EXECUTIVE SUMMARY

I. Introduction

1. In response to a request from the Government of the Socialist Republic of Vietnam, the Government of Japan conducted the Study on the Red River Inland Waterway Transport System in the Socialist Republic of Vietnam.

2. The objectives of the Study are; (1) to formulate a long-term strategy for the IWT (Inland Waterway Transport) 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.

II. Socio-economic Profile and Demand Forecast

3. Northern Vietnam consists of three economic regions, namely the Red River Delta (9 provinces), the Northeast (13 provinces) and the Northwest (3 provinces). As of 2000, the total population of the Northern Vietnam is 28.3 million or 36% of the national total. As of 1999, GDP of the Northern Vietnam is VND 100 trillion or 25% of the national total. Population and GDP in the Northern Vietnam in 2020 are forecast to increase to 38.8 million and VND 271.5 trillion respectively.

4. The IWT conventional cargo demand in the Northern Vietnam is estimated to increase from 18.6 million tons in 2001 to 32.3 million tons in 2010 and 51.3 million tons in 2020. Main commodity items include construction material, coal, cement and fertilizer.

5. Potential SRV (sea-cum-river vessel) cargo demand is estimated at 1.0 million tons to/from Hanoi and 2.4 million tons to/from Ninh Binh in 2020. Potential IWT container demand between northern seaports and Hanoi is forecast at 32 thousand TEUs in 2010 and 67 thousand TEUs in 2020.

6. 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. In addition, the probable number of tourists choosing the river cruise is estimated at 0.1 million in 2010 and 0.3 million in 2020.

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

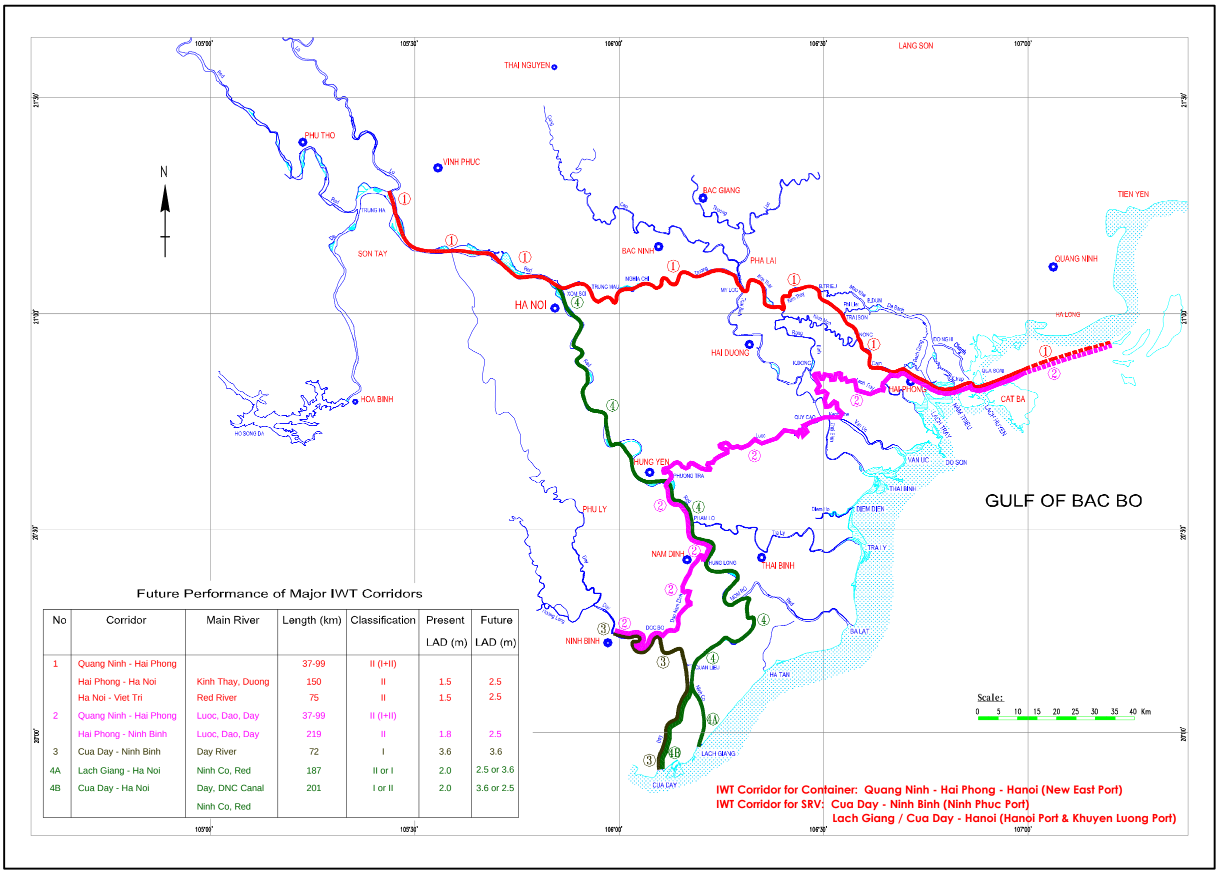
7. The IWT system in the Red River Delta is expected to play an important role in the socio-economic development as well as bettering the lives of people living there, by making full use of its advantages and potential such as; (i) dense and convenient waterway network, (ii) low utilization of inland waterways, (iii) ideal port locations, (iv) low energy consumption and (v) low CO2 discharge.

8. The basic policy for the IWT system in the Red River Delta should include the following items; (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 and (5) to enhance state management of the IWT system and to develop its capacity by allocating proper budget, personnel and equipment.

9. For the future, vessels of larger size and higher speed are considered to be introduced in order to meet the IWT demand. The following maximum vessel size can be assumed in the time range of the Long-term Strategy; (1) Barge train of 2units@600DWT+Tug, (2) Barge train of 4units@400DWT+Tug, (3) Self-propelled vessel of 300DWT (400DWT - 600DWT of shallow draft type) and (4) SRV of 1,000DWT.

10. 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.

11. Future performance of major inland waterways can be set as follows; (1) to make it possible for increasing traffic to pass through waterways, (2) to make it possible for larger vessels/barge trains to pass through waterways and (3) to meet the technical standard of waterway classification for major corridors. Future performance of major IWT corridor is shown in **Figure 1**.



Source) JICA Study Team

Figure 1 Future Performance of Major IWT Corridor

12. The future performance of major river ports can be set as follows; (1) to handle increasing traffic at port groups, (2) to raise cargo handling efficiency, (3) to reduce total vessel staying time at port, (4) to accommodate larger vessels/barge trains and (5) to clarify role and function of each port within a port group. Major river ports in the Red River Delta are identified as shown in **Table 1**.

Table 1 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

IV. Plan for Navigation Channel in Hanoi Segment

13. Future dimensions of navigation channel are proposed as shown in **Table 2** and **Figure 2**.

Table 2 Future Dimensions of Navigation Channel in Hanoi Segment

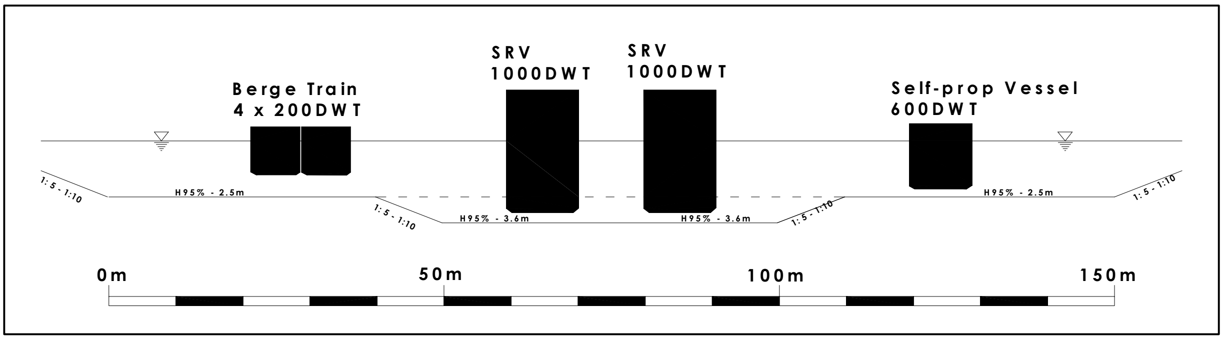
Section	Corridor	LAD	LAW	Bend Radius	Vertical Clearance of Bridge
Red River (Don Lai - Hanoi Port)	1 (Quang Ninh - Viet Tri)	2.5m	50m - 150m	500m-700m	H5% + 7m
Red River (Hanoi Port - Yen Mi)	4 (Sea - Hanoi)	3.6m (2.5m)	50m - 150m	> 700m (500m-700m)	H5% + 10m
Duong River (Bifurcation - Phu Dong)	1 (Quang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

Note) LAD and bend radius of corridor 4 in 2010 is 2.5m and 500m-700m as mentioned in parentheses.

Source) JICA Study Team



Note) SRVs will be deployed up to Hanoi Port in 2020.

Source) JICA Study Team

Figure 2 Typical Cross Section of Navigation Channel in Hanoi Segment

14. Three main river forms have historically been observed. Among them, the present one (Alternative A) is proposed as a desirable river alignment from the viewpoints of the sedimentation at ports, bifurcation and sluices, possible erosion at resident quarters, investment scale, etc.

15. Small vertical clearance of Duong Bridge causes a major bottleneck to IWT on Corridor 1 during flood season. Vertical clearance improvement project of Duong Bridge should be prepared as a comprehensive transport project through close consultation with Vietnam Railway and Vietnam Road Administration.

V. Plan for Channel Stabilization in Hanoi Segment

16. The **direct purposes** of channel stabilization are to stabilize the channel alignment, or to maintain the river alignment of Alternative A, and to secure the requirements on channel dimensions for safe and efficient navigation of vessels, while satisfying **other requirements** from MARD, HNPC, etc. Such requirements include avoidance of undesirable adverse effects on floods, especially increase in water level and inundation area during floods, and decrease in flood discharge capacity. From the viewpoint of agriculture, there should be no hindrance in irrigation from the Red River, especially closure of water intakes along the Hanoi segment. Flow distribution between the Red River and the Duong River shall be maintained. There are other requirements such as harmony with city planning, stability of existing bridges, and preservation of natural and social environment.

17. Comprehensive natural conditions on the river are surveyed and investigated, specifically at Hanoi segment in the dry and flood seasons, or January and August 2002. **Water levels** and **discharges** are fluctuating within broad ranges with the average seasonal water level fluctuations of about 9m, discharge fluctuations with factors of 10 to 20. Distribution of discharge between the Red River and the Duong River is about 27% into the Duong. The **current speeds** observed are mostly less than 1.0m/sec in the dry season and 1.0 to1.8 m/sec in the rainy season. **Riverbed sediments** consisting mainly of fine well-sorted sand in the deeper channels, and mixtures of sand, silt and clay prevail on the shoals and banks. These fine sediments are quite mobile and susceptible to be easily transported as bed-load or as suspension-load. The current velocity falls into the range of **scouring zone** in the flood season and intermediate to scouring zones in the dry season.

18. In this Hanoi segment, three different **alternatives for the alignment** of the main stream proposed by TEDI are considered as Alternatives A, B, and C. Preference is given to Alternative A as it ascertains an open access to the flow-discharge into the Duong River, prevent siltation at the quays of Hanoi Port and other planned ports, and also has advantages to maintain major water intakes existing along the segment.

19. The river adopts a **multi-channel character** with strong lateral shifts of channels and banks, and erosion/sedimentation. The cross section at Thang Long Bridge shows quite stable features. The significant dynamic change of riverbed, or the order of 10m differences in elevations, has been occurring at Tu Lien-Trun Ha Sand Bar. This is mainly because of instability of the Talweg and meandering.

20. Very recently, there is a sign of **change in the main stream** from Alternative A to Alternative C, which appeared after the flood season in 2002 and should be stopped.

21. Taking account of the purposes of the channel stabilization plan, first the **basic sinuosity** is assumed as the guideline of the desirable channel alignment in planning the channel stabilization facilities in consideration of the above-mentioned purposes such as considerations on the existing ports and water intakes. Then, as the **measures for river and channel stabilization**, three basic alternative plans (**Alternative 1, 2** and **3**) are selected, where **Alternative 1** aims at stabilization and maintenance of the present alignment of the channel, not to change the primary features of the dual channels. **Alternative 2** is to intend the waterway to be a single channel by means of two weirs at the mouths of the second channels. **Alternative 3** is a modified plan of Alternative 2 by widening the main channel.

22. **Computer simulations** with two-dimensional shallow water model is introduced to analyze hydraulic and morphological phenomena and to predict the effect of channel development. The model is first calibrated in terms of velocity and SS between the simulated and the measured values in the dry and flood seasons. They agree each other very well, which proves the model's reliability.

23. According to the result of simulations, the **present state of the river configuration and flow** are stable and no significant change is expected during the dry season (water level at Hanoi H-M Station = LSD +3.1m). Deviation of the **current direction** from the present one at Thang Long Bridge would bring about drastic change in the downstream flow condition.

24. For the flood season (water level at Hanoi H-M Station = LSD +9.3m), the degree of difference in current speed of the Alternatives is compared with that of the present condition. As the result, **Alternative 1** is chosen as the most basically preferable case of the river stabilization measures in terms of increase in water level, change of current velocity, and distribution of water discharge.

25. The channel stabilization facilities planned in Alternative 1, or the **priority project**, include groin fields at Vong La and Dong Ngoc, training walls at the left slopes of Nhat Tan and Tu Lien - Trung Ha Sand Bars, and slope protections at riverside banks of Hai Boi, An Ninh, Bac Cau - Bode, and Ly Thai To - Back Dang.

26. In order to confirm the **appropriate width of the channels**, surveyed hydraulic parameters are examined in terms of hydraulic section; A, water surface

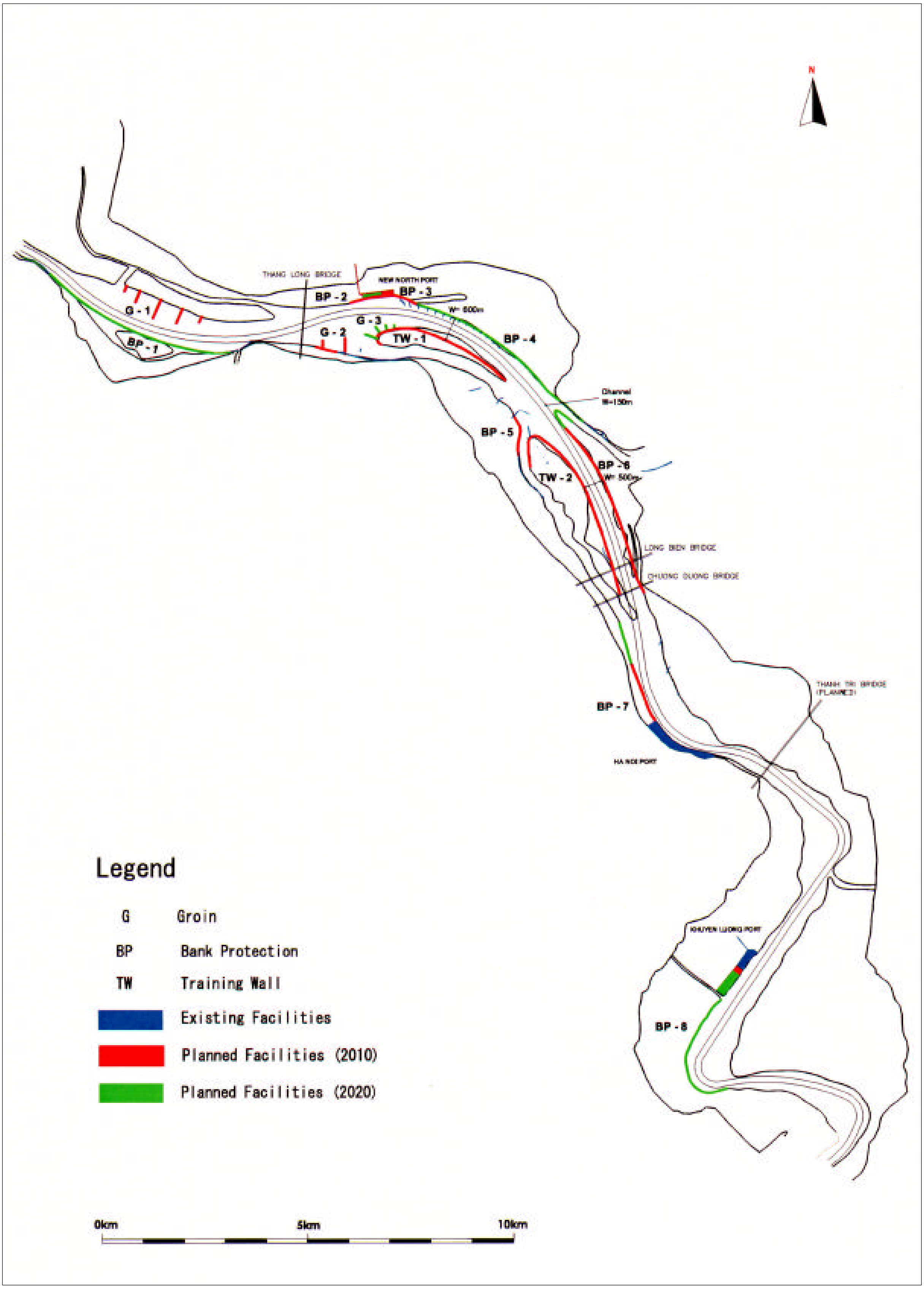
width; B, and average water depth; H. It is derived that the existing channels have the dimensional characteristics of B = 600m (main channel) + 300m (secondary channel) = 900m at Nhat Tan Sand Bar, and B = 500m (main channel) + 200m (secondary channel) = 700m at Tu Lien - Trung Ha Sand Bar.

27. Another examination is made based on a **theoretical relationship** between width and depth of a rectangular channel under dynamic equilibrium state, which is expressed by $y = a\, x^{-b}$, where $y = B/B_0$ and $x = H/H_0$. The actual data are applied to this equation by the least squares method, and the result is a = 1.0624 and b = 0.8218. Thus, the optimum main channel widths are confirmed to be about 600m for Nhat Than Sand Bar and about 500m for Tu Lien - Trung Ha Sand Bar.

28. Lastly, the **flood drainage capacity** is examined by the simulation model for a very high water level of +12.5 m (Water discharge at the upper boundary = 22,700 m^3/sec) and the extremely high water level of 13.4 m (Water discharge at the upper boundary = 32,400 m^3/sec). Under these conditions, all the riverside areas between both dikes are inundated. Comparing with the result of simulation for **Alternative 1**, it is confirmed that the channel stabilization facilities have little effects on the flood discharge. The **change in water levels** at major points in the Hanoi segment is minimal, or slight decrease at the upper portion and increase at the lower portion of Chuong Duong Bridge in an order of cm, owing to self-scouring effect. Discharge into the Duong River decreases slightly during flood. Hence, the effect of the facilities on floods can be neglected. It is noted that the **flood drainage corridor** is considered to be the river area between the existing dikes.

29. The **proposed plane alignment** of the channel stabilization facilities is shown in **Figure 3**. The groins are to be build one by one, and the training walls, in principle, to be constructed from upstream to downstream. Attentions are paid to effectuate and economize the facilities such as fixing of the entrance of the secondary channel at Lach Quyt.

30. In conclusion, considering the **recent trend of change** of the main channel, the proposed stabilization measures should be undertaken urgently. The channel stabilization facilities should be **constructed step by step** with careful monitoring on the effects of the facilities by follow up surveys, and should be reviewed taking account of the expected and realized effects, priority, timing, and scale of the facilities. Flexible and mobile operations of **dredging** should be incorporated in addition to construction of hard facilities. A capital dredging volume with an order of 3 million m^3 and a certain amount of the periodical maintenance dredging should be taken into account.



Source) JICA Study Team

Figure 3 Proposed Alignment of Channel Stabilization Facilities

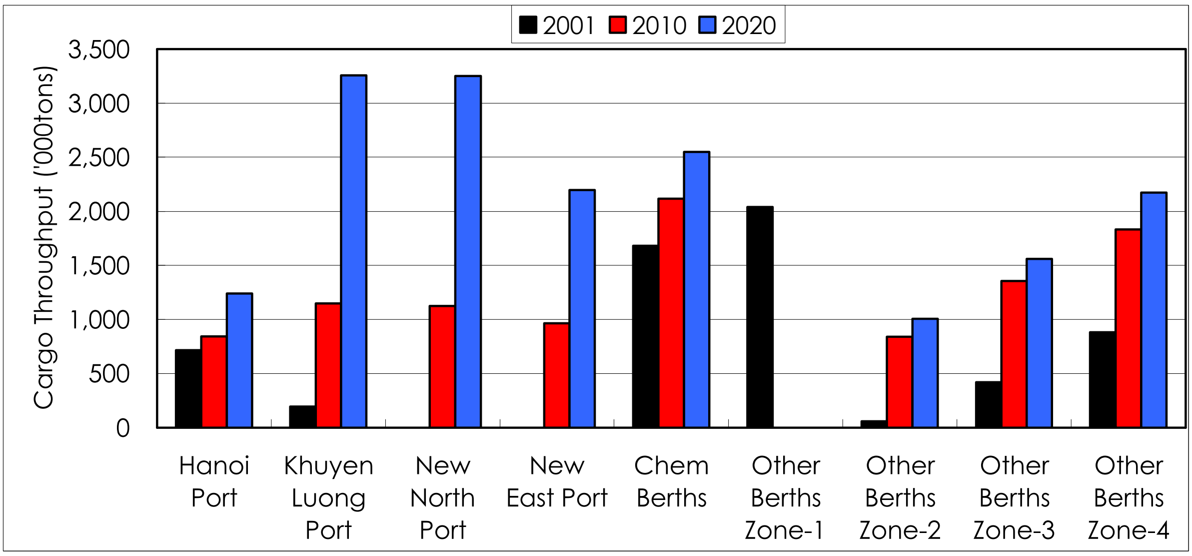
VI. Plan for Port System in Hanoi Segment

31. Taking into account the development direction of Hanoi City, future road network, alignment of navigation channel and land use of flood plane, distribution of roles and functions among ports/Berths is set as follows:

- Hanoi Port
  + To serve mainly for Citadel districts.
  + To receive SRV from Southern and Middle Vietnam by 2020.
  + To decrease bulk cargo and increase clean cargo.
  + To become main passenger gateway.
- Khuyen Luong Port
  + To serve mainly for whole right bank of Red River (SRV cargo: for whole city).
  + To receive SRV from Southern and Middle Vietnam by 2020.
- New North Port
  + To serve mainly for Dong Anh and Soc Son Districts.
  + To contribute to urban and industrial development.
- New East Port
  + To serve mainly for Gia Lam District (container: for whole city).
  + To receive container vessel/barge from northern seaports.
  + To become the 1st gateway from northern seaports.
- Chem Berths
  + To serve mainly for Tu Liem District.
  + To be improved in terms of safe and environmental aspects.
- Other Berths
  + To prohibit extension of other cargo Berths.
  + To remove temporary cargo Berths located between Thang Long Bridge and Thanh Tri Bridge and to transfer to the outside by 2010 in principle.
  + To construct satellite passenger berths at 4 major tourist spots.

32. Cargo throughputs of ports/Berths in the Hanoi Segment in 2001, 2010 and 2020 are shown in **Figure 4**. In order to handle these cargoes, required length and depth of berth, handling equipment, land space, number of access road lanes and elevation of port facilities are identified in the Study.

33. Locations of ports/Berths and their scales in terms of berth length are shown in **Figure 5**. Master plans of Hanoi, Khuyen Luong, New North and New East Ports are shown in **Figure 6** through **Figure 13**.



Note) Zone-1: Red River between Thang Long and Thanh Tri Bridges
Zone-2: Red River upstream of Thang Long Bridge
Zone-3: Red River downstream of Thanh Tri Bridge
Zone-4: Duong River

Note) Cargo transfer from Zone-1 (2010): Zone-1(0%), Zone-2(30%), Zone-3(40%), to Zone-4(30%), outside HN(0%).
Cargo transfer from Zone-1 (2020): Zone-1(0%), Zone-2(30%), Zone-3(40%), to Zone-4(30%), outside HN(0%).

Note) New East Port will handle another 32,000 TEUs in 2010 and 67,000 TEUs in 2020 of container.

Source) JICA Study Team

Figure 4 Cargo Throughput of Ports/Berths in Hanoi Segment (2001, 2010, 2020)

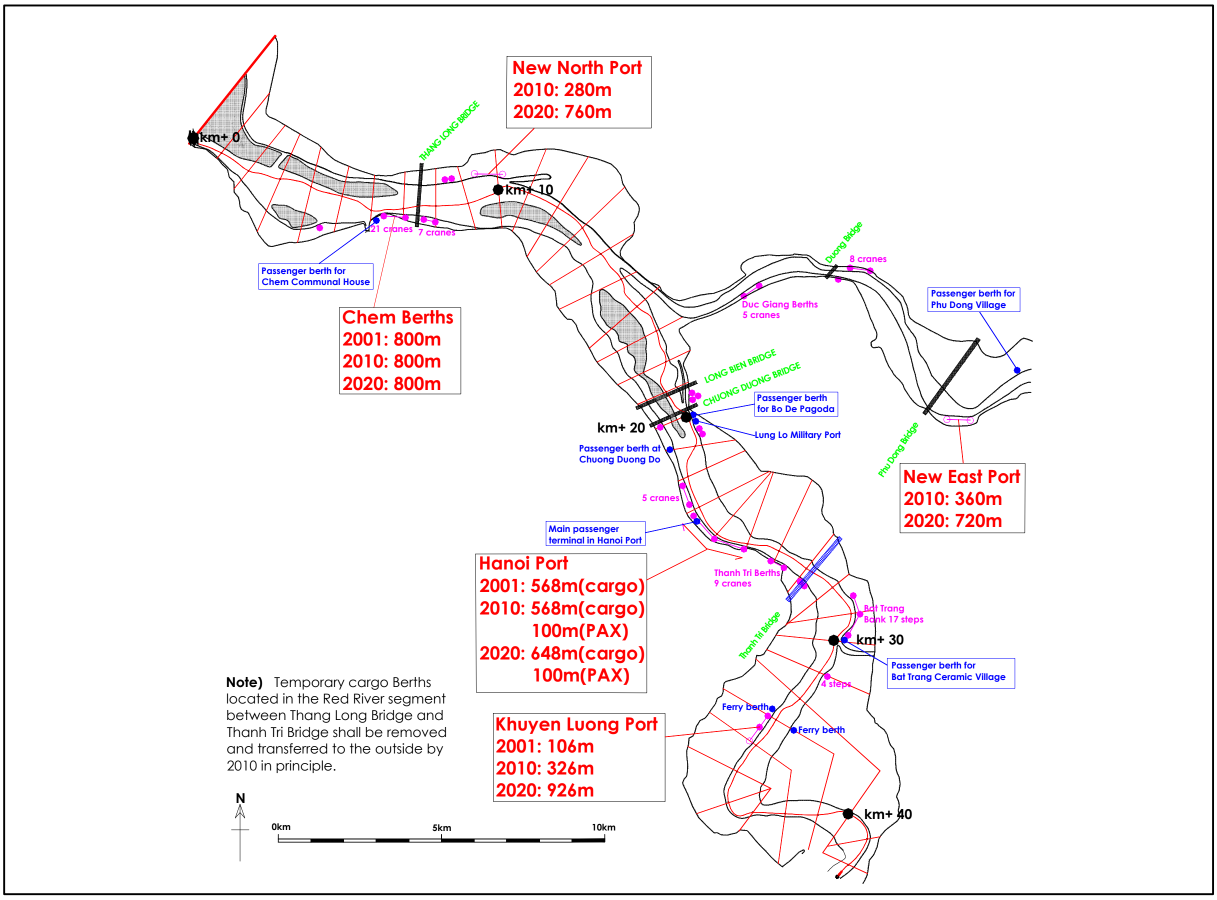


Figure 5 Location of Ports/Berths (2001, 2010, 2020)