Appendix 27 Vessel Traffic Simulation

In the course of formulating the Master Plan and Short-term Development Plan for IWT system in the Hanoi segment, the vessel traffic simulation by using computer was carried out in order to check the appropriateness of the Master Plan and Short-term Development Plan for waterways and ports in terms of BOR (Berth Occupancy Ratio), vessel waiting time and smoothness of vessel traffic.

Main input data for the vessel traffic simulation are as follows:

- Berth property (see **Table A27.1.1**)
- Vessel Fleet Mix (see **Table A27.1.2** and **Table A27.1.3**)
- Average speed of vessel (see **Table A27.1.4**)
- Rules of navigation (see **Table A27.1.5**)
- Seasonal change in cargo flow (see **Table A27.1.6**)
- Day-night change in cargo flow (see **Table A27.1.7**)
- Conditions at Duong Bridge (see **Table A27.1.8**)
- Cargo Flow in Hanoi Segment (see **Table A27.1.9** and **Table A27.1.10**)

The result of vessel traffic simulation shows that there is no fatal bottleneck for vessel traffic in Hanoi segment in 2010 and 2020, and hence the Master Plan and Short-term Development Plan are judged from the above-mentioned viewpoint to be appropriate as a whole (see **Table A27.1.11**).

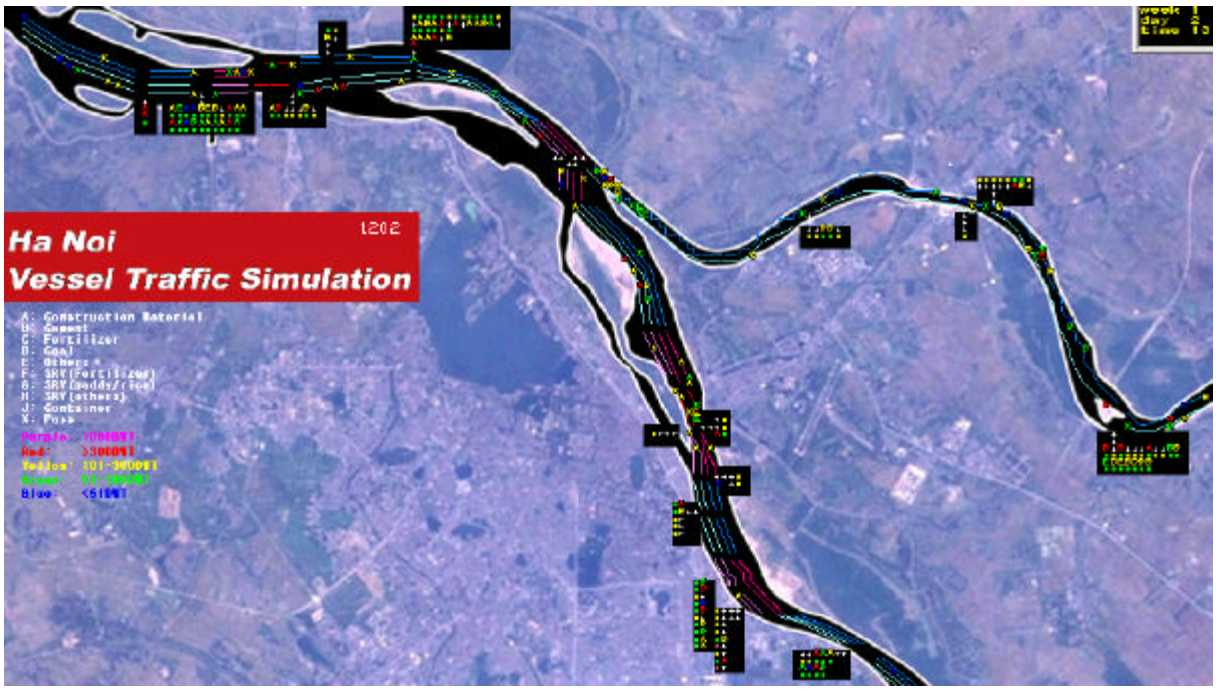


Figure A27.1.1 Screen Image of Vessel Traffic Simulation

Table A27.1.1 (1) Berth Property

Port / Berth Group	Berth Name		Unavailable Berth			Dimension of Berth						Working Hours				Handling Rate						Berth Close Period							Vessel cannot call at the berth		
	in Study	Original	2001	2010	2020	Length			Continuous Use	LAD	Crest Level	Cargo Handling		Idle Time per vessel		2001		2010		2020		7/7-7/16	7/17-7/23	7/24-7/30	7/30-8/1	8/2-8/7	8/8-8/14	8/15-8/24	101-300	>300	SRV1000
						2001 (m)	2010 (m)	2020 (m)		(m)	(m)	from	to	2001 (hour)	2010, 2020 (hour)	Bulk (ton/h)	Others (ton/h)	Bulk (ton/h)	Others (ton/h)	Bulk (ton/h)	Others (ton/h)	WL8.0	WL9.0	WL10.0	WL11.0	WL10.0	WL9.0	WL8.0	(DWT)	(DWT)	(DWT)
Hanoi Port	HN1	B2				20	20	20		>3.6	+8.5	07:00	04:00	4	3	19	7	28	11	42	14		X	X	X	X	X		X	X	X
	HN2	B3				50	50	50		>3.6	+11.5	07:00	04:00	4	3	48	18	70	26	105	35										
	HN3	B4				18	18	18		>3.6	+8.5	07:00	04:00	4	3	17	6	25	9	38	13		X	X	X	X	X		X	X	X
	HN4	N0.1				55	55	55		>3.6	+11.5	07:00	04:00	4	3	53	19	77	29	116	39										X
	HN5	No.2, 3				40	40	40	YES	>3.6	+11.5	07:00	04:00	4	3	39	14	56	21	84	28										
	HN6					40	40	40		>3.6	+11.5	07:00	04:00	4	3	39	14	56	21	84	28										
	HN7					62	62	62		>3.6	+11.5	07:00	04:00	4	3	60	22	87	33	130	43										
	HN8	T4				12	12	12		>3.6	+8.0	07:00	04:00	4	3	12	4	17	6	25	8	X	X	X	X	X	X	X	X	X	X
	HN9		X	X				40	YES	>3.6	+11.5	07:00	04:00		3	0	0	0	0	120	40										
	HN10		X	X				40		>3.6	+11.5	07:00	04:00		3	0	0	0	0	120	40										
	HN11	No.4,5,6				40	40	40		>3.6	+11.5	07:00	04:00	4	3	39	14	56	21	84	28										
	HN12					40	40	40		>3.6	+11.5	07:00	04:00	4	3	39	14	56	21	84	28										
	HN13					40	40	40		>3.6	+11.5	07:00	04:00	4	3	39	14	56	21	84	28										
	HN14					47	47	47		>3.6	+11.5	07:00	04:00	4	3	45	16	66	25	99	33										
	HN13	No.7				50	50	50	YES	>3.6	+9.0	07:00	04:00	4	3	69	25	100	38	150	50		X	X	X	X	X				X
	HN14	No.7+	X	X	X					>3.6	+9.0	07:00	04:00		3	0	0	0	0	0	0		X	X	X	X	X				X
	HN15	T8				14	14	14		>3.6	+8.5	07:00	04:00	4	3	13	5	20	7	29	10		X	X	X	X	X		X	X	X
	HN16	No.8				40	40	40	YES	>3.6	+9.5	07:00	04:00	4	3	55	20	80	30	120	40			X	X	X					X
	HN17	No.8+	X	X	X					>3.6	+9.5	07:00	04:00		3	0	0	0	0	0	0			X	X	X					X
	Total					568	568	648								584	212	849	318	1,514	505										
Khuyen Luong Port	KL1		X				30	30	YES	>3.6	+10.0	07:00	04:00		3	0	0	53	18	63	21				X						
	KL2		X				30	30		>3.6	+10.0	07:00	04:00		3	0	0	53	18	63	21				X						
	KL3	No.2				40	40	40		2.2	+10.0	07:00	04:00	4	3	55	20	100	35	120	40				X						
	KL4					44	44	44		2.2	+10.0	07:00	04:00	4	3	61	22	110	39	132	44				X						
	KL5	No.1				22	22	22		2.2	+9.5	07:00	04:00	4	3	30	11	55	19	66	22			X	X	X			X	X	X
	KL6		X				40	40	YES	>3.6	+10.5	07:00	04:00		3	0	0	100	35	120	40										
	KL7		X				40	40		>3.6	+10.5	07:00	04:00		3	0	0	100	35	120	40										
	KL8		X				40	40		>3.6	+10.5	07:00	04:00		3	0	0	100	35	120	40										
	KL9		X				40	40		>3.6	+10.5	07:00	04:00		3	0	0	100	35	120	40										
	KL10		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL11		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL12		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL13		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL14		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL15		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL16		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL17		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL18		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL19		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL20		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL21		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL22		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL23		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	KL24		X	X				40		>3.6	+10.5	07:00	04:00		3	0	0	0	0	120	40										
	Total					106	326	926								146	53	770	270	2,724	908										
Chem Berth G.	CM1					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM2					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM3					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM4					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM5					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM6					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM7					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	CM8					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM9					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM10					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM11					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM12					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM13					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM14					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30			X	X	X					X
	CM15					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	CM16					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	CM17					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	CM18					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	CM19					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	CM20					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	CM21					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30		X	X	X	X	X					X
	Total					840	840	840								1,365	525	1,680	630	2,100	630										

Note) Berth length of a landing stage is set to 40m per crane.
Note) Handling rate of Detached-pier type berth is decreased to 70% of standard type berth.

Table A27.1.1 (2) Berth Property

Port / Berth Group	Berth Name		Unavailable Berth			Dimension of Berth						Working Hours				Handling Rate						Berth Close Period							Vessel cannot call at the berth		
	in Study	Original	2001	2010	2020	Length			Continuous Use	LAD	Crest Level	Cargo Handling		Idle Time per vessel		2001		2010		2020		7/7-7/16	7/17-7/23	7/24-7/30	7/30-8/1	8/2-8/7	8/8-8/14	8/15-8/24	101-300	>300	SRV1000
						2001 (m)	2010 (m)	2020 (m)		(m)	(m)	from	to	2001 (hour)	2010, 2020 (hour)	Bulk (ton/h)	Others (ton/h)	Bulk (ton/h)	Others (ton/h)	Bulk (ton/h)	Others (ton/h)	WL8.0	WL9.0	WL10.0	WL11.0	WL10.0	WL9.0	WL8.0	(DWT)	(DWT)	(DWT)
Thanh Tri Berth G.	TT1					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT2					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT3					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT4					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT5					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT6					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT7					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT8					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	TT9					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	Total					360	360	360								585	225	720	270	900	270										
Duc Giang Berth G.	DG1					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	DG2					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	DG3					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	DG4					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	DG5					40	40	40				07:00	04:00	4	3	65	25	80	30	100	30										X
	Total					200	200	200								325	125	400	150	500	150										
Bat Trang Bank	BT1					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20									X	X
	BT2					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20									X	X
	BT3					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20									X	X
	BT4					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20									X	X
	BT5					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20			X	X	X				X	X
	BT6					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20			X	X	X				X	X
	BT7					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20			X	X	X				X	X
	BT8					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20		X	X	X	X	X			X	X
	BT9					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20		X	X	X	X	X			X	X
	BT10					(-)	(-)	(-)				07:00	04:00	4	3	20	20	20	20	20	20		X	X	X	X	X			X	X
	Total					0	0	0								200	200	200	200	200	200										
Other Berths	OB1					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB2					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB3					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB4					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB5					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB6					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB7					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB8					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB9					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB10					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB11					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB12					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB13					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB14					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB15					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB16					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB17					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB18					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB19					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB20					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB21					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB22					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB23					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB24					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB25					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB26					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB27					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB28					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB29					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	OB30					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30		X	X	X	X	X				X
	OB31					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30										X
	OB32					40	40	40				07:00	04:00	4	3	55	20	70	30	90	30			X	X	X					X
	Total					1,280	1,280	1,280								1,760	640	2,240	960	2,880	960										

Note) Berth length of a landing stage is set to 40m per crane.
Note) Handling rate of Bat Trang Bank is set to 20 ton/h/berth taking into account human-wave tactics in cargo handling.
Note) Handling rate of Detached-pier type berth is decreased to 70% of standard type berth.

Table A27.1.1 (3) Berth Property

Port / Berth Group	Berth Name		Unavailable Berth			Dimension of Berth						Working Hours				Handling Rate						Berth Close Period							Vessel cannot call at the berth		
	in Study	Original	2001	2010	2020	Length			Continuous Use	LAD	Crest Level	Cargo Handling		Idle Time per vessel		2001		2010		2020		7/7-7/16	7/17-7/23	7/24-7/30	7/30-8/1	8/2-8/7	8/8-8/14	8/15-8/24	101-300	>300	SRV1000
						2001 (m)	2010 (m)	2020 (m)		(m)	(m)	from	to	2001 (hour)	2010, 2020 (hour)	Bulk (ton/h)	Others (ton/h)	Bulk (ton/h)	Others (ton/h)	Bulk (ton/h)	Others (ton/h)	WL8.0	WL9.0	WL10.0	WL11.0	WL10.0	WL9.0	WL8.0	(DWT)	(DWT)	(DWT)
New North Port	NP1		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP2		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP3		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP4		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP5		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP6		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP7		X				40	40		>2.5	+12.5	07:00	04:00		3	0	0	120	40	120	40										X
	NP8		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP9		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP10		X	X				40	YES	>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP11		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP12		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP13		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP14		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP15		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP16		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP17		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP18		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	NP19		X	X				40		>2.5	+12.5	07:00	04:00		3	0	0	0	0	120	40										X
	Total					0	280	760								0	0	840	280	2280	760										
New East Port	EP1		X				40	40		>2.5	+11.0	07:00	04:00		3	0	0	120	40	120	40										X
	EP2		X				40	40		>2.5	+11.0	07:00	04:00		3	0	0	120	40	120	40										X
	EP3		X				40	40		>2.5	+11.0	07:01	04:01		3	0	0	120	40	120	40										X
	EP4		X				40	40		>2.5	+11.0	07:02	04:02		3	0	0	120	40	120	40										X
	EP5		X				40	40		>2.5	+11.0	07:03	04:03		3	0	0	120	40	120	40										X
	EP6		X				40	40		>2.5	+11.0	07:04	04:04		3	0	0	120	40	120	40										X
	EP7		X				40	40		>2.5	+11.0	07:05	04:05		3	0	0	120	40	120	40										X
	EP8		X				40	40		>2.5	+11.0	07:06	04:06		3	0	0	120	40	120	40										X
	EP9		X				40	40		>2.5	+11.0	07:07	04:07		3	0	0	120	40	120	40										X
	EP10		X	X				40	YES	>2.5	+11.0	07:08	04:08		3	0	0	0	0	120	40										X
	EP11		X	X				40		>2.5	+11.0	07:09	04:09		3	0	0	0	0	120	40										X
	EP12		X	X				40		>2.5	+11.0	07:10	04:10		3	0	0	0	0	120	40										X
	EP13		X	X				40		>2.5	+11.0	07:00	04:00		3	0	0	0	0	120	40										X
	EP14		X	X				40		>2.5	+11.0	07:00	04:00		3	0	0	0	0	120	40										X
	EP15		X	X				40		>2.5	+11.0	07:00	04:00		3	0	0	0	0	120	40										X
	EP16		X	X				40		>2.5	+11.0	07:00	04:00		3	0	0	0	0	120	40										X
	EP17		X	X				40		>2.5	+11.0	07:00	04:00		3	0	0	0	0	120	40										X
	EP18		X	X				40		>2.5	+11.0	07:00	04:00		3	0	0	0	0	120	40										X
	Total					0	360	720								0	0	1,080	360	2,160	720										
Hanoi Segment Total						3,354	4,214	5,734								4,965	1,980	8,779	3,438	15,258	5,103										

Note) Berth length of a landing stage is set to 40m per crane.
Note) Handling rate of Detached-pier type berth is decreased to 70% of standard type berth.

Table A27.1.2(1) Vessel Fleet Mix (DWT share by size class, 2001)

			Construction Material	Cement	Fertilizer	Coal	Others	Total
Cargo Flow in Hanoi Segment	1000 tons		3,771	1,177	0	499	546	5,993
Vessel Size Class	Ave. DWT	DWT Share						
<50DWT	38	3%	3%	4%	4%	3%	4%	3%
51-100DWT	76	24%	22%	28%	28%	22%	28%	24%
101-300DWT	145	47%	44%	55%	55%	44%	55%	47%
>300DWT	411	26%	31%	13%	13%	31%	13%	26%
Total	128	100%	100%	100%	100%	100%	100%	100%

Note) DWT share of over 300DWT for vessel carrying non-bulk cargo is assumed to be half of that for all vessels.

Note) A barge train (e.g. Pusher + 4 barges) is counted as 1 vessel not 5 vessels.

Source) DWT Share of all vessels in 2001: based on passing vessel through sections counted by IWMS

Table A27.1.2(2) Vessel Fleet Mix (DWT share by size class, 2010)

			Construction Material	Cement	Fertilizer	Coal	Others	Total
Cargo Flow in Hanoi Segment	1000 tons		6,574	1,769	56	698	1,217	10,314
Vessel Size Class	Ave. DWT	DWT Share						
<50DWT	38	3%	3%	4%	4%	3%	4%	3%
51-100DWT	76	20%	18%	25%	25%	18%	25%	20%
101-300DWT	145	45%	41%	56%	56%	41%	56%	45%
>300DWT	411	32%	39%	16%	16%	39%	16%	32%
Total	137	100%	100%	100%	100%	100%	100%	100%

Note) DWT share of over 300DWT for vessel carrying non-bulk cargo is assumed to be half of that for all vessels.

Note) A barge train (e.g. Pusher + 4 barges) is counted as 1 vessel not 5 vessels.

Source) DWT share in 2010: JICA Study Team estimation

Table A27.1.2(2) Vessel Fleet Mix (DWT share by size class, 2020)

			Construction Material	Cement	Fertilizer	Coal	Others	Total
Cargo Flow in Hanoi Segment	1000 tons		11,030	3,408	182	861	1,749	17,230
Vessel Size Class	Ave. DWT	DWT Share						
<50DWT	38	2%	2%	3%	3%	2%	3%	2%
51-100DWT	76	15%	13%	20%	20%	13%	20%	15%
101-300DWT	145	43%	37%	57%	57%	37%	57%	43%
>300DWT	411	40%	49%	20%	20%	49%	20%	41%
Total	155	100%	100%	100%	100%	100%	100%	100%

Note) DWT share of over 300DWT for vessel carrying non-bulk cargo is assumed to be half of that for all vessels.

Note) A barge train (e.g. Pusher + 4 barges) is counted as 1 vessel not 5 vessels.

Source) DWT share in 2020: JICA Study Team estimation

Table A27.1.3 Vessel Fleet Mix (DWT share by size class, SRV & Container, 2020)

Type	Ave. DWT	DWT Share
SRV	1000	100%
Container Vessel 36TEU	600	100%

Source) DWT share in 2020: JICA Study Team estimation

Table A27.1.4 Average speed of vessel (km/h)

Year		Vessel Size Class	Construction Material	Cement	Fertilizer	Coal	Others	SRV	Container
2001	To upstream	<50DWT	4	10	10	4	10	10	4
		51-100DWT	4	10	10	4	10	10	4
		101-300DWT	4	10	10	4	10	10	4
		>300DWT	4	10	10	4	10	10	4
	To downstream	<50DWT	10	16	16	10	16	16	10
		51-100DWT	10	16	16	10	16	16	10
		101-300DWT	10	16	16	10	16	16	10
		>300DWT	10	16	16	10	16	16	10
2010	To upstream	<50DWT	5	12	12	5	12	12	5
		51-100DWT	5	12	12	5	12	12	5
		101-300DWT	5	12	12	5	12	12	5
		>300DWT	5	12	12	5	12	12	5
	To downstream	<50DWT	11	18	18	11	18	18	11
		51-100DWT	11	18	18	11	18	18	11
		101-300DWT	11	18	18	11	18	18	11
		>300DWT	11	18	18	11	18	18	11
2020	To upstream	<50DWT	7	14	14	7	14	14	7
		51-100DWT	7	14	14	7	14	14	7
		101-300DWT	7	14	14	7	14	14	7
		>300DWT	7	14	14	7	14	14	7
	To downstream	<50DWT	13	20	20	13	20	20	13
		51-100DWT	13	20	20	13	20	20	13
		101-300DWT	13	20	20	13	20	20	13
		>300DWT	13	20	20	13	20	20	13

Note) Current velocity is set to 3 km/h.

Source) Average speeds are assumed by JICA Study Team.

Table A27.1.5 Rules of navigation

Item	Navigation Rule						
Least Distance from Preceding Vessel	Vessel Size Class	Ave. DWT	LOA	Interval of Vessels (m)			
				Generating Distance		Least Distance	
				for upstream (7L and >200m)	for downstream (7L and >300m)	while navigating upstream	while navigating downstream
	<50DWT	38	25	200	300	200	300
	51-100DWT	76	30	210	300	200	300
	101-300DWT	145	40	280	300	200	300
	>300DWT	411	50 - 100	560	560	200	300
	Container Berge	800	90	630	630	200	300
	SRV 1000DWT	1,000	80	560	560	200	300
Overtaking	Overtaking is possible as far as all vessels can keep the distance from preceding vessel as mentioned above except for the vicinity of bridges and Duong Bifurcation as well as narrow section.						
Priority at Duong Bifurcation	Vessel (Duong - Red down) shall give way to vessel (Red up - Red down) and vessel (Red up - Duong).						
	Vessel (Duong - Red up) shall give way to vessel (Red down - Red up).						
	Vessel (Red down - Red up) shall give way to vessel (Red up - Duong) and vessel (Duong - Red down).						
	Vessel (Red down - Duong) shall give way to vessel (Red up - Duong).						

Source) JICA Study Team

Table A27.1.6 Seasonal change in cargo flow

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Cargo Flow	12%	10%	12%	10%	8%	6%	5%	5%	6%	8%	8%	10%	100%

Source) Set by JICA Study Team based on information from VIWA.

Table A27.1.7 Day-night change in cargo flow

Day (08:00 - 20:00)	86%
Night (20:00 - 08:00)	14%

Source) Analyzed by JICA Study Team based on the channel traffic survey by TEDI-port.

Table A27.1.8 Conditions at Duong Bridge

Vessel Size Class	2001, 2010	2020		
	Waterway Closure at Duong Bridge	Moving Span Operation of Duong Bridge	Waterway Closure at Duong Bridge	Moving Span Operation of Duong Bridge
<50DWT	7/17-8/15	7/17-7/31	-	8/1-8/15
51-100DWT	7/11-8/21	7/11-7/30	7/31-8/1	8/2-8/21
101-300DWT	7/6-8/26	7/6-7/29	7/30-8/2	8/3-8/26
>300DWT	7/1-9/4	7/1-7/26	7/27-8/5	8/6-9/4

Note) Waterway closure at Duong Bridge
Vessel crossing Duong Bridge must change its route to via Luoc River.
Note) Moving span operation of Duong Bridge
Vessel crossing Duong Bridge can only pass 10'-25' and 40'-55' in each hour.
Source) JICA Study Team

Table A27.1.9 (1) Cargo Flow in Hanoi Segment (2010, Construction Materials)

(1000tons)

Destination / Origin	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bat Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		436	401	367	722	1,609	685	24	0	1,624	903	180	6,714	6,952
Downstream of Phu Dong	86			11	21	45	20	1	0	47	26	5	177	263
Downstream of Yen My	121			17	33	74	32	1	0	75	42	8	283	404
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bat Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	207	436	401	395	776	1,728	737	26	0	1,746	971	194	7,174	7,699

Table A27.1.9 (2) Cargo Flow in Hanoi Segment (2010, Cement)

(1000tons)

Destination / Origin	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bat Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	0	0	0	0	0	0	0	0	0	0	0	0
Downstream of Phu Dong	375			170	170	248	142	227	0	432	85	425	1,899	2,274
Downstream of Yen My	37			28	28	41	23	37	0	71	14	70	312	350
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bat Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	412	0	0	198	198	289	165	264	0	503	99	495	2,212	2,624

Table A27.1.9 (3) Cargo Flow in Hanoi Segment (2010, Fertilizer)

(1000tons)

Destination / Origin	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bat Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	0										0	0
Downstream of Phu Dong	34												0	34
Downstream of Yen My	0												0	0
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bat Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	34	0	0	0	0	0	0	0	0	0	0	0	0	34

Table A27.1.9 (4) Cargo Flow in Hanoi Segment (2010, Coal)

(1000tons)

Destination / Origin	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bat Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	0	0	0	0	0	0	0	0	0	0	0	0
Downstream of Phu Dong	811			204	127	0	0	104	0	73	32	134	694	1,504
Downstream of Yen My	0			0	0	0	0	0	0	0	0	0	0	0
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bat Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	811	0	0	204	127	0	0	104	0	73	32	134	694	1,504

Table A27.1.9 (5) Cargo Flow in Hanoi Segment (2010, Others)

(1000tons)

Destination / Origin	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bat Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	19	0	0	0	0	0	0	0	0	0	0	19
Downstream of Phu Dong	328			45	39	93	3	0	324	67	22	173	716	808
Downstream of Yen My	147			7	7	4	0	0	12	3	1	4	27	324
Hanoi Port													0	0
Khuyen Luong Port		0											0	4
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bat Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Total	299	4	19	47	41	97	3	0	336	70	23	176	743	1,052

Table A27.1.9 (6) Cargo Flow in Hanoi Segment (2010, Total)

(1000tons)

Destination / Origin	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bat Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo	0	436	419	367	722	1,609	685	24	0	1,624	903	180	6,714	6,952
Downstream of Phu Dong	1,144	0	0	430	357	389	164	331	324	619	165	700	3,480	4,593
Downstream of Yen My	405	0	0	47	83	119	55	38	12	149	57	83	423	1,096
Hanoi Port	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Khuyen Luong Port	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Chem Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thang Tri Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Duc Giang Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bat Trang Bank	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New North Port	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New East Port	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,549	440	419	844	1,162	2,119	908	394	336	2,392	1,125	963	10,617	12,641

Table A27.1.9 (7) Cargo Flow in Hanoi Segment (2010, Fertilizer by SRV)

Table A27.1.9 (8) Cargo Flow in Hanoi Segment (2010, Paddy/Rice by SRV)

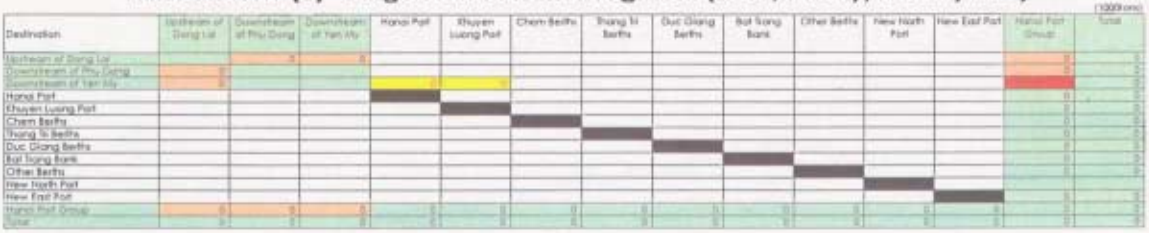


Table A27.1.9 (9) Cargo Flow in Hanoi Segment (2010, Others by SRV)

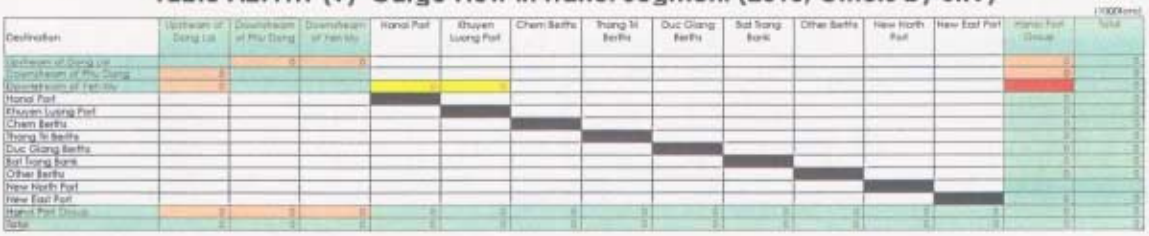


Table A27.1.9 (10) Cargo Flow in Hanoi Segment (2010, SRV Total)

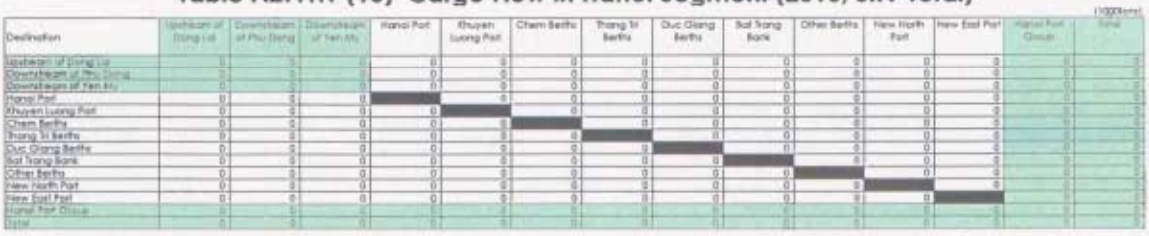


Table A27.1.9 (11) Cargo Flow in Hanoi Segment (2010, Container, unit: 1000TEU)

Table A27.1.10 (1) Cargo Flow in Hanoi Segment (2020, Construction Materials)

(1000tons)

Origin \ Destination	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bai Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		744	891	202	1,794	1,950	831	29	0	1,968	2,563	749	10,106	11,740
Downstream of Phu Dong	76			5	47	52	22	1	0	52	68	20	267	343
Downstream of Yen My	196			49	117	127	54	2	0	128	167	53	657	853
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bai Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	273	744	941	256	1,958	2,129	907	33	0	2,148	2,797	824	11,030	12,936

Source: JICA Study Team

Table A27.1.10 (2) Cargo Flow in Hanoi Segment (2020, Cement)

(1000tons)

Origin \ Destination	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bai Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	0	0	0	0	0	0	0	0	0	0	0	0
Downstream of Phu Dong	738			356	356	271	134	347	0	471	267	891	2,924	3,662
Downstream of Yen My	338			89	89	65	26	41	0	78	64	133	484	822
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bai Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,076	0	0	445	445	336	160	388	0	549	331	1,024	3,408	4,484

Source: JICA Study Team

Table A27.1.10 (3) Cargo Flow in Hanoi Segment (2020, Fertilizer)

(1000tons)

Origin \ Destination	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bai Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	0										0	0
Downstream of Phu Dong	86												0	86
Downstream of Yen My	0												0	0
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bai Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	86	0	0	0	0	0	0	0	0	0	0	0	0	86

Source: JICA Study Team

Table A27.1.10 (4) Cargo Flow in Hanoi Segment (2020, Coal)

(1000tons)

Origin \ Destination	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bai Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	0	0	0	0	0	0	0	0	0	0	0	0
Downstream of Phu Dong	440			114	212	0	0	128	0	89	79	238	841	1,340
Downstream of Yen My	0			0	0	0	0	0	0	0	0	0	0	0
Hanoi Port													0	0
Khuyen Luong Port													0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bai Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	440	0	0	114	212	0	0	128	0	89	79	238	841	1,340

Source: JICA Study Team

Table A27.1.10 (5) Cargo Flow in Hanoi Segment (2020, Others)

(1000tons)

Origin \ Destination	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bai Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo		0	20	0	0	0	0	0	0	0	0	0	0	20
Downstream of Phu Dong	161			78	70	101	4	0	321	74	39	177	884	1,044
Downstream of Yen My	241			4	3	5	0	0	13	3	3	8	40	332
Hanoi Port													0	0
Khuyen Luong Port		0											0	0
Chem Berths													0	0
Thang Tri Berths													0	0
Duc Giang Berths													0	0
Bai Trang Bank													0	0
Other Berths													0	0
New North Port													0	0
New East Port													0	0
Hanoi Port Group	0	4	0	0	0	0	0	0	0	0	0	0	0	4
Total	402	4	20	82	73	106	4	0	334	77	42	185	924	1,426

Source: JICA Study Team

Table A27.1.10 (6) Cargo Flow in Hanoi Segment (2020, Total)

(1000tons)

Origin \ Destination	Upstream of Dong Lo	Downstream of Phu Dong	Downstream of Yen My	Hanoi Port	Khuyen Luong Port	Chem Berths	Thang Tri Berths	Duc Giang Berths	Bai Trang Bank	Other Berths	New North Port	New East Port	Hanoi Port Group	Total
Upstream of Dong Lo	0	744	911	202	1,794	1,950	831	29	0	1,968	2,563	749	10,106	11,740
Downstream of Phu Dong	1,501	0	0	554	665	424	180	376	321	686	473	1,237	4,736	6,467
Downstream of Yen My	643	0	0	76	179	176	80	43	13	209	253	191	1,181	2,004
Hanoi Port	0	0	0	0	61	0	0	0	0	0	0	0	0	0
Khuyen Luong Port	0	4	0	0	0	0	0	0	0	0	0	0	0	5
Chem Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thang Tri Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Duc Giang Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bai Trang Bank	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Berths	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New North Port	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New East Port	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hanoi Port Group	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	2,144	748	911	831	2,699	2,550	1,091	448	334	2,863	3,289	2,176	16,023	20,287

Source: JICA Study Team

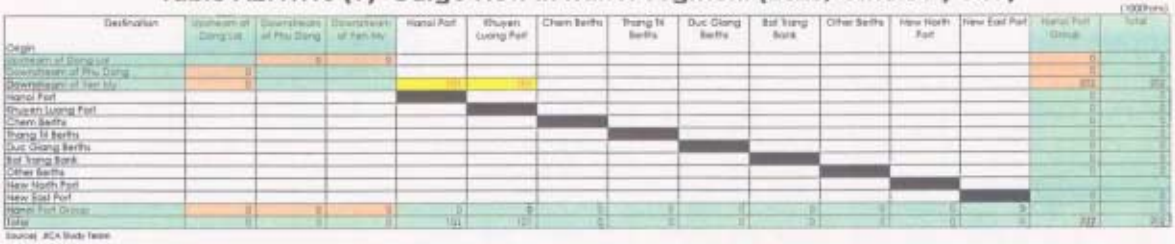
Table A27.1.10 (7) Cargo Flow in Hanoi Segment (2020, Fertilizer by SRV)

Source: JICA Study Team

Table A27.1.10 (8) Cargo Flow in Hanoi Segment (2020, Paddy/Rice by SRV)

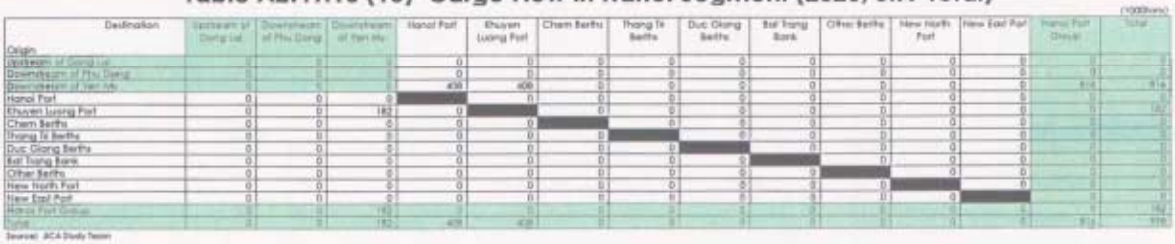
Source: JICA Study Team

Table A27.1.10 (9) Cargo Flow in Hanoi Segment (2020, Others by SRV)



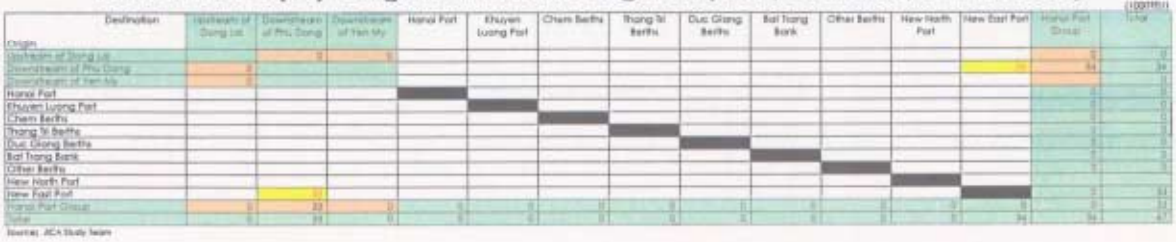
Source: JICA Study Team

Table A27.1.10 (10) Cargo Flow in Hanoi Segment (2020, SRV Total)



Source: JICA Study Team

Table A27.1.10 (11) Cargo Flow in Hanoi Segment (2020, Container, unit: 1000TEU)



Source: JICA Study Team

Table A27.1.11 Main Output of Vessel Simulation in Hanoi Segment (2001, 2010, 2020)

Port/Berth	Case	Berth Occupancy Ratio (%)													Waiting Time (min)	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	whole	Max.	Ave.
Hanoi Port	2001	44%	47%	43%	46%	41%	38%	30%	25%	30%	36%	38%	44%	39%	261	5
	2001r	55%	60%	56%	59%	54%	49%	39%	32%	39%	46%	48%	56%	50%	2,323	197
	2010	35%	43%	39%	41%	38%	31%	23%	23%	29%	32%	32%	36%	34%	207	4
	2020	48%	52%	48%	49%	46%	40%	30%	30%	35%	36%	36%	49%	42%	738	9
Khuyen Luong Port	2001	62%	75%	73%	67%	62%	53%	27%	42%	53%	68%	64%	64%	60%	3,500	330
	2001r	65%	64%	65%	65%	65%	65%	74%	71%	64%	65%	64%	65%	66%	78,512	47,968
	2010	66%	75%	67%	72%	63%	56%	34%	40%	53%	57%	59%	67%	59%	915	53
	2020	67%	72%	67%	67%	60%	59%	35%	36%	49%	56%	59%	68%	58%	592	20
Chem Berts	2001	66%	71%	64%	66%	59%	55%	45%	46%	44%	51%	52%	63%	57%	1,836	36
	2001r	66%	71%	63%	66%	59%	55%	45%	46%	44%	51%	52%	63%	57%	1,848	36
	2010	55%	58%	56%	55%	47%	45%	38%	33%	35%	44%	45%	53%	47%	435	6
	2020	60%	65%	59%	63%	53%	48%	38%	38%	45%	50%	49%	59%	53%	497	10
Thanh Tri Berts	2001	65%	71%	64%	65%	55%	55%	31%	32%	49%	51%	53%	70%	55%	617	24
	2001r	65%	71%	64%	65%	55%	55%	31%	32%	49%	51%	53%	70%	55%	617	24
	2010	51%	59%	51%	51%	51%	44%	27%	26%	39%	41%	47%	55%	45%	266	11
	2020	56%	65%	61%	61%	53%	48%	29%	31%	45%	50%	44%	59%	50%	303	16
Duc Giang Berts	2001	67%	75%	69%	72%	62%	56%	34%	38%	56%	59%	56%	66%	59%	1,130	76
	2001r	67%	74%	70%	72%	62%	56%	34%	38%	56%	59%	56%	66%	59%	1,130	76
	2010	54%	53%	60%	61%	52%	46%	31%	27%	44%	45%	46%	60%	48%	826	28
	2020	60%	67%	58%	61%	59%	52%	32%	30%	46%	45%	54%	63%	52%	805	42
Bat Trang Bank	2001	59%	64%	59%	57%	51%	47%	34%	34%	44%	48%	46%	57%	51%	1,062	20
	2001r	59%	64%	59%	57%	51%	47%	34%	34%	44%	48%	46%	57%	51%	1,062	20
	2010	39%	45%	41%	40%	35%	32%	25%	26%	29%	33%	32%	40%	35%	384	5
	2020	40%	46%	41%	39%	36%	33%	25%	25%	26%	34%	34%	40%	35%	492	5
Other Berths	2001	53%	60%	54%	58%	48%	44%	36%	34%	38%	42%	46%	54%	48%	4,301	71
	2001r	53%	61%	54%	58%	48%	44%	36%	34%	38%	42%	46%	53%	48%	4,304	71
	2010	40%	45%	39%	42%	36%	34%	26%	26%	31%	33%	33%	40%	36%	3,869	30
	2020	44%	51%	45%	46%	42%	39%	30%	29%	33%	36%	39%	46%	40%	1,789	36
New North Port	2001															
	2001r															
	2010	73%	74%	71%	72%	67%	59%	36%	37%	53%	55%	62%	72%	61%	838	61
	2020	77%	79%	76%	78%	70%	66%	40%	41%	57%	65%	67%	73%	66%	411	43
New East Port	2001															
	2001r															
	2010	74%	83%	75%	77%	65%	62%	40%	42%	56%	61%	63%	72%	64%	694	67
	2020	78%	84%	78%	80%	73%	66%	45%	44%	62%	63%	68%	78%	68%	651	62
Total	2001	57%	63%	57%	59%	51%	48%	36%	35%	41%	46%	48%	57%	50%	4,301	53
	2001r	59%	65%	59%	61%	53%	50%	39%	37%	43%	48%	49%	59%	52%	78,512	1,447
	2010	50%	56%	51%	52%	46%	42%	31%	30%	37%	41%	42%	50%	44%	3,869	30
	2020	59%	65%	60%	61%	55%	50%	35%	35%	44%	49%	50%	59%	52%	1,789	31

Note) Case (2001r) is revised case of Case (2001) in working hour at HN Port and KL Port: Cargo handling (07:00-21:00), Idle time per vessel (6 hours).

Source) JICA Study Team

Appendix 28 Management and Operation of Duong Movable Bridge

To solve the problem of shortage of vertical clearance the Study Team proposes that Duong Bridge be transformed to a movable bridge. Although the focus here is on the management and operation of Duong movable bridge; it goes without saying that safety is also an important factor.

(1) Priority of traffic

Priority of traffic is as follows.

1. Railway (train)
2. IW (vessel)
3. Road (car)

The bridge is opened and closed according to the vessel traffic except when train is coming.

(2) Switching operation

Switching should be done by one operator from the standpoint of safety. Before switching, operator should confirm the situation of railway, IW and road visually. Confirmation can be done using TV monitor but final check should be done visually.

(3) Blocking period

Based on advanced examples in Europe, blocking period should be within 15 minutes / move.

(4) Maintenance

In the event of a problem with switching mechanics, railway, IW and road would be cut off. To prevent this kind of situation, movable bridge should be maintained more carefully than a normal bridge. Therefore maintenance manual should be prepared and mechanical and electrical check should be done regularly (daily and weekly during flood season, weekly and monthly during dry season). And of course results of inspections should be recorded.

(5) Personnel distribution

24-hour service (8 hour × 3 shifts) is needed. 1 shift consists of 8 person; 1 manager,

1 switching operator, 2 assistant for switching operation, 2 traffic controller, 1 mechanical engineer and 1 electrical engineer.

Appendix 30 Preliminary Economic Analysis

As supporting and/or complementary data and information for **Chapter 30**, the following tables are provided in this Appendix:

Table A30.1 covering estimation of ship operation cost (SOC) corresponding to two types of pushers in different combination of barges and tug boats, in terms of basic conditions, time related fixed cost, running cost per km, and summary

Table A30.2 covering estimation of ship operation cost (SOC) for different types of self-propelled barges, in terms of basic conditions, time related fixed cost, running cost per km, and summary

Table A30.3 covering estimation of ship operation cost for different types of passenger boats, in terms of basic conditions, time related fixed cost, running cost per km, and summary

Table A30.4 covering estimation of vehicle operation cost (VOC) in Vietnam in terms of basic conditions, time related fixed cost, running cost per km, and summary

Table A30.5 covering economic analysis contemplating improvement of IWT System in Red River Total, rendering four kinds of economic analysis indicators

Table A30.6 covering economic analysis contemplating Corridor 4B, and comparison with 10,000DWT + IWT case

Table A30.7 covering economic analysis contemplating Corridor 4B, and comparison with 5000DWT + IWT case

Table A30.8 covering economic analysis contemplating Corridor 4B and comparison with 3000DWT + IWT case

Table A30.9 covering economic analysis contemplating Corridor 3NB and comparison with 200 DWT x 4 barges + tug boat

Table A30.10 covering economic analysis contemplating Corridor 3NB with 200DWT x 2 barges + tug boat

Table A30.11 covering economic analysis contemplating vertical clearance improvement of Duong Bridge

Table A30.1 Estimation of Ship Operation Cost (SOC) for Pusher-barge

	Unit	Variable Element	200DWT Barge	200DWTx2 Tug	Pusher Barge+Tug	200DWT Barge	200DWTx4 Tug	Pusher Barge+Tug
			A	B	C=A*4+B*1	A	B	C=A*4+B*1
Basic conditions								
Loading Capacity	Tons		200		400	200		800
Number of Barge	Unit		2		2	4		4
Vessel Life	Year	15			15			15
Operating day per year	Days				300			300
Operating Ratio per Year	%				0.8			0.8
Vessel Waiting Time for Cargo Handing per Day	Hours	10			10			10
Vessel Operating Hours per Day	Hours	14			4			4
Vessel operating hours per year	Hours				1,200			1,200
Vessel Life Operating Hours	Hours				18,000			18,000
Vessel Speed per Hour	km				10			10
Vessel Running Distance per Minute	km				0.17			0.17
Vessel Life Km	km				180,000			180,000
Time Related Fixed Cost								
Economic Conversion Factor (Time Related)		0.8						
Body Cost								
Base Body Cost	US$		27,500	75,000	130,000	27,500	100,000	210,000
Economic Body Cost (Time Related)	US$				1,040			1,680
Depreciation Time Related Share	%	65			65			65
Fixed Economic Body Cost (For Depreciation)	US$				67,600			109,200
Fixed Economic Body Cost per Minute	US$				0.06259			0.10111
Labor Cost								
Captain								
Number of Captain	Psn				1			1
Monthly Salary	US$	120			120			120
Working Days per Month	Days	25			25			25
Working Hours per Day	Hours	12			12			12
Financial Cost of Captain Per Hour	US$				0.40			0.40
Total Cost of Captain per Hour	US$				0.40			0.40
Total Economic Cost of Captain per Hour	US$				1.00			1.00
Economic Cost of Captain per Minute	US$				0.01667			0.01667
Assistant Captain								
Number of Assistant Captain	Psn				1			1
Monthly Salary	US$	100			100			100
Working Days per Month	Days	25			25			25
Working Hours per Day	Hours	12			12			12
Financial Cost of Captain Per Hour	US$				0.50			0.50
Total Cost of Captain per Hour	US$				0.50			0.50
Economic Conversion Factor	%				1.00			1.00
Total Economic Cost of Asst. Cap. per Hour	US$				0.50			0.50
Economic Cost of Asst. Cap. per Minute	US$				0.00833			0.00833
Crew								
Number of Crew	Psn				3			4
Monthly Salary	US$	80			80			80
Working Days per Month	Days	25			25			25
Working Hours per Day	Hours	12			12			12
Financial Cost of Crew per Hour	US$				0.40			0.40
Total Cost of Crew per Hour	US$				1.20			1.60
Economic Conversion Factor	%				1.00			1.00
Total Economic Cost of Crew per Hour	US$				1.20			1.60
Economic Cost of Crews per Minute	US$				0.02000			0.02667
Labor Cost	US$							
Economic Labor Cost per Minute	US$				0.04500			0.05167
Total Time Related Cost per Minute	US$				0.10759			0.15278
Running Cost per km								
Distance Related Fixed Cost								
Depreciation Distance Related Share	%	35			35			35
Economic Body Cost (Distance Related)	US$				36,400			58,800
Economic Body Cost per km	US$				0.2022			0.3267
Fuel Cost								
Fuel Price/Liter (Market Price)	US$	0.33			0.33			0.33
Economic Fuel Price per Liter	US$	0.26			0.26			0.26
Fuel Consumption (Liter per Km)	Liter				3.62			4.52
Economic Fuel Cost per km	US$				0.9430			1.1786
Lubricant Cost								
Lubricant Oil Price/Liter (Market Price)	US$	0.73			0.73			0.73
Economic Lubricant Oil Price/Liter	US$	0.58			0.58			0.58
Lubricant Consumption (Liter per 1000km)	Liter				20			20
Economic Lubricant Oil Cost per km	US$				0.0117			0.0117
Maintenance Cost								
Economic Cost of Spare Part	%	3			3			3
Economic Cost of Spare Part	US$				31			50
Maintenance Period	Month	12		12	12		12	12
Maintenance Parts Cost per One Time	US$				2			6
Maintenance Labor Hours	Hours	80		80	80		80	80
Maintenance Labor Cost per Hours	US$	0.50		0.50	0.50		0.50	0.50
Number of Maintenance Labor	Psn			10	10		10	10
Maintenance Overhead Cost (%)	%	100		1.00	1.00		1.00	1.00
Maintenance Labor Cost per One Time	US$			800	800		800	800
Maintenance Cost in Total per One Time	US$				802			806
Number of Maintenance per Vessel Life	times	5			5			5
Maintenance Cost in Total per Life	US$				4,010			4,030
Economic Maintenance Cost per km	US$				0.02228			0.02239
Total Economic Running Cost per km	US$				1.17915			1.53936
Summary								
Ship Cruise Speed	km/hr				8.0			8.0
Time per km in Minute	Minute				7.50			7.50
Time Related Fixed Cost per km	US$				0.80694			1.14583
Economic Running Cost per km	US$				1.17915			1.53936
Ship Operation Cost at above Cruise Speed	US$				1.98609			2.68519
SOC per Vessel-km in VND	VND				29,791			40,278
Cargo Load Factor	Ratio				0.5			0.5
SOC per ton-km at above Cruise Speed	US$				0.00993			0.00671
In Vietnam Dong per ton-km	VND				**149**			**101**
Vessel Cost per Vessel per Day	US$				261			353
Exchange Rate (VND/US$)	VND		15,000					

Source: JICA Study Team

Table A30.2 Estimation of Ship Operation Cost (SOC) for Self-propelled Barge

	Unit	Variable Factors	50 DWT SelfProp	100DWT SelfProp	200DWT SelfProp	250DWT SelfProp	300DWT SelfProp	400DWT SelfProp	500DWT SelfProp	600DWT SelfProp	700DWT SelfProp	800DWT SelfProp	1000DWT (SRV)
Basic conditions													
Loading Capacity	Tons		50	100	200	250	300	400	500	600	700	800	1000
Vessel Life	Year	15	15	15	15	15	15	15	15	15	15	15	15
Operating day per year	Days	300	300	300	300	300	300	300	300	300	300	300	300
Operating Ratio per Year			0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Vessel Waiting Time for Cargo Handing per Day	Hours	6	6	6	6	6	6	6	6	6	6	6	6
Vessel Operating Hours per Day	Hours	18	18	18	18	18	18	18	18	18	18	18	18
Vessel operating hours per year	Hours		5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400	5,400
Vessel Life Operating Hours	Hours		81,000	81,000	81,000	81,000	81,000	81,000	81,000	81,000	81,000	81,000	81,000
Vessel Speed per Hour	km		8	9	10	10.5	11	12	13	14	15	16	16
Vessel Running Distance per Minute	km		0.13	0.15	0.17	0.18	0.18	0.20	0.22	0.23	0.25	0.27	0.27
Vessel Life Km	km		648,000	729,000	810,000	850,500	891,000	972,000	1,053,000	1,134,000	1,215,000	1,296,000	1,296,000
Time Related Fixed Cost													
Economic Convesion Factor		0.80											
Body Cost													
Base Body Cost	US$		45,000	80,000	120,000	150,000	180,000	195,000	280,000	325,000	360,000	400,000	500,000
Economic Body Cost (Time Related)	US$		36,000	64,000	96,000	120,000	144,000	156,000	224,000	260,000	288,000	320,000	400,000
Depreciation Time Related Share	%	65	65	65	65	65	65	65	65	65	65	65	65
Fixed Economic Body Cost (For Depreciation)	US$		23,400	41,600	62,400	78,000	93,600	101,400	145,600	169,000	187,200	208,000	260,000
Fixed Economic Body Cost per Minute	US$		0.00481	0.00856	0.01284	0.01605	0.01926	0.02086	0.02996	0.03477	0.03852	0.04280	0.05350
Labor Cost													
Captain													
Number of Captain	Psn		1	1	1	1	1	1	1	1	1	2	3
Monthly Salary	US$	120	120	120	120	120	120	120	120	120	120	120	120
Working Days per Month	Days	25	25	25	25	25	25	25	25	25	25	25	25
Working Hours per Day	Hours	12	12	12	12	12	12	12	12	12	12	12	12
Financial Cost of Captain Per Hour	US$		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Total Cost of Captain per Hour	**US$**		0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.80	1.20
Economic Cost of Captain per Minute	US$		0.00667	0.00667	0.00667	0.00667	0.00667	0.00667	0.00667	0.00667	0.00667	0.01333	0.02000
Assistant Captain													
Number of Assistant Captain	Psn		1	1	1	1	1	1	2	2	2	2	3
Monthly Salary	US$	100	100	100	100	100	100	100	100	100	100	100	100
Working Days per Month	Days	25	25	25	25	25	25	25	25	25	25	25	25
Working Hours per Day	Hours	12	12	12	12	12	12	12	12	12	12	12	12
Financial Cost of Assistant Captain Per Hour	US$		0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Total Cost of Captain per Hour	US$		0.50	0.50	0.50	0.50	0.50	0.50	1.00	1.00	1.00	1.00	1.50
Economic Cost of Asst. Cap. per Minute	US$		0.00833	0.00833	0.00833	0.00833	0.00833	0.00833	0.01667	0.01667	0.01667	0.01667	0.02500
Crew													
Number of Crew	Psn		1	1	1	1	2	2	2	3	3	3	3
Monthly Salary	US$	80	80	80	80	80	80	80	80	80	80	80	80
Working Days per Month	Days	25	25	25	25	25	25	25	25	25	25	25	25
Working Hours per Day	Hours	12	12	12	12	12	12	12	12	12	12	12	12
Financial Cost of Crew per Hour	US$		0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Total Cost of Crew per Hour	US$		0.27	0.27	0.27	0.27	0.53	0.53	0.53	0.80	0.80	0.80	0.80
Economic Cost of Crews per Minute	US$		0.00444	0.00444	0.00444	0.00444	0.00889	0.00889	0.00889	0.01333	0.01333	0.01333	0.01333
Labor Cost	US$												
Economic Labor Cost per Minute	US$		0.01944	0.01944	0.01944	0.01944	0.02389	0.02389	0.03222	0.03667	0.03667	0.04333	0.05833
Total Time Related Cost per Minute	US$		0.02426	0.02800	0.03228	0.03549	0.04315	0.04475	0.06218	0.07144	0.07519	0.08613	0.11183
Annual Cost	US$		10,480	12,098	13,947	15,333	18,640	19,333	26,862	30,862	32,480	37,209	48,311
Annual Cost per DWT	US$		209.60	120.98	69.73	61.33	62.13	48.33	53.72	51.44	46.40	46.51	48.31
Running Cost per km													
Distance Related Fixed Cost													
Depreciation Distance Related Share	%	35	35	35	35	35	35	35	35	35	35	35	35
Economic Body Cost (Distance Related)	US$		12,600	22,400	33,600	42,000	50,400	54,600	78,400	91,000	100,800	112,000	140,000
Economic Body Cost per km	US$		0.01944	0.03073	0.04148	0.04938	0.05657	0.05617	0.07445	0.08025	0.08296	0.08642	0.10802
Fuel Cost													
Fuel Price/Liter (Market Price)	US$	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Economic Fuel Price per Liter	US$	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Fuel Consumption (Liter per Km)	Liter		1.86	2.36	2.82	3.18	3.53	3.58	3.62	3.90	4.13	4.25	8.94
Economic Fuel Cost per km	US$		0.4849	0.6144	0.7356	0.8275	0.9193	0.9330	0.9430	1.0153	1.0749	1.1062	2.3286
Lubricant Cost													
Lubricant Oil Price/Liter (Market Price)	US$	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
Economic Lubricant Oil Price/Liter	US$	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
Lubricant Consumption (Liter per 1000km)	Liter		12.00	14.00	14.00	15.00	15.00	15.00	16.00	16.00	18.00	18.00	20.00
Economic Lubricant Oil Cost per km	US$		0.0070	0.0082	0.0082	0.0088	0.0088	0.0088	0.0093	0.0093	0.0105	0.0105	0.0117
Maintenance Cost													
Economic Cost of Spare Part	%	5	5	5	5	5	5	5	5	5	5	5	5
Economic Cost of Spare Part	US$		1,800	3,200	4,800	6,000	7,200	7,800	11,200	13,000	14,400	16,000	20,000
Maintenance Period	Month	12	12	12	12	12	12	12	12	12	12	12	12
Maintenance Parts Cost per One Time	US$		120	213	320	400	480	520	747	867	960	1,067	1,333
Maintenance Labor Hours	Hours		60	60	60	60	75	75	80	80	100	100	160
Maintenance Labor Cost per Hours	US$	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
Number of Maintenance Labor	Psn		7	7	8	8	8	8	10	10	10	12	15
Maintenance Overhead Cost (%)	%	100	100	100	100	100	100	100	100	100	100	100	100
Maintenance Labor Cost per One Time	US$		255	255	291	291	364	364	485	485	606	727	1,454
Maintenance Cost in Total per One Time	US$		375	468	611	691	844	884	1,231	1,351	1,566	1,794	2,788
Number of Maintenance per Vessel Life	times	15	15	15	15	15	15	15	15	15	15	15	15
Maintenance Cost in Total per Life	US$		5,618	7,018	9,163	10,363	12,654	13,254	18,472	20,272	23,490	26,908	41,816
Economic Maintenance Cost per km	US$		0.00867	0.00963	0.01131	0.01218	0.01420	0.01364	0.01754	0.01788	0.01933	0.02076	0.03227
Total Economic Running Cost per km	US$		0.52004	0.66289	0.79657	0.89779	0.99886	1.01156	1.04430	1.12278	1.18770	1.22392	2.48053
Summary													
Ship Cruise Speed	km/hr		10.0	10.0	10.0	10.5	11.0	12.0	13.0	14.0	15.0	16.0	16.0
Time per km in Minute	Minute		6.00	6.00	6.00	5.71	5.45	5.00	4.62	4.29	4.00	3.75	3.75
Time Related Fixed Cost per km	US$		0.14556	0.16802	0.19370	0.20282	0.23535	0.22377	0.28699	0.30617	0.30074	0.32299	0.41937
Economic Running Cost per km	US$		0.52004	0.66289	0.79657	0.89779	0.99886	1.01156	1.04430	1.12278	1.18770	1.22392	2.48053
Ship Operation Cost at above Cruise Speed	US$		0.66560	0.83091	0.99027	1.10061	1.23421	1.23533	1.33129	1.42895	1.48844	1.54692	2.89989
SOC per Vessel-km in VND	VND		9,984	12,464	14,854	16,509	18,513	18,530	19,969	21,434	22,327	23,204	43,498
Cargo Load Factor	Ratio		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
SOC per ton at above Cruise Speed	US$		1.33	1.66	1.98	2.20	2.47	2.47	2.66	2.86	2.98	3.09	5.80
SOC per ton-km at above Cruise Speed	US$		0.02662	0.01662	0.00990	0.00880	0.00823	0.00618	0.00533	0.00476	0.00425	0.00387	0.00580
In Vietnam Dong per ton-km	VND		**399**	**249**	**149**	**132**	**123**	**93**	**80**	**71**	**64**	**58**	**87**
Vessel Cost per Vessel per Day	US$		158	221	293	342	402	439	512	592	661	732	1,373
Average Size of Vessel	DWT		<50	50-100	100-300	100-301		>300					
Average SOC per ton-km in US$	US$		0.02662	0.02162	0.01158	0.00829		0.00488					
Average SOC per ton-km in VND	VND		**399**	**324**	**174**	**124**		**73**					
Exchange Rate (VND/US$)	VND	15000											

Note: 1) SRV means Sea-cum-River Vessel

Source: JICA Study Team

Table A30.3 Estimation of Ship Operation Cost for Passenger Boat

	Unit	Variable	50 Pax	100 Pax	120 Pax
Basic conditions					
Number of Passenger	Pax		50	100	120
Number of Passenger (net)	Pax		38	75	90
Vessel Life	Year	15	15	15	15
Operating day per year	Days	300	300	300	300
Operating Ratio per Year	%		0.8	0.8	0.8
Vessel Waiting Time for Loading/Unlaoding per Day	Hours	4	4	4	4
Vessel Operating Hours per Day	Hours		20	20	20
Vessel operating hours per year	Hours		6,000	6,000	6,000
Vessel Life Operating Hours	Hours		90,000	90,000	90,000
Vessel Speed per Hour	km		20	30	30
Vessel Running Distance per Minute	km		0.33	0.50	0.50
Vessel Life Km	km		1,800,000	2,700,000	2,700,000
Time Related Fixed Cost					
Economic Conversion Factor	0.80				
Body Cost					
Base Body Cost	US$		15,000	480,000	600,000
Economic Body Cost (Time Related)	US$		12,000	384,000	480,000
Depreciation Time Related Share	%	65	65	65	65
Fixed Economic Body Cost (For Depreciation)	US$		7,800	249,600	312,000
Fixed Economic Body Cost per Minute	US$		0.00144	0.04622	0.05778
Labor Cost					
Captain					
Number of Captain	psn		1	1	1
Monthly Salary	US$	200	200	200	200
Working Days per Month	Days	25	25	25	25
Working Hours per Day	Hours	12	12	12	12
Financial Cost of Captain Per Hour	US$		0.67	0.67	0.67
Total Cost of Captain per Hour	US$		0.67	0.67	0.67
Economic Conversion Factor	%		1.00	1.00	1.00
Total Economic Cost of Captain per Hour	US$		0.67	0.67	0.67
Economic Cost of Captain per Minute	US$		0.01111	0.01111	0.01111
Assistant Captain					
Number of Assistant Captain	Psn	1	1	1	1
Monthly Salary	US$	180	180	180	180
Working Days per Month	Days	25	25	25	25
Working Hours per Day	Hours	12	12	12	12
Financial Cost of Captain Per Hour	US$		0.90	0.90	0.90
Total Cost of Captain per Hour	US$		0.90	0.90	0.90
Economic Conversion Factor	%		1.00	1.00	1.00
Total Economic Cost of Asst. Cap. per Hour	US$		0.90	0.90	0.90
Economic Cost of Asst. Cap. per Minute	US$		0.01500	0.01500	0.01500
Crew					
Number of Crew	pan	1	1	1	1
Monthly Salary	US$	150	150	150	150
Working Days per Month	Days	25	25	25	25
Working Hours per Day	Hours	12	12	12	12
Financial Cost of Crew per Hour	US$		0.75	0.75	0.75
Total Cost of Crew per Hour	US$		0.75	0.75	0.75
Economic Conversion Factor	%		1.00	1.00	1.00
Total Economic Cost of Crew per Hour	US$		0.75	0.75	0.75
Economic Cost of Crews per Minute	US$		0.01250	0.01250	0.01250
Labor Cost	US$				
Economic Labor Cost per Minute	US$		0.03861	0.03861	0.03861
Total Time Related Cost per Minute	US$		0.04006	0.08483	0.09639
Running Cost per km					
Distance Related Fixed Cost					
Depreciation Distance Related Share	%	35	35	35	35
Economic Body Cost (Distance Related)	US$		4,200	134,400	168,000
Economic Body Cost per km	US$		0.0023	0.0498	0.0622
Fuel Cost					
Fuel Price/Liter (Market Price)	US$		0.326	0.326	0.326
Economic Fuel Price per Liter	US$		0.261	0.261	0.261
Fuel Consumption (Liter per Km)	Liter		0.66	0.72	0.72
Economic Fuel Cost per km	US$		0.1714	0.1886	0.1886
Lubricant Cost					
Lubricant Oil Price/Liter (Market Price)	US$		0.730	0.730	0.730
Economic Lubricant Oil Price/Liter	US$		0.584	0.584	0.584
Lubricant Consumption (Liter per 1000km)	Liter		15	12	12
Economic Lubricant Oil Cost per km	US$		0.0088	0.0070	0.0070
Maintenance Cost					
Economic Cost of Spare Part	%	5	5	5	5
Economic Cost of Spare Part	US$		600	19,200	24,000
Maintenance Period	Month	12	12	12	12
Maintenance Parts Cost per One Time	US$		40	1,280	1,600
Maintenance Labor Hours	Hours	24	24	24	24
Maintenance Labor Cost per Hours	US$	0.5	0.50	0.50	0.50
Number of Maintenance Labor	psn	10	10	10	10
Maintenance Overhead Cost (%)	%		1.00	1.00	1.00
Maintenance Labor Cost per One Time	US$		240	240	240
Maintenance Cost in Total per One Time	US$		280	1,520	1,840
Number of Maintenance per Vessel Life	times	5	5	5	5
Maintenance Cost in Total per Life	US$		1,400	7,600	9,200
Economic Maintenance Cost per km	US$		0.00078	0.00281	0.00341
Total Economic Running Cost per km	US$		0.18331	0.24818	0.26122
Summary					
Ship Cruise Speed	km/hr		22	28	30
Time per km in Minute	Minute		2.73	2.14	2.00
Time Related Fixed Cost per km	US$		0.10924	0.18179	0.19278
Economic Running Cost per km	US$		0.18331	0.24818	0.26122
Ship Operation Cost at above Cruise Speed	US$		0.29255	0.42997	0.45400
SOC per Vessel-km in VND	VND		4,388	6,449	6,810
SOC per Pax-km at above Cruise Speed	US$		0.00780	0.00573	0.00504
In Vietnam Dong per pax-km	VND		**117**	**86**	**76**
Exchange Rate (VND/US$)	VND		15,000		
Loading factor of passenger is assumed at	75%				

Table A30.4 Estimation of Vehicle Operation Cost (VOC) in Vietnam

	Variables	Unit	Medium Truck	Medium Truck	40' Trailer Truck	Large Bus
Basic Conditions						(Pax)
Loading Capacity			6	10	20	40
Loading Capacity (Net)		ton	6	10	20	30
Vehicle Life		Year	10	12	12	8
Vehicle Life km		km	960,000	960,000	960,000	800,000
Vehicle Life Operating Hours		hours	24,000	24,000	24,000	35,040
Vehicle Annual Operating Hours		hours	2,000	2,000	2,000	2,000
Time Related Fixed Cost						
Body Cost						
Base Body Cost in US$		US$	40,000	55,000	134,400	110,000
Economic Conversion Factor	80	%	80	80	80	80
Economic Body Cost in US$		US$	32,000	44,000	107,520	88,000
Depreciation Time Related Share	65	%	65	65	65	65
Fixed Economic Body Cost per Minute		US$	0.0040	0.0045	0.0111	0.0136
Crew Cost						
Driver		Nos	1	1	1	1
Assistant Driver		Nos	1	1	1	1
Financial Cost of Crew Per Month		US$	100	100	100	100
Financial Cost of Crew Per Hour		US$	0.33	0.33	0.33	0.33
Economic Conversion Factor		%	100	100	100	100
Economic Cost of Crew per Minutes		US$	0.0056	0.0056	0.0056	0.0056
Total Time Related Fixed Cost per Minute		US$	0.0095	0.0101	0.0166	0.0192
Running Cost per km						
Distance Related Fixed Cost						
Depreciation Distance Related Share	35	%	35	35	35	35
Economic Body Cost (Distance Related)		US$	11,200	15,400	37,632	30,800
Economic Body Cost per km		US$	0.0117	0.0160	0.0392	0.0385
Fuel Cost						
Fuel Price/Litter (Market Price)		US$	0.33	0.33	0.33	0.33
Economic Conversion Factor	80	%	80	80	80	80
Economic Fuel Price per Litter		US$	0.26	0.26	0.26	0.26
Fuel Consumption (Liter per km)		Liter	2.00	2.00	3.00	3.00
Economic Fuel Cost per km		US$	0.0525	0.0525	0.0525	0.0525
Lubricant Cost						
Lubricant Oil Price/Liter (Market Price)		US$	1.30	1.30	1.30	1.30
Economic Conversion Factor	80	%	70	70	70	70
Lubricant Consumption (Liter per 1000 km)		Liter	3.5	3.5	3.5	3.5
Economic Lubricant Oil Cost per km		US$	0.0032	0.0032	0.0032	0.0032
Tire Cost						
Tire Unit Price		US$	150	180	200	400
Economic Conversion Factor	80	%	80	80	80	80
Number of Tires		Nos	4	6	10	4
Tire Life km		km	35,000	35,000	35,000	35,000
Economic Tire Life Cost per km		US$	0.0137	0.0247	0.0457	0.0366
Maintenance Cost						
Economic Cost of Spare Parts	10	%	3,200	4,400	10,752	8,800
Maintenance Labor (Hour/1000km)		Hours	12	12	12	12
Maintenance Labor Cost per Hours		US$	0.60	0.60	0.60	0.60
Maintenance Overhead Cost	20	%	0.12	0.12	0.12	0.12
Maintenance Labor Cost per 1000 km		US$	8.64	8.64	8.64	8.64
Maintenance Labor Cost in Total		US$	8,294	8,294	8,294	6,912
Maintenance Cost in Total		US$	11,494	12,694	19,046	15,712
Economic Maintenance Cost per km		US$	0.0120	0.0132	0.0198	0.0196
Total Economic Running Cost per km		US$	0.0930	0.1096	0.1604	0.1504
Summary						
Vehicle Running Speed		km/hour	50	50	50	50
Time per km in Minute		Minute	1.20	1.20	1.20	1.20
Time Related Fixed Cost per km at above km/hour		US$	0.0114	0.0121	0.0200	0.0230
Economic Running Cost per km		US$	0.0930	0.1096	0.1604	0.1504
Vehicle Operation Cost at above speed		US$	0.1045	0.1217	0.1804	0.1734
VOC per ton-km in US$		US$	0.0174	0.0122	0.0090	0.0058
VOC per ton-km in VND		VND	**261**	**183**	**135**	**87**
Loading Factor			0.50	0.50	0.50	0.50
Net VOC per ton-km in US$		US$	0.0348	0.0243	0.0180	0.0116
VOC per Vehicle-km at above speed in VND		VND	1,567	1,826	2,706	2,601
VOC per ton(pax) - km at above speed in VND		VND	**522**	**365**	**271**	**173**
Exchange Rate per US$	15,000	VND	193			
Note: Load factor for large bus is assumed as	75	%				

Table A30.5 Economic Analysis (Improvement of IWT System in Red River Total)

		Base Data	Transport Cost under Without Situtation										Transport Cost under With Situation												
		Forecast	Transport Cost by Truck for Over-flow Cargo					Transport Cost by Existing IWT Transport						Transport Cost by Improved IWT				Economic Benefit			Capital	Maintenance Cost		Cost	Benefit	Discount		
		Cargo Volume	Cargo Volume	Cargo Transport	Transport Cost	Cargo Handling Cost	Sub-total Truck Cost	Cargo Volume	Cargo Transport	Transport Cost	Cargo Handling Cost	Sub-total IWT Cost	Total Cost (A)	Cargo Transport	Transport Cost	Cargo Handling Cost	Total Cost (B)	Cost Saved (A)-(B)	Saved SOC	Total Saved Cost	Initial Investment	Port	Fairway	Total Cost	Net Benefit	Cost 10 % D.R.	Benefit 10 % D.R.	Net Present Value
Year	Calender Year	Million Tons	Milion Tons	Million Ton-km	US$ Million	US$ Million	US$ Million	Million Tons	Million Ton-km	US$ Million	US$ Million	US$ Million	US$ Million	Million Ton-km	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million	US$ Million
	2003	21.0																										
	2007	26.9																										
	2008	28.6																			92.4			92.38	-92.38	92.38	0	-92.38
	2009	30.4																			154.0			153.97	-153.97	139.97	0	-139.97
1	2010	32.3	11.3	1229.0	42.8	4.5	47.3	21.0	2290.4	19.0	16.8	35.8	83.1	3519.3	29.2	25.9	55.1	28.1	3.7	31.8		12.32	4.00	16.32	15.48	13.49	26.27	12.79
2	2011	33.9	12.8	1395.0	48.6	5.1	53.7	21.0	2290.4	19.0	16.8	35.8	89.5	3685.3	30.6	27.1	57.7	31.9	3.9	35.8		12.32	4.00	16.32	19.44	12.26	26.87	14.61
3	2012	35.5	14.4	1568.8	54.6	5.8	60.4	21.0	2290.4	19.0	16.8	35.8	96.2	3859.2	32.0	28.4	60.4	35.8	4.1	39.9		12.32	4.00	16.32	23.60	11.14	27.26	16.12
4	2013	37.1	16.1	1750.9	61.0	6.4	67.4	21.0	2290.4	19.0	16.8	35.8	103.2	4041.2	33.5	29.7	63.2	40.0	4.3	44.3		12.32	4.00	16.32	27.95	10.13	27.49	17.35
5	2014	38.9	17.8	1941.5	67.6	7.1	74.7	21.0	2290.4	19.0	16.8	35.8	110.6	4231.9	35.1	31.1	66.2	44.4	4.5	48.8		12.32	4.00	16.32	32.51	9.21	27.56	18.35
6	2015	40.7	19.7	2141.1	74.5	7.9	82.4	21.0	2290.4	19.0	16.8	35.8	118.2	4431.5	36.8	32.6	69.3	48.9	4.7	53.6		12.32	4.00	16.32	37.28	8.37	27.50	19.13
7	2016	42.6	21.6	2350.1	81.8	8.6	90.5	21.0	2290.4	19.0	16.8	35.8	126.3	4640.5	38.5	34.1	72.6	53.7	4.9	58.6		12.32	4.00	16.32	42.28	7.61	27.33	19.72
8	2017	44.6	23.6	2569.0	89.4	9.4	98.9	21.0	2290.4	19.0	16.8	35.8	134.7	4859.4	40.3	35.7	76.0	58.7	5.1	63.8		12.32	4.00	16.32	47.51	6.92	27.07	20.15
9	2018	46.7	25.7	2798.3	97.4	10.3	107.7	21.0	2290.4	19.0	16.8	35.8	143.5	5088.6	42.2	37.4	79.6	63.9	5.4	69.3	154.0	12.32	4.00	170.28	-100.98	65.65	26.72	-38.93
10	2019	49.0	27.9	3038.3	105.8	11.2	117.0	21.0	2290.4	19.0	16.8	35.8	152.8	5328.6	44.2	39.2	83.4	69.4	5.6	75.0	215.6	12.32	4.00	231.87	-156.83	81.27	26.30	-54.97
11	2020	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	5.9	81.0		12.32	4.00	16.32	64.73	5.20	25.83	20.63
12	2021	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	4.73	27.35	22.62
13	2022	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	4.30	24.86	20.56
14	2023	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	3.91	22.60	18.69
15	2024	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4	184.8	12.32	4.00	201.08	-106.67	43.76	20.55	-23.21
16	2025	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	3.23	18.68	15.45
17	2026	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	2.93	16.98	14.05
18	2027	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	2.67	15.44	12.77
19	2028	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	2.43	14.03	11.61
20	2029	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	2.20	12.76	10.55
21	2030	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	2.00	11.60	9.59
22	2031	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	1.82	10.54	8.72
23	2032	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	1.66	9.58	7.93
24	2033	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	1.51	8.71	7.21
25	2034	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4	184.8	12.32	4.00	201.08	-106.67	16.87	7.92	-8.95
26	2035	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	1.24	7.20	5.96
27	2036	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	1.13	6.55	5.42
28	2037	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	1.03	5.95	4.92
29	2038	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.94	5.41	4.48
30	2039	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4	184.8	12.32	4.00	201.08	-106.67	10.48	4.92	-5.56
31	2040	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.77	4.47	3.70
32	2041	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.70	4.06	3.36
33	2042	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.64	3.70	3.06
34	2043	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.58	3.36	2.78
35	2044	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.53	3.05	2.53
36	2045	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.48	2.78	2.30
37	2046	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.44	2.52	2.09
38	2047	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.40	2.29	1.90
39	2048	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4		12.32	4.00	16.32	78.09	0.36	2.09	1.73
40	2049	51.3	30.2	3289.6	114.5	12.1	126.6	21.0	2290.4	19.0	16.8	35.8	162.5	5580.0	46.3	41.0	87.3	75.2	19.2	94.4	-61.6	12.32	4.00	-45.27	139.68	-0.91	1.90	2.81
	Total																				1,108.56	492.69	160.00	1,761.26	1,578.54	576.42	578.05	1.63

Note)

1	Initial capital investment	US$	**616**	million (in Economic Price)
2	Max. allowable capital investment for IWT infrastructure	US$	725	million (in Financial Price)
3	Cargo Handling Cost*1(IWT)	US$	0.80	per ton (in Economic Price)
	Cargo Handling Cost*2 (Truck)	US$	0.40	per ton (in Economic Price)
4	Annual maintenance cost of capital asset		2%	of total capital investment
	Maintenance Dredging	US$	4.00	million (in Economic Price)
5	Road Distance		109	km
	VOC of Typical Truck for Construction Material	US$	0.01741	per ton-km (6 ton truck)
	Load Factor for Truck		0.50	
6	IWT Distance		109	km
	SOC of Typical IWT Transport	US$	0.00829	per ton-km (250 DWT Self-propelled)
7	Saved SOC due to enlargement of fleet (2001-2010)	US$	0.00105	per ton-km
	Saved SOC due to enlargement of fleet (2010-2020)	US$	0.00239	per ton-km
8	Standard Coversion Factor		0.85	

Economic Analysis Indicator		
Project Life	Years	40
EIRR		**10.0%**
NPV at	10%	1.63
B/C Ratio at	10%	1.00

Table A30.6 Economic Analysis (Corridor 4B, Comparison with 10,000 DWT + IWT Case)

	Year	Economic Benefit		Cost (US$)			Net Benefit	Discounted Cost		Discounted Benefit		Net Discounted Benefit	
		Cargo (ton)	Benefit (US$)	Initial Investment	Maintenance Expense	Total Cost	Balance	Cost 10% D.R.	Cost 15% D.R.	Benefit 10 % D.R.	Benefit 15 % D.R.	Net Benefit 10% D.R.	Net Benefit 15% D.R.
1	2008			8,844,609		8,844,609	-8,844,609	8,844,609	8,844,609	0	0	-8,844,609	-8,844,609
2	2009			8,844,609		8,844,609	-8,844,609	8,040,553	7,690,964	0	0	-8,040,553	-7,690,964
3	2010	650,000	5,219,637		169,500	169,500	5,050,137	140,083	128,166	4,313,750	3,946,796	4,173,667	3,818,629
4	2011	676,000	5,428,423		169,500	169,500	5,258,923	127,348	111,449	4,078,454	3,569,276	3,951,106	3,457,827
5	2012	703,040	5,645,560		169,500	169,500	5,476,060	115,771	96,912	3,855,993	3,227,867	3,740,222	3,130,955
6	2013	731,162	5,871,382		169,500	169,500	5,701,882	105,246	84,271	3,645,666	2,919,114	3,540,420	2,834,843
7	2014	760,408	6,106,237		169,500	169,500	5,936,737	95,678	73,280	3,446,812	2,639,895	3,351,133	2,566,615
8	2015	790,824	6,350,487		169,500	169,500	6,180,987	86,980	63,721	3,258,804	2,387,383	3,171,823	2,323,662
9	2016	822,457	6,604,506		169,500	169,500	6,435,006	79,073	55,410	3,081,051	2,159,025	3,001,978	2,103,615
10	2017	855,356	6,868,686		169,500	169,500	6,699,186	71,885	48,182	2,912,994	1,952,509	2,841,109	1,904,327
11	2018	889,570	7,143,434		169,500	169,500	6,973,934	65,350	41,898	2,754,103	1,765,748	2,688,753	1,723,850
12	2019	925,153	7,429,171		169,500	169,500	7,259,671	59,409	36,433	2,603,879	1,596,850	2,544,470	1,560,417
13	2020	962,159	7,726,338		169,500	169,500	7,556,838	54,008	31,681	2,461,849	1,444,108	2,407,841	1,412,427
14	2021	962,159	7,726,338		169,500	169,500	7,556,838	49,098	27,548	2,238,045	1,255,746	2,188,947	1,228,197
15	2022	962,159	7,726,338		169,500	169,500	7,556,838	44,635	23,955	2,034,586	1,091,953	1,989,952	1,067,998
16	2023	962,159	7,726,338		169,500	169,500	7,556,838	40,577	20,831	1,849,624	949,524	1,809,047	928,694
17	2024	962,159	7,726,338		169,500	169,500	7,556,838	36,888	18,114	1,681,476	825,673	1,644,588	807,560
18	2025	962,159	7,726,338		169,500	169,500	7,556,838	33,535	15,751	1,528,615	717,977	1,495,080	702,226
19	2026	962,159	7,726,338		169,500	169,500	7,556,838	30,486	13,696	1,389,650	624,328	1,359,164	610,631
20	2027	962,159	7,726,338		169,500	169,500	7,556,838	27,715	11,910	1,263,318	542,894	1,235,603	530,984
21	2028	962,159	7,726,338		169,500	169,500	7,556,838	25,195	10,356	1,148,471	472,081	1,123,276	461,725
22	2029	962,159	7,726,338		169,500	169,500	7,556,838	22,905	9,006	1,044,064	410,506	1,021,160	401,500
23	2030	962,159	7,726,338		169,500	169,500	7,556,838	20,822	7,831	949,150	356,961	928,327	349,130
24	2031	962,159	7,726,338		169,500	169,500	7,556,838	18,929	6,810	862,863	310,401	843,934	303,592
25	2032	962,159	7,726,338		169,500	169,500	7,556,838	17,209	5,921	784,421	269,914	767,213	263,993
26	2033	962,159	7,726,338		169,500	169,500	7,556,838	15,644	5,149	713,110	234,708	697,466	229,559
27	2034	962,159	7,726,338		169,500	169,500	7,556,838	14,222	4,477	648,282	204,094	634,060	199,616
28	2035	962,159	7,726,338		169,500	169,500	7,556,838	12,929	3,893	589,347	177,473	576,418	173,579
29	2036	962,159	7,726,338		169,500	169,500	7,556,838	11,754	3,386	535,770	154,324	524,016	150,939
30	2037	962,159	7,726,338		169,500	169,500	7,556,838	10,685	2,944	487,064	134,195	476,379	131,251
31	2038	962,159	7,726,338		169,500	169,500	7,556,838	9,714	2,560	442,785	116,691	433,071	114,131
32	2039	962,159	7,726,338		169,500	169,500	7,556,838	8,831	2,226	402,532	101,471	393,701	99,245
33	2040	962,159	7,726,338		169,500	169,500	7,556,838	8,028	1,936	365,938	88,235	357,910	86,300
34	2041	962,159	7,726,338		169,500	169,500	7,556,838	7,298	1,683	332,671	76,726	325,373	75,043
35	2042	962,159	7,726,338		169,500	169,500	7,556,838	6,635	1,464	302,428	66,719	295,794	65,255
36	2043	962,159	7,726,338		169,500	169,500	7,556,838	6,032	1,273	274,935	58,016	268,903	56,743
37	2044	962,159	7,726,338		169,500	169,500	7,556,838	5,483	1,107	249,941	50,449	244,458	49,342
38	2045	962,159	7,726,338		169,500	169,500	7,556,838	4,985	962	227,219	43,869	222,234	42,906
39	2046	962,159	7,726,338		169,500	169,500	7,556,838	4,532	837	206,563	38,147	202,031	37,310
40	2047	962,159	7,726,338		169,500	169,500	7,556,838	4,120	728	187,784	33,171	183,665	32,443
	Total							18,384,875	17,513,330	59,154,007	37,014,816	40,769,132	19,501,487

Note) Difference of transport cost (via HP - via HN/KL): US$ 8.03 per Ton

Unit rate for dredging (RRWP Table 4.12): US$ per cum

Capital Dredging (incl. DNC canal, RRWP Table 4.07) c.m cum

Capital Dredging Cost US$

Total (Initial Investment) US$ 17,689,217

Yearly maintenance dredging (RRWP 4.120) US$ 169,500

Cost difference between Case A and Case B per ton in US$ US$ 8.03

Case A Cargo is transported to Hanoi from HCMC by combination of 10,000 DWT coastal shipping vessel and IWT (Hai Phone - Hanoi)

Case B Cargo is transported to Hanoi from HCMC directly by 1000 SWT Sea-cum-River Vessel

SOC per ton in US$

Case A 10000 DWT Coastal Shipping + IWT (HCMC - HN via HP) US$ 13.83 per ton

Case B 1000 DWT SRV (HCMC - HN) US$ 5.80 per ton

Economic Analysis Indicator		
Project Life	Years	40
EIRR		28.66%
NPV at	10%	40.8
NPV at	15%	19.5
B/C Ratio at	10%	3.22
B/C Ratio at	15%	2.11

Table A30.7 Economic Analysis (Corridor 4B, Comparison with 5000 DWT + IWT Case)

	Year	Economic Benefit		Cost (US$)			Net Benefit	Discounted Cost		Discounted Benefit		Net Discounted Benefit	
		Cargo (ton)	Benefit (US$)	Initial Investment	Maintenance Expense	Total Cost	Balance	Cost 10% D.R.	Cost 15% D.R.	Benefit 10 % D.R.	Benefit 15 % D.R.	Net Benefit 10% D.R.	Net Benefit 15% D.R.
1	2008			8,844,609		8,844,609	-8,844,609	8,844,609	8,844,609	0	0	-8,844,609	-8,844,609
2	2009			8,844,609		8,844,609	-8,844,609	8,040,553	7,690,964	0	0	-8,040,553	-7,690,964
3	2010	650,000	5,551,137		169,500	169,500	5,381,637	140,083	128,166	4,587,717	4,197,457	4,447,634	4,069,291
4	2011	676,000	5,773,183		169,500	169,500	5,603,683	127,348	111,449	4,337,478	3,795,961	4,210,130	3,684,512
5	2012	703,040	6,004,110		169,500	169,500	5,834,610	115,771	96,912	4,100,888	3,432,869	3,985,117	3,335,957
6	2013	731,162	6,244,274		169,500	169,500	6,074,774	105,246	84,271	3,877,203	3,104,508	3,771,957	3,020,236
7	2014	760,408	6,494,045		169,500	169,500	6,324,545	95,678	73,280	3,665,719	2,807,555	3,570,041	2,734,275
8	2015	790,824	6,753,807		169,500	169,500	6,584,307	86,980	63,721	3,465,771	2,539,006	3,378,791	2,475,285
9	2016	822,457	7,023,959		169,500	169,500	6,854,459	79,073	55,410	3,276,729	2,296,145	3,197,656	2,240,735
10	2017	855,356	7,304,918		169,500	169,500	7,135,418	71,885	48,182	3,097,998	2,076,514	3,026,114	2,028,331
11	2018	889,570	7,597,114		169,500	169,500	7,427,614	65,350	41,898	2,929,017	1,877,891	2,863,667	1,835,993
12	2019	925,153	7,900,999		169,500	169,500	7,731,499	59,409	36,433	2,769,252	1,698,266	2,709,843	1,661,833
13	2020	962,159	8,217,039		169,500	169,500	8,047,539	54,008	31,681	2,618,202	1,535,823	2,564,194	1,504,143
14	2021	962,159	8,217,039		169,500	169,500	8,047,539	49,098	27,548	2,380,184	1,335,499	2,331,085	1,307,950
15	2022	962,159	8,217,039		169,500	169,500	8,047,539	44,635	23,955	2,163,803	1,161,303	2,119,169	1,137,348
16	2023	962,159	8,217,039		169,500	169,500	8,047,539	40,577	20,831	1,967,094	1,009,829	1,926,517	988,998
17	2024	962,159	8,217,039		169,500	169,500	8,047,539	36,888	18,114	1,788,267	878,112	1,751,379	859,998
18	2025	962,159	8,217,039		169,500	169,500	8,047,539	33,535	15,751	1,625,697	763,576	1,592,163	747,825
19	2026	962,159	8,217,039		169,500	169,500	8,047,539	30,486	13,696	1,477,907	663,979	1,447,421	650,282
20	2027	962,159	8,217,039		169,500	169,500	8,047,539	27,715	11,910	1,343,552	577,373	1,315,837	565,463
21	2028	962,159	8,217,039		169,500	169,500	8,047,539	25,195	10,356	1,221,410	502,063	1,196,215	491,707
22	2029	962,159	8,217,039		169,500	169,500	8,047,539	22,905	9,006	1,110,373	436,577	1,087,469	427,571
23	2030	962,159	8,217,039		169,500	169,500	8,047,539	20,822	7,831	1,009,430	379,632	988,608	371,801
24	2031	962,159	8,217,039		169,500	169,500	8,047,539	18,929	6,810	917,664	330,115	898,734	323,305
25	2032	962,159	8,217,039		169,500	169,500	8,047,539	17,209	5,921	834,240	287,056	817,031	281,135
26	2033	962,159	8,217,039		169,500	169,500	8,047,539	15,644	5,149	758,400	249,614	742,756	244,465
27	2034	962,159	8,217,039		169,500	169,500	8,047,539	14,222	4,477	689,454	217,056	675,232	212,578
28	2035	962,159	8,217,039		169,500	169,500	8,047,539	12,929	3,893	626,777	188,744	613,848	184,851
29	2036	962,159	8,217,039		169,500	169,500	8,047,539	11,754	3,386	569,797	164,125	558,043	160,740
30	2037	962,159	8,217,039		169,500	169,500	8,047,539	10,685	2,944	517,997	142,718	507,312	139,774
31	2038	962,159	8,217,039		169,500	169,500	8,047,539	9,714	2,560	470,907	124,102	461,193	121,542
32	2039	962,159	8,217,039		169,500	169,500	8,047,539	8,831	2,226	428,097	107,915	419,266	105,689
33	2040	962,159	8,217,039		169,500	169,500	8,047,539	8,028	1,936	389,179	93,839	381,151	91,904
34	2041	962,159	8,217,039		169,500	169,500	8,047,539	7,298	1,683	353,799	81,599	346,501	79,916
35	2042	962,159	8,217,039		169,500	169,500	8,047,539	6,635	1,464	321,636	70,956	315,001	69,492
36	2043	962,159	8,217,039		169,500	169,500	8,047,539	6,032	1,273	292,396	61,701	286,364	60,428
37	2044	962,159	8,217,039		169,500	169,500	8,047,539	5,483	1,107	265,815	53,653	260,331	52,546
38	2045	962,159	8,217,039		169,500	169,500	8,047,539	4,985	962	241,650	46,655	236,665	45,692
39	2046	962,159	8,217,039		169,500	169,500	8,047,539	4,532	837	219,681	40,569	215,150	39,732
40	2047	962,159	8,217,039		169,500	169,500	8,047,539	4,120	728	199,710	35,278	195,591	34,550
	Total							18,384,875	17,513,330	62,910,888	39,365,633	44,526,013	21,852,304

Note) Difference of transport cost (via HP - via HN/KL): US$ 8.54 per Ton

Unit rate for dredging (RRWP Table 4.12): US$ per cum

Capital Dredging (incl. DNC canal, RRWP Table 4.07) c.m cum

Capital Dredging Cost US$

Total (Initial Investment) US$ 17,689,217

Yearly maintenance dredging (RRWP 4.120) US$ 169,500

Cost difference between Case A and Case B per ton in US$ US$ 8.54

Case A Cargo is transported to Hanoi from HCMC by combination of 5,000 DWT coastal shipping vessel and IWT (Hai Phone - Hanoi)

Case B Cargo is transported to Hanoi from HCMC directly by 1000 SWT Sea-cum-River Vessel

SOC per ton in US$

Case A 5000 DWT Coastal Shipping + IWT (HCMC - HN via HP) US$ 14.34 per ton

Case B 1000 DWT SRV (HCMC - HN) US$ 5.80 per ton

Economic Analysis Indicator		
Project Life	Years	40
EIRR		30.16%
NPV at	10%	44.5
NPV at	15%	21.9
B/C Ratio at	10%	3.42
B/C Ratio at	15%	2.25

Table A30.8 Economic Analysis (Corridor 4B, Comparison with 3000 DWT + IWT Case)

	Year	Economic Benefit		Cost (US$)			Net Benefit	Discounted Cost		Discounted Benefit		Net Discounted Benefit	
		Cargo (ton)	Benefit (US$)	Initial Investment	Maintenance Expense	Total Cost	Balance	Cost 10% D.R.	Cost 15% D.R.	Benefit 10 % D.R.	Benefit 15 % D.R.	Net Benefit 10% D.R.	Net Benefit 15% D.R.
1	2008			8,844,609		8,844,609	-8,844,609	8,844,609	8,844,609	0	0	-8,844,609	-8,844,609
2	2009			8,844,609		8,844,609	-8,844,609	8,040,553	7,690,964	0	0	-8,040,553	-7,690,964
3	2010	650,000	6,292,137		169,500	169,500	6,122,637	140,083	128,166	5,200,113	4,757,760	5,060,031	4,629,593
4	2011	676,000	6,543,823		169,500	169,500	6,374,323	127,348	111,449	4,916,471	4,302,670	4,789,123	4,191,221
5	2012	703,040	6,805,576		169,500	169,500	6,636,076	115,771	96,912	4,648,300	3,891,110	4,532,529	3,794,198
6	2013	731,162	7,077,799		169,500	169,500	6,908,299	105,246	84,271	4,394,756	3,518,917	4,289,510	3,434,645
7	2014	760,408	7,360,911		169,500	169,500	7,191,411	95,678	73,280	4,155,042	3,182,325	4,059,364	3,109,045
8	2015	790,824	7,655,347		169,500	169,500	7,485,847	86,980	63,721	3,928,403	2,877,928	3,841,423	2,814,207
9	2016	822,457	7,961,561		169,500	169,500	7,792,061	79,073	55,410	3,714,127	2,602,648	3,635,054	2,547,238
10	2017	855,356	8,280,023		169,500	169,500	8,110,523	71,885	48,182	3,511,538	2,353,699	3,439,654	2,305,517
11	2018	889,570	8,611,224		169,500	169,500	8,441,724	65,350	41,898	3,320,000	2,128,563	3,254,650	2,086,665
12	2019	925,153	8,955,673		169,500	169,500	8,786,173	59,409	36,433	3,138,909	1,924,961	3,079,500	1,888,528
13	2020	962,159	9,313,900		169,500	169,500	9,144,400	54,008	31,681	2,967,696	1,740,835	2,913,688	1,709,154
14	2021	962,159	9,313,900		169,500	169,500	9,144,400	49,098	27,548	2,697,905	1,513,769	2,648,807	1,486,221
15	2022	962,159	9,313,900		169,500	169,500	9,144,400	44,635	23,955	2,452,641	1,316,321	2,408,006	1,292,366
16	2023	962,159	9,313,900		169,500	169,500	9,144,400	40,577	20,831	2,229,674	1,144,627	2,189,097	1,123,796
17	2024	962,159	9,313,900		169,500	169,500	9,144,400	36,888	18,114	2,026,976	995,328	1,990,088	977,214
18	2025	962,159	9,313,900		169,500	169,500	9,144,400	33,535	15,751	1,842,705	865,502	1,809,171	849,751
19	2026	962,159	9,313,900		169,500	169,500	9,144,400	30,486	13,696	1,675,187	752,611	1,644,701	738,914
20	2027	962,159	9,313,900		169,500	169,500	9,144,400	27,715	11,910	1,522,897	654,444	1,495,182	642,534
21	2028	962,159	9,313,900		169,500	169,500	9,144,400	25,195	10,356	1,384,452	569,082	1,359,257	558,725
22	2029	962,159	9,313,900		169,500	169,500	9,144,400	22,905	9,006	1,258,593	494,854	1,235,688	485,848
23	2030	962,159	9,313,900		169,500	169,500	9,144,400	20,822	7,831	1,144,175	430,308	1,123,353	422,477
24	2031	962,159	9,313,900		169,500	169,500	9,144,400	18,929	6,810	1,040,159	374,181	1,021,230	367,371
25	2032	962,159	9,313,900		169,500	169,500	9,144,400	17,209	5,921	945,599	325,374	928,391	319,453
26	2033	962,159	9,313,900		169,500	169,500	9,144,400	15,644	5,149	859,636	282,934	843,992	277,785
27	2034	962,159	9,313,900		169,500	169,500	9,144,400	14,222	4,477	781,487	246,030	767,265	241,552
28	2035	962,159	9,313,900		169,500	169,500	9,144,400	12,929	3,893	710,443	213,939	697,514	210,046
29	2036	962,159	9,313,900		169,500	169,500	9,144,400	11,754	3,386	645,857	186,034	634,103	182,648
30	2037	962,159	9,313,900		169,500	169,500	9,144,400	10,685	2,944	587,143	161,769	576,458	158,825
31	2038	962,159	9,313,900		169,500	169,500	9,144,400	9,714	2,560	533,766	140,668	524,052	138,108
32	2039	962,159	9,313,900		169,500	169,500	9,144,400	8,831	2,226	485,242	122,320	476,411	120,094
33	2040	962,159	9,313,900		169,500	169,500	9,144,400	8,028	1,936	441,129	106,365	433,101	104,430
34	2041	962,159	9,313,900		169,500	169,500	9,144,400	7,298	1,683	401,026	92,492	393,728	90,808
35	2042	962,159	9,313,900		169,500	169,500	9,144,400	6,635	1,464	364,569	80,428	357,935	78,964
36	2043	962,159	9,313,900		169,500	169,500	9,144,400	6,032	1,273	331,427	69,937	325,395	68,664
37	2044	962,159	9,313,900		169,500	169,500	9,144,400	5,483	1,107	301,297	60,815	295,814	59,708
38	2045	962,159	9,313,900		169,500	169,500	9,144,400	4,985	962	273,906	52,882	268,922	51,920
39	2046	962,159	9,313,900		169,500	169,500	9,144,400	4,532	837	249,006	45,985	244,474	45,148
40	2047	962,159	9,313,900		169,500	169,500	9,144,400	4,120	728	226,369	39,987	222,249	39,259
	Total							18,384,875	17,513,330	71,308,621	44,620,401	52,923,746	27,107,071

Note) Difference of transport cost (via HP - via HN/KL): US$ 9.68 per Ton
Unit rate for dredging (RRWP Table 4.12): US$ per cum
Capital Dredging (incl. DNC canal, RRWP Table 4.07) c.m cum
Capital Dredging Cost US$
Total (Initial Investment) US$ 17,689,217
Yearly maintenance dredging (RRWP 4.120) US$ 169,500
Cost difference between Case A and Case B per ton in US$ US$ 9.68

Case A Cargo is transported to Hanoi from HCMC by combination of 5,000 DWT coastal shipping vessel and IWT (Hai Phone - Hanoi)
Assumption)
Case B Cargo is transported to Hanoi from HCMC directly by 1000 SWT Sea-cum-River Vessel

SOC per ton in US$
Case A 3000 DWT Coastal Shipping + IWT (HCMC - HN via HP) US$ 15.48 per ton
Case B 1000 DWT SRV (HCMC - HN) US$ 5.80 per ton

Economic Analysis Indicator		
Project Life	Years	40
EIRR		33.45%
NPV at	10%	52.9
NPV at	15%	27.1
B/C Ratio at	10%	3.88
B/C Ratio at	15%	2.55

Table A30.9 Economic Analysis (Corridor 3NB, Comparison with 200 DWT x 4 Barge + Tug Boat)

	Year	Economic Benefit		Cost (US$)			Net Benefit	Discounted Cost		Discounted Benefit		Net Benefit	
		Cargo (ton)	Benefit (US$)	Initial Investment	Maintenance Expense	Total Cost	Balance	Cost 10% D.R.	Cost 15% D.R.	Benefit 10 % D.R.	Benefit 15 % D.R.	Net Benefit 10% D.R.	Net Benefit 15% D.R.
1	2008			612,417		612,417	-612,417	612,417	612,417	0	0	-612,417	-612,417
2	2009			612,417		612,417	-612,417	556,742	532,536	0	0	-556,742	-532,536
3	2010	400,000	646,056		350,000	350,000	296,056	289,256	264,650	533,931	488,511	244,674	223,861
4	2011	450,000	726,813		350,000	350,000	376,813	262,960	230,131	546,065	477,891	283,105	247,761
5	2012	500,000	807,570		350,000	350,000	457,570	239,055	200,114	551,581	461,731	312,527	261,617
6	2013	550,000	888,327		350,000	350,000	538,327	217,322	174,012	551,581	441,656	334,259	267,644
7	2014	600,000	969,084		350,000	350,000	619,084	197,566	151,315	547,023	418,962	349,457	267,647
8	2015	650,000	1,049,841		350,000	350,000	699,841	179,605	131,578	538,735	394,674	359,129	263,096
9	2016	700,000	1,130,598		350,000	350,000	780,598	163,278	114,416	527,432	369,595	364,155	255,179
10	2017	750,000	1,211,355		350,000	350,000	861,355	148,434	99,492	513,733	344,343	365,299	244,851
11	2018	800,000	1,292,112		350,000	350,000	942,112	134,940	86,515	498,165	319,390	363,225	232,876
12	2019	850,000	1,372,869		350,000	350,000	1,022,869	122,673	75,230	481,182	295,089	358,509	219,859
13	2020	900,000	1,453,626		350,000	350,000	1,103,626	111,521	65,418	463,170	271,693	351,649	206,276
14	2021	900,000	1,453,626		350,000	350,000	1,103,626	101,383	56,885	421,064	236,255	319,681	179,370
15	2022	900,000	1,453,626		350,000	350,000	1,103,626	92,166	49,465	382,785	205,439	290,619	155,974
16	2023	900,000	1,453,626		350,000	350,000	1,103,626	83,787	43,013	347,987	178,643	264,199	135,630
17	2024	900,000	1,453,626		350,000	350,000	1,103,626	76,170	37,403	316,351	155,341	240,181	117,939
18	2025	900,000	1,453,626		350,000	350,000	1,103,626	69,246	32,524	287,592	135,080	218,347	102,555
19	2026	900,000	1,453,626		350,000	350,000	1,103,626	62,951	28,282	261,447	117,460	198,497	89,179
20	2027	900,000	1,453,626		350,000	350,000	1,103,626	57,228	24,593	237,680	102,140	180,452	77,547
21	2028	900,000	1,453,626		350,000	350,000	1,103,626	52,025	21,385	216,072	88,817	164,047	67,432
22	2029	900,000	1,453,626		350,000	350,000	1,103,626	47,296	18,596	196,429	77,232	149,134	58,636
23	2030	900,000	1,453,626		350,000	350,000	1,103,626	42,996	16,170	178,572	67,158	135,576	50,988
24	2031	900,000	1,453,626		350,000	350,000	1,103,626	39,087	14,061	162,338	58,399	123,251	44,338
25	2032	900,000	1,453,626		350,000	350,000	1,103,626	35,534	12,227	147,580	50,781	112,046	38,554
26	2033	900,000	1,453,626		350,000	350,000	1,103,626	32,304	10,632	134,164	44,158	101,860	33,526
27	2034	900,000	1,453,626		350,000	350,000	1,103,626	29,367	9,245	121,967	38,398	92,600	29,153
28	2035	900,000	1,453,626		350,000	350,000	1,103,626	26,697	8,039	110,879	33,390	84,182	25,350
29	2036	900,000	1,453,626		350,000	350,000	1,103,626	24,270	6,991	100,799	29,034	76,529	22,044
30	2037	900,000	1,453,626		350,000	350,000	1,103,626	22,064	6,079	91,636	25,247	69,572	19,168
31	2038	900,000	1,453,626		350,000	350,000	1,103,626	20,058	5,286	83,305	21,954	63,247	16,668
32	2039	900,000	1,453,626		350,000	350,000	1,103,626	18,235	4,597	75,732	19,091	57,497	14,494
33	2040	900,000	1,453,626		350,000	350,000	1,103,626	16,577	3,997	68,847	16,601	52,270	12,603
34	2041	900,000	1,453,626		350,000	350,000	1,103,626	15,070	3,476	62,588	14,435	47,519	10,960
35	2042	900,000	1,453,626		350,000	350,000	1,103,626	13,700	3,022	56,899	12,552	43,199	9,530
36	2043	900,000	1,453,626		350,000	350,000	1,103,626	12,454	2,628	51,726	10,915	39,272	8,287
37	2044	900,000	1,453,626		350,000	350,000	1,103,626	11,322	2,285	47,024	9,491	35,701	7,206
38	2045	900,000	1,453,626		350,000	350,000	1,103,626	10,293	1,987	42,749	8,253	32,456	6,266
39	2046	900,000	1,453,626		350,000	350,000	1,103,626	9,357	1,728	38,862	7,177	29,505	5,449
40	2047	900,000	1,453,626		350,000	350,000	1,103,626	8,507	1,503	35,330	6,241	26,823	4,738
	Total							3,653,495	2,551,504	10,031,004	6,053,217	6,377,509	3,501,713

Note) Difference of transport cost (via Luoc - via Coast): US$ 1.62 per Ton
Unit rate for dredging (RRWP Table 4.12): US$ per cum
Capital Dredging (incl. DNC canal, RRWP Table 4.07) c.m cum
Capital Dredging Cost (Ref. ADB RRWP Vol.5 Annex. 3 Apx. 3.4) US$ 1,224,833

Canal protection US$ 0
Bridge Cost US$ 0
Total (Initial Investment) US$ 1,224,833
Yearly maintenance dredging (RRWP 4.120) but at 30 % of capital US$ 350,000

Assumption) Cost difference between Case A and Case B per ton in US$ US$ 1.62
Case A Coal is transported from QN to NB by 200 DWT x 4 Barges + Tug Boat Configulation through channels.
Case B Coal is transported from QN to NB by 1000 DWT SRV through coastal route and river mouth of the Da River.
SOC per ton-km in US$
200 DWT x 2 Barges + Tug Boat Configulation US$ 0.00993 per ton-km
1000 DWT SRV US$ 0.00580 per ton-km
Distance Case A (QN - NB via Cua Loc) 318 km
Case B (QN - NB via Cua Day) 266 km

Reference) SOC Data

Economic Analysis Indicator		
Project Life	Years	40
EIRR		**67.71%**
NPV at	10%	6.38
NPV at	15%	3.50
B/C Ratio at	10%	2.75
B/C Ratio at	15%	2.37

Table A30.10 Economic Analysis (Corridor 3NB with 200 DWT x 2 Barges + Tug Boat)

	Year	Economic Benefit		Cost (US$)			Net Benefit	Discounted Cost		Discounted Benefit		Net Benefit	
		Cargo (ton)	Benefit (US$)	Initial Investment	Maintenance Expense	Total Cost	Balance	Cost 10% D.R.	Cost 15% D.R.	Benefit 10 % D.R.	Benefit 15 % D.R.	Net Benefit 10% D.R.	Net Benefit 15% D.R.
1	2008			612,417		612,417	-612,417	612,417	612,417	0	0	-612,417	-612,417
2	2009			612,417		612,417	-612,417	556,742	532,536	0	0	-556,742	-532,536
3	2010	400,000	236,794		350,000	350,000	-113,206	289,256	264,650	195,698	179,051	-93,558	-85,600
4	2011	450,000	266,394		350,000	350,000	-83,606	262,960	230,131	200,146	175,158	-62,815	-54,973
5	2012	500,000	295,993		350,000	350,000	-54,007	239,055	200,114	202,167	169,235	-36,888	-30,879
6	2013	550,000	325,592		350,000	350,000	-24,408	217,322	174,012	202,167	161,877	-15,155	-12,135
7	2014	600,000	355,192		350,000	350,000	5,192	197,566	151,315	200,496	153,559	2,931	2,244
8	2015	650,000	384,791		350,000	350,000	34,791	179,605	131,578	197,459	144,657	17,853	13,079
9	2016	700,000	414,390		350,000	350,000	64,390	163,278	114,416	193,316	135,465	30,038	21,049
10	2017	750,000	443,989		350,000	350,000	93,989	148,434	99,492	188,295	126,210	39,861	26,718
11	2018	800,000	473,589		350,000	350,000	123,589	134,940	86,515	182,589	117,064	47,649	30,549
12	2019	850,000	503,188		350,000	350,000	153,188	122,673	75,230	176,364	108,157	53,691	32,927
13	2020	900,000	532,787		350,000	350,000	182,787	111,521	65,418	169,762	99,582	58,242	34,164
14	2021	900,000	532,787		350,000	350,000	182,787	101,383	56,885	154,330	86,593	52,947	29,708
15	2022	900,000	532,787		350,000	350,000	182,787	92,166	49,465	140,300	75,298	48,134	25,833
16	2023	900,000	532,787		350,000	350,000	182,787	83,787	43,013	127,545	65,477	43,758	22,464
17	2024	900,000	532,787		350,000	350,000	182,787	76,170	37,403	115,950	56,936	39,780	19,534
18	2025	900,000	532,787		350,000	350,000	182,787	69,246	32,524	105,409	49,510	36,164	16,986
19	2026	900,000	532,787		350,000	350,000	182,787	62,951	28,282	95,826	43,052	32,876	14,770
20	2027	900,000	532,787		350,000	350,000	182,787	57,228	24,593	87,115	37,436	29,887	12,844
21	2028	900,000	532,787		350,000	350,000	182,787	52,025	21,385	79,195	32,553	27,170	11,168
22	2029	900,000	532,787		350,000	350,000	182,787	47,296	18,596	71,996	28,307	24,700	9,712
23	2030	900,000	532,787		350,000	350,000	182,787	42,996	16,170	65,451	24,615	22,455	8,445
24	2031	900,000	532,787		350,000	350,000	182,787	39,087	14,061	59,501	21,404	20,413	7,343
25	2032	900,000	532,787		350,000	350,000	182,787	35,534	12,227	54,092	18,613	18,558	6,386
26	2033	900,000	532,787		350,000	350,000	182,787	32,304	10,632	49,174	16,185	16,871	5,553
27	2034	900,000	532,787		350,000	350,000	182,787	29,367	9,245	44,704	14,074	15,337	4,828
28	2035	900,000	532,787		350,000	350,000	182,787	26,697	8,039	40,640	12,238	13,943	4,199
29	2036	900,000	532,787		350,000	350,000	182,787	24,270	6,991	36,945	10,642	12,675	3,651
30	2037	900,000	532,787		350,000	350,000	182,787	22,064	6,079	33,587	9,254	11,523	3,175
31	2038	900,000	532,787		350,000	350,000	182,787	20,058	5,286	30,533	8,047	10,475	2,761
32	2039	900,000	532,787		350,000	350,000	182,787	18,235	4,597	27,758	6,997	9,523	2,401
33	2040	900,000	532,787		350,000	350,000	182,787	16,577	3,997	25,234	6,084	8,657	2,087
34	2041	900,000	532,787		350,000	350,000	182,787	15,070	3,476	22,940	5,291	7,870	1,815
35	2042	900,000	532,787		350,000	350,000	182,787	13,700	3,022	20,855	4,601	7,155	1,578
36	2043	900,000	532,787		350,000	350,000	182,787	12,454	2,628	18,959	4,001	6,504	1,373
37	2044	900,000	532,787		350,000	350,000	182,787	11,322	2,285	17,235	3,479	5,913	1,194
38	2045	900,000	532,787		350,000	350,000	182,787	10,293	1,987	15,668	3,025	5,375	1,038
39	2046	900,000	532,787		350,000	350,000	182,787	9,357	1,728	14,244	2,630	4,887	902
40	2047	900,000	532,787		350,000	350,000	182,787	8,507	1,503	12,949	2,287	4,443	785
	Total							3,653,495	2,551,504	3,676,593	2,218,643	23,098	-332,861

Note) Difference of transport cost (via Luoc - via Coast): US$ 0.592 per Ton
Unit rate for dredging (RRWP Table 4.12): US$ per cum
Capital Dredging (incl. DNC canal, RRWP Table 4.07) c.m cum
Capital Dredging Cost US$ 1,224,833
Canal protection US$ 0
Bridge Cost US$ 0
Total (Initial Investment) US$ 1,224,833
Yearly maintenance dredging (RRWP 4.120) US$ 350,000

Economic Analysis Indicator		
Project Life	Years	40
EIRR		10.21%
NPV at	10%	0.02
NPV at	15%	-0.33
B/C Ratio at	10%	1.01
B/C Ratio at	15%	0.87

Assumption Cost difference between Case A and Case B per ton in U US$ 0.592

Case A Coal is transported from QN to NB by 200 DWT x 4 Barges + Tug Boat Configulation through channels.

Case B Coal is transported from QN to NB by 500 DWT Self-propelled Barge through coastal route and river mouth of the Da River.

SOC per ton-km in US$
200 DWT x 4 Barges + Tug Boat Configulation US$ 0.00671 per ton-km
1000 DWT SRV US$ 0.00580 per ton-km

Distance Case A 318 km
Case B 266 km

Reference) SOC Data

Table A30.11 Economic Analysis (Vertical Clearance Improvement of Duong Bridge)

	Year	Economic Benefit		Cost (US$)			Net Benefit	Discounted Cost		Discounted Benefit		Net Discounted Benefit	
		Cargo (ton)	Benefit (US$)	Initial Investment	Maintenance Expense	Total Cost	Balance	Cost 10% D.R.	Cost 15% D.R.	Benefit 10 % D.R.	Benefit 15 % D.R.	Net Benefit 10% D.R.	Net Benefit 15% D.R.
1	2008			1,775,000		1,775,000	-1,775,000	1,613,636	1,543,478	0	0	-1,613,636	-1,543,478
2	2009			1,775,000		1,775,000	-1,775,000	1,466,942	1,342,155	0	0	-1,466,942	-1,342,155
3	2010	3,900,000	424,294		142,000	142,000	282,294	106,687	93,367	318,778	278,980	212,092	185,613
4	2011	4,036,402	439,134		142,000	142,000	297,134	96,988	81,189	299,934	251,076	202,946	169,887
5	2012	4,177,575	454,492		142,000	142,000	312,492	88,171	70,599	282,204	225,963	194,033	155,364
6	2013	4,323,685	470,388		142,000	142,000	328,388	80,155	61,391	265,522	203,362	185,367	141,971
7	2014	4,474,905	486,840		142,000	142,000	344,840	72,868	53,383	249,826	183,021	176,957	129,638
8	2015	4,631,414	503,867		142,000	142,000	361,867	66,244	46,420	235,058	164,715	168,814	118,295
9	2016	4,793,398	521,490		142,000	142,000	379,490	60,222	40,365	221,163	148,240	160,941	107,875
10	2017	4,961,046	539,729		142,000	142,000	397,729	54,747	35,100	208,089	133,413	153,342	98,313
11	2018	5,134,558	558,606		142,000	142,000	416,606	49,770	30,522	195,788	120,069	146,018	89,547
12	2019	5,314,139	578,143		142,000	142,000	436,143	45,246	26,541	184,214	108,059	138,969	81,518
13	2020	5,500,000	598,364		142,000	142,000	456,364	41,132	23,079	173,325	97,251	132,192	74,172
14	2021	5,500,000	598,364		142,000	142,000	456,364	37,393	20,069	157,568	84,566	120,175	64,497
15	2022	5,500,000	598,364		142,000	142,000	456,364	33,994	17,451	143,243	73,536	109,250	56,085
16	2023	5,500,000	598,364		142,000	142,000	456,364	30,903	15,175	130,221	63,944	99,318	48,769
17	2024	5,500,000	598,364		142,000	142,000	456,364	28,094	13,195	118,383	55,603	90,289	42,408
18	2025	5,500,000	598,364		142,000	142,000	456,364	25,540	11,474	107,621	48,351	82,081	36,877
19	2026	5,500,000	598,364		142,000	142,000	456,364	23,218	9,978	97,837	42,044	74,619	32,067
20	2027	5,500,000	598,364		142,000	142,000	456,364	21,107	8,676	88,943	36,560	67,836	27,884
21	2028	5,500,000	598,364		142,000	142,000	456,364	19,189	7,545	80,857	31,791	61,669	24,247
22	2029	5,500,000	598,364		142,000	142,000	456,364	17,444	6,560	73,507	27,645	56,062	21,084
23	2030	5,500,000	598,364		142,000	142,000	456,364	15,858	5,705	66,824	24,039	50,966	18,334
24	2031	5,500,000	598,364		142,000	142,000	456,364	14,417	4,961	60,749	20,903	46,333	15,943
25	2032	5,500,000	598,364		142,000	142,000	456,364	13,106	4,314	55,227	18,177	42,121	13,863
26	2033	5,500,000	598,364		142,000	142,000	456,364	11,915	3,751	50,206	15,806	38,291	12,055
27	2034	5,500,000	598,364		142,000	142,000	456,364	10,831	3,262	45,642	13,744	34,810	10,483
28	2035	5,500,000	598,364		142,000	142,000	456,364	9,847	2,836	41,493	11,952	31,646	9,115
29	2036	5,500,000	598,364		142,000	142,000	456,364	8,952	2,466	37,720	10,393	28,769	7,926
30	2037	5,500,000	598,364		142,000	142,000	456,364	8,138	2,145	34,291	9,037	26,154	6,892
31	2038	5,500,000	598,364		142,000	142,000	456,364	7,398	1,865	31,174	7,858	23,776	5,993
32	2039	5,500,000	598,364		142,000	142,000	456,364	6,725	1,622	28,340	6,833	21,614	5,212
33	2040	5,500,000	598,364		142,000	142,000	456,364	6,114	1,410	25,764	5,942	19,650	4,532
34	2041	5,500,000	598,364		142,000	142,000	456,364	5,558	1,226	23,421	5,167	17,863	3,941
35	2042	5,500,000	598,364		142,000	142,000	456,364	5,053	1,066	21,292	4,493	16,239	3,427
36	2043	5,500,000	598,364		142,000	142,000	456,364	4,594	927	19,357	3,907	14,763	2,980
37	2044	5,500,000	598,364		142,000	142,000	456,364	4,176	806	17,597	3,397	13,421	2,591
38	2045	5,500,000	598,364		142,000	142,000	456,364	3,796	701	15,997	2,954	12,201	2,253
39	2046	5,500,000	598,364		142,000	142,000	456,364	3,451	610	14,543	2,569	11,092	1,959
40	2047	5,500,000	598,364		142,000	142,000	456,364	3,137	530	13,221	2,234	10,083	1,704
	Total							4,222,757	3,597,915	4,234,939	2,547,595	12,181	-1,050,320

Note) Annual cargo volume passing under Duong Bridge in 2010 — 3,900,000 tons
Annual cargo volume passing under Duong Bridge in 2020 — 5,500,000 tons
Initial capital investment — US$ 3,550,000 (in Economic Price)
Annual bridge operation and maintenance cost — 4% of Initial capital investment
Benefit per Annual Cargo Volume of 1 ton — US$ 0.1088 per ton
Standard Coversion Factor — 0.85

Maximum allowable capital investment for bridge — US$ 4,200,000 (in Financial Price)
120 504

Economic Analysis Indicator		
Project Life	Years	40
EIRR		10.00%
NPV at	10%	0.00
B/C Ratio at	10%	1.00

Appendix 31 Initial Environmental Examination for Master Plan

A31.1 Natural conditions

A31.1.1 Topographical conditions

The Red River segment through Hanoi City has the length of approximately 40 km. This river section (named "Survey area") flows pass administration localities as Tu Liem district, Tay Ho district, Hoan Kiem district, Hai Ba Trung district and Thanh Tri district in the right bank and Dong Anh, Gia Lam districts in the left bank.

The Survey area can be divided into three small stretches due to the topographical characteristics as shown in **Table A31.1.1.**

Table A31.1.1 Stretches of The Red River Segment

Stretches	Dong Lai – Cua Duong	Cua Duong – Thanh Tri	Thanh Tri – Van Phuc
Chainage (Length)	Km 0 to Km 17 (17 km)	Km 17 to Km 27 (10 km)	Km 27 to Km 38 (11 km)
Distance between 2 dykes (m)	1,200 – 4,050	1,250 – 2,800	2,100 – 6,500
Channel width in WL + 9m (m)	700 – 1,700	720 – 1,600	450 – 1,050
Channel width in WL + 6m	500 – 1,200	300 – 800	300 – 900

Source) Pre-Feasibility Study of Red River Section – Hanoi Section – Rehabilitation Project

Dong Anh district is a prolongation of the Tam Dao mountains mass in the Middle Region of the North stretching towards the Delta. So the land level of Dong Anh district is 7 – 10 m. The other areas comprising Gia Lam, Tu Liem, Thanh Tri districts and seven urban districts (i.e. Ba Dinh, Ho Tay, Hoan Kiem, Hai Ba Trung, Dong Da, Thanh Xuan, Cau Giay) belong to the Delta with the average height of 4 – 5 m.

A31.1.2 Meteorological conditions

(1) Wind

- Wind regime

Wind data were collected from July 1956 to 2000 at the National Meteorological Station (Lang Station). The observation interval was 4 times a day . The general wind rose is presented in **Table A31.1.2.**

Table A31.1.2 Annual Wind Rose in Hanoi

Speed / Dir.	Calm		0.1 – 3.9 (m/s)		4.0 – 8.9 (m/s)		9.0 – 14.9 (m/s)		> 15 (m/s)		Total	
	Occur.	%	Occur.	%	Occur.	%	Occur.	%	Occur.	%	Occur.	%
N			3203	4.99	563	0.88	6	0.01	2	0.00	3774	5.88
NNE			2157	3.36	815	1.27	16	0.02			2988	4.65
NE			5721	8.91	1788	2.78	44	0.07	1	0.00	7554	**11.76**
ENE			1157	1.80	224	0.35	4	0.01	1	0.00	1386	2.16
E			3962	6.17	359	0.56	2	0.00	1	0.00	4324	6.73
ESE			3090	4.81	872	1.36	3	0.00	1	0.00	3966	6.17
SE			10979	17.09	3091	4.81	11	0.02	1	0.00	14082	**21.92**
SSE			1989	3.10	486	0.76	6	0.01			2481	3.86
S			2136	3.33	270	0.42	2	0.00			2408	3.75
SSW			389	0.61	50	0.08	1	0.00			440	0.68
SW			1062	1.65	55	0.09	1	0.00	1	0.00	1119	1.74
WSW			198	0.31	9	0.01					207	0.32
W			1480	2.30	92	0.14	2	0.00			1574	2.45
WNW			839	1.31	153	0.24	3	0.00			995	1.55
NW			2986	4.65	363	0.57	2	0.00	1	0.00	3352	5.22
NNW			929	1.45	126	0.20	1	0.00			1056	1.64
Calm	12529	19.50									12529	19.50
Total	12529	19.50	42277	65.82	9316	14.50	104	0.16	9	0.01	64235	100

Source) Lang Station 1956 – 2000

The above table shows that there are two prevailing wind directions, i.e. NE and SE in annual wind rose. According to monthly wind roses it is found that NE wind direction occurs from November to January with frequency of 15.1 to 21.8%, and SE direction occurs from February to October with frequency of 12.2 to 35.7%.

- Monthly maximum wind speed

Monthly average and maximum wind speeds in Hanoi are shown in **Table A31.1.3.**

Table A31.1.3 Monthly Maximum Wind Speed in Hanoi

(Unit: m/sec)

Wind velocity	Month												Year
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average	2.0	2.1	2.2	2.1	2.2	1.9	1.9	1.7	1.6	1.7	1.7	1.8	1.9
Average of monthly max.	10.8	10.0	10.8	11.7	13.4	12.7	14.1	13.2	11.8	11.4	10.8	10.9	11.8
Max. of monthly max.	18	14	15	20	30	28	34	31	28	17	22	18	
Direction	NE	NE	NNE	W	SW	WNW	N	E	ENE	NE	NE	NE	

Source) Lang Station 1956 - 2000

From the above table, it can be seen that monthly average wind speed and average of monthly maximum wind speeds in the past 45 years (1956 – 2000) are 1.9 and 11.8 m/s, respectively.

(2) Typhoons and tropical depressions

Number of the typhoons and tropical depressions passed in the North Vietnam region of latitude 19 – 22^0 North (Hanoi City N 21^0) in the past 26 years (1954 – 1980) was counted as 64 times.

(3) Rainfall

- Monthly average rainfall

The rainfall in the Survey area is clearly characterized by two monsoon seasons, i.e. the dry and rainy seasons:

+ The rainy season prevails from May to October with monthly average rainfall of 182 – 282 mm/month
+ The dry season prevails from November to April with monthly average rainfall of 21 – 97 mm/month

Monthly average rainfall in Hanoi in the past 45 years (1956 – 2000) could be summarized in **Table A31.1.4.**

Table A31.1.4 Monthly Maximum and Minimum Rainfall in Hanoi

(Unit: mm)

Rainfall	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	23.6	29.4	50.0	97.1	181.8	251.0	262.4	282.3	227.3	143.2	67.5	20.8
Monthly max.	97.4	90.8	259.5	268.3	550.7	522.7	491.7	664.8	562.0	407.4	614.4	103.7
Monthly min.	0.8	2.7	9.0	12.7	22.4	39.3	61.6	39.4	29.1	3.2	0.0	0.0

Source) Lang Station 1956 - 2000

A31.1.2.4 Air temperature

Monthly average and maximum air temperature in Hanoi are shown in **Table A31.1.5.**

Table A31.1.5 Monthly Maximum and Minimum Air Temperature in Hanoi

(Unit: ^{0}C)

Air temperature	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	16.4	17.2	20.0	23.9	27.0	28.9	29.2	28.5	27.4	24.8	21.5	18.1
Average of monthly max.	26.3	27.4	29.3	32.5	36.5	37.0	36.8	35.7	34.2	32.5	30.3	27.5
Average of monthly min.	9.1	9.8	12.6	16.9	20.5	22.9	23.5	23.5	22.0	17.8	14.0	10.2
Max. of monthly max.	31.5	34.1	36.1	38.8	39.8	40.1	39.1	38.2	36.5	34.4	34.7	31.5
Min. of monthly min.	5.4	5.0	7.0	12.9	17.3	20.0	31.0	31.8	16.1	13.9	8.5	5.1

Source) Lang Station 1956 – 2000

From the above table, it can be seen that monthly average air temperature and average of monthly maximum air temperature in the past 45 years (1956 – 2000) are 18.1 and 27.5^{0}C respectively.

(5) Humidity

Air humidity in Hanoi is shown in **Table A31.1.6.**

Table A31.1.6 Monthly Average and Minimum Relative Air Humidity in Hanoi

(Unit: %)

Air humidity	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	81	81	86	86	83	82	82	84	83	81	79	78
Average of monthly min.	40	45	49	53	48	50	52	57	48	40	38	37
Minimum of monthly min.	21	22	24	32	29	32	36	47	31	24	26	24

Source) Lang Station 1956 – 2000

From this table it can be seen that monthly average relative air humidity in the past 45 years (1956 – 2000) varies from 78% in December to 86% in April.

(6) Shining hour

Shining hour in Hanoi is shown in **Table A31.1.7.**

Table A31.1.7 Monthly Maximum and Minimum Sunshine Duration in Hanoi

(Unit: hour)

Shining hour	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average	73.7	48.9	48.8	89.9	181.9	164.8	192.6	174.8	176.7	165.8	140.3	124.1
Monthly max.	178.3	117.9	109.5	146.0	254.5	259.7	251.7	248.6	243.6	247.0	222.3	204.8
Monthly min.	14.5	1.9	3.6	33.9	104.6	85.1	77.3	114.5	92.9	95.5	70.9	45.9

Source) Lang Station 1956 – 2000

From this table, it can be seen that monthly average sunshine duration in the past 45 years (1956 – 2000) varies from 48.9 hours in February to 192.6 hours in July.

A31.1.3 Hydrological conditions

(1) Water level

The maximum and minimum water levels recorded at Hanoi gauging station in **Table A31.1.8** for the past 16 years. The maximum water level occurred from June to September. The minimum water level occurred from December to April, mostly in February.

Table A31.1.8 Maximum and Minimum Water Levels Recorded In Hanoi Gauging Station

(Unit: + m above NLSD)

Year	Highest	Date	Lowest	Date	Year	Highest	Date	Lowest	Date
1986	12.19	29/7	2.01	26/3	1994	10.47	19/7	2.68	16/3
1987	10.02	25/8	2.03	21/3	1995	11.57	19/8	2.82	31/12
1988	9.99	10/9	1.91	5/4	1996	12.43	21/8	2.40	22/3
1989	10.07	14/6	1.96	23/2	1997	11.09	24/9	2.86	3/2
1990	11.78	31/7	2.44	13/2	1998	11.00	13/7	2.22	31/2
1991	11.33	16/8	2.70	4/5	1999	10.95	4/9	2.00	20/2
1992	11.30	27/7	2.62	28/4	2000	11.29	26/7	2.55	29/2
1993	9.46	26/8	2.82	4/1	2001	11.21		2.38	

Source) Hanoi gauging station 1986 – 2001

Various water levels at Hanoi gauging station to be used for design purposes are summarized in **Table A31.1.9.**

Table A31.1.9 Water Levels at Hanoi Gauging Station for Designed Purposes (1956 – 2001)

Representative Water Levels	Elevation (NLSD: m)
Highest Water Level (1971)	+ 13.97
Annual Mean Highest Water Level	+ 10.96
Mean Water Level in Flood Season (May to October)	+ 7.34
Annual Mean Water Level	+ 5.04
Mean Water Level in Dry Season (November to April)	+ 3.47
Annual Mean Lowest Water Level	+ 2.20
Lowest Water Level (1960)	+ 1.55

Source) TEDI

These water levels are shown in the National Land Survey Datum (NLSD) (is also called as National Elevation System in Vietnam), (zero m = mean water level at the Hon Dau island in Hai Phong City), which is 1.86 m higher than water levels referred to Chart Datum Level (zero m = lowest water level).

(2) Water flow speed

Water flow speed is measured for consecutive 25 hours in the time when tidal fluctuation was remarkable i.e. during days of the spring tide on January 15 and 16, 2002.

Measuring points consist of 7 main points (to obtain input data for implementation of simulation of navigational channel stabilization) and 13 supplemental points (to obtain data for checking numerical values computed from simulation).

The results of measurements of river water flow are respectively summarized in **Table A31.1.10.**

Table A31.1.10 River Water Flow Speed in the Red River Segment

Water depths	Speed case	Speed (m/s)									
		V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
0.5m below water surface	Maximum	0.91	0.88	0.63	0.55	0.88	0.91	1.12	0.66	1.05	0.89
	Average	0.82	0.83	0.58	0.50	0.85	0.86	1.01	0.62	1.02	0.79
	Minimum	0.73	0.76	0.49	0.47	0.80	0.82	0.94	0.58	0.97	0.68
Middle depth	Maximum	0.83	0.86	0.58	0.51	0.84	0.84	1.04	0.62	0.97	0.82
	Average	0.70	0.73	0.52	0.47	0.79	0.80	0.97	0.57	0.91	0.73
	Minimum	0.57	0.67	0.44	0.43	0.75	0.77	0.89	0.53	0.79	0.59
0.25m above river bed	Maximum	0.65	0.59	0.45	0.43	0.69	0.78	0.72	0.51	0.71	0.65
	Average	0.50	0.5	0.35	0.39	0.62	0.65	0.61	0.49	0.62	0.58
	Minimum	0.37	0.4	0.18	0.36	0.51	0.56	0.52	0.48	0.49	0.49

Source) JICA Study Team

Table A31.1.10 (continued)

Water depths	Speed case	Speed (m/s)									
		V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
0.5m below water surface	Maximum	0.42	0.79	0.91	0.97	1.44	0.63	0.66	0.57	0.53	0.68
	Average	0.28	0.65	0.81	0.85	1.41	0.61	0.62	0.51	0.49	0.59
	Minimum	0.20	0.50	0.73	0.79	1.36	0.58	0.59	0.44	0.43	0.50
Middle depth	Maximum	0.40	0.79	0.95	0.81	1.29	0.60	0.56	0.53	0.52	0.59
	Average	0.29	0.61	0.81	0.79	1.19	0.57	0.53	0.47	0.44	0.53
	Minimum	0.22	0.46	0.79	0.76	1.01	0.52	0.50	0.30	0.39	0.50
0.25m above river bed	Maximum	0.26	0.52	0.76	0.63	0.88	0.42	0.38	0.43	0.42	0.50
	Average	0.18	0.40	0.57	0.60	0.77	0.33	0.33	0.38	0.37	0.44
	Minimum	0.12	0.28	0.31	0.57	0.66	0.30	0.23	0.30	0.32	0.38

Source) JICA Study Team

(3) Discharge volume

The volume of water and sediment discharges are shown in **Table A31.1.11.**

Table A31.1.11 Discharge Volume

Discharge Volume	Unit	Hanoi Station	Thuong Cat Station
Maximum discharge	m^3/s	22,200 (20/8/1971)	9,000 (20/8/1971)
Average discharge	m^3/s	2,710	880
Minimum discharge	m^3/s	350 (9/5/1960)	28.8 (28/4/1958)
Maximum sandy mud volume	kg/s	65,400	25,100
Average sandy mud volume	kg/s	2,280	829
Minimum sandy mud volume	kg/s	269	0.346
Maximum suspended mud degree	g/m^3	6,530	5,770
Average suspended mud degree	g/m^3	847	932

Source) Pre-feasibility Study Report, TEDI, 2001

(4) Concentration of suspended solid (SS) and materials of riverbed

1) Suspended solid

Suspended solid is measured along with water flow. The result of concentration of SS is shown in **Table A31.1.12.**

Table A31.1.12 Concentration of Suspended Solid in The Red River Segment

Water depths	Speed case	Suspended solid (mg/l)									
		V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
0.5m below water surface	Maximum	160.4	202.2	136.0	162.0	174.0	148.0	132.6	120.6	165.8	191.4
	Average	85.8	132.1	96.1	134.1	125.1	110.0	105.7	99.4	142.3	143.0
	Minimum	32.8	71.0	57.8	91.2	71.0	73.0	74.4	69.2	117.2	95.8
Middle depth	Maximum	216.4	281.2	222.8	238.8	192.8	187.2	143.0	137.0	167.4	194.4
	Average	142.9	198.8	143.4	213.2	157.6	155.5	118.3	110.1	151.9	168.7
	Minimum	76.8	128.8	93.8	167.0	147.6	131.2	86.2	96.0	126.0	146.2
0.25m above river bed	Maximum	288.2	374.4	306.0	360.0	247.0	194.6	148.2	156.8	229.2	274.0
	Average	205.7	281.3	197.8	271.8	200.4	177.2	131.2	120.5	188.3	195.7
	Minimum	151.4	170.2	142.6	209.8	159.2	146.6	100.2	102.0	149.6	147.4

Source) JICA Study Team

Table A31.1.12 (continued)

Water depths	Speed case	Suspended solid (mg/l)									
		V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
0.5m below water surface	Maximum	131.0	165.0	192.0	192.8	168.2	153.4	150.6	152.2	149.8	135.6
	Average	104.1	118.4	167.5	134.3	142.8	120.1	132.3	116.4	85.6	89.9
	Minimum	69.8	80.4	149.4	125.8	102.8	82.0	112.4	51.6	55.4	36.4
Middle depth	Maximum	149.4	242.6	219.0	209.8	217.8	172.8	186.4	299.6	195.6	191.4
	Average	123.1	166.3	181.6	162.6	181.0	148.5	156.3	157.2	126.9	131.3
	Minimum	100.8	137.4	150.2	125.4	119.4	121.8	115.0	112.8	74.2	100.2
0.25m above river bed	Maximum	168.6	379.0	225.2	243.8	228.8	314.2	307.6	334.0	210.8	211.6
	Average	145.0	273.9	198.4	183.7	208.5	233.1	194.7	209.7	132.4	170.0
	Minimum	128.4	168.0	153.4	151.4	167.6	178.6	138.0	149.0	96.0	151.2

Source) JICA Study Team

2) Riverbed materials

Riverbed materials are measured at 28 points consisting of the same 20 points as those in measurements of water flow and 8 points at sand bars.

These samples were taken from two depths comprising the surface of riverbed and 0.50 to 0.55 m below the ground. Specific gravity (ASTM D854) and analysis of grain size distribution by sieve test and hydraulic test (ASTM D422), were carried out at the laboratory to identify grain sizes (diameter) of soil participles of d25, d50 (median diameter) and d75. These values are indispensably needed for analysis of navigation channel stabilization.

These sizes (d50) at surface of riverbed varies from 0.133 to 0.283 mm.

Table A31.1.13 Median Diameter of Riverbed Materials in The Red River Segment

Diameter	Median diameter (mm)	
	Surface of riverbed	0.5 m below riverbed
Maximum	0.283	0.301
Minimum	0.133	0.120
Average	0.007	0.010

Source) JICA Study Team

(5) Flood

The high volume of water flows, the monsoon climate, and frequent TDs make the Red River Basin vulnerable to severe flooding.

The high bank of the riverside land in the Red River in Hanoi has elevations of Land Survey Datum + 10.0 m to 13.0 m water levels over this elevation cause flooding for the houses on the right bank.

In the Red River, the warning water levels are 9.5 m, 10.5 m, and 11.5 m for class I, II, and III, respectively.

The following is general feature of historical or typical floods:

- Flood in 1971: this was the flood recorded the highest flood level in the 20th

Century. The peak water level at Thuong Cat station was LSD + 13.68 m, and at Hanoi station was LSD + 13.97 m. The water level higher than LSD + 12.0 m lasted for about 5 days, and water level above LSD + 10.0 m continued for more than 30 days.

- High water in 1999: This is a record at Hanoi station. The variation is rather smooth compared with that 1971. The highest water level was LS + 10.95 m. the water level higher than LSD +10 m was maintained for 7 days.

At Hanoi Segment of the Red River, to protect this area from flooding, they had constructed dikes at both sides of the Red River and the Duong River, groynes at some banks, and protected slopes at the riverbanks.

A31.1.4 Geological and seismic conditions

(1) Existing study reports (by the Study Team, 1997 – 1999)

1) Thanh Tri Bridge

(a) Bearing layer

According to a result of standard penetration test carried out at intervals of 1 m with a total boring holes of 19 at the location of the planned Thanh Tri bridge, it is found that elevation where N- value reached 50 or more (i.e. bearing layer for pile foundation) appears from – 26.21 m to – 50.11 m as shown in **Table A31.1.14.**

Table A31.1.14 Elevation of Bearing Layer at the Planned Thanh Tri Bridge

Boring	Elevation of N- value reached	Boring	Elevation of N- value
1	-31.53	11	-32.59
2	-33.44	12	-40.40
3	-43.46	13	-34.39
4	-28.90	14	-26.21
5	-50.77	15	-35.32
6	-32.68	16	-35.28
7	-31.44	17	-38.06
8	-34.17	18	-39.57
9	-35.51	19	-38.10
10	-33.99		

Source) JICA, 9/1998

(b) Soil strength

Based on the results of direct shear, unconfined compression and triaxial compression tests of undisturbed soil samples obtained from alluvium stratum, the soil design characteristics, applied for slope stability analysis of the road/embankment structures were determined in his study as shown in **Table A31.1.15.**

Table A31.1.15 Design Soil Strength at The Planned Thanh Tri Bridge

Test	Angle of internal friction (ø)	Cohesion C (kg/fcm^2)
Direct shear	15	0.15
Unconfined compression	16	0.25
Triaxial compression	12	0.26
Designed condition	15	0.25

Source) JICA, 9/1998

(c) Consolidation characteristics

Based on the results of consolidation tests for undisturbed samples obtained from clay and slit layers, the design consolidation values were established in his study for consolidation settlement analysis as shown in **Table A31.1.16.**

Table A31.1.16 Design Coefficient of Consolidation (Cv) and Consolidation Index (Cc)

Depth (m)	Coefficient of consolidation Cv (cm^2/sec)	Consolidation index (Cc)
0 – 10	0.51 x 10^{-3}	0.10
10 – 20	0.43 x 10^{-3}	0.12
20 – 30	0.45 x 10^{-3}	0.14
Below 30	0.38 x 10^{-3}	0.28

Source) JICA, 9/1998

2) Hanoi Port

The Study Team collected the 2 existing reports of geotechnical investigation carried out in 1999 (4 boring logs) and 1996 (6 boring logs) around Berth No. 7 and Berth No. 8. In this connection standard penetration test was not carried out in this

investigation at Hanoi port.

Based on the results of laboratory test in his reports, the Study Team prepared soil profile.

3) Khuyen Luong Port

The Study Team collected the existing report of geotechnical investigation carried out in 1997 (5 boring logs) along the face line of the planned berth, standard penetration test was not carried out too in this investigation at Khuyen Luong port.

Based on the results of laboratory test in his reports, the Study Team prepared soil profile.

(2) Result of geotechnical investigation by the Study Team

The Study Team carried out geotechnical investigation at the 3 alternative sites proposed for new port construction including Thuong Cat port, Van Kiep port and Khuyen Luong port. Total 6 holes of under-water boring with a total boring length of about 210 m was carried out.

There are 2 main purposes in this geotechnical investigation, as follows:

- To confirm elevation and strength of bearing layer for file foundation structure related to the project facilities including wharf, revetment and others.
- To confirm and establish design soil construction of soil stratum at the Survey area.

1) Confirmation of bearing layer

It is estimated that bearing layer (sand stratum) exists below 20 m depth from ground surface in the Survey area. It is quite important to confirm the exact elevation of this bearing layer for the determination of design conditions. Therefore, at least one boring hole shall reach this bearing layer, then the depth of other one boring hole shall be adjusted within a total the length of 210 m.

Standard penetration test (SPT) to measure N- value and to obtain samples of disturbed soil were carried out at every one meter interval. And in case cohesive soil layer was found, sampling of 4 undisturbed soil per hole were taken.

Table A31.1.17 Elevation of Bearing Layer at the Survey Area

Thuong Cat		Van Kiep		Khuyen Luong	
No.	El.(*) (m)	No.	El.(*) (m)	No.	El.(*) (m)
TC1	-23.8	VK1	-40.4	TC1	-28.9
TC2	-24.3	VK2	-40.7	TC2	-28.7

Source) JICA Study Team

(*) elevation of N- value reached 50 and more, express above NLSD

The above table shows that elevation of bearing layer exceeding N- value 50 varies from about – 24 m to – 40 m.

2) Laboratory test

All samples to be used for laboratory test were obtained and testing data are presented in the Interim Report . The laboratory tests comprises the following items.

Table A31.1.18 Items of Laboratory Test

Disturbed sample	ASTM	Undisturbed sample	ASTM
Bulk density	Slide caliper method	Unconfined compression	D2116
Specific gravity	D854	Triaxial compression test	CU
Grain size analysis	D422 (D_{25}, D_{50}, D_{75})	Consolidation test	D2435
Moisture content test	D2216		
Atterberg limit	D423 & D424		

A31.1.5 Historical change of riverbank

(1) Change of river configuration and depth in Hanoi segment

1) Old Maps

The configuration of the Red River has changed drastically in the past. It is said that the records of old maps have been kept since 1885, as far as the portions from Son Tay and Hanoi concern.

Reliable and usable maps are limited in terms of horizontal and vertical reference systems. In this context the data after 1975 are valuable to be taken into account. The older maps before 1958 lack in information of water level, and are useful to

acquire rough images of the change in configuration and fluctuations of the river flows.

2) Aero-photographs

Besides the above maps, there are three sets of vertical aero – photographs taken in 1954, 1977 – 79, and 1992 – 93, those are useful to confirm the water boundaries as well as conditions of land use at each time.

3) Newest maps

There are recently surveyed two topographic and bathymetric maps at the Hanoi segment:
(a) Survey by Pre – feasibility Study in December, 1999 with a scale of 1/10,000 and
(b) Survey by this Study in January, 2002 with the same scale.

They have the same accuracy of survey, and are very suitable to compare each other to know the changes occurred during the two years.

(2) Change in the configuration from 1901 to 1958 on maps

The maps show change in the shape of river banks and sand bars between the places of the present Thang Long Bridge and Chuong Duong Bridge, from 1901 to 1958. The Long Bien Bridge, which was build from 1889 to 1902, always appears on these maps.

Significant characteristics of the change are as follows:
- The sand bars between the mouth of the Duong River and the Long Bien Bridge changed the shape almost every year
- The present Trung Ha Bank was merged with the present Phu Xa High Bank in 1952 and 1958
- The stream became single at the immediate upstream of the Long Bien Bridge in 1952. The rest of the period had the axial stream and a minor stream
- The large sand bar at the present Tam Sa Flood Palin and Nhat Tan Bank was maintained from 1901 to 1952
- It is noticed that the change in around 1952 was drastic, and
- Other changes.

In consideration of the above facts, it is considered in the Pre – Feasibility report that there are following three alternative river alignments of the main stream.

- Alternative A: Similar to the present alignment, passing in front of Tam Xa High bank, the mouth of Duong River, and Hanoi Port
- Alternative B: Modified Alternative A with much a larger meandering at Tam Xa, but almost same at downstream portion, and
- Alternative C: Smoother alignment passing Hanoi side all around the segment of this portion.

In consideration of the importance of the Duong River and Hanoi Port, Alternative A is preferred to maintain.

(3) Changes confirmed on the aerial photographs

An example of comparison of the aero – photographs at the mouth of the Duong River is presented. It is amazing that configuration of the right bank of the Duong River, or the area of the present Bac Cau 1 and 2 communes, has been maintained same throughout the times. This can be judged to be owing to the stiff foundation consisting of hardened silty sand layers. It is noted that the other side of the Duong River is protected by the river dike.

It also can be expected that, after a drastic change in around 1952, the situation of the main stream alignment changed again in between 1979 and 1992.

(4) Changes occurred in the past two years

1) Changes in plane alignment

The contour line of the two bathymetric maps in December 1999 and January 2002 are superimposed. The major changes occurred can be summarized, from the upstream to the downstream, as follows:

- The Dong Lai Bank is widened significantly
- The sand bars in front of Thuong Cat suffered erosion on the main stream side
- The Phu Thuong Bank moved northward, or the main stream in the north had accumulation and bank slope on the secondary stream in the south had erosion
- Cross section in front of the Duong River does not have significant change. There is a large movement of Talweg toward the north east, or to Tam Xa side
- The Tu Lien Bank and the Trung Ha Bank has been connected. The width of the bank became narrower, and the width of the connecting bank decreased

significantly
- The tail of the Trung Ha Bank has prolonged considerably
- The cross section at Hanoi Port has not changed significantly except advancement of the Tach Cau Bank
- The downstream portion from the Thanh Tri Bridge site does not changed much, or proved relatively stable profile under the past and the present upstream conditions, and
- At the narrow corner of Van Phuc, however, considerable accumulation between the Phu Thuong Bank to the Chuong Duong Bridge.

2) Changes in cross sections

In total 12 cross sections are prepared to confirm the above changes at place. The characteristics described above can be verified by these cross sections. The following are noted:
- The Locations of Hanoi Port and Khuyen Luong Port are among the most stable in the segment for the past two years, and
- The main stream under the Thang Long Bridge, which is a nodal point of the flow, had an accumulation of about 1 m under the conditions in the past two years.

A31.2 Social conditions

A31.2.1 Population and number of households inside the Red River Segment through Hanoi City

Hanoi city covering approximately 921 km^2 is located at nearly the center of the triangular basin of the Red River. Population of Hanoi city in the year of 2000 is 2,736,400 persons. The average population density is 2,971 persons/km^2.
Rapid growth of the population in the inner Hanoi city is shown in **Table A31.2.1.**

Table A31.2.1. Rapid Growth of The Population in The Inner Hanoi City

Year	Population in the inner Hanoi city (person)
1945	250,000
1954	300,000
1983	800,000
1995	1,000,000
1999	1,538,900

Source) JICA Study Team, Jan., 2002

From the above table, the population in the inner Hanoi city is increased 5 times for 45 years. The population in the inner city is occupied 53.3% of total population, that is distributed on the 84 sq. km area, equivalent to 9.1% of total natural area of Hanoi city. The population density in the inner city is very high (17,207 persons/km^2).

The rapid population growth causes the negative impacts on the environments, such as :

- Poor technical infrastructure
- Flooding in the raining seasons.
- Traffic jams.
- Deficits in the water supply in the Summer (about 30% of population in the Vinh Tuy ward is supplied by the tape water).
- Uncontrolled solid waste disposal.

A31.2.2 Residential areas inside the Red River Segment through Hanoi City

(1) Existing data

At present, Hanoi city consists of 7 inner districts and 5 suburban districts. Under inner districts there are wards and under suburban districts there are communes and towns. Each area has the population and land area shown in **Table A31.2.2.**

Table A31.2.2 Population and Land Area in Hanoi City by Districts

At 31/12/2000

Name	Area (km^2)	Population (thousand)	Population density (pers./km^2)	Number of admi. unit	
				Ward/ Commune	Town
7 inner districts	**84.30**	**1,474.3**	**17,489**	**102**	**-**
Ba Dinh	9.25	205.9	22,259	12	-
Tay Ho	24.00	94.8	3,950	8	-
Hoan Kiem	5.29	172.9	32,684	18	-
Hai Ba Trung	14.65	360.9	24,635	25	-
Dong Da	9.96	342.3	34,367	21	-
Thanh Xuan	9.11	159.3	17,486	11	-
Cau Giay	12.04	138.2	11,478	7	-
5 suburban districts	**836.67**	**1,282.3**	**1,533**	**118**	**8**
Soc Son	306.51	247.8	808	25	1
Dong Anh	182.30	263.3	1,444	23	1
Gia Lam	174.32	345.9	1,984	31	4
Tu Liem	75.32	198.0	2,629	15	1
Thanh Tri	98.22	227.3	2,314	24	1
Total	**920.97**	**2,756.6**	**2,993**	**220**	**8**

Source) Hanoi Statistical year book 2000

(2) Planned data

The first Master Plan of land use for Hanoi city up to the year 2000 was issued in April 1992 under the approval of Government upon the Decision No.132/CT. However, due to the rapid economic development and urbanization, the plan needed to be amended and adjusted. Then the new plan including surrounding suburban areas in Ha Tay, Vinh Phuc, Bac Ninh and Hung Yen provinces with the influential radius of 30 – 50 km from the center of Hanoi city had been studied by the Ministry of Construction and the Hanoi Peoples Committee (HNPC) since in 1995.

In 1998, the Prime Minister in the Decision No.108/1988/QD-TTg approved the amended Master Plan. In this Master Plan the population and land use framework is planned as in **Table A31.2.3.**

Table A31.2.3 Framework of Population and Area

Area	Urban areas	Present population (thousand)	2005		2020	
			Population (thousand)	Areas (ha)	Population (thousand)	Areas (ha)
	Hanoi capital region	1,690	2,465	24,600	4,500-5,000	56,000
I	**Hanoi city**	**1,312**	**1,725**	**14,603**	**2,500**	**25,000**
I.1	Development restricted area (South Hanoi city)	900	839	3,557	800	3,557
I.2	The right of Red River (South Hanoi city)	322	566	6,346	700	8,623
I.3	The left of Red River (North Hanoi city)	89	320	4,700	1,000	12,820
II	**Urban area constellation and well balanced development group**	**85**	**320**	**4,700**	**1,000**	**12,820**
II.1	Western satellite cities group: Son Tay, Hoa Lac, Mieu Mon, Xuan Mai, (Ha Tay province)	54	280	6,000	1,000	1,700
II.2	Northern satellite cities group: Soc Son, Phuc Yen, Viet Tri	31	110	1,500	500	7,500
III	**Other satellite cities**	**294**	**350**	**2,500**	**500**	**6,500**

Note) 1) Hanoi capital region means the areas covering 30 – 50 km from the center of Hanoi
2) Present population is as of 1995

Source) Compiled from the Summary report of the 2020 M/P

The targets of the population density are set at 100 persons/ha in the city center and 65 – 85 persons/ha in other urban area.

The center area within ring road No.2 (Vinh Thuy – Vong – Cau Giay – Nhat Tan) in the right bank of the Red River is restricted to develop and to disperse population with the target number of inhabitant 900,000, while new western satellite cities groups such as Son Tay, Hoa Lac, Mieu Mon, Xuan Mai (Ha Tay province) and Viet Tri (Phu Tho province) will be developed.

Hanoi city should be expanded to North-West, South-West and North directions, especially the North of Red River, where new towns will be constructed in Thang Long North – Van Tri and Dong Anh – Co Loa. In the East to South area, Gia Lam – Sai Dong – Yen Vien will be also developed.

This Master Plan aims at orienting the urban development and construction planning only, so that it needs to make detailed plans in accordance with the Urban Development Plan and to have the approval of the competent state authorities.

The Decree No.91/CP in August 1994 stipulated the management on urban planning. According to this Decree, an urban development master plan and a detailed plan are summarized as **Table A31.2.4.**

Table A31.2.4 Urban Development Master Plan and Detailed Plan

Item	Urban Development Master Plan	Detailed plan
Format	Geographical map on the 1/2000-25,000 scale depending on the urban class	Geographical and cadastral map on the 1/500-2,000 scale
Aim and term	To orient the urban development (15-20 year) and construction planning at first stage (5-10 year)	To concretize the Master Plan (up to 10 year) the detailed plan is the basis to set up the investment projects, to choose the right location for construction and to grant the planning certificate, to decide the allocation of land and to grant the construction permit
Coverage	To be prepared for whole city area or group of cities	To be prepared for specific areas within a city
Preparation	The preparation of Master Plan for class I or II cities is the responsibility of MOC	Development or investor or district
Approval	Prime Minister in the name of Government following consultation with the provincial peoples committee	Chief architect office

Source) the Decree No.91/CP

During the formulation work or after approval of Urban Development Plan of Hanoi city by Prime Minister in June 1998, some detailed urban development plans has been studied as the followings.

- OECF: Urban Infrastructure Development Project (Improvement of national highway [NH] No.2, 3, 6, 32 and Hoa Lac Highway, Expansion of NH-5 to NH-3, Construction of Ring Road No.3), SAPROF Study in March 1998
- KOICA: New Town (Tu Liem and Ho Tay 840 ha, Dong Anh 7,990 ha, planned population 750,000) Development Plan up to 2020 in April 2000

A31.2.3 Number of households and distribution illegally occupied inside the Red River Segment through Hanoi city

According to Architect Office of HNPC, the number of people who will be needed to remove is not authorized by any upper organization.

Table A31.2.5 shows the number of people who will be needed to remove for enlarging dykes 30 m wide for road.

Table A31.2.5 People Living Near Dyke

Precinct	Length of dyke (m)	A (person/ha)	B (person/ha)	Total
Ba Dinh	1,300	950/3.9	1,045/3.9	1,995/7.8
Hoan Kiem	2,950	3,570/8.2	3,925/8.2	7,495/16.4
Hai Ba Trung	1,400	1,400/4.2	1,540/4.2	2,940/8.4
Total	5,450	5,920/16.3	6,510/16.3	12,430/32.6

Note) A means number of people per area has to be remove to other place for enlarging dyke 30 m wide
B means number of people living in foot area of dykes needed to remove to other place for protection of the dyke

Source) HNPC Architect Office

A31.2.4 Regulations on compensation for resettlement of inhabitants

Current compensation systems for residents who are compelled to relocate are based on the "Regulation on land acquisition for security, defense purpose, national and public benefits in Hanoi city People's Committee dated 13 September 1997". At the same time in the Decision No. 3528/OD-UB land price list was issued based on the Government Decree No.87/CP dated 17 August 1994.

As for the land price this decree is the basic regulation and all People's Committee and central city (Hanoi, Hai Phong, Da Nang, Ho Chi Minh) should define land prices for deciding land transfer tax, rental fee, estimation of property value and compensation etc.

Compensation system consists of two items tabulated as in **Table A31.2.6.**

The following **Table A31.2.6** shows an example of land price stipulated by the State.

Table A31.2.6 Land Price

(Unit: 1,000 VND/m^2)

Urban class	Street class	Standard prices following locations							
		Location No.1		Location No.2		Location No.3		Location No.4	
		Mini. price	Max. price	Mini. price	Max. price	Mini. price	Max. price	Mini. price	Max. price
1	1	4,600	11,500	2,760	6,900	1,380	3,450	460	1,150
	2	2,700	6,750	1,620	4,050	810	2,025	270	675
	3	1,800	4,500	1,080	2,700	540	1,350	180	450
	4	900	2,250	540	1,350	270	675	90	225

Source) Government Decree No.87/CP dated 17 August 1994

Urban class 1 corresponds Hanoi city and Ho Chi Minh city. Street class and location class are defined in detail.

Based on the prices shown in the above **Table A31.2.6**, Hanoi city stipulated the following land prices shown in **Table A31.2.7**, which are much higher than that of Government.

Table A31.2.7 Land Price in Hanoi City

(Unit: 1,000 VND/m^2)

Road class	Price levels following allocation			
	1	2	3	4
Class I				
A level	9,800	3,920	2,350	1,410
B level	7,800	3,120	1,870	1,150
Class II				
A level	6,300	2,520	1,510	910
B level	5,050	2,020	1,210	730
Class III				
A level	4,040	1,620	970	580
B level	3,230	1,300	780	470
Class IV				
A level	2,200	880	530	320
B level	1,540	620	370	225

Source) HNPC

Price road class and level or level allocation is decided in detail. And we have to follow the above table in case of compensation occurring in our Project. However, it should be noticed that recently actual land price becomes higher.

Table A31.2.8 Summary of Items of Compensation and Subsidy

	Compensation		Subsidy
	Land	Asset	
Agriculture / Aquaculture / Forestry	Cash in accordance with the land price stipulated by People's Committee	- Annual crop land: Yield of crops according to average yield of 3 previous crops at present price - Perennial crop land: Compensation according to stages of planning, harvesting and after harvesting	- Annual crop land: Subsidy of 60 tons of harvested rice per 1 ha based on three criteria - Perennial crop land: Compensation according to stages of planning, harvesting and after harvesting
Residential	- Cash in accordance with the price of handing over and leasing land by the Government - Land of similar usage (need to pay land charge) - Even without legal documents, land owners who have permanent address in Hanoi city can be compensated	- Villa, house of levels I, II, III: House compensation in accordance with retained value by level within 60% of construction cost - House of level IV, temporary-house: House compensation of construction cost	- Villa, house of level I, II, III: 50% of discount value specified in compensation alternative evaluated by Steering Committee - House of level III: 35,000 VND/sq.m of building area - House of level III: 25,000 VND/sp.m of building area - Perennial crop land: Compensation according to stages of planting, harvesting and after harvesting - Additional 450,000 VND/person for arranging own accommodation
Illegal house	None	None	- On legal land: Maximum 80% of remaining value - On illegal land: Dismantling and removing labor costs
State owned house	None	- Rehabilitation and maintenance expenses - The cost to lease or buy new houses of appropriate area	- If house user does not buy or quits leasing state owned house: Subsidy for new accommodation equal to 25% of construction cost - 60% of land using value of leasing area (single or multi story house by 1 owner) - 90% of land using value of rental house by story (multi story houses occupied by multiple household)
Grave	None	- Unit price in accordance with types of grave - Moving to new location in current condition	None

Note) Three criteria:

- Land area given by State for long term: 20 years
- Profit by production per hectare is equal to 30% of revenue
- Yield by paddy is 10 tons/ha. Therefore 10 tons/year x 30% x 20 years = 60 tons of paddy per hectare

Source) Urban infrastructure development project in Hanoi capital region OECF in March 1998

A31.2.5 Procedures on resettlement of inhabitants

(1) Legal framework

1) Vietnam policy

The constitution is the basis for all laws and civil rights in Vietnam. A fourth revision was approved in 1992 which was in response to a strategy endorsed by Government in the late 1980s for socio - economic stability and development up to the year 2000. The new Constitution guarantees the democratic rights of citizens, the State ownership of land and resources, the rights of organizations and individuals to use land, the rights of property ownership, and other civil rights and obligation of citizens. Significant changes made in 1992 include the recognition and protection of land use rights and private ownership rights for property and production. The most important aspect of the Constitution in terms of involuntary resettlements is Article 23, which enables the state to recover land for purposes of national defense and security and national interest.

2) ADB resettlement policy

The principles of ADB regarding involuntary Resettlement Policy have been formulated in documents R. 179-95 dated 12 September 1995. Previously ADB followed World Bank's Operational Directive 4.30. The ADB policy documents observes the principles from OD.

A summary of objectives and principles reads as follows:

- Involuntary resettlement should be avoided where feasible;
- Where population displacement is unavoidable, it should be minimized by exploring all viable project options;
- Unavoidably displaced people should be compensated and assisted, so that their economic and social future would be generally as favourable as it would have been in the absence of the project;
- Existing social and cultural institutions of resettled families and their hosts should not be a constraint to compensation, particular attention should be paid to female headed households and other vulnerable groups, such as indigenous people and ethnic minorities and appropriate assistance provided to help them improve their status;
- As far as possible, involuntary resettlement should be conceived and executed as a part of the project;
- The full costs of resettlement and compensation should be included in the

presentation of project costs and benefit;
- Costs of resettlement and compensation may be considered for inclusion in the Bank loan financing the project.

3) MOT resettlement policy

The Ministry of Transport (MOT) is responsible for construction, maintenance and operation of roads, inland waterways, ports, railways and airports. In the course of its mandate MOT is involved with the recovery of land, clearance of land, compensation for land and users and resettlement of affected people to new sites. For projects with ODA, MOT has set up project management units. For example, PMU-1 for Highway No.1 and PMU-5 for Highway No.5 project. Of all institutions and agencies in Vietnam MOT has acquired most experience with involuntary resettlement and with the policies and implementation requirements of foreign multilateral and bilateral donors as World Bank, ADB, Japan, Great Britain, etc. The rehabilitation of Highway I and implementation of the associated resettlement component has been a valuable learning process for Donors as well as for MOT. At present the experience of the Highway I resettlement programme provides most of the case material from which the Government is formulating a National Resettlement Policy.

Adverse effects of the Inland Waterways Improvement Project per farmer are limited and in view of the large number of farmers involved in eight different locations the drafting of a comprehensive resettlement plan was deemed warranted.

(2) Land requirements

According to the results of the ADB TA No. 2615-VIE on the Red River Waterways Project, land acquisition and resettlement activities are foreseen for 8 locations. In addition, as stated in the introduction, land requirements and locations for spoil soil deposit remain to be defined in the final design phase of the project. An overview of the number of affected families per location is shown below (see **Table A31.2.9**).

Table 4.2.9 Families and Holdings affected per Location

Location	Number of families	Agricultural land (m^2)	Houses
Mom Ro	47	18,000	
Hung Long	8	4,000	
Doc Bo	20	25,000	2
Keo	60	30,000	
Trai Son	15	10,000	
Luoc Loop	271	115,000	
Lach tray	100	18,000	
Day/Ninh Co River	70	120,000	8
Total	591	340,000	10

Source) The ADB TA No. 2615-VIE on the Red River Waterways Project,1998

(3) Socio-economic survey

According to the results of the ADB TA No. 2615-VIE on the Red River Waterways Project, the total number of families affected by the implementation of the Red River Waterways Project is 591. Most of these households, however, will have very marginal losses. A socio-economic survey has been undertaken and its outcome is complemented by date obtained from desk research, focused discussions with authorities and individuals and date from District Land Registration Offices.

In order to obtain a comprehensive sample which would include the various segments of population affected their landholdings and the degree of project impact groups of PAF from all 8 locations were included in the survey. Ha Thanh Commune in Tu Ky district and Nghia Lac Commune in Nghia Hung district represent all types of land loss and all types of soil. Farmers practizing sericulture in Truc Chinh Commune were included as well as families which will have to be relocated. Total number of families included in the survey is 103 among which all families with more than marginal losses. The remainder of the households surveyed is complemented by random sampling of households with marginal losses.

Average age of the heads of households interviewed is 43. Average family size is with 5.2 persons higher than the delta's overall average of 4.3 persons. Per family 2.9 persons are economically active. Of the total sample of 103 families, 101 gave secondary source of income. Other secondary occupations include fishing, transport and trade. In 8 families the income was supplemented by government-salaries and pensions. All families, but two, have electricity.

Average monthly per capita income (1996) is 129,000VND or 11US$ and varies from 98,000 VND or 8.4US$ in Nghia Lac to 188,000VND or 16US$ Truc Chinh. This compares reasonably well with the poverty line for the RRD which has been fixed at 70-80.000VND or 6.5US$. Working as hired laborer or rearing livestock brings more revenues that rice cultivation. Sericulture provides a relatively good income. Almost half of all persons interviewed expressed concerns regarding impact and changes in living conditions as a result of project implementation. The relative living standard for various district can be illustrated by the extent to which families manage to save or are forced to borrow.