate, local and temporary.

Excavation phase for connection between canal and rivers:

During this short phase – in end phase of the works, the excavation phase will combine with dredging to open the canals on the river. A part of the materials could fall in the water and increase locally the turbidity and TSS concentration. The materials are very compact (clay or clay + sand) and the risk of dispersion will be minimized. This impact is rated negative, minor, local and temporary.

The underground fresh water is very deep in the soil (from 20 to more than 100 m) made of very low permeability. So the groundwater resources won't be influenced by the excavation phase.

c) Impacts on Aquatic Life

The excavation phase does not largely affect the rivers. But, it can overlay with ponds. In this case, the ponds will be dewatered (by pumping and/or by direct drainage).The aquatic communities will have to move to the river (if dewatered by drainage) or risk to disappear in case of pumping. This phase can be assimilated to a major local and permanent impact because all the aquatic life in the ponds will be destroyed. It will be very high impact for the less mobiles species or for those who won't be able to escape (fishes, invertebrates, plants). The impact is lower for amphibians, reptiles, birds and small mammals dependent on wetlands and aquatic areas.

To minimize the impacts, it will be necessary to organize the dewatering phase of the ponds by drainage and to reserve the pumping on the last step of the phase. A progressive drying must be done to permit mobile species to escape from the ponds.

Of course, if the water level of the river is very similar to the ponds water level, other mitigations means will have to be organized. They are detailed in chapter 7 but we can summarize the adapted ones:

Fishing rescuing and transfer to other ponds or to the river

Recovery/collect of wildlife trapped in the ponds during pumping and transfer to other ponds and/or river.

d) Impacts on Protected Aquatic / Wetland Habitats

The excavation phase will not impact any protected area because they are all located far from the project locations.

e) Impacts on Air Quality

Impacts of the dredging on air quality will emanate from the operations of diesel fuelled engines. The project will have to comply with QCVN 05:2009/BTNMT for emissions of dredging equipment. This impact is rated negative, minor, local and of short term duration.

f) Impacts on Land Use, Agricultural Productivity and Livelihood

The excavation phase will impact the land use. On Mom Ro it will impact agriculture production, fishing on ponds and modify the clay storage of the local brick factory.

Table 30: Land occupation on DNC area

Land occupation	Impacted surfaces (ha)
	DNC
Aquatic (river) area	**0.0**
Bank vegetation	**1**
Reeds/wetlands vegetation	**9.3**
Aquatic (pond/lake) area	**2**
Agricultural land	**32**
Forest/wood	**0**
Industrial area	**0**
Urban area (houses)	**0.7**
Total	**45**

The excavation phase concerns mostly DNC link canal (1.56 Mm3). The quantity of excavation for the road is minimal (< 0.12 Mm3)

Table 31 summarizes the actual land occupation. The excavations will mainly impact agricultural land (32 ha), semi-natural areas and ponds. The urban surfaces impacted are low but it concerns 31 habitations.

The distance from Church to the nearest pier is about 100m. Thus, the construction activities such as pilling, excavation, transportation ... will be impacted to local people.

These impacts can be rated as negative, major, temporary and local. However, the Contractor must ensure that the vibration and noise must be within the Vietnamese regulations. If not, the construction activities must be stopped until having the mitigation measures.

The detailed impacts on social and economic are developed in the Resettlement Action Plan (RAP)

i) Impacts on Occupational and Public Health and Safety

Excavations can impact public health and safety from following points:

Runoff of turbid water close to fresh water pumping for domestic or agricultural use can cause local impacts. The return of water from the disposal sites will be located as far as

possible from the pumping areas. If some remaining pumps are identified as possible impacted, the contractor will take care of the relocation in an acceptable place of the pump.

Dust emission: in dry season, dust emission is possible from disposal area. All the mitigation means for dust emission reduction will be activated. Especially, water spraying to block dust on the ground

Noise emission: disturbance is possible by noise emission. All the material will comply with Vietnamese regulations and independent controls will be organized. In case of complains from local people, verification will be organized and if necessary, mitigation means for noise reduction will be engaged by contractors.

Road/tracks accident: The traffic on the roads and on the tracks will increase in locations where materials transport will be organized by trucks. The transport solutions will be proposed by the contractors. In every case, all the means needed to ensure the safety on roads and tracks will be respected. The huge topographic modifications will also impact the circulation networks and roads + tracks will need to be modified and relocated for some of them. People will be disturb by these modifications and may cause more road accidents if the road signs is not reinforced.

The excavations will utilize land based heavy equipment. The workers will be exposed to work related hazards posed by operating heavy equipment, exposed to possibly long and elevated noise levels and dusty conditions. In addition, they will be working around water; hence they will also be exposed to water hazards such as drowning. This impact is rated negative, minor, short term duration

j) Impacts on Cultural and Historical Resources

The excavation/pilling can cause damage on Cultural and Historical heritages if they are present on the works areas and if they not have been protected or relocated before works start.

On DNC, the project perimeter has been modified to avoid destroying any part of the 2 cemeteries and the church near DNC canal. But, the excavation/pilling phase still concerns these religious symbols and buildings because the works will take place very close to the church and from the cemetery. The impact is rated as negative, medium, temporary and local.

a) Impacts on Air Quality

Stockpiles of the spoils may generate dust during the dry season. Hauling and handling will also have the same impact on air quality. Minimize the impact on local residents, stockpiles should be located away from residences and areas where people congregate (e.g. ferry boat stations).

Operations of diesel fuelled engines (dredge, vehicles) during project implementation will generate emissions. The project will have to comply with diesel fuelled engines. The project will have to comply with QCVN05:2009/BTNMT for emissions of dredging equipment. This impact is rated minor, negative and of short duration.

b) Impacts on Topography

Disposal of dredged material on land will have short to long term impact on topography. However, if dredged and excavated materials are used, then the impact on topography will be temporary in nature. The land will be restored to its original condition after the sediments have been exhausted. This impact is rated negative, minor, short to long term duration.

c) Impacts on Soils

The soil in the disposal site can be affected by the leaching of the dredged material. But the impact can be minor if the storage of sediment is only temporary. Further, the sediments, based on the analysis of samples are not contaminated. The dredged material can be used for beneficial purposes if it complies with TCVN 7209-2002 (see Table 30) and the Dutch Standards for Sediments.

Table 31: TCVN-7209-2002 -Standards for Soil Quality in Vietnam mg/kg

Parameter	**Agricultural Soil**	**Forest Soil**	**Residential Soil**	**Commercial Soil**	**Industrial Soil**
Arsenic	12	12	12	12	12
Cadmium	2	2	5	5	10
Copper	50	70	70	100	100
Lead	70	100	100	200	300
Zinc	200	200	200	300	300

d) Impacts on Erosion and Sedimentation

The return to the river of the surplus water used in pumping the spoils in the disposal site can cause local erosions if not protection is provided. This is a significant risk for important flows of surplus dredge water which returned to the waterway through unprotected canal. It can cause erosion along the bank.

If the storage is not protected from storm erosion and close to the river bed, it can provide locally large quantities of sediments to the river by runoff water. The storage of soil and sediment will be design to protect it from storm/rain erosion. This impact is rated local, minor, negative and of short duration.

In addition, silted water may flow into low lying areas during hydraulic placing of spoils in sloping land. The silted water may smother growing crops on the low lying areas. This impact is rated local, minor, negative and of short duration.

e) Impacts on Stream Sediment Quality

The dredging will remove contaminated stream sediments, if present. This will mitigate pollution of stream beds, but considering the relatively unpolluted state of the dredging

areas, the expected environmental improvement will not be very significant. This impact is rated insignificant. For sediment quality evaluation, we refer to new Vietnamese standard from December 2012: ***QCVN 43: 2012/BTNMT***: Vietnamese Limit concentrations in sediments.

f) Impacts on Surface Water Quality

The return of the surplus dredge water (< 100mg/l of suspended sediments) can cause water quality degradation through local increased turbidity. But this impact is not expected to persist far downstream of discharge. The flowing water will effectively dilute the turbid run-off. This effect is not expected to persist beyond 100 meters downstream of point of discharge. This impact is rated local, minor, negative, short term.

g) Impacts on Groundwater Quality

The groundwater won't be affected by pollution because the clay rich soil is not permeable and minimize the groundwater pollution. This impact is rated as insignificant.

h) Impacts on Aquatic Fauna and terrestrial fauna

Disposal on land will not have direct impact on aquatic life. The return of turbid surplus water into waterway is a possible source of impact on the aquatic life but the TSS increase will be limited in concentrations and in locations (plum < 100 / 200 m). This impact is considered negative, local, minor and short term duration.

On terrestrial fauna, the soil disposal of materials will create habitat destruction for small fauna (birds, reptiles, amphibians, small mammals) due to the clearance phase and, because of the human activities, a local disturbance of the limited terrestrial fauna still in situ.

It's important to note that the actual conditions of the soil disposal areas are agricultural or industrial lands and don't offer a very large interest for terrestrial fauna which can easily move and find similar habitats very close. This impact is rated negative, local, medium and short to long term.

For the site located at Lach Giang, the project will use the Southern Disposal area already built within the construction of Lach Giang break-waters. But the lack of sediments at Lach Giang has not permitted to fill it and then to plant the Casuarina trees as expected. The use of this area for soil and sediment filling will permit to achieve the commune project to create 30 ha of Casuarina trees forest in this place. In this case, on a long term period, the habitats diversity will increase and the impact can be rated as positive, local, medium and medium or long term depending of the "Casuarina forest" management. If all the trees are cut at the same time, the positive impact will only be for a medium duration (10 to 15 years). If the trees are cut and replanted gradually, "forest" management can be considered as sustainable and the impact will be positive for long-term.

i) Impacts on Protected Aquatic / Wetland Habitats

All the protected areas are very far from the soil disposal areas. So there won't be any impact on these areas.

j) Impacts on Land Use, Agricultural Productivity and Livelihood

The actual uses of these lands are:

Actual use	Agriculture	Ponds	Clay/sand	Total
Surfaces (ha)	100	10	10	120

For DNC project, 80 ha distributed on 3 sites will be used:

- 30 ha could become Casuarina trees plantation at Lach Giang
- Clay material will temporary be disposed on the brick factories storage areas (50 ha);

A large concentration with communes, people committees and brick factories had permitted to minimize the quantity of land for soil disposal. An important part of the material (excavated or dredged) will be reused for bricks production (clay + sandy clay). It concerns 400 to 600.000 m3 (25 % of dredged and excavated materials) with 200.000 m3 available for direct reuse by brick factories.

The temporary use of agricultural land as holding area for dredge material will preclude the cultivation of the land for as long as the area is utilized as a spoils holding area. This will result to temporary loss of livelihood for land users. This impact is rated major, negative, local and short term duration.

This is a negative impact on short term duration but for long term it will improve the land use and permit a positive evolution on these areas. The final magnitude is rated positive, important, local and permanent.

k) Impacts on Occupational and Public Health and Safety

Soils disposal can impacts public health and safety from following points:

Runoff of turbid water close to fresh water pumping for domestic or agricultural use can cause impacts on water resource. The return of water from the disposal sites will be located as far as possible from the pumping areas. If some remaining pumps are identified as possible impacted, the contractor will take care of the relocation in an acceptable place of the pump.

Dust emission: in dry season, dust emission is possible from disposal area. All the mitigation means for dust emission reduction will be activated. Especially, water spraying to block dust on the ground

Noise emission: disturbance is possible by noise emission. All the material will comply with Vietnamese regulations and independent controls will be organized. In case of complains from local people, verification will be organized and if necessary, mitigation means for noise reduction will be engaged by contractors.

Road/tracks accident: The traffic on the roads and on the tracks will increase in the place of materials transport will be organized by trucks. The transport solutions will be proposed by the contractors. In every case, all the means needed to ensure the safety on roads and tracks will be respected.

l) Impacts on Historic and Cultural Resources

There is no historical and cultural heritage in the disposal areas so there will not be impacts on the historical and cultural resources.

Impact of Bend Corrections

Some small bend cuttings are necessary in DNC but the surfaces are very low. The impact of bend correction is very similar to dredging impacts for water and aquatic components and to excavation for land/terrestrial components. Just as in dredging and excavating, the materials of the outcrop cutting will be disposed in a land disposal site or used beneficially.

a) Impacts on Air Quality

Impacts of the bend correction on air quality will emanate from the operations of diesel fuelled engines. The project will have to comply with QCVN05:2009/BTNMT or emissions of dredging equipment. This impact is rated negative, minor and of short term duration.

b) Impacts on Morphology

The bend improvement will result to change in river morphology. This activity will entail the excavation of inside bank to improve the bend radius. This is the desired impact. This is a positive, minor, long term impact.

c) Impacts on Soils and Soil Quality

The stockpiling of the remaining materials can affect soil quality on site if they are contaminated and if the in situ soil has high adsorption capacity. On DNC area the analysis did not show soil contamination so the risk of pollution is very low or non-existent. This impact is rated as insignificant.

d) Impacts of Erosion and Sedimentation

During the excavation, the bare river banks will be exposed to flowing water. Loose sediments will be eroded away and deposited downstream of the working area. This impact will persist until the river banks have stabilized either through growth of vegetation or the completion of the river bank protection program under the DNC.

d) Impacts on Stream Sediment Quality

The impact on sediment quality is predicted to be minor. The soil type in the bend cutting area is uncontaminated and is not expected to cause significant change in the stream sediment at the work site.

e) Impacts on Water flow

The small bend cutting in DNC will not have significant impact on the river's morphology, hence impacts on water flow is predicted to be minimal.

f) Impacts on Surface Water Quality

Earthworks during the excavation of the river bend will affect water quality through increased suspended sediment load. River bank will be exposed to water flow which can erode loose sediments and in the process release the clay and silt particles into the water column. This impact will persist until the banks have been stabilized. The extent of the impact will be confined to a limited area in the work site and downstream of the work site.

g) Impacts on Groundwater Quality

The permeability of the soil disposal areas is very low and reduces / prevents the transfer of pollution from the materials to the soil. So, Quality of groundwater will not be affected. Furthermore, the soils from DNC are not polluted. So the impact is nonexistent or insignificant.

h) Impacts on Aquatic and terrestrial Life

The bend cutting/bend correction will induce:

Terrestrial and aquatic/wetlands habitats permanent destructions. This impact is moderate here because most of the land is used for agriculture and the natural habitats are very common. This impact is rated as negative, minor, local and permanent

Sedimentation which can smother benthic organisms near the work site. The turbidity that will be caused by the excavation may temporarily drive away mobile organisms. This impact is negative, minor and of short duration which will persist only for the duration of the activity.

Distribution of fauna living near the works areas because of the increasing of human activity and noises emissions. This impact is negative, minor, local and temporary

i) Impacts on Protected Aquatic / Wetland / terrestrial Habitats

All the protected areas are very far from the soil disposal areas. So there won't be any impact on these areas.

j) Impacts on Agricultural Productivity and Livelihood

The bank cutting on DNC does not impact agricultural land.

k) Impacts on Historic and Cultural Resources

On DNC, the Cultural and historical objects present on the works areas and in their vicinity have been identified and none of them will be impacted. If an impact risk was identified, displacements were considered with local people.

The site limits overlay with 3 recent tombs (< 20 years) and compensation for these is covered in the RAP and will need discussion with the families and economical compensations for their relocation.

l) Impacts on Occupational Health and Public Health and Safety

The bend correction will utilize land based heavy equipment. The workers will be exposed to work related hazards posed by operating heavy equipment, exposed to possibly long elevated noise levels and dusty condition. In addition, they will be working around water; hence they will also be exposed to water hazards such as drowning. This impact is rated negative, minor, short term duration.

Other impacts:

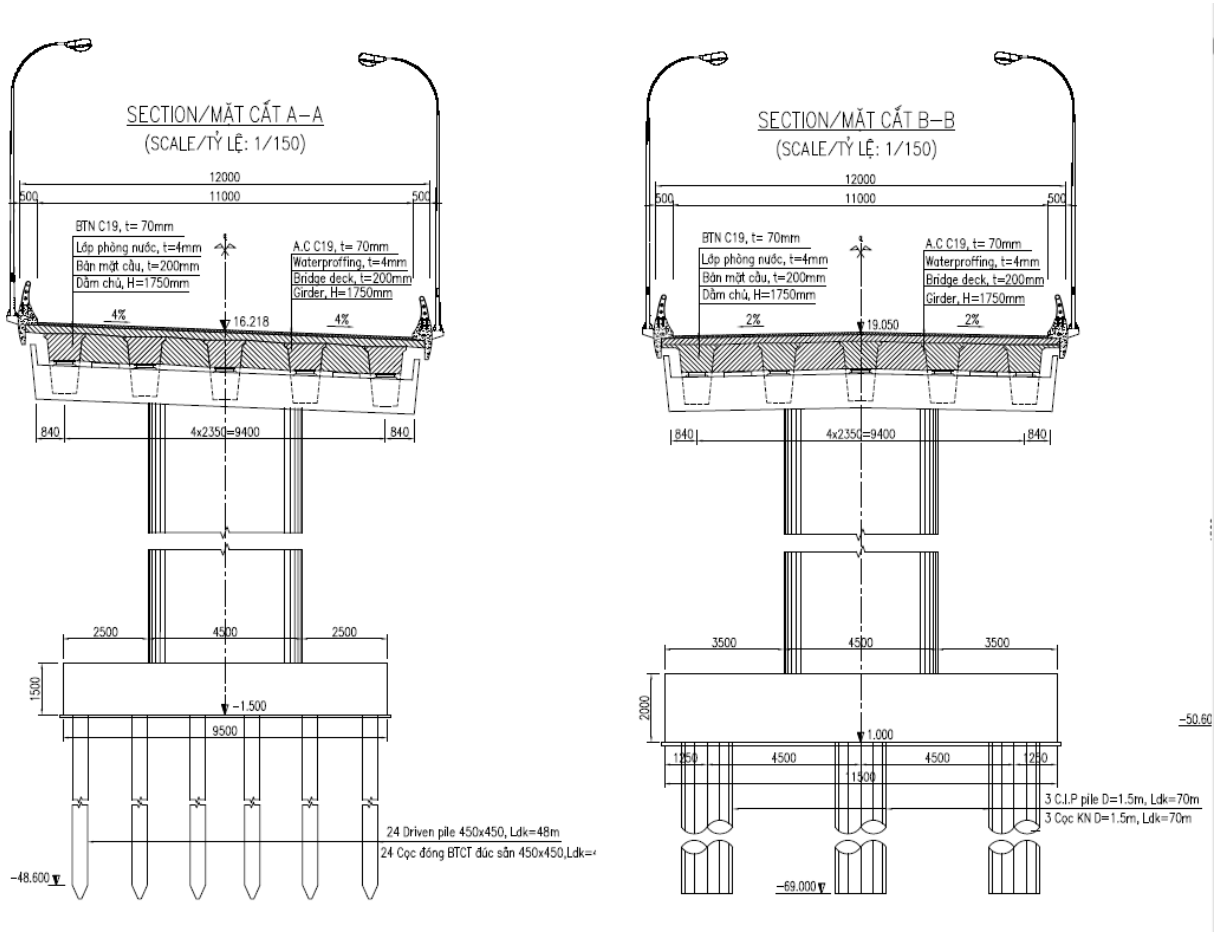
Runoff of turbid water close to fresh water pumping for domestic or agricultural use. The return of water from the disposal sites will be located as far as possible from the pumping areas. If some remaining pumps are identified as possible impacted, the contractor will take care of the relocation in an acceptable place of the pump.

Dust emission: in dry season, dust emission is possible from disposal area. All the mitigation means for dust emission reduction will be activated. Especially, water spraying to block dust on the ground

Noise emission: disturbance is possible by noise emission. All the material will comply with VN regulations and independent controls will be organized. In case of complains from local people, verification will be organized and if necessary, mitigation means for noise reduction will be engaged by contractors.

Impact of piling for Fixed Bridge

The piling phase during the bridge construction will involve drilling up to 48 m to 70 m depth in the soil (depending of the pillars). The depth of piling is important but regarding the thickness of 100 m of sandy-clay soil, environmental impacts are assessed as limited.



The piles density will be important (from 10 to 20 for each abutment or pier) and around 490 piles will be necessary below the bridge and to stabilize the road.

The main impacts from piling phase will concern surface water infiltrations and very local modification of surface and deep soil permeability. However, regarding the actual very low permeability of the sandy-clay soil on 100 m of thickness, this local modification is not significant, and partly balances by the reduction of exposition to rain falls below the bridge.
On the area of the bridge and road location there is no underground pumping station pumping and so no impact are expected on water intakes.

The geotechnical and hydrogeology specialists from CNR and VIPO confirmed that the piles network below the road and bridge will not create a barrier and will not modify the underground flow. They also confirm that the permeability of the soils in contact with the concrete of the piles will prevent any vertical water movement in the underground aquifer and so will avoid any water infiltration along the piles.

The other impact suspected can be the alteration of deep groundwater resources. On DNC area, the fresh underground water natural reservoir is located at 100 m depth and will not be affected by the pilling. A minimum of 30 m of deep soil will cover the underground water below the deepest piles of 70 m. For the piles of 48 m depth, the thickness of cover will be around 50 m.

The other impacts are similar to the rest of the construction phases and are detailed in the other sections of the report.

Impact of bank protections

The objective of bank protection is to prevent bank erosion and scouring. 3 kinds off bank protections are proposed:

- **Classical Bank protection** – based on mineral protection (block, concrete, Reno mattress, etc.) and civil works engineering methods. They are particularly effective for very strong physical constraints which cannot be blocked by softer techniques.

- **Ecological bank protection** – based on natural plants' ability to stabilize the banks and energy dissipation by absorbing and deforming. These ecological engineering technologies are very good alternatives to classical bank protection, permitting lower impacts on environment, cost reduction and maintaining possibility for local people to use natural resources from the plants. Only specific species can be used for ecological bank protection. In Vietnam the most used is Vetiver but other local species can be proposed.

- **"Mixed technique" bank protection** – mixing classical and ecological used at the same times some classical bank protections (blocks) and complemented by ecological techniques (interstitial plantations) leading to very strong bank protection and maintaining some ecological interests.

Among the negative impacts of bank protection, particularly the impermeable type of bank protection is the displacement of fauna that dwells on the river banks. Also, use of impermeable bank protection blocks the exchanges between groundwater and the river. However, this may not be significant since exchange can still occur at the river bed. Impairment of the aesthetics because of its unnatural appearance is another potential impact of bank protection.

From environmental point of view, ecological bank protections are the least impactful technics. The mixed technics are much harder for ecological items but the mixed with vegetation permit to maintain ecological functions for ecosystems. The classical techniques cause more important impacts and result in a real artificialization of the riverbanks and can reduce strongly the natural functions of the river.

a) Impacts on Air Quality

The Impact of the construction of the bank protection on ambient air quality will emanate from the operations of diesel fuelled heavy equipment, like excavators. The standard for motorized vehicle is contained in QCVN05:2009/BTNMT. The other sources of noise and dust are the construction staging areas and the materials stockpiles areas. These will have to be located more than 200 meters away from residences and places where people congregate. This impact is rated minor, negative, short duration.

The ecological bank protections need less heavy materials and equipment. They permit to reduce gas emission and fuel consumption.

Furthermore, the vegetation planted for bank protections will be also useful for CO2 catchment. The ecological bank protection or mixed techniques cause lower impacts than classical bank protections.

b) Impacts on Morphology, Erosion and Deposition

A river bank protection (ecological or not) is, by definition, a mean to block erosion and minimize the possibility of divagation for the river. The lateral and longitudinal dynamic will be reduced or non-allowed and the river will lose its natural functions.

The mineral/classical bank protection can be considered as “hard spot” on the river and the energy flow won’t be totally dissipated and, depending of the shape of the river, some collateral erosion can be identified on middle/long term. These “hard” bank protections often require strengthening the banks over large distances to avoid induced co-lateral erosions. The impact is rated negative, important, permanent and, depending on the river characteristics, local to general.

The ecological bank methods are based on the vegetation capacity to protect the banks but also to its faculties to absorb energy of flow and to dissipate it very easily: “the reed bends but does not break”. On sea side, the mangrove has the same capacities and can afford storms and hurricanes. So the linear and lateral effects of an ecological bank protection cause fewer impacts to morphology. The impact can be considered as negative, medium, local and permanent. On places actually eroded without any ecological interests, the impact of ecological bank can be positive – through increasing bio-diversity and providing natural resources for local people.

The beneficial impact of bank protection structures is the control of bank erosion to prevent shallowing of the waterways. Additionally, the bank protection will also protect properties and human activities along the river bank. This is a positive impact, minor of long term duration from social and economic point of view.

However, river bank protection has the potential to upset the natural process of bank erosion and deposition. This project under the NDTDP will have cumulative impact on reduction of sediment load of the rivers since it will increase the length of protected bank in the stretch of Corridor 3.

Ecological and mixed bank protections are proposed DNC.

Heavy / mineral bank protections are proposed on some location with high level of hydraulic constraints: entrance/way out of DNC ship lock.

c) Impacts on Hydrology

The river bank stabilization modifies the shape of the river and it is recognized in the literature that morphological simplification can lead to faster evacuation of floods downstream and therefore a potential increase of risks. On the area of works, the level in flood is dependent of the flood and of the sea level and the river slope is very small so the risk of "flood acceleration" from the bank modification is very low and can be rated as negative, minor, general and permanent.

d) Impacts on Surface Water Quality

The construction of the bank protection can affect water quality when work is done below water level. The water quality degradation will be mainly due to suspended sediment due to disturbance of the soil along the bank. This impact is minor since it will affect a limited area and will be short term.

Impervious bank protection may hinder the exchange between surface water and groundwater. But in the Red Delta area, the soils have very low permeability and the relations between river and underground water are insignificant so there will be no impact.

e) Impacts on Important Habitats

The protected areas along the coast of the Red River Delta are distantly located from the construction areas and the construction of the bank protections will not have any direct impact on important habitats / protected areas.

f) Impacts on Aquatic Flora and Fauna

The construction of the heavy and impervious bank protection can eliminate spawning areas along the river bank and it can also displace fauna that inhabits the water's edge. Impact is negative, local, minor, long term duration.

On the opposite, ecological bank protection, after vegetation has grown, offer very interesting places for spawning, nutrition and protection (especially during flood). In this case, the impact will be positive, medium, local and permanent.

g) Impacts on Agricultural Productivity

The construction of the bank protection will require a slope of 1:4 to 1:3 (1m rise for every 4m – 3 m horizontal). So where river bank heights reaches 3 or 4m. The bank protection (ecological or not) will occupy a land strip of about 12 to 16m. This strip will be graded and will be permanently occupied by the bank protection structure. This impact is classified as negative, permanent, local and moderate because of the potential social impacts.

Ecological protection banks lead the same problem during construction phase but after the vegetation has grown, it can be possible –depending of the choice of species – to harvest portion of the vegetation. Depending of the species, the vegetation can be used for animal feeding, human feeding (berry or fruit trees) or other economical use (Vetiver essential oil). In

this case, impact of ecological bank protection is considered as positive, moderate to important, permanent and local.

h) Impacts on Land Use

The bank protection will permanently convert an agricultural strip of land along the river and will preclude the future use of this land for production. Considering the relatively limited land area that will be affected, this impact on land use is classified as minor, negative and long term duration.

i) Impacts on Historical and Cultural Resources

The mineral bank protections will not affect any historical or cultural resources. However, it will have negative impacts on the landscape because it will look unnatural. This impact is considered negative, long term, of minor significance.

The ecological bank protections have a negative impact on landscape during the 1^{st} / 2^{nd} years after the works. Then, the vegetation has grown and the bank protections look like natural vegetation and, depending on the selected species, can improve the landscape in some areas. So the final impact for ecological bank protections is positive, medium, local and permanent.

Impact related to wastes

Characterization of wastes impacts

Inherent to construction activities is the generation of wastes. Wastes generated during the implementation of the project are enumerated below:

a) Dust emissions and noise.

Dust emissions and noise are caused by:

- Dredging
- Excavating
- Dumping of dredged and excavated materials
- Bend correction, bend cutting
- Bank protection

It concerns:

- Exhaust (CO, CO2, NO2, SO2) and noise: mainly from machinery, equipment, ship, dredger for dredging, means of transport on site, mobile sources (e.g. vehicles);
- Dust from disposal sites and means of transport that delivers materials and disposals from and to site;
- Dust from temporary storage areas (sand, soils, etc.).

Dust emission is mainly important in dry season (from October to June). On the Red River Delta, even in dry season, the soils are wet most of the times and minimize dust emissions. But special attention will still be held on this issue, especially for works areas close to habitations, schools, medical centers, hospitals and religious, cultural or touristic places.

b) Wastewater:

Wastewater rejects are caused by:

- Workers camps
- Dredging
- Excavating
- Dumping of dredged and excavated materials
- Bend correction, bend cutting
- Bank protection

It concerns:

- Domestic wastewater: from workers' activities on site;
- Dredging wastewater: water is drawn and pumped together with mud into disposal sites then flows back to river;
- In excavation, bend cutting, bank correction: water is drawn and pumped together with mud into disposal sites then flows back to river;
- Oil-containing wastewater: from cleaning machinery, equipment, ship, dredger, means of transport on site, etc.;
- Construction wastewater;
- Surface run-off: mostly rain water that flows through the construction ground;
- Runoff and drainage water from soil disposal sites returning to the river.

c) Solid waste

Domestic solid waste: from workers' activities on site; including "domestic wastes" (mostly nylon, waste paper, left-over food) but also "industrial wastes" (iron, empty drums, plastics, concrete and broken bricks, etc.);

Solid waste from disposal areas: mainly dredged mud and soil, clay, rock, geotextile used in embanking and enclosing disposal sites;

Solid waste from excavation: mud, sand, wrappers, bags, plastic tarpaulins, bamboo, wood, stone, casks for construction and site camps for workers on site;

Solid waste from bank protection: mainly wrappers, bags, plastic tarpaulins, bamboo, wood, stone, casks for construction and site camps for workers on site, soil, cement, sand and damaged mortar;

d) Quantification of wastes impacts

Emission/waste factors used in the quantification of project wastes were taken from the publications made by International Organizations like the World Health Organization (WHO). Additional assumptions were also made based on professional exposure on similar tasks. Presented below are the waste factors and the calculations made to derive the waste generated per activity location.

a) Solid waste (workers) : 0.5kg/person/day

b) Water consumption: 100 liters/person/day

c) Wastewater (80% of water consumed) : 80 liters/person/day.

d) Emission factors from WHO

	Unit	Dust(kg)	SO_2(kg)	NO_2(kg)	CO(kg)	HC (kg)
Fuel Oil	Ton	26.8	20	2.84	0.71	0.24

Solid Waste from Construction

Estimated at 0.1% of the total volume of dredging and bend excavation soils.

f) Construction Equipment and Manpower Requirements

Table 32- Synthesis Construction Equipment and Manpower Requirements

Seq	Equipment	Manpower (number of workers)	
		Construction phase	Operation phase
DNC	02 cutter suction dredger 900HP; 02 backhoe dredgers 1.5 m3; 04 bulldozers 140HP; 04 roller 16T; 01 motor grader 108 HP; 02 concrete plant; 02 concrete batching plants 120 m3/h; 01 barge 200T; 01 barge 400T; 10 cranes 16T; 5 cranes 25T; 10 piling driving machines ; 10 excavator; 5 electric generator 50kW; 5 pumps 0.4-1kW; 01 laboratory	100 to 150	15 - 20

Based on the above assumptions, the quantity of wastes was computed to determine the level of impacts on the environment. Result of computation is shown below.

g) Quantified Impacts on Air

When the work is constructed, there is involvement of many means of construction machinery. Besides, vehicles transporting raw materials to the work will increase traffic in the project area. Those vehicles working on the site will cause a major impact on air environment:

- Noise pollution due to construction and transport activities etc.
- Emissions pollution by from vehicles and construction machinery etc.

To determine the pollutant load of emissions sources, we use the rapid assessment method by the World Health Organization - WHO. The emission coefficient for vehicles using diesel DO, Diesel with the load> 16 tons according to the WHO are presented in the following table:

Table 33: Emission pollution coefficient according to the WHO

	Unit	Dust (kg/km.1vehicle)	SO_2 (kg/km.1vehicle)	NO_2 (kg/km.1vehicle)	CO (kg/km.1vehicle)	HC (kg/km.1vehicle)
DO oil	Tone	1,6	7,43	24,1	3,7	3,0

Application of Sutton formula to calculate average concentration of the pollutants at any point on the route of the project area is as follows:

$$\frac{0{,}8E\left\{\exp\left[\frac{-(z+h)^2}{2\sigma_z^2}\right]+\exp\left[\frac{-(z-h)^2}{2\sigma_z^2}\right]\right\}}{\sigma_z.u}$$

In which:

C: Concentration of pollutants in the air (mg/m3)

E: load of contaminants from waste source (mg / ms)

z: The height of the calculation point (m)

h: height of the road surface compared with the surrounding ground (m)

u: average wind speed in the region (m / s)

σz: pollutant diffusion coefficient in z direction (m)

Assuming stability of the atmosphere in the computing area is B, the diffusion of pollution emissions is determined by the formula:

$$\sigma z = x^{0,73}$$

In which:

x: distance between calculating point and generated source, along with the wind blowing, m

Calculations results are presented in the following table:

Table 34. Emission diffusion model calculation results

DNC									
		20m	40m	60m	80m	100m	120m	140m	QCVN 05: 2009/BTNMT
TSP	µg/m3	17	11	8	8	7	6	5	300
SO2	µg/m3	72	46	38	32	28	25	21	350
NO2	µg/m3	**233**	150	113	99	86	76	68	200
CO	µg/m3	39	26	21	18	18	17	15	30000
HC	µg/m3	32	21	15	15	13	12	11	-

- Table 35 shows that with the distance of 20m from road center, at most of positions, only NO2 concentration is approximate and pass allowed standards comparing to QCVN 05:2009 / MONRE: maximum level of suspended dust (TSP) is 300µg/m3 (0.3 mg/m3); SO2 is 350µg/m3 (0.35 mg/m3); NOx is 200µg/m3 (0.2 mg/m3); suspended dust and toxic gas concentrations are under allowed standards.

- Substance concentration concentrated of about 20m from the road center, decreases rapidly with distance; at the distance of about 140m from the road center, the concentration is almost negligible.

- Due to the fact that average wind velocity of the winter (2.45 m / s) is not so much different from summer, the distribution of emissions is somehow equivalent. However, in summer the prevailing wind will blow in the Southeast direction; in winter prevailing wind will blow in the direction of northeast.

- However, a significant amount of dust arises during transportation and loading and unloading of raw materials. Construction process takes place mainly in the dry season resulting in greater the impact. In fact, in the construction areas of Vietnam dust generated from scattered dust during the transportation material period, dust swept up from the gathering materials warehouse often has very large concentrations; even many times greater than (sometimes hundreds of times) compared to the amount of dust generated from the fuel combustion engine. Normally suspended dust value measured in the air at the warehouse or loading and unloading area is in the range of from 0.9 - 2.7 mg/m^3, from 3-9 times higher than the surrounding air standards (QCVN05: 2009/BTNMT regulates 300 µg/m3). For the project area with relatively high number of sunshine hours per day, large average wind velocity, the effects of dust in the warehouse yard bulk materials to the surrounding residential area is entirely possible if they are not carefully covered.
- In the process of transporting curved cutting materials through rural roads at curved area, mud and soil are scattered especially when vehicle go over bumpy roads. Fine sediment accumulated for a long time will be reeled in and released into the atmosphere when there is wind or trucks passing by affecting the sanitation and health of people living in neighborhood.

Overall assessment:

* *Level of impact*: on average, low negative, short term, ends when the project is completed
* *Impact scope*: air environment in construction area.
* *Mitigation measures*: it is necessary to get measures to mitigate at source. Details of mitigation measures are presented in Chapter 7.

h) Quantified Impacts on wastewater

Construction runoff wastewater

Construction wastewater includes: waste water when transport dredging material through pipelines, construction waste water such as material washing, equipment washing and concrete maintaining wastewater.

+ Waste water in the process of dredging mud transportation to disposal area is relatively large, agricultural land of the people in the region is around the disposal area. If this waste water spill to surrounding area, it will cause damage to people's crops.
+ The waste water is with soluble substances contained in the dredging material, particularly concentration of metals such as As, Hg, Cd, Fe degrading land quantity around the disposal area.
+ Most of disposal areas are located near the river, when the water spill around, this will contribute to the reduce river water quality adjacent to the disposal area.

Overall rating:

* *Level of impact*: average, negative, from medium to long term impact duration.
* *Range of action*: crop agricultural land of the people and the water in the river near the disposal area.

* *Mitigation measures*: It is necessary to have mitigation measures at the disposal area to prevent the waste water from coming to surrounding area, down to the river and the sea. Details of mitigation measures are discussed in Chapter 7.

- Construction waste water is with high concentration of suspended content and organic matter causing pollution to rivers, canals in the area.

Table 35: The concentration of substances in the construction wastewater

Parameters	**Unit**	**Construction wastewater**	**QCVN 24: 2009/BTNMT** (B column)
pH	-	6,99	5,5-9
TSS	mg/l	663,0	100
COD	mg/l	640,0	100
BOD_5	mg/l	429,26	50
NH_4^+	mg/l	9,6	10
Total N	mg/l	49,27	30
Total P	mg/l	4,25	6
Zn	mg/l	0,004	3
Pb	mg/l	0,055	0,5
Oil	mg/l	0,02	5
Coliform	MPN/100ml	53.10^4	5.000

Source: Centre for Environmental Engineering of Towns and Industrial Areas - CEETIA

Note:

- QCVN 40:2011 / BTNMT: National Technical Regulation on industrial wastewater

Column B: regulate parameters on pollutant concentration in industrial wastewater when discharge into the receiving water which is not used for water supply purposes.

- From the table above it shows: a number of wastewater quality indicators are under allowed standards as regulated in allowed standards QCVN 40:2011/BTNMT for wastewater discharging into B level water sources. Only suspended solid criteria is 6.6 times greater than allowed standards; COD is 6.4 times greater; BOD5 is 8.6 times greater and the coliform is 108 times greater.

- *Overall rating:*

* *Level of impact*: average, negative, short term ending when the project ends.

* *Range of action*: water environment near the project area.

* *Mitigation measures*: It is necessary to have mitigation measures at source. Details of mitigation measures are discussed in in Chapter 7.

Domestic waste water in the construction process cause impacts to surface water quality of the project area. In particular, storm water carrying pollutants in construction site with workers' domestic waste water will contaminate surface water of the project area. According to the WHO rapid assessment, pollutant concentration is listed in the following table:

Table 36: Concentration of pollutants in domestic waste water

Parameters	Quantity (g/person/day)	micro-organism (MPN/100ml)
BOD_5	45-54	-
COD	72-102	-
TSS	70-145	-
ΣN	6-12	-
Ammonia	2,4-4,8	-
ΣP	0,8-4,0	-
Total Coliform	-	10^6-10^9
Fecal Coliform	-	10^5-10^6
Worm ovisac	-	10^3

- From the above it shows: the amount of organic matter in the waste water is very high comparing with Vietnamese standards QCVN 14:2008/MONRE; BOD5 levels from 11 to 13.5 times excess the permitted standards; concentration of TSS is 8.75 to 18.125 times and Ammonium concentration is 3-6 times excess the permitted standards.

- *Overall rating:*

* *Level of impact*: quite high, negative, short term ending when the project ends.

* *Range of action*: surface water of canals and rivers near the project site office area.

* *Mitigation measures*: It is necessary to have mitigation measures at source. Details of mitigation measures are discussed in in Chapter 7.

i) Waste grease

According to hazardous waste management regulation, waste oil is classified as hazardous waste. Grease from the vehicles and construction equipment maintaining and repairing area of the project is inevitable. The amount of waste oil generated during construction depends on the following factors:

- The number of vehicles and motorized construction on site;
- The amount of oil released from the transport and construction equipment;
- Oil changes, machinery and equipment maintenance cycle.

Average amount of grease discharged from transport and construction equipment maintenance is about 7litre/one maintaining time. Oil changes, machinery and equipment maintenance cycle is from an average of 3-6 months depending on the operation intensity of vehicles and construction equipment. Hence, the maximum amount of waste oil in each replacing time is from 2.3 litters/month/equipment. The average amount of waste oil in each region is about litter/month.

- *Overall rating:*

* *Level of impact*: medium, negative, short term to long term.

* *Range of action*: soil and water environment near the project site office area.

* *Mitigation measures*: It is necessary to have mitigation measures at source. Details of mitigation measures are discussed in in Chapter 7.

According to the World Health Organization (WHO), the amount of pollutant in storm water is listed in the following table:

Table 37: Concentration of pollutant in storm water

Pollutant	Concentration (mg/l)	QCVN 08:2008/BTNMT	
		B1	B2
Total N	0,5-1,5	-	-
Total P	0,004-0,03	-	-
COD	10-20	30	50
TSS	10-20	50	100

Note:

+ QCVN08: 2008/BTNMT: national technical regulation on quality of surface water

+ Column B1: Water used for irrigation purposes or other purposes which have similar water quality requirements or other purposes such as B2 type;

+ Column B2: Water used in waterways and other purposes with low quality requirements.

The above table shows that rainy water is relatively clean. However, in the rainy day, storm water passing through the project area will catch up soil, sand, debris, grease contaminating rainwater.

- *Overall rating:*

* *Level of impact*: medium, negative, short term, end when the Project completes.

* *Range of action*: construction area and temporary tents of the workers in each project site area.

* *Mitigation measures*: It is necessary to have mitigation measures at each construction area and temporary tents. Details of mitigation measures are discussed in Chapter 7.

j) Quantified Impacts on solid waste

Dredging material

The bed material dredging will not only cause water pollution due to turbidity increase and SS, but also due to toxic substances concentration increase (heavy metals, chemicals and pesticides, oil and grease). Sediment analysis results in the area shows that: although the hazardous content is still low compared with Bed Sludge Dutch Standards (Appendix), the mud stirring is likely to increase its concentration in the river dredging area. The high toxicity of heavy metals (mercury, lead, chromium, etc.) and insecticide is able to affect human health and the life of the fish species. WHO drinking water standard for lead, chromium, mercury, is 0.05 mg/l, 0.05 mg/liter, 1miro g/liter respectively. FAO aquaculture water standards also very strictly regulate concentration of this substance, it even below the drinking water standards for humans.

The increase of water pollution due to turbidity and suspended solids will cause harm to the life of the fish species. Most fish cannot live in water source with suspended solids of 2000 mg/liter (here, the highest anticipated concentration of suspended solids is 1800 mg/liter). Therefore, they have to migrate from areas with high turbidity. High turbidity and suspended solids are able to prevent the dissolved oxygen in the water, high turbidity also affect the life of the plankton which is a major food source for fish, obstruct their ability to find decoy

limiting living conditions of the fish. The experience around the world shows that dredging by bucket will cause smaller impacts than dredging with sludge cutter machine. Laboratory research results show that acidity from acidic alum soil can be arisen from the use of sludge cutter in digging canals. The release of acid from soil is significant only a few days after the water discharges from disposal area. However, according to the analysis results, acidic soil has not been detected from bed sludge and sediment in the project area.

The dredging activities would cause harm to the presence of the organism on the banks and river bottom. Only after a while of dredging, new benthos comes back again. The digging of two river bank affects fish and aquatic organism populations. If only one side of the river is dredged (the selection alternative), the other side of the river will be less affected during construction. Therefore, organism populations can find suitable habitats. Although a part of organism population will be reduced, but damage is still less than the cases construction activities are carried out in both sides of the channel at the same time.

- *Overall rating:*

* *Level of impact*: negative, short term, end when the Project completes.

* *Range of action*: water environment and aquatic plant and animal populations within 500m from the dredge point to downstream.

* *Mitigation measures*: It is necessary to have mitigation measures in the process of selecting alternative and construction equipment. Details of mitigation measures are discussed in Chapter 7.

In the case the dredging is conducted in the alkaline soil area, pyrite in the soil will be exposed to the air, with the presence of water, the pyrite oxidation and acid creation will happen according to the mechanism:

$2FeS_2 + 2H_2O + 7O_2 \rightarrow 2FeSO_4 + 2H_2SO_4$ (strong acid)

$2FeS_2 + O_2 + 2H_2SO_4 \rightarrow 2Fe(SO_4)_3 + 2H_2O_4$

$FeSO_4 + 6H_2O \rightarrow 2Fe(OH)_3 + 3H_2SO_4$

At higher pH pyrite can be oxidized in the presence of ion Fe^{3+}

$FeS_2 + 14Fe^{3+} + 8H_2O \rightarrow 15Fe^{2+} + 2SO_4^{2-} + 16H^+$

The transfer of sulfate of iron II into ferric sulfate happens very slowly with pH <4 but that will be very fast with the presence of catalytic micro-organisms (microbial oxidation of iron). The acidified level of river water and canals depends on factors such as:

- The volume of bed acidic sediment to be dredged and the acidity of the bottom sludge.
- The size of the alkaline soil disposal area, bed sludge, and the ability to cover dump

Acidic sludge quantity to be dredged depends on the depth to be dug, the thickness of the acidic soil layer (pyrite class), and width need training.

Overall rating:

* *Level of impact*: small, negative, short term, ends when the project is completed.

* *Mitigation Measures*: no.

Domestic solid waste: includes waste from construction workers, project staff, from kitchen, hygiene etc. on site. Generally the waste contains from 60 to 70% organic matter, which is easily decomposable (leftovers) remaining persistent wastes such as cans, plastic and paper will be collected separately. There are normally between 30 and 60 workers in a site. Estimated domestic solid waste is about 0.3 kg per day

The amount of waste generated in each construction area is not big. However, if it not collected for treatment on rainy days, domestic solid waste caught up in storm water go to the canal area/river in project surrounding causing surface pollution. In addition, domestic waste with high organic matter content attracts rodents and insects causing disease and affects to the health of construction workers and staff on site.

Overall rating:

** Level of impact*: medium, short term, negative, ends when the project is completed.

** Range of action*: construction site and tent in each construction area.

** Mitigation measures*: It is necessary to have mitigation measures at source. Details of mitigation measures are discussed in in Chapter 7.

k) Quantified Impacts on construction solid waste

Construction solid waste include: cement bags, plastic canvas, broken geotextile, scaffolding wooden, broken purlin, steel trimmings. If it not collected, it will be carried by storm water into rivers, affecting the river environment around the project and river downstream area. In addition, solid waste scattering in construction area is un-aesthetic.

- The quantity of broken cement bags, plastic canvas, and geotextiles is estimated from 10-15kg/month.
- The quantity of scaffolding wooden, broken purlin is estimated at 25-30kg/month.
- The amount of the steel trimmings is estimated 5kg/ month.

Overall rating:

** Level of impact*: medium, short term, negative.

** Range of action*: water environment surrounding the construction project and downstream of the river; land environmental of the project area.

** Mitigation measures*: It is necessary to have mitigation measures at source. Details of mitigation measures are discussed in Chapter 7.

l) Quantified Impacts on hazardous waste

Hazardous generated waste includes grease, rags containing grease, paint, batteries, light bulbs, etc. generated in the construction period; if it is not collected, it can impact water, air and soil environmental and eco-environment project area.

- Grease generation is evaluated in article "b. Impact of waste water"
- The quantity of grease rags generated from washing equipment is estimated about 5kg/month/area.
- The quantity of batteries, bulbs generated during construction is estimated from 3-5kg/ month/area.

The above data shows that: The hazardous waste quantity generated is not large in each area. However, if it is not collected and treated, it may cause major impact on water, soil, air and eco-environment in project area.

Overall rating:

** Level of impact*: large, short term, negative, end when the project ends.

** Range of action*: water, air, soil environment surrounding the project area.

** Mitigation measures*: It is necessary to have mitigation measures at source. Details of mitigation measures are discussed in Chapter 7.

Impacts on noise emissions

Noise that is higher than permitted standards would cause bad impacts on the environment and primarily to the health of direct workers produced as insomnia, fatigue, psychological discomfort, reducing labors' capacity. Exposure to high-intensity noise in the long run will lead to hearing decline, leading to occupational deafness.

According to statistics of the Ministry of Health, the Institute for labor protection Scientific and Technical Research of the Vietnam General Labor Confederation, the noise adversely affecting most parts of the human body. Noise impact on the human body depends of different frequency bands.

Table 38: The impact of noise at different range

Noise range (dB)	**Impact on the listener**
0	hearing threshold
100	Start alter heartbeat
110	strong stimulation to eardrum
120	Deafening threshold
130-135	Causes neuropathy and vomiting, weaken tactile and muscular
140	Cause shrill pain, dementia and psychosis
145	limit noise that humans can tolerate
150	ear perforation if endure for a long time
160	long-term dangerous consequences if endure for a long time

The ability the noise spreads to surrounding environment is defined as follows:

$Li = Lp - \Delta L_d - \Delta L_c - \Delta L_{cx}$

In which:

Li: noise level in the calculation point which is far from the noise source with the distance d (meter)

Lp: The noise level measured at noise source (1.5 m)

ΔL_d: noise level decreases with the distance d at frequency i:

$\Delta L_d = 20 \lg[(r_2/r_1)^{1+a}]$

r_1: distance from the noise source which is appropriate with Lp (m)

r_2: calculated distances to reduce the noise level by a distance corresponding to Li (m).

ΔLc: The noise reducing level through obstructions (resumed ΔLc = 0)

ΔL_{cx}: The noise level reduction after the tree belts

$\Delta L_d = \Delta L_d + 1{,}5Z + \beta \Sigma Bi$

ΔL_d: noise level reduction due to distance (dB_A)

1.5 Z: noise level reduction due to the reflection of the green tree belts.

ΣBi: Total width of the green tree belts (m). Z-number of green tree belts

βΣBi: reduced noise level as noise is diffused in green tree belts

β: lower average value according to frequency (β = 0.10 - 0.20 dB / m)

As the major construction activities mainly are on the ground, it should take the noise reducing level after the green strip is none (approximate value ΔLcx = 0)

Thus, the formula for calculating the level of noise propagation is:

Li Li= $Lp-\Delta L_d - \Delta L_c - \Delta L_{cx} = Lp - \Delta L_d = Lp - 20 \lg[(r_2/r_1)^{1+a}]$

Noise levels caused by construction equipment at a distance of 1.5 m are listed in the following table. The above table shows that level of noise propagation quickly reduces according to distance. The distance from construction area to residential area is about 100m, therefore the effects of noise on residential are negligible.

Table 39: The noise level (dB) of the equipment at a distance of 1.5 m

Construction equipment	**Noise (dB) level at the distance of 1.5 m**
Bulldozer	93
Drill	87
Diesel Compressor	80
Concrete pile driver	90
Concrete mixer	75
Truck	75
Crane, hoist crane	85
Concrete vibrator	80
TCVN 3985-1999	85

Note: TCVN3985:1999: Noise standards to production area

Source: U.S Environmental protection committee. Noise from construction equipment and machines

During construction, dredging and excavation, equipment used includes concrete pile driver, borer, barge, earth mover, concrete-mixer, truck, crane, hoisting crane.

The above table shows that the main noise-causing equipment types are earth mover, concrete pile driver, and driller.

Based on the above formula, the level of noise propagation can be calculated as follows:

Table 40: Noise level (dB) of equipment with different distance

Equipment	Noise far from 1,5m	Noise far from 5m	Noise far from 10m	Noise far from 20m	Noise far from 50m	TCVN 3985-1999
Concrete pile driver	90	79.5	73.5	67.5	59.5	85
Earth mover	93	82.5	76.5	70.5	62.5	85
Boring machine	87	76.5	70.5	64.5	56.5	85

The above table shows that level of noise propagation quickly reduces according to distance. The distance from construction area to residential area is about 100m, therefore the effects of noise on residential are negligible. However, the high level of noise with 1.5m from location of equipment operators will directly effect on them if they do not use noise protection equipment.

General evaluation:

** Impact level:* average, negative, short term when the project completes

* *Impact scope:* 1.5 m far from the equipment

** Mitigation measure:*

Prevention measures for machine operator should be provided (noise protection equipment). Details of mitigation measures are mentioned in Chapter 7.

Economic and Social Impacts

Positive significant impacts are expected contributory to the progress of Vietnam's economy as an ultimate goal of the NDTDP.

As assessed, the following positive impacts the project is expected to provide are as follows:

- Generation of employment
- People engage in businesses, manufacturing, services including farming will generate more profit.
- Safe and efficient navigation
- Efficient flow of goods
- Boost the economy of Vietnam as a whole
- Promote tourism
- Attracts entrepreneurs to establish more businesses
- Traffic congestion will be lessened
- Air pollution will be minimized
- Speed up improvement of infrastructures and other facilities
- Less flooding in the project area

Resettlement impacts were quantified based on the type of structures/activities to be undertaken. This impact and the proposed mitigation measures are presented in detail in the Resettlement Action Plan.

a) Impacts of dredging and land excavation

-Temporary impacts on livelihood and employment:

Besides land acquisition and resettlement, impact on livelihood of the local people may occur around the dredging area (Ex.: they cannot fish or conduct aquaculture) in the short term duration. However, this impact is assessed as minor, temporary, local, and manageable. On the contrary, the project will create jobs within the project for local labor people (minor positive, temporary and local impact).

- Impacts on households:

The dredging and land excavating can be affected by noise or dust to some households near the work area (minor and medium negative, temporary and local impact, respectively).

- Impacts on land use and agriculture:

The land use impact will be local only, impacted by dredging and land excavating works, respectively (Ex: the land of the local people will be borrowed in the short term for land excavating works).

- Impacts on industries:

The materials obtained from dredging and land excavating can be used to make brick or to backfill for some communes. Therefore, it is minor positive and local impact.

- Impacts on road/tracks:

The road / tracks can be disturbed by materials transportation around the work areas. This is minor negative, temporary and local impact.

- Impacts on cultural and historical resources:

The cultural and historical resources areas are located away from the work area of DNC. Thus, the dredging will not have direct impact on it.

- Impacts on public health and safety:

During dredging operations and land excavating, the workers will be exposed to hazards of operating heavy equipment, noise, heat, ergonomic stress. Besides, they will also be exposed to water hazards, such as drowning. In addition, the high rate exposal with dredging material may cause the occupational disease risk such as respiratory illnesses due to odor of dredging material (i.e. mud) /cold for workers. The appropriate health and safety measures taken (wearing of masks and lifejackets) would render the impact minor, negative, temporary, and local. This impact is rated minor negative, temporary and local.

b) Impacts of temporary and definitive soil disposal

- Impacts on livelihood and agriculture:

The project will not need to acquire land for disposal sites. Thus, the 03 designated, existing, MONRE-approved disposal sites will have no impact on livelihoods and agriculture.

- *Impacts on land use:*

In order to build DNC connecting canal and ship lock, the project will remove around 1,500,000 m^3 of soil by excavation and dredging. Of the 1,500,000 m^3, there are around 200,000 m^3 of clay which could be used as materials for 2 brick factories located at Nghia Son and Nghia Lac communes as well as materials for fill up the access road to the bridge (around 30,000 m^3). The remaining non-clay soil of about 1,270,000 m^3 will be used to fill up the Lach Giang's southern disposal area which was prepared to keep dredging/excavation materials during construction of the Lach Giang complex, but there was not enough soil material to fill up the site to reach attitude as designed for planting trees. Therefore, it is not required to set up new disposal areas in order to keep 1,500,000 m^3 of soil mentioned above for this sub-project. It is not required to acquire the land for disposal sites. Thus, 03 disposal sites will have no impact on land use.

- *Impacts on cultural and historical resources:*

The disposal of the dredged material will not have impacts on historical and cultural resources.

d) Impacts of bank protection

- *Impacts on livelihood and agriculture:*

The bank protection will impact to the reduction of uses of natural bank for fishing/hunting/harvesting natural vegetation. Therefore, this impact is medium impact, permanent and local.

- *Impacts on land use:*

The bank protection will permanently convert an agricultural strip of land along the river and will preclude the future use of this land for production. Considering the relatively limited land area that will be affected, this impact on land use is classified as medium negative and long term duration.

- *Impacts on the road / tracks, ferries and navigation:*

Bank protection will partly interrupt local road and waterways traffic due to the transportation and construction. Therefore that is considered as negative, minor and short-term impact

- *Impacts on cultural and historical resources:*

The bank protection will not specifically affect any historical or cultural resources.

However, the general construction phase will temporarily disturbed the church (noise and access road) and some tombs will be relocated. It will have negative impacts on the aesthetics because it will look unnatural. This impact is considered negative, long term, of minor significance.

e) Impacts of equipment and materials transportation

Impacts on waterway transport

During construction, the vehicles and equipment might cause congestion or cause water traffic accidents are: dredger, dredging material transport pipe, crane, floating pile driver.

Dredger itself obstructs the waterway transport in small scale but the dredging material transport pipe obstructs transport with high level.

When construction, equipment such as floating crane, floating pile driver which hardly cannot remove therefore they occupy a part of channel especially in narrow sectors which vessels just go in one lane and thus obstruct the circulation in lane.

On the other hand, as vehicles and equipment do not operate at night it's easy for collision without warning and lack of concentration of captain when driving vessels.

Although the ESIA has evaluated the damages on transport when constructing on Corridor 3, with the above-mentioned analysis these impacts are negative, may be significant but temporary. Scope of impacts mainly occurs in dredging area, training work construction.

Realizing this matter, the Employer commits to cooperate with local authorities, waterway management agencies to minimize the incidents. In addition, mitigation measures will also be shown in Chapter 5 of this report.

Impact on road transportation

As building materials are mainly transported by waterway the impacts on road transport are caused by transport of bend correction materials.

Rural road mainly road of 3-4m wide and earth road with smaller width, truck of 2.3 – 2.5m wide cause traffic congestion especially when there are vehicles going in the opposite direction.

Besides, people's awareness during traffic involvement is poor, signing boards are hardly available the accident occurrence is relatively high.

Realizing this matter, the Employer commits to cooperate with local authorities to ensure traffic safety in material transport areas for bend correction. Details in mitigation are mentioned in Chapter 5 and construction plan.

Evaluation:

* *Impact level:* negative, large, temporary

* *Impact scope:* in road route transporting materials for bend

* *Mitigation measures:* measures shall be provided to ensure traffic safety, details in mitigation measures are mentioned in in Chapter 7.

f) Impacts on labor safety and public health

For the risk of drowning, most workers operating on pilots and dredging vessels are trained and learn the safety regulations on the river so the possibility of drowning is relatively small.

Evaluation:

* *Impact level:* negative, large, temporary

* *Impact scope: workers work at site and residential area around the site*

* *Mitigation measures:* specific provisions should be provided during construction to ensure the safety for staffs and workers. Details of mitigation measures are discussed in in Chapter 7.

For the civil works concerning to handling; usage of electricity, gas, fuel etc.; working on height, the workers must be trained and learn the safety regulations. Evaluation:

* *Impact level:* negative, large, temporary

** Impact scope: workers work at site and residential area around the site*

** Mitigation measures:* specific provisions should be provided during construction to ensure the safety for staffs and workers. Details of mitigation measures are discussed in in Chapter 7.

During construction a large number of workers gathered at the construction site will cause a certain impact on the social environment, local security and order and affect the life, routine practices and living habits of local people.

The disagreement on employment disputes between local people and workers, and between workers could lead to unfortunate consequences.

Infectious diseases caused by living conditions and hygiene lacking may arise and spread faster.

Social problems such as gambling, drinking, and the presence of sex workers may increase and create bad habits for a part of local youth. Many kinds of services arising in the area of large construction sites are a common phenomenon in the region and in the country. These types of effects attract young people, including not only workers but the local people also. This might increase conflicts among young groups. These impacts may lead to the loss of assets as well as social impacts, but these will be mitigated through close management and cooperation between the project implementing agencies, contractors, local authorities, and local people.

The growth of a large number of workers will impact the surrounding environment due to the increase of garbage and waste water (as statistic in the above table). If the sanitation, waste collection is not done regularly and seriously, the ability to spread infectious diseases from workers to local people and on the contrary (diseases: cholera, petechial fever, etc.) is very likely to occur. During storage, waste accumulation will create a habitat for disease caused animals and insects (rats, flies, mosquitoes, cockroaches, microorganisms, etc.) and increase the risk of disease infection in residential communities in the region and surrounding areas.

The emission produced during decomposition of waste water, domestic solid waste causes bad smelling (H_2S, NH_4) which affect the lives of workers and people in the surrounding area.

In fact, the collection and treatment of domestic waste at the construction camp is often unsatisfactory in hygiene, a part of construction workers' waste will directly be thrown in to surrounding area, and intrude into water and soil causing pollution in the camp area and loss of beauty, especially when the camp is located in residential area.

Evaluation:

- *Impact level:* negative, large, temporary
- *Impact scope:* workers work at site and residential area where camp for workers is located.

- *Mitigation measures:* specific provisions will be provided during construction to reduce bad impacts. Details of mitigation measures are discussed in in Chapter 7.

g) Impacts on public facilities

Impacts on ferry and navigation: To construct the canal Do Muoi ferry in Nghia Son commune will be temporarily relocated to a site about 50m from the original location, to maintain transportation between Nam Dinh and Ninh Binh provinces. The temporary relocation of the ferry will not affect households or vendors on either side of the ferry because they will continue to do business at the new, temporary location uninterruptedly. The project will build access roads and ferry docks on both sides before temporarily relocating the ferry. Therefore, transportation of local people will not be disrupted. The ferry will be restored to its current location after project construction, with the provision of adequate navigational aids, such as safety flash-lights and floating signal boards, to guarantee safety of navigation in the canal area. The costs of ferry relocation will be borne by the project in that this will be included under the canal contractor's package, and all associated construction will be carried out by the contractor.

Impact on transmission line: Two high volt transmission lines of 110 KV and 35 KV in area of DNC canal at Nghia Son commune, Nghia Hung district, will be also relocated to another area nearby. Relocation of the transmission lines will disrupt temporarily the local power supply, but does not affect the living conditions and production of local residents.

Impact on the road No. 490: The canal construction will cut across the road No 490 with a section of about 300 m in the area of Nghia Lac and Nghia Son commune. However, it will not disrupt transport activities of residents along the road because the permanent fixed-span bridge crossing the canal will be built to connect the two sides of the canal before breaking the road section.

Impact on the dyke: The canal will cut 260 m of dyke on Day's right bank and 260 m of dyke on the Ninh Co's left bank. Construction of the DNC canal also affects irrigation systems located along Day and Ninh Co Rivers. In the absence of mitigation measures, the change of the irrigation system may disrupt water supply for rice cultivation of local farmers and create a strong impact on cultivation and on local people access to resources. PMU-W has consulted with local authorities and local irrigation agency about mitigation measures and agreed that a new irrigation scheme will be constructed before construction of DNC canal to ensure no impact on cultivation/production of local farmers in terms of irrigation.

Impact on other facilities of communities: The canal construction will also affect some inter-village roads at Nghia Son commune, especially the road connecting some villages of Nghia Son commune to the Church. The electricity supply for the Church also will undergo impacts. Mitigation measures will be consulted with local people and included in bidding documents.

Impact on underground cable: The canal construction will affect 300m of the underground communication cable along the road No 490. It may disrupt temporary the communication activities of local people and a temporary cable will be used during relocation of the underground cable.

h) Impacts on climate change

Regarding global climate change, this is a great matter and widespread influence. However, in the project scope, the emissions concern the fuel from the machines and equipment during

the construction phase. This phase will not increase the global climate change, temperate and sea level. Therefore the Employer proposes a close coordination between contractors, levels and individuals to raise awareness of protecting living environment.

6.7. DETAILED IMPACT DURING CONSTRUCTION PHASE FOR EACH PROJECT AREA

The following tables proposed a synthetic description of the impacts during construction phase for each project area.

The legend is :

T = Temporary impact
P = Permanent impact
L = Local impact
G = general impact
/ = No impact

Kind of impact	Level of impact	Cotation
Serious conflict or major deterioration	Major negative impact	-3
Medium Conflict or medium deterioration	Medium negative impact	-2
Minor adverse/negative effect or slight deterioration in mild conflict	Minor negative impact	-1
Insignificant or no impact	No or unsignifiant impact	0
Minor positive effect, slight improvement	Minor positive impact	+1
Medium improvement	Medium positive impact	+2
Significant improvement or removal of serious conflicts	Major positive impact	+3

Table 41: DNC canal - ship lock – road impacts matrix

	Components	DNC Canal Door open only when boats enter + Fix separate bridge					
THEMES	**Parameters**	**Impact of canal and ship Lock**	**Duration & Location of impact**	**Impact of Fixe separate bridge**	**Duration & Location of impact**	**Observations**	**Mitigation means**
PHYSICAL	**Climate**	0		0			
	Wind	0		0			
	Rainfall	0		0			
	Temperature	0		0			
	Weather phenomenas / Typhoons	0		0			
	Air quality	-1	T+L	-1	T+L	Dust + gaz emission from construction equipments during construction phase	Equipments must respect VN Standards for gaz emission Means for dust emission reduction : water sprinkling on tracks + roads + sheeted/covered trucks to prevent dust.
	Noise	-2	T+L	-1	T+L	The construction phase will last 2-3 years and the canal + lock construction will be an important source of noise emissions and will fluctuate depending on the stages of construction. The nearest residences are located in immediate proximity of the work. The villages are located in them more than 500 m upstream and downstream.	Equipments must respect VN Standards; Noise measurment during construction; Equipments adaptation if not respecting VN Standards.
	Geology	0		0			
	Soil	-1	T+L	0		Most of the excavated soils will be reused for bricks and no significant changes on soils around the canal and ship-lock. The excavated soil are almost the same than surface soils on disposal areas.	Reduction of soil quantities in disposal areas Maximize reusing of remainig soils (brick factory, construction…)
	River system characteristics and morphological conditions	0		0		The canal and ship-lock will not have significant impact on rivers characteristics and on morphology	
	Oceanographics characteristics and morphological conditions	-/-		-/-		Not concern	
	Ocean Waves	-/-		-/-		Not concern	
	River waves (from wind and navigation)	0		-/-		Not concern during construction phase	
	Hydrology	0		0		Not concern during construction phase	
	Ocean sedimentation	-/-		-/-		Not concern during construction phase	
	River sedimentation	0		0		Moderate increasing of TSS close to the excavation areas = very low iimpact on sedimentation comparating with natural TSS concentration	Use methods of excavation and dredging with adaptations to ensure a low level of TSS + TSS/turbidity survey during construction phase.
	Water surface quality	-1	T+L	-1			
	Ground water quality	0		0		Underground water is > 100 m deep and covered by clay (80 - 100 m thickness) and the construction is limitated to 15/20 m deep ==> no contact between surface water and underground water	Underground water survey
	Salinity	0		0		The canal will be build under protection and wil be permanently separate from rivers influencies. The last phase of construction - open canal on Ninh Co and Day rivers side - will be done with the ship-lock closed ==> no transfer of water from Ninh Co to Day = no impact on salinity	Salinity survey include n water quality and underground water surveys
	Sediment quality	0		0			
BIOLOGICAL	**Terrestrial Ecosystems**	-1	P+T+L	-1	P+T+L	Destruction of agricultural land = low interest terrestrian ecosystem	Limitating of excavated area
	Wetland Eosystem	-2	P+T+L	0		On Ninh Co river side : Destruction of ponds and river banks with aquatic and semi-aquatic vegetation + reeds and some wetland / aquatics functions	Ecological bank protection + trees plantations
	Aquatic Ecosystems	-2	P+T+L	0			
	Oceanic Ecosystems (sea)	-/-		-/-		Not concern	
	Protected areas	0		0		Construction area not concerner by protectded areas	
	Protected species (flora/fauna)	0		0		Construction area not concerner by protectded fauna / flora	
	Vegetation / flora	-2		-1		Destruction of Natural vegetation on right river bank of Ninh Co River On Day River + bridge = agricultural végétation	Ecological bank protection + trees plantations
	Plankton	0		0			
	Benthos community (aquatic)	-1	T+L	-1	T+L	Impact on aquatic invertebrats only at junction between canal and Day/Ninh Co rivers = destruction of habitats + invertabrates - small areas	Mimizing dredging areas
	Invertebreas (terrestrian)	-1	T+L	-1	T+L	Destruction of terrestrian vegetation (agriculture) = destruction of common terrestrian invertebrates habitats	Replanting vegetation
	Fishes	-1	T+L	0	0	Destruction of small surfaces of aquatic habitats + disturbtion of fishes from junction between canal and rivers. No impact from bridge construction	Adapt equipments + methods to Minimize TSS/turbidity during construction phase
	Reptiles / amphibians	-2	P+T	-1	P+L	Destruction of terrestrian and wetland surfaces = temporary and local reduction of reptiles/amphibians and birds habitats + Increasing human activity = disturbtion	Limitating of excavated area Minimizing destruction on aquatic areas Ecological bank protection
	Birds	-2	P/T+L	0		Important on Ninh Co side Low impact on Day river	Ricefield rat catchement if concentration population is identified outside the construction area.
	Mammals	-2	P+T	0		Destruction of terrestrian and wetland surfaces = temporary and local reduction of small commons mammals habitats Increasing human activity = disturbtion Impact is unsignificant because only common species. Impact on Ricefield Rat (*Rattus argentiventer)* can be be positive for the specie but negative in concequency with an important risk of rats populations concentration outside the construction area.	Adapt / improve Integrated Ecological Rodent Management (IERM) for Ricefield Rat population control (catchement and destruction).
SOCIO-ECONOMICAL	**Mineral ressources**	-2	T+L	-2	T+L	Cunsumtion of mineral ressources (sand, ciment, concrete, rocks) for canal, ship-lock and fix bridge = negative impact but reuse of excavated clay is positive. Balance is negative	
	Energies consumtions	-2	T+L	-2	T+L	Local increase of energies consumtions from engines equipments + electricity and fuel for construction	Minimize energies consumtion by engines maintenance + construction phases organization for optimization
	Employment	-2	T+L	1	T (P)+L	Canal + ship Lock = Reduction of employement on the agricultural land but increase of local employment (100 persons) during construction phase. The balance is negative Bridge = low impact on agricultural employment but increase of local employment for construction. the balance is positive.	Design phase has permit to reduce agricultural land destruction = reduce employment loss. Reuse of clay and sandy clay for bricks construction = improve local bricks factories economic conditions and increase production capacity =possible increase of undirect employment During construction phase - reserve part of employment to local people
	Agriculture	-3	P+L	-1	P+L	Permanent Loss of 20 ha of agricultural land	Design phase has permit to reduce agricultural land destruction
	Fishery	-1	P+L	0		Permanent loss of 2 ha of ponds	
	Industrial	0		0		No impact on industry	
	Human habitat	-3	P+L	-1		Destruction of 30 houses (0.6 ha) for canal construction + important disturbtion on access (roads+tracks). No impact on houses from the bridge	Detail design phase permit to avoid destruction of 20 houses Resettlement Action Plan
	Living conditions	-2	T+L	-1	T+L	Disturbance + land use modifications + noise emission	Speed limits for circulation + equipments must be conform to VN standards for noise and gaz emission + reduction of dust with water sprinkling and covered trucks
	Health and safety	-2	T+L	-1	T+L	Temporary increase of road accident risks + dust emission + disturbance	
	Irrigation	-1		0	T+L	Temporary disturbtion during relocation of some irrigartion canals	Relocation of irrigation canals
	Drinking water	0		0		No impact on drinking water	
	Navigation (transport)	2		0		Increase of inland waterway navigation = improve of economic activity + incomes for navigation linked to the construction phase	
	Waterway safety	-1		0		Temporary disturbtion of navigation during some phases of the construction period	Foresee navigation aids and signalization during construction phase
	Ferries	-2		0		Relocation of 1 ferry	Relocation of ferry + information to local people
	Trafic Road	-2	P+L	-1	T+L	Modification of road and tracks network + Increase of road/track traffic by vehicules for construction phase	Foresee trafic aids and signalization + information to local people during construction phase + respect of speed limits by contractors
	Leasures	0		0			
	Other water uses	0		0			
	Cultural and Historical heritage	-2	P+L	0		Modification of local acces to church and cimeteries + impacts on landscape around church and cimeteries	Detail Design permit to preserve church and cimeteries from destruction + new raods and tracks access to church and cimeteries
	TOTAL COTATION	**-44**		**-16**			

6.8. IMPACT DURING OPERATION PHASE

Waste related impacts:

- Vessels' engine in corridor 3 generates emissions which include TSP, CO, NO_2, SO_2, CO_2, Hydro – Carbon to pollute the air environment;
- Pollution caused by the hull materials;
- Operation of vessels of large load will increase suspended solid concentration, turbidity in water;
- Waste water and sewage from living activities in vessels will increase the possibility to water pollution;
- Oil and grease leaking from ships will increase the amount of oil, grease in water, particularly in mooring areas;
- Spread of infectious disease will increase through water due to vessel movement.
- Land occupation for periodic maintenance and dredging

Impacts sources not relating to wastes

- Possibility of collisions and water traffic congestion in the area;
- River bed sedimentation and bank protection erosion;
- Impacts on aquatic biota system
- Hydrologic regime change (water level, flow speed, discharge…);
- Potential risk of canal landslide in the position of groin, bend correction;
- Potential limited risk of salinity intrusion from Ninh Co River to Day River at DNC.

Affected objects

- After the project completion, transport capacity will increase and some natural and socio-economic characteristics would be impacted as follows, as a result of the project interventions. Affected objects and scope are mentioned as follows:

Table 42: Affected objects and scope during project implementation

Environment factors	Impact scope
Climate and air quality	
Air quality	all construction phase
Geology and Topography	Excavation + canal/ship lock and bridge construction
Topography / Morphology	In dredging, disposal area and training work construction area.
Soil and soil quality	Mainly in disposal areas
Erosion and accretion	No
Water source	
Surface water quality	Mostly during dredging and disposal of sediment. Limited risks during ship lock operating
Ecology and Biological Source	
Aquatic animals and plants	During site clearance + dredging/excavating
Culture - Society	
Traffic	During construction phase
Economy	Due to project

Impact assessment

a) Waste related impact assessment

- Vessels' engine in corridor 3 generates emissions which include TSP, CO, NO_2, SO_2, CO_2, and Hydrocarbon to pollute the air environment. However vessels running in the channel are periodically checked and provided with certificate of suitable standards before being allowed to operate in channel, hazardous gas content in emission is in accordance with current regulation and standards the impact on air environment is small.

- Vessels operating in the channel for a long time especially old vessels whose protected paint is peeled and fall and dissolve in river water. When paint cover is peeled, iron boat skin will be oxidized; rusty things will be dissolved in to water causing environment pollution. However, vessels operating in channel like emissions are periodically checked by shipping register and granted a suitable certificate prior to operation permission which will limit water environment pollution. Therefore the impact of shell materials on water environment is small.

- The impact of waste water and domestic waste from the vessel operating in channel depends very much on the consciousness of the transport participants. Sometimes, sewage and water waste is not treated but discharged directly in to river. As analyzed in waste water assessment during construction, organic substance content as BOD_5, COD, TSS, T-N, T-P, NH_4^+, microorganism in domestic waste water is very high and will cause river water pollution if not treated. Domestic waste such as sacks and canvas which cannot be decomposed might make fish and shrimp die when discharged in to the river.

- Oil and grease leaking from vessels might cause river water pollution. However, these vessels are periodically checked to be in accordance with standards before operation, their impact on water is small.
- The ability to spread infectious diseases are limited due to the quarantine location is available on each river section, the infectious disease spread is small.

b) Assessment of impacts not relating to waste

Traffic collision and congestion

Collision between vessels and between vessels with bridge in DNC is possible to occur as vessels go through the canal. However traffic control has been implemented well during past years which help minimize waterway traffic congestion and collision.

Accretion

Since rivers on corridor 3 have much alluvial the re-accretion is possible in the locations mentioned in Chapter 1 after dredging. Due to lack of information, we cannot evaluate the sediment after dredging of corridor 3. However, the river management unit conducts channel depth survey annually to guide navigation and propose measures for dredging and maintenance.

Landslide

There are many reasons for landslide during exploitation on Corridor 3. This is resonant impacts of factors such as current velocity, hydrologic regime, flow direction, wave induced impacts and groin structures. However, the maximum flow velocity on Corridor 3 is about 1m/s, we define 2 critical factors to stabilization of channel bank on Corridor 3 are wave and the stability of groin structure.

Indeed, for this channel the natural wave is very small and wave induced landslide mainly arises from navigation in which navigation induced wave height is defined according to the Pylarczyk formula (Guidance to inland channel design of United Nation):

$$\frac{Hi}{h} = \alpha_i \frac{V_s^2}{gh}\left[\frac{s}{h}\right]^{1/3} \qquad (3.1)$$

H_i: secondary wave height (m);

h: water depth (m);

α_i: factor deepens full-load of vessels

V_s: navigation velocity (m/s);

s: Distance from board to bank (m);

g: gravitational acceleration (g = 9,81m/s^2).

Table 43: Calculation results of vessel induced wave height in channel

Slope	Wave height	Wave length	Coefficient	Coefficient	Vessel induced wave height R_u corresponding to different roof tiling materials (m)			
m	Hi (m)	Li (m)	X	b	Rip-rap (r = 0,6)	Smooth concrete (r = 1)	Sand mattress, stone mattress (r = 0,7)	Building stone (r = 0,9)
2,00	0,739	5,640	1,381	55,00	0,70	1,17	0,82	1,05
2,50	0,698	5,733	1,147	55,00	0,55	0,92	0,64	0,83
3,00	0,667	5,824	0,985	55,00	0,45	0,75	0,53	0,68

Wave height ranges approximately 0.7 m with waterway vehicle density on route is average. It can be seen that the dynamic impact of the wave on bank protection works in this corridor is small.

In the report, the numerical modeling is used to study hydraulic regime, consider and assess the work impacts such as dredging, bank protection, groin and hydraulic regime.

The hydraulic regime research results shows that lane expansion at locations on the channel does not increase the flow speed as well as changes in flow regime. Therefore, the dredging location of bank correction for channel expansion does not affect the hydraulic conditions of the flow.

Therefore, dredging during construction in route does not affect the hydraulic regime and influence a little on bank erosion.

c) Hydraulic regime change, flood relief of flow

The proposed design will not affect the flow regime. The connection between the 2 rivers is controlled by the gates which open only when boats need to cross the canal.

d) Impact on climate change

Regarding global climate change, this is a great matter and widespread influence. However, in the project scope, we do not conduct any operations or use toxic chemicals which increase the global climate change, temperate and sea level.

Report on scenario of climate change, sea level rise in Vietnam (Ministry of Natural Resources and Environment -2009) recommends climate change and sea level rise in Vietnam is the average scenario, accordingly:.

"At the end of 21st century, our country temperature might increase by 2.3^{0}C compared to the average temperature in 1980-1999. Temperature increases from 1,6-2,8^{0}C in areas of different climate. Temperature in North and Northern Central increases faster than temperature in the South. In each region, temperature in winter increases faster than in summer."

Total yearly rainfall and rainfall in the rainy season in all climatic regions of the country are increasing, while rainfall in the dry season tends to decrease, especially in the southern climates.

The yearly rainfall in the whole country in the end of 21st century increases about 5% compared to the period of 1980-1999. In the Northern climates, rainfall will increase more

than in Southern climate. In the mid- 21st century, the sea level might rise by 30 cm and to the end of 21st century sea water level will rise by 75cm compared to the period of 1980-1999…"
Sea level rise and dredging activities decreasing water level will increase salinity intrusion of sea water. However, according to the survey, river water level lowers in 6km while dredging areas is 20km far from the sea. Thus, impacts of river water level lower leading to salinity intrusion of sea water is negligible.

6.9. DETAILED IMPACT DURING OPERATION PHASE FOR EACH PROJECT AREA

The following tables proposed a synthetic description of the impacts during operation phase for each project area.

The legend is :

T = Temporary impact
P = Permanent impact
L = Local impact
G = general impact
/ = No impact

Kind of impact	Level of impact	Cotation
Serious conflict or major deterioration	Major negative impact	-3
Medium Conflict or medium deterioration	Medium negative impact	-2
Minor adverse/negative effect or slight deterioration in mild conflict	Minor negative impact	-1
Insignificant or no impact	No or unsignifiant impact	0
Minor positive effect, slight improvement	Minor positive impact	+1
Medium improvement	Medium positive impact	+2
Significant improvement or removal of serious conflicts	Major positive impact	+3

Table 44: DNC impacts during operation phase

	Components	DNC Canal Door open only when boats enter + Fix separate bridge					
THEMES	**Parameters**	**Impact of Lock (doors open only when boats)**	**Duration & Location of impact**	**Impact of Fixe separate bridge**	**Duration & Location of impact**	**Observations**	**Mitigation means**
PHYSICAL	**Climate**	0					
	Wind	0					
	Rainfall	0					
	Temperature	0					
	Weather phenomenas / Typhoons	0					
	Air quality	-1	P+L	-1	P+L	1 boat = 220 trucks. The gaz and noise emission from 1 boat is very lower than 220 trucks and the improvment of navigation inland waterway permit to limite the road trafic increasing. But on Lach Giang	Improve and updating the motors on boats will permit to reduce more the gaz and noise emission from boats
	Noise	-1	P+L	-1	P+L		
	Geology	0		0			
	Soil	0		0			
	River system caracteristics and morphological conditions	0		0			
	Oceanographics caractéristics and morphological conditions	-/-		-/-			
	Ocean Waves	-/-		-/-			
	River waves (from wind and navigation)	-1	P+L	0		Increase of navigation near the canal will increase waves fron navigation on the banks at the entrances/exits of the canal	bank protection + speed limit for navigation
	Hydrology	0					
	Ocean sedimentation	-/-					
	River sedimentation	-1	P+L	0		Local sedimentation modification close to the canal and shiplock but with very low impacts	Dredging in case of sedimentation
	Water surface quality	-1	P+L	0	0	Increase of navigation near the canal will increase local water quality modification (effects of waves + pollution from the boats)	Water quality monitoring Information to boats pilots to maitain propely motors and prvent oil or fuel linking
	Ground water quality	0					
	Salinity	-1	T+L	0		The risk of salinity intrusion from Ninh Co to Day rivers is low and limitate to very low discharge period of Ninh Co river combine with very Hight level of sea (few days/year). Most of the time the bigger flow from Day river will avoid salinity intrance from Ninh Co + Ship lock open only when boats enter.	Ship-lock close when no boat No flow modification on Nonh Co river Temporary cessation of navigation during critical period (very low flow of Ninh Co + hight tide) Salinity survey If necessary adaptation in the ship lock to reduce water entrance from Ningh Co river
	Sediment quality	0		0			
BIOLOGICAL	**Terrestrial Ecosystems (banks and coasts)**	0		0		Loss of land concern only agriculture	
	Wetland Ecosystem (river)						
	Aquatic Ecosystems (river)						
	Oceanic Ecosystems (sea)	-/-		-/-			
	Protected areas	-/-		-/-			
	Protected species (flora/fauna)	-/-		-/-			
	Vegetation / flora	0		0			
	Plankton	0		0			
	Benthos community (aquatic)	-1	L+P	0		Navigation intensification near the canal will increase the wake produced (waves action) and disturb local bethos community	Ecological bank protection Navigation speed limits
	Invertebreas (terrestrian)	0		0			
	Fishes	-1	L+P	0		Navigation intensification near the canal will increase the wake produced (waves action) and disturb fishes (less density and less diversity) close to the DNC	Ecological bank protection Navigation speed limits
	Reptiles / batrachians	-1	L+P	0		Navigation intensification near the canal will increase the wake produced (waves action) + human activities will disturb batrachians and reptiles (less density and less diversity) close to the DNC	Ecological bank protection Navigation speed limits Preserve some areas with low human activities (natural refuge areas)
	Birds	-1	L+P	1	L+P	Navigation intensification near the canal will increase the wake produced (waves action) + human activities will disturb birds (less density and less diversity) close to the DNC but the fix bridge can permit nesting for some species	Ecological bank protection Navigation speed limits Preserve some areas with low human activities (natural refuge areas)
	Mammals	1	L+P	1	L+P	The ship lock and the bridge can be used by some bats species as resting place and breeding sites.	Ecological bank protection Setting up shelters for bats Preserve some areas with low human activities (natural refuge areas)
SOCIO-ECONOMICAL	**Mineral ressources**						
	Energies consumtions						
	Employment	1	P+L	0		May have some service at Lock for visitors	Priority to local employment for maintaning canal and ship lock Encourage Economical initiatives around the DNC Inform industry of the opportunities offered by the corridor 3 waterways
	Agriculture	0		0			
	Fishery	-1		0		Increase of navigation will disturb fishery - the increase of water surface can be an opportunity but the compatibility beween navigation use of the DNC and fishery will be difficult	Once in service, evaluate the possibilities of maintaining fishing in the canal and its compatibility with the navigation trafic
	Industrial	1		0		DNC will permit to save time and money for transport from Ninh Co to Day River = positive for industries	
	Human habitat	0		0			
	Living conditions	-2	P+L	-3	P+L	Very important modification of landscape can be rated as negative for the shiplock and very negative for the bridge	landscaping and architectural treatmeant of canal, lock, bridge and surrounding to improve the landscape quality Ecological bank protection Trees and vegetation plantations in surronding Enhancement of the landscape around the church
	Health and safety	-1	T+L	-1	T+L	Shiplock and bridge will change the habits of the population and increase the risk of accidents during the first months following the commissioning	Information signs Information about saftey to local people Temporary reinforcement of police controls
	Irrigation	-1		0		Low risk of salinity increase close to Day side of DNC - limitied to few days/year	Ship-lock close when no boat No flow modification on Nonh Co river Temporary cessation of navigation during critical period (very low flow of Ninh Co + hight tide) Salinity survey + information to farmers with irrigated lands near Day side of DNC If necessary adaptation in the ship lock to reduce water entrance from Ningh Co river
	Drinking water	0		0		Level of salinity not modified in ground water Level of salinity in surface water always below drinking water standards	Salinity survey on Day side
	Navigation (transport)	3	P+G	0		Navigation is better due to connection between Day and Ninh Co rivers	
	Waterway safety	3	P+G	0		Better navigation lead to reduce risk of accident	
	Ferries	0		0			
	Trafic Road	0		1	P+G	Bridge facilitate normal trafic activity on road No 489	
	Leasures	1	P+L	0		Canal and bridge contribute to local better view. Along the canal may create some places for pleasure as café …	
	Other water uses	0		0			
	Cultural and Historical heritage	-1	T+L	-1	T+L	Increasing of navigation + road trafic on the bridge will disturb tranquility of the church area	
	TOTAL COTATION	**-6**		**-4**			

Salinity intrusion

In DNC area, Day River is fresh water whereas Ninh Co River salinity is much more influenced by the sea and can be considered as salted to brackish depending of river flow, sea level and wind intensity when blowing from the sea (= sea intrusion more important).

It's important to note that 5 km upstream from DNC area, the Quan Lieu canal is a permanent way of water exchanges between Day River and Ninh Co River. The salinity influence of Ninh Co River on the Day actually exists during low flows of the 2 River and very high level of sea in Lach Giang. Day River near DNC can be considered as actually temporary affected by salinity intrusion. But most of the time it can be considered as fresh water river.

The results of modeling for salinity show a negligible risk for most of the time (>350 days/year) due to the Day River flow always more important than Ninh Co river flow and from dilution.

The salinity risk intrusion from Ninh Co to Day is only important few days per year during very low flow period (dry season) and very high tide combines with important wind from the sea. Those conditions can cause salinity intrusion through the ship lock when the doors are open to let the boats enter and exit from the ship lock. In the worth case, the salinity level will stay below the VN and WHO standards for drinking water and irrigation. So the impact is consider as insignificant for most of the time and temporary (< 15 days/year) and locally (downstream vicinity of DNC on Day River side) important.

When the ship lock door is closed, the salinity is blocked on Ninh Co side.

3 mitigations means are proposed:

- Keep ship lock doors closed when there are no boats
- Salinity survey to inform farmers and local people in case of salinity increasing
- In case of occurrence of conditions favorable to salinity intrusion (very low flows of rivers, high tide, strong wind from the sea), prevent salinity intrusion by a temporarily prohibition / close of the ship lock + information to navigation.

In this case the impact on salinity will be very low.

Table 45: Salinity intrusion evaluation near DNC

	Salinity from Ninh Co river = 25g/l ==> low flow + high tide + high wind from sea		Possible case during dry season Salinity from Ninh Co River = 12 g/l ==> low flow + very high tide		Possible case in median season Salinity from Ninh Co River = 5 g/l ==> medium flow + high tide		Possibe case during rainy season Salinity from Ninh Co River <1 g/l ==> Important flow + high tide	
Ship lock Length	165	m	165	m	165	m	165	m
Ship Lock width	17	m	17	m	17	m	17	m
Water level in Ship Lock	7	m	7	m	7	m	7	m
Fréquency of flood + tide conditions	Exceptional (< 5 days/year)		Infrequent (< 10 days / year)		Regular (> 200 days/year)		Regular during Rainny season (> 100 j/an)	
	DAY	NINH CO	DAY	NINH CO	DAY	NINH CO	DAY	NINH CO
Salinity- mg/l	200	25 000	200	12 000	200	5 000	200	1 000
Flood- m3/s	240	60	240	60	800	210	1600	400
Potability standards (OMS) (mg/l NaCl)	1000		1000		1000		1000	
Agricultural limits (OMS) (mg/l NaCl)	4000		4000		4000		4000	
	NINH CO -> DAY	DAY -> NINH CO	NINH CO -> DAY	DAY -> NINH CO	NINH CO -> DAY	DAY -> NINH CO	NINH CO -> DAY	DAY -> NINH CO
Ship lock water volume (m3)	19 635	19 635	19 635	19 635	19 635	19 635	19 635	19 635
Number of ship lock cycles	1	1	1	1	1	1	1	1
Total volume of water per hydropeaking/pondage (m3/h)	19 635	19 635	19 635	19 635	19 635	19 635	19 635	19 635
Volume eau naturel (m3/h)	864 000	216 000	864 000	216 000	2 880 000	756 000	5 760 000	1 440 000
Natural NaCl flow by rivers(t/h)	173	5 400	173	2 592	576	3 780	1 152	1 440
NaCl flow by pondage from shiplock (t / h)	487	-487	232	-232	94	-94	16	-16
Total NaCl Flow (t / h)	660	4 913	404	2 360	670	3 686	1 168	1 424
Final Salinity in rivers (mg/l)	747	20850	458	10017	231	4752	202	976
Différence / natural conditions mg/l NaCl	547	-4150	258	-1983	31	-248	2	-24
Différence %	273%	-17%	129%	-17%	16%	-5.0%	1%	-2.4%

Respectes but approaches from WHOand VN potability standards and exceeds natural values on Day river upstream DNC canal = strong impact may require temporary closure of the lock and/or specific actions on agricultural/domestic pumping in Day river close to the DNC canal to avoid local salinity problems	**Respectes WHO and VN potability standards but exceeds natural values on Day river upstream DNC canal = low impact (acceptable) May require vigilance when pumping and agricultural water supply in the immediate vicinity of the channel output side Day River**	**Respectes WHO limit for drinking water and is very close to natural values = Negligible impact**	**Respectes WHO limit for drinking water and is very close to natural values = Negligible impact**

6.10. RISKS

Risks during construction phase

Incidents in DNC Construction phase are potential. However, their scope and level depend on many factors, particularly human beings. It could be work-related accident, traffic-related accident due to vessels or reckless vehicle operators. Some potential incidents predicted during construction are tabulated below:

Table 46: Potential incidents during construction phase

Incidents	Impacts
Dumping chemicals, fuel, oil to water	Water pollution/Health impact – Used oil, fuel, paint and other toxic substances may accidently leak or spill out into the river. This could threaten aquatic life and could affect fish catch. When contaminated fish is eaten by humans, this will cause sickness and other serious ailments. Concentrated substances could cause fire and will severely affect those that will be reached by fire like the construction equipment and facilities near the burning materials.
Leak/leachate from disposal site	Soil pollution/Health impact – Leaks or leachate of contaminated spoils could cause soil pollution. It can affect public health through inhalation or ingestion. However, sediments to be dredged that will be placed in permanent disposal sites are not contaminated, hence, there is no risk for this. Even then, necessary measures will be implemented. Water pollution/Health Impact – Leaks or leachate of contaminated spoils can affect water quality through run-off or seeping down the aquifer. Dredged materials from identified locations particularly in the Red River are not contaminated.
Erosion at bank	Accidents to workers and damage to assets are the potential impacts when erosion in the river banks occurs. This may result to serious injury or death of workers or other people. Water transport, construction equipment, on-going works and facilities could be damaged when covered with eroded soil.
Flooding	Accidents to workers and people; damage to water transport, construction equipment, completed project structures, construction camps, access roads, bridges and trees – A flood that rises and falls rapidly with little or no advance warning is called a flash flood. They are usually the result of intense rainfall over a relatively small area. Streams and rivers periodically flood and the adjacent dry lands that are covered are called flood plains. The main cause of flood in the project area is heavy rain. Floods can damage and destroy property including water transport, construction equipment, completed project structures, construction camps, access roads and bridges. They endanger the lives of people and animals. Flooding currents erode the flood plains and carry and deposit sediment downstream. The habitat of fish and other wildlife are often destroyed. The financial losses due to flooding amounts to millions of dollars every year.

The safety management plan and Environment management plan will be followed to prevent, avoid and reduce the risk factors and to minimize the consequences on human safety and Environment using the appropriate protection means and action plans. The safety and Environmental management plans implemented during construction phase on Corridor 1 and Corridor 3 between 2012 and 2016 had proven that the risk level can be strongly reduce and controlled with adapted means of prevention.

Risks during operation phase

Upon completion of the project, transportation capacity of DNC has improved with busier traffic. Even if the risk of boats accidents in the canal is reduced because of the very low speed of navigation, it cannot be totally impossible. In this case, oil leaking from the boats tanks is the most sensitive risk.

In case of boats accident in the canal, the ship lock doors will not been opened and the traffic in the canal will be stopped during the time necessary to run an emergency plan for pollution control.

The other advantage of the DNC canal is that the water flow is zero when the ship lock doors are close, and it permits to maintain / confine the pollution in the canal, preventing a pollution dispersion in the Day or Ninh Co Rivers. The ship lock and canal management staff under the pollution control authority should use absorbing product and anti-pollution floating barrier.

Risks from Natural Disaster

The natural disasters and environmental incidents in the region can be considered a threat during the implementation and operation phases of the project. As discussed in Chapter 2, the natural disasters being experienced in the project area are as follows:

a) Storms and tropical Low Pressures
b) Flooding and Water-Logging
c) Sedimentation, Erosion and Land Slide
d) Drought and Hot Temperature
e) Earthquake

As explained in pages 47 to 49, the risk and safety management will be based on the following resources:

- **Staff**

The DNC lock will be operated by a team of 6 lock keepers to ensure the service 24h/24. This one opens and closes barrier systems, gates, and sluices for insuring the emptying or the filling of the lock and traffic of boats. It also switches the traffic lights to indicate to the boats they can enter or exit the lock. They communicate with the boats 'crews using a VHF radio, in a predefined channel reserved for river radio communications.

Lock maintenance is provided by a team of 2 mechanical technicians, and 3 electrical-and-control-systems technicians. Each technician of the team insures one-week-long 24h/24 on-call duty.

A lad is present only during working hours of the week.

A guard is present at working hours (from 5am to 21h). 2 people have this function. The operation staffs also include a secretary and a manager. The manager of the team can be joined 24h/24 in case of major event.

- **Safety and security**

Safety in the control is provided by different means:

The central PLC (programmable language controller) is computing data from sensors to check that there's no unsafe situation in the position of the different equipment (gate, sluices, barrier system).

The main risks are:

Risk identification	Risk reduction measures
A gate is trying to open while the other one is not closed,	1 specific relay controls that at least one gate is closed
A gate is trying to open while the water-level is not equal on both side of it	2 sets of analog water-level sensors are used to control the water level. If one set is out of service, during its repair, the process can go one with only 1 set.
The lock chamber is emptying while the upstream gate is not entirely closed	The "closed" position is checked by PLC from 2 different sensors
The lock chamber is filling while the downstream gate is not entirely closed,	The "closed" position is checked by PLC from 2 different sensors
The traffic light is put to green while the gate is not entirely open	The "closed" position is checked by PLC from 2 different sensors and traffic light are forced to Red if the gate is not entirely open
The gate is opening while the traffic light is GREEN.	The traffic lights are controlled by PLC with safe wiring: in case of a broken wire, the light is put to RED. The PLC receives information from the traffic light in case of leds dysfunction.

A specific contactor called "Main Power Contactor - MPC" (cf. annex diagram 5.5.xx) in the LV (Low Voltage) motors switchboard is controlled by the PLC to switch off the 400V~ energy to the motors. In case of a negative control made by the PLC, this one switches off the MPC contactor. The consequences are:

- Gates stop immediately and remain in position, brakes apply
- Barrier systems stop immediately and remain in position,
- Sluices stop immediately and remain in position.

Several Emergency stops are located around the lock chamber:

- near the upstream gate (right + left sides),
- along the lock wall, in the middle of the lock chamber length (right + left sides),
- in the technical room,

- in the central control room

These emergency stops buttons are controlled by the PLC and by a safety relay, that ensure that all equipment and all systems involved in the lockage process (gates, sluices, shock-absorbers) are stopped.

Safety in the process is provided by safety in the control (see above) and additional measures to reduce the risks that cannot be detected by PLC or control systems:

Risk identification	Risk reduction measures
The lockkeeper starts a cycle (that means select and validate: the gate begins closing), while a boat is entering the lock chamber	A fixed camera is installed closed to the gate and allows the lockkeeper to see the area around the gate 2 mobile cameras, one on each side of the gate are installed. They allow the lockkeeper to check that no boat is coming.
Risk of drowning in the lock chamber (sailors)	The lock filling and emptying duration has to be tuned to avoid too high turbulences in the lock chamber Life buoys are arranged around the lock chamber and can be thrown by the lockkeeper in case of drowning
Risk of having a fall in the lock chamber from the platforms (operating and maintenance staff)	Use of collective protections near the buildings and equipment (safe rails) Use of floating jackets in case of work near water.
Risk of fire on a boat in the lock chamber	This probability is very low. The access to lock is limited (see below – security) so that In case of fire on a boat, the lockkeeper: selects the cycle to allow the boat exiting the lock chamber In case of major fire, the lockkeeper: selects the cycle to allow the boat exiting the lock chamber leave the control room
Risk of fire in the technical room	Fire detectors are implemented in the different rooms (control rooms, offices) and in the technical room. The diesel generator is a source of risk because of the use of flammable liquid. To reduce the risk, it is located in a separate specific concrete box.

Security is provided by different means:

A fence is implemented all around the lock area to prevent unwanted access. Accesses to the different buildings are secured with an access control system, and a guard is present at the entrance of the lock during working hours (5h-21h), except night.

7. METHODS TO AVOID, REDUCE OR COMPENSATE NEGATIVE IMPACTS

7.1. PRINCIPLE OF IMPLEMENTATION

To minimize if not totally manage the major impacts of the project on the environment as determined in Chapter 3, analysis of appropriate mitigation measures was done and recommended in this Chapter. In the selection of measures to protect the environment, its technical and financial feasibilities were given due consideration. Analysis of alternatives was performed of which a copy is attached in this report.

7.2. MITIGATION MEANS TO AVOID, REDUCE OR COMPENSATE NEGATIVE IMPACTS

7.2.1. Preparation Phase

The impacts mitigation is due to land acquisition. Negative impacts due to land acquisition for the project are expected. The proponent and consultant will consider the State Regulations on compensation, relocation, and land acquisition. The following procedure will be complied:

- Land Acquisition and Resettlement Action Plan (RAP): The RAP has been prepared in compliance with the World Bank's Operational Policy on Involuntary Resettlement (OP 4.12) and Vietnam's laws and regulations. All mitigation measures including compensation, assistance and resettlement have been integrated in the RAP and implemented before commencing construction. The RAP needs to be approved by the Bank and PPC before implemented (see details in the RAP);
- Unexploded ordnance removal will be carried out in the construction area under PMU responsibility before any works would be done on site.
- Delineation and limitation of access (by fencing and information dissemination) to the construction area to prevent intrusion on land note covered by the RAP.
- The Land Acquisition Board will inform the affected people within the time frame the reason for land acquisition, the overall schemes for compensation, ground clearance and resettlement. After the decision on land recovery and schemes for compensations, ground clearance and resettlement have been agreed on and approved by the competent State Agencies and made public, the land holder must abide by the decision on land recovery or acquisitions.
- The Project-Affected Households will be compensated or relocated that will improve their living standard or at least the same with the previous condition.
- PMU will co-ordinate with Land Acquisition Board of concerned areas to set up schemes for compensation and resettlement which will be implemented before the commencement of the project.

To further lessen the impacts caused by relocation, compensation and land acquisition, advance activities were carried out in line with the State Policies, such as:

Compensation Principle

The compensation principle requires that persons with land to be recovered will be compensated with the assignment of new land with the same use. If there is no land to

compensate the affected landholder, a monetary compensation shall be paid based on the land use right value at the time of issuance of the land acquisition decisions.

Compensation for loss of agricultural land

Cash compensation for the lost land at 100% of replacement cost, AND Support for job change and creation in cash equal to 3 times the agricultural land price for the whole area of recovered agricultural land; the land area eligible for support must not exceed the land allocation limit in the locality.

Compensation Policy for residential land

Compensation policy for residential land under this project is as follow:

In case of land acquired without structures built therein, affected HHs get cash compensation for land at 100% of replacement cost of the land acquired to the legal/legalizable users;

In case HHs losing residential land with structures built thereon and the remaining land is sufficient to rebuild on (reorganizing HH), affected HHs get cash compensation for land at 100% of replacement cost of the land acquired to the legal/legalizable users; If HHs have to rebuild their main house, besides the compensation for rebuilding an equivalent house, the project will provide a cash subsistence allowance of the value of 30 kg of rice/person/months for duration of 12 months;

In case HHs losing residential land with structures built thereon and without remaining land sufficient to rebuild on (relocating HH). The minimum remaining size determining the relocation entitlement of DPs is not less than 30 m^2 for an urban area and 80 m^2 for a rural area. The HHs, who have legal or legalizable rights to the affected land or are compensated in cash for loss of land with at full (100 %) replacement cost and provision of relocation at new site at the amount regulated by local authorities.

The relocated DPs who use the borrowed land are entitled to as follows: compensation in cash to the land borrowers for their remaining investment that they had placed on the land, while the cash compensation for the acquired land area will be paid to the legal land users. The residential land use negotiation relationship between parties will be resolved on the civil basis.

Compensation Policy for loss of houses/structures

The HHs will be entitled to the following:

- Compensation in cash for all affected structures will be provided at 100 % of the replacement cost for materials and labor in accordance with the government's policy.
- If house/structure is partially affected, the project will provide a house/structure repairing cost, in addition, to HHs to restore it to former or better conditions.

- Compensation and assistance will be provided in the form of cash. No deductions will be made for depreciation or salvageable materials.

The calculation of rates will be based on the actual affected area and not the useable area.

Compensation Policy for loss of standing crops and trees

For annual and perennial standing crops, regardless of the legal status of the land, compensation will be paid to households who cultivate the land, according to the value of the affected crops and/or at replacement cost for affected perennial trees. Regarding the removable affected trees, the compensation will be equal to the transportation cost plus actual loss.

Compensation Policy for loss of Community assets

Policy of compensation for Loss of Community Assets are as follow: (i) Restoration of affected community buildings and structures to at least previous condition, or (ii) Replacement in areas identified in consultation with affected communities and relevant authorities, or (iii) The compensation will be provided at replacement cost without depreciation but includes deduction of salvage materials.

If income loss is expected (e.g. irrigation, community forest, community grazing land), the village is entitled to compensation for the total production loss. This compensation should be used collectively for income restoration measures and/ or new infrastructure.

Compensation Policy for Rehabilitation Support

Policies for rehabilitation support for those affected HH who lose a lot of agriculture land are as follow:

- A) If the HHs lose from more than 20% to 70% of their agricultural holding, then in addition to the item (1), they are entitled to a subsistence assistance equivalent to the market value of 30 kg of rice/person/month for 6 months if the HHs do not have to relocate to new place, and for 12 months if HHs have to be relocated;
- B) If the HHs lose from more than 70% of their agricultural holding, then in addition to the item (1), they are entitled to a subsistence assistance equivalent to the market value of 30 kg of rice/person/month for 12 months if the HHs do not have to relocate to new place, and for 24 months if HHs have to be relocated;

Affected HHs of (a) and (b) are provided one training course free of charge for those at labor age (15-59) if it is required. The labors of affected HHs may take the training course at any time during 3 years after the land is cleared.

Table 47: Number of affected HH by agriculture land getting subsistence support

Loss of agriculture land	No of DP will be received subsistence assistance		
	6 month	12 month	24 month
Loss from 20% to less 50% of land	100	10	
Loss from 50% to 70% of land	88	8	
Loss more than 70% of land		42	5
Total	**188**	**60**	**5**

Source: Statistic results of damages according to socio-economic survey in November 2015

Agree Policy

Series of public consultations were conducted to address the issues raised by the affected people particularly the compensation for loss assets. Documentations made during the conduct of public consultation are attached in Appendix.

The Compensation Policy Framework which is the most advantageous to people will be applied.

In the resettlement process of the NDTDP Phase 1, Client will closely coordinate with the local authorities and the Land Acquisition Boards will carry out the tasks identified above. To minimize loss on land acquisition, policy framework to be selected is the one that will be suitable to the local condition. Policy framework which is the most advantageous to people will be applied. The socio-economic condition of affected people will be thoroughly reviewed and will be considered as to what policy will be considered to suit each person or households affected by the project.

Reduce Poverty Risks

Households will be encouraged to use compensation payment in the most effective way. Local authorities will guide people to use this fund, especially farmers, women, and young people. It enhances the assistance of unions to reduce poverty risks and stabilize the socio-economic condition of affected people.

Reduce public/communities facilities impacts

Regarding impacts on public/communities facilities, PMU-W has conducted a series of consultations with different stakeholders, including Department of Transport, Department of Agriculture and Rural Development, Power Company, Irrigation management Company, EVN NPT, local authorities and local people on the project impacts and mitigation measures to resolving project impacts. Following is summary of mitigation measures, including compensation:

- *Do Muoi ferry*: Related parties (Nam Dinh authorities and local people) agreed to temporarily relocate the ferry 50m to the south along the left bank of the Day River. The relocation will be completed prior to construction, to ensure the operating

continuity of the ferry. After dyke construction completion, the ferry will be restored as before. Local authorities and people will select the permanent location for the ferry. All related works of relocation and construction of the temporary ferry will be done by the project's contractors. The cost of temporary relocation and permanent reconstruction of the ferry will be included in the contractors' package value and therefore falls under the project's cost.

- *High-voltage electric lines 110KV and 35KV on DNC*: Related parties agreed to relocate the electric lines before DNC construction. The relocation will be completed in the shortest time as possible to ensure power supply to factories and local communities. All costs related the electric line relocation will be covered by the project.
- *Provincial road 490*: The project will finance construction of a fixed-span bridge crossing the DNC canal to replace the lost road section. The bridge will be built before constructing the canal, thereby avoiding any impact on local road connectivity along road 490. All related costs will be covered by the project.
- *Dyke on the left bank of Day river and dyke on the right bank of Ninh Co river*: Parties agreed that reinforcement of affected dyke section will be timely done before flood season to ensure no risk occurred due to the project impact. All related costs will be covered by the project.
- *Irrigation system:* Parties agreed that a temporary irrigation system will be timely built before construction of the canal to ensure agriculture production of the farmers. The irrigation system will be restored to previous or better condition. All related costs will be covered by the project.
- *Inter-village local road and domestic electric lines:* Local roads and domestic electric line damaged by the project will be timely recovered to ensure living condition and production activities of local people. All related costs will be covered by the project.
- *Underground communication cable a long road 490*: The cable line will be relocate before commencing construction of the canal. A temporary cable may be used during relocation and the relocation will be done for the shortest time as possible to minimize interruption of local communication.

Clarify responsibilities of land acquisition agencies

i) Ministry of Transport (MOT)

Ministry of Transport is the governing body and Client for the "Project on the improvement of Corridor 3 responsible for making decisions to invest on projects like the improvement of Corridor 3.

ii) *Project Management Unit of Waterways (PMU-W)*

PMUW is the representative of Client for the "Project on the improvement of Corridor 3" and manage the payment of compensation for land acquisition (e.g. compensation, support for resettlement).

iii) People's Committees of concerned areas

The committees have the following responsibilities:

Take the lead in land acquisition in accordance with the current policies and regulations of the Government.

As representative of the client, they are responsible in making decision on land acquisition in the local area. They are tasked to appraise the unit price of land, house and crops affected by the project; to determine the resettlement alternatives ; level of assistance needed by families affected by the project; on-job-training, and ; designating land to households.

Guide concerned agencies to handle claims and complaints on compensation and support as mandated by the law.

Provide guidance and perform monitoring on how violations on compensation and support for resettlement is handled and resolved.

Land acquisition and Resettlement Board of concerned provinces (Phu Tho, Ninh Binh and Nam Dinh),

PMU will assign one staff member f to be the representative for Client in land acquisition by the People's Committee.

Respective Land Acquisition and Resettlement Board of concerned provinces will be responsible in the coordination works among Land Acquisition and Resettlement Board of affected districts.

vi) People's Committees of Project-affected districts

The Land Acquisition and Resettlement Board on the district level will be in-charged in the determination of the legality of land and its classification, the compensation alternatives and price for land within project area in accordance with the Vietnam policies.

vii) Compensation and Support Board of Project-affected districts

The District Compensation and Support Board co-ordinates with the Province Resettlement Board (or other consultants) to support People's Committees to prepare submit and implement compensation and support alternatives. They are in-charge of checking the accuracy and sufficiency of data in the compensation documents of districts to warrant approval of authorized agencies. They are obliged to carry out other tasks required by the People's Committees but not limited to the above works, the coordination with People's Committees of wards, communes, to conduct public information dissemination, suspend and prohibit construction within the acquired area, co-ordinate with Province PMU relative to the determination of land acquisition benchmarks and project benchmarks, structures and property limits based on the approved designs, and to determine exactly the number of structures and area affected by the project.

7.2.2. Construction Phase

Mitigation for impacts due to pollution

a) Integration of Environmental Management Concerns in Tender Document

The project management unit (PMU-W) of MOT in collaboration with the Consultant will prepare a Tender Document, incorporating the requirements for pollution prevention and

control in accordance with the Vietnamese Standards for environmental protection in all phases of the project implementation.

During the pre-construction stage, a Dredged and Excavated Materials Disposal Plan has been prepared with the assistance of Consultant. This is appended in this report and the provisions written in the plan will be included in the Tender Document.

b) Mitigation of Impacts on Air Quality

The construction work will require the use of motorized vehicles and heavy equipment for construction. These are mostly diesel fuelled which emits CO, NO2, SO2, hydrocarbon, lead and particulate matter. The contractor will have to ensure that all the equipment supplied for the project complies with the Vietnamese Government standard for vehicle emission (QCVN05:2009/BTNMT). Prior to deployment, the equipment owner will have to submit service records of the equipment and results of emission testing.

Work will be done mostly during the dry season and hence it is expected that bare areas will be exposed resulting to dusty condition. Dust suppression will be done especially if there are human receptors near the construction area.

Selection of alignment of temporary access roads will be taken into consideration the presence of residences. As much as feasible, temporary access roads will be in places that are unpopulated or sparsely populated. All vehicles transporting construction materials (sand, clay, cement, stones) will be covered to prevent dust dispersion. Installation and maintenance of mufflers on vehicles are necessary.

Concrete mixing plants will be located over 500m from the boundary of dense residential sites. Plant emission will have to comply with the Vietnam Standard for Air Emission (QCVN05:2009/BTNMT). Otherwise, plant will have to install emission control equipment.

Spoils stockpile area will be located away from residential areas to protect them from dust that may be generated by materials stockpile.

Compliance with air quality management will be one of the criteria for selecting equipment supplier and contractor. This condition will be stated in the Bid Document. As for staging areas, this will be specifically identified in the construction plan. This is the responsibility of the contractor.

c) Mitigation of Impacts on Surface Water Quality

Mitigation measures intend to minimize the negative impacts particularly the following:

- Decrease in quality of surface water
- Decrease aquatic habitats
- Selection of dredging methods

The level of turbidity generated by dredging is partly dependent on the type of dredge used. Experience with hydraulic cutter head shows that maximum concentrations generally remain less than 500mg/L and bottom suspended-sediment plumes are limited to within 500m of

the dredge (Havis 1988; LaSalle 1990) (DOER 2000). Mechanical dredging on the other hand can cause much more severe condition.

Mechanical dredges which generate suspended-sediments through the impact of the bucket on the bottom and withdrawal from the bottom, washing of material out of the bucket as it moves through the water column and above the water surface, and additional loss when the barge is loaded (LaSalle 1990). A suspended- sediment plume associated with clamshell dredging at its maximum concentration (1,100mg/L) may extend up to 1,000m on the bottom (Havis 1988; LaSalle 1990; Collins 1995).(DOER 2000). This type of dredging machine is only used in narrow area where other methods cannot be applied; hence it will be used selectively.

However, due to various quantity and topographical characteristics at dredging and bend cutting areas, it requires specific dredging and bends cutting alternatives for each area to optimize economic effectiveness and to guarantee environmental requirements. Re-alignment and re-profiling of the channels will be achieved mostly by cutter suction dredging within the Rivers or use of excavators and other earth-moving equipment for excavation of side banks and headlands. To minimize re-suspension and off-site transport of materials during dredging, several key mitigation measures will be implemented which include the following: "***During dredging, operator "best practices" are critical to minimizing impacts to the environmental quality of the waterway. The operators should ensure they minimize unnecessary bottom disturbance; do not discharge dredged materials beside the dredge rather than by pipeline to a disposal site; and do not over-dredge a channel section***".

For dredging areas, a maximum limit – based on upstream natural value of TSS or Turbidity and on VN standards is proposed. The TSS or Turbidity will be measured:

1°) Reference samples (natural value): 100 to 200 m upstream from the dredging area on 3 points (left side, middle, and right side) under 1 m depth. The mathematical average will be calculated as the upstream reference value

2°) Monitoring samples: 500 m downstream from the dredging area on 3 points

Maximum downstream value - 500 m downstream dredging area - must not exceed more than 100 mg/l of TSS / or 50 NTU the reference value measured upstream.

In case of exceeding, the dredging works will be reduced of 20% and new measurements, in the same conditions, will be organized.

If the NTU / TSS value downstream don't recover acceptable value, the dredging works will be again reduced of 50 %.

If the NTU/TSS value stays over the acceptable value, the dredging works must have to be temporary stop and the contractor will have to propose means of TSS/NTU reduction to respect the acceptable value.

Where shoreline sections above the waterline or headlands are to be removed by land-based excavation, a "berm" of material should be retained during excavation in the dry. This berm should not be removed by a dredge until all of the shoreline section or headland has been excavated to design depth and the exposed area is suitably clean and free of debris and detritus. The size of the berm should be minimized, but should be sufficient to constrain the river during the excavation process.

Where shoreline sections are small and will be removed by cutter suction dredge, it may be necessary to temporarily deploy a silt curtain to constrain loss of re-suspended materials during the site activity. Implementation of this mitigation measure will be a function of inspection and comment/advice by the Consultant – Site Engineer.

d) Mitigation measures for ground piling and groundwater quality

The site works should be carried out under an appropriate quality assurance and quality control (QA/QC) regime, which should be rigorously specified in the contract. This is normally the case with geotechnical and structurally significant aspects of piling and ground improvement; where dependent on the detail of the installation method a number of parameters are normally monitored.

In that case of potential environmental impacts, even limited, appropriate methods and measures for quality assurance and quality control will be considered specifically in the context of the avoidance and mitigation of the environmental impact. This is likely to result in a number of QA/QC procedures relevant to geotechnical and structural issues will also be relevant to environmental impacts. For example, poor workmanship in installation of non-displacement piles, which could lead to loss of load bearing capacity, could also lead to the creation of preferential migration pathways, where a pile is not in intimate contact with the surrounding soil.

It will be important that the environmental QA/QC procedures are rigorously specified and carried out according to the specification, and that those responsible for workmanship are made aware of the reasoning behind the required procedures. Ignorance of the need for these procedures may lead to omission.

Beside the measure related the quality of works, a survey will be done at the closer well located at downstream part of the site. The quality of water here will be controlled weekly with a procedure included and fully detailed into the Environmental Management Plan.

Mitigation of Impacts on Aquatic Life

Timing of Dredging Activities

For protection of Corridor 3's aquatic life, timing of dredging should consider the known seasonal biologic processes. The seasonality of the known biologic processes is enumerated in the chart below (Tab 78).

Most of the potentially environment sensitive processes takes place during the flood season. From this information, this period corresponds to the natural high level TSS/turbidity on Ninh Co and Day River.

The meetings with local fishermen confirm the importance of rainy season for aquatic activity in Red River with an important increase of fish's density and activity.

But for the crustacean (shrimps, crabs), the most important period is from June to October.

So the period with the lower level of biological activity is from November to April. But during this period, the natural level of TSS/Turbidity in the rivers is lower than in the rainy season.

A balance between biological activity and water quality need to be search.

Prior to dredging, an assessment of biological activity relative to water quality will be undertaken, to ensure civil works are undertaken to ensure minimal impact on aquatic life.

Table 48: Matrix of Season and Documented Seasonality of Biologic Processes 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 Zoo benthos												
Reproductive season, Squaliobarbus curriculus (Long Huang Gua et al. 2004)												
Reproductive season freshwater shrimps & crabs (Dudgeon 2000)												

To mitigate possible impacts on aquatic life, it is proposed:

- Dredging close to the bank and on wetlands (most important places for aquatic life) and on spawning areas should be carried out between October to May, avoiding the peak of biological activity of the flood/rainy season.

- Dredging of the center of the channel can be done throughout the year but, during the dry season, contractors must take into consideration that the TSS/turbidity level downstream the dredging areas will be very lower than during rainy season.

Ecological Bank protections at DNC

The mineral or heavy bank protection based on rocks, concrete and similar technologies from civil works engineering can cause important damage to ecological function of the river.

The alternative technologies are assessed based on thirty years of international experience in ecological engineering and use of the vegetation capacities to fix the river banks materials and to protect it from erosion. On specific cases, these techniques can be mixed with classical bank protection to propose a larger scale of possibilities.

Consultant proposes to design of some bank protections using ecological engineering. These techniques are based on the plants system roots capacities to block the erosion. It can be used alone or mixed with classical bank protections techniques like blocks for example. Ecological engineering on in-land waterways from more 20 years have developed numerous projects in France and worldwide.

These “ecological technologies” have also been developed in Vietnam on different projects by other companies, mostly with Vetiver plantation which can grow on dry areas or

wetlands. These technologies permit to stabilize banks but also to restore natural conditions favorable for river ecosystems. Depending on the plants used, they can also add economic value to natural resources or livelihood enhancement possibilities for local people.

Figure 80: Vetiver River bank protection in Vietnam against flash floo

Ecological and Mixed Banks protections are proposed on DNC canal.

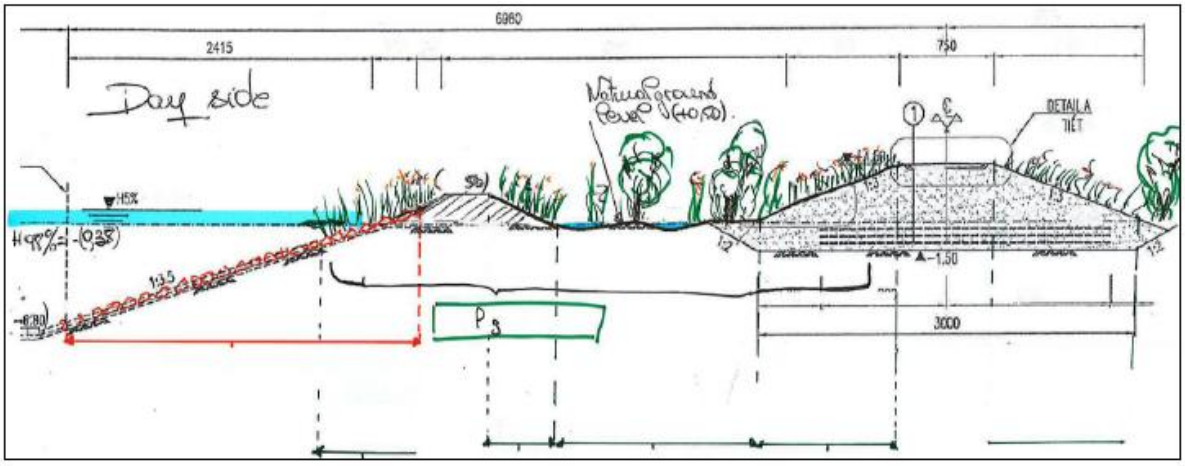


Figure 81 : Cross section of Ecological protection bank proposed for DNC Canal.

The following figure shows the results of the existing ecological technology adapted to large inland waterways. The example below was implemented on the Southern Rhône River in France in the end of the 90s'. After 2 years, the vegetation was covering the rip rap and a new ecosystem was present. The biodiversity was recovering. The monitoring done on this area shown up to 50 % of biodiversity (fishes, birds, insects, batrachians and of course vegetation) increasing compared to classical mineral bank protection.

On DNC banks it will permit to restore / create around 9 ha of natural habitats.

Ecological bank protection during construction
(CNR – Rhône river 1998)

Ecological bank protection 1 year after construction
(CNR – Rhône river 1999)

Ecological bank protection 2 year after construction
(CNR – Rhône river 2000)

Figure 82 : Example of ecological bank protection on Rhône River Waterway (CNR – 1998-2000).

Mitigation of Impacts of Spoil Disposal

Providing environmental protection on dumping of spoil is aimed at mitigating negative impacts below:

- Decreasing quality of surface water;
- Decreasing quality of ground water
- Impacts to elements of the terrestrial and built environments.

Evaluating alternatives and selecting disposal sites

As part of environmental management, a materials management plan needs to be prepared by the dredging/excavating consultant. The should contain, among others, containment plan, lists of possible disposal sites, permanent and temporary, persons or projects that may have demand for fill materials or construction materials, private land stages are willing to accommodate or taken on clean sediments.

Management of dredged and excavated materials shall be dependent upon the quality of the material. There are various options for disposal of dredged material and the recommended methods for particular quality of spoils are listed on Table 50.

Implementation of the Dredged and excavated Materials Disposal Plan

During the construction phase, the contractor with the supervision of the proponent and consultants shall implement the Dredged and Excavated Materials Disposal Plan as attached in this report.

Appropriate technique will be employed during the disposal of dredged and excavated materials.

From the dredge, a pipe will be used to convey the material in the selected disposal site while in some areas; both the pipe and a barge will be used.

From cohesive materials, excavated or dredged, the purpose will be to reduce the water quantities and minimize the impacts. The possible methods can be to transfer the materials by boats (for important quantities with access on the river) or by trucks (small quantities of difficult access from the river) to the disposal areas.

The details of the methods are described in the DDR but will be adapted on each site conditions with the contractor. The impact in the surrounding environment will be minimal.

Table 49: Management of Dredged and excavated Materials according to Quality

Highly Contaminated	Moderately Contaminated	Lightly Contaminated	Clean Sediments
Landfill at controlled sites (silts and clays)	Land reclamation (capped)	Land Reclamation	Land Reclamation
	Landfill (capped)	Land Improvement	Landfill (capped)
	Replacement Fill (e g. mines) silt and sands	Habitat Creation (capped)	Land improvement (sand and silt)
		Construction (cleaned sand)	Habitat creation
		Beach Nourishment (sand)	Saltmarsh protection /regeneration
		Inter-tidal mudflats (silts. sand)	Construction (sand)
		Sea defense	Beach Nourishment
		Coastal Protection	Inter Tidal Mudflats (silt,. Sand. Clay)
			Sea Defense
			Coastal Protection

Mitigations of impacts on transport at DNC

Because the Project involves a significant scope of activity at any one site, whether on the river or on land, there will be numerous pieces of equipment, machinery, associated supplies and workers. Use of available road routes and navigation channels is necessary. As soon as possible after receiving approval to proceed and obtaining management of a site, the boundary of the construction site must be identified and signs installed, especially at material storage and components yards. On the river side, appropriate signs and navigation aids should be placed to define the navigation channel area and ensure navigation safety. It is critical to keep vehicles from illegally entering the construction area.

With respect to the roadways, the contractor will coordinate with the Client and supervision Engineers, as well as traffic police to ensure traffic safety is maintained on relevant areas of local roads.

With respect to work in the Rivers, the contractor will coordinate with the Port management agency, the River management sub- stations and the River management stations on the construction area to ensure navigation safety in relevant areas of the river.

The first priority for the Contractor should be to ensure traffic safety in and outside the construction locations. It is important to ensure shipping and road vehicles are not inadvertently diverted to non-traffic areas or involved in accidents.

As appropriate, construction site signs should be posted at roadside, as well as within and along the river, including appropriate navigation aids. Signage should be posted in any area of operating equipment or construction activities. Speed limit signs should be posted for all vehicles passing the site.

At any construction site entry and exit location, there must be a traffic control flagman to control passing vehicles.

Construction vehicles will use material cover to ensure there is no accidental spillage of materials from equipment. All materials will be handled, unloaded and stored according to regulations. As soon as a site activity is completed, the site will be fully cleaned and no debris or garbage should be left.

Construction vehicles will avoid operating in peak hours of traffic. The Contractor will always check the traffic situation and implement measures to minimize traffic congestion in and out of the construction site area.

The Contractor will coordinate with regional traffic police and River management stations to regulate traffic properly during the construction process.

Any roads, particular smaller local roads should be regularly maintained, repairing damages caused by construction vehicles so as not to affect public transport.

All vehicles and vessels should strictly follow road and river traffic law.

Construction vehicles should be properly maintained to meet conditions of technical and quality requirements, as well as operational safety. Damaged or non-operating equipment and vehicles should be repaired appropriately.

With the project, the circulation of waterway vehicles in the alignment will be aggravated if not managed properly. Additional measures below will be implemented during construction phase in about 36 month period.

The impacted/relocated existing ferry will be able to adapt its location to ensure the service as close as possible from the access road upstream or downstream. The disruption will mainly concern a changing in the way to approach the ferry by road and change from a certain distance (from 500 m to 1 km) the access to the ferry.

PMU-W has consulted the Department of Transport in Nam Dinh province and local authorities on the project impacts on Do Muoi ferry during construction of DNC. The related parties agree to temporally remove the ferry 50m to the south along left bank of Day River. The relocation will be completed prior to construction to ensure the operating continuity of ferry. After dyke construction completion, the ferry will be restored as before. The local authorities and public will not have to pay any ferry relocation related cost. Local authorities and people will select and consult on new location for the ferry. All related works of relocation and construction of the ferry will be done by the project's contractors. The cost for ferry relocation and construction is under the project's cost.
Currently, the technical plans for relocation and new construction to Do Muoi was provided by Design Consultant and has been approved by MOT.

Regulation, Control and Instruction Unit (or Traffic Management Unit)

Establish the Traffic Control/Management Unit to be in-charge of regulating the flow of waterway transport in the construction area to promote safety to the public. Traffic Control Stations will be designated. The selection of station will be decided between the contractors and the navigation control administration before the implementation of the work.

The tasks assigned to the Regulation, Control and Instruction Unit are enumerated as follows:

Issue notices to concerned parties relative to the waterway safety regulations

Duty will be in three (3) shifts/day to regulate, limit, control and instruct the concerned operators of waterway transport and equipment on the designated route.

Patrol regularly the entire alignment to control the traffic situation and promote safety among construction workers and the public.

Implement transport regulations.

Coordination with construction units to ensure waterway transport safety during the construction.

Organize weekly meetings with construction units to catch the construction progress in order to have a suitable transport assurance solution.

Regularly check, acquire and summarize the waterway transport changes in the alignment and area.

Coordinate the stations in 24 per 24 hours to inform the transport situation in the alignment.

Selection of the construction method

Considering the section for channel re-profiling, backhoe excavator will be used for digging and truck or barge will be used to transport the spoil into the disposal sites.

It is also done in bend cutting sections with extended construction sections (dig from the middle out) and soil is not directly filled into the old channel. This will ensure the use of navigation channel while there excavation being done in the section of the alignment.

Pumping and cutting equipment will be used in dredging works. Before construction, buoys and pipelines will be properly installed in such a way that it will not obstruct the navigation route . The equipment will be anchored to the right position and located within the extent of the buoys.

The access in the navigation route is ensured for each construction section by the Management Unit.

The construction will be done in the East half (left bank) first, then in the West/right bank by each construction section.

Shown in Figure 83 below will be one of the strategies to be employed when it comes to equipment orientation during channel re-profiling.

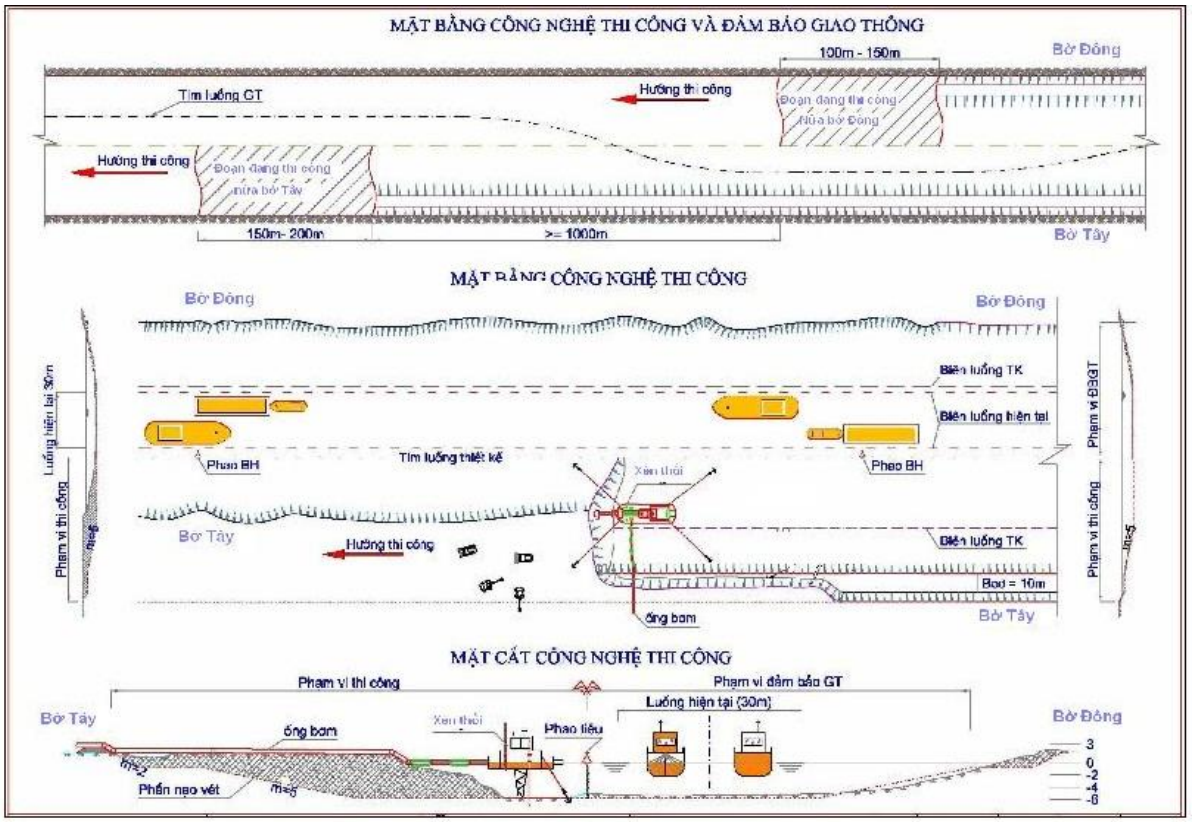


Figure 83: Dredging methodology Orientation

Source: Corridor 1- Detailed Design Report - EGIS, August 2008

Technical Management

Qualified manpower will be hired. Inspection of the works will be done closely to minimize problems, to address immediately the project-related concerns, to ensure employment of appropriate construction methodology and to ensure quality works.

Equipment to be used in the works will be in good working conditions. All equipment will be checked periodically, maintained and repaired as necessary. The equipment specifications and efficiency will be in accordance with the Law on Inland Waterway Transport. Overloading will not be allowed.

Mitigation of Impacts of Wastes

Various kinds of wastes will be generated during the implementation phase of the project. It could be in solid, in liquid or in gaseous form. The wastes could be recycled, non-hazardous/non-toxic or hazardous/toxic. Handling or treatment and disposal of wastes depend on the above classification and accordance with the existing regulations.

Management of Wastes

Contractors will be required to prepare respective Wastes Management Plan. The waste management hierarchy that will be followed is presented as follows: waste minimization or

reduce at source, segregation, recycling, treatment and disposal. A team will be organized to manage the handling of wastes.

Solid Wastes

Construction camps will employ Wastes Management Plan. All materials that can be re-used and recycled e.g. waste papers, carton boxes, plastic wrappings, used tires, used equipment spare parts and others, will be segregated and sold to contract buyers.

Other domestic solid wastes expected to be generated per day per camp is approximately 140 kg/day. Each construction camp will be provided with three (4) garbage bins:

- **Organic wastes** (food/vegetation) will be given to the local people for use as animal feeds.
- **Reusable materials**: wood, metal, etc. Will be store separately and collection will be organized for economic valorization;
- **Plastic (bags and materials)**: will be separate and store separately. Collection can be organized with local people who can earn money from it or use industrial collection and reuse for energy;
- **Residual wastes** that cannot be recycled or re-used will be collected and disposed into official landfill or waste treatment center through a private or public contractor.
- This will help to cut down the cost for transportation rental while it ensures the collection and treatment up to 70 - 80% of solid waste produced each day by the workers.

Wastewater

Other possible sources of pollutants from construction camps are wastewater from the workers' living quarters. To prevent contamination from these sources the workers' quarters should be provided with sealed septic tanks.

Latrines will be also provided as temporary sanitary facility of workers in the construction site. The quantity of latrines needed in each construction camp with more than ten (10) workers will be two (2) mobile latrines. A contract will be made with the private contractor for periodic suction and disposal of waste into the landfill or for treatment e.g. composting to convert it into fertilizer.

The septic tanks rejects must be design to guarantee sufficient flow evacuation and avoid stagnant water because of sanitary risks.

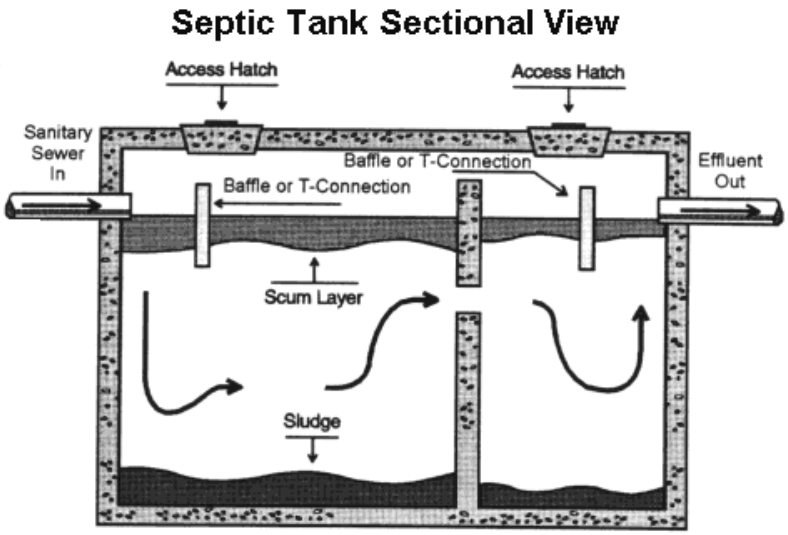


Figure 84: Block diagram of a septic tank

Figure 85: Picture of a rustic septic tank

Hazardous Wastes and Spillage

Hazardous wastes (spent solvents, used lubricants or used oil) will be stored in Government-approved containers and stored within bermed areas to limit dispersal of any spilled product. The services of an accredited hauler and treatment will be employed when there is enough volume of such materials to be discharged.

Possible water or soil contamination due to spillage of lubricants, fuel from equipment, repair yard and fuel depot will be prevented by providing impervious flooring and containment wall. The floor sump will be provided to collect oily wash water and to allow separation of solids. With such protection installed, the dredging and excavation contractors will still be required to maintain suitable equipment, booms and other clean-up supplies to respond to spills or leaks. All land-based equipment will be fuelled and serviced in the appropriate area.

The Project Environmental Protection and Implementation Plan will provide detailed instruction on reporting, clean-up of spills and general response procedures. These will be also detailed in the general operating requirements pursuant to various dredging contracts.

Figure 86: Latrines for Workers and Covered Construction Materials

Restoration of Land Occupied temporarily by Construction Camp / Staging Area

The use of the construction camp/staging area is only temporary, hence, at the end of construction period, the land will be returned to the landholder who can then resume the former productive use of the land. As such, the contractor will remove all equipment, structures, rubbish and obstructions and restore the land to its condition prior to use for construction. Contractors will be required to include the above mitigation measures in the EMP.

Livelihood restoration programs

Beside of compensation and allowances provided for households and individuals losing productive land and directly involving in agricultural production, a livelihood restoration program will be provided to severely affected households to help them have more opportunity to get new jobs to restore and/or improve their income and livelihood. This program will be prepared during project implementation by conducting a need assessment and consultation with affected households and other stakeholders in localities. The program should include specific rehabilitation activities, budget scheme, responsible agencies/persons, timeline and monitoring and evaluation. An agriculture extension program will be also provided for affected farmers who have the remaining agriculture land viable for continue cultivation. They also receive seeds, young trees, breeders, fertilizer and technical support, according to the Land law 2013. Support for vocational training and/or job creation for labourers whose land is acquired will be followed Decision no. 63/2015/QD-TTg of Prime Minister.

PMU-W will recruit livelihood specialist and social development specialist to conduct need assessment and prepare the LRP. The LRP needs to be reviewed by the Bank and updated in the RAP before implementation. Periodical monitoring on implementation of the programs must be included in internal and external monitoring reports and submitted to the Bank. All costs for above programs and supports are covered by the project.

Relocating ferry: Related parties (Nam Dinh authorities and local people) agreed to temporarily relocate the ferry 50m to the south along left bank of Day River. The relocation will be completed prior to construction to ensure the operating continuity of the ferry. After dyke construction completion, the ferry will be restored as before. Local authorities and people will select the temporary location for the ferry. All related works of relocation and construction of the temporary ferry will be done by the project's contractors. The cost for ferry relocation and construction is under the project's cost.

Mitigation of Impacts on Health and Safety

Mitigation of negative impacts on workers' 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 goggles;
- 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;
- Sanitary facilities shall be available in the 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.

Mitigation of negative impacts on community health

Protection of public health and safety will 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;
- Disposal sites of contaminated spoils shall also be off-limits to people. An IEC will be implemented to inform the host community of such activity and warning signs will be posted.
- Health screening will be done for workers to prevent spread of disease to the host community;
- Use of illegal drugs shall be strictly prohibited in the construction site to prevent spread of HIV disease and other possible social problems.

For navigational safety, the dredging works will be announced in the Notice to Mariners so vessels will be forewarned of the presence of the dredges. The dredges should have the necessary navigational lights and signals. Fog is known to occur in the Red River delta and the dredger's crew should be aware of this.

The implementation of programs to protect occupational health and safety as well as public health and safety is the responsibility of the Contractor.

Safety and Fire Prevention Plan

During construction, Contractors must strictly follow safety standards according to TCVN 5308 – 91. Specifically:

Waterway safety (Regulations on signals and signs for inland waterway 22TCVN 269-2000).

Road safety.

Safety in operation of a disposal site;

Implement safety protection measures required for waterway activities.

No activity should affect operation and safety of waterway during a construction period.

Ensure that all works, equipment and installed machinery does not result in dangerous conditions for the waterway and roadways.

All tasks and activities are planned and coordinated according to requirements from the Project Manager.

The Contractor should always implement instructions from waterway and road authorities.

Follow safety regulations on fire/explosion prevention.

Before starting works, Contractors must conduct worker safety training and disseminate safety regulations to all staff and workers in the construction site.

Contractors must assign one staff person specialized in work safety with sufficient experience in construction site safety. Safety staff should recommend on issues affecting workers' safety and propose measures to increase safety in construction.

All equipment, vehicles operating in the construction should be registered and have operational permits. The Contractor should ensure all vehicles are functional and maintained regularly.

Signage should be placed in the area of construction site and disposal sites.

Dredging locations should be fully identified and traffic controlled using buoys and lights to ensure vessels can operate. It may be necessary to set up a temporary fence or berm to limit spreading of disposed sands/mud and signs should be posted to limit entry of people.

The Contractor should regularly ensure anchored vessels and other equipment do not impede passing vessels.

All anchored vehicles must be located, with appropriate safety equipment according to current regulations and instructions.

All barges to transport dredged materials, tug boats and other vessels related to dredging will be equipped with signal light while anchoring and moving on the river, following strictly Government Circular No. 40/CP on waterway traffic safety.

Workers safety

All work site conditions will strictly follow Law of Labor, Ordinance of Labor Protection, and social insurance regulations. The Contractor will buy and maintain accident insurance for laborers.

All workers on site should be trained and strictly follow safety regulations. Staff should fully implement the slogan "Safe to work, work safe".

Contractors are responsible to develop safety rules and procedures for laborers during for construction. The Manual of rules and procedures will be submitted to the Consultants and Client to review and approve before carrying out construction.

All staff must learn and understand approved safety procedures. The Contractor should ensure all workers follow these safety procedures when constructing civil works. All staff must be equipped with proper Personal Protective Equipment (PPE) such as hardhat, gloves, insulated shoes, eyes protection glasses (for welders), toxic/dust proof gauze mask (for cement porters), etc. to avoid accidents.

Contractors must assign experienced staff and specialized safety staff equipped with warning signs, warning tape and other equipment to identify dangerous work areas.

Contractors must arrange signs and remind workers to maintain safe working practices in all locations.

For a construction site, there must be a medical station, first aid supplies and medical officers with appropriate professional certifications to treat people in time in case of accidents or sickness.

There must be adequate equipment to respond to safety or fire protection requirements and this equipment must always be ready to respond.

All construction vehicles on the water must be equipped with life buoys/rings that are regularly checked to meet regulation.

When working the night shift, there must be sufficient light to ensure proper and safe working conditions.

Facilities and Equipment Safety

Contractors must build a temporary fence to protect the site with security guards present 24/7 to ensure site security, protect equipment and keep unauthorized people out of the site.

The Contractor should prepare protocols and procedures to protect the general and area environment, machinery and other equipment during the course of construction.

The Contractor should carefully check the anchor system of the vehicles and signal systems such as floating beacons, signs, and signal lights both on the river and on shore.

The Contractor should develop regular maintenance and repair schedules for equipment and implement as required.

All equipment and machinery should be operated according to instructions from manufacturers.

Any lifting equipment and cranes should be located on the ground with solid structure or on a floating system with sufficient pressure bearing capability, be stable and be anchored by firm anchoring system.

All equipment operators must be trained properly and possess appropriate certifications.

The Contractor should ensure social and public security within the site as well as nearby areas. Measures must be taken to manage staff and workers including registering temporary staff with local police.

The Contractor should regularly coordinate and cooperate with authorities and functional agencies to ensure public security on the site.

Contractors must possess the following types of insurance:

- Insurance for all risks in construction
- Insurance for laborers
- Insurance for responsibility of the third party
- Insurance for vehicles, equipment
- Other insurance as required by the contract

Site Safety

Transferring, handling and storage of equipment and supplies will be conducted carefully during construction; ensuring items are able to bear weights and are not affected by components under construction or still to be built.

Before removing formworks and supports for concrete components, the concrete quality will be tested by sample or other methods accepted by Consultants.

Avoid accidental hitting of materials or civil works during crane operations.

Waterway vessels must not anchor or tie-up to site works during the course of construction.

Any rebar or other internal structural components should be selected so as to not affect the appearance of the works, the pressure-bearing capacity and anti-corrosion capacity of the works.

When floods or storms occur, all works will be supported and protected properly. Bank protection or temporary road sections must be secured and covered properly.

Electricity cables serving construction and living purposes will be covered and located in appropriate locations, unaffected by working equipment.

At working locations, ground wire and automatic circuit breakers must be installed.

Electric cables must be selected to have sufficient handling capacity.

Joints of electric cables must be appropriately joined and sealed with insulated waterproof materials.

Electric equipment will have signs, ground wire and appropriately shielded. The Contractor should strictly follow TCVN 4086 “Electricity Safety in Construction – General requirements”

Mobile fire extinguishers will be placed, strictly following regulations on fire protection for vehicles, equipment with fire risks. Activities at a site must be organized according to TCVN “Fire safety – General requirements”.

The Contractor will frequently check technical and operational specifications of all machinery both directly and indirectly taking part in activities of the site. To ensure safety for workers, all machinery and equipment will be operated in a safe manner, following safety regulations.

Mitigation of Hazards Due to the War Residues

The PMU-W will cooperate with an experienced unit of the Engineering Corp of the Ministry of Defense to seek assistance in the investigation of the project area. This follows the removal of all residual materials (bombs, mines) found during the site survey. After the war, the area of the NDTDP is being used for agricultural purposes or for crop cultivation. The residual explosive materials may not be present in the topsoil layer, however, there could be a possibility that some explosive materials are on deeper layer. To fully accomplish the work, it will take some months; hence, the time element will be considered as early as the planning stage of the project.

Archeological Findings

The history of Vietnam is one of the longest to be found in any country, with archaeological excavations revealing a past that goes back almost as far as earth's recorded time. Archeological findings should be reported to the National Museum or the Institute of Archaeology in Hanoi in the event it is found in the project area.

All contracts will include a Chance Finds Procedure clause so that all the Contractors will be responsible for familiarizing themselves, their staffs and there sub-contractors with the following "Chance Finds Procedures", in case culturally valuable materials are uncovered during excavation, including:

- Stop work immediately following the discovery of any materials with possible archeological, historical, paleontological, or other cultural value, announce findings to project manager and notify relevant authorities;
- Protect artifacts as well as possible using plastic covers, and implement measures to stabilize the area, if necessary, to properly protect artifacts;
- Prevent and penalize any unauthorized access to the artifacts;
- Restart construction works only upon the authorization of the relevant authorities.

7.2.3. Operation Phase

Mitigation of impacts on transport activities

In order to mitigate the impacts on transport activities during the operation of the project, the quantity of the existing navigation aids will be maintained with additional ones to be installed. Its objective is to improve the efficiency of the existing system and further enhance safety in the waterway.

The new installations or additional navigation aids to be installed was designed based on Vietnam Waterway Signal Code - 22TCN269-2000

Based on site survey, the quantity of the navigation aids along the Ninh Co and Day rivers + estuary, complementary navigation aids will be installed following the DDR recommendations.

The Contractor is responsible for familiarizing themselves with the following "Chance Finds Procedures", in case culturally valuable materials are uncovered during excavation, including:

- Stop work immediately following the discovery of any materials with possible archeological, historical, paleontological, or other cultural value, announce findings to project manager and notify relevant authorities;
- Protect artifacts as well as possible using plastic covers, and implement measures to stabilize the area, if necessary, to properly protect artifacts
- Prevent and penalize any unauthorized access to the artifacts
- Restart construction works only upon the authorization of the relevant authorities.

All contracts should include a Chance Finds Procedure clause

Mitigation of Impacts on Air Quality

The MOT, PMU-W in coordination with the MONRE should strictly impose the Vietnamese Standards on Ambient Air Quality and the implementation of the existing policies relative to air emission control. Low-sulfur fuel is another option MOT could require the waterway transport owners/operators to use.

Mitigation Impacts on Erosion and Deposition

Included in the NDTDP Phase I is the installation of navigation aids and advisory/signs. These should include speed limit and other public advisory for the protection of erosion and deposition. The Investor should allocate budget for the regular maintenance of soil erosion protection structures including tree planting. Tree planting in the disposal sites, to river banks with no river training structures and other available areas will be considered.

The MOT, PMU-W in coordination with the MONRE and other concerned agencies will consider the formulation of Zoning Ordinance to regulate settlements along river banks. This could lessen soil erosion and water pollution.

Mitigation Impacts on Water Quality

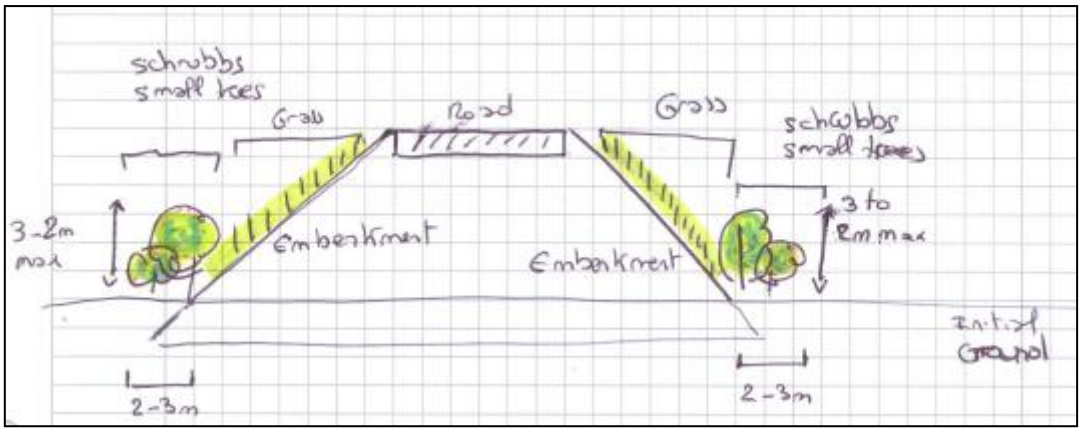
Discharge of oily bilge water and wash water from the vessels cause water quality degradation. The situation is aggravated by the disposal of solid waste in the river , which at the same time cause impairment of the aesthetic quality of the river. Propeller wash, specifically in shallow river ways, can cause re-suspension of sediments in the water column. To police such practices, the MOT, PMU-W in coordination with the MONRE should strictly impose the regulations relative to waste disposal in the water bodies. Operators and owners of water transport should be provided with seminars/training for them to be aware of the negative impact of such practice.

Mitigation Impacts on Protected Areas

There are no protected areas within the vicinity of the Project.

Propositions to improve the Sustainable Development of the project

1°) Grassing and shrubs / small trees planting on Road Embankments



- Length application: 1000 m on each side of the (southern) embankments = 2000 m long
- Average surface for grassing : 10 m² / 1 m long of embankment
- Total surface to be grassed: 20 000 m² (2 ha)

Length for trees/scrubs plantations: 2000 m x 2 m width = 4000 m²

Benefits for sustainable development:

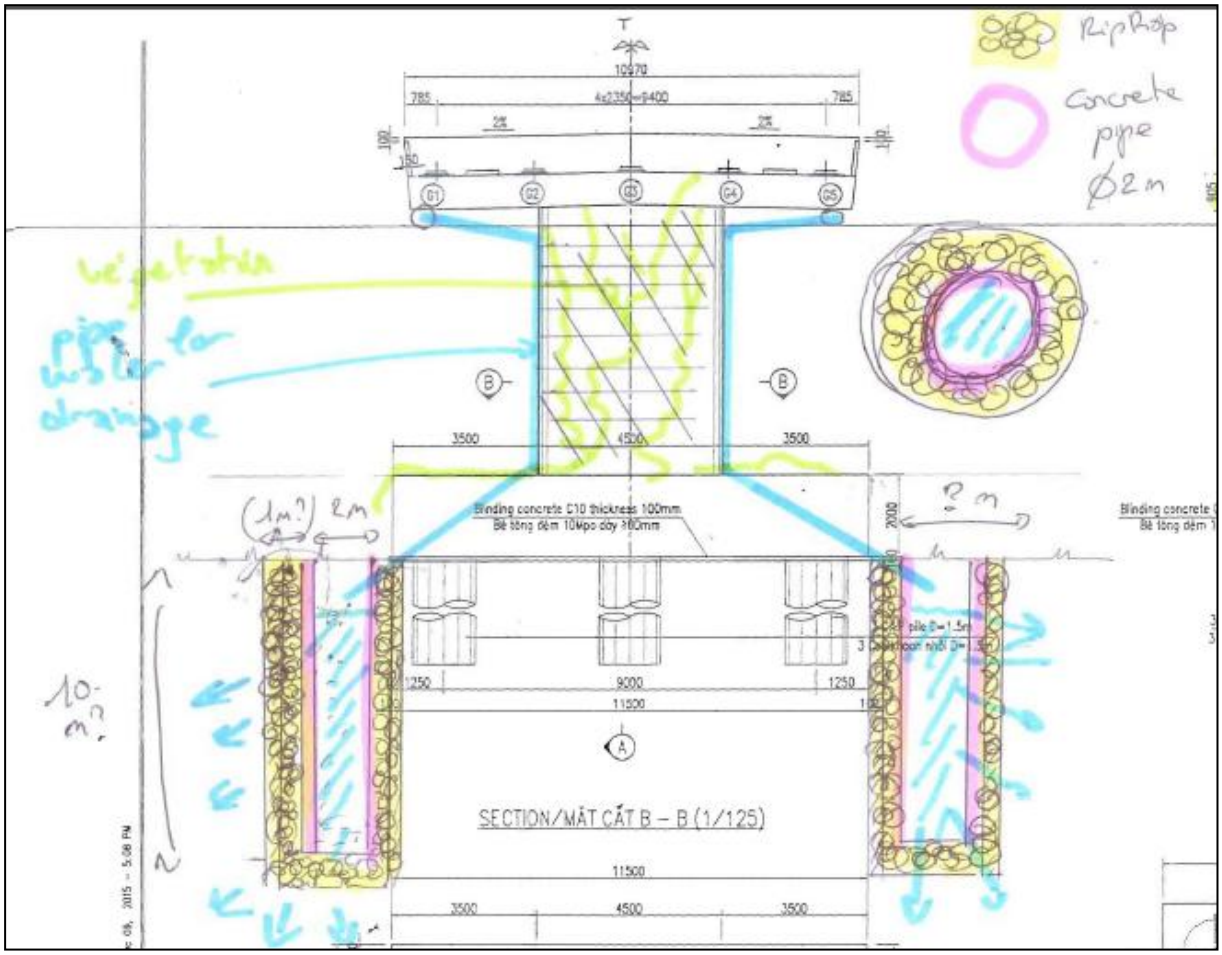
- Better Landscaping
- Ecological integrations
- Ecological corridor
- C02 catchment and 02 productions
- Limitation of rain erosion on the embankments and at the base of embankments
- Use trees that produce fruits will permits incomes for local people (harvesting fruit) and help to prevent tree cutting for wood.

Additional Cost estimation

Grassing: 2ha

Tree/scrubs furniture and plantation: 1tree / m² = 4000 trees for 4000 m².

2°) Bridge Rainy water management ➔Drainage, Infiltration and ground filtering system

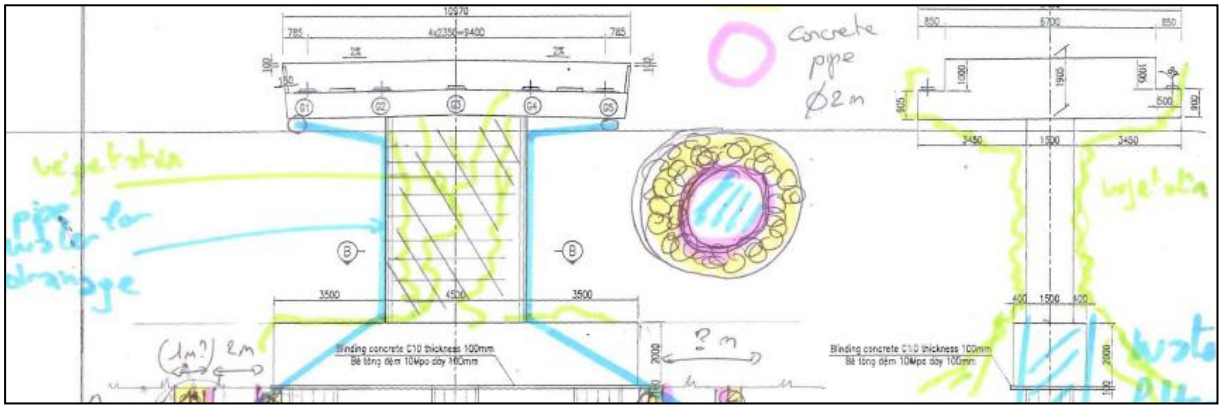


- 2 water drainage – Infiltration – ground filtering rainy water from the bridge for each pile
- (2 x 18 piles = 36 infiltration / filtering system along the bridge)
- Drill hole (10 m deep – 3 m diameter)
- Vertical concrete pipe (2 m diameter)
- Rip Rap around the concrete pipe
- Add a cover with lock on the hole prevent falling and add ladders inside the system in case of some fall.

Benefits for sustainable development:

- Permits to improve the water drainage from the bridge
- Reduces the pollution dispersion by the rainfalls
- Permits to infiltrate the rainy water and to use the soil/ground capacity of biodegrading on oil/petrol pollutants = ground filter
- Prevent / reduce direct outlet of pollutants (from road traffic) to the fields

3°) Vegetation growing on bridge piles



- Fix metallic or bamboo grids on the 2 larger face of the piles
- Plantation of creepers (climbing plants) / lianas and make them climbing on this 2 face
- (One part of the drainage water can be use for watering the plants if necessary)
- Plants species to be choose by the detail design
- 18 piles x 2 faces x surface of each pile = ~500 m²

Benefits for Sustainable development:

- Better Landscaping
- Ecological integrations
- Ecological corridor
- Participate to C02 catchment and 02 productions
- If plants produce fruits = incomes for local people

Additional Cost estimation

- 36 grids +fixation on the piles
- Plants furniture and plantation

Similar approach can be imagined for the retaining wall of the road/bridge:

8. PUBLIC CONSULTATION

The public Consultation is a part of Environmental Impact Assessment for the project. The public consultation is conducted with the cooperation of representatives of the Client, environmental consulting, local government and communities in the project area. Public consultation results will be used to evaluate design alternatives, proposed mitigation measures and express the support of the community during the process of project implementation. A first public consultation was organized in 2012 on the DNC initial project. After the preliminary design of the road relocation and crossing bridge, an additional public consultation was organized in 2015 in the 2 communes concerned by the road and bridge.

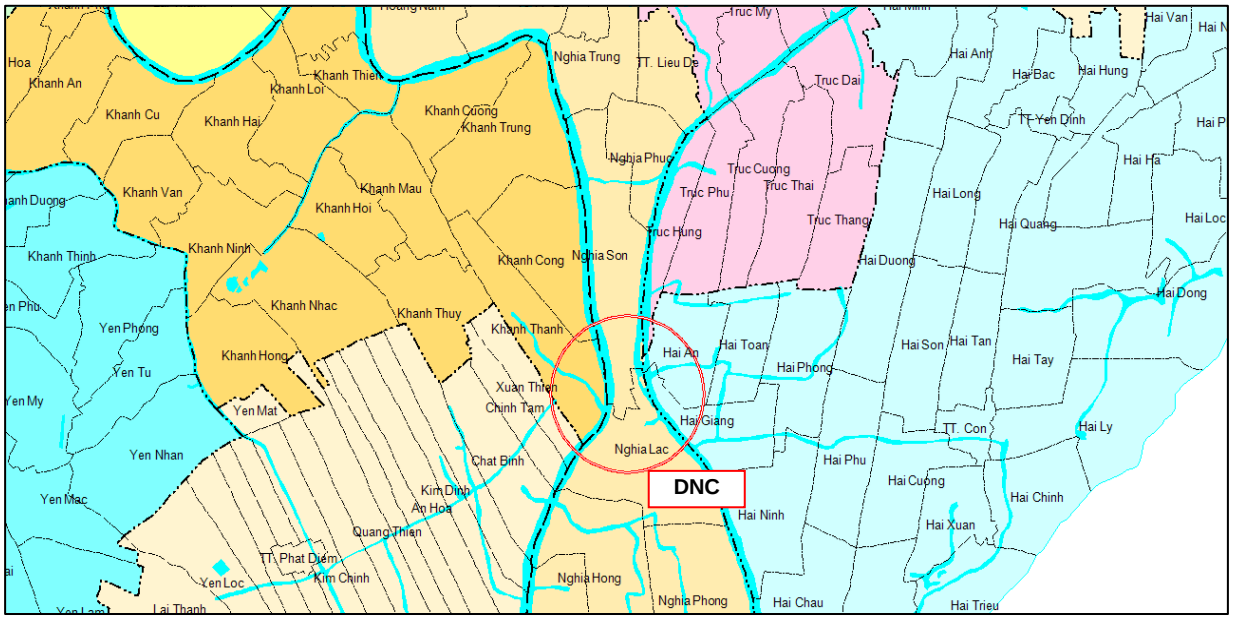
The scope of the DNC project crosses through 2 communes in Nam Dinh province. Hence, to focus on solving effects and problems that may occur during preparation and as well as construction, it was conducting the public consultation in the communes directly affected by the activities of this project.

8.1. PURPOSES OF THE PUBLIC CONSULTATION

To understand the opinions and concerns of the community on projects, especially those affected HHs by the construction and operation of the project. On this basis, these concerns can be resolved rationally in the process of setting up the project, selecting design solutions:

- To listen to the community's comments and concerns on the project, especially the direct impact on community life.
- To resolve conflicts in recommendations from the community with environmental problems and delays in implementation of the construction plan of the government.
- To confirm the rationality and legality of the administration's decision to meet the legal requirements of the local people, to consider proposals from the community and local government.
- To understand the main problems that the project area people are interested in, to propose the most reasonable solutions.

MAP OF COMMUNE/WARD/TOWN FOR PUBLIC CONSULTATION



8.2. IMPLEMENTED METHODS

In 2012 : According to the guidance of the Circular No. 26/2011/BTNMT dated July 18, 2011 regarding detailed regulation on some articles of Decree No. 29/2011/NĐ-CP dated April 18, 2011 of the government regulating on Strategic Environmental Impact Assessment, Environmental Impact Assessment, Environmental Protection Commitment, the representative of the Project owner – Project Management Unit of Waterways (PMU-W) had sent an official letter with a brief report on the project (contents of the project, environmental impacts and mitigation of impacts) to People Committees, Fatherland Front Committees of communes, wards of Nam Dinh province, to inform of work items, environment negative impacts, project environment protection solutions and to request the agencies to send their feedback/comments in writing.

Area	Commune/ward/ town	District/City	Province	Results
DNC	Nghia Son commune	Nghia Hung	Nam Dinh	Received response
	Nghia Lac commune	Nghia Hung	Nam Dinh	Received response
	Khanh Thanh commune	Yen Khanh	Nam Dinh	Received response
	Truc Hung commune	Truc Ninh	Nam Dinh	No comment
	Hai Giang commune	Hai Hau	Nam Dinh	Received response

List of communes concerned by Public consultation for DNC Canal and ship lock in 2012

In 2015 : According to the guidance of the Circular No. 27/2015/TT-BTNMT dated May 29, 2015 regarding detailed regulation on some articles of Decree No. 18/2015/ND-CP dated February 14, 2015 of the government regulating on Strategic Environmental Impact Assessment, Environmental Impact Assessment, Environmental Protection Commitment, the representative of the Project owner – Project Management Unit of Waterways (PMU-W) had sent an official letter with a brief report on the road and bridge projects (contents of the project, environmental impacts and mitigation of impacts) to People Committees, Fatherland Front Committees of communes, wards of Nam Dinh province, to inform of work items, environment negative impacts, project environment protection solutions and to request the agencies to send their feedback/comments in writing.

Area	Commune/ward/ town	District/City	Province	Results
DNC	Nghia Son commune	Nghia Hung	Nam Dinh	Received response
	Nghia Lac commune	Nghia Hung	Nam Dinh	Received response

List of communes concerned by Public consultation for DNC road relocation and crossing bridge in 2015

8.3. SYNTHESIZE COMMENTS OF THE COMMUNE'S PEOPLE COMMITTEE AND FATHERLAND FRONT IN THE PROJECT AREA

Results 2012

Total communes/ward/town consulted: 5 (four)
Received response: 4 (four) communes/ward/town
Not receive reply: 1 (one) -(signed by the recipient)

The general opinions of the commune / ward / township agree with the projects and with the safeguards and means proposed to minimize the environmental impact of the project. The mains comments concern the water quality, dust and noise emission. The communes close to DNC care also about salinity intrusion risk in the Day River from the Ninh Co River.

However, projects need to strictly supervise and manage the implementation of the environmental protection commitments outlined in the project. In addition, the project needs to look at the compensation plan, support for the relocation of public works and the local people lose their land in farming and agriculture.

A new public consultation should be organized to update the information including the last lay out of the road and bridge.

8.3.1. Opinions of People Committee of communes and wards:

Opinions of People Committee of communes and wards	Contents	Feedback from Project owner
Nghia Son commune		
The project's negative impacts on natural environment and socio-economy.	Agree	-
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	Agree	-
Recommendation to Project owner	Agree	-
Nghia Lac commune		
The project's negative impacts on natural environment and socio-economy.	Agree	-
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	Agree	-
Recommendation to Project owner	Project owner follows the state regulated documents	Project owner commits to implement in accordance with the contents stated in ESIA and the approval decision of Ministry of Natural Resource and Environment.
Khanh Thanh commune		
The project's negative impacts on natural environment and socio-economy.	Agree with project's assessment but there is no assessment of Day river water salinity when flow in -Ninh Co connecting canal circulates.	Project owner will include this contents in ESIA and simultaneously will have specific mitigation measures (if necessary)
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	*Recommendation to Project owner*	-
Recommendation to Project owner	There are many vehicles operating in DNC canal head, near ferry stage 10 which makes complication of river transport security. Ninh Co river water with high salinity will intrude in to Day river affecting agricultural production of communes along Day river.	Project owner will include this contents in ESIA and simultaneously will have specific mitigation measures (if necessary)
Nghia Phuc commune		
The project's negative impacts on natural environment and socio-economy.	Agree, however the project design shall ensure the maximum mitigation of impacts on environment as the project area is for aquaculture.	Project owner commits to limit maximum the project impacts on environment.
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	Agree, project implementation shall be in compliance with planning design.	Project owner commits to implement in accordance with approved design.
Recommendation to Project owner	Implement in accordance with project design regulations.	Project owner commits to implement in accordance with approved design.

Comments from Fatherland Front Committee of communes and wards :

Comments from Fatherland Front Committee in wards, communes	Contents	Feedback from Project owner
Nghia Son commune		
The project's negative impacts on natural environment and socio-economy.	Agree	-
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	Agree	-
Recommendation to Project owner	Agree	-
Nghia Lac commune		
The project's negative impacts on natural environment and socio-economy.	Agree	-
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	Strongly agree with state's document and management procedures.	-
Recommendation to Project owner	Strongly agree with state's document and management procedures. Project owner implements in accordance with state regulated documents	Project owner commits to implement in accordance with the contents stated in ESIA and the approval decision
Khanh Thanh commune		
The project's negative impacts on natural environment and socio-economy.	Implement in accordance with Vietnam's current legislation.	Project owner commits to implement in accordance with the contents stated in ESIA and the approval decision
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	Commits to implement fully minimum the project negative impacts on environments in all periods.	Project owner commits to implement in accordance with the contents stated in ESIA and the approval decision
Recommendation to Project owner	Project owner must commits to follow design alternative in accordance with approved planning and work design standards.	Project owner commits to implement in accordance with the approved design.
Nghia Phuc commune		
The project's negative impacts on natural environment and socio-economy.	Agree that it's necessary to minimize the project impacts on natural and socio-economic environment.	Project owner commits to minimize the negative impacts on natural and socio-economic environment.
Solutions and measures of project bad impact mitigation to natural, socio-economic environment	It's necessary to strictly implement treatment of impacts on environment.	Project owner commits to implement in accordance with the contents stated in ESIA and the approval decision.
Recommendation to Project owner	Necessary to ensure environmental hygiene and commits not to affect on aquaculture and living activities of local people.	Project owner commits to minimize the impacts on aquaculture area and living activities of local people.

Results 2015

Total communes/ward/town consulted: 2 (two)
Received response: 2 (two) communes/ward/town

A new public consultation has been organized on December 18th, 2015 to update the information including the last layout of the road and bridge. The general opinions of the commune / ward / township agree with the projects and with the safeguards and means proposed to minimize the environmental impact of the project. The mains comments concern the water quality, dust and noise emission. The communes in DNC project care about salinity intrusion risk in the Day River from the Ninh Co River. However, projects need to strictly supervise and manage the implementation of the environmental protection commitments outlined in the project. In addition, the project needs to look at the compensation plan, support for the relocation of public works and the local people lose their land in farming and agriculture.

8.3.2. Results of Public consultation in Nghia Son Commune

Location: Do Muoi commune
Participants: People Committee in Nghia Son Commune
Time: 9 :00 a.m December 28, 2015
Total affected households: 205
21 households are affected relating to cultivation land
9 households are affected relating to residential land (Mr Hai, Loi, Vinh)

1) Beside 4 directly affected households, 4m of local road is narrow, the project should consider to widen to5m (Nguyen Van Nhuong, village 16)
2) Total: 21 households are affected by bridge
3) Field compensation:
   People Committee will be responsible for this compensation.
4) Propose the project to compensate reasonably → propose PMU-W to support job creation to local people (Nguyen Van Thin)
5) What local road will be made of? It will be made of concrete

8.3.3. Results of Public consultation in Nghia Lac Commune

Location: Nghia Lac commune
Time: 2:00 p.m, December 18, 2015
Contents:

- Project introductions:

+ Area of rice: 50ha
+ Total affected households: 59

- Discussion:

+ Many wood piles driven at 6m deep in DNC canal (information from commune head)
+ B52 bomb in Han field

Question	Answer
During construction, residential people will be given a job?	Before project and at present, local people have been interviewed if they need jobs or not ? If yes, the government will support according to law
Commune head: Mr. Bach + 28 households lost residential land, most of them work in agriculture, they wonder that they will not study any occupations	Acknowledged and will inform to higher level to minimize affection level
DNC canal opens and closes if irrigation will be affected?	Lock ship is 15m wide, 110m long therefore it will not affect irrigation system
MR Bach: if machine can't access to the field although they are compensated, the remaining area is too small	If the remaining area is too small, there will be a policy to compensate all.
Will local road be affected?	It will be restituted

Comments from Communal chairman:

- 34 ha are lost and 27 households are affected; 59 households are cultivating rice in Dong Ang commune ;
- Had a meeting with district:

+ Previous alternative: 30 ha lost and now 34 ha lost;
+ Province and district must plan resettlement;

+ Propose to government to measure in details;
+ Inform to 59 households before harvest in order that they will plan to harvest;
+ What is policy on residential land and reclaimed land so that local people orient?

Public consultations at Nghia Son and Nghia Lac communes – December 18th, 2015

8.4. FEEDBACK AND COMMITMENT OF THE PROJECT OWNER

In the spirit of listening, absorbing and recording the comments of the People's Committee and Fatherland Front Committee of the commune where are crossed by the project. On that basis, the Client will collect and analyses the above comments. For the key issues that the People's Committee as well as the Fatherland Front Committee of communes and towns is interested in, the Project Owner would have the answers and commitments as follows:

- Project owner commits to implement in accordance with the contents stated in ESIA and the approval decision and minimize the negative impacts on environment of local people;
- Project owner and contractors will ensure to strictly follow the environmental standards and reduce: minimize exhaust gas, dust, noise and construction equipment and machines in accordance with the Vietnamese regulated standards;
- Resettlement Plan is made by social/resettlement teams associated with provincial departments to solve the impacts reasonably, and problems are presented in a specific report.