# I. Introduction

## A. Introduction

1. In response to a request from the Government of the Socialist Republic of Vietnam (hereinafter referred to as "GOV"), the Government of Japan (hereinafter referred to as "GOJ") has decided to conduct the Study on the Red River Inland Waterway Transport System in the Socialist Republic of Vietnam (hereinafter referred to as "the Study").

2. Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of GOJ, dispatched a preparatory study team to Vietnam in August 2001, and reached an agreement with GOV on the scope of the Study.

3. JICA dispatched a full-scale study team (hereinafter referred to as "the Study Team") in December 2001 to carry out the Study. The reports submitted to the Vietnamese side through the Ministry of Transport by the Study Team are as follows:

| | |
|---|---|
| - Inception Report | Submitted in December 2001 |
| - Progress Report (I) | Submitted in March 2002 |
| - Interim Report | Submitted in July 2002 |
| - Progress Report (II) | Submitted in October 2002 |
| - Draft Final Report | Submitted in January 2003 |
| - Final Report | Completed in March 2003 |

## B. Background of the Study

4. Vietnam has been undergoing major economic changes and transition from a centrally planned economic system to a more market oriented economy since the formal adoption of "Doi Moi" in 1986. Deregulating policies towards a market economy have greatly encouraged economic development in Vietnam and the capacity of the transport sector has to be increased to cope with the transport demand.

5. Reflecting the above situation, the Inland Waterway Transport (hereinafter referred to as "IWT") system in the Red River Delta is expected to play an important role in the socio-economic development in Vietnam by making full use of its peculiarity as an environment friendly and cost effective mode of transport.

6. However, the IWT system in the entire Red River Delta and the segment through Hanoi in particular is facing difficulties such as insufficiency of port facilities and related services as well as instability of navigation channel and the riverbank erosion due to hydrological effects and sedimentation.

7. Furthermore, the improvement of the Red River segment through Hanoi is expected to be a part of the anniversary celebration of "1000 years of Thang Long - Hanoi".

8. Taking into account the above situation, a comprehensive study on the Red River Inland Waterway Transport System is needed more than ever.

## C. Objectives of the Study

9. The objectives of the Study are:

(1) To formulate a long-term strategy for the IWT system in the Red River Delta for the year 2020.
(2) To formulate a master plan for the IWT system in the Red River segment through Hanoi for the year 2020.
(3) To formulate a short-term development plan for the IWT system in the Red River segment through Hanoi for the year 2010.
(4) To conduct a feasibility study on the priority projects.
(5) To undertake relevant technology transfer to Vietnamese counterpart personnel in the course of the Study.

## D. Study Area

10. The Study covers the entire Red River Delta for the Long-term Strategy and the Hanoi segment for the Master Plan and the Short-term Development Plan.

## E. Study Schedule

11. Work schedule of the Study is shown in **Figure I-1**.

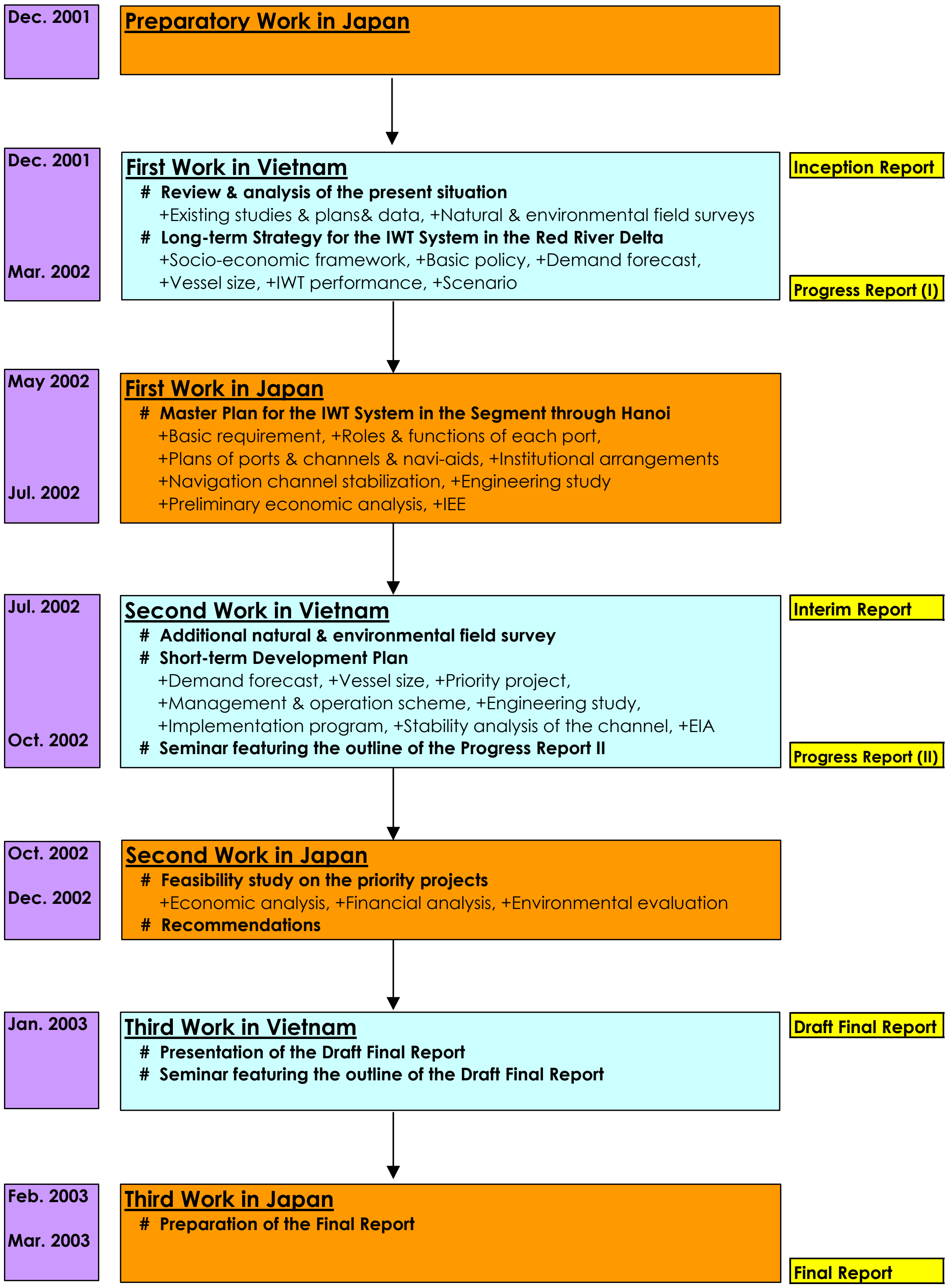



**Figure I-1 Study Schedule**

# F. Members of Steering Committee, Counterparts and Study Team

**Vietnamese Side**

Ministry of Transport (MOT)

| | |
|---|---|
| Mr. Nguyen Viet Tien | Vice Minister (*) |
| Mr. Truong Tan Vien | General Director, Planning & Investment Dept. (*) |
| Ms. Dang Thi Hoc | Deputy Director, International Relation Dept. (*) |
| Mr. Vu Tru | Deputy Director, Science & Technology Dept. (*) |

Vietnam Inland Waterway Administration (VIWA)

| | |
|---|---|
| Dr. Ngo Xuan Son | General Director (*) |

Hanoi People's Committee (HNPC)

| | |
|---|---|
| Mr. Bui Xuan Dung | Deputy Director, Hanoi Public Works and Transport Dept. (*) |

Ministry of Planning and Investment (MPI)

| | |
|---|---|
| Mr. Nguyen Ngoc Nhat | General Director, Infrastructure Dept. (*) |

Ministry of Agriculture and Rural Development (MARD)

| | |
|---|---|
| Mr. Le Van Hoc | Deputy Director, Institute of Water Resources Planning (*) |

Ministry of Science, Technology and Environment (MOSTE)

| | |
|---|---|
| Mr. Ngo Xuan Hung | Deputy Director, Dept. for S&T Management in Industry (*) |

Project Management Unit of Waterways (PMU-Waterways)

| | |
|---|---|
| Mr. Nguyen Ngoc Hai | General Director (*)(**) |
| Mr. Le Huy Thang | Project Officer (**) |
| Ms. Nguyen Thi Hien Van | Project Officer (**) |

Note) (*): Steering Committee member (**): Counterparts

**Japanese Side**

JICA Study Team

| | |
|---|---|
| Mr. Hisao Ouchi | Team Leader / Inland Waterway Policy (June 2002 - ) |
| Mr. Takechiho Tabata | Team Leader / Inland Waterway Policy (Dec. 2001 - Jun. 2002) |
| Mr. Seiji Sato | Sub Team Leader / Port Planning (1)/ River Port Planning |
| Mr. Kohei Nagai | Sub Team Leader / Transport Planning |

| | |
|---|---|
| Mr. Shinichi Tezuka | Port Planning (2) / Navigation Channel Planning |
| Mr. Masashi Murayama | Management and Operation |
| Mr. Hunki Lee | Demand Forecast |
| Mr. Bernard Malherbe | Waterway Maintenance / Sedimentation Control Measures |
| Mr. Takahisa Sogabe | Land Use Planning / Social Consideration |
| Mr. Koichiro Harada | Engineering Design / Cost Estimation / Construction Program |
| Mr. Isamu Koike | Economic Analysis / Financial Analysis |
| Mr. Saburo Fujitsuka | Natural Condition |
| Dr. Phung Chi Sy | Environmental Consideration |
| Mr. Yuji Kagawa | Bridge Engineering (July 2002 - ) |
| Mr. Tadasu Okude | Mechanical Engineering (July 2002 - ) |
| Mr. Masayuki Fujiki | Coordination (December 2001 - January 2002) |

## G. Composition of the Reports

12. Final Report of this Study consists of Summary Report, Main Reports of (I), (II), (III) and Appendix to the Main Reports.

- Summary Report
- Main Report (I): Present Situation
- Main Report (II): Long-term Strategy and Master Plan
- Main Report (III): Short-term Development Plan, Feasibility Study and Recommendations
- Appendix

# II. Socio-economic Profile and Demand Forecast

## A. Socio-economic Profile

13. Northern Vietnam consists of three economic regions, namely the Red River Delta (9 provinces), the Northeast (13 provinces) and the Northwest (3 provinces) with a total area of 115,751 $km^2$. Most of lands are dominated by agricultural and industrial purpose. The climate of the region is tropical to sub-tropical in character.

14. As of 2000, the total population of the Northern Vietnam is 28.3 million or 36% of the national total. The population shares of the Red River Delta, the Northeast and Northwest in the Northern Vietnam's total are 53%, 39% and 8% respectively. The population growth rate of the region is 1.4 % for the past 10 years.

**Table II-1 Population of Northern Vietnam**

| Item | Unit | Total | RRD | Northeast | Northwest |
|---|---|---|---|---|---|
| Population in 2000 | million | 28.3 | 15.0 | 11.0 | 2.3 |
| Regional Share | % | 100 | 53 | 39 | 8 |
| Area | $km^2$ | 115,751 | 14,788 | 65,326 | 35,637 |
| Population Density | Pers./$km^2$ | 240 | 1,010 | 170 | 60 |
| AAGR for 10 years | % | 1.4 | 1.3 | 1.5 | 2.1 |

Note) AAGR - average annual growth rate

Source) GSO, "Statistical Yearbook ", 2000

15. Vietnam's average annual growth rate of GDP in the period 1991 – 1997 was over 8% due mainly to the rapidly expanding industrial sector. However, the Asian financial crisis in 1997 has affected Vietnam's economy, resulting in a slight decline in GDP growth rate since 1998.

16. The share of industry in the GDP expanded significantly and continuously from 25% in 1990 to 35% in 2000 whereas the share of agriculture decreased from 32% to 25% in the same period.

17. As of 1999, GDP share of the Northern Vietnam in the whole country accounted for only 25%. The Red River Delta contributed the most in Northern Vietnam, even though its GDP per capita of VND 4.34 million was lower than the national average.

**Table II-2 GDP and Its Sectoral Composition (at Current Price, 1999)**

| Region | GDP (bil. VND) | Per Capita GDP (mil. VND) | Regional Share | Share by Sector | | |
|---|---|---|---|---|---|---|
| | | | | Agriculture | Industry | Service |
| Red River Delta | 73,219 | 4.34 | 18.3% | 23.7% | 30.8% | 45.5% |
| Northeast | 22,726 | 2.57 | 5.7% | 38.6% | 26.8% | 34.6% |
| Northwest | 4,368 | 1.95 | 1.1% | 52.9% | 14.7% | 32.5% |
| Subtotal | 100,314 | 3.59 | 25.1% | 28.4% | 29.2% | 42.4% |
| Whole country | 399,942 | 5.22 | 100% | 25.4% | 34.5% | 40.1% |

Source) GSO, "Statistical Yearbook", 2000

# B. Socio-economic Framework

## 1. Population

18. Population is projected considering two government documents of population forecast issued by the National Committee for Population and Family Planning (NCPFP) and the Ministry of Construction (MOC), indicating the following points:

- The NCPFP is a reliable source and has been used as the primary basis for relevant projections, but it is still likely to underestimate rural-to-urban migration caused by urbanization. Therefore, there is a need to adjust the provinces' forecast populations with those of the neighboring provinces to meet urbanization trends.
- The MOC expected a sharp increase in the number of urban residents, ie 30.4 million in 2010 and 46 million in 2020 compared with 14.7 million now. This sharp increase substitutes emerging mega cities by developing small to medium-sized urban centers all over the country and does not reflect the trend forecast by the NCPFP and the provincial breakdown made by the MPI/DSI. Therefore, a moderate urbanization trend is needed.

19. As a result, population is forecast to increase from 77.7 million in 2000 to 94.5 million in 2010 and 109.5 million in 2020 at the national level with growth rates of 1.98% for 2000-2010 and 1.48% for 2010-2020. In the Northern Vietnam, population will increase 28.3 million in 2000 to 38.8 million in 2020.

**Table II-3 Population Forecast**

Unit: '000

| Year / Region | 2000 | 2010 | 2020 | AAGR | |
|---|---|---|---|---|---|
| | | | | '10-'00 | '20-'10 |
| Red River Delta | 14,971 | 17,699 | 20,024 | 1.69% | 1.24% |
| Northeast | 10,998 | 13,616 | 15,613 | 2.16% | 1.38% |
| Northwest | 2,287 | 2,764 | 3,158 | 1.91% | 1.34% |
| Sub-total | 28,256 | 34,079 | 38,795 | 1.89% | 1.30% |
| Whole country | 77,686 | 94,548 | 109,521 | 1.98% | 1.48% |

Source) JICA Study Team

## 2. GDP

20. Vietnam's GDPs are estimated by applying a macro econometric model, key concept of which is that GDP growth heavily relies on investment and investment largely depends on saving. Experiences show that an increase in GDP by 1% requires a corresponding investment increase in investment of 3% in developing countries.

21. In Vietnam where foreign investment has offset insufficient gross saving, such available resources should sufficiently be taken into account. Thus Vietnam enjoyed large investments during the period 1992-1997, ranging from 30% to 40% per GDP.

22. However, this does not seem to be continuing, judging from the economic performance of the country since 1998. The regional economic perspective is also unclear. Experiences of neighboring countries, whose market economies were built much earlier than Vietnam's, show that economic recession at intervals are inevitable and that there is a need for continuous economic reform.

23. Under these considerations, GDPs are estimated according to the following assumptions:

Scenario 1: Economic growth will continue at the same pace at present (trend-based forecast)

Scenario 2: Foreign investment will decline to half of the current amount (low–assumption forecast)

Scenario 3: Investment amount will be placed between scenario 1 and scenario 2 (high-assumption forecast)

24. The estimate results show that their annual growth rates during the project period are more than 9% for the trend-based forecast, more than 7% for the high-assumption forecast and about 6% for the low-assumption forecast. As it is thought to be difficult for the economy to increase at a growth rate of trend-based forecast, the high- and low-assumption scenarios are mainly taken for transport demand forecast.

25. In the Northern Vietnam, an average of the high and low assumptions is projected to grow to 150.9 VND trillion in 2010 and 271.5 VND trillion in 2020. Hanoi's GDP share to RRD's will increase to 38% in 2010 and 40% in 2020, compared to 36% in 2000.

**Table II-4 GDP Forecast**

Unit: VND Billion at 1994 Constant Price

| Region | Scenario | Year | | | AAGR | |
|---|---|---|---|---|---|---|
| | | 2000 | 2010 | 2020 | '10-'00 | '20-'10 |
| North | Low | 72,128 | 142,308 | 237,173 | 7.03% | 5.24% |
| | High | | 159,667 | 305,995 | 8.27% | 6.72% |
| Whole county | Low | 273,582 | 531,255 | 885,634 | 6.86% | 5.24% |
| | High | | 598,574 | 1,143,800 | 8.14% | 6.69% |

Source) JICA Study Team

# C. IWT Demand Forecast

**1. Methodology**

26. Taking into account the strong relationship between transport demand and socio-economic activities, the following conventional four-step method was adopted for IWT demand forecast in the Northern Vietnam:

(1) Generation and attraction of transport demand
(2) Traffic distribution
(3) Modal split
(4) Traffic assignment

27. Models for generation and attraction of transport demand are developed based on surplus and deficit of commodities in all provinces that are calculated from socio-economic indicators. The surplus and deficit can also be calculated

from production and consumption of commodities. Then OD traffic in terms of inter-provincial movement is estimated by applying future generation and attraction of transport demand as a control total.

28. Transport demand by mode and on inland waterway routes is at the same time calculated while assigning OD traffic on each mode's route to minimize total transport costs composed of operating and maintenance cost, loading/unloading cost and time-related cost.

## 2. IWT Conventional Cargo Transport

29. The IWT conventional cargo transport demand in the Northern Vietnam is estimated to increase to 32.3 million tons in 2010 and 51.3 million tons in 2020 with annual growth rate of 6.3% in 2001-2020 and 4.7% in 2010-2020.

30. Values of elasticity to GDP are calculated at 0.87 in 2001-2010 and 0.78 in 2010-2020. Both the growth rate and value of elasticity are lower than those of the present and will continue to decrease over time.

31. In Vietnam, although cargo transport demand steadily increased at a growth rate of 7.47% during 1991-2000, modal share of inland waterway is predicted to be low since the cargo volume transported by truck will substantially increase, resulting in a decline of cargo transport demand growth rate of inland waterway, as shown in experiences of developing and developed countries.

**Table II-5 IWT Conventional Cargo Transport Demand in the North**

| | | 2001 | 2010 | 2020 | AAGR | |
|---|---|---|---|---|---|---|
| | | | | | '10-'01 | '20-'10 |
| Million Tons | Construction Material | 7.1 | 12.8 | 21.0 | 6.8% | 5.1% |
| | Cement | 2.5 | 4.4 | 8.0 | 6.6% | 6.2% |
| | Fertilizer | 0.2 | 0.4 | 0.6 | 8.4% | 4.2% |
| | Coal | 6.1 | 10.5 | 15.3 | 6.2% | 3.8% |
| | Others | 2.7 | 4.2 | 6.4 | 4.9% | 4.2% |
| | Total | 18.6 | 32.3 | 51.3 | 6.3% | 4.7% |
| Million Ton-km | | 2,010 | 3,446 | 5,580 | 6.2% | 4.9% |

Source) JICA Study Team

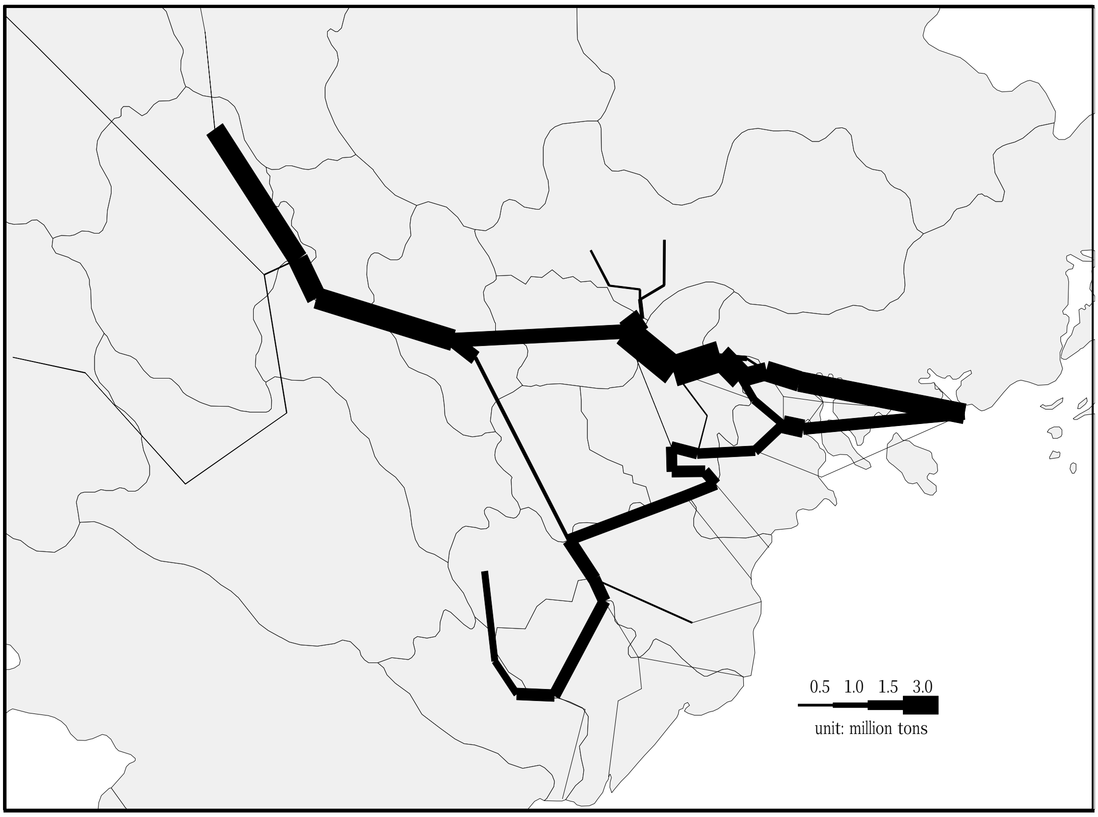



**Figure II-1 IWT Conventional Cargo Traffic Flow, 2001**

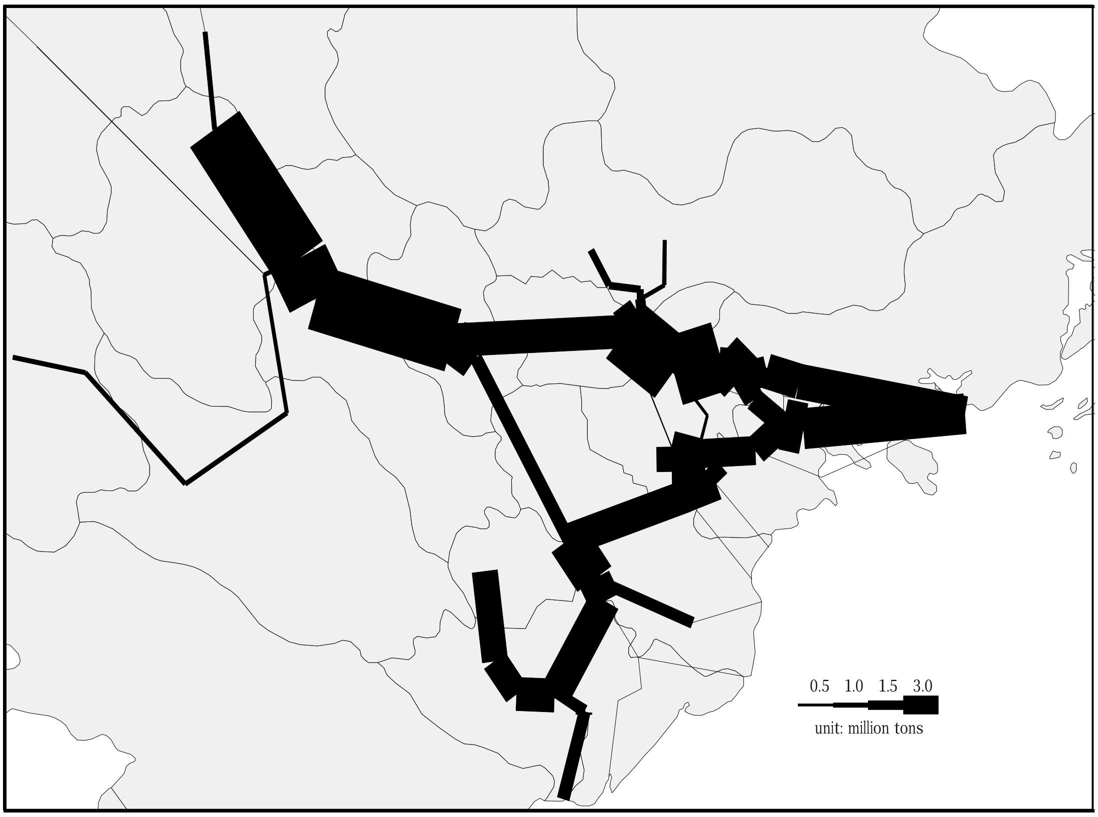



**Figure II-2 IWT Conventional Cargo Traffic Flow, 2020**

32. There remains a substantial gap between the two studies: ADB's and VIWA's. The ADB took a very conservative approach, resulting in an annual growth rate of less than 4% during 2001-2020, whereas VIWA's approach seems to be too generous with an annual growth rate of more than 7% even in 2010-2020. Values of elasticity are 0.4 for ADB and 1.15 for VIWA.

33. Judging from the historical trend of cargo transport demand and empirical evidences in other countries, the former value is too low and the latter too high. The study team's approach is more moderate, lying between ADB's and VIWA's with an annual growth rate of 6.3% in 2001-2010 and 4.7% in 2010-2020.

**Table II-6 Comparison with Other Studies**

| | 1995 | 2001 | 2010 | 2016 | 2020 | AAGR | |
|---|---|---|---|---|---|---|---|
| | | | | | | 10-'01 | 20-'10 |
| JICA 1/ | | 18.6 | 32.3 | | 51.3 | 6.3% | 4.7% |
| VIWA 2/ | | | 31.4 | | 61.7 | 7.8% | 7.0% |
| ADB 3/ | 10.2 | 15.9 | | 27.7 | | 3.8% | 3.8% |

Note) 1/ "The Study on the Red River Inland Waterway Transport System", JICA, 2002
2/ "Red River Waterways Project Vietnam", ADB, 1998
3/ "Master Plan of Inland Waterway in Vietnam to the Year 2020", VIWA&TDSI, 2000

## 3. Passenger transport

34. In forecasting IWT passenger demand, potential routes that will attract sufficient passengers to ensure financial viability are firstly chosen based on nested logit model reflecting road conditions, service characteristics of alternative transport modes and so on.

35. As a result, in addition to the existing service route of Hai Phong - Quang Ninh, new service routes of Hanoi - Hun Yen - Thai Binh and Hanoi - Viet Tri - Phu Tho are selected as alternatives due to the comparatively high probability of passengers choosing inland waterway.

36. For selected service routes, passenger demand of inland waterway is estimated under the following assumptions:

i) Travel cost of inland waterway is the same as that of bus.
ii) Passengers can get on a passenger boat without waiting at terminals, ie waiting time of inland waterway is almost the same as that of bus.

37. As a result, potential IWT passenger demand of new service routes from Hanoi is estimated at 0.6 million passengers in 2010 and 0.9 million passengers in 2020. Additionally, a sensitivity analysis reveals that passenger demand will, if waiting time is 30 minutes longer or if fare is more than VND 5,000, decrease by about 30%.

**Table II-7 Potential Passenger Demand from Hanoi**

| Direction | Section | Distance(Km) | | Travel Time(hr) | | All Modes('000) | | IW('000) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Road | IW | Bus | IW | 2010 | 2020 | 2010 | 2020 |
| To South | Ha Noi <--> Hung Yen | 64 | 60 | 2.1 | 2.1 | 1,691 | 2,516 | 210 | 309 |
| | Ha Noi <--> Thai Binh | 109 | 101 | 3.4 | 3.5 | 2,391 | 3,436 | 159 | 224 |
| | Hung Yen <--> Thai Binh | 45 | 41 | 1.3 | 1.6 | 299 | 590 | 32 | 64 |
| | subtotal | | | | | 4,381 | 6,542 | 402 | 597 |
| To West | Ha Noi <--> Viet Tri | 84 | 75 | 2.5 | 2.6 | 1,285 | 1,794 | 135 | 189 |
| | Ha Noi <--> Phu Tho | 123 | 115 | 3.8 | 4.0 | 964 | 1,345 | 101 | 141 |
| | Viet Tri <--> Phu Tho | 39 | 40 | 1.4 | 1.4 | 25 | 45 | 3 | 5 |
| | subtotal | | | | | 2,274 | 3,184 | 239 | 335 |
| Total | | | | | | 6,655 | 9,725 | 641 | 932 |

Source) JICA Study Team

## 4. Other issues: SRV, Container and Tourism

38. Additional factors that can have a substantial impact on cargo movement in the North Vietnam are potential demand of SRV (sea-cum-river vessel) and container.

39. Transport demand of SRVs can be converted from the cargo volume carried by coastal shipping. A total of cargo volume moving from/to the Northern Vietnam by coastal shipping was recorded at around 7 million tons in 1999 which is largely dominated by paddy and other crops, cement, coal, and petroleum products.

40. Among them, commodity items carried by SRV can be identified, considering location of industrial plants, transported type, and produced and consumed area. As a result, the following commodity items are analyzed to be difficult to transport from/to Hanoi by SRV: steel, construction materials, coal and petroleum products.

41. Excluding the above, major commodity items that could make use of SRV include paddy and other crops, cement and fertilizer. Estimate results show a total

of cargo volume moving from/to the Northern Vietnam would increase by around 3 times in 2020 over the 1999 level, and a quarter of the total could be converted to SRV. As a result, potential SRV cargo demand is estimated to 1.0 million tons to/from Hanoi and 2.4 million tons to/from Ninh Binh in 2020.

**Table II-8 SRV Transport Demand**

| Commodity (1000 tons) | 2010 | | 2020 | | Note |
|---|---|---|---|---|---|
| | Hanoi | Ninh Binh | Hanoi | Ninh Binh | |
| Paddy/rice | 373 | 294 | 614 | 465 | to North |
| Steel | 1 | 1 | 5 | 3 | to North |
| Construction Material | | 87 | | 133 | from North |
| Cement | | 144 | | 338 | from North |
| Fertilizer | 56 | 114 | 182 | 267 | from North |
| Coal | | 439 | | 1,092 | within North |
| Others | 110 | 66 | 197 | 113 | to North |
| Total | 540 | 1,145 | 998 | 2,411 | |

Source) JICA Study Team

42. In examining the possibility of inland waterway carrying containers, the transport cost and time of truck and IWT are roughly compared based on a users' interview survey of financial cost. A comparison of their economic cost suggests IWT has competitive advantages, i.e., the transport cost of IWT is about 30% lower than that of truck. IWT could thus be an alternative to transport containers of low value-added products, less time-sensitive products, LCL (less than container load) one or empty ones.

43. Assuming that Vietnam adopts a transport strategy to enhance economically preferred transport mode and travel time of truck would progressively increase in the future due to traffic congestion on National Highway No.5, it is judged that IWT could be capable of transporting 15% of containers moving between Hanoi and Hai Phong and 10% of those between Hanoi and Quang Ninh.

44. As a result, potential container demand is forecast at around 32 thousand TEUs in 2010 and around 67 thousand TEUs in 2020.

**Table II-9 IWT Container Demand**

| | 2010 (1,000TEU) | | | 2020(1,000TEU) | | |
|---|---|---|---|---|---|---|
| | Hai phong - Hanoi | Quang Ninh - Hanoi | Total | Hai Phong - Hanoi | Quang Ninh - Hanoi | Total |
| Export | 3.9 | 11.6 | 15.5 | 6.6 | 26.5 | 33.2 |
| Import | 4.1 | 12.2 | 16.3 | 6.8 | 27.2 | 34 |
| Total | 7.9 | 23.8 | 31.7 | 13.4 | 53.7 | 67.2 |

Source) JICA Study Team

45. As of 2000, the number of tourists visiting Hanoi is estimated at approximately 1.9 million which is composed of 0.45 million foreign tourists and 1.45 million domestic tourists. Considering the past growth rate, the number of tourists visiting Hanoi is projected to increase to 4.8 million in 2010 and 9.1 million in 2020.

46. Among those tourists, some is assumed to choose the river cruise attraction, if the river cruise operation is made available to the tourists as one of attractive tourism products. The probable number of tourists choosing the river cruise is assumed at 118 thousand in 2010 and 315 thousand in 2020 based on probable share of total tourists.

**Table II-10 Projection of River Cruise Tourist in Hanoi (,000 PAX)**

| Year | Foreign | Domestic | Total |
|---|---|---|---|
| 2010 | 45 | 73 | 118 |
| 2020 | 114 | 201 | 315 |

Source) JICA Study Team

# III. Long-term Strategy for IWT System in the Red River Delta

## A. Basic Policy for IWT System

### 1. Advantages and potential of the IWT system

47. The IWT system in the Red River Delta is expected to play an important role in the socio-economic development as well as bettering the lives of people living there, by making full use of its advantages and potential such as:

+ Dense and convenient waterway network
+ Low utilization of inland waterways
+ Ideal port locations
+ Low energy consumption
+ Low CO2 discharge

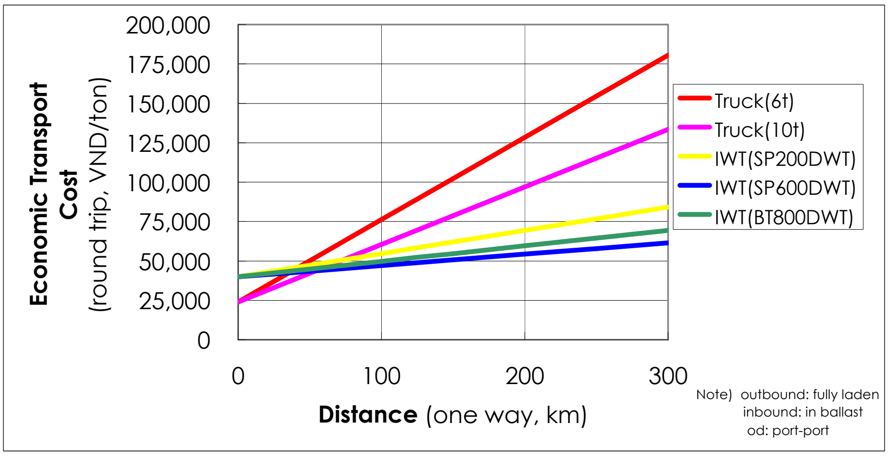
48. There are two major river systems of Red River and Thai Binh River in the Northern region. Together with Duong and Luoc Rivers which link these two major river systems, both make a convenient waterway network.

49. The density of exploited inland waterways in Vietnam is 0.034 km/sq.km equivalent to almost 2 times of that of 6 countries in Europe where the IWT system is considerably developed. The density of inland waterways in Northern region is 0.170 km/sq.km equivalent to almost 2 to 14 times of those of nearby countries.

50. Furthermore, there is a great potential to exploit the inland waterways since at present only 27% of inland waterways in Vietnam are being utilized.

51. Ports in the Red River Delta are located at capitals of province, other major cities, major industrial plants or major mines where cargoes such as coal, construction material, cement and fertilizer are produced or consumed.

52. In addition, it should be noted that energy consumption of road transport by commercial truck is about 6 times as much as that of railway and waterway transport according to the investigation conducted by Japanese Ministry of Transport. As to CO2 discharge, railway and waterway transport have also significant advantage.




Source) JICA Study Team

**Figure III-1 Transport Cost Comparison**

## 2. Necessity of improving the IWT system

53. Vietnam has been undergoing major economic changes as part of its transition from a centrally planned economic system to a more market oriented economy since the formal adoption of "Doi Moi Policy" in 1986. Deregulating policies towards a market economy have greatly encouraged economic development in Vietnam and has resulted in high economic growth.

54. The GDP in 2000 reached VND 276 trillion which is more than double compared with that in 1990. Once beset with a serious scarcity of goods, Vietnam can now produce enough to satisfy the essential needs of the population and the economy, increase exports and have some reserves.

55. The economic structure in GDP share has also made a shift in these 10 years. The share of agriculture has dropped from 38.7% to 24.3%, that of industry and construction has risen from 22.7% to 36.6%, and that of services from 38.6% to 39.1%.

56. In the Strategy for Socio-economic Development (2001 - 2010), the target of GDP is set to have at least doubled the level of 2000 and the economic and labor structures been vigorously transformed toward industrialization and modernization. The Five -year Plan for Socio-economic Development (2001 - 2005) also strives for high average GDP growth rate of 7.5% a year.

57. Along with high economic growth that is expected to continue for the future, the transport demand is constantly increasing and therefore the capacity of the transport sector has to be strengthened to cope with the increasing transport

demand.

58. Reflecting the above situation, the IWT system in the Red River Delta is expected to play an important role in the socio-economic development as well as bettering the lives of people living in Vietnam and in the Northern region in particular, by making full use of its potential and peculiarity as an environment friendly and cost effective mode of transport.

## 3. Identified problems and issues on IWT system

### 3.1 Problems and issues on navigation channels

59. The rivers are subject to the meteorological and hydrological regime of the Northern region. Peculiarity of rivers in the Northern region are summarized as follows:

- Minimum width of channel bottom: 30m - 60m
- Minimum depth: 1.5m - 2m
- The flood season: from June to October
- The low water season: from November to May
- The water level difference between the two seasons: 5m - 7m (over 10m)
- In the flood season, the flow speed is high.
- In the low water season, the depth and the curving radius are limited.
- After the flood, shoals are usually formed, which change year by year.
- In river mouths, the sediments develop complicatedly.

60. There are many rivers that can be used to enhance living standards and promote socio-economic development, but they have not been fully exploited. General problems related to the navigational channel are as follows:

(1) Severe river conditions
(2) Shortage of bridge clearance
(3) Obstacles in the channels
(4) Sedimentation
(5) Accidents
(6) Inadequate navigation aids
(7) Shortage of investment fund

### 3.2 Problems and issues on ports

61. Major river ports in the Red River Delta do not make full use of their designed capacity in general except some ports. The main reasons why these ports cannot make full use of their designed capacity can be summarized as follows:

(1) Competition among major ports and other berths
(2) Outdated and Inefficient handling equipment
(3) Low mechanization
(4) Insufficient and damaged port facilities
(5) Poor access to hinterland
(6) Shortage of investment fund

### 3.3 Problems and issues on management and operation aspects

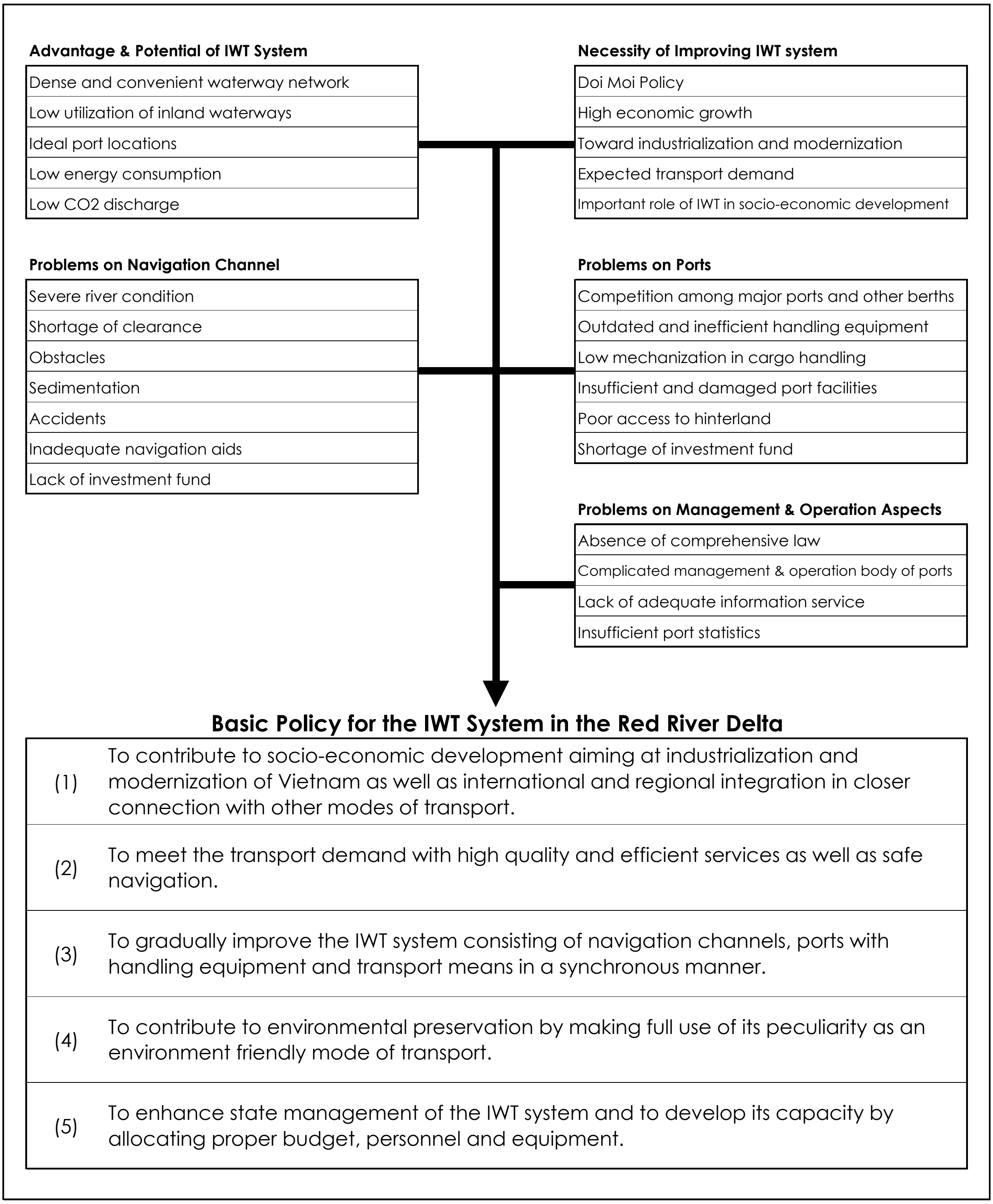
62. As to management and operation aspects, identified problems and issues can be summarized as follows:

(1) Absence of comprehensive law
(2) Complicated management and operation body of ports
(3) Lack of adequate information service
(4) Insufficient port statistics

## 4. Basic Policy for the IWT System in the Red River Delta

63. Taking account of advantages and potential of the IWT system, necessity of improving the IWT system as well as its identified problems and issues, the basic policy for the IWT system in the Red River Delta should include the following items (see **Figure III-2**):

(1) To contribute to socio-economic development aiming at industrialization and modernization of Vietnam as well as international and regional integration in closer connection with other modes of transport.
(2) To meet the transport demand with high quality and efficient services as well as safe navigation.
(3) To gradually improve the IWT system consisting of navigation channels, ports with handling equipment and transport means in a synchronous manner.
(4) To contribute to environmental preservation by making full use of its peculiarity as an environment friendly mode of transport.
(5) To enhance state management of the IWT system and to develop its capacity by allocating proper budget, personnel and equipment.




Source) JICA Study Team

**Figure III-2 Basic Policy for the IWT System in the Red River Delta**

# B. Vessel Fleet Perspective

## (1) Existing vessel fleet

64. Barge trains are mainly used for transport of bulk cargo such as coal and construction material. Prevailing size of barge is 200 DWT and barge trains of

"4@200DWT+Pushing Tug" are commonly deployed.

65. Self-propelled vessels of larger than 100 DWT are mainly used for transport of cargo in bag including import cargo unloaded at major northern seaports.

66. Sea-cum-river vessels of 1000 DWT were introduced to IWT corridor 3 (Cua Day - Ninh Binh) in 2000.

**(2) Future vessel size**

67. For the future, vessels of larger size and higher speed are considered to be introduced in order to meet the IWT demand which is forecast to considerably increase and to raise the quality and efficiency of services. However, larger vessel/barge train requires larger dimensions of waterways.

68. The following maximum vessel size can be assumed in the time range of the Long-term Strategy taking into account the progress of shipbuilding technology and the effort of VIWA for the development of inland waterways.

(1) Barge train: 2units@600DWT + Pushing Tug@200CV
(Length=115m, Breadth=11m, draft=1.8m, Speed=8-12km/h)
For: Corridor 1, 3, 4 (except Corridor 2: Quang Ninh - Ninh Binh)
Note: Corridor 2 is excluded taking into account the difficulty in satisfying the requirement of bend radius and the future shifting of coal transport route (Quang Ning - Ninh Binh via Luoc River) to the new route (coastal + Corridor 3).

(2) Barge train: 4units@400DWT + Pushing Tug@250CV
(Length=95-109m, Breadth=18-19m, draft=1.2-1.6m, Speed=8-12km/h)
For: Corridor 1, 2, 3, 4
Note: Although this size of barge train requires LAW of 55m (for 3B) - 75m (for 4B), this size of barge train is actually deployed in the RRD. This size of barge train should be deployed in specific season (excluding low water season) and operated with special caution. Restriction in width may be eased to some extent by optimizing the dimensions of barge, namely by deepening the draft and narrowing down the breadth as far as possible.

(3) Self-propelled vessel: 300DWT (400DWT - 600DWT of shallow draft type)
(Length=38-50m, Breadth=7-10m, draft=1.9-2.1m, Speed=14-20km/h)
For: Corridor 1, 2, 3, 4
Note: Self-propelled vessel of 600DWT (draft=2.0m) has recently been introduced in the RRD.

(4) Sea-cum-river vessel: 1,000DWT

(Length=73-81m, Breadth=10-11m, draft=3.0-3.2m, Speed=18-20km/h)

For: Corridor 3 (Cua Day - Ninh Binh) and Corridor 4 (Sea - Hanoi)

Note: Movable bridge (cabin) system, which can decrease the maximum height of vessel and facilitate passing through bridges of low air clearance, is needed for Corridor 4 (Sea - Hanoi). As to Corridor 3, the introduction of further large vessel (sea-vessel of 3,000DWT for example) may be possible since restriction of waterway is only the depth at 1km section of Cua Day river mouth.

### (3) Future fleet mix

69. As to the future fleet mix for the IWT in the RRD, the share of vessels of larger than 300DWT must be raised along with the increase of transport demand. On the other hand, smaller vessels of less than 100DWT, which are mainly deployed for family use or intra-provincial transport, are considered to drop their share for the future.

70. Although the fleet mix must have different configurations by waterway, JICA Study Team sets two kinds of fleet mix, namely average fleet mix in the whole Red River Delta (**Table III-1**) and that in only the Hanoi segment (**Table III-2**).

**Table III-1 Future Fleet Mix in the Red River Delta (DWT share by size class)**

| Year | <50DWT | 51-100DWT | 101-300DWT | >300DWT | Total |
|---|---|---|---|---|---|
| Ave. Size in 2001 | 31 DWT | 81 DWT | 151 DWT | 461 DWT | 113DWT |
| 2001 | 8% | 25% | 41% | 26% | 100% |
| 2010 | 7% | 20% | 41% | 32% | 100% |
| 2020 | 5% | 15% | 40% | 40% | 100% |

Note) A barge train (e.g. Pusher + 4 barges) is counted as 1 vessel not 5 vessels.
Note) Effects by SRV and container in 2010 and 2020 are excluded.
Source) Data in 2001: based on passing vessels in the Red River Delta, VIWA
Data in 2010 & 2020: JICA Study Team estimation

**Table III-2 Future Fleet Mix in Hanoi Segment (DWT share by size class)**

| Year | <50DWT | 51-100DWT | 101-300DWT | >300DWT | Total |
|---|---|---|---|---|---|
| Ave. Size in 2001 | 38 DWT | 76 DWT | 145 DWT | 411 DWT | 127DWT |
| 2001 | 3% | 24% | 47% | 26% | 100% |
| 2010 | 3% | 20% | 45% | 32% | 100% |
| 2020 | 2% | 15% | 43% | 40% | 100% |

Note) A barge train (e.g. Pusher + 4 barges) is counted as 1 vessel not 5 vessels.
Note) Effects by SRV and container in 2010 and 2020 are excluded.
Source) Data in 2001: based on passing vessels in sections nearby Hanoi, VIWA
Data in 2010 & 2020: JICA Study Team estimation

# C. Future Performance of Major Waterways

71. Based on the Basic Policy for the IWT System in the Red River Delta, the transport demand forecast and the vessel fleet perspective, the future performance of major inland waterways can be set as follows:

### (1) To make it possible for increasing traffic to pass through waterways

- Cargo transport volume in the RRD: 19 million tons (2001)
  51 million tons (2020)
  2.0 billion ton-km (2001)
  5.6 billion ton-km (2020)
- Vessel traffic: Heaviest traffic stretch: approx. 240 - 280 vessels/day (2001)
  approx. 450 - 490 vessels/day (2020)

### (2) To make it possible for larger vessels/barge trains to pass through waterways

- Barge train: 2units@600DWT + Pushing Tug@200CV
  For: Corridor 1, 3, 4 (except Corridor 2: Quang Ninh - Ninh Binh)
- Barge train: 4units@400DWT + Pushing Tug@250CV
  For: Corridor 1, 2, 3, 4
- Self-propelled vessel: 300DWT (400DWT - 600DWT of shallow draft type)
  For: Corridor 1, 2, 3, 4
- Sea-cum-river vessel: 1,000DWT
  For: Corridor 3 (Cua Day - Ninh Binh) and Corridor 4 (Sea - Hanoi)

### (3) To meet the technical standard of waterway classification for major corridors

- Future performance of major IWT corridors: see **Table III-3** and **Figure III-3**.

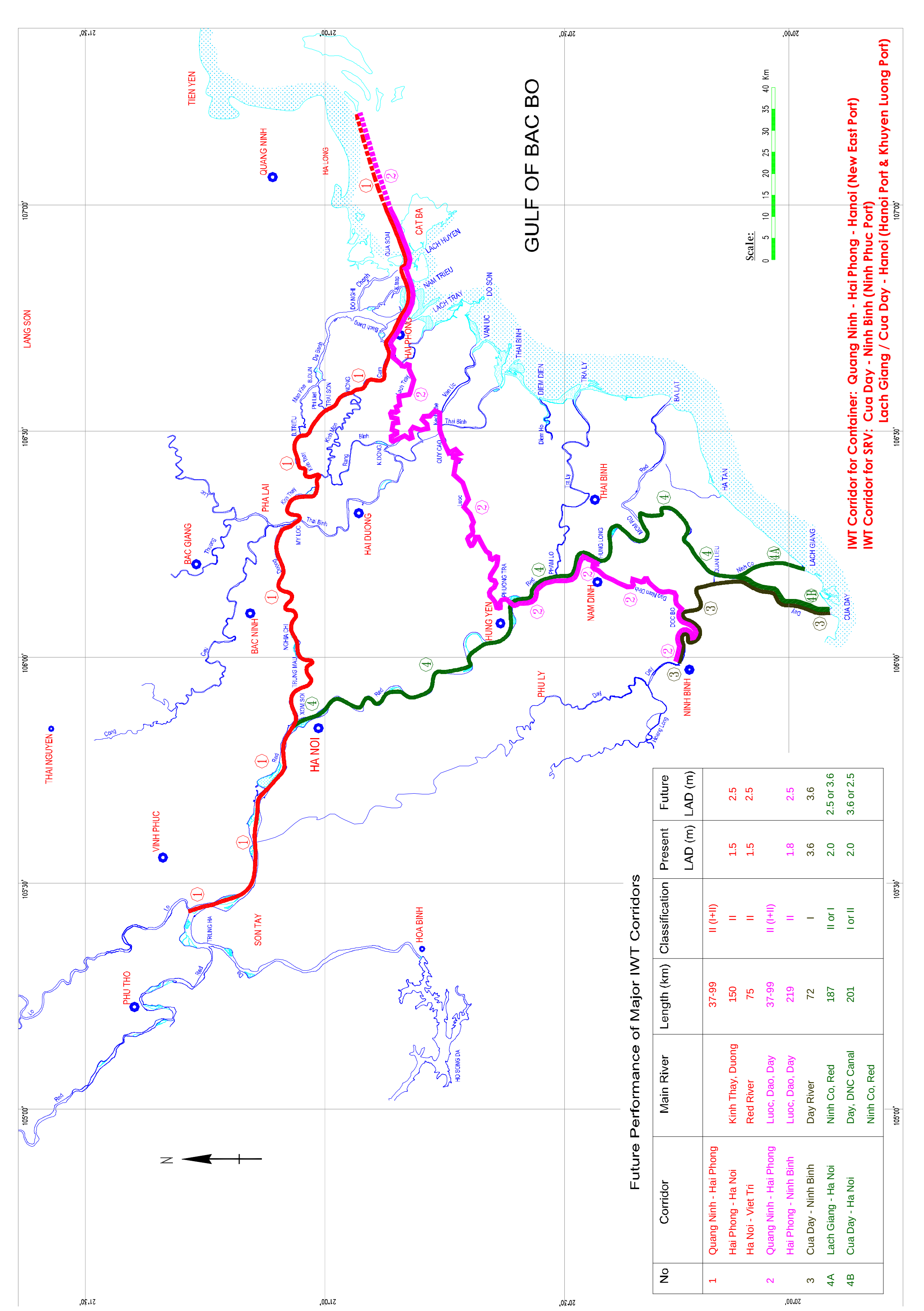
**Table III-3 Future Performance of Major IWT Corridors**

| No | Corridor | Main River | Length (km) | Classification | Present LAD (m) | Future LAD (m) |
|---|---|---|---|---|---|---|
| 1 | Quang Ninh - Hai Phong<br>Hai Phong - Hanoi<br>Hanoi - Viet Tri | <br>Kinh Thay, Duong<br>Red | 37 - 99<br>150<br>75 | II (I+II)<br>II<br>II | <br>1.5<br>1.5 | <br>2.5<br>2.5 |
| 2 | Quang Ninh - Hai Phong<br>Hai Phong - Ninh Binh | <br>Luoc, Dao, Day | 37 - 99<br>219 | II (I+II)<br>II | <br>1.8 | <br>2.5 |
| 3 | Cua Day - Ninh Binh | Day | 72 | I | 3.6 | 3.6 |
| 4A | Lach Giang - Hanoi | Ninh Co, Red | 187 | II or I | 2.0 | 2.5 or 3.6 |
| 4B | Cua Day - Hanoi | Day, DNC Canal, Ninh Co, Red | 201 | I or II | 2.0 | 3.6 or 2.5 |

Note) There may be some locations where it is difficult to realize future dimensions of waterway because of the site condition such as narrow width between dykes.
Note) As to air clearance of bridge for Class II, 7m seem to be enough although Class II requires 9m.
Note) As to Corridor 4, careful feasibility study will be needed before initiating the project.
Source) JICA Study Team

72. As to inland waterways outside the Red River Delta, the Study Team proposes future direction for their development as follows:

(1) Thao River route (Red River segment from Viet Tri to Lao Cai) is proposed to be developed in the long run up to class III on condition that careful feasibility study is conducted.
(2) Da River and Lo River routes are proposed to be developed as the need arises to serve specialized plants.




Future Performance of Major IWT Corridors

| No | Corridor | Main River | Length (km) | Classification | Present LAD (m) | Future LAD (m) |
|---|---|---|---|---|---|---|
| 1 | Quang Ninh - Hai Phong | | 37-99 | II (I+II) | | |
| | Hai Phong - Ha Noi | Kinh Thay, Duong | 150 | II | 1.5 | 2.5 |
| | Ha Noi - Viet Tri | Red River | 75 | II | 1.5 | 2.5 |
| 2 | Quang Ninh - Hai Phong | Luoc, Dao, Day | 37-99 | II (I+II) | | |
| | Hai Phong - Ninh Binh | Luoc, Dao, Day | 219 | II | 1.8 | 2.5 |
| 3 | Cua Day - Ninh Binh | Day River | 72 | I | 3.6 | 3.6 |
| 4A | Lach Giang - Ha Noi | Ninh Co, Red | 187 | II or I | 2.0 | 2.5 or 3.6 |
| 4B | Cua Day - Ha Noi | Day, DNC Canal<br>Ninh Co, Red | 201 | I or II | 2.0 | 3.6 or 2.5 |

Source) JICA Study Team

**Figure III-3 Future Performance of Major IWT Corridor**

# D. Future Performance of Major Ports

73. Based on the Basic Policy for the IWT System in the RRD, the transport demand forecast and the vessel fleet perspective, the future performance of major river ports can be set as follows:

### (1) To handle increasing traffic at port groups

- Total cargo throughput in the Northern region: 37 million tons (2001)
  103 million tons (2020)

Note) SRV cargoes (Hanoi: 1.0 million tons, Ninh Binh: 1.3 million tons) and containers (Hanoi: 67,000TEUs) are excluded.

74. Within the total, cargo throughputs in 2020 at ports managed by central and local level as well as private Berths excluding intra-provincial cargoes in eight provinces are more than 0.8 million tons. In these 8 provinces, major river ports of which cargo throughput capacity is more than some 0.5 million tons will be needed, although some minor ports and private Berths would handle a part of cargoes of their provinces (see **Table III-4**).

**Table III-4 Major River Ports in the Red River Delta (2020)**

| City / Province | Cargo throughput (million tons) | | | | Major river port in 2020 | | |
|---|---|---|---|---|---|---|---|
| | 2001 total | 2001 (*) | 2020 total | 2020 (*) | Major river port | Throughput (million tons) Low case | High case |
| Hanoi | 6.0 | 6.0 | 16.2 | 16.2 | Hanoi, Khuyen Luong, New Nort, New East, Chem | 8.1 | 13.0 |
| Ninh Binh | 1.4 | 1.2 | 3.2 | 2.8 | Ninh Binh &Ninh Phuc | 1.4 | 2.2 |
| Bac Ninh | 0.5 | 0.4 | 1.8 | 1.4 | Dap Cau | 0.7 | 1.1 |
| Nam Dinh | 0.6 | 0.4 | 1.6 | 1.1 | Nam Dinh | 0.6 | 0.9 |
| Thai Binh | 0.6 | 0.3 | 3.2 | 1.1 | Thai Binh | 0.6 | 0.9 |
| Phu Tho | 4.7 | 0.5 | 14.0 | 1.0 | Viet Tri | 0.5 | 0.8 |
| Hai Duong | 6.5 | 0.4 | 14.9 | 0.9 | Cong Cau | 0.5 | 0.7 |
| Bac Giang | 0.6 | 0.5 | 1.2 | 0.8 | A Lu | 0.4 | 0.6 |

Note) SRV cargoes (Hanoi: 1.0 million tons, Ninh Binh: 1.3 million tons) and containers (Hanoi: 64,000TEUs) are excluded.
Note) Container handling port: New East Port, SRV calling port: Hanoi Port, Khuyen Luong Port and Ninh Phuc Port.
Note) Cargo throughput in column of (*) is that excluding specialized ports, seaports, exploitation sites, etc.
Note) Cargo throughputs of major ports are set assuming the following shares in their provinces.
Low case: 50%
High case: 80%
Source) JICA Study Team

75. As to passenger traffic, the following service routes have potential to be realized. In order to become obvious potential passenger demand of service route 2 and 3, it is indispensable to provide a service almost as same as that of bus in terms of transit time and fare.

- Service route 1: Hai Phong - Quang Ninh (existing)
- Service route 2: Hanoi - downstream of Red River (Hung Yen, Thai Binh)

- Service route 3: Hanoi - upstream of Red River (Viet Tri, Phu Tho)
  (Note) In addition to normal passenger traffic, it is important to promote the river cruse for international and domestic tourists in Hanoi segment in particular.

**(2) To raise cargo handling efficiency**

- Bulk cargo at major ports: 2,000 tons/m/year (2001)
  4,800 tons/m/year (2020)
- Non-bulk cargo at major ports: 900 tons/m/year (2001)
  2,400 tons/m/year (2020)
- Mechanization rate: almost 100% (excluding hooking process, 2020)
- Unitization: introduction of the unitization in cargo handling

**(3) To reduce total vessel staying time at port**

- Reduction of waiting and idle time: By constructing adequate numbers of permanent berths, operating ports 24 hours a day and handling cargoes in 3 shift.
- Reduction of handling time: By raising cargo handling efficiency and providing adequate handling equipment.

**(4) To accommodate larger vessels/barge trains**

- Barge train: 2units@600DWT + Pushing Tug@200CV
  For: Major ports in Corridor 1, 3, 4 (except Corridor 2: Quang Ninh - Ninh Binh)
- Barge train: 4units@400DWT + Pushing Tug@250CV
  For: Major ports in Corridor 1, 2, 3, 4
- Self-propelled vessel: 300DWT (400DWT - 600DWT of shallow draft type)
  For: Major ports in Corridor 1, 2, 3, 4
- Sea-cum-river vessel: 1,000DWT
  For: Ninh Phuc Port, Khuyen Luong Port and Hanoi Port through Corridor 3 (Cua Day - Ninh Binh) and Corridor 4 (Sea - Hanoi)

**(5) To clarify role and function of each port within a port group**

76. When planning several ports within a certain area, it is important to clarify the role and function of each port and to arrange them in rational places.

# E. Scenario for Improving IWT System

## 1. Measures for improving IWT system

77. The following four measures are needed to improve IWT system.

- Realization of set performance of waterways
- Realization of set performance of river ports
- Promotion of shipbuilding industry
- Realization of proper management and operation of IWT system

## 2. Organization and investment fund

### 2.1 Organization

78. Organizations responsible for inland waterway facilities or port facilities and equipment should be clearly defined taking into account the traffic volume, dimensions and other socio-economic importance of each waterway or port.

- Major corridors: Master planning and investment of major corridors mainly consisting of class I, II and III shall be conducted by MOT (PMU-Waterways), while their management by VIWA.
- Major river port: Master planning and investment of major river port, of which annual throughput capacity is more than 0.5 - 1.0 million tons, shall be conducted by MOT or other central government after getting approval of MOT. Management shall be conducted by VIWA. Operation shall be conducted by port operating organization including private company. Port operator can make small-scale investment after getting approval of MOT.

### 2.2 Investment fund

79. Many of the current problems on the IWT system accrue from the shortage of funds. Budget of central and local governments has been and will be the principal funds for development, improvement and maintenance of inland waterways and ports. In addition, it should be examined to make use of foreign funds such as ODA, BOT and FDI schemes by making favorable conditions to attract them. A wide variety of alternatives to raise fund is important.

# IV. Plan for Navigation Channel in Hanoi Segment

## A. Basic Requirements

### (1) To make it possible for increasing traffic to pass through waterways

- Cargo transport volume in Hanoi segment: 7.3 million tons (2001)
  12.6 million tons (2010)
  20.3 million tons (2020)
  Note) Containers are excluded.
- Vessel traffic: + Dong Lai: approx. 200 vessels/day (2001)
  approx. 320 vessels/day (2010)
  approx. 480 vessels/day (2020)
  + Phu Dong: approx. 130 vessels/day (2001)
  approx. 190 vessels/day (2010)
  approx. 240 vessels/day (2020)
  + Yen My: approx. 30 vessels/day (2001)
  approx. 50 vessels/day (2010)
  approx. 130 vessels/day (2020)
  Note) Vessels carrying containers are excluded.

### (2) To make it possible for larger vessels/barge trains to pass through waterways

- Barge train: 2units@600DWT + Pushing Tug@200CV
- Barge train: 4units@400DWT + Pushing Tug@250CV
- Self-propelled vessel: 300DWT (400DWT - 600DWT of shallow draft type)
- Sea-cum-river vessel: 1,000DWT for the year 2020

(Note) Corridor 4 (from sea up to Hanoi Port) will be improved and maintained.

### (3) To meet the technical standard of waterway classification for major corridors

Corridor 1: Quang Ninh - Hai Phong - Hanoi - Viet Tri (through Duong River)
Classification: II (LAD=2.5m)
(Note) Special attention should be paid to the vertical clearance of Duong Bridge which causes a major bottleneck to IWT on corridor 1 during flood season.

Corridor 4: sea - Hanoi
Classification: I (LAD=3.6m) for the year 2020

### (4) To stabilize the alignment of waterway in Red River Hanoi segment

80. Comparison of bathymetric surveys conducted in December 1999 and January 2002 suggests that the river alignment of the section between Thang Long Bridge and Hanoi Port may drastically change in the near future. Accordingly, the section should be given urgent and necessary countermeasures.

## B. Dimensions of Navigation Channel

81. Future dimensions of navigation channel for the year 2020 are proposed as shown in **Table IV-1** and **Figure IV-1**.

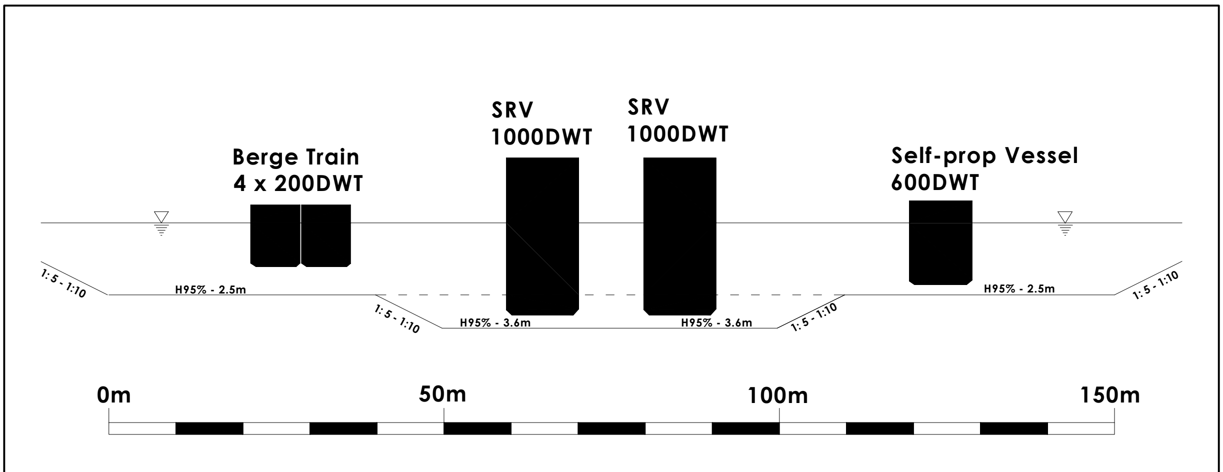
**Table IV-1 Future Dimensions of Navigation Channel in Hanoi Segment (2020)**

| Section | Corridor | LAD | LAW | Bend Radius | Vertical Clearance of Bridge |
|---|---|---|---|---|---|
| Red River (Don Lai - Hanoi Port) | 1 (Quang Ninh - Viet Tri) | 2.5m | 50m - 150m | 500m-700m | H5% + 7m |
| Red River (Hanoi Port - Yen Mi) | 4 (Sea - Hanoi) | 3.6m | 50m - 150m | > 700m | H5% + 10m |
| Duong River (Bifurcation - Phu Dong) | 1 (Quang Ninh - Viet Tri) | 2.5m | > 50m | 500m-700m | H5% + 7m |

Note) Navigation channel in the Red River Hanoi segment shall be 4-lane channel.

Note) As to vertical clearance of bridge for Corridor 1, 7m is proposed although Class II requires 9m.

Source) JICA Study Team




Note) SRVs will be deployed up to Hanoi Port.

Source) JICA Study Team

**Figure IV-1 Typical Cross Section of Navigation Channel in Hanoi Segment (2020)**

82. Future dimensions of navigation channel for the year 2010 are proposed as shown in **Table IV-2** and **Figure IV-2**.

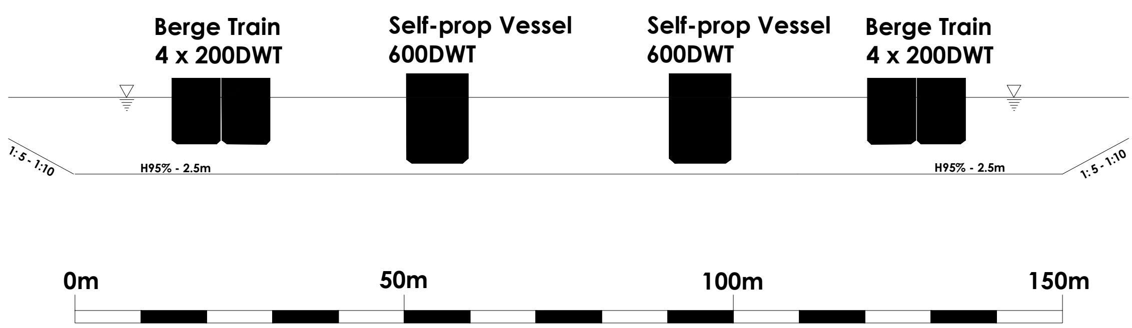
**Table IV-2 Future Dimensions of Navigation Channel in Hanoi Segment (2010)**

| Section | Corridor | LAD | LAW | Bend Radius | Vertical Clearance of Bridge |
|---|---|---|---|---|---|
| Red River (Don Lai - Hanoi Port) | 1 (Quang Ninh - Viet Tri) | 2.5m | 50m - 150m | 500m-700m | H5% + 7m |
| Red River (Hanoi Port - Yen Mi) | 4 (Sea - Hanoi) | 2.5m | 50m - 150m | 500m-700m | H5% + 10m |
| Duong River (Bifurcation - Phu Dong) | 1 (Quang Ninh - Viet Tri) | 2.5m | > 50m | 500m-700m | H5% + 7m |

Note) Navigation channel in the Red River Hanoi segment shall be 4-lane channel.

Note) As to vertical clearance of bridge for Corridor 1, 7m is proposed although Class II requires 9m.

Source) JICA Study Team




Source) JICA Study Team

**Figure IV-2 Typical Cross Section of Navigation Channel in Hanoi Segment (2010)**

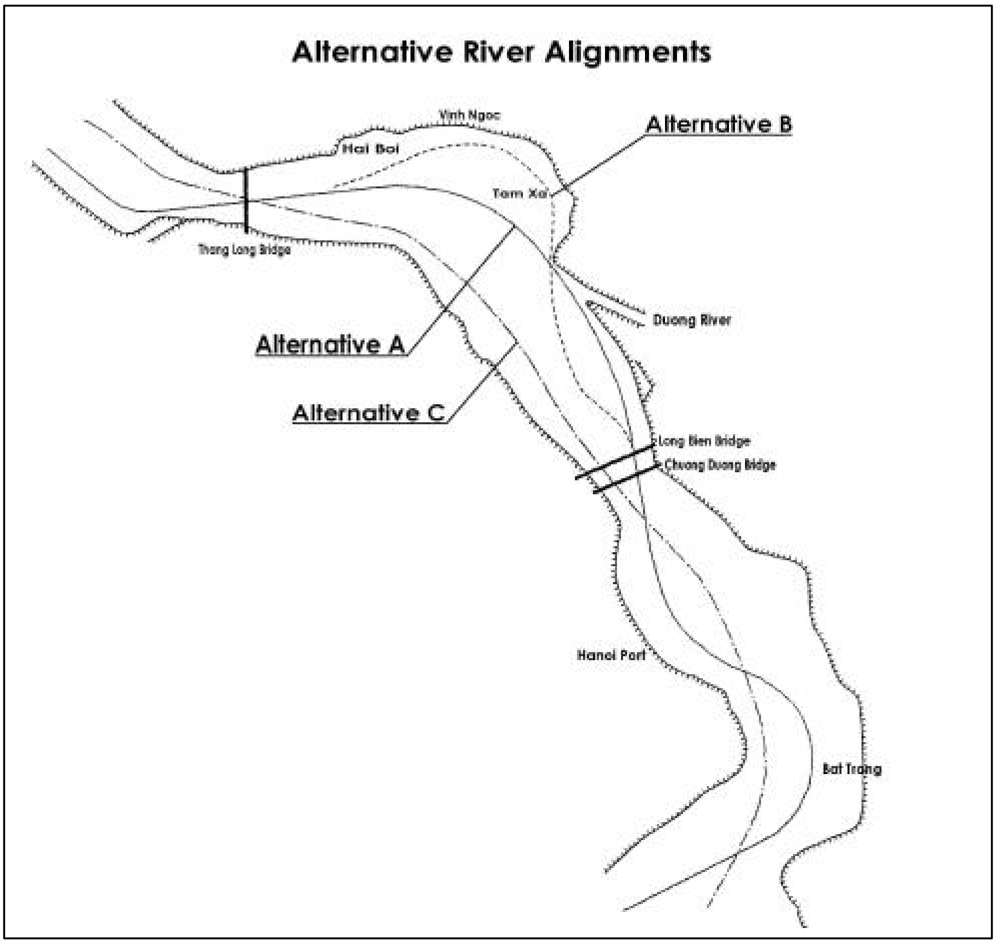
# C. Alignment of Navigation Channel

83. Three main river forms have historically been observed (see **Figure IV-3**). Among the 3 Alternatives, Alternative A is proposed as a future desirable river alignment from the viewpoints of the sedimentation at ports, bifurcation and sluices, possible erosion at resident quarters, making good use of existing constructions of river training works and investment scale.

River Alignment A: The flow goes from Lien Mac to Tam Xa bank, and along the left bank up to Chuong Duong Bridge, and then moves to the right bank. This form is the present one.

River Alignment B: The flow goes along the left dyke (Hai Boi - Vinh Ngoc - Tam Xa). This form has not existed for more than 60 years.

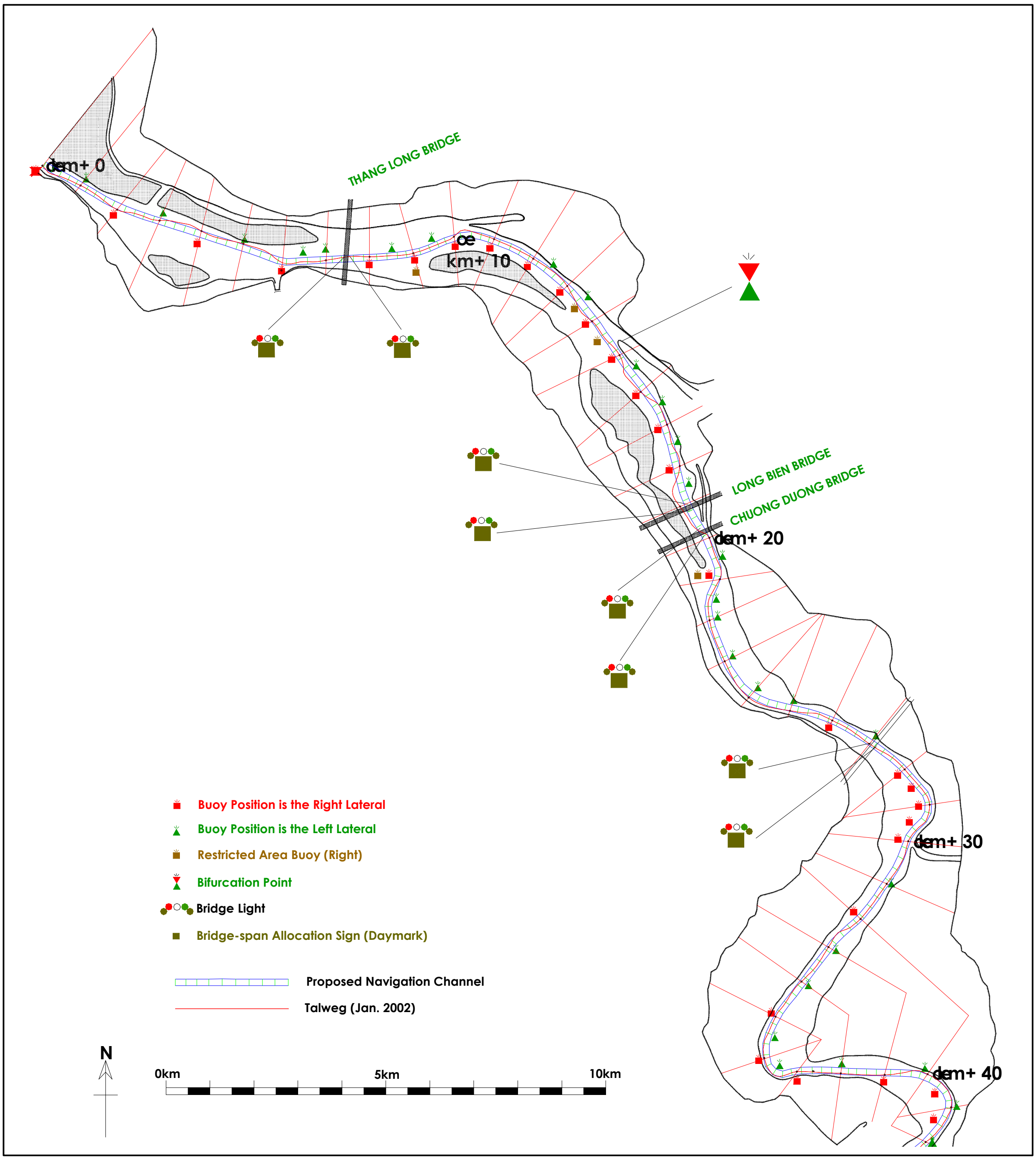
River Alignment C: The flow goes along the right bank between Thang Long and Chuong Duong Bridges, and then moves to the left bank. When this form appeared in around 1990, Hanoi Port experienced serious sedimentation.




Source) Pre-F/S on Red River - Hanoi Section Rehabilitation Project

**Figure IV-3 Alternative River Alignment**

84. An alignment of navigation channel on condition that the talweg line is as of January 2002 (minimum bend radius: 500m - 700m, lateral clearance from ports: 50m) is shown in **Figure IV-4**. It should be noted that the talweg line changes year by year by natural forces, therefore perfect fixing of the navigation channel would be impracticable and costly.




Source) JICA Study Team

**Figure IV-4 Alignment of Navigation Channel in Hanoi Segment (Case-2)**

# D. Vertical Clearance Improvement of Duong Bridge

85. Duong Bridge is located on Highway No.1 as well as a railway between Gia Lam and Yen Vien Stations crossing Duong River at km+8 in Hanoi. Highway No.1 and the railway are under the management of VRA (Vietnam Road Administration) and VR (Vietnam Railway) respectively.

86. Small vertical clearance of Duong Bridge causes a major bottleneck to IWT

on Corridor 1 during flood season. The traffic regulation is conducted by IWMS No.6 when water level becomes more than +6.8m for about 75 days a year. Once the traffic regulation starts, vessels, in due order from higher height of mast/cabin to lower height, are obliged to make a detour of 60km (equivalent to 9 hours at a speed of 7km/h) through Luoc and Red Rivers.

87. The following structural alternatives are conceived in order to improve vertical clearance of Duong Bridge:

Alternative-1: This alternative is to improve vertical clearance of all spans of the bridge. Estimated cost (the Study Team) is US$ 17.7 million.

Alternative-2: This alternative is to improve vertical clearance of only the center span of the bridge with movable span technique. Estimated cost (the Study Team) is US$ 9.6 million.

88. On the other hand, the maximum cost, of which vertical clearance improvement project of Duong Bridge is justified from the benefit of IWT sector, is estimated at some US$ 4 million. Hence, the project is not feasible as an IWT project alone. Therefore, the Study Team recommends that vertical clearance improvement project of Duong Bridge should be prepared as a comprehensive transport project through close consultation with VR and VRA.

## E. Navigation Safety Measures for Duong Bifurcation

89. Special attention should be paid to Duong Bifurcation in terms of vessel traffic capacity and safety since many vessels will pass through Duong Bifurcation.

90. Therefore, distribution of roles and functions among ports/Berths in this Study is carried out taking into account easing vessel traffic concentration at Duong Bifurcation. However, a large number of vessels will still pass through Duong Bifurcation and thus prudent navigation safety measures should be implemented.

91. The basic measures are giving clear priority to vessel navigation. There are six patterns of vessel navigation at Duong Bifurcation:

(a) From upstream in the Red River to the Duong River
(b) From upstream to downstream in the Red River
(c) From the Duong river to upstream in the Red River
(d) From the Duong River to downstream in the Red River
(e) From downstream to upstream in the Red River

(f) From downstream in the Red River to the Duong River

92. The top priority shall be given to the vessel that goes from upstream in the Red River to Duong River (a) and to downstream in the Red River (b). The second priority shall be given to the vessel from Duong River to downstream in the Red River (d). In other cases, ships shall navigate paying special attention to other vessels near Duong Bifurcation.

93. There are four alternatives on additional navigation safety measures for Duong Bifurcation as follows:

Alternative-1

Every vessel that passes through Duong Bifurcation in the day time shall put up the international signal flag showing its destination and shall navigate according to the above mentioned priority rule. During the night, every vessel shall navigate with whistles according to the priority rule. In general a vessel going straight blows one short whistle continuously and a vessel turning to the left blows two short whistles continuously.

Alternative-2

Vessel navigation is limited to particular times. Vessels going in the Red River can navigate during a certain time and vessels in the Duong River during the other time. This method may be difficult if many vessels concentrate on Duong Bifurcation.

Alternative-3

"Traffic Control Center" will be set up at Duong Bifurcation. Vessels shall communicate with the Center through VHF and shall navigate according to the direction from the Center.

Alternative-4

Turning left point for vessels from the Duong River to downstream in the Red River is moved to upstream in the Red River by installing land signs of "No Left Turn". This method may be effective for the improvement of vessel traffic capacity and safety at the Duong Bifurcation, although the navigation length of the vessel becomes longer.

94. JICA Study Team proposes that Alternative-1 should be adopted in the beginning. It is also advisable to study the details of Alternative-3 and Alternative-4 as vessel traffic will increase. In addition to the above measures, navigation aids should be installed at closer intervals near Duong Bifurcation.

# F. Navigation Aids

95. Planning fundamentals for providing navigation aids in the Red River Hanoi segment are proposed as follows:

- To install lateral/cardinal lighted marks conforming to the buoyage system for Vietnamese inland waterway (22 TCN 269-2000) as well as that of the International Association of Lighthouse Authority (IALA) zone A.
    + Each lateral mark (lighted buoy) should be placed 1000 meters apart (500 meters apart at sharp bends and near Duong Bifurcation) in a zigzag pattern as a general rule.
    + A lighted beacon should be placed at Duong Bifurcation as at present.
    + Cardinal marks should be placed at obstacles and restricted areas.
- To install bridge light sets and daymarks at bridges.
- To install jetty markers at ports. Each jetty marker should be placed 40m apart as a general rule.
- The source of light should be solar battery system with LED (light emitting diode) as a general rule.

96. Proposed number of navigation aids is listed in **Table IV-3**.

**Table IV-3 Proposed Number of Main Navigation Aids**

| Type | Location | Interval | Required Number | Note |
|---|---|---|---|---|
| Lateral Mark(Lighted Buoy) | 40km Red River Hanoi Segment | 1000 m (500m) apart in a zigzag pattern | 60 | |
| Lateral Mark(Lighted Beacon) | Duong Bifurcation | (-) | 1 | Existing |
| Cardinal Mark(Lighted Buoy) | at obstacles and restricted areas | (-) | 20 | |
| Bridge Light set | Thang Long, Long Bien, Chuong Duong, Thanh Tri | (-) | 8 | |
| Bridge Daymark | Thang Long, Long Bien, Chuong Duong, Thanh Tri | (-) | 8 | Existing |
| Jetty Marker | Hanoi, Khuyen Luong, New North, New East | 40 meters apart | 80 | |

Note) Bridge Light set consists of a center light, a port edge light, a starboard edge light and two pier lights for both side of a bridge.
Source) JICA Study Team