6. CONSTRUCTION METHOD AND COST ESTIMATE

6.1 Construction Method

1) General

(1) Description of the Project

The construction works of UMRT Line No. 2 consist of the following works:

(i) Bored Tunnels;
(ii) Cut & Cover Tunnels;
(iii) Elevated Viaducts;
(iv) Underground Stations;
(v) Elevated Stations; and
(vi) Depot.

(2) Earthworks

Due to the planned tunnels and underground stations, huge amount of excavated soil will be produced. Some of those surplus soils may be used as the embankment filling material for the depot and approaches for the elevated viaduct portion but most of the soil has to be disposed. It seems that such surplus soils and debris can be normally disposed in the area within 20 to 40km around Hanoi City. Disposal of surplus soil shall be carried out in order not to affect the environment around such areas. The surplus soil may also be used for other projects, such as Ring Road 4 and other road projects that need huge amount soil for embankment.

Borrow soil are also available around Hanoi City within the distance of 20 to 30km.

According to the soil investigation, the groundwater depth was found to be relatively deep (GL-1.2m to GL-9.3m). However, the investigation was conducted in February (dry season) so, the water level may rise in the rainy season. For deep excavations, attention shall be paid for the groundwater.

Furthermore, deep excavation for the construction of underground stations and cut & cover tunnels, diaphragm wall needs to be adopted as earth retaining wall for excavation. The embedment length shall be carefully determined not only by the structural stability but as well as by the groundwater effect, since the soil investigation results shows that the permeable sand and gravel layer exist in the lower portion below GL-10m or GL-15m.

The proposed location of depot is in a swampy area so that attention shall be paid in case of embankment fill. Top soil shall be removed and replaced with well graded granular materials.

(3) Concrete

Ready mixed concrete are available in Hanoi City and commonly used for many projects. Pre-cast concrete products such as kerb stones, concrete pipes, etc. are also available.

Temporary batching plant may be established for fabrication of segment rings for bored tunnel, PC sleepers for railway tracks, box girder segments for viaducts, etc. whenever required.

(4) Steel Fabricators

Steel fabrication shops in and around Hanoi City can be sourced for the fabrication of structural steels.

(5) Traffic Management

Since the bored tunnel is applied for a long stretch of the Project, the disturbance to the traffic will be minimized. Also where the cut & cover method with temporary deck cover or top down construction techniques are adopted, the effects on the road traffic will be minimized. However, at the intersections of major roads and on busy roads, traffic management will be essential for the construction works.

2) Shield Tunnel

According to the “Standard Specification of Tunnel (Shield Tunnel)” issued by the Japan Society of Civil Engineering, the shield tunnel (or bored tunnel) is classified into seven types. The applicability to the soil conditions are summarized in the Table below.

Table 6.1.1 Applicability of Shield Tunnel

Soil Classification / Shield Type				Manual Shield			Semi Manual Shield			Mechanical Shield			Blind Shield			Earth Pressure Type Shield						Slurry Shield		
																Earth Pressure Shield			Mud Pressure Shield					
Classification	Soil	N-Value	Water Content	Supporting Method			Supporting Method			Supporting Method			Supporting Method			Supporting Method			Supporting Method			Supporting Method		
			(%)	w/o	with	type	w/o	with	type	w/o	with	type	w/o	with	type	w/o	with	type	w/o	with	type	w/o	with	type
Alluvium Clay	Organic Soil	0	≥300		x		x	x		x	x		x	△	A	x	△	A	x	△	A	x	△	A
	Silt/Clay	0-2	100-300	x	△	A	x	x		x	x		○	-		x	△	A	△	○	A	△	○	A
	Sandy Silt/Clay	0-5	≥80	x	△	A	x	x		x	x		○	-		△	○	A	△	○	A	△	○	A
	Sandy Silt/Clay	0-10	≥50	△	○	A	x	△	A	△	○	A	△	-		○	-		△	○	A	△	-	
Diluvium Clay	Loam/Clay	10-20	≥50	○	-		○	-		△	-		x	x		○	-		○	-		○	-	
	Sandy Loam/Clay	15-25	≥50	○	-		○	-		○	-		x	x		○	-		○	-		○	-	
	Sandy Loam/Clay	≥20	≥20	△	-		○	-		○	-		x	x		○	-		○	-		○	-	
Soft Rock	Mud Stone	≥50	≤20	x	-		○	-		○	-		x	x		-	-		-	-		-	-	
Sandy Soil	Sand with Silty Clay	10-15		△	○	A	△	○	A	△	○	A	x	x		○	-		○	-		○	-	
	Loose Sand	10-30	≤20		△	A·B	x	x		x	△	A·B	x	x		△	△	A	○	-		△	○	A
	Dense Sand	≥30		△	○	A·B	△	○	A·B	△	○	A·B	x	x		△	△	A	○	-		○	-	
Sand/Grave	Loose Sand	10-40		x	△	A·B	x	△	A·B	x	△	A·B	x	x		△	△	A	○	-		△	○	A
	Dense Sand	≥40		△	○	A·B	△	○	A·B	△	○	A·B	x	x		△	△	A	○	-		○	-	
	Sand with Gravel			x	△	A·B	△	○	A·B	x	x		x	x		△	△	A	○	-		△	△	A
	Gravel			x	△	A·B	x	△	A·B	x	x		x	x		△	△	A	△	-		△	△	A

Note 1) Plenum system will be principally used for Manual, Semi Mechanical and Blind type shields.

w/o: without supporting method ○ Applicable

with: with supporting method △: Detail study is required for application

A: Chemical Injection Method x : Not applicable

B: Groundwater Lowering Method - : No supporting method required

Source: "Standard Specification of Tunnel (Shield Tunnel)" Japan Society of Civil Engineering

Source: HAIDEP Study Team

From the soil conditions, earth pressure type or slurry shield will be recommended. Both are also called as closed type shield machine, having a partition wall in the front. The cutter chamber between the excavation surface and the partition wall will be filled with soil or slurry with sufficient pressure to stabilize the excavation surface during excavation.

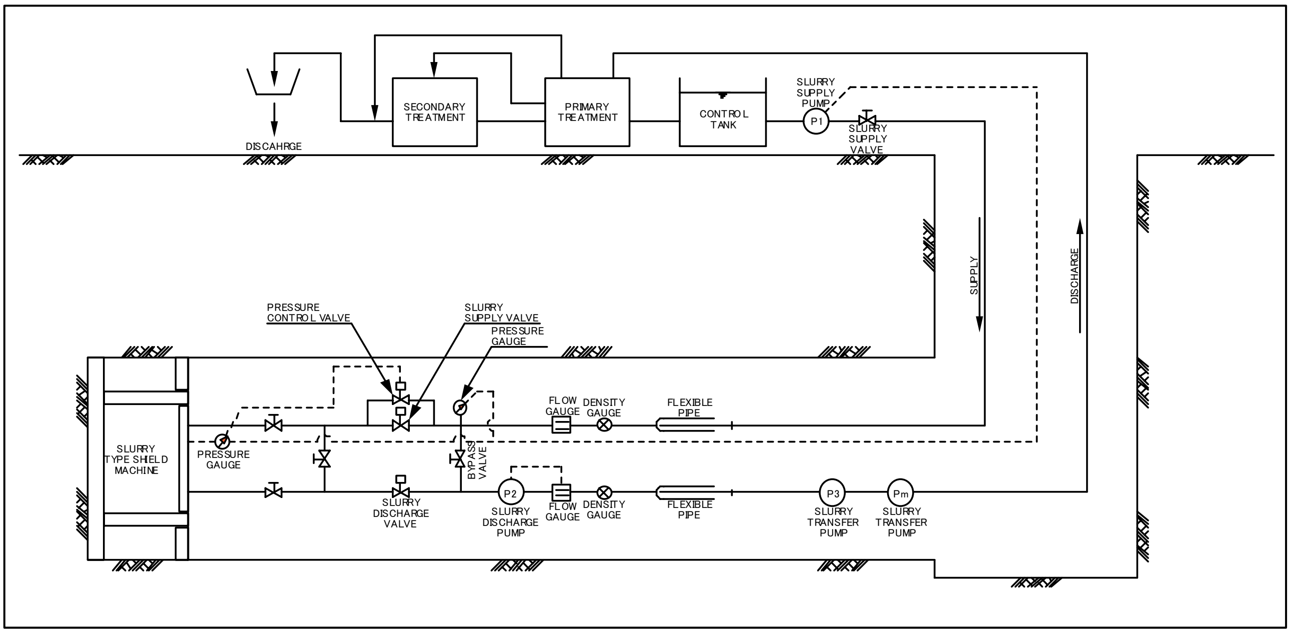
The earth pressure shield is to fill the chamber between excavation surface and the partition wall with excavated soil pressurized with propulsion thrust of the boring machine to stabilize the excavation surface. The excavated soil will be carried by screw conveyor or other means for disposal.

The mud pressure type is similar to the above but to plasticize and fluidize the excavated soil by providing additives in the soil.

The slurry type is to fill the chamber with mud slurry by circulation to stabilize the excavation surface as well as to convey the excavated soil from the tunnel as fluid. The boring machine is equipped with functions for excavation, mixing excavated soil, circulation of slurry, pressurizing control, slurry treatment to segregate the slurry, etc. The systematic flow of slurry type tunnel boring machine is illustrated in Figure 6.1.1.

The excavation by boring machine will normally progress around seven to ten meter per day depending on the conditions.

Figure 6.1.1 Systematic Flow of Slurry Type Shield Tunnel



Source: HAIDEP Study Team

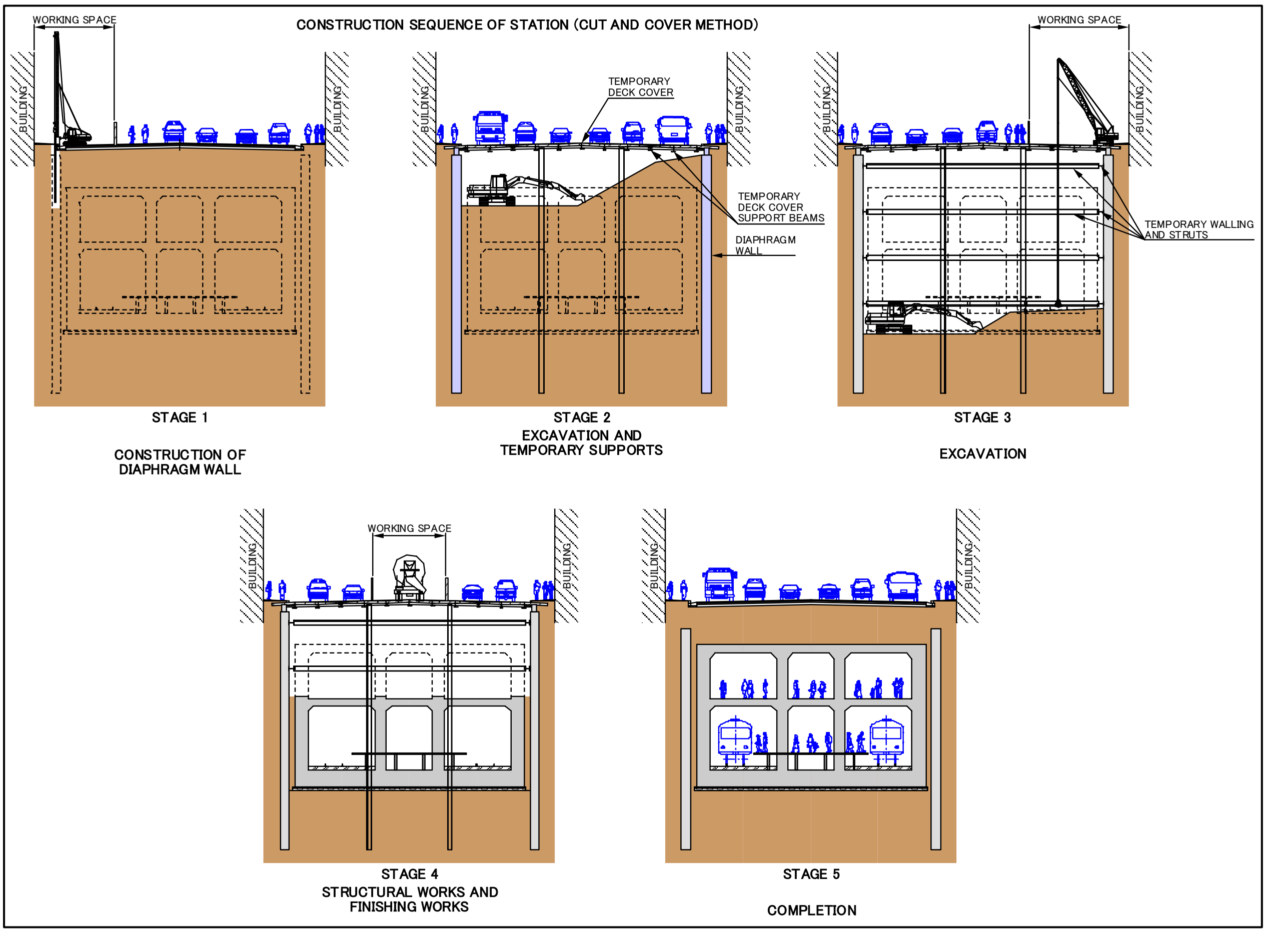
3) Cut and Cover Method

Conventional cut & cover method is adopted for underground stations and some stretches of the tunnel. Cut & covert method is to construct earth retaining structures for the excavation laterally supported with temporary walling and struts. In order to allow the road traffic above, temporary deck covers will be provided on the top and the excavation and structure work can be carried out underground minimizing the disturbance to the traffic. The work sequence of cut & cover method is illustrated in Figure 6.1.2.

For shallow excavation, temporary sheet pile may be adopted while for deep excavation diaphragm wall shall be constructed to retain the earth. Attention to be paid for the groundwater and the embedment length of the diaphragm wall shall be determined considering the effect on the groundwater. Some pumps shall be provided to keep the excavated pit dry during the construction.

During the excavation, underground utilities such as drainage line, water mains, electric and telecommunication cables, gas pipes, etc. may require relocation and shall be protected to secure continued service for the residents living nearby.

Figure 6.1.2 Construction Sequence of Cut & Cover Method

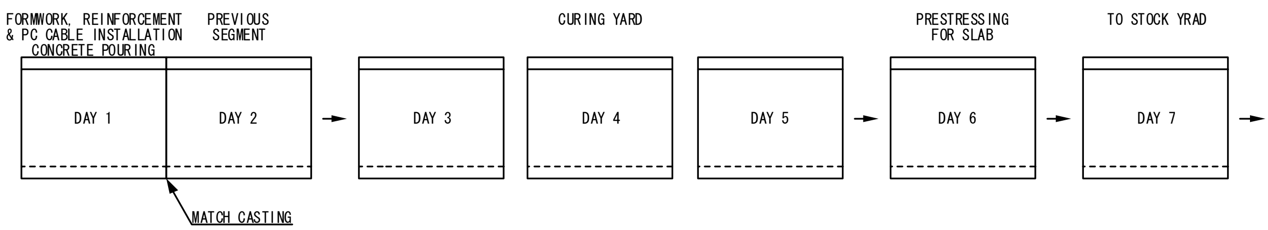


Source: HAIDEP Study Team

4) Viaduct

The elevated viaduct is designed as segmental pre-stressed concrete box girder. PC box girder segments will be fabricated in a yard near the site. The first segment will take six days including curing period while the remaining segments will be produced by the pace of a segment per day. Fabrication procedure is shown in Figure 6.1.3.

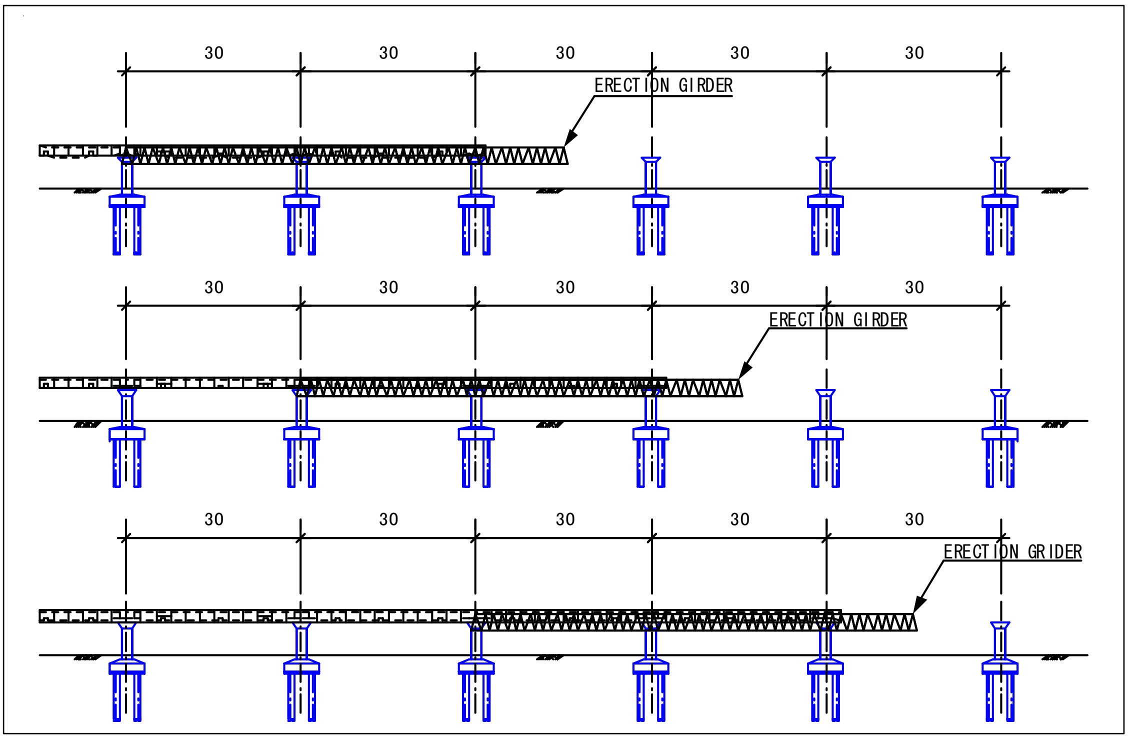
Figure 6.1.3 Fabrication Procedure of PC Box Girder Segments



Source: HAIDEP Study Team

Span-by-span erection with temporary erection girder will be adopted, which is shown in Figure 6.1.4.

Figure 6.1.4 Span-by-Span Erection with Temporary Erection Girder.



Source: HAIDEP Study Team

6.2 Construction Schedule

Construction schedules for UMRT Line 2 Option 1 & 2 are shown in figures 6.2.1 and 6.2.2, respectively. Construction schedules for 1a & 2a which are from station 3 to 16 are also shown in figures 6.2.3 and 6.2.4, respectively.

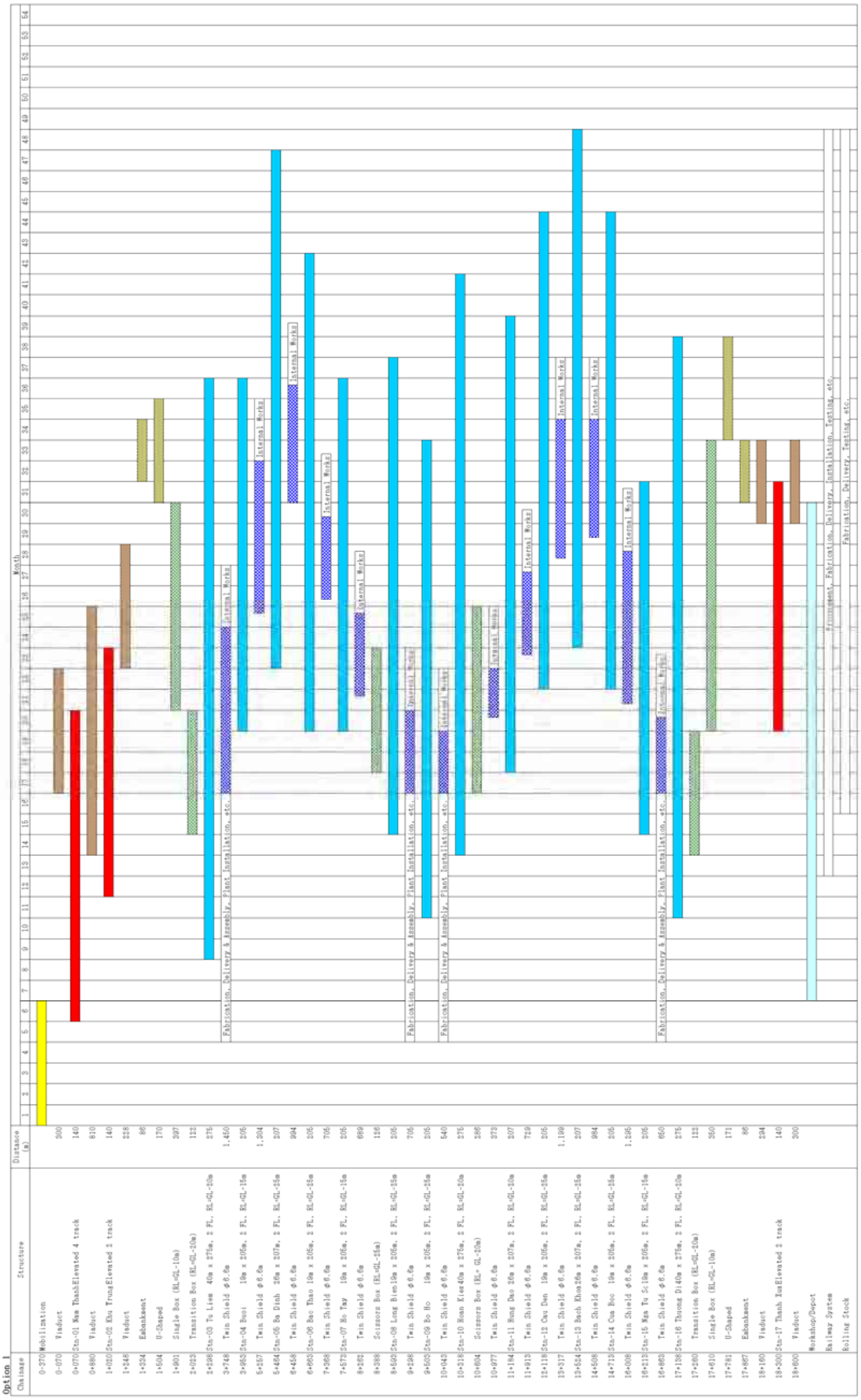
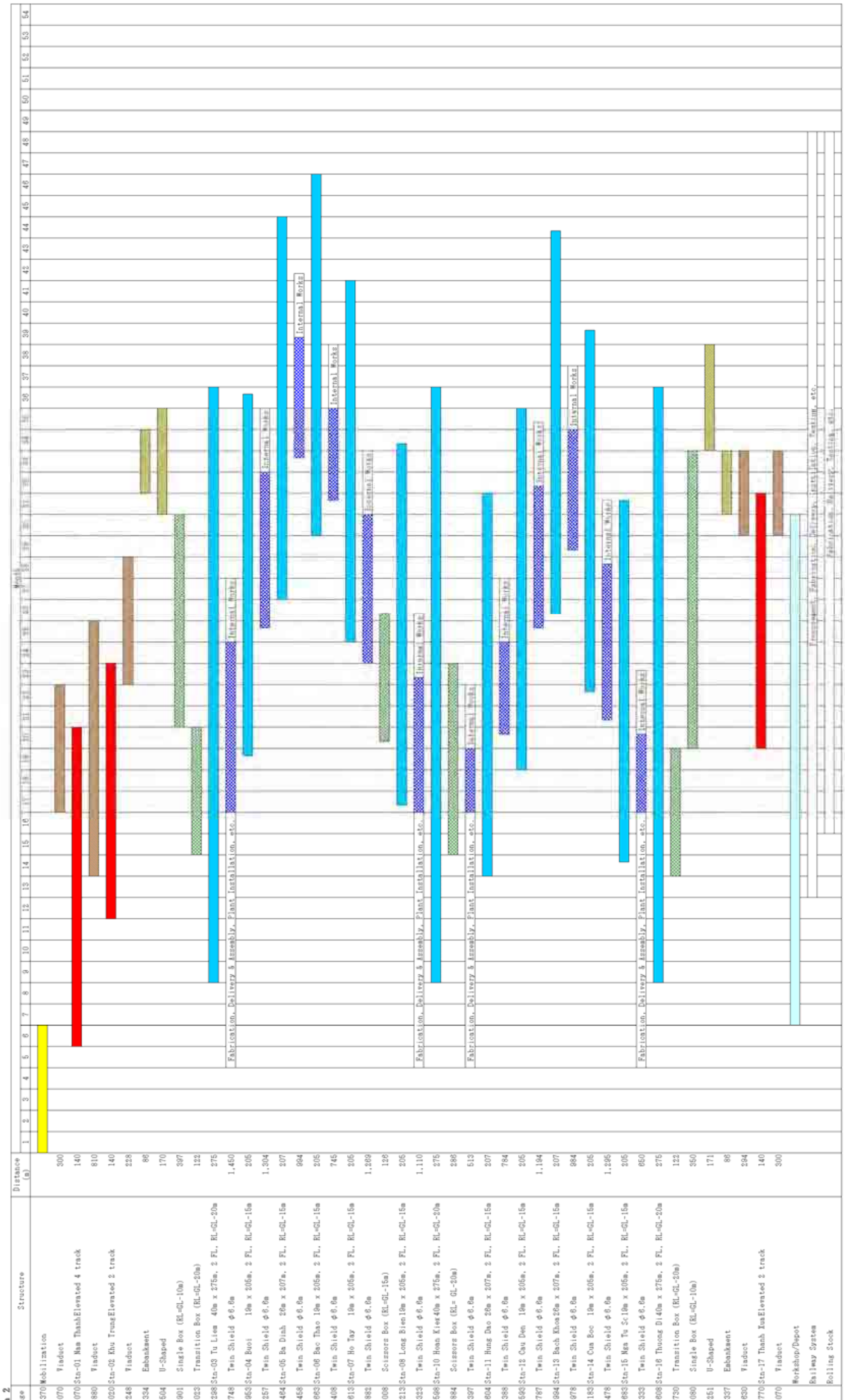


Figure 6.2.1 Construction Program for UMRT Line 2 (Option 1)

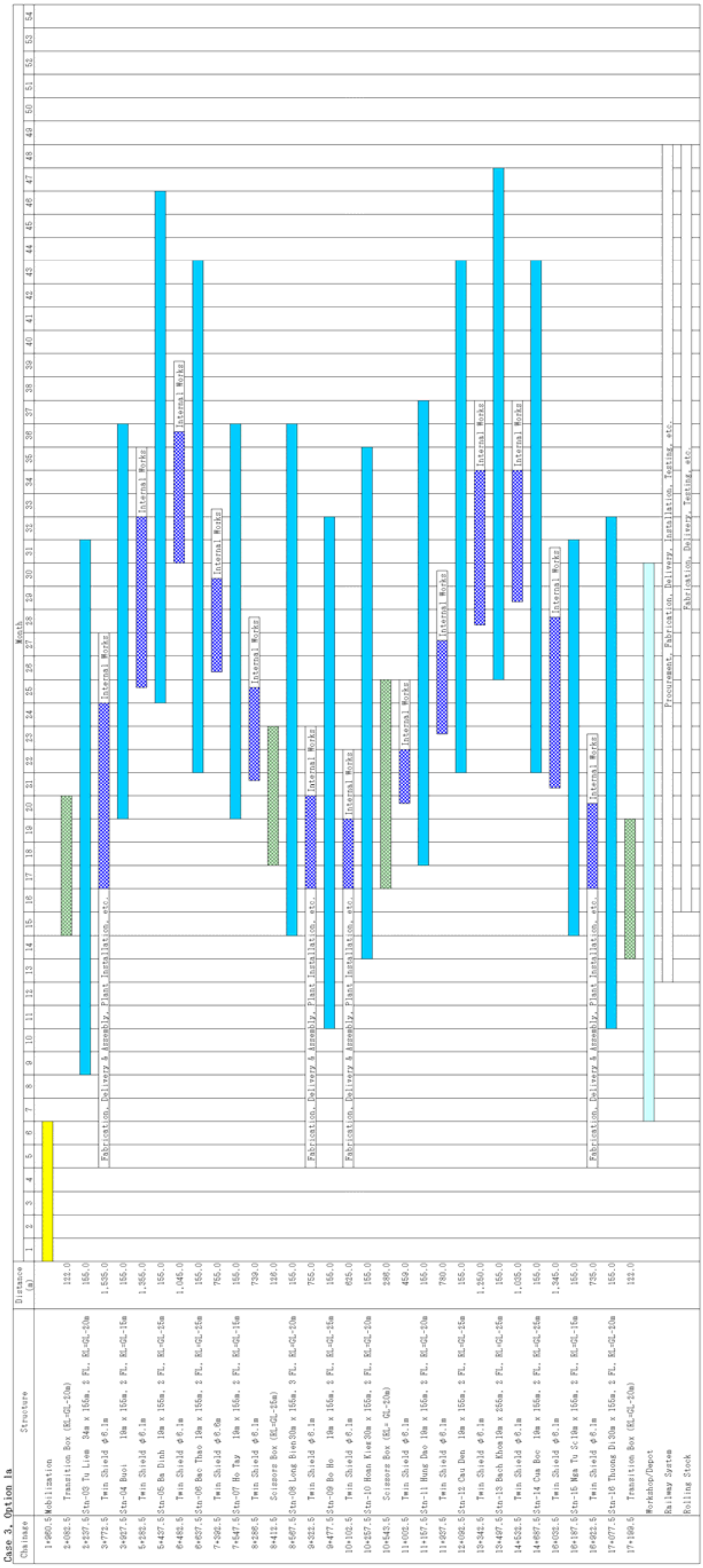
Source: HAIDEP Study Team

Figure 6.2.2 Construction Program for UMRT Line No. 2 (Option 2)



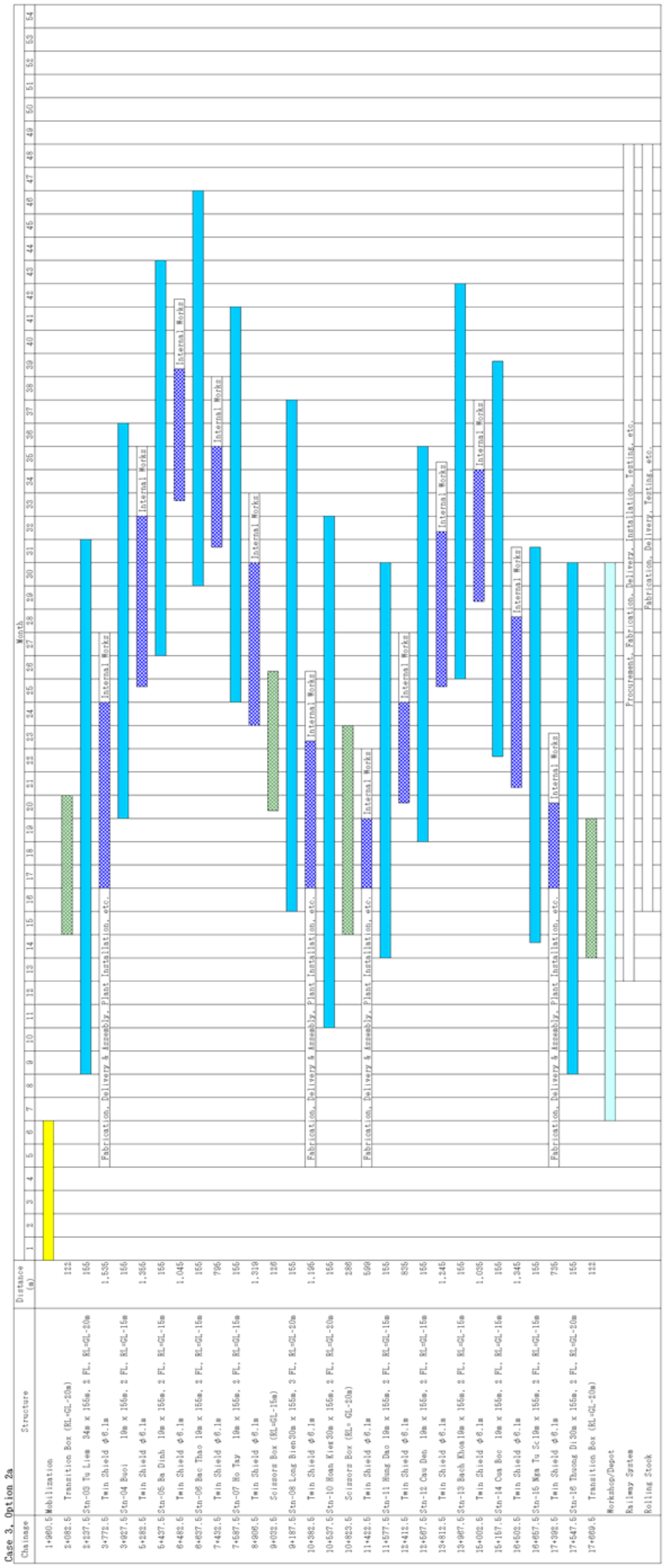
Source: HAIDEP Study Team

Figure 6.2.3 Construction Program for UMRT Line No. 2 (Option 1a)



Source: HAIDEP Study Team

Figure 6.2.4 Construction Program for UMRT Line 2 (Option 2a)



Source: HAIDEP Study Team

6.3 Construction Cost Estimate

1) Overview

Capital costs were estimated for all costs expressed in (June 2006) US Dollars. The cost estimate utilizes parametric unit costs and special condition costs for the majority of the cost estimate. The parametric unit costs were based on a conceptual scope appropriately developed for each specific work item. Parametric unit costs is an estimate developed for all elements included in a "cross section" of a work item for a unit of measurement.

Costing begins with a cross section or sketch of a typical facility. For a typical section, the quantities of construction units required to construct one route meter or square meter are computed and unit costs are applied to determine the base cost for constructing a typical route meter.

The "basic cost method" in construction cost estimation was adopted where assumptions from Unit Price Analysis were based on the results of preliminary investigation and field reconnaissance survey. The scope of works were identified and broken down into component works items. Then most practical and cost-effective construction method was determined and studied, including the sequencing of activities. Following these activities, the size and composition of crews, type and number of equipment, and construction materials requirements were established. Finally, deviations from the work program of each activity involved were determined, taking into consideration the foreseen constraints, obstruction and other impediments to be encountered in project implementation.

(1) Rail Infrastructure

The construction of permanent works includes tunnels, viaducts, stations, depot and structures were derived from conventional cost analysis procedures. Unit prices of individual items were determined from various sources, and then checked for accuracy and applicability to Hanoi conditions. After the unit prices of each work items were determined, the costs for each item were arrived at simply by multiplying the quantities of the work items involved. Cost estimation for track work and the depot followed the same procedures.

(2) Rail System and Rolling Stock

While each individual component of rail system works i.e. rolling stock, signaling communications, power supply, trackwork, were also carefully studied; these components could not be further disaggregated into sub-components. Thus, costing for planning purposes were utilized in terms of costs per route-kilometer, per station, or per unit. These were then compared to local and international urban transit projects.

(3) Civil Works Components

Direct Costs: These cost, which are identifiable from a particular accounting standpoint as having been incurred in the performance of a specific item of work. It basically involves the following:

(i) Equipment Cost: these were derived from reliable sources in the local and international construction industry.

(ii) Labor Cost: includes wages and all fringe benefits were based on Vietnam labor law requirements

(iii) Materials Cost: The current market price of construction materials within Hanoi were gathered and compared with prices obtained from other sources. Quotations from various suppliers are also taken most especially major construction materials. Supplies of existing plants within the vicinity of the Project site were also taken into consideration. Inquiries were also conducted in some on-going projects in Hanoi.

Indirect Cost: These are the mark-ups on the estimated direct costs that are not directly involved in the execution of the work items. It is taken as a percentage of the estimated direct costs to cover, among other things, expenses that are incurred in the completion of the works which include but not necessary limited to the following:

(i) Mobilization;

(ii) Taxes;

(iii) Profits or Mark-ups; and

(iv) Overhead.

Foreign, Local and Tax Components: Tax components of the various material, equipment and labor were arrived at based on the pertinent requirements by the relevant Vietnam construction cost guidelines on construction projects.

(4) Summary of Assumptions

(i) Taxes comprise 11-18% of direct cost and are chargeable to the local currency.

(ii) No price escalation factor is applied to the base cost for local and foreign currencies to anticipate inflationary pressures during construction.

(iii) A physical contingency factor of 10% for local and foreign currency is applied as a buffer for quantity adjustment during construction.

(iv) Costs of General Items Preliminaries comprise 6% of total Direct Cost.

(v) Right of Way (ROW) acquisition is estimated based on average land values for urban, suburban, agricultural land uses

(vi) Engineering services (Construction Management & Supervision) comprise 7.5% of total Direct Cost

(vii) Office Cost is estimated at 1% of the total Direct Cost

(viii) Base year in cost estimation is mid 2006 and exchange rate is US$=VND16000=115yen.

(ix) Includes general items & office (7%)

(x) Includes VAT (10%) on material & equipment

(xi) Includes tax on contractors profit (5.5%)

(xii) Taxes/Import duties on foreign equipment and materials (10%)

(xiii) Number of rolling stock vehicles for initial system based on 2020 ridership forecasts

(xiv) Design year for infrastructure based on 2050 ridership

(xv) Phased construction/operations between 2013 and 2020 (earliest start date of operations)

(xvi) Design life: Infrastructure: 100 years; Rolling stock: 30 years; Rail systems 15 years;

(5) Summary of Exclusions

(i) New Transport interchanges/ Highway structures/road works (except reinstatement)

(ii) Priority Feeder bus system vehicle and O&M costs

(iii) Utilities/traffic management costs
(iv) Project Contingency (10%)
(v) Consultants & PM fees
(vi) Land acquisition costs
(vii) Resettlement costs
(viii) Interest during construction
(ix) Currency fluctuation
(x) Finance Arrangement fees
(xi) Finance charges/interest
(xii) Government levy/fees
(xiii) Local government taxes
(xiv) MOT/PMU costs
(xv) Franchise fees
(xvi) Operations & maintenance training costs
(xvii) Property development revenue/costs

2) Methodology

(1) Vietnamese Guidelines

The guidelines for the cost estimation for the public works in Vietnam are explained in the collected various documents listed in Table 6.3.1.

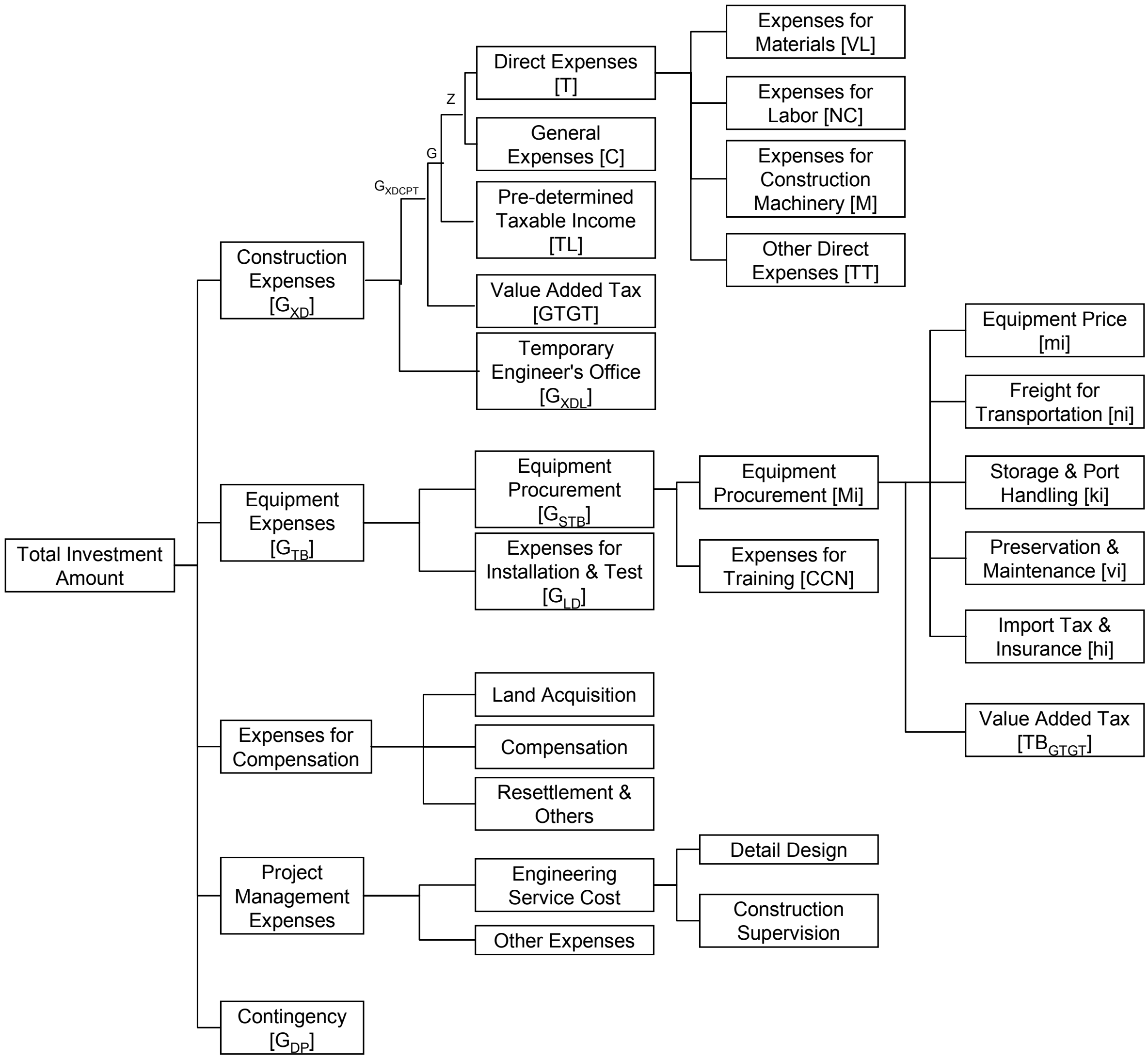
Table 6.3.1 Guidelines for Cost Estimation in Vietnam

No.	Title	Date
Circular 04/2005/TT-BXD	Guiding the formulation and management of expenses of investment projects on construction of works	2005/04/01
Decree No. 26/CP	Temporarily Regulating The Salary in Enterprises	1993/05/23
Circular 03/2005/TT-BXD	Guiding the Adjustment of Cost Estimates of Capital Construction Works	2005/03/04
Circular 16/2005/TT-BXD	Guiding the Adjustment of Work Construction Cost Estimates	2005/10/13
Decree No. 16/2005/ND-CP	On Management of Investment Projects on the Construction Works	2005/02/07
Decision No. 24/2005/QD-BXD	Decision on Promulgation of Estimate Norms for Construction Projects – Part of Construction	2005/07/29
Decision No. 24/1999/QD-UB	Decision on Promulgation of Unit Price in Capital Construction in Hanoi City	1999/05/15
Decree No. 118/2005	Readjusting the Minimum Wage Level	2005/09/15
Decree No. 158/2003/ND-CP	Detailing the Implementation of the Value Added Tax Law and the Law Amending and Supplementing a Number of Articles of the Value Added Tax Law	2003/12/10
Decree No. 03/2006/ND-CP	Providing for Provisions on Minimum Wages of Vietnamese Employees Working for Foreign Invested Enterprises, Foreign Agencies and Organizations and Foreign Individuals based in Vietnam	2006/01/06
Decree No. 233-HDBT	Regulations on Labor for Enterprises with Foreign Owned Capital	1990/06/22
Decree No. 204/ND-CP	Regarding Salary System for Public Servants, Officials and Military Force	2004/12/14
Decree No. 155/2004/ND-CP	Amending and Supplementing a Number of Articles of the Government's Decree No. 41/2002/ND-CP of April 11, 2002 on Policies towards Laborers Redundant due to the Restructuring Enterprises	2004/08/10
Decree No. 41/2002/ND-CP	On Policies towards Laborers Redundant due to the Restructuring of State Enterprises	2002/4/11

Source: Various publications

The calculation methodology for the construction cost specified in the Circular No. 04/2005/TT-BXD (1 April 2005) of Ministry of Construction is summarized in the Figure 6.3.1 and Table 6.3.2.

Figure 6.3.1 Cost Estimation Process in Vietnam



Source: Circular No. 04/2005/TT-BXD (April 1st, 2005)

Table 6.3.2 Calculation Method for Construction Cost

No.	Expense Item	Method of Calculation	Result
1	Direct Expenses		
	1 Material expenses	$\Sigma Qj \times D_{jvl} + CL_{vl}$	VL
	2 Labor expenses	$\Sigma Q_j \times D_{jnc} + (1 + K_{nc})$	NC
	3 Construction machine expenses	$\Sigma Q_j \times D_{jm} + (1 + K_{mtc})$	M
	4 Other direct expenses	1.5% x (VL + NC + M)	TT
	Total direct expenses	VL + NC + MM + TT	T
2	General Expenses	P x T	C
	Cost estimates for construction	T + C	Z
3	Pre-determined taxable income	(T + C) x prescribed rate	TL
	Value of pre-tax cost estimates for construction	(T + C + TL)	G
4	Value added tax	$G \times T^{XD}_{GTGT}$	GTGT
	Value of after-tax cost estimates	G + GTGT	G_{XDCPT}
	Expenses for building of make-shift houses in construction sites for accommodation and construction management	G x prescribed rate x $(1 + T^{XD}_{GTGT})$	G_{XDLT}

Q_j : The volume of construction job No. j

D_{jvl}, D_{jnc}, D_{jm} : Expenses for materials, labor, construction machines in the construction unit price of construction job No. j

K_{nc} : Labor adjustment co-efficient (if any)

K_{mtc} : Construction machine expense adjustment co-efficient (if any)

P : Norm for general expenses (%) provided for in Table 2

TL : Pre-determined taxable income provided for in Table 2

G : Pre-tax value of cost estimates for construction of principal works, auxiliary works and make-shift works in service of construction

G_{XDCPT} : After-tax value of cost estimates for construction of principal works, auxiliary works and make-shift works in service of construction

CL_{vl} : Difference of material quantities (if any)

T^{XL}_{GTGT} : Value added tax rate prescribed for construction job

G_{XDLT} : Expenses for building make-shift house in construction sites for accommodation and construction management

Z : Price of construction cost estimate.

Norms of General Expenses and pre-determined Taxable Income

No.	Type of work	General expenses P	Pre-determined taxable income
1	Civil works	6.0%	5.5%
2	Industrial works	5.5%	6.0%
3	Traffic works	5.3%	6.0%
4	Irrigation works	5.5%	5.5%
5	Technical infrastructure works	4.5%	5.5%

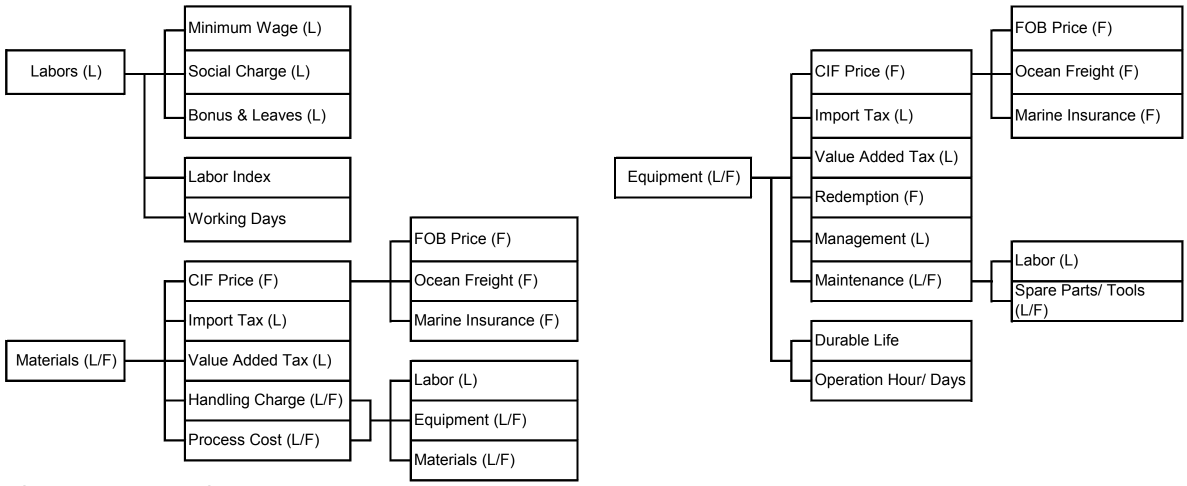
Source: Circular 04/2005/TT-BXD issued on Apr. 1, 2005 (Ministry of Construction)

(2) Adopted Methodology

The guidelines of cost estimation in Vietnam is respected in principle, while some adjustment were made considering that the projects proposed in the Prefeasibility study will be international tender projects. For example, regarding the minimum wage of labor, Decree 118/2005 issued on 15th September 2005 indicates that minimum wage is 350,000 VND per month, while Decree No. 03/2006/ND-CP issued on January 6th 2006 specifies 870,000 VND per month for Vietnamese employees working for foreign agencies and organizations and foreign individuals based in Vietnam. The adjustment rate specified in the Circular No. 16/2005/TT-BXD issued on 13 October 2005 does not seem to cover the recent sharp increase of the fuel cost for the construction equipment.

Therefore, the basic costs i.e. labor costs, material costs and equipment costs are estimated based on the latest market survey. The composition of the basic costs is shown in the following figure.

Figure 6.3.2 Composition of Basic Costs



Source: HAIDEP Study Team
Note: (L) Local portion, (F) Foreign portion, (L/F) Mix of local and foreign portion

The costs are composed of foreign and local currency portion. The foreign currency portion is generally the Cost, Insurance and Freight (CIF) price of the imported goods and materials. The local currency portion consists of import tax, value added tax, domestic handling and transportation costs, local process costs, overhead and local sales and market costs, profits of local firms, etc. Imported equipment and materials used except for the domestic handling and transportation, local process, overhead, etc. shall be deemed to be foreign portion.

The proportion of the foreign and local currency will be estimated based on the following principle as shown in Table 6.3.3.

Table 6.3.3 Foreign and Local Currency Portion

Foreign Currency Portion	Local Currency Portion
- Wages of foreign personnel - Overheads and profits of foreign firms - CIF price of imported equipment, materials and supplies	- Wages of local personnel - Overheads and profits of foreign firms - Import tax, value added tax - Local components of equipment, materials and supplies

Source: HAIDEP Study Team

Both foreign and local components will be expressed in US$ converted by the current exchange rate. Adopted exchange rate for the cost estimation is US$1.00 =16,000 VND = ¥115 as of June 2006.

Indirect costs, i.e. general expenses, contractor's profits (described as pre-determined taxable income in the guidelines), and temporary engineer's office (described as expenses for building of make-shift houses in construction sites for accommodation and construction management) are calculated by the percentage specified in the Circular 04/2005/TT-BXD of 1 April 2005.

The cost for UMRT Project is also compared with similar overseas projects in Asian countries to verify the adequacy of the estimated amount.

3) Basic Cost

(1) Labor Cost

The labor cost is estimated based on the minimum wage of 870,000 VND/month specified in Decree No. 03/2006/ND-CP issued on 6 January 2006. The daily wages of classified labors considering the workable days, allowances, social charges, etc. are calculated as shown in Table 6.3.4.

Table 6.3.4 Labor Cost

Labor Cost

1US$ = 16,000 VND = 115.00 yen

National Holiday = 8 days/week
Work Days/Week = 5.5 days/week = (7 Weekdays – Sunday – 0.5x Saturday)
Annual Paid Work Days = 279 days = 365 days/7 days x Weekly Work Days – National Holiday
Annual Rainy Days = 50 days/ year = Daily Precipitation of 10mm and mote (assumed)
Annual Workable Days = 242 days = [(365/7)week x Weekly work days / 365] x [(365-Holidays) / 365] x [1-(Annual Rainy Days/365)] x 365 days
Minimum Daily Wage = 43,140 VND/day = 870,000 VND/month x 12 month / Annual Workable days
2.70 US$/day
Leave (Paid Holidays) 1.00 month/year
Bonus 1.00 month/year
Basic Daily Wage = Min. Daily Wage x Labor Cost Index
Basic Monthly Salary = (Basic Daily Wage x Annual Paid Work Days)/12 Months

Day work	Night work	Total
75.00%	25.00%	100.00%
1.00	1.50	2.50
75.00%	37.50%	112.50%

Allowances (overtime) = [Day Work (%) x 1.00 + Night Work (%) x 1.50 – 100%] x Basic monthly salary
Leave (Paid Holidays) = 1.00 x Basic Monthly Salary
Bonus = 1.00 x Basic Monthly Salary
Social Charge 10.0% x (Basic Monthly Salary x 12 + Leave + Bonus)
Annual Cost Paid by Employer = (Basic Monthly Salary + Allowances) x 12 Months + Leave + Bonus + Social Charge
Daily Labor Cost for Estimate = Annual Cost Paid by Employer / Annual Workable Days

Item No.	Description	Labor Cost Index	Basic Daily Wage	Basic Monthly Salary	Allowance (overtime) 12.50%	Leave (Paid Holidays)	Bonus	Social Charge 10.00%	Annual Cost Paid by Empoyer	Daily Labor Cost for Estimate
			US$/day	US$/month	US$/month	US$/year	US$/year	US$/year	US$/year	US$/day
L002	Foreman	1.80	4.86	113.00	14.13	113.00	113.00	175.16	1,926.72	7.96
L003	Operator	1.30	3.51	81.61	10.20	81.61	81.61	126.49	1,391.43	5.75
L004	Driver	1.20	3.24	75.33	9.42	75.33	75.33	116.77	1,284.43	5.31
L005	Carpenter	1.40	3.78	87.89	10.99	87.89	87.89	136.23	1,498.57	6.19
L006	Re-Bar Worker	1.30	3.51	81.61	10.20	81.61	81.61	126.49	1,391.43	5.75
L007	Masonry	1.50	4.05	94.16	11.77	94.16	94.16	145.95	1,605.43	6.63
L008	Blaster	1.70	4.59	106.72	13.34	106.72	106.72	165.42	1,819.58	7.52
L009	Welder	1.60	4.32	100.44	12.56	100.44	100.44	155.69	1,712.57	7.08
L010	Painter	1.40	3.78	87.89	10.99	87.89	87.89	136.23	1,498.57	6.19
L011	Mechanic	1.40	3.78	87.89	10.99	87.89	87.89	136.23	1,498.57	6.19
L012	Electrician	1.30	3.51	81.61	10.20	81.61	81.61	126.49	1,391.43	5.75
L019	Skilled Labor	1.30	3.51	81.61	10.20	81.61	81.61	126.49	1,391.43	5.75
L020	Unskilled Labor	1.00	2.70	62.78	7.85	62.78	62.78	97.31	1,070.43	4.42
L021	Diver	1.90	5.13	119.27	14.91	119.27	119.27	184.87	2,033.57	8.40
L022	Captain	2.50	6.75	156.94	19.62	156.94	156.94	243.26	2,675.86	11.06
L023	Office Crew	2.00	5.40	125.55	15.69	125.55	125.55	194.60	2,140.58	8.85
L024	Common Crew	1.50	4.05	94.16	11.77	94.16	94.16	145.95	1,605.43	6.63
L030	Foreign Expert									

Minimum Wage
DECREE No. 03/2006/ND-CP Hanoi, 06 January 2006
Providing for Provisions on Minimum Wages of Vietnamese Employees Working for Foreign Invested Enterprises, Foreign Agencies and Organizations and Foreign Individuals based in Vietnam

Effective from 01 February 2006
Minimum Wage

No.	Area	VND/month
1	Districts of Hanoi and Ho Chi Minh City;	870,000
2	Suburb districts of Hanoi, Ho Chi Minh City; districts of Hai Phong City, Ha Long City of Quang Ninh Province, Bien Hoa City of Dong Nai Province, vung Tau City of Ba Ria – Vung Tau Province, Thu Dau Mot Town and Districts of Thuan An, Di An, Ben Cat and Tan Uyen of Binh Duong Province	790,000
3	Other areas	710,000

The minimum wages provided for in Article 1 under this Decree are used as a basic for establishing a salary scale, payroll ledgers and allowances; for determining salary levels to be started under the labor contracts; and for the implementation of other regime.

The lowest salary paid to workers who have undergone industrial training (including on-the-job training provided by enterprises) should be at least 7% higher than minimum wages provided for in Article 1 under this Decree.

Enterprises are encouraged to apply a rate of minimum wage that is higher than those of minimum wages provided for in Article 1 of this Decree.

REGULATIONS ON LABOR FOR ENTERPRISES WITH FOREIGN OWNED CAPITAL
(Issued with Decree No. 233.HDBT of the Council of Ministers dated 22 June 1990.)

CHAPTER VIII Social Insurance

Article 46
Every month, each enterprise shall pay a contribution to social insurance in a sum equivalent to ten (10) per cent of the amount of total wages and salary paid to its employees. This sum shall be applied as follows:
Two per cent to the labor office for the purpose of unemployment benefits.
Eight per cent to the social insurance fund established at the enterprise and administered jointly by the representative of the director and the labor representative on order to meet expenses which may arise as a result of:
sickness, labor accidents, occupational diseases (including leave taken and medical expenses);
pregnancy, maternity and childcare; and
burial and funeral expenses (for those who die during the term of employment).

(2) Material Cost

For the material costs many information were gathered and compared with the price in Japan to comprehend the tendency of the prices. The comparison of the costs for major materials is summarized in the following table.

Table 6.3.5 Comparison of Major Material Cost

Items		Unit	Market Rate			Comparison with Japanese Rate		
			(VND)	(US$)	(J. Yen)	Cost (¥)	(%)	Remarks
Diesel Oil		ltr	7,900	0.49	57	66	86.0	
Gasoline		ltr	11,000	0.69	79	91	86.9	
Electricity		kWh	528 ~ 1,661	0.07	8	16	50.6	
Water Supply		m^3	3,500	0.22	25	216	11.6	
Telecommunication		min	400	0.03	3	3	96.6	
Reinforcing Bars	SD295A	t	7,330,000 ~ 8,095,000	482.03	55,434	58,000	95.6	
	SD390A	t	7,480,000 ~ 8,095,000	486.72	55,973	62,000	90.3	
Steel Round Bars		t	7,130,000 ~ 7,480,000	456.56	52,505	58,000	90.5	
Structural Steel (S shapes)		t	7,980,000 ~ 8,180,000	505.00	58,075	77,000	75.4	
Structural Steel (shapes)		t	7,280,000 ~ 7,680,000	647.50	53,763	68,000	79.1	
Steel Pipes	Ø 38.1	m	8,714 ~ 15,159	0.75	86	73	117.1	
	Ø 42.2	m	10,571 ~ 16,857	0.88	99	96	103.0	
	Ø 48.1	m	12,095 ~ 19,286	0.98	113	110	103.0	
Portland Cement		t	780,000	48.75	5,606	8,400	66.7	
Coarse Aggregates		m^3	94,000	5.88	676	2,900	23.3	
Fine Aggregates		m^3	115,000	7.19	827	2,900	28.5	
Ready-Mix Concrete	M150	m^3	415,780 ~ 458,580	27.32	3,142	8,700	36.1	18-8-25
	M200	m^3	458,580 ~ 524,000	30.71	3,531	8,900	39.7	21-8-25
	M250	m^3	484,040 ~ 557,000	32.53	3,741	9,250	40.4	24-8-25
	M300	m^3	514,620 ~ 623,810	35.58	4,091	9,900	41.3	30-8-25
	M350	m^3	539,000 ~ 671,429	37.83	4,350	10,800	40.3	36-8-25
	M400	m^3	571,000 ~ 788,571	42.49	4,886	11,250	43.4	40-8-25
Stone		m^3	80,000	5.00	575	3,000	19.2	
Gravels		m^3	80,000 ~ 110,000	5.94	683	2,900	23.5	
Crushed Stones		m^3	100,000 ~ 125,000	7.03	809	1,900	42.6	
Sand		m^3	30,000 ~ 70,000	3.13	359	2,700	13.3	
Concrete Pipes	Ø 300	m	75,600 ~ 107,000	5.71	656	3,215	20.4	
	Ø 400	m	117,000 ~ 133,000	7.81	898	3,985	22.5	
	Ø 600	m	220,000 ~ 251,000	14.72	1,693	9,794	17.3	
	Ø 800	m	437,000 ~ 466,000	28.22	3,245	16,749	19.4	
	Ø 1000	m	596,000 ~ 726,000	43.31	4,751	26,132	18.2	
	Ø 1500	m	1216,000 ~ 1,483,000	84.34	9,700	48,305	20.1	
	Ø 2000	m	1938,000 ~ 2,112,000	126.56	14,555	83,051	17.5	
Lumber		m^3	1300,000 ~ 1,500,000	87.50	10,063	37,000	27.2	
Lumber		m^3	5800,000 ~ 7,500,000	415.63	47,797	80,000	59.7	
Lumber	High Quality	m^3	14,700,000 ~ 16,000,000	959.38	110,328	140,000	78.8	
Plwood	1220x2440x12	m^3	64,140	4.01	461	549	83.9	
Plwood	1220x2440x18	m^3	87,000	5.44	625	824	75.9	
Paint		kg	1,980 ~ 85,227	2.73	313	600	52.2	
Alkyd paint		kg	15,000 ~ 20,000	1.09	126	490	25.7	
Road Marking Paint		kg	11,700	0.73	84	135	62.3	
Asphalt		t		370.00	42,550	27,000	157.6	
Asphalt 60/70		t	4,720,000	295.00	33,925	27,000	125.6	
Alkali Emulsion Asphalt		t	3,300,000	206.25	23,719	45,000	52.7	
Acid Asphalt Emulsion		t	2,864,000	179.00	20,585	45,000	45.7	
Traffic Sign Board	▽ 700	each	215,782	13.49	1,551	4,400	35.2	▽ 800
Traffic Sign Board	▽ 900	each	348,725	21.80	2,506	7,280	34.4	▽ 800
Traffic Sign Board	Ø 700	each	304,600	19.04	2,189	7,980	27.4	Ø 600
Traffic Sign Board	Ø 900	each	526,200	32.89	3,782	13,190	28.7	Ø 600
Traffic Sign Board		m^2	787,000	49.19	5,657	44,000	12.9	
Traffic Sign Poles	Ø 90mm x 3.5m	each	314,000	19.63	2,257	8,980	25.1	Ø 60.5mm x 3.5m
Traffic Sign Poles	Ø 113.5mm x 3.5m	each	434,500	27.16	3,123	16,880	18.5	Ø 76.3mm x 3.5m
Interlocking Blocks 112.5x225x60	Gray	m^2	56,564	3.54	407	2,600	15.6	
Interlocking Blocks 112.5x225x60	red,yellow	m^2	80,817	5.05	581	2,600	22.3	
Interlocking Blocks 112.5x225x60	green	m^2	90,495	5.66	650	2,600	25.0	
Interlocking Blocks 130x130x60	Gray	m^2	55,132 ~ 69,125	3.88	447	2,600	17.2	
Interlocking Blocks 130x130x60	red,yellow	m^2	80,817 ~ 98,750	5.61	645	2,600	24.8	
Interlocking Blocks 130x130x60	green	m^2	90,495 ~ 110,600	6.28	723	2,600	27.8	
Pathway Paving Blocks		m^2	70,000 ~ 80,000	4.69	539	11,200	4.8	
Bentonite		kg	1,600	0.10	12	22	52.8	
Galvanized Iron Pipe	Ø 20	m	14,919	0.93	107	229	46.9	
	Ø 25	m	20,593	1.29	148	320	46.3	
	Ø 32	m	25,829	1.61	186	425	43.7	
	Ø 40	m	32,343	2.02	232	485	47.9	
	Ø 50	m	41,854	2.62	301	670	44.9	
	Ø 65	m	59,251	3.70	426	958	44.5	
	Ø 80	m	69,564	4.35	500	1,148	43.6	
	Ø 100	m	99,314	6.21	714	1,648	43.3	
PVC Pipe	Ø 16 x 2.29 m	each	13,182	0.82	95	179	52.9	
	Ø 20 x 2.29 m	each	14,545	0.91	105	216	48.3	
	Ø 25 x 2.29 m	each	26,818	1.68	193	313	61.7	
HDPE	Ø 40/30	m	9,640	0.60	69	163	42.5	
	Ø 50/40	m	13,180	0.82	95	200	47.4	
	Ø 65/50	m	16,850	1.05	121	294	41.2	
	Ø 105/80	m	35,380	2.21	254	626	40.6	
	Ø 130/100	m	40,470	2.53	291	887	32.8	
	Ø 195/150	m	91,720	5.73	659	1,640	40.2	
Bricks	200x105x60	each	850	0.05	6	180	3.4	210x100x60
Brick CN 50	200x200x50	each	770	0.05	6	760	0.7	200x200x60
Concrete Block	200x105x60	each	5,638	0.35	41	490	8.3	
Concrete Block	200x105x60	each	3,480	0.22	25			
Concrete Hollow Block	200x105x60	each	3,000	0.19	22	100	21.6	390x190x100
Concrete Hollow Block	200x105x60	each	4,546	0.28	33	195	16.8	390x190x190
Glass	4.5mm	m^2	50,000	3.13	359	950	37.8	

Source: HAIDEP Study Team

(3) Equipment Cost

Most of the construction equipment is imported. The equipment operation cost, in principle, consists of depreciation cost, operator or driver cost and fuel cost. The equipment depreciation costs shall be estimated from the basic equipment costs, considering the import tax, value added tax, standard operation hours, standard working days, resumption rate, repair and maintenance rate and annual management rate. The hourly (or daily) equipment depreciation costs are calculated using the following equation.

$$DP = BP \times \left(\frac{RD + MT}{DY} + MN \right) \times \frac{1}{SO}$$

Where, DP: Hourly (or Daily) equipment depreciation cost
BP: Basic equipment cost = CIF price + Import tax + VAT
RD: Redemption rate = 1 – Resumption rate
MT: Maintenance and repair rate
MN: Annual management rate
DY: Durable years
SO: Standard annual operation hours (or days)

The CIF prices of the equipment are taken as the equipment cost of Japan in accordance with “Construction Equipment Depreciation Cost” issued by the Japan Construction Mechanization Association, and 10% import tax and 10% value added tax was added for the basic equipment cost. Redemption rate, durable years and standard operation hours (or days) are taken as the same as in Japan, while maintenance and repair rate, and annual management rate are reduced to 75% and 50% respectively of those used in Japan to reflect the difference in personnel expenditure.

The hourly (or daily) equipment operation costs are calculated by adding the operator/driver cost and the fuel consumption cost to the above depreciation costs.

The operation costs for major equipment are summarized in the Table 6.3.6.

4) Productivity and Quantities

The productivity of the works was determined referring to the Decision No. 24/2005/QD-BXD “Decision on Promulgation of Estimate Norms for Construction Projects – Part of Construction” issued by Ministry of Construction on 29 July 2005, as well as the “Cost Estimation Standard for Civil Works” and “Cost Estimation Standard for Public Architectural Works” both issued by the Ministry of Land Infrastructure and Transport of Japan for the year 2005.

The quantities are roughly estimated from the preliminary design drawings prepared in the prefeasibility study.

Table 6.3.6 Major Equipment Operation Costs

Items	Unit	Operation Cost (US$)	Components (%)	
			Foreign	Local
Bulldozer, 15t	hr	50.30	52.9	47.1
Bulldozer, 21t	hr	72.50	54.6	45.4
Backhoe, hydraulic. Crawler, 0.1m^3	day	90.70	54.5	45.5
Backhoe, hydraulic. Crawler, 0.35m^3	Hr	23.40	55.7	44.3
Backhoe, hydraulic. Crawler, 0.60m^3	hr	40.00	56.7	43.3
Clamshell, crawler, Hydraulic, 0.6m^3	hr	41.80	55.6	44.4
Clamshell, crawler, Hydraulic, 0.8m^3	hr	66.40	49.8	50.2
Concrete Breaker, 20kg	day	1.02	65.4	34.6
Motor Grader, 3.1m	hr	35.60	51.0	49.0
Road Roller, macadam, 10~12t	hr	27.70	48.8	51.2
Tire Roller, 8~20t	hr	26.50	49.2	50.8
Vibration Roller, combined, 3~4t	hr	15.20	49.4	50.6
Tamper and Rammer, 60~100kg	day	11.30	63.3	36.7
Vibration Compactor, 100~110kg	day	12.30	62.6	37.4
Crawler Crane, Hydraulic, 40~45t	hr	69.60	51.2	48.8
Crawler Crane, Hydraulic, 50~55t	hr	83.40	51.3	48.7
Truck Crane, Hydraulic, 15~16t	hr	37.80	52.7	47.3
Truck Crane, Hydraulic, 20t	hr	40.50	52.8	47.2
Truck Crane, Hydraulic, 50t	hr	96.70	53.4	46.6
All Casing Excavator, Crawler, Φ1500max	hr	386.00	53.5	46.5
Diaphragm Wall Excavator, Lateral Rotation type,	hr	401.00	53.5	46.5
Dump Truck, Diesel, 10t	hr	27.70	51.0	49.0
Concrete Mixer Truck 4.4~4.5m3	hr	28.30	53.9	46.1
Concrete Pump Vehicle (Piping), 90~100m^3/hr	hr	62.40	56.1	43.9
Concrete Pump Vehicle (Boom), 90~110m^3/hr	hr	67.60	55.6	44.4
Grout Pump, 15~30 1tr/min	day	12.40	52.0	48.0
Asphalt Finisher, crawler, 2.4~4.5m	hr	70.70	52.3	47.7
Electric Welder, 500A	day	1.80	50.8	49.2
Generator, 100kVA	day	107.00	60.4	39.6
Air Compressor, 3.5~3.7m^3/min	day	41.80	59.3	40.7
Submerged Pump, Φ100mm, 3.7kW	day	5.20	45.6	54.4
PC Bridge Cantilever Construction Operation Wagon,	day	423.00	60.1	39.9

Source: HAIDEP Study Team

5) Indirect Cost

Indirect costs are taken as specified in the Circular 04/2005/TT-BXD (1 April 2005) of Ministry of Construction.

(a) **Other Direct Expenses:** 1.5% of the direct cost (sum of labor, materials and equipment) which is defined as to cover water pumping, mud dredging, tests of materials, movement of labor and construction equipment to and within construction sites, labor safety and protection of the environment for laborers and protection of surrounding environment.

(b) **General Items:** 6.0% of the total direct cost which covers expenses for production management in construction sites, expenses for management and administration staffs, expenses of for temporary construction in construction sites and other expenses.

(c) **Pre-determined Taxable Income (Contractor's Profit):** 5.5% of the sum of total direct cost and general items which will be the profit of the contractor.

6) Other Costs

In addition to the construction cost, the project cost shall include the following expenses specified in the Circular 04/2005/TT-BXD (1 April 2005) of Ministry of Construction.

Table 6.3.7 Other Costs to be Included in the Project Cost

Expense	Content	Remark
Expenses for Compensation	1. Expenses for compensation for houses, architectural objects and crops on land, etc. 2. Expenses for resettlement related to compensation and ground clearance boards 3. Expenses for land use such as lent rents during the time of construction 4. Expenses for investment in technical infrastructure (if any)	
Project Management Expenses	1. Expenses for general management of projects 2. Expenses for performing compensation and ground clearance work under the responsibility of investors 3. Expenses for performing evaluation or verification of designs, total cost estimates and cost estimates for construction of works 4. Expenses for complication of dossiers of invitation for participation in bidding, dossiers of invitation for bids, analysis and evaluation of bids 5. Expenses for construction supervision, construction survey and equipment installation 6. Expenses for expertise and certification of quality conformity of works 7. Expenses for pre-acceptance test, financial settlement and conversion of investment capital 8. Expenses for project formulation 9. Expenses for selection of architectures (if any) 10. Expenses for construction survey and design 11. Loan interest paid by investor during the construction period under credit contract or loan agreement (for ODA funded projects) 12. Expenses for the State steering committee and the State council for test and acceptance 13. Expenses for international quality registry 14. Expenses for observation of works, deformation (if any) 15. Start-up working capital for production 16. Expenses for fuel, energy and labour for the process of load and non-load trial operation (for production and business projects) 17. Expenses for work insurance 18. Expenses for audit, verification and approval of financial settlement and other expenses	10-15% of the total construction cost
Contingency Expenses	Those set aside for arising volumes, inflation elements and unforeseeable jobs in the process of project implementation	Not greater than 15% of the sum including the total construction cost, compensation and project management cost.

Source: HAIDEP Study Team

For Project management cost, 7.5% was taken as the engineering cost for the design and the construction supervision.

For contingency, 10% was taken as physical contingency which does not include price escalation.

7) Estimated Cost

The costs for UMRT Line No. 2 are estimated for various cases and options (see table 6.3.8 to Table 6.3.11).

Table 6.3.8 Cost Estimation for the Total Route (Option 1)

Phase		St. No.	Chainage	Structure		Distance (m)	RL (m)	GL (m)	RL-GL (m)	Rate (US$)	Amount (US$)	In case of 3 FL and 4 FL Station
Phase 4			0-350.0									
			0-077.5	Scissors Box (RL=GL-15m)		273				45,500	12,399	
		1	0+077.5	Stn-N1 Noi Bai airport	30m x 155m, 2FL, RL = GL-15m	155			-16.00	21,200,000	21,200	
			2+722.5	Twin Shield 6.1m		2,645				36,400	96,278	
		2	2+877.5	Stn-N2	19m x 155m, 2FL, RL = GL-15m	155			-16.00	15,600,000	15,600	
			2+999.5	Transition Box (RL = GL - 15m)		122				42,500	5,185	
			3+300.0	Single Box (RL = GL - 10m)		301				23,800	7,152	
			3+470.0	U- Shaped		170				6,850	1,165	
			3+556.0	Embankment		86				2,320	200	
			5+030.0	Viaduct		1,474				7,410	10,922	
Phase 3			5+300.0	Viaduct		300				7,410	2,223	
		3	5+470.0	Stn-N3 Thai Phu (Depot)	Elevated 4 track	140			+11.00	8,070,000	8,070	
			7+030.0	Viaduct		1,560				7,410	11,560	
		4	7+170.0	Stn-N4 Bac Hong	Elevated 2 track	140			+11.00	7,190,000	7,190	
			8+730.0	Viaduct		1,560				7,410	11,560	
		5	8+870.0	Stn-N5	Elevated 2 track	140			+11.00	7,190,000	7,190	
			10+530.0	Viaduct		1,660				7,410	12,301	
		6	10+670.0	Stn-N6	Elevated 2 track	140			+11.00	7,190,000	7,190	
			12+230.0	Viaduct		1,560				7,410	11,560	
		7	12+370.0	Stn-N7 Hai Boi	Elevated 2 track	140			+11.00	7,190,000	7,190	
			12+730.0	Viaduct		360				7,410	2,668	
			13+090.0	Red River crossing Approach Bridge		360				9,660	3,478	
			14+910.0	Red River crossing Main Bridge		1,820				27,100	49,322	
			15+270.0	Red River crossing Approach Bridge		360				9,660	3,478	
			15+730.0	Viaduct		460				7,410	3,409	
Phase 2			16+030.0	Viaduct		300				7,410	2,223	
		8	16+170.0	Stn-01 Nam Thanh Long	Elevated 2 track	140	+18.20	+7.20	+11.00	7,190,000	7,190	
			16+980.0	Viaduct		810				7,410	6,002	
		9	17+120.0	Stn-02 Khu Trung	Elevated 2 track	140	+17.50	+6.50	+11.00	7,190,000	7,190	
			17+348.0	Viaduct		228				7,410	1,689	
			17+434.0	Embankment		86				2,320	200	
			17+604.0	U- Shaped		170				6,850	1,165	
			18+060.5	Single Box (RL = GL - 10m)		457				23,800	10,865	
Phase 1	Package 1		18+182.5	Transition Box (RL = GL - 20m)		122				52,400	6,393	
		10'	18+337.5	Stn-03 Tu Liem (Depot)	34m x 155m, 2 FL, RL=GL-20m	155	-16.50	+5.50	-22.00	27,100,000	27,100	
			19+872.5	Twin Shield 6.1m		1,535				36,400	55,874	
		11	20+027.5	Stn-04 Buoi	19m x 155m, 2 FL, RL=GL-15m	155	-10.40	+6.90	-17.30	15,600,000	15,600	
			21+382.5	Twin Shield 6.1m		1,355				36,400	49,322	
		12	21+537.5	Stn-05 Ba Dinh	19m x 155m, 2 FL, RL=GL-25m	155	-16.35	+8.10	-24.45	22,000,000	22,000	25,800
			22+582.5	Twin Shield 6.1m		1,045				36,400	38,038	
		13	22+737.5	Stn-06 Bac Thao	19m x 155m, 2 FL, RL=GL-25m	155	-13.80	+9.20	-23.00	22,000,000	22,000	25,800
			23+492.5	Twin Shield 6.1m		755				36,400	27,482	
		14	23+647.5	Stn-07 Ho Tay	19m x 155m, 2 FL, RL=GL-15m	155	-5.30	+8.70	-14.00	15,600,000	15,600	
			24+386.5	Twin Shield 6.1m		739				36,400	26,900	
			24+512.5	Scissors Box (RL=GL-15m)		126				68,400	8,618	
		15	24.667.5	Stn-08 Long Bien	30m x 155m, 3 FL, RL=GL-20m	155	-15.70	+9.50	-25.20	28,300,000	28,300	28,300
			25+442.5	Twin Shield 6.1m		755				36,400	27,482	
		16	25+577.5	Stn-09 Bo Ho	19m x 155m, 2 FL, RL=GL-25m	155	-13.90	+10.00	-23.90	22,000,000	22,000	25,800
			26+202.5	Twin Shield 6.1m		625				36,400	22,750	
		17	26+357.5	Stn-10 Hoan Kiem	30m x 155m, 2 FL, RL=GL-20m	155	-12.40	+8.50	-20.90	26,000,000	26,000	28,300
			26+643.5	Scissors Box (RL=GL-15m)		286				56,200	16,073	
			27+102.5	Twin Shield 6.1m		459				36,400	16,708	
		18	27+257.5	Stn-11 Tran Hung Dao	19m x 155m, 2 FL, RL=GL-20m	155	-10.70	+8.40	-19.10	18,700,000	18,700	20,500
			28+037.5	Twin Shield 6.1m		780				36,400	28,292	
		19	28+192.5	Stn-12 Cau Den	19m x 155m, 2 FL, RL=GL-25m	155	-16.60	+7.20	-23.80	22,000,000	22,000	25,800
			29+442.5	Twin Shield 6.1m		1,250				36,400	45,500	
		20	29+597.5	Stn-13 Bach Khoa	19m x 255m, 2 FL, RL=GL-25m	155	-17.10	+6.50	-23.60	22,000,000	22,000	25,800
	Package 2		30+632.5	Twin Shield 6.1m		1,035				36,400	37,674	
		21	30+787.5	Stn-14 Cua Boc	19m x 155m, 2 FL, RL=GL-25m	155	-19.20	+6.10	-25.30	22,000,000	22,000	25,800
			32+132.5	Twin Shield 6.1m		1,345				36,400	48,958	
		22	32+287.5	Stn-15 Nga Tu So	19m x 155m, 2 FL, RL=GL-15m	155	-8.60	+6.60	-15.20	15,600,000	15,600	
			33+022.5	Twin Shield 6.1m		735				36,400	26,754	
		23	33+177.5	Stn-16 Thuong Dinh	30m x 155m, 2 FL, RL=GL-20m	155	-15.10	+6.90	-22.00	26,000,000	26,000	28,300
			33+299.5	Transition Box (RL=GL-20m)		122				52,400	6,393	
Phase 2			33+649.5	Single Box (RL = GL - 10m)		350				23,800	8,330	
			33+820.5	U- Shaped		171				6,850	1,171	
			33+906.5	Embankment		86				2,320	200	
			34+260.0	Viaduct		354				7,410	2,619	
		24	34+400.0	Stn-17 Thanh Xuan	Elevated 2 track	140	+17.60	+6.60	+11.00	7,190,000	7,190	
			36+060.0	Viaduct		1,660				7,410	12,300	
		25	36+200.0	Stn-S1	Elevated 2 track	140			+11.00	7,190,000	7,190	
			37+560.0	Viaduct		1,360				7,410	10,078	
		26	37+700.0	Stn-S2	Elevated 2 track	140			+11.00	7,190,000	7,190	
			39+360.0	Viaduct		1,660				7,410	12,301	
		27	39+500.0	Stn-S3	Elevated 2 track	140			+11.00	7,190,000	7,190	
			40+760.0	Viaduct		1,260				7,410	9,337	
		28	40+900.0	Stn-S4 Ha Dong (Depot)	Elevated 2 track	140			+11.00	8,070,000	8,070	
			41+200.0	Viaduct		300				7,410	2,223	
				Sub Total A		41,552					1,244,514	
					29,954 US$/m		30,657US$/m					
3				Workshop/Depot	(Thai Phu Deport)	550				5,100,000	5,100	
				Viaduct						7,410	4,076	
1				Workshop/Depot	(Tu Liem Depot)	550				20,800,000	20,800	
				Single Box (RL=GL-10m)						23,800	13,090	
2				Workshop/Depot	(Ha Dong Depot)	550				5,100,000	5,100	
				Viaduct						7,410	4,076	
				Sub Total B							52,242	
			Railway System			15%				195,000,000	195,000	199,000,000
			Rolling Stock			252 cars				1,590,000	400,680	
				Sub Total C							595,680	
				Total A+B+C							1,892,436	1,925,729,215
			General Items				6.0%				113,551,753	115,543,753
			Temporary Engineer's Office				1.0%				20,060,810	20,412,730
											2,026,141,778	2,061,685,698
						48,764 US $/m	49,619 US $/m					

Source: HAIDEP Study Team

Table 6.3.9 Cost Estimation for the Total Route (Option 2)

Option-2 Total Route

Phase	Package	St. No.	Chainage	Structure		Distance (m)	RL (m)	GL (m)	RL-GL (m)	Rate (US$)	Amount (US$)	In case of 3 FL & 4 FL Station
Phase 4			0-350.0									
			0-077.5	Scissors Box (RL=GL-15m)		273				45,500	12,398,750	
		1	0+077.5	**Stn-M1 Noi Bai Airport**	30m x 155m, 2 FL, RL=GL-15m	155			-18.00	21,200,000	21,200,000	
			2+722.5	Twin Shield φ6.1m		2,645				36,400	96,278,000	
		2	2+877.5	**Stn-M2**	19m x 155m, 2 FL, RL=GL-15m	155			-16.00	15,600,000	15,600,000	
			2+999.5	Transition Box (RL=GL-15m)		122				42,500	5,185,000	
			3+300.0	Single Box (RL=GL-10m)		301				23,800	7,151,900	
			3+470.0	U-Shaped		170				6,850	1,164,500	
			3+556.0	Embankment		86				2,320	199,520	
			5+030.0	Viaduct		1,474				7,410	10,922,340	
Phase 3			5+330.0	Viaduct		300				7,410	2,223,000	
		3	5+470.0	**Stn-M3 Thai Phu (Depot)**	Elevated 4 track	140			+11.00	8,070,000	8,070,000	
			7+030.0	Viaduct		1,560				7,410	11,559,600	
		4	7+170.0	**Stn-M4 Bac Hong**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			8+730.0	Viaduct		1,560				7,410	11,559,600	
		5	8+870.0	**Stn-M5**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			10+530.0	Viaduct		1,660				7,410	12,300,600	
		6	10+670.0	**Stn M6**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			12+230.0	Viaduct		1,560				7,410	11,558,800	
		7	12+370.0	**Stn-M7 Hai Boi**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			12+730.0	Viaduct		360				7,410	2,667,600	
			13+090.0	Red River Crossing Approach Bridge		360				9,660	3,477,600	
			14+910.0	Red River Crossing Main Bridge		1,820				27,100	49,322,000	
			15+270.0	Red River Crossing Approach Bridge		360				9,660	3,477,600	
			15+730.0	Viaduct		460				7,410	3,408,600	
Phase 2			16+030.0	Viaduct		300				7,410	2,223,000	
		8	16+170.0	**Stn-01 Nam Thanh Long**	Elevated 2 track	140	+18.20	+7.20	+11.00	7,190,000	7,190,000	
			16+980.0	Viaduct		810				7,410	6,002,100	
		9	17+120.0	**Stn-02 Khu Trung**	Elevated 2 track	140	+17.50	+6.50	+11.00	7,190,000	7,190,000	
			17+348.0	Viaduct		228				7,410	1,689,480	
			17+434.0	Embankment		86				2,320	199,520	
			17+604.0	U-Shaped		170				6,850	1,164,500	
			18+060.5	Single Box (RL=GL-10m)		457				23,800	10,864,700	
Phase 1	Package 1		18+182.5	Transition Box (RL=GL-20m)		122				52,400	6,392,800	
		10	18+337.5	**Stn-03 Tu Liem (Depot)**	34m x 155m, 2 FL, RL=GL-20m	155	-16.50	+5.50	-22.00	27,100,000	27,100,000	
			19+872.5	Twin Shield φ6.1m		1,535				36,400	55,874,000	
		11	20+027.5	**Stn-04 Buoi**	19m x 155m, 2 FL, RL=GL-15m	155	-9.10	+6.90	-16.00	15,600,000	15,600,000	
			21+382.5	Twin Shield φ6.1m		1,355				36,400	49,322,000	
		12	21+537.5	**Stn-05 Ba Dinh**	19m x 155m, 2 FL, RL=GL-15m	155	-7.90	+8.10	-16.00	15,600,000	15,600,000	
			22+582.5	Twin Shield φ6.1m		1,045				36,400	38,038,000	
		13	22+737.5	**Stn-06 Bac Thao**	19m x 155m, 2 FL, RL=GL-15m	155	-6.80	+9.20	-16.00	15,600,000	15,600,000	
			23+532.5	Twin Shield φ6.6m		795				36,400	28,938,000	
		14	23+687.5	**Stn-07 Ho Tay**	19m x 155m, 2 FL, RL=GL-15m	155	-8.10	+7.90	-16.00	15,600,000	15,600,000	
			25+006.5	Twin Shield φ6.1m		1,319				36,400	48,011,600	
			25+132.5	Scissors Box (RL=GL-15m)		126				45,500	5,733,000	
		15	25+287.5	**Stn-08 Long Bien**	30m x 155m, 3 FL, RL=GL-20m	155	-4.50	+11.50	-16.00	28,300,000	28,300,000	28,300,000
			25+812.5	Twin Shield φ6.1m		525				36,400	19,110,000	
		16	25+967.5	**Stn-09 Bo Ho**	19m x 155m, 2 FL, RL=GL-15m	155	-6.00	+10.00	-16.00	15,600,000	15,600,000	
			26+482.5	Twin Shield φ6.1m		515				36,400	18,746,000	
		17	26+637.5	**Stn-10 Hoan Kiem**	30m x 155m, 2 FL, RL=GL-20m	155	-13.50	+8.50	-22.00	26,000,000	26,000,000	28,300,000
			26+923.5	Scissors Box (RL= GL-20m)		286				56,200	16,073,200	
			27+522.5	Twin Shield φ6.1m		599				36,400	21,803,600	
		18	27+677.5	**Stn-11 Hung Dao**	19m x 155m, 2 FL, RL=GL-15m	155	-8.60	+7.40	-16.00	15,600,000	15,600,000	
			28+512.5	Twin Shield φ6.1m		835				36,400	30,394,000	
		19	28+667.5	**Stn-12 Cau Den**	19m x 155m, 2 FL, RL=GL-15m	155	-8.80	+7.20	-16.00	15,600,000	15,600,000	
			29+912.5	Twin Shield φ6.1m		1,245				36,400	45,318,000	
		20	30+067.5	**Stn-13 Bach Khoa**	19m x 155m, 2 FL, RL=GL-15m	155	-9.50	+6.50	-16.00	15,600,000	15,600,000	
	Package 2		31+102.5	Twin Shield φ6.1m		1,035				36,400	37,674,000	
		21	31+257.5	**Stn-14 Cua Boc**	19m x 155m, 2 FL, RL=GL-15m	155	-9.90	+6.10	-16.00	15,600,000	15,600,000	
			32+602.5	Twin Shield φ6.1m		1,345				36,400	48,958,000	
		22	32+757.5	**Stn-15 Nga Tu So**	19m x 155m, 2 FL, RL=GL-15m	155	-9.40	+6.60	-16.00	15,600,000	15,600,000	
			33+492.5	Twin Shield φ6.1m		735				36,400	26,754,000	
		23	33+647.5	**Stn-16 Thuong Dinh**	30m x 155m, 2 FL, RL=GL-20m	155	-15.10	+6.90	-22.00	26,000,000	26,000,000	28,300,000
			33+769.5	Transition Box (RL=GL-20m)		122				52,400	6,392,800	
Phase 2			34+119.5	Single Box (RL=GL-10m)		350				23,800	8,330,000	
			34+290.5	U-Shaped		171				6,850	1,171,350	
			34+376.5	Embankment		86				2,320	199,520	
			34+730.0	Viaduct		354				7,410	2,619,435	
		24	34+870.0	**Stn-17 Thanh Xuan**	Elevated 2 track	140	+17.60	+6.60	+11.00	7,190,000	7,190,000	
			36+530.0	Viaduct		1,660				7,410	12,300,600	
		25	36+670.0	**Stn-S1**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			38+030.0	Viaduct		1,360				7,410	10,077,600	
		26	38+170.0	**Stn-S2**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			39+830.0	Viaduct		1,660				7,410	12,300,600	
		27	39+970.0	**Stn-S3**	Elevated 2 track	140			+11.00	7,190,000	7,190,000	
			41+230.0	Viaduct		1,260				7,410	9,336,600	
		28	41+370.0	**Stn-S4 Ha Dong (Depot)**	Elevated 4 track	140			+11.00	8,070,000	8,070,000	
			41+670.0	Viaduct		300				7,410	2,223,000	
				Subtotal A		42,020					1,217,330,815	1,221,930,815
						28,970 US$/m	29,080 US$/m					
3				Workshop/Depot	(Thai Phu Depot)					5,100,000	5,100,000	
				Viaduct		550				7,410	4,075,500	
1				Workshop/Depot	(Tu Liem Depot)					20,800,000	20,800,000	
				Single Box (RL=GL-10m)		550				23,800	13,090,000	
2				Workshop/Depot	(Ha Dong Depot)					5,100,000	5,100,000	
				Viaduct		550				7,410	4,075,500	
				Subtotal B							52,241,000	
				Railway System		15%				190,400,000	190,400,000	191,100,000
				Rolling Stock		252 cars				1,590,000	400,680,000	
				Subtotal C							591,080,000	
				Total A+B+C							1,860,651,815	1,865,951,815
				General Items			6.0%				111,639,109	111,957,109
				Temporary Engineer's Office			1.0%				19,722,909	19,779,089
											1,992,013,833	1,997,688,013
						47,406 US$/m	47,541 US$/m					

Source: HAIDEP Study Team

Table 6.3.10 Cost Summary of Total Route (Option 1)

Items			Phase 1 Package 1	Phase 1 Package 2	Phase 1 Total	Phase 2	Phase 3	Phase 4	Total
Total Length (m)			11,537	3,702	15,239	10,231	10,700	5,380	41,550
No. of Stations			11	3	14	7	5	2	28
Civil Works			610,831,600	183,378,800	794,210,400	131,912,005	148,385,800	170,100,010	1,244,608,215
Workshop/Depot			33,890,000	0	33,890,000	9,175,500	9,175,500	-	52,241,000
Railway System			96,700,000	27,500,000	124,200,000	21,200,000	23,600,000	25,500,000	194,500,000
Rolling Stock		Cars	84	24	108	60	48	36	252
			133,560,000	38,160,000	171,720,000	95,400,000	76,320,000	57,240,000	400,680,000
General Item		6.00%	52,498,896	14,942,328	67,441,224	15,461,250	15,448,878	15,170,401	113,521,753
T.E. Office		1.00%	9,274,805	2,639,811	11,914,616	2,731,488	2,729,302	2,680,104	20,055,510
Total Construction Cost			936,755,301	266,620,939	1,203,376,240	275,880,243	275,659,480	270,690,515	2,025,606,478
US$ / m			81,196	72,021	153,217	26,965	25,763	50,314	48,751
Components (%)	Labor Cost	Unskilled	2.04	2.76	2.15	1.27	1.22	2.16	1.81
		Others	2.64	2.44	2.61	3.02	2.91	2.80	2.77
		Foreign	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Material Cost	Foreign	48.01	36.91	46.39	50.45	50.05	50.82	48.38
		Local	30.58	41.85	32.23	21.93	22.83	25.58	27.70
	Equipment Cost	Foreign	8.64	8.41	8.61	12.17	12.03	9.67	10.06
		Local	8.08	7.62	8.02	11.15	10.96	8.97	9.29
	Tax		10.42	10.52	10.44	11.09	11.38	10.59	10.76
Land Compensation									
Engineering Cost		7.50%	70,256,648	19,996,570	90,253,218	20,691,018	20,674,461	20,301,789	151,920,486
Contingency		10.00%	100,701,195	28,661,751	129,362,946	29,657,126	29,633,394	29,099,230	217,752,696
Grand Total			1,107,713,143	315,279,261	1,422,992,404	326,228,387	325,967,335	320,091,534	2,395,279,660

Source: HAIDEP Study Team

Table 6.3.11 Cost Estimation for the Total Route (Option 2)

Items			Phase 1 Package 1	Phase 1 Package 2	Phase 1 Total	Phase 2	Phase 3	Phase 4	Total
Total Length (m)			12,007	3,702	15,709	10,231	10,700	5,380	42,020
Nos. of Station			11	3	14	7	5	2	28
Civil Works			589,954,200	176,978,800	766,933,000	131,912,005	148,385,800	170,100,010	1,217,330,815
Workshop/Depot			33,890,000	0	33,890,000	9,175,500	9,175,500	0	2,241,000
Railway System			93,600,000	26,500,000	120,100,000	21,200,000	23,600,000	25,500,000	90,400,000
Rolling Stock		Cars	84	24	108	60	48	36	252
			133,560,000	38,160,000	171,720,000	95,400,000	76,320,000	57,240,000	400,680,000
General Item		6.00%	51,060,252	14,498,328	65,558,580	15,461,250	15,448,878	15,170,401	111,639,109
T.E. Office		1.00%	9,020,645	2,561,371	11,582,016	2,731,488	2,729,302	2,680,104	9,722,909
Total Construction Cost			911,085,097	258,698,499	1,169,783,596	275,880,243	275,659,480	270,690,515	1,992,013,833
US$ / m			75,879	69,881	74,466	26,965	25,763	50,314	47,406
Components (%)	Labor Cost	Unskilled	2.22	2.94	2.32	1.27	1.22	2.16	1.88
		Others	2.77	2.55	2.73	3.02	2.91	2.80	2.83
		Foreign	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Material Cost	Foreign	49.21	37.15	47.46	50.45	50.05	50.82	48.97
		Local	28.85	41.14	30.63	21.93	22.83	25.58	26.96
	Equipment Cost	Foreign	8.75	8.51	8.71	12.17	12.03	9.67	10.17
		Local	8.21	7.72	8.14	11.15	10.96	8.97	9.39
	Tax		10.33	10.46	10.35	11.09	11.38	10.59	10.73
Land Compensation									
Engineering Cost		7.50%	68,331,382	19,402,387	87,733,770	20,691,018	20,674,461	20,301,789	149,401,037
Contingency		10.00%	97,941,648	27,810,089	125,751,126	29,657,126	29,633,394	29,099,230	214,141,487
Grand Total			1,077,358,127	305,910,975	1,383,269,102	326,228,387	325,967,335	320,091,534	2,355,556,358

Source: HAIDEP Study Team

8) Railway Projects Costs in Other Countries

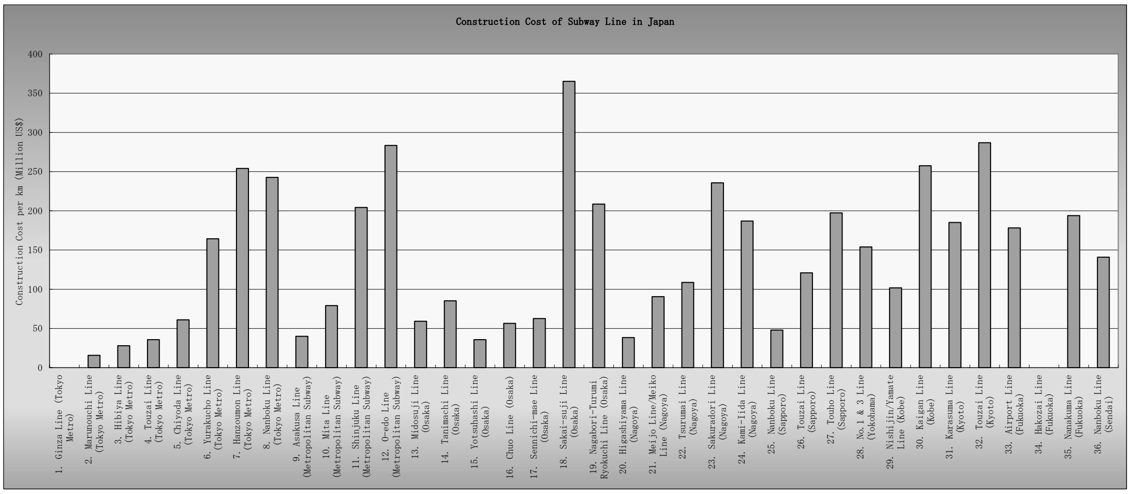
The construction cost of subways in Japan is summarized in the following figures for reference. (Table 6.3.12). The railway cost in other countries mainly in Asia is summarized in Table 6.3.13 for further reference.

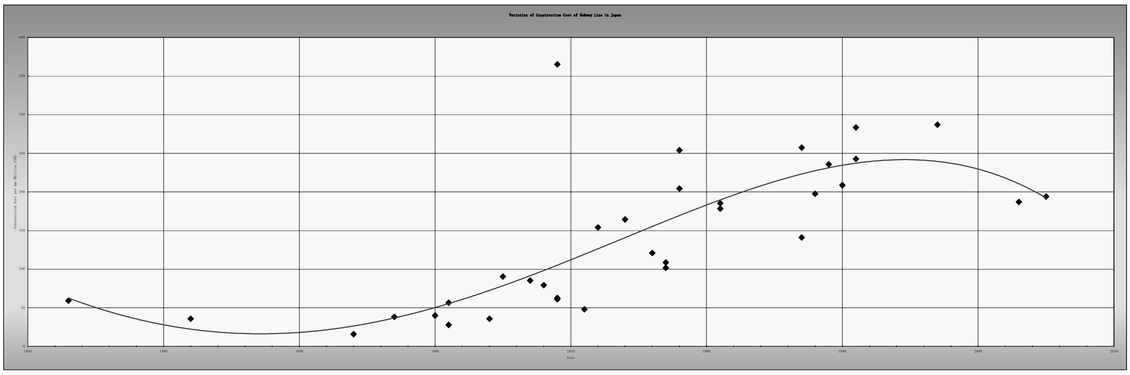
Table 6.3.12 Summary of Present Status of Subway Line in Japan

Summary of Present Status of Subway Line in Japan (Japan Subway Association)

District	Name of Subway Line	Rolling Stocks		Operation Distance (km)	Passenger per day (x1000)	Construction Cost per km (*1) (Million US$)	Number of Station	Railway Gauge (mm)	Required time for total stretch	Operation Interval		Average Velocity (km/hr)	Commencement of Operation	
		Number of cars possesed	Number of cars per							Peak Hours	Off-Peak Hours		Partial Open	Overall Open
Tokyo Metro	1. Ginza Line (Tokyo Metro)	228	6	14.3	1028	–	19	1435	31'25"	2'00"-2'15"	3'00"	27.3	1927	1939
	2. Marunouchi Line (Tokyo Metro)	336	6/3	27.4	1103	15.7	28	1435	48'15"	1'50"-2'50"	4'00"	30.1	1954	1962
	3. Hibiya Line (Tokyo Metro)	336	8	20.3	1099	27.8	21	1067	43'00"	2'10"-2'30"	5'00"	28.3	1961	1964
	4. Touzai Line (Tokyo Metro)	470	10	30.8	1215	35.7	23		49'30"	2'30"-3'10"	5'00"	37.3	1964	1969
	5. Chiyoda Line (Tokyo Metro)	369	10/3	24	1085	60.9	20	1067	38'10"	2'05"-3'10"	5'00"	34.4	1969	1979
	6. Yurakucho Line (Tokyo Metro)	400	10	28.3	752	164.3	24	1067	49'50"	2'30"-4'20"	6'00"	34.1	1974	1994
	7. Hanzoumon Line (Tokyo Metro)	250	10	16.8	570	253.9	14	1067	30'10"	2'15"-4'35"	7'30"	33.4	1978	2003
	8. Nanboku Line (Tokyo Metro)	126	6	21.3	202	242.6	19	1067	39'15"	4'00"-5'00"	6'00"	32.6	1991	2000
Tokyo Metropolitan Subway	9. Asakusa Line (Metropolitan Subway)	224	8	18.3	572	40.0	20	1435	34'30"	2'30"	5'00"-8'30"	31.8	1960	1968
	10. Mita Line (Metropolitan Subway)	222	6	26.5	468	79.1	27	1067	51'10"	2'45"-4'00"	6'00"	31.1	1968	2000
	11. Shinjuku Line (Metropolitan Subway)	224	8	23.5	595	204.3	21	1372	40'00"	2'30"-7'00"	4'30"-10'00"	35.3	1978	1989
	12. O-edo Line (Metropolitan Subway)	424	8	40.7	219	283.5	37	1435	81'10"	4'00"-5'00"	6'00"	30.1	1991	2000
Osaka	13. Midosuji Line (Osaka)	410	10	24.5	1258	59.1	20	1435	45'45"	2'00-2'30"	4'00"	32.1	1933	1987
	14. Tanimachi Line (Osaka)	246	6	28.1	514	85.2	26	1435	52'55"	2'30"-3'30"	5'00"	31.9	1967	1983
	15. Yotsuhashi Line (Osaka)	132	6	11.4	314	35.7	11	1435	21'40"	2'30"-3'30"	5'00"-6'00"	31.6	1942	1972
	16. Chuo Line (Osaka)	108	6	15.5	263	56.5	13	1435	26'25"	4'00"-5'00"	7'00"	35.2	1961	1986
	17. Sennichi-mae Line (Osaka)	68	4	12.6	197	62.6	14	1435	25'00"	3'45"-4'45"	7'00"	30.2	1969	1981
	18. Sakai-suji Line (Osaka)	136	8	8.5	328	365.2	10	1435	17'00"	2'45"-3'30"	5'00"	30	1969	1993
	19. Nagabori-Turumi Ryokuchi Line (Osaka)	100	4	15	150	208.7	17	1435	30'25"	3'00"-5'00"	7'00"	29.6	1990	1997
Nagoya	20. Higashiyama Line (Nagoya)	288	6	20.6	546	38.3	22	1435	37'30"	2'00"	4'00"	33	1957	1982
	21. Meijo Line/Meiko Line (Nagoya)	216	6	32.4	457	90.4	35	1435	48'10"	2'30"-3'00"	10'00"	32.8	1965	1971
	22. Tsurumai Line (Nagoya)	150	6	20.4	279	108.7	20	1067	35'30"	4'00"	7'30"	34.6	1977	1993
	23. Sakuradori Line (Nagoya)	100	5	14.9	241	235.7	17	1067	27'00"	4'00"-5'00"	7'30"	33.1	1989	1994
	24. Kami-Iida Line (Nagoya)	8	4	0.8	22	187.0	2	1067	1'30"	7'30"	10'00"	32	2003	2003
Sapporo	25. Nanboku Line (Sapporo)	142	6-8	14.3	235	47.8	16	–	26'30"	3'30"-5'30"	6'30"-7'00"	32.3	1971	1978
	26. Touzai Line (Sapporo)	182	7	20.1	216	120.9	19	–	34'00"	3'30"-5'00"	6'30"-7'00"	35.4	1976	1999
	27. Touho Line (Sapporo)	80	4	13.6	115	197.4	14	–	24'30"	2'30"-6'00"	7'00-7'30"	33.4	1988	1994
Yokohama	28. No.1 & 3 Line (Yokohama)	228	6	40.4	412	153.9	32	1435	66'00"	4'20"	8'00"	36.9	1972	1999
Kobe	29. Nishijin/Yamate Line (Kobe)	168	6	22.7	252	101.7	16	1435	31'40"	3'00"-6'00"	7'30"	43	1977	2001
	30. Kaigan Line (Kobe)	40	4	7.9	80	257.4	10	1435	14'00"	6'00"-7'30"	10'00"	32.9	1987	
Kyoto	31. Karasuma Line (Kyoto)	120	6	13.7	226	185.2	15	1435	26'30"	3'30"-5'00"	6'00"-7'30"	31	1981	1997
	32. Touzai Line (Kyoto)	84	6	15.1	118	287.0	15	1435	30'00"	5'00"-8'00"	7'30"	31.8	1997	
Fukuoka	33. Airport Line (Fukuoka)	144	6	13.1	296	178.3	13	1067	24'55"	3'00"-5'00"	7'30"	31.5	1981	1993
	34. Hakozai Line (Fukuoka)	(*2)	6	4.7	(*2)	(*2)	7	1067	10'05"	6'40"-7'30"	7'30"	28	1982	1986
	35. Nanakuma Line (Fukuoka)	68	4	12	–	193.9	16	1435	24'00"	4'00"-7'30"	7'30"	30	2005	
Sendai	36. Nanboku Line (Sendai)	84	4	14.8	166	140.9	17	1067	28'15"	3'00"-5'30"	7'00"	30	1987	1992

Source : Japan Subway Association
Notes
(*1) Conversion Rate 1 US$ = 115 yen
(*2) Included in Airport Line





Source: HAIDEP Study Team

Table 6.3.13 Railway Project Cost in Other Countries (1/2)

Overseas Railway Projects

Country	Project Name	Main Components	Total Length (km)	Construction Perod			Cost (million US$)									Remarks
				Start	End	Months	Land	Civil	M & E	R/S	Eng	Others	Total	Civil/km	Total/km	
China	Nunning - Kunming Railway	Single track railroad 898km including 95 stations, 263 tunnels (195.33km), 463 bridges (72.014km), 2631 culverts (61.983km), track bed (101.74 million m3)	898	1990/10	1997/12	87							3,062.1	0.0	3.4	JBIC Actual
China	Beijing Subway Phase 1 (Fuxingmen - Xidan)	1.8km long extension of East-West Subway Line including construction of Xidan Station, excluding rolling stock and consulting services	1.8	1988/01	1992/09	57							137.8	0.0	76.6	JBIC Actual
China	Beijing Subway Phase 2 (Xidan - Sihuidong)	11 km extension of East-West Subway Line including 10 stations, depot 274,000m2, 174 cars	11	1992/01	2000/06	102							945.8	0.0	86.0	JBIC Actual
China	Beijing Subway No. 10 Line, Olympic Branch Line		4.34										181.5	0.0	41.8	
China	Beijing Subway No. 10 Line		33										1,904.3	0.0	57.7	
China	Beijing Subway No. 4 Line		28.14										1,884.3	0.0	67.0	
China	Shanghai No.1 Subway Line (Shanghai Raiway St. - Jinjiang Playground	16.1km long including 13 stations (avg. 20 - 24m wide x 230m long with 2 levels), mostly by shield tunnelling machine (inner radius 5.5m). Double track 10.02km (9.27km Cylindrical, 0.75km rectangular).	16.1	1990/01	1995/04	63							300.0	0.0	18.6	Budget
China	Nanjing Subway No. 1 Line		43.44	2000/12	2005/09								883.7	0.0	20.5	
China	Wuhan Subway No. 1 Line		10.23										278.3	0.0	27.2	
Hong Kong	KCRC Tai Lam Tunnel	Railway Tunnel (Section 110m2 NATM x 5480m Long)	5.48		2002			218.3					218.3	39.8	39.8	Nishimatsu Contract
India	Calcutta Metro Railway (Dum Dum to Tollygunge)	Cut & Cover Metro Railway 16.43km long including 17 stations (15 underground, 1 elevated, 1 on surface)	16.43	1983/09	1996/06	155							1,090.1	0.0	66.3	
India	Calcutta Metro Railway (Tollygunge to Garia)	Extension to south. Mostly elevated.	8.7	1999									197.2	0.0	22.7	Kolkata Metro
India	Calcutta Metro Railway (Rajarhat2 to New Dansnagar)	Shield tunnel 6.15km, elevated viaduct 10.29km and access section of cut & cover tunnel and retaining walls 1.18km with 17 stations (8 underground, 1 elevated), 2 depots, 48 rolling stocks.	23.8			60	21.0	363	118.0	73.0	35.0		911.0	23.0	38.3	JETRO F/S, (without contingency)
India	Calcutta Extension of Circular Railway (Princepghat to Majerhat)	Total 5.8km, 3.2km elevated, 2.6 km at-grade	5.8										25.0	0.0	4.3	Kolkata Metro
India	Kolkata (Dum Dum Cantonment to N.S.B. Airpot	Total 4km, mostly elevated	4										13.5	0.0	3.4	Kolkata Metro
India	Delhi Metro Railway Line No. 2, MC1A Section (Vishwa Vidyala - ISBT)	Cut & Cover Metro Railway 4.5km long including 4 underground stations and 434m long depot	4.5	2001/05	2005/07	51		222.3					222.3	49.5	49.5	Kumagai Contract
India	Delhi Metro Railway Line No. 2, MC1B Section	7km long cut & cover and shield tunnel including 6 underground stations	7	2001/05				0.0					0.0	0.0	0.0	Shimizu Contract
Singapore	LTA Contract 708	Subway (Station: 33m wide x 204m long x 22.5m deep, EPB/Open faced shield tunnel: Inner dia. 5.8m x 3098m long)	3.098		2000			101.7					101.7	32.8	32.8	Nishimatsu Contract
Singapore	MRT Contract 301	Subway (EPB shield tunnel: Inner dia. 5.3m x 2588m long, 2 underground stations)	2.588		1989			140.0					140.0	54.1	54.1	Nishimatsu Contract
Singapore	MRT Contract 107B	Subway (Open faced shield/ NATM tunnel: inner dia. 5.3m x 820m long, underground stations with 3 floors)	0.82		1987			60.8					60.8	74.2	74.2	Nishimatsu Contract

Source: HAIDEP Study Team

Table 6.3.13 Railway Project Cost in Other Countries (2/2)

Country	Project Name	Main Components	Total Length (km)	Construction Perod			Cost (million US$)									Remarks
				Start	End	Months	Land	Civil	M & E	F/S	Eng	Others	Total	Civil/km	Total/km	
Thailand	Bangkok	Approx. 20km long	20	1998	2005								3,440.0	0.0	172.0	
Thailand	Bangkok Blue Line (Bang Sue - Tha Phra Section)	Elevated 13.1km long with 7 elevated stations	13.1				9.3	269.7	186.0		8.2		473.2	20.6	36.1	Estimated
Thailand	Bangkok Blue Line (Hua Lum Phong - Bang Khae Section)	14.0km long (Elevated 8.9km + Underground 4.9km) with 4 underground stations and 8 elevated stations	13.9				83.3	647.6	183.2		37.9		952.0	46.6	68.5	Estimated Mass Rapid Transit Authority (MRTA)
Thailand	Bangkok Orange Line (Bang Kapi - Bang Bumru Section)	24km long (Elevated twin-track viaduct 2.9km + Underground twin tunnel 21.1km) with 17 stations (14 underground, 3 elevated)	24				105.4	1,101.7	346.4		31.5		1,585.0	45.9	66.0	Estimated Mass Rapid Transit Authority (MRTA)
Thailand	Bangkok Purple Line (Bang Yai - Rat Burana Section)	40km long (Elevated twin-track viaduct 25.8km + Underground twin tunnel 14.21km) with 30 stations (11 underground, 19 elevated) & Depot for 500 cars	40				97.1	1,334.9	575.6		38.6		2,046.2	33.4	51.2	
Thailand	Bangkok New Airport Line Phase 1 (Phaya Thai - Prachongkrao - SBIA)	Mostly elevated. SBIA station will be undeground	28				0	398	145.35	216.8	0	43.05	761.2	14.3	27.2	JETRO F/S
Thailand	Eastern Seaboard Development Plan Railway (Sattahip - Map Ta Phut)	24km long track construction including signaling system & communication system	24	1992/05	1995/04	35							60.4	0.0	2.5	JBIC Actual
Thailand	Eastern Seaboard Development Plan Railway (Klong Sip Kao - Kaeng Khoi)	82.42km long track construction including signaling system & communication equipment	82.42	1993/04	1997/10	54							129.7	0.0	1.6	JBIC Actual
Thailand	Sriracha - Laem Chabang Railway	9.3km long single track construction including marshalling yard (4 lines total 5.1km), communication system, signal, lighting system, maintenance building & drainage system	9.3	1991/06	1994/04	34							20.9	0.0	2.2	JBIC Actual
Vietnam	Ho Chi Minh City UMRT Line 1 (East Section)	Total Length of14km (Underground 3.8km, Elevated 2.0km, at-grade 8.2km) with 8 stations (4 underground, 1 elevated, 3 at-grade)	14			36		222	104.8	126.5		45.3	498.6	15.9	35.6	F/S Japan Railway Technical Service (w/o contingency)
United Kingdom	Dockland Light Railway Lewisham Extension	Railway Tunnel (Slurry shield tunnel: Inner dia. 5.2m × 1080m long x 2 lines	1.08		2000			76.5					76.5	70.8	70.8	Nishimatsu Contract
Australia	New Metro Rail. Doubling Transperth's Rail Network (Total)	Total 81.5km, including 15 stations, shield tunnel, bridges & structures, at-grade, depot (8ha), 98 railcars, etc.	81.5										1,078.4	0.0	13.2	
Australia	New Metro Rail. Doubling Transperth's Rail Network (Package F :TBM Section)	φ6.9m Twin TBM.	0.77	2005/10									244.4	0.0	317.5	Kumagai Contract
Japan	Kawsaki Urban Rapid Transit (Shin Yurigaoka - Moto Sumiyoshi) Phase 1	15.6 km Tunnel (NATM, Shield 10m outer dia for double track, 7m outer dia for single track) with partly at-grade track ne Shin Yurigaoka including 10 stations (1 at-grade, 9 underground)	15.6		2011		192.2	2,781.7		79.1	88.7	568.7	3,710.4	178.3	237.8	Budget
Japan	Kawsaki Urban Rapid Transit (Moto Sumiyoshi - Kawasaki) Phase 2	Under planning	6.2		2015								1,685.2	0.0	271.8	Budget
Japan	Sendai East-West Line (Yagiyama Zoo - Arai) (Linear Motor Car)	13.9km mostly shield tunnel (Inner dia. 4.8m), partly NATM and bridge for river crossing with 13 Station, depot (6ha). Linear motor car.	13.9	2003	2014								2,378.3	0.0	171.1	Budget
Japan	Yokohama Subway No. 4 (Nakayama - Hoyoshi) (Linear Motor Car)	Total 13.1 km (tunnel 10.7km, above ground 2.4km) with 10 stations (7 underground, 3 above ground), depot (8ha)	13.1	2001/01	2007/01	73	260.9	1,054.8	615.7			251.3	2,182.6	80.5	166.6	Budget
Japan	Osaka Subway No. 8 (Itakano - Imasato) (Linear Motor Car)	Total 12km (cut & cover and shield tunnel: outer dia 5.3m) with 11 stations														

Source: HAIDEP Study Team

6.4 Operations and Maintenance Cost

These O & M costs have been estimated for Phase I, Tu Liem to Thanh Xuan and Phase 1a Tu Liem to Bach Khoa in 2020 and Phase 4, the complete system, from Noi Bai International Airport to Ha Dong in 2020 and 2040.

1) Basic Assumptions

(i) The costs are expressed at July 2006 prices (except where otherwise stated).

(ii) Manpower numbers are based on staffing on similar transit systems in Hong Kong, Singapore and the Philippines.

(iii) Manpower costs are an average at US$5,700 per year, per member of staff.

(iv) Energy consumption and costs have been estimated under three headings: stations (auxiliaries and environmental control systems); traction (train operation), and depot.

(v) Energy consumption of rolling stock, has been based on similar rolling stock and station spacing used on transit systems elsewhere and is assumed at 2.2 kwh/car-km. It assumes the headways and service requirements indicated in the Rail Operation Plan.

(vi) Annual energy consumption at underground stations has been assumed at 5,000 Mwh and at grade/elevated station at 2,250 Mwh.

(vii) Annual energy consumption at Tu Liem Depot which includes the Workshop, Administration Building and Operations Control Center has been estimated at 15,000 Mwh and at the two subsidiary depots in Thai Phu and Ha Dong at 6,000 Mwh.

(viii) The energy costs have been calculated using a tariff plus other charges of US$ 0.055 per kwh.

(ix) Train maintenance costs have been based on a staff requirement of 0.7 staff per car in the fleet. Annual cost of consumable materials, spares, stores and any contracted out work has been estimated at around 1% of the capital cost of the rolling stock.

(x) The number of infrastructure maintenance staff, while varying depending on system type (whether underground, elevated, or at grade) and in complexity, has been estimated at 10 staff per route kilometer. Annual cost of consumable materials, spares and stores etc. has been estimated at around 0.5% for E & M systems and 0.1% for civil works, of capital costs.

(xi) Capital spares, example rolling stock car bogies, traction motors etc. are assumed to be part of construction and supply contracts.

(xii) No account has been taken of asset depreciation. Note that for rolling stock for example a life of 35 to 40 years has been assumed and replacement rolling stock would not be needed by 2040.

(xiii) Functions such as station and train cleaning, and some aspects of maintenance eg. lifts and escalators, are often outsourced. A notional 10% of the direct staff cost has been assumed for indirect staff costs.

(xiv) It is assumed that security of the railway is the responsibility of the local police authority.

(xv) Insurance for the railway and domestic taxes, will need to be covered. A notional 3% of total cost has been assumed.

(xvi) To take account of management and administration of the railway including functions such as personal, finance, marketing, legal and contractual, a 15% increase in the number of direct staff has been included.

(xvii) There will inevitably be some costs not covered under specific headways. A notional 5% of total cost has been assumed to cover miscellaneous items.

Table 6.4.1 Staff Costs Assumption

Staff	Staff Numbers/Cost			
	Phase 1a 2020	Phase 1 2020	Phase 4 2020	Phase 4 2040
	No	No	No	No
Train Operators	52	68	136	188
Train Staff Supervisors	4	6	12	16
Station Manager	8	8	16	16
Station Supervisor	44	56	112	112
Station Staff	132	168	308	336
OCC Staff	16	16	16	16
Train Maintenance	59	76	155	214
Infrastructure Maintenance	113	150	312	417
Mgt, Admin Support Staff at 15%	64	82	160	197
Total (US$ millions)	492	630	1227	1512
Average Staff Rate (US$)	5,700			
Cost (million US$)	2.8	3.6	7	8.6

Source: HAIDEP Study Team

2) O&M Cost Estimate

Based on the above assumption, the following table details the O&M cost of UMRT Line 2.

Table 6.4.2 Operations and Maintenance Costs

Item	Cost US$ Millions			
	Phase 1a 2020	Phase 1 2020	Phase 4 2020	Phase 4 2040
Staff Cost (Direct)	2.8	3.6	7	8.62
Staff Cost (Indirect)	0.28	0.36	0.7	0.86
Energy	4.8	6	9	11
Spares	2.5	3	5.5	5.5
Insurance/Taxes	0.31	0.39	0.67	0.78
Miscellaneous	0.52	0.65	1.11	1.3
Total	11.21	14	23.98	28.06

Source: HAIDEP Study Team
Note: In US$ million at July 2006 prices.

If O&M activities require outside assistance due to insufficient local skills and experience, there will be an associated cost for expatriate expertise. In this case an additional cost of US$5 million should be added to the total cost.

7 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

7.1 Overview

The Urban Mass Rapid Transit Line 2 Transit (UMRT Line 2) Project is a priority project of the National Government to increase the public transport capacity of Hanoi. Its objective is to decongest traffic and improve public transport in Metro Hanoi. By linking the UMRT Line 2 with other proposed UMRT and public transport projects will complete the public transport loop of the capital's urban mass rapid transit system.

The UMRT Line 2 will increase the transport capacity of the important north-south public transport corridor and provide a faster and more convenient means of public transport. Currently, the Hanoi bus system can carry about 3 to 6% of the daily trips into Hanoi. The UMRT Line 2 will be designed to carry more than 20% of the corridor traffic by 2040. However, the UMRT Line 2 will have its own effects on the surrounding environment (air, water, soil, etc.) as well as issues on its social acceptability. Noteworthy is that majority of the effects will be positive.

For example, the UMRT Line 2 is one mode that does not contribute to the already alarming levels of air and noise pollution along the route alignment. Moreover, it can serve as a catalyst in changing the urban landscape. That is, with CBD-bound commuters patronizing the UMRT Line 2, the Ancient and French quarters of the city can still find room to avoid choking from traffic congestion and to grow 'vertically' instead of sprawling development of new satellite CBDs.

Along the UMRT Line 2's route, urban renewal into higher density property developments around the passenger stations is a possibility.

An environmental overview of the project was conducted to characterize the environmental conditions along the proposed route alignment. The results of the assessment guided the study team to come up with a conceptual design in consonance with an environment-friendly program that not only preserves the integrity of the existing environment but also enhances its assets and promotes the improvement of the environmental quality of the project's area of influence.

Both positive and negative effects on the environment were identified. For the adverse environmental effects, mitigation measures were recommended, most of which are incorporated in the conceptual designs of the UMRT Line 2.

It is to be noted that this overview is not a detailed Environmental Impact Statement (EIS) by itself, but only a characterization of the environmental landscape of the project area.

This chapter discusses the findings of this initial study. Vietnam environmental laws would ultimately require the submission of an EIS formatted to international specifications. The EIA will be a detailed discussion of the environmental overview of what is outlined in this report and the latter part of this chapter will be devoted to an implementing strategy of preparing an EIA and complying with the environmental laws of Vietnam.

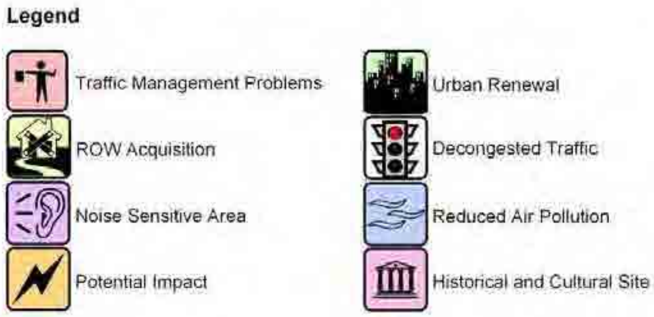
7.2 Physical Environmental Setting

At the conceptual design and planning stage of project development, the environmental overview was performed which entailed technical review of secondary data, consultation meetings with Study Team, local agencies, and field ocular inspection of the project area. These activities generated sufficient data that provided the basis to establish baseline environmental information of the existing physical, ecological, social resources and values at the general location of the project area. The probable influence area of the project is also provisionally established. Key environmental and social considerations were then identified.

A reconnaissance survey of the UMRT Line 2 project's proposed alignment was conducted to characterize its immediate vicinity and to identify the potential assets and constraints that will have to be considered in pursuit of the preferred development scheme.

The existing condition of the physical and ecological resources and values within the general location of the project site is described in the succeeding tables and figures.

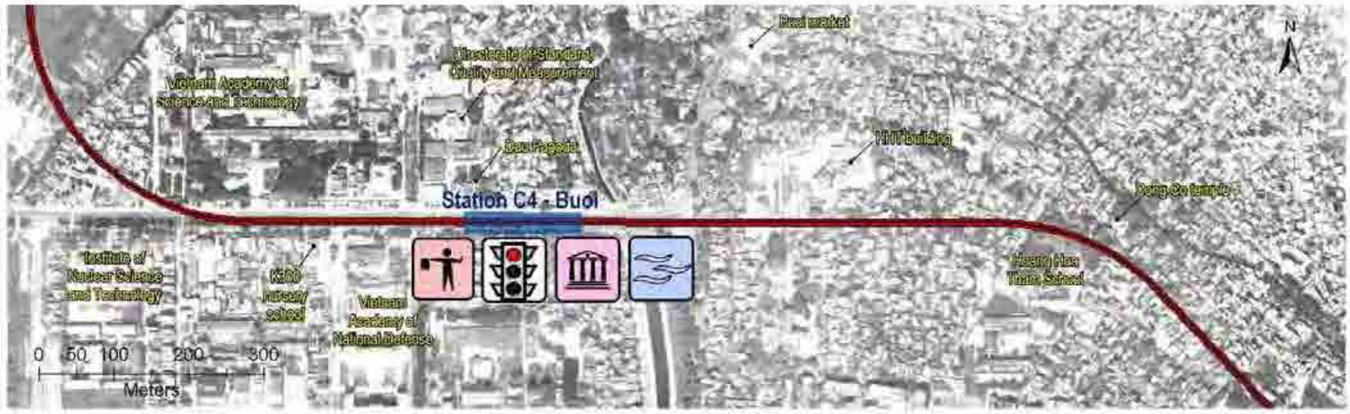
Figure 7.2.1 Environmental Consideration at the Tu Liem Station Section

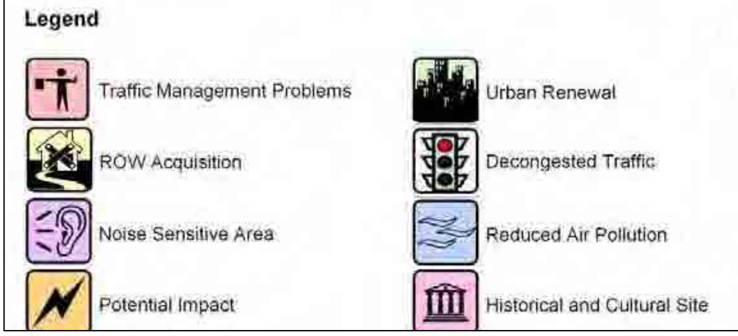


Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
Land use changes	Encourage commercial development in the vicinity Encourage transport infrastructure development in the vicinity
Proposed new urban area and road	
ROW acquisition for station area	Formulation and prompt implementation of appropriate RAP

Source: HAIDEP Study Team

Figure 7.2.2 Environmental Consideration at the Buoi Station Section

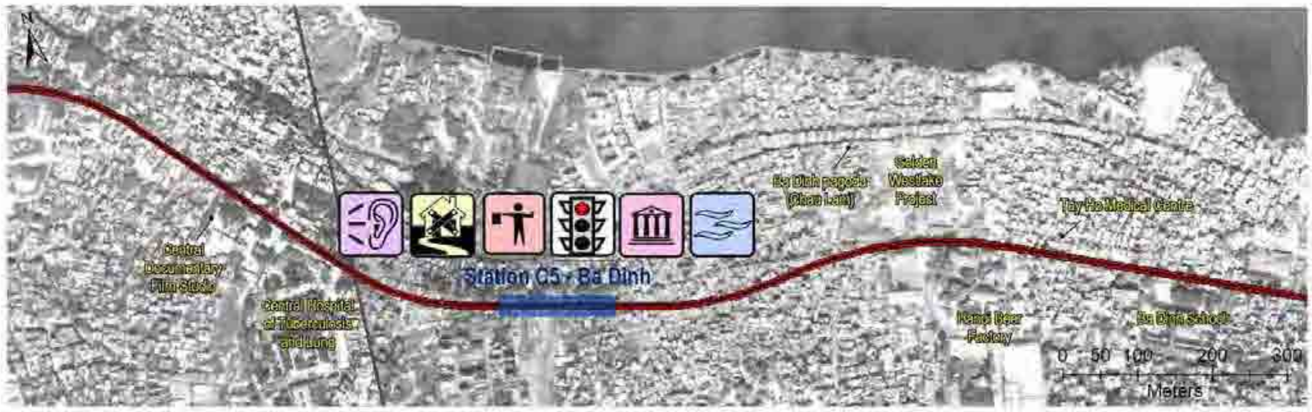




Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Dau Pagoda and Dong Co temple	Noise barrier during construction phase
Buried Thang Long ancient wall remains	Needs further study
Visual intrusion	Underground station

Source: HAIDEP Study Team

Figure 7.2.3 Environmental Consideration at the Ba Dinh Station Section



Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Row acquisition (Involuntary Resettlement)	Formulation and prompt implementation of appropriate RAP
Buried Thang Long ancient wall remains	Needs further studies
Interface with UMRT line 3B (BRT)	Factor in UMRT line 3B in station design

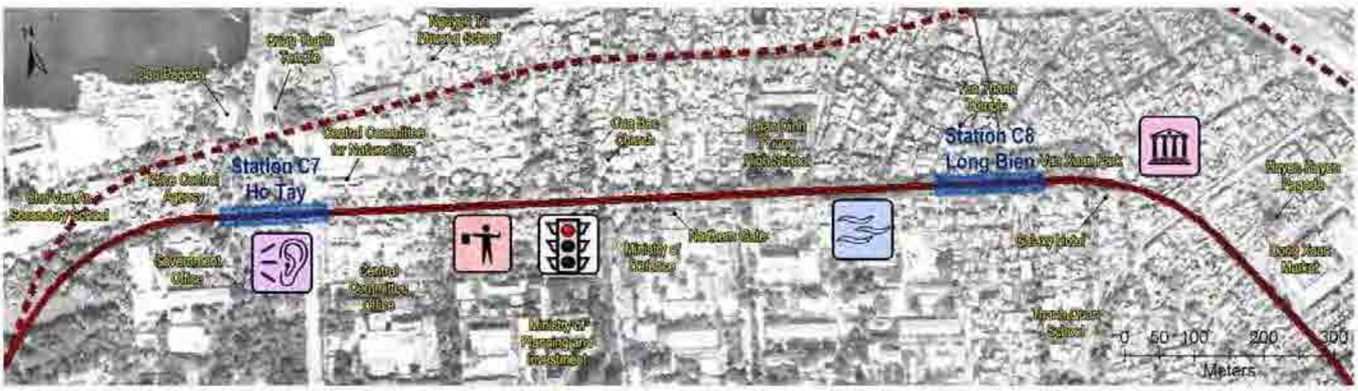
Source: HAIDEP Study Team

Figure 7.2.4 Environmental Consideration at the Bach Thao Station Section

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Row acquisition	Formulation and prompt implementation of appropriate RAP
Buried Thang Long ancient wall remains	Needs further studies

Source: HAIDEP Study Team

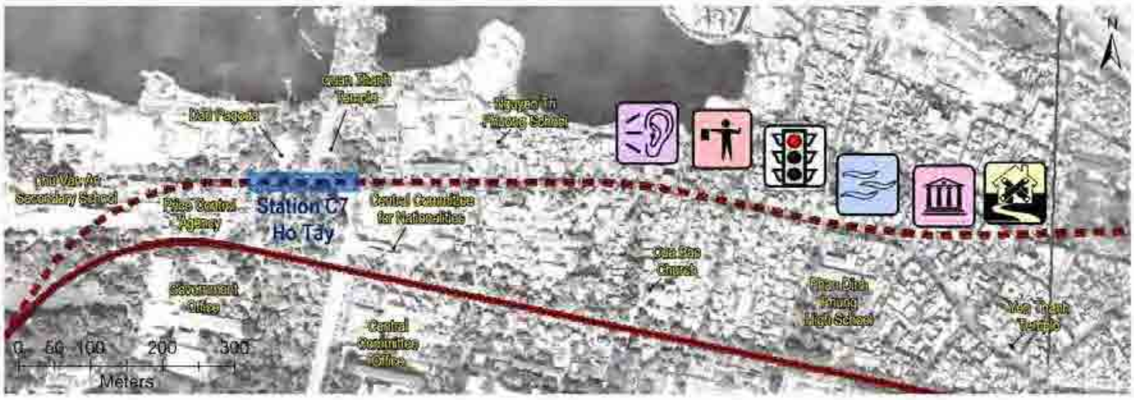
Figure 7.2.5 Environmental Consideration at Ho Tay Station (1) & Long Bien Station (1) Section



Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Visual intrusion	Design review
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Interface with UMRT line 1 and VR	Factor in UMRT line 1 in station design

Source: HAIDEP Study Team

Figure 7.2.6 Environmental Consideration at the Ho Tay Station (2) Section



Legend

- Traffic Management Problems
- ROW Acquisition
- Noise Sensitive Area
- Potential Impact
- Urban Renewal
- Decongested Traffic
- Reduced Air Pollution
- Historical and Cultural Site

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Visual intrusion	Design review
Residential area may be effected by tunnelling	Compensation plan (RAP)

Source: HAIDEP Study Team

Figure 7.2.7 Environmental Consideration at the Long Bien Station (2) Section

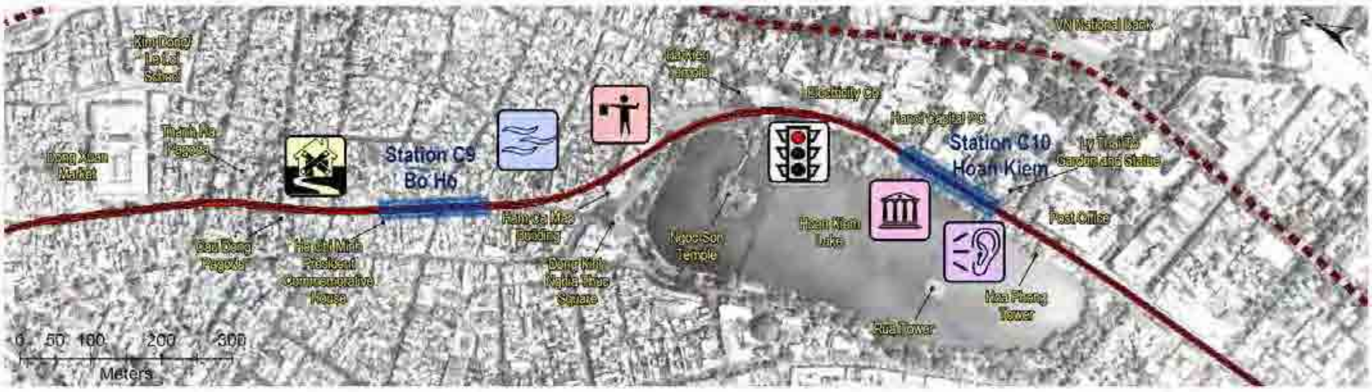
Legend

- Traffic Management Problems
- ROW Acquisition
- Noise Sensitive Area
- Potential Impact
- Urban Renewal
- Decongested Traffic
- Reduced Air Pollution
- Historical and Cultural Site

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Visual intrusion	Design review
Residential area may be effected by tunnelling	Compensation plan (RAP)
Interface with Long Bien Railway station	Factor in LB RS in station design
Dyke protection zone	Coordinate/consultation with Dyke Protection Agency (DPA)
Vinh Ninh deep fault existing parallel with Red River. Dike edge strips of land near to the Red River have the biggest potential of liquefaction.	Route alignment design review. Better to avoid locations near to the Red River dike systems.

Source: HAIDEP Study Team

Figure 7.2.8 Environmental Consideration at the Bo Ho (1) and Hoan Kiem (2) Station Section



Legend

- Traffic Management Problems
- ROW Acquisition
- Noise Sensitive Area
- Potential Impact
- Urban Renewal
- Decongested Traffic
- Reduced Air Pollution
- Historical and Cultural Site

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Row acquisition (Involuntary Resettlement)	Formulation and prompt implementation of appropriate RAP
Ancient Quarter	Needs further studies
Ho Chi Minh president commemorative house	Station design review
Interface with Airport express	Factor in AE in station design
Hoan Kiem Lake may be affected by underground railway works	Needs further studies
Visual intrusion	Design review

Source: HAIDEP Study Team

Figure 7.2.9 Environmental Consideration at Chuong Duong (2) & Hoan Kiem Station (2) Section

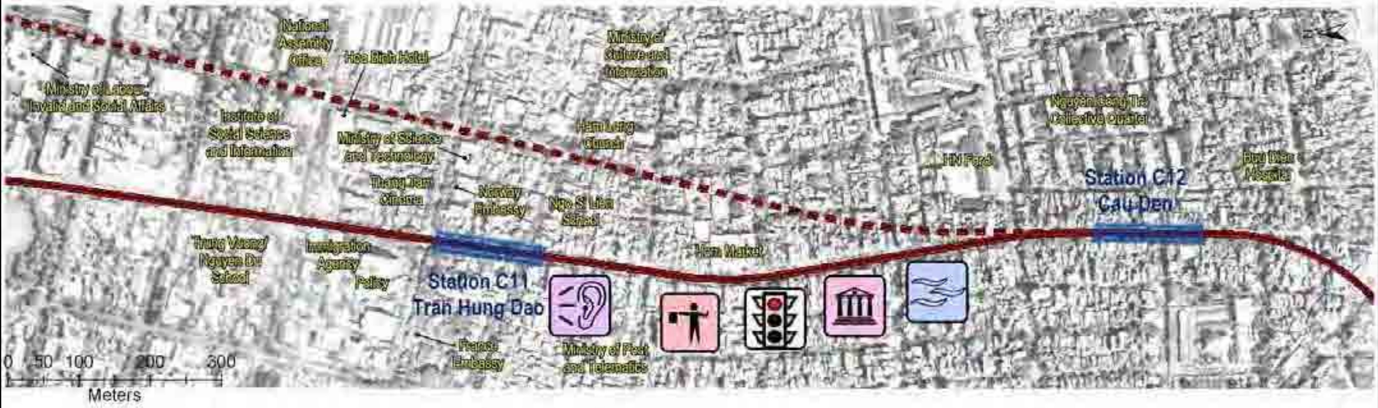
Legend

- Traffic Management Problems
- ROW Acquisition
- Noise Sensitive Area
- Potential Impact
- Urban Renewal
- Decongested Traffic
- Reduced Air Pollution
- Historical and Cultural Site

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Noise	Noise barrier during construction
Residential area may be effected by tunnelling	Compensation plan
Ancient Quarter	Needs further studies

Source: HAIDEP Study Team

Figure 7.2.10 Environmental Consideration at the Tran Hung Dao (1) & Cau Den Station Section



Legend

- Traffic Management Problems
- ROW Acquisition
- Noise Sensitive Area
- Potential Impact
- Urban Renewal
- Decongested Traffic
- Reduced Air Pollution
- Historical and Cultural Site

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Interface with UMRT line 3a	Factor in UMRT line 3a in station design
Visual intrusion	Design review

Source: HAIDEP Study Team

Figure 7.2.11 Environmental Consideration at the Tran Hung Dao (2) & Cau Den Station Section

Legend

- Traffic Management Problems
- ROW Acquisition
- Noise Sensitive Area
- Potential Impact
- Urban Renewal
- Decongested Traffic
- Reduced Air Pollution
- Historical and Cultural Site

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Residential area may be effected by tunnelling	Compensation plan
Interface with UMRT line 3a	Factor in UMRT line 3a in station design
Visual intrusion	Design review

Source: HAIDEP Study Team

Figure 7.2.12 Environmental Consideration at the Bach Khoa Station Section

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Residential area may be effected by tunnelling	Compensation plan
Interface with UMRT line 1, VR and Kim Lien underpass	Factor in UMRT line 1, VR and KL in station design
	Station location review
Visual intrusion	Design review

Source: HAIDEP Study Team

Figure 7.2.13 Environmental Consideration at the Chua Boc Station Section

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Residential area may be effected by tunnelling	Compensation plan
Noise	Noise barrier during construction

Source: HAIDEP Study Team

Figure 7.2.14 Environmental Consideration at the Nga Tu So and Thuong Dinh Station Section

Environmental and Social Considerations	Possible Mitigating/Enhancement Measures
Construction disturbance	Use of proper construction techniques and methods
	Prepare and implement a traffic management plan
Land use changes	Encourage commercial development in the vicinity
	Encourage transport infrastructure development in the vicinity
Traffic congestion	Decongestion measures
Noise	Noise barrier during construction
Interface with UMRT line 4 and Nga Tu So overpass	Factor in UMRT line 4 in station design
	Station location review

Source: HAIDEP Study Team

7.3 Key Findings

(a) **Project Location:** The UMRT Line 2 proposed project is located in an area with rapid urbanization. It has a great role in facilitating the expansion of Hanoi City to the northern part of Red River, improving the transport system and reducing traffic jam in Hanoi urban districts thereby promoting economic growth in the region.

(b) **Environment at Project Area:** Current status of the environment at the project site is degraded by high noise level, concentration of suspended particulate matters, those often exceed Vietnam's permissible standards, and by the pollution of most surface water bodies and ground water in some places. Although biodiversity of the region is low, there exist some precious biological species.

(c) **Environmental Impacts:** The major negative environmental impacts of the proposed project are as follows:

(i) Resettlement, land acquisition, and demolition of some parts in the ancient quarter if the cut and cover method is implemented, are the most significant negative impacts.

(ii) A number of negative impacts on physical environment are expected in the construction phase, such as vibration, noise, air pollution, water pollution, erosion and sedimentation; negative environmental impacts associated with temporary roads, stockpiles, etc. However, most of these impacts are temporary and can be mitigated.

(iii) There exist some expected significant but unknown negative impacts, impacts of construction works to Hoan Kiem lake ecosystem; effect of the project on underground buried historical remains, etc. that need more detail study in the FS phase.

(d) **Next Step:** A full EIA in the feasibility study phase is important and necessary.

8 IMPLEMENTATION PLAN

8.1 Outline

In the implementation of UMRT 2, the basic context is that the financial analysis clearly demonstrates the weak financial state of UMRT 2 despite the undeniable economic impact and strategic value of the project. Another key aspect is maximizing the economic impact of UMRT 2 through integrated urban development.

The organization and funding of UMRT 2, which are two interrelated implementation issues, would therefore need to be carefully and strategically approached by taking account of the involvement and the roles of key stakeholders, including the private sector, local governments, central government, and donors.

To address these issues, this chapter examines relevant organizational models of urban rail development in Asia and identifies a recommendable approach for UMRT 2. Funding sources are also preliminarily identified in conjunction with the proposed organizational setup.

8.2 Project Implementation Issues

1) Implementation Agencies

One of the critical issues in the project implementation is to consider what kind of institutional and organizational set up the development of the UMRT Line 2 system would require. The progress of the development of the UMRT Line 1 of the HCMC, which precedes the UMRT Line 2 of the Hanoi PC, should give good guidance in this respect.

In the project implementation, funding should play an important role. Based on the fact that ODA funding is being contemplated for the initial investment of the project, the treatment of the ODA funding would become one of the deciding factors when the organizational set-up is considered.

As illustrated in the Figure 8.2.1, the organizational set up could have two extreme cases when the treatment of the ODA funding is considered. One extreme case is the option for which all the responsibility regarding the ODA funding is assumed by the Vietnamese Government. The other option is the Hanoi PC will shoulder all the risks including the repayment of ODA loan. There could be a variety of options in between these two cases depending on the degree of risk-sharing between the Vietnamese Government and the Hanoi PC.

Figure 8.2.1 Variety of Implementation Options

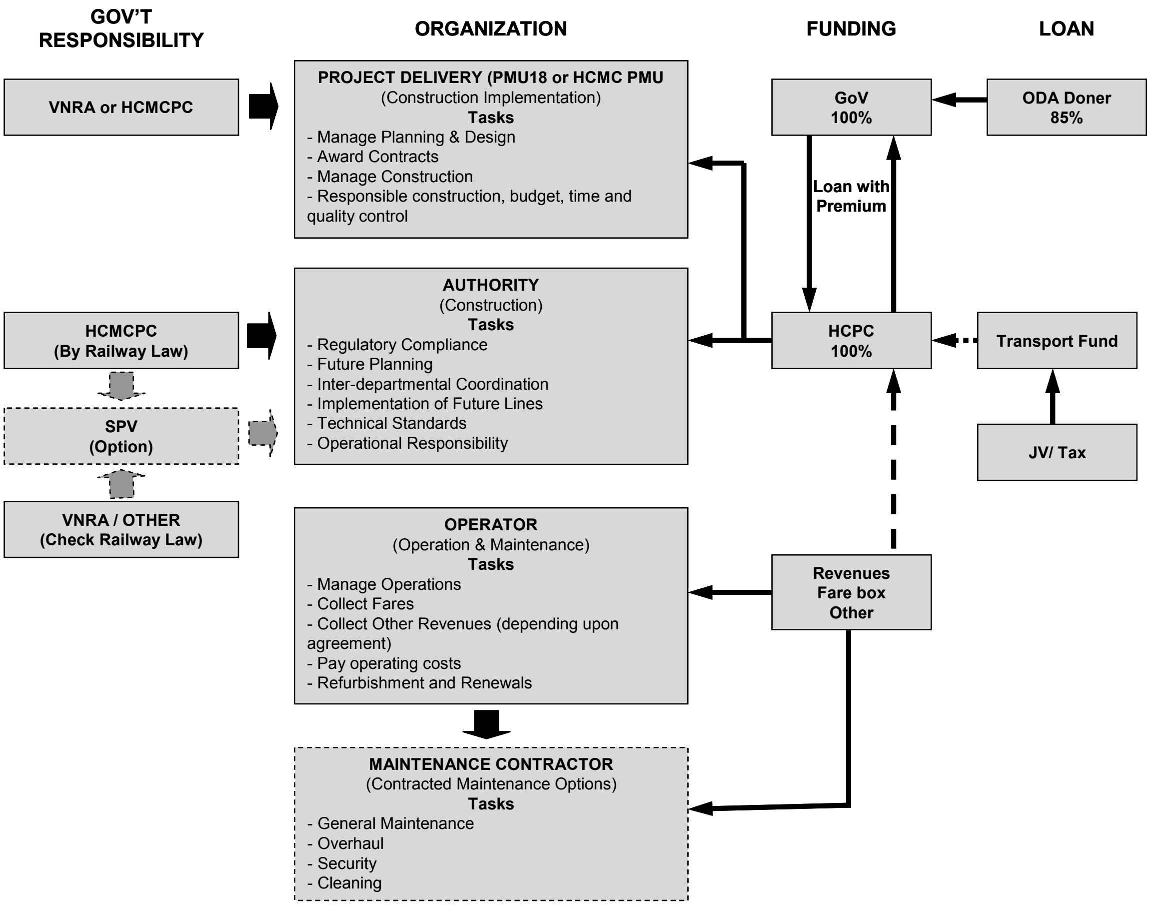
ELEMENTS				OPTION **A**	OPTION **B**	● ● ● ● ● ● ● ● ● ● ●	OPTION **Y**	OPTION Z
INITIAL INVESTMENT	ODA	ENTITY		**MOF/MPI (MOT)**				**HPC (RELENDING)**
	ODA	REPAYMENT		**MOF (NO RELENDING)**				**HPC (RELENDING)**
	CONSTRUCTION	INFRASTRUCTURE	ENTITY	**PMU(MOT)**				**HPC**
	CONSTRUCTION	INFRASTRUCTURE	OWNERSHIP	**VRA**		OPTION VARIATION		**HPC**
	CONSTRUCTION	ROLLING STOCK	ENTITY	**PMU(MOT)**				**HPC**
	CONSTRUCTION	ROLLING STOCK	OWNERSHIP	**VRA**				**HPC**
	LOCAL PORTION	ROW		**MOT**				**HPC**
	LOCAL PORTION	OTHER		**MOT**				**HPC**
OPERATION	ENTITY			**SOE(HPC)**				**SOE(HPC)**
	CASH FLOW SHORTAGE RISK	REPAYMENT FOR CAPITAL COST		**MOF/MPI**				**HPC**
	CASH FLOW SHORTAGE RISK	O&M COST		**SHARED (MOT/HPC)**				**SOE(HPC)**

Source: HAIDEP Study Team

Based on the progress of the development of the UMRT Line 1 of the HCMC, the following is the basic implementation set up which is being discussed as of June 2006, in the course of the JBIC SAPROF Study. However, the details of risk sharing as illustrated in the above figure, is still a subject for future discussion among the stakeholders.

It is also proposed in the HAIDEP Master Plan that the Hanoi Public Transport Authority (HPTA) will be created for the operation of the UMRT Line 2 system. The necessity of such institutional set up would be further looked into in succeeding sections.

Figure 8.2.2 Implementation Setup for the UMRT Line 1 of HCMC



Source: JBIC HCMC-UMRT SAPROF Study Team.

2) Competitive Costs for Both Users and the Government

One of the key aspects to the development of the UMRT Line 2 is Technical Competitiveness, i.e. to develop efficient operation and management system at competitive costs for both users and the government.

In order to attain the competitive costs for both users and the government, the following elements should be taken into consideration:

(i) Competitive procurement in both the construction of the infrastructure and in the purchase of the rolling stock;

(ii) Competition or appropriate benchmarking in the operation and management of the UMRT Line 2 system;

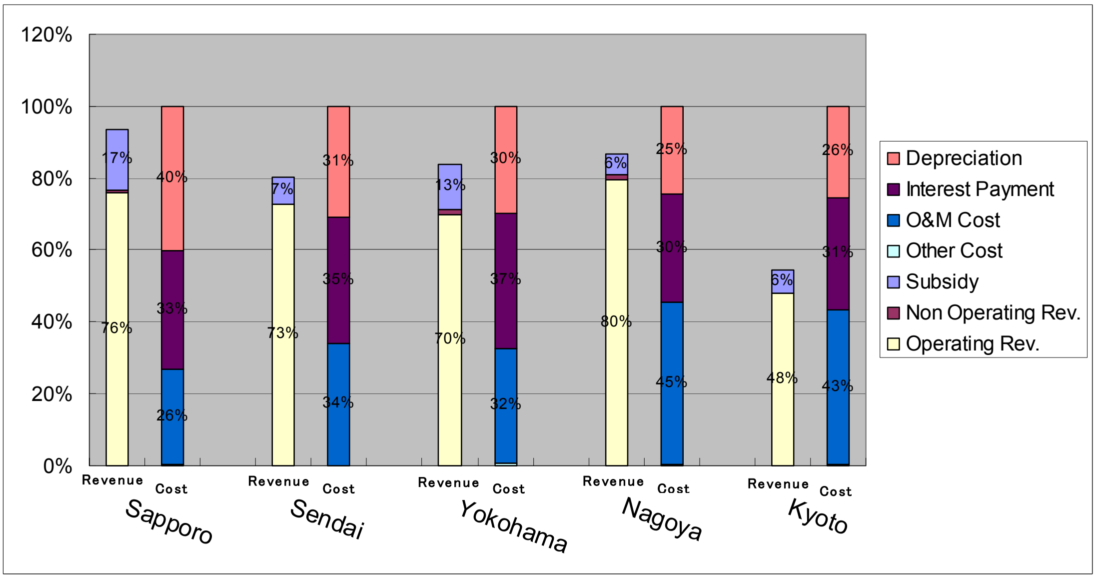
(iii) Affordable fare setting and sustainable funding mechanism to mitigate the risk of fund shortage; and

(iv) Alternative funding sources for both the initial investment and the operation.

Even though the Metro systems in Japan are generally developed with grants from the government of about 50 to 60% of the initial investment on the average, their revenue barely covers the cost of O&M and the interest payment. The revenue is usually not enough to cover the depreciation. This kind of cost and revenue profile is common among the urban rapid transit systems throughout the world.

It is very likely that the UMRT Line 2 will face the same kind of financial problem. Therefore it would be essential to consider the sustainable funding mechanism and alternative funding sources to support the UMRT Line 2 operation.

Figure 8.2.3 Comparison of Cost and Revenue for the Metro Systems in Japan



Source: Profit and Loss Statements of each system, 2004 or 2005

3) Land Acquisition

The right of way for the UMRT Line 2 development should be within public land as much as possible to minimize the cost required for land acquisition. There needs to be a new set of rules in compensation and land right treatment for both the underground and the elevated portion of the UMRT Line 2 system. The land readjustment mechanism may also be required to coordinate land owners in order to create the necessary land area for the integrated urban development in the vicinity of UMRT stations.

4) Integrated Urban Development

There have been various laws enacted that relate to urban development. However, the supporting decrees and circulars have not yet been prepared. Therefore, a mechanism which controls effectively the development in the urban area in accordance with the soundness and the needs of the government has not yet been instituted.

Issues with regards to the integrated urban development are the following:

(i) Major area of the UMRT route is located within development controlled districts such as the Ancient Quarter, Hong Kiem Lake District and the French Quarter.

(ii) Grand design and commonly agreed detailed plan of urban functions along the UMRT route and its vicinity do not exist.

(iii) Majority of the UMRT route is underground and the function of the UMRT stations in terms of urban development is rather limited.

(iv) The land price of the areas along the UMRT route is very high, and maybe too high to justify the reasonable floor price in the market when the land is newly acquired for the purpose of development. Therefore the potential land available for the commercial and residential development may be limited to the following land categories in the condition of joint venture arrangement with current land owners (the government agencies and SOEs):

- Industrial/ factory land to be relocated away from the urban area;
- Old housing development done by SOE housing developers for relocation;
- Government offices for relocation;
- Educational institutions for relocation.

5) Legal Constraints

The following are legal issues to be considered:

(i) No rules for the development and the protection of the underground route/stations/private property.

(ii) No rules for the integrated development of the underground UMRT related facilities and the urban development.

(iii) No detailed decrees and circulars to support the Land laws, the Construction laws, and so on.

This discussed in more detail in a succeeding section.

6) Other Issues

There are other issues to be considered in the implementation as described below which have already been discussed in other sections of this report.

(i) Phasing of the development

(ii) Connectivity issues

(iii) Marketing and community awareness

(iv) Operation and effective indicators

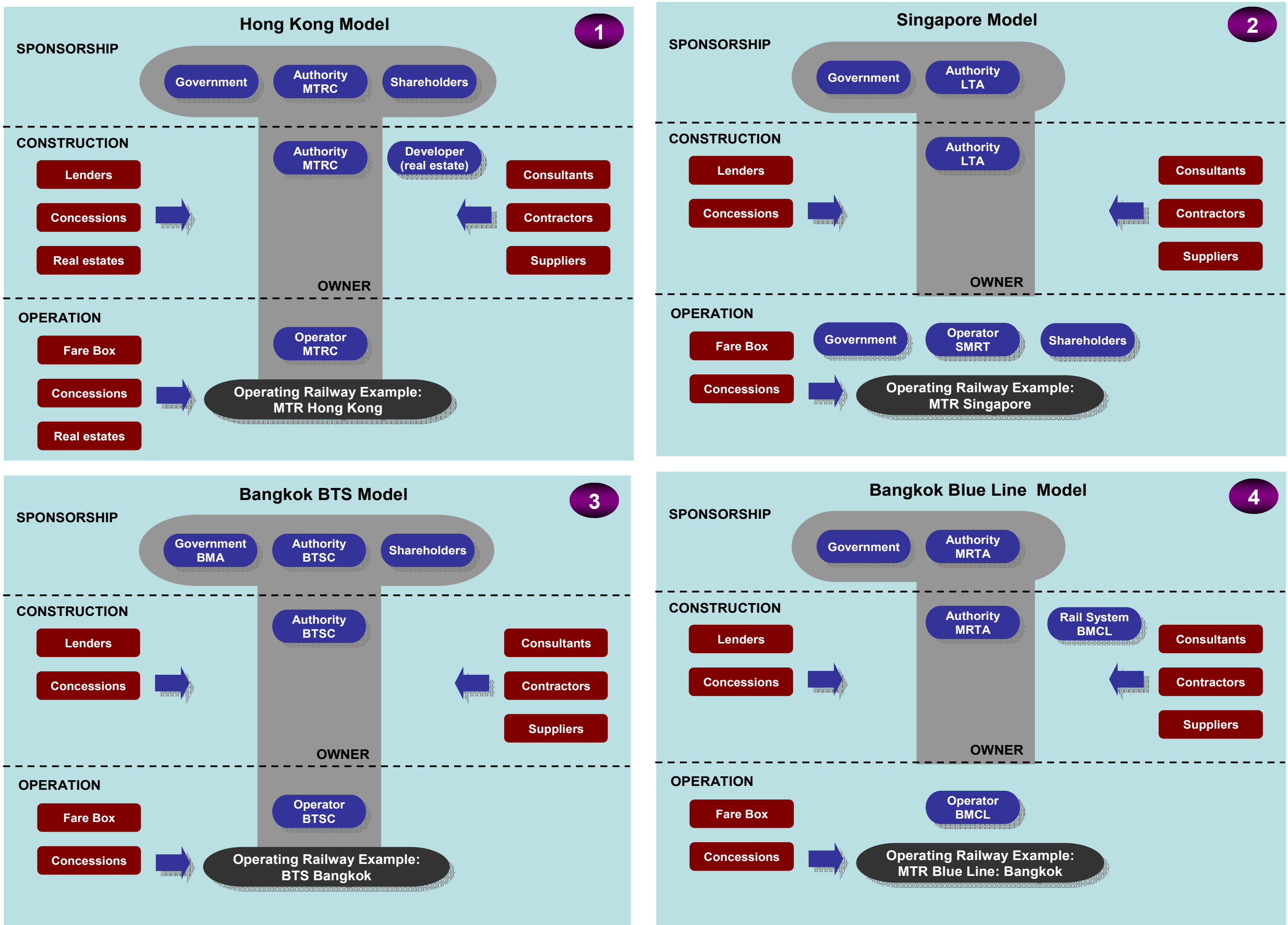
(v) Environmental issues

8.3 Preliminary Evaluation of Implementation Methods

1) Potential Implementation Models

Based on the difference in the role which the public sector play, implementation model can be classified into the following four options as illustrated in the Figure 8.2.1 :(i) Hong Kong Model; (ii) Singapore Model; (iii) Bangkok BTS Model; and, (iv) Bangkok Blue Line Model.

Figure 8.3.1 Potential Options for the Implementation Model



Source: HAIDEP Study Team

(1) Hong Kong Model

The Hong Kong Model is characterized by the creation of a government owned public corporation which constructs, owns and operates the whole mass rapid transit system in Hong Kong. The regulatory function is also within the charter of the corporation backed up by an ordinance. The corporation is very active in railway related property development to support the financial sustainability of its railway business.

The Mass Transit Railway Corporation (MTRC) was established in 1975 as a government owned statutory corporation in order to oversee the initial construction of the Hong Kong Mass Transport System, and later to run and manage the functioning transport system. In June 2000 the MTRC was succeeded by the MTR Corporation Limited (MTRCL). The MTRCL was listed on the Hong Kong Stock Exchange in October 2000; however the government maintains a majority stake in the MTRCL.

Besides railway operations, the MTRCL is also actively involved in the development of key residential and commercial projects above existing stations and along new line extensions as well as many other commercial activities associated with the railway. The MTRCL is also involved in the letting of retail and poster advertisement space, ATM banking facilities, and personal telecommunication services. It also provides consultancy services to organizations worldwide. The company is also exploring business opportunities outside Hong Kong.

The regulatory functions for the railway are handled by the Hong Kong government.

(2) Singapore Model

Singapore Model is characterized by a dual structure where construction and asset ownership is clearly separated with regards to the operation of the railway system. The independent and multimodal private companies are responsible for the operation in competitive manner, while the public authority governs the former's activities including the regulatory functions. Property development is designed and promoted by the authority as well.

The Singapore government established a provisional Mass Rapid Transit Authority in July 1980 for the preparation of the first MRT line. The Mass Rapid Transit Corporation (MRTC) was established to take over the role of the provisional authority in October 1983. The first section of the North South Line started operation, consisting of five stations over six kilometers in November 1987, and in the same year the Singapore MRT (SMRT) Corporation was incorporated to take over the role of MRTC. SMRT was listed on the Singapore Stock Exchange and the majority of its share is now owned by private companies. There is another mass transit operator, SBS Transit Limited, which started operating the North East MRT line in 2003 and now operating some other LRT lines as well.

The construction and regulation matters are handled by the Land Transport Authority (LTA) which was established in September 1995 through the merger of public sector entities, namely: Registry of Vehicles, Mass Rapid Transit Corporation, Roads & Transportation Division of the Public Works Department and Land Transport Division on the Ministry of Communications.

The railway assets are constructed and owned by the LTA, which constructs and regulates all land transport including rail and road whereas the operation is managed by SMRT which was originally a public entity and is now a private corporation providing rail, bus and taxi services and SBC Transit which was originally formed by the merger of three bus companies.

(3) Bangkok BTS Model

Bangkok BTS Model is characterized by a BOT concession in which a private entity designed, built, financed and operated the whole railway system with the public sector playing limited role in policy making and regulatory functions.

Bangkok Mass Transit System Public Company Limited (BTSC) was established in 1992 as a joint venture between Bangkok Metropolitan Administration (BMA) and the Italian-Thai Development PLC for a BOT concession to design, build, finance and operate the BTS Sky Train. The policy making and regulatory functions are conducted by BMA, a local government body.

(4) Bangkok Blue Line Model

Bangkok Blue Line Model is characterized by the separation of construction and ownership of the basic railway infrastructure which was done by the public sector and the procurement of rolling stock and E&M system plus the operation of the whole railway system was by private sector on a concession basis. The policy making and regulatory functions are conducted by the same public authority which owns the infrastructure.

The Metropolitan Rapid Transit Authority was established in July 1992 under the Office of the Prime Minister as the SOE responsible for the implementation of projects on Mass Rapid Transit Systems in the Greater Bangkok Area. In year 2000 it was renamed Mass Rapid Transit Authority of Thailand (MRTA) under a new act to expand its responsibility to include other provinces.

ODA funding was sourced for the construction of the basic infrastructure of the railway which included civil work, depot, rail track, escalators and others. The operation and the procurement of the rolling stock and the electrical and mechanical system were bidded for BOT concession for 25 years. The concession was awarded to the consortium of Siemens and CH Karnchang.

The Bangkok Mass Transit Public Company limited (BMCL) was formed by CH Karnchang and other investors to procure the rolling stock and the electrical and mechanical system and to operate the Blue Line.

2) Preliminary Evaluation

The four models are assessed on the basis of the following aspects:

(i) Government Control and Network Development;
(ii) Competition and Cost Efficiency;
(iii) Financial Output of the Railway Business and its Sustainability; and
(iv) Burden on Public Sector in management of the whole system.

Each model has advantages and disadvantages as shown in the Table 8.3.1. When looked at the government control and network development perspective, both Hong Kong Model and Singapore Model seem to have a clear advantage due to the following reasons:

- Integration of the Railway Network with other mode of transportation; and
- Performance in integrated property development.

However, those models require considerable level of management expertise and financial strength in its implementation.

Table 8.3.1 Preliminary Evaluation of Potential Options

	1 Hong Kong Model	2 Singapore Model	3 Bangkok BTS Model	4 Bangkok Blue Line Model
1) Government Control/ Network Development	◉	◉	△	△
2) Competition/ Cost Efficiency	○	◉	◉	○
3) Financial Output/ Sustainability	◉	○	△	△
4) Burden on Public Sector in Management	△	△	○	○

◉ High Performance ○ Medium Performance △ Some Constraints

Source: HAIDEP Study Team

3) Recommended Implementation Model

It is recommended that the Hanoi City creates a Mass Transit Authority which designs, builds, finances and operates the whole UMRT Line 2 System with active involvement in the railway related property development along the corridor. In other words, project implementation shall start with the Hong Kong Model with a single implementation body strongly backed up by the government which is also active on railway related property development and as the experience and know-how for railway business accumulate, the structure shall move towards the Singapore Model for which a clear separation of regulator function and service provision function (operation) is materialized by introducing competition among the private sector players in service provision. Meanwhile the public sector maintains the control over the public transport network development and effective integration of urban development. It is also recommended that the possibility of creating competition among multi-modal companies of railway, bus and taxi services be looked into as done in Singapore.

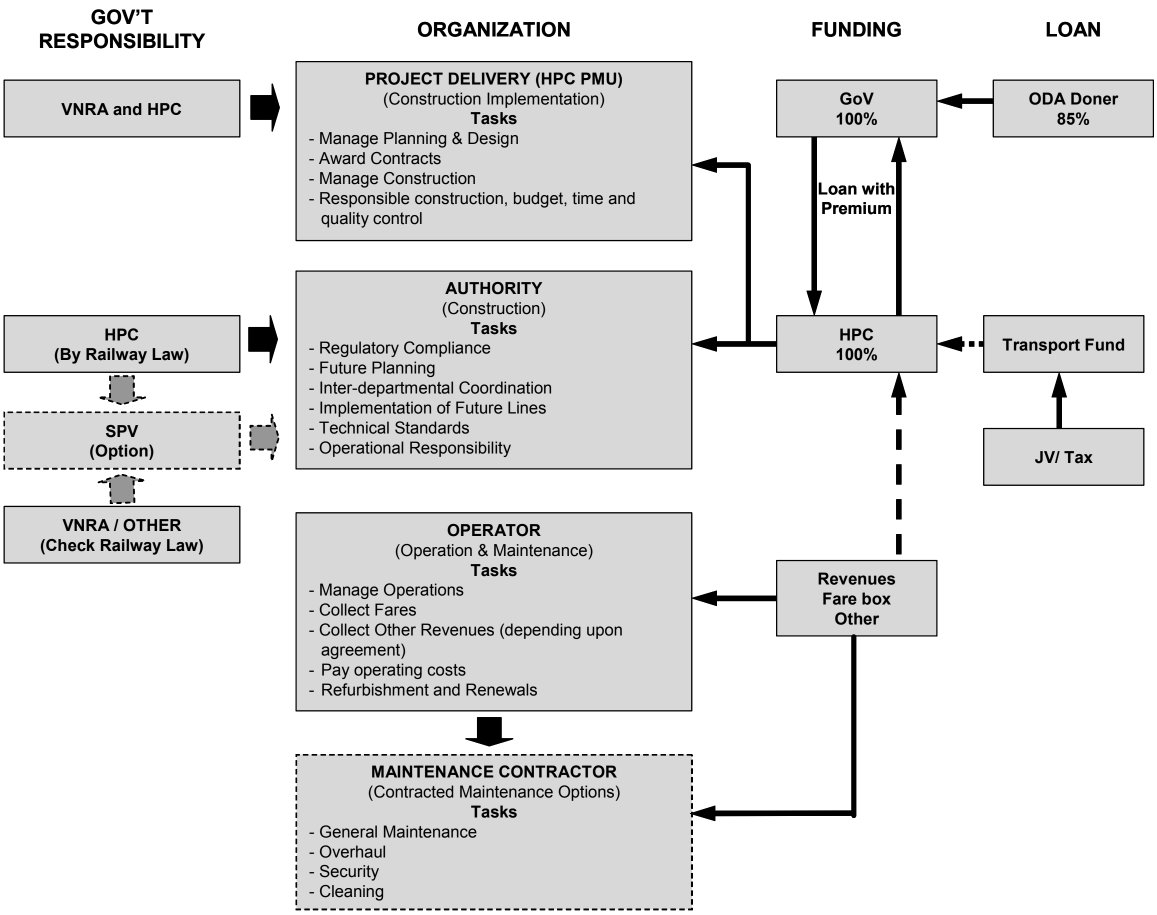
8.4 Institutional Framework for Project Implementation

1) Overall Organization Structure

Overall organization structure of the implementation of UMRT Line 2 system is illustrated in Figure 8.4.1.

Design and construction of the system and ODA funding management shall be executed by a Project Management Unit created under HPC. Operation and maintenance of the system will be covered by the Mass Transit Authority and the operator in the ultimate structure. However, there will be a transition issue to be considered as described in the following section.

Figure 8.4.1 Overall Organization Structure



Source: HAIDEP Study Team.

A major task of each player is outlined as follows:

(i) HPC Project Management Unit

- Manage Planning & Design
- Award Contracts
- Manage Construction
- Responsible construction, budget, time and quality control

(ii) Mass Transit Authority

- Regulatory Compliance

- Future Planning
- Interdepartmental Coordination
- Implementation of Future Lines
- Technical Standards
- Operational Responsibility

(iii) Operator

- Manage Operations
- Collect Fares
- Collect Other Revenues (depending upon agreement)
- Pay operating costs
- Refurbishment and Renewals

(iv) Maintenance Contractor (as an Option)

- General Maintenance
- Overhaul
- Security
- Cleaning

2) Transition Issue

Institutional framework for the project implementation of the UMRT Line 2 must be structured taking the following transitions into consideration:

(i) VNRA to HPC
(ii) Construction Management Unit/ Project Management Unit to Mass Transit Authority
(iii) Construction to Operation and Maintenance

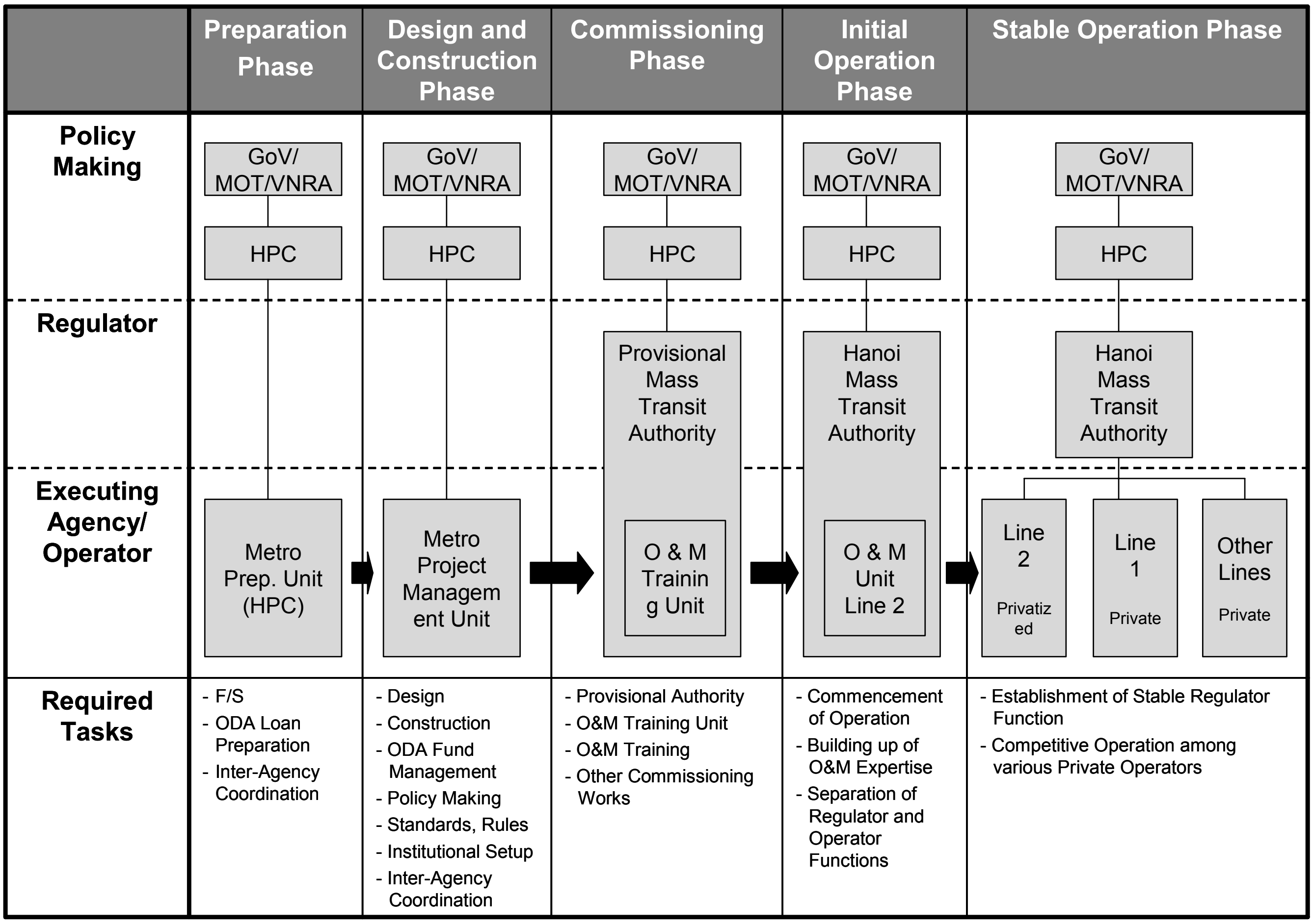
The appropriate market structure in the future when multiple railway lines come to operation would also have to be considered. Figure 8.4.2 illustrates a possible transition of the institutional setup from the beginning to attaining an appropriate market structure in the urban railway services in the future.

The transition may be divided into the following five phases:

(i) Preparation Phase;
(ii) Design and Construction Phase;
(iii) Commissioning Phase;
(iv) Initial Operation Phase; and
(v) Stable Operation Phase.

The details of each phase shall be described in the following section.

Figure 8.4.2 Transition of Institutional Setup



Source: HAIDEP Study Team

3) Preparation Phase

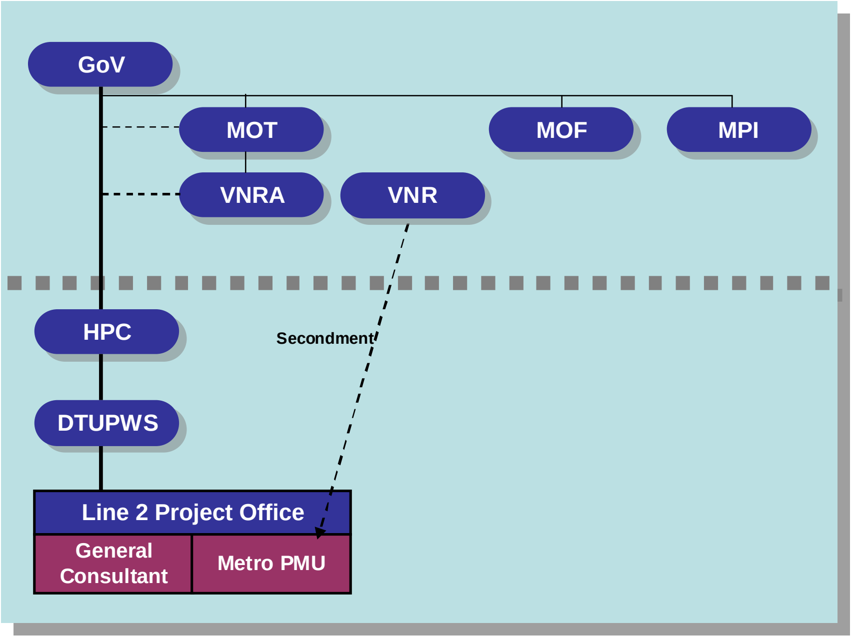
A Metro Preparation Unit (MPU) shall be created as was done in the HCMC UMRT Line 1 project. The unit shall handle the feasibility study of the system, ODA loan preparation and necessary inter-agency coordination.

4) Design and Construction Phase

The MPU shall transform into a Metro Project Management Unit (MPMU) which shall manage the design and construction of the system; coordinate the policy making, standards/ rules setting, and institutional setup; and, conduct necessary inter-agency coordination.

MPMU shall, together with a general consultant who will provide consultancy services regarding various aspects of the implementation, will constitute the Line 2 Project Office. The expertise of the Vietnam Railway may be utilized by seconding experts to the MPMU.

Figure 8.4.3 Institutional Framework (Design and Construction Phase)

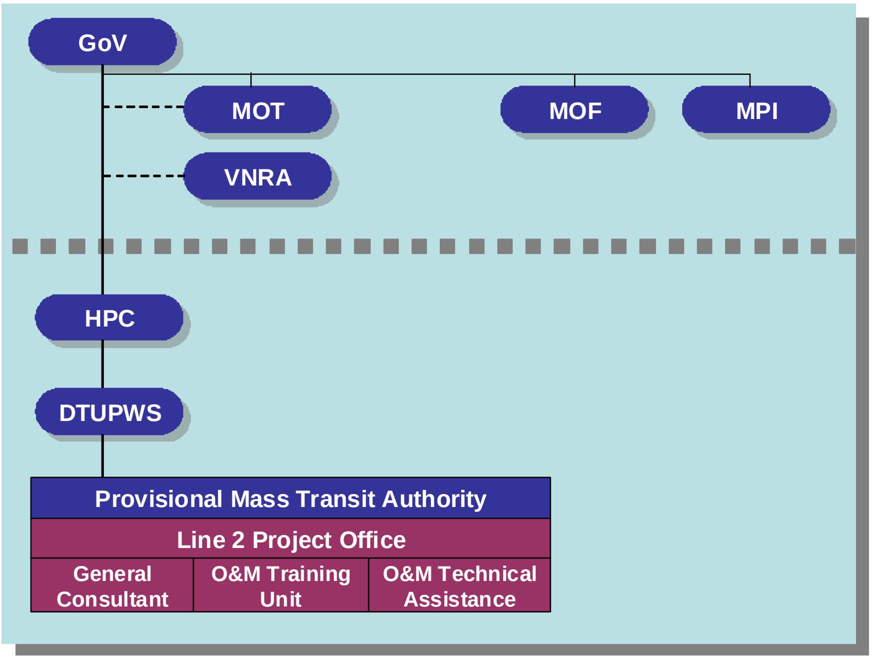


Source: HAIDEP Study Team

5) Commissioning Phase

A provisional Mass Transit Authority shall be created with an O&M training Unit who will receive the necessary O&M training and will conduct other commissioning works. ODA technical assistance may be utilized to provide O&M training to the O&M training unit.

Figure 8.4.4 Institutional Framework (Commissioning Phase)



Source: HAIDEP Study Team

6) Initial Operation Phase

The Provisional Authority shall transition to the Hanoi Mass Transit Authority (HMTA) upon the commencement of the operation of the Line 2. In the Initial Operation Phase, the O&M unit for the Line 2 will be under the management of the Authority and will build up necessary O&M expertise and the know-how of the urban railway business, so the separation of the regulatory function and the service provision would be possible in the later phase. Possibility of a corporation structure for the O&M unit shall also be looked into since independency and more freedom of the service provider may often result in efficiency and better quality of the service (a good exaple is TRANSERCO in Hanoi), and could make it easier for the future privatization.

Major legal issues would be addressed as follows:

(i) Legislation empowering the authority to plan, design, construct, finance, operate and maintain the UMRT Line 2 system;

(ii) The authority should have the right to purchase land or in the case of underground structures have the right of easement under existing public and non public properties;

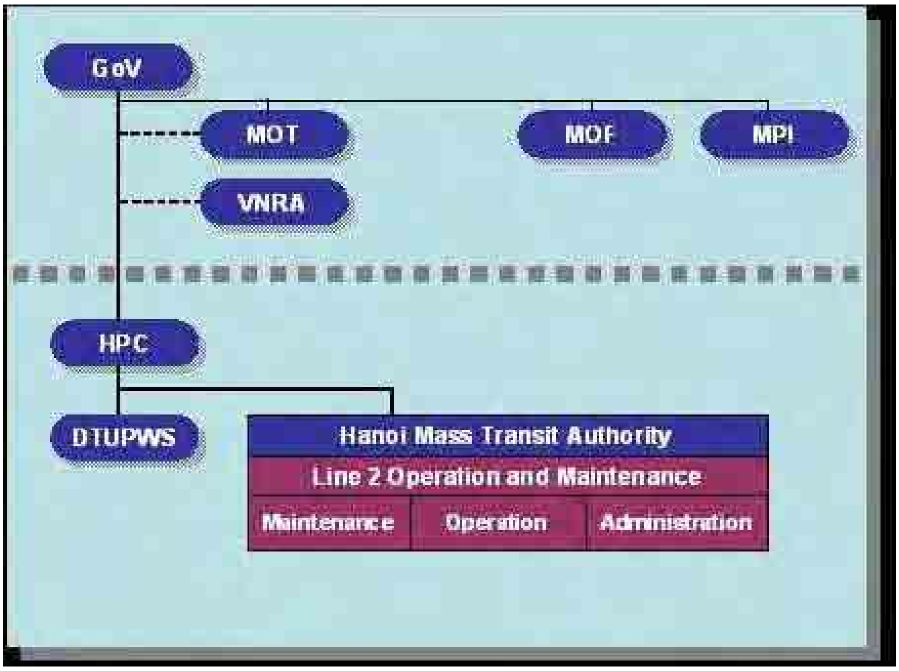
(iii) The authority should have the right to develop adjacent property on a commercial basis;

(iv) The authority should have the right to form associations or joint ventures with other public and private entities if it is beneficial to the development of the public transport network.

(v) Degree of freedom of the authority in fare setting

(vi) Benchmarking mechanism to be adopted to monitor the performance of the UMRT Line 2 System

Figure 8.4.5 Institutional Framework (Initial Operation Phase)

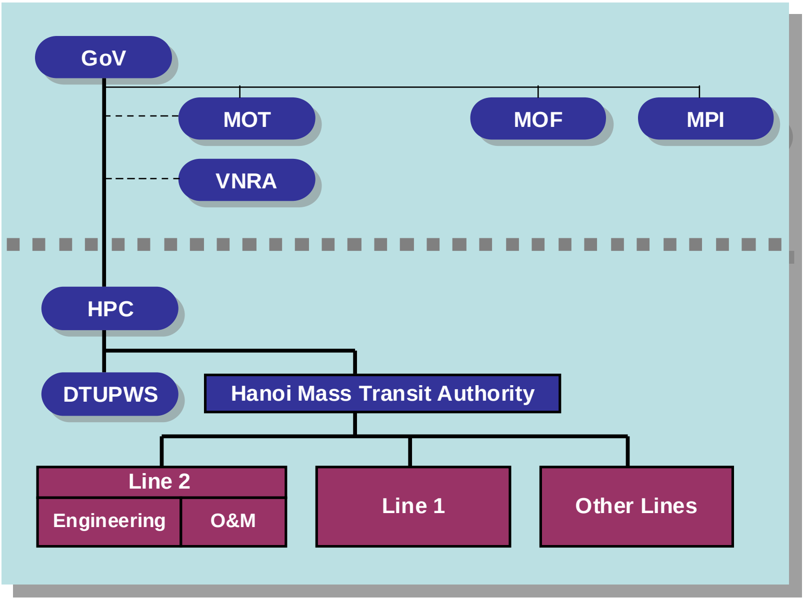


Source: HAIDEP Study Team

7) Stable Operation Phase

Stable regulatory function shall be established by a clear separation of the regulatory and the service provision functions. Operation and maintenance of the Line 2 shall be separated from the HMTA and privatized. The HMTA shall then oversee as a regulator of the operations of Line 2, Line 1 and other lines of the urban railway services which are provided in a competitive manner.

Figure 8.4.6 Institutional Framework (Stable Operation Phase)



Source: HAIDEP Study Team

8) Other Institutional Arrangements

The following institutional arrangement shall also be necessary for the implementation of the UMRT Line 2:

(i) ODA funding arrangement with procurement of general consultant who will provide to HPC appropriate expertise and advice for the implementation and urban railway business.

(ii) ODA technical assistance arrangement for O&M training and for other necessary expertise such as formulation of new rules and regulations of the urban railway business.

(iii) Preparation of new rules and regulations, revision of related laws and decrees with particular importance on the following issues:

- Subway route protection
- Design and safety standards for the underground structures
- Operating Procedures
- Liaison Mechanism with emergency services, such as police, fire, and ambulance.
- Fare Structure/ Policies
- Integrated Ticketing System
- Drafting of various contracts, such as operating/management contract, maintenance contract and other related contracts.

(iv) A unit specially focused on the integrated commercial/property development with the UMRT Line 2 system may be necessary under HPC to conduct the following tasks:

- Prepare a master plan for the integrated development.
- Prepare implementation for each development including funding mechanism.
- Conduct inter-agency coordination
- Arrange joint venture for the development and conduct bidding when necessary.
- Monitor each development in coordination with related agencies.

8.5 Implementation Schedule

1) Project Phasing

The implementation of the UMRT Line 2 system shall be divided into the following four phases:

(i) Phase 1: Tu Liem-Thuong Dinh (14 stations/terminals: 15.2km)

(ii) Phase 2: Nam Thanh Long-Ha Dong (21 stations/terminals: 25.4knm)

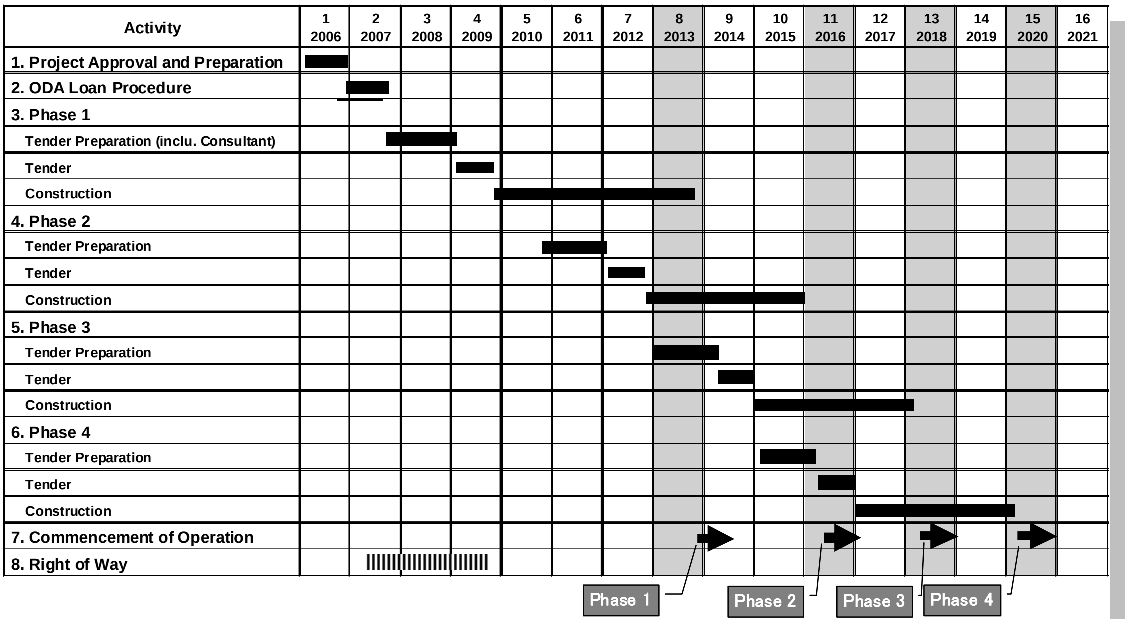
(iii) Phase 3: Thai Phu (Depot)- Ha Dong (26 stations/terminals: 36.1km)

(iv) Phase 4: Noi Bai-Hoan Kiem (Air Port Link: 28 stations/terminals: 41.5km)

As illustrated in the previous chapter the implementation shall start with a 15.6 km section which is completely underground covering the core CBD area of the City. In additional phases, the line will be extended to the north to Nam Tanh Long and to the south to Hadong in Phase 2, and crossing the Red River to cover the new urban development of Dong Anh District in Phase 3. Phase 4 will be the construction and the operation of the Air Port Link to the Noi Bai International Airport.

Figure 8.5.1 shows the development timeline of the UMRT Line 2 from its inception in 2006 to operational revenue within 8 to 15 years depending on the phasing of the project. In order to meet the target year of 2020 for the commencement of the whole system of the UMRT Line 2 as planned in HAIDEP Master Plan, Phase 1 which shall start its operation in the year 2013 will be relatively tight in its schedule. Efficient processing of the ODA loan and measures to shorten the design and construction period such as adoption of Design and Build approach as discussed in the later section of this chapter will be required.

Figure 8.5.1 Phasing of Implementation



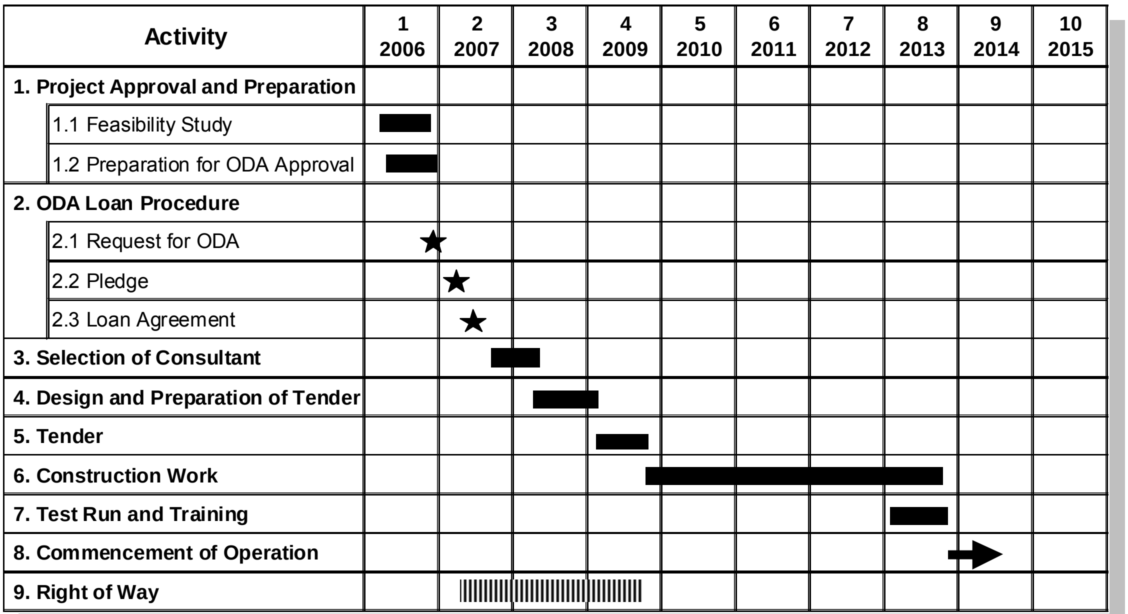
Source: HAIDEP Study Team

2) Project Schedule (Phase 1)

The project schedule of the Phase 1 will be further broken down in the Figure 8.5.2. The schedule is based on the premise of the Government of Vietnam and HPC making use of ODA bilateral fund sources. This financing mode will entail a minimum 2 years lead-time, before actual tendering and construction can commence.

The design and project management of a modern mass transit rail system implementation program would most likely require the assistance from experienced foreign consultants as the required urban mass rail transit expertise is not available domestically or limited to what may have been experienced earlier in the implementation of mass transit rail systems in HCMC. Rail systems are built-to-order and adapted to meet the particular needs of every city. Thus before they can be built and operated successfully, the manufacturer or systems supplier must know what the buyer/operator wants, which means detailed technical performance specifications will have to be prepared by the project consultants.

Figure 8.5.1 Project Schedule (Phase 1)



Source: HAIDEP Study Team

The project will start with the conduct of a feasibility study and preparation for ODA loan. The normal and mandatory stages on which the project will go through to use ODA funds are as follows:

(i) Preparation of the feasibility study;

(ii) Evaluation of the study and inclusion of the project in the lending agency's portfolio;

(iii) Appoint a consultant to carry out the basic engineering design and

(iv) Preparation of detailed design, bill of quantities, and firm cost estimates;

(v) Preparation of bid documents, followed by bidding, evaluation and award;

(vi) Actual construction of the civil works, with the manufacture and installation of the rolling stocks and the railway system;

(vii) Testing and commissioning; and

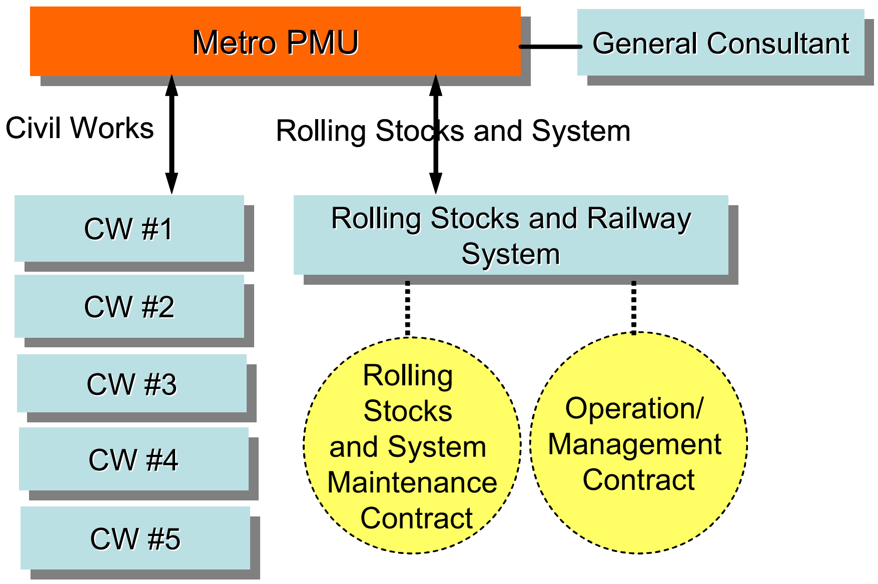
(viii) Commercial revenue service for operation.

Almost four years will be needed before the commencement of actual construction work. During the same period, necessary right of way for the Line 2 shall be cleared by HPC. Again, the design-build approach and the performance specification approach shall be adopted to shorten the design/construction/procurement period. It is also recommended that ODA technical assistance be used for the training and the commissioning.

The construction of the system would be packaged into six packages constituting of five civil works packages and one rolling stock and railway system package as illustrated in Figure 8.5.3. Technical detail of each package is described in the previous section of this report. The design-build approach shall be adopted for the civil work components and performance specification approach shall be adopted for rolling stocks and railway system component. This transfers the risk and the detailed design responsibility of the more complex systems technologies to the contractor/manufacturer/supplier, rather than the government as the project owner. This system has the added advantage of allowing bidders to optimize their own work and products with a resulting lower cost beneficial to the owner.

However, to ensure long-term system performance, the EPC contract should require a concomitant maintenance support of over five to ten years after turnover. It should also be noted that when the design-build approach is adopted for the civil work components, the evaluation of the bids will need a very detailed preliminary engineering and an experienced program management team employed for the project implementation.

Figure 8.5.2 Construction Package for UMRT Line 2 (Phase 1)



Source: HAIDEP Study Team

8.6 Funding Plan

1) Project Cost

Table 8.6.1 shows the project cost that is required to develop the whole system. Total project cost inclusive of the land cost shall be US$ 2,886 million. Of which Phase 1 will comprise about 63%, US$ 1,806.2 million.

Table 8.6.1 Project Cost and Investment Schedule

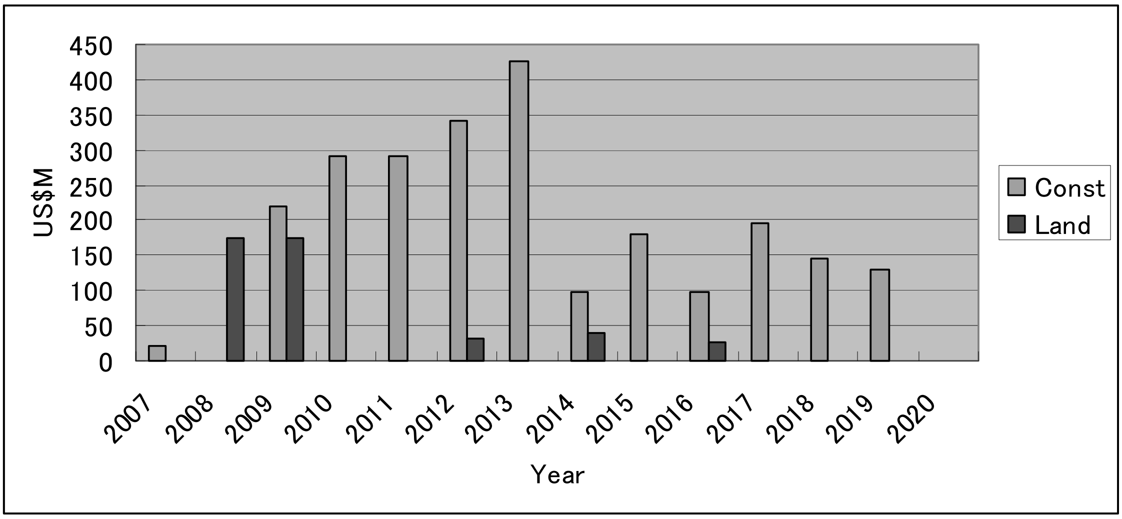
(US$ million)

Year	Phase 1		Phase 2		Phase 3		Phase 4		Total Project Cost		
	Const	Land	Const	Land	Const	Land	Const	Land	Const	Land	Total
2007	21.9								21.9	0.0	21.9
2008		174.2							0.0	174.2	174.2
2009		174.2							218.7	174.2	392.9
2010	218.7								291.6	0.0	291.6
2011	291.6								291.6	0.0	291.6
2012	291.6		49.4	30.9					341.0	30.9	371.9
2013	342.6		82.3						424.9	0.0	424.9
2014			98.8			40.8			98.8	40.8	139.6
2015			98.8		82.5				181.3	0.0	181.3
2016					99.0			26.0	99.0	26.0	125.0
2017					99.0		96.8		195.8	0.0	195.8
2018					49.5		96.8		146.3	0.0	146.3
2019							129.1		129.1	0.0	129.1
2020									0.0	0.0	0.0
Total	1,457.8	348.4	329.3	30.9	330.0	40.8	322.7	26.0	2,439.9	446.1	2,886.0

Source: HAIDEP Study Team

As illustrated in Figure 8.6.1, in order to complete the entire length of UMRT Line 2, HPC should continuously invest in construction of over ten years period with about three hundred US$ million each year for the first five to six years.

Figure 8.6.1 Capital Investment Requirement Over the Years



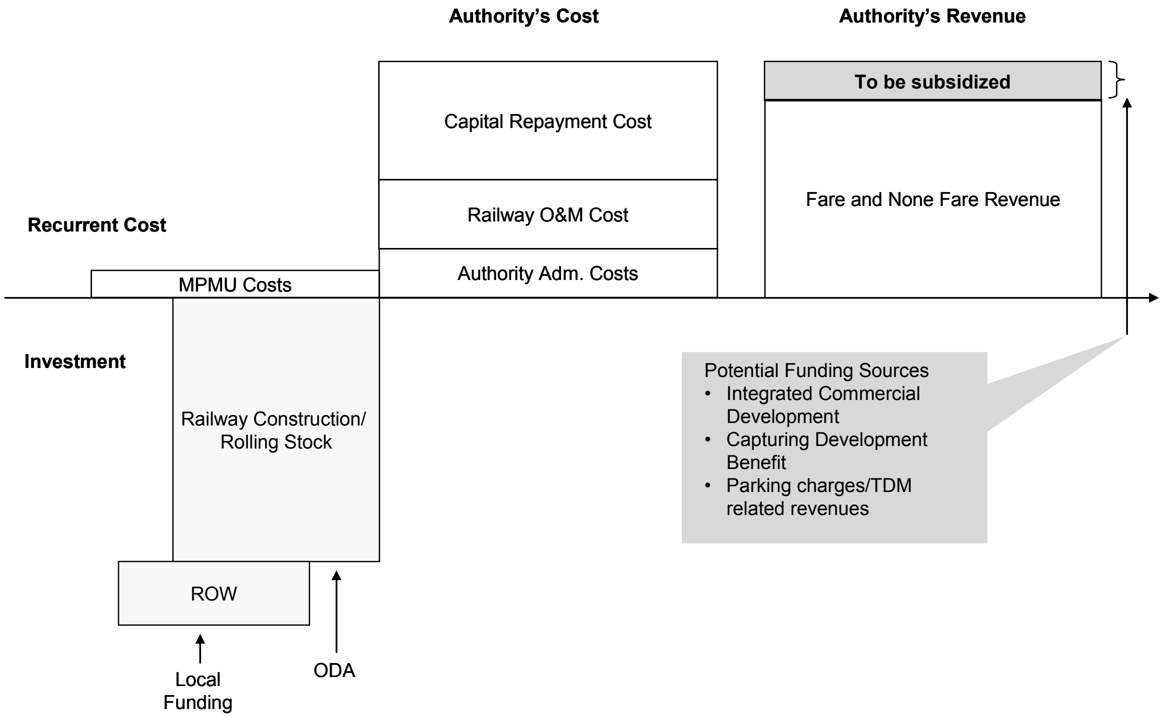
Source: HAIDEP Study Team

2) Overview of the Total Funding Framework

The result of financial evaluation (detailed in succeeding chapter) implied that positive private sector participation is not likely in the implementation of the project. However, the project may generate enough cash flow to cover the O&M costs and most of the depreciation of the project which indicates that it may be possible to create a sufficient standing operating body for the operation of UMRT Line 2.

A possible funding scheme is illustrated in Figure 8.6.2 where the basic infrastructure of the UMRT Line 2 is financed by public funding including ODA funds and the operation is funded by its fare box and non fare box revenues.

Figure 8.6.2 Total Funding Framework for the UMRT Line 2 Project



Source: HAIDEP Study Team

It is usual for most of urban mass transit systems that risks are high that initial demand and revenues would be insufficient ramp up and will result in fund shortage for regular operation. Therefore, the funding framework for the UMRT Line 2 shall be equipped with a system to cover such contingent cash flow shortage

HPC should look into further the following measures to mitigate such risks in the implementation of the UMRT Line 2:

(i) Maximize the non fare box revenues up to 10 to 15% of the total revenues;

- Rental for station kiosks, shops, and banking facilities(ATM)
- Advertising in stations, on trains and on tickets
- Provisions for utilities and communication networks
- Financial services, SMART cards, etc
- Promotion and events, in large station spaces

(ii) Maximize opportunities for integrated commercial development

- Joint commercial development with stations/terminals
- Integrated commercial development in the vicinity of stations/terminals
- Related large commercial and residential development in the corridor of UMRT Line 2

(iii) Seek for opportunities in capturing the development value of UMRT Line 2

- Car/ motor bike parking charges
- Other TDM related revenues
- Other value capture methods such as Developer Fee, Special Assessment District and etc.

(iv) Utilize low cost funds such as ODA grant facilities for the planning and preparation of the above mentioned measures;

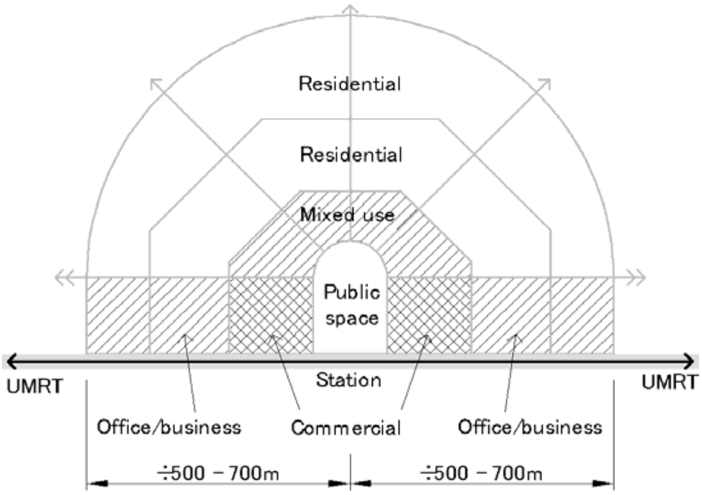
- Bilateral and multilateral technical assistance
- Special Assistance Facilities
- Engineering Services of the Main Loan Package

8.7 Orientation in Integrating UMRT and Urban Development

1) Concept of Transit-oriented Development

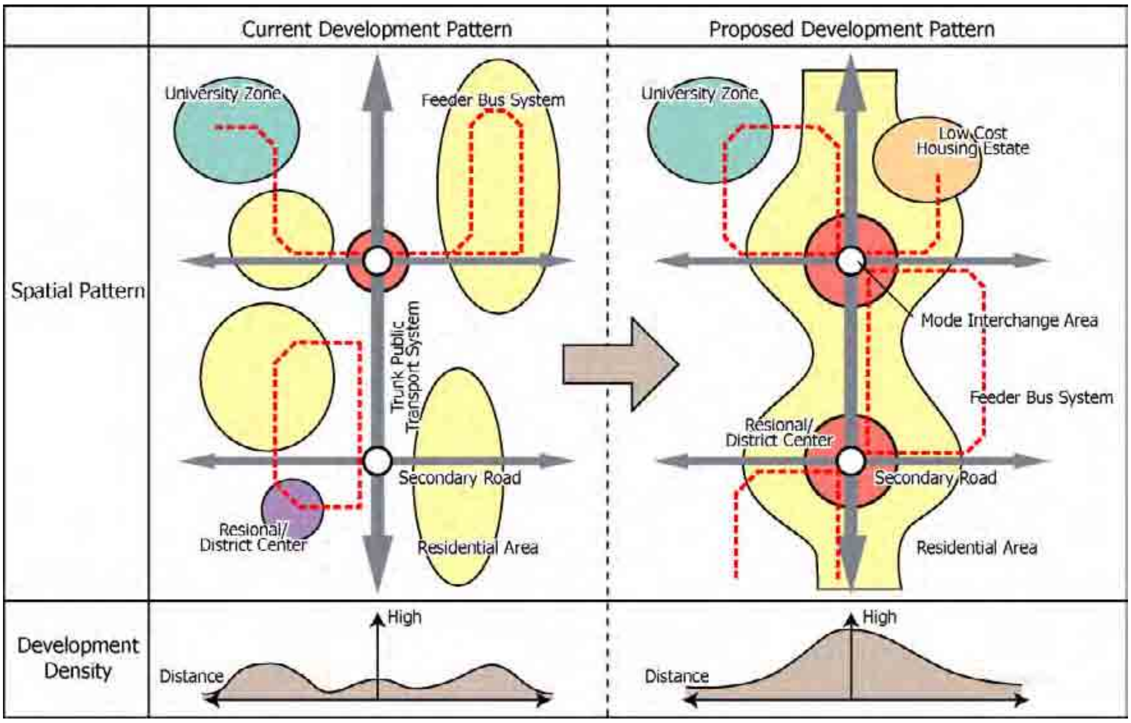
It is increasingly being recognized that urban areas must be developed in a way that their competitiveness and livability are maximized, while minimizing the negative impacts on the environment, improving traffic safety, and saving energy. Thereby, the concept of a transit-oriented development (TOD) has caught the attention of planners. This concept has been practiced widely in many countries, but more so in Japan. The concept is carried out in two levels: one at the station level and its vicinity (see Figure 8.7.1), and the other at the corridor and influence area level (see Figure 8.7.2).

Figure 8.7.1 Concept of Transit-Oriented Development at Station Level



Source: HAIDEP Study Team

Figure 8.7.2 Concept of Transit-oriented Development at Corridor Level



Source: HAIDEP Study Team

2) Development Concept at Corridor Level

The UMRT Line 2 corridor has experienced rapid urban development and is considered as one of the most important development corridor that will sustain the growth of Hanoi City. Many development projects are either ongoing or being planned in the area whose population is expected to increase sharply. The corridor's strength includes its high-capacity which will be further strengthened. The proposed UMRT Line 2 which will offer high-quality mass transit system, and the availability of land and space for urban development. However, unless these development projects and opportunities are implemented or tapped in an integrated manner, the potential synergy from such projects may not be fully realized. On the other hand, the successful implementation of the integrated development will substantially benefit both the urban and the transport sectors and will greatly contribute to the realization of a public transport-based urban development.

The development concept for the UMRT Line 2 corridor involves the following:

(i) Development of compact urban areas surrounded by and dotted with greeneries and open spaces.

(ii) Integration of existing and planned key developments with UMRT Line 2.

(iii) Development of a corridor with multiple functions including commercial, business, residential, recreational, educational, industrial, etc.

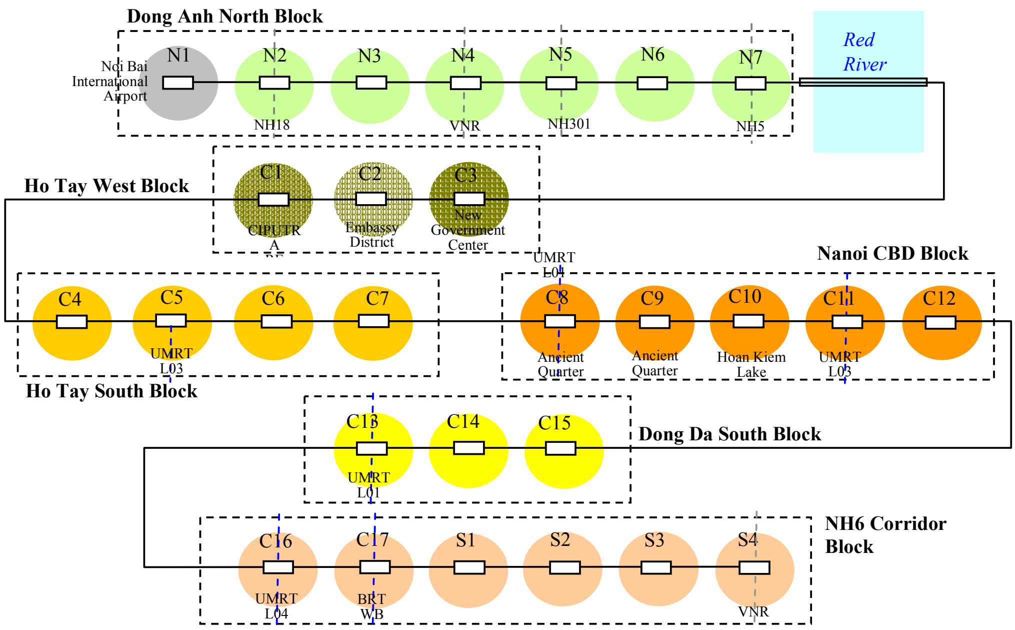
(iv) Development of a high-quality, high-speed transport corridor offering public transport services through UMRT Line 2 and integrated feeder services, on the one hand, and private transport services on NH1 and an improved access road network, on the other.

When these different types of developments are strategically located along the UMRT Line, positive impact on UMRT operation can be expected such as better distribution of traffic in directions and hours.

3) Development Concept at Station and its Vicinity

The development concept for each of the 28 UMRT stations has been further elaborated. It should be noted that these concepts are still preliminary and need further discussions with related organizations, especially HPC/APD (see Figure 8.7.3).

Figure 8.7.3 Integrated Development of UMRT Stations and Their Vicinities



Source: HAIDEP Study Team

4) Importance of the Integrated Urban Development

The importance of the commercial/urban development integrated with the development of the UMRT Line 2 system is summarized in the following points:

(i) There are significant opportunities to develop transport related multimodal development sites in Hanoi.

(ii) The profit/income for developing these sites should be used to contribute towards the cost of the public transport infrastructure such as UMRT stations, transport interchanges, parking structures.

(iii) Over 40 potential developments sites have been identified which are strategically located in the central business district, Hanoi City and its suburbs.

(iv) Some development sites should be prioritized particularly at the terminal and interchange stations identified in the Master plan, in the central business district and these should include Tu Liem, Long Bien and Bach Khoa.

(v) The type of development mix at each site will vary depending on market forces but may include retail, commercial, residential, recreation/leisure, government, education and social welfare facilities.

(vi) There is a need for the Hanoi Public Transport Authority and the landowner to identify potential public/private joint venture partners who would take commercial risk for the development.

(vii) Government may consider setting up a special unit, similar to Singapore's Urban Renewal Agency (URA) to coordinate government's strategy for the development of public land.

(viii) The ongoing management and operation costs of the transport infrastructure facilities including station should be subsidized from the development rental, advertising, and management/parking fees generated from the commercial development.

(ix) A specialist real estate adviser should be approached to advise on the commercial aspects of the multimodal development including how to consolidate multiple sites into a viable project.

(x) More detailed study and the preparation of a local outline development master plan for each multimodal site should be prepared to identify the commercial viability of each site development is required.

(xi) Control briefs for soliciting private sector proposals should be prepared which include the following:

- site inventory
- conceptual development plan
- forecast of demand and facility space provision
- infrastructure plans, which covers road traffic and parking, other transport specifications, associated community facilities, utilities, drainage and flood protection
- potential developer package specifications
- community liaison
- approval requirements
- engineering design specifications
- other design considerations

(xii) Before implementing a concept, it is recommended that a pilot project should be identified and developed to ascertain the commercial viability of such developments in the local context.

9 EVALUATION OF UMRT Line 2

9.1 Economic Evaluation

1) Methodology and Assumptions

UMRT Line 2 was economically evaluated in the future network proposed by the HAIDEP Master Plan. It means that the other projects of HAIDEP were assumed to be implemented as the recommended schedule in the "with" and "without" comparison. Each phase of UMRT Line 2 was scheduled to open in the following years:

Phase 1	Tu Liem - Thung Dinh	14.6km	2013
Phase 2	Nam Thanh Long - Ha Dong	24.4km	2016
Phase 3	Depot 3 - Ha Dong	36.6km	2019
Phase 4	Noi Bai Airport - Ha Dong	41.8km	2020

The economic evaluation was conducted by comparing the project cost expressed in economic terms and the economic benefit generated by the project. The economic cost was estimated based on the financial cost, by deducting all the taxes included in the financial cost and applying the shadow wage rate to unskilled labor cost.

The economic benefit was defined as savings in transportation cost which consists of two components of vehicle operating cost and travel time cost. They were estimated using the traffic assignment results on the networks of "with" and "without" the project.

In traffic assignment, the fare of UMRT Line 2 was assumed at US$ 0.20 (VDN 3,200) for the first 4.0 kilometer and US$ 0.05 (VDN 800) per one kilometer exceeding 4.0 kilometer.

Fare of UMRT Line 2 = 0.05 x (km-4.0) + 0.2 US$

2) Economic Cost

Table 9.1.1 presents the financial and economic cost of UMRT Line 2 by development phases. Total economic cost corresponds to 87% of total financial cost. Half of contingency was regarded as the price contingency and is excluded from the economic cost.

Table 9.1.1 Financial and Economic Cost of UMRT Line 2

(US$ million)

Phase	Financial Cost				
	Construction Cost	Engineering Cost	Land Cost	Contingency (10%)	Total
Phase 1	1203.4	90.3	348.4	164.2	1806.2
Phase 2	275.9	20.7	30.9	32.7	360.2
Phase 3	275.7	20.7	40.8	33.7	370.8
Phase 4	270.7	20.3	26.0	31.7	348.7
Total	2025.6	151.9	446.1	262.4	2886.0
Phase	Economic Cost				
	Construction Cost	Engineering Cost	Land Cost	Contingency (5%)	Total
Phase 1	1075.4	80.7	348.4	75.2	1579.7
Phase 2	245.0	18.4	30.9	14.7	309.0
Phase 3	244.0	18.3	40.8	15.2	318.2
Phase 4	241.5	18.1	26.0	14.3	299.9
Total	1805.9	135.4	446.1	119.4	2506.8

Source: HAIDEP Study Team

Following the investment schedule, the economic costs were distributed annually over the construction period as shown in Table 9.1.2.

Table 9.1 2 Investment Schedule of UMRT Line 2 in Economic Cost

(US$ million)

Year	Phase 1		Phase 2		Phase 3		Phase 4		Total Project Cost		
	Const	Land	Const	Land	Const	Land	Const	Land	Const	Land	Total
2007	18.5								18.5	0.0	18.5
2008		174.2							0.0	174.2	174.2
2009	184.7	174.2							184.7	174.2	358.9
2010	246.3								246.3	0.0	246.3
2011	246.3								246.3	0.0	246.3
2012	246.3		41.7	30.9					288.0	30.9	318.9
2013	289.4		69.5						358.9	0.0	358.9
2014			83.4			40.8			83.4	40.8	124.2
2015			83.4		69.4				152.8	0.0	152.8
2016					83.2			26.0	83.2	26.0	109.2
2017					83.2		82.2		165.4	0.0	165.4
2018					41.6		82.2		123.8	0.0	123.8
2019							109.6		109.6	0.0	109.6
2020									0.0	0.0	0.0
Total	1231.3	348.4	278.1	30.9	277.4	40.8	273.9	26.0	2060.7	446.1	2506.8

Source: HAIDEP Study Team

Economic operating and maintenance costs were simply assumed to be 85% of the financial O&M costs. They were estimated as shown in Table 9.1.3.

Table 9.1.3 O&M Cost of UMRT Line 2 in Economic Cost

(US$ million)

Cost Item Year	Phase 1	Phase 4	Phase 4
	2020	2020	2040
Staff (Direct)	3.06	6.73	7.33
Staff (Indirect)	0.31	0.67	0.73
Energy	5.10	8.42	9.35
Spares	2.55	4.68	4.68
Insurance & Taxes	0.33	0.61	0.66
Miscellaneous	0.55	1.03	1.11
Total	11.90	22.13	23.85

Source: HAIDEP Study Team

3) Economic Benefit

Savings brought by UMRT Line 2 in vehicle operating cost and travel time cost are presented in Table 10.1.4, where the benchmark years were shifted to 2010 and 2020 in order to avoid overestimation of economic benefit. This is because, in general, the saved time tends to become extraordinarily large as traffic demand reaches near the road network capacity. Therefore, it will be safer to use the benefit estimated for the near future, instead of the long-future.

If UMRT Line 2 should exist in 2010, the annual benefit would be US$ 259 million, equivalent to about 21% of the total investment cost. Approximately 80% of the benefit is savings in travel time cost. Transport mode-wise, 70% of the benefit is attributed to savings of VOC and TTC of public transport.

In 2020, the total benefit will be US$ 754 million, 2.9 times of 2010. Composition of VOC and TTC and modal composition will not change significantly.

Table 9.1.4 Economic Benefit of UMRT Line 2

(US$ million)

Year	Benefit Source	Motorcycle	Car	Bus/Train	Truck	Total
2010	VOC Savings	3.0	12.5	40.4	3.6	59.4
	TTC Savings	17.9	45.7	135.2	-	198.9
	Total Benefit	20.9	58.2	175.6	3.6	258.3
2020	VOC Savings	6.8	28.5	92.2	8.1	135.6
	TTC Savings	55.6	142.1	420.2	-	618.0
	Total Benefit	62.4	170.6	512.4	8.1	753.6

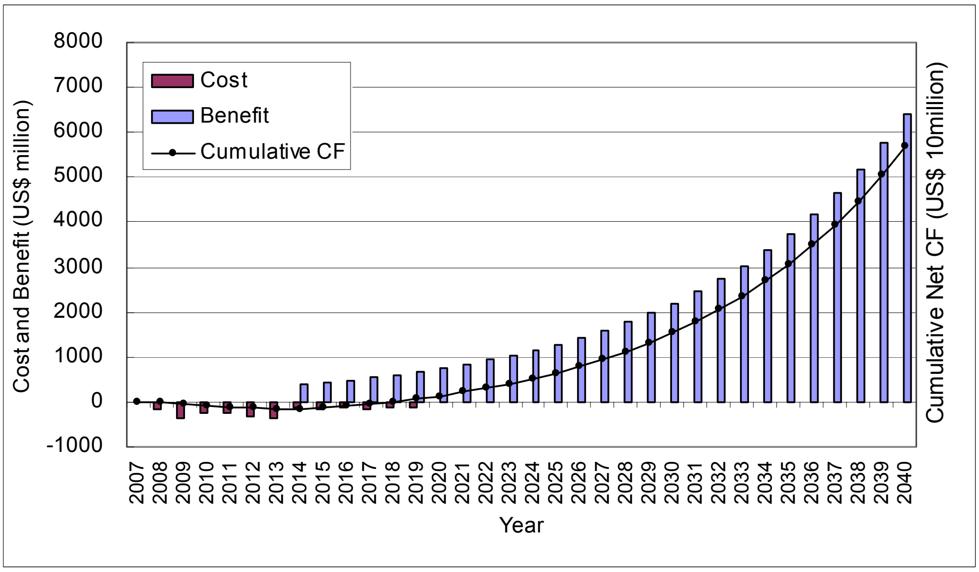
Source: HAIDEP Study Team

4) Economic Evaluation

The stream of the economic cost and benefit of UMRT Line 2 is shown in Table 9.1.5 and illustrated in Figure 9.1.1. The benefit will rapidly increase after 2020 and reach almost 8 times of the 2020 benefit in 2040. The demand for UMRT Line 2 will almost reach the capacity and then, the benefit will gradually level off after 2040. (In the table, benefit was assumed to grow no longer.)

Based on the cash flow, the economic internal rate of return (EIRR) was estimated to be 22.5%, the net present value (NPV) was US$ 3,846 and B/C was 3.6, all of which showed that the project UMRT Line 2 is highly feasible from the economic point of view (see Table 9.1.5).

Figure 9.1.1 Cash Flow of Cost and Benefit of UMRT Line 2



Source: HAIDEP Study Team

Table 9.1.5 Cash Flow of Economic Cost and Benefit of UMRT Line 2

(US$ million)

Year	Cost	O&M Cost	Economic Benefit	Net Cash Flow	Economic IRR (%)	Discounted NCF (d=12%)	
						Cost	Benefit
2007	18.5			-18.5	-	18.5	0.0
2008	174.2			-174.2	-	155.5	0.0
2009	358.9			-358.9	-	286.1	0.0
2010	246.3			-246.3	-	175.3	0.0
2011	246.3			-246.3	-	156.5	0.0
2012	318.9			-318.9	-	180.9	0.0
2013	358.9			-358.9	-	181.8	0.0
2014	124.2	9.7	396.4	262.5	-	60.6	179.3
2015	152.8	10.0	441.2	278.4	-	65.7	178.2
2016	109.2	10.4	491.1	371.5	-	43.1	177.1
2017	165.4	10.7	546.6	370.4	-	56.7	176.0
2018	123.8	11.1	608.3	473.4	-	38.8	174.9
2019	109.6	11.5	677.1	556.0	-	31.1	173.8
2020		11.9	753.6	741.7	-	2.7	172.7
2021		12.3	838.8	826.4	11.3%	2.5	171.6
2022		12.8	933.6	920.8	13.3%	2.3	170.6
2023		13.2	1039.1	1025.9	14.9%	2.2	169.5
2024		13.7	1156.5	1142.8	16.2%	2.0	168.4
2025		14.2	1287.2	1273.1	17.2%	1.8	167.4
2026		14.7	1432.7	1418.0	18.0%	1.7	166.3
2027		15.2	1594.6	1579.4	18.7%	1.6	165.3
2028		15.7	1774.8	1759.1	19.3%	1.5	164.3
2029		16.3	1975.4	1959.1	19.8%	1.3	163.3
2030		16.8	2198.7	2181.8	20.2%	1.2	162.2
2031		17.4	2447.1	2429.7	20.5%	1.1	161.2
2032		18.1	2723.7	2705.6	20.8%	1.1	160.2
2033		18.7	3031.5	3012.8	21.1%	1.0	159.2
2034		19.4	3374.1	3354.8	21.3%	0.9	158.2
2035		20.0	3755.5	3735.4	21.5%	0.8	157.2
2036		20.8	4179.9	4159.2	21.6%	0.8	156.3
2037		21.5	4652.3	4630.8	21.8%	0.7	155.3
2038		22.2	5178.1	5155.9	21.9%	0.7	154.3
2039		23.0	5763.3	5740.3	22.0%	0.6	153.4
2040		23.9	6414.7	6390.8	22.1%	0.6	152.4
2041		24.7	6414.7	6390.0	22.2%	0.5	136.1
2042		25.6	6414.7	6389.1	22.3%	0.5	121.5
2043		26.5	6414.7	6388.2	22.3%	0.4	108.5
2044		27.4	6414.7	6387.3	22.3%	0.4	96.9
2045		28.4	6414.7	6386.3	22.4%	0.4	86.5
2046		29.4	6414.7	6385.3	22.4%	0.4	77.2
2047		30.4	6414.7	6384.2	22.4%	0.3	68.9
2048		31.5	6414.7	6383.2	22.4%	0.3	61.6
2049		32.6	6414.7	6382.1	22.5%	0.3	55.0
2050		33.8	6414.7	6380.9	22.5%	0.3	49.1
Total	2506.8	715.2	123812.5	120590.4	22.5%	1483.6	5329.7

Source: HAIDEP Study Team

Table 9.1.6 Economic Evaluation Indicators of UMRT Line 2

Indicator	Unit	Value
Economic IRR	%	22.5
NPV	US$ million	3,846.1
B/C	-	3.59

Source: HAIDEP Study Team

Table 9.1.7 shows the results of sensitivity analysis by changing cost and benefit. The economic IRR of UMRT Line 2 is very stable against the change of cost and benefit. It will become lower than the threshold of 12% only when the cost becomes over 1.6 times of the base estimate and at the same time the benefit becomes less than 0.4 times of the base. These big changes will hardly occur and then, economic feasibility of the project will not be eroded by cost over-run or benefit decrease due to implementation of some competing project or other unexpected events.

Table 9.1.7 Sensitivity Analysis of Economic IRR of UMRT Line 2

(%)

Benefit Down by (%)	Cost up by (%)			
	Base Case	20%	40%	60%
Base Case	22.5	20.6	19.2	18.8
20%	20.2	18.6	17.3	16.2
40%	17.6	16.2	15.0	14.1
60%	14.5	13.2	12.2	11.4

Source: HAIDEP Study Team

9.2 Financial Evaluation

1) Methodology and Assumptions

UMRT Line 2 was financially evaluated by comparing the cost and the revenue of the project generating in the project life of 30 years. Demand and revenue were forecasted in the future network in the same way as the economic evaluation. In other words, all the other projects recommended in the HAIDEP master plan were assumed to be implemented as scheduled. If this assumption is not true and some projects are not implemented, the demand and revenue will increase and the financial evaluation result will be improved.

The evaluation was done in two ways. Firstly, a cash flow of the project was estimated at the 2006 constant price in order to calculate the financial internal rate of return (FIRR) of the project as a whole. In this step, such factors as inflation, interest payment and tax payment are not taken into account. The resulting FIRR shows the profitability essentially implied in the project regardless of distribution of the profit among stakeholders.

Secondly, another financial analysis was conducted from a standpoint of the company to invest and operate the project. For this purpose, an income statement of the company was estimated in more practical conditions, considering inflation and tax payment. The investment fund was assumed to be covered by own capital and loan. If the cash flow goes bankrupt, a subsidy by public investment was considered.

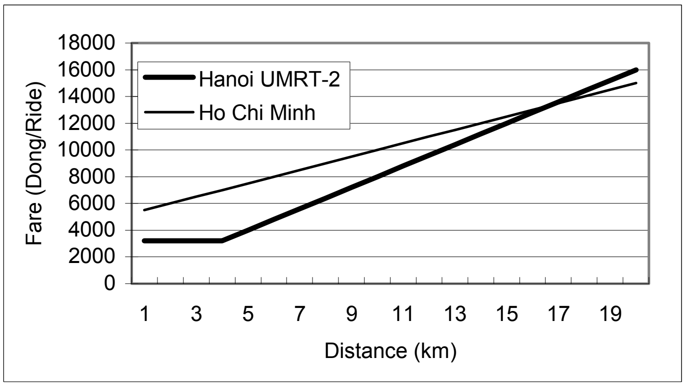
2) Fare Rate

The fare of UMRT Line 2 was set so to maximize the revenue. For the first 4.0 km, the fare is flat at US$ 0.20 (VDN 3,200) and afterwards US$ 0.05 (VDN 800) per one kilometer over 4.0 km.

Fare of UMRT Line 2 (US$) = 0.20 + 0.05 x (km-4.0)

A feasibility study on a subway line in Ho Chi Minh City was conducted in 2005 to 2006. In the study, the fare was assumed at a constant of VDN 5000 plus VDN 500 per kilometer as shown in Figure 9.2.1. As the average riding distance of passengers is less than 10 km, the fare of UMRT Line 2 in Hanoi is cheaper than that of Ho Chi Minh.

Figure 9.2.1 Fare System of UMRT Line 2



Source: HAIDEP Study Team

3) Capital Cost

The project cost was estimated in the preceding chapter. Following the recommended investment schedule, annual investment amounts are calculated as shown in Table 9.2.1. The total amount is USD 2,886 million (VDN 46,176 billion) at 2006 price. Total land cost accounts for 15% of the total. The first phase is the most costly at about US$ 1.800 million or 62% of the total, due to expensive underground construction of most section.

The total amount will be expanded over 13 years from 2007 to 2019. The largest amount is US$ 425 million in 2013 for Phase 1 and 2.

Table 9.2.1 Investment Schedule of UMRT Line 2 (Phase 1- 4)

(US$ million)

Year	Phase 1		Phase 2		Phase 3		Phase 4		Total Project Cost		
	Const	Land	Const	Land	Const	Land	Const	Land	Const	Land	Total
2007	21.9								21.9	0.0	21.9
2008		174.2							0.0	174.2	174.2
2009	218.7	174.2							218.7	174.2	392.9
2010	291.6								291.6	0.0	291.6
2011	291.6								291.6	0.0	291.6
2012	291.6		49.4	30.9					341.0	30.9	371.9
2013	342.6		82.3						424.9	0.0	424.9
2014			98.8			40.8			98.8	40.8	139.6
2015			98.8		82.5				181.3	0.0	181.3
2016					99.0			26.0	99.0	26.0	125.0
2017					99.0		96.8		195.8	0.0	195.8
2018					49.5		96.8		146.3	0.0	146.3
2019							129.1		129.1	0.0	129.1
2020									0.0	0.0	0.0
Total	1,457.8	348.4	329.3	30.9	330.0	40.8	322.7	26.0	2,439.9	446.1	2,886.0

Source: HAIDEP Study Team

4) O&M Cost

Operating and maintenance costs were estimated based on the line length and operation plan. The costs are expressed at 2006 constant price and the depreciation cost of rolling stock and infrastructure are ignored at this step. More than 40% of annual cost is spent for energy consumption as shown in Table 9.2.2.

Table 9.2.2 O&M Cost of UMRT Line 2

(US$ million p.a. at 2006 price)

Cost Item	Phase 1a	Phase 1	Phase 4	Phase 4
	2020	2020	2020	2040
Staff (Direct)	2.80	3.60	7.92	8.62
Staff (Indirect)	0.28	0.36	0.79	0.86
Energy	4.80	6.00	9.90	11.00
Spares & Maintenance	2.50	3.00	5.50	5.50
Insurance & Taxes	0.31	0.39	0.72	0.78
Miscellaneous	0.52	0.65	1.21	1.30
Total	11.21	14.00	26.04	28.06

Source: HAIDEP Study Team

5) Revenue

When forecasting the demand, fare revenue is also calculated for the benchmark years of 2020 and 2040. The annual revenues in other years were interpolated by using a logistic curve as shown in Table 9.2.3 and Figure 9.2.2.

Table 9.2.3 Annual revenue of UMRT Line 2 by Phase

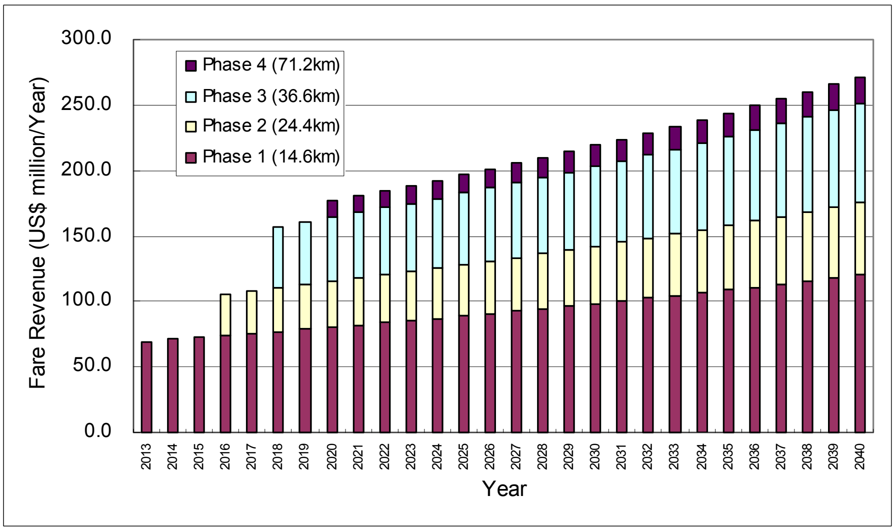
(US$ million at 2006 constant price)

Year	Phase 1	Phase 2	Phase 3	Phase 4	Total
2013	69.6				69.6
2014	71.0				71.0
2015	72.5				72.5
2016	74.0	31.9			105.9
2017	75.5	32.7			108.2
2018	77.1	33.4	46.9		157.4
2019	78.6	34.2	47.9		160.8
2020	80.2	35.0	49.0	12.6	176.8
2021	81.9	35.8	50.0	12.9	180.6
2022	83.6	36.7	51.1	13.2	184.6
2023	85.3	37.5	52.2	13.5	188.6
2024	87.0	38.4	53.4	13.9	192.7
2025	88.8	39.3	54.6	14.2	196.8
2026	90.6	40.2	55.7	14.5	201.1
2027	92.5	41.1	57.0	14.9	205.5
2028	94.4	42.1	58.2	15.3	209.9
2029	96.3	43.1	59.5	15.6	214.5
2030	98.3	44.1	60.8	16.0	219.2
2031	100.3	45.1	62.1	16.4	223.9
2032	102.3	46.1	63.5	16.8	228.8
2033	104.4	47.2	64.9	17.2	233.7
2034	106.6	48.3	66.3	17.7	238.8
2035	108.8	49.4	67.7	18.1	244.0
2036	111.0	50.6	69.2	18.5	249.3
2037	113.3	51.7	70.7	19.0	254.7
2038	115.6	52.9	72.3	19.4	260.2
2039	117.9	54.2	73.9	19.9	265.9
2040	120.4	55.4	75.5	20.4	271.7

Source: HAIDEP Study Team

Figure 9.2.2 Annual Revenue of UMRT Line 2 by Phase

(US$ million at 2006 constant price)



Source: HAIDEP Study Team

6) Project Evaluation

(1) Project FIRR in Constant Price

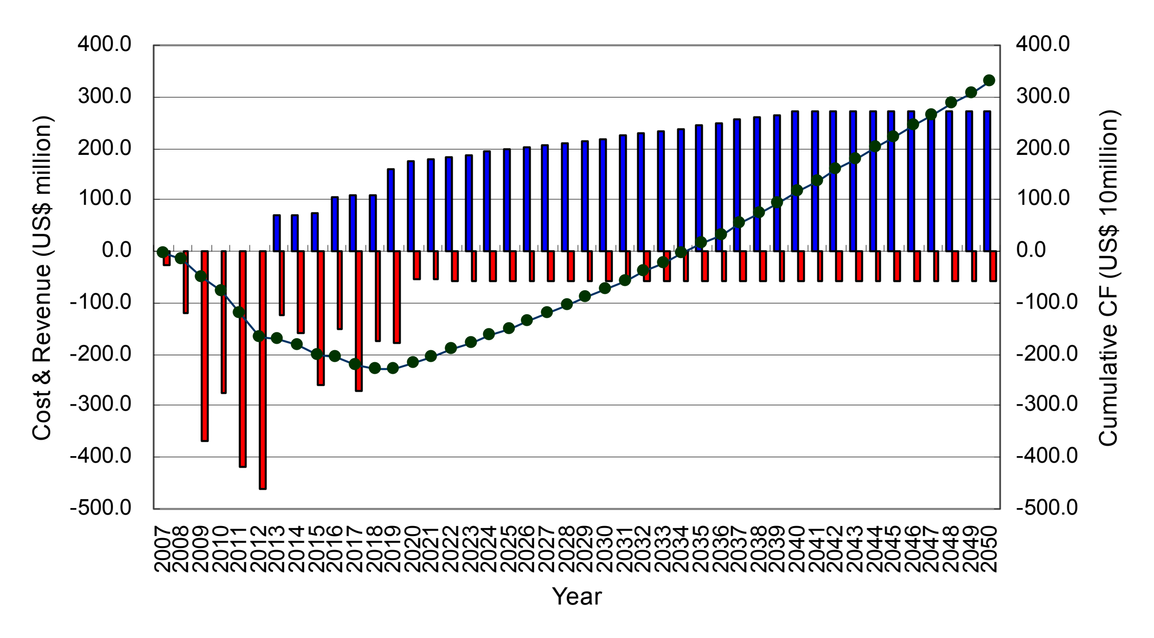
Since the Phase 4 of UMRT Line 2 is scheduled to open in 2020, the cash flow of the entire project is calculated up to 2050 as shown in Table 9.2.4 and Figure 9.2.3. Financial IRR is estimated at 3.9% at 2006 constant price.

Table 9.2.4 Financial Cash Flow of UMRT Line 2 (Entire Section)

Year	Investment	Maintenance	Operation Cost	Revenue	NCF	Cumulative Cash Flow	FIRR
2007	25.9				-25.9	-25.9	
2008	118.5				-118.5	-144.3	
2009	366.9				-366.9	-511.2	
2010	274.3				-274.3	-785.4	
2011	419.7				-419.7	-1205.1	
2012	461.8				-461.8	-1667.0	
2013	85.4	25.0	14.2	69.6	-55.0	-1721.9	
2014	119.4	26.3	14.4	71.0	-89.0	-1811.0	
2015	215.9	28.1	14.6	72.5	-186.1	-1997.0	
2016	103.9	31.3	14.8	105.9	-44.0	-2041.1	
2017	223.2	32.9	15.0	108.2	-162.8	-2203.9	
2018	123.9	36.2	15.2	110.5	-64.8	-2268.7	-
2019	123.4	38.1	15.4	160.8	-16.1	-2284.8	-
2020		39.9	15.6	176.8	121.3	-2163.5	-
2021		39.9	15.8	180.6	124.9	-2038.6	-
2022		39.9	16.0	184.6	128.6	-1910.0	-
2023		39.9	16.3	188.6	132.4	-1777.7	-
2024		39.9	16.5	192.7	136.2	-1641.4	-
2025		39.9	16.7	196.8	140.2	-1501.2	-
2026		39.9	16.9	201.1	144.2	-1357.0	-7.8%
2027		39.9	17.2	205.5	148.4	-1208.6	-6.2%
2028		39.9	17.4	209.9	152.6	-1056.0	-4.9%
2029		39.9	17.7	214.5	156.9	-899.1	-3.8%
2030		39.9	17.9	219.2	161.3	-737.8	-2.8%
2031		39.9	17.9	223.9	166.1	-571.7	-2.0%
2032		39.9	17.9	228.8	170.9	-400.7	-1.3%
2033		39.9	17.9	233.7	175.9	-224.8	-0.7%
2034		39.9	17.9	238.8	181.0	-43.8	-0.1%
2035		39.9	17.9	244.0	186.2	142.3	0.4%
2036		39.9	17.9	249.3	191.5	333.8	0.8%
2037		39.9	17.9	254.7	196.9	530.7	1.2%
2038		39.9	17.9	260.2	202.4	733.1	1.6%
2039		39.9	17.9	265.9	208.1	941.1	1.9%
2040		39.9	17.9	271.7	213.8	1155.0	2.2%
2041		39.9	17.9	271.7	213.8	1368.8	2.4%
2042		39.9	17.9	271.7	213.8	1582.6	2.7%
2043		39.9	17.9	271.7	213.8	1796.4	2.9%
2044		39.9	17.9	271.7	213.8	2010.3	3.1%
2045		39.9	17.9	271.7	213.8	2224.1	3.2%
2046		39.9	17.9	271.7	213.8	2437.9	3.4%
2047		39.9	17.9	271.7	213.8	2651.8	3.5%
2048		39.9	17.9	271.7	213.8	2865.6	3.7%
2049		39.9	17.9	271.7	213.8	3079.4	3.8%
2050		39.9	17.9	271.7	213.8	3293.2	3.9%

Source: HAIDEP Study Team
Note: In US$ million at 2006 constant prices.

Figure 9.2.3 Cash flow of UMRT Line 2 (Phase 1-4) at 2006 Constant Price



Source: HAIDEP Study Team

Regarding the increase by extension as the revenue of the extension phase, each phase is financially evaluated (Table 9.2.5). Phase 1 implies the FIRR of only 1.0%, which means that the project is not financially feasible. However, this result is considered favorable as an underground subway of which FIRR becomes hardly positive in usual case. The FIRRs of Phase 2 and 3 are higher but less than the threshold of 12%. The FIRR of Phase 4 is slightly below zero. As a conclusion, the project is judged financially unfeasible and requires non-commercial fund such as public investment.

Table 9.2.5 Financial Evaluation of UMRT Line 2 by Phase

Indicator	Unit	Phase 1	Phase 2	Phase 3	Phase 4	Entire Project
F-IFRR	%	1.0	6.9	9.7	-1.1	3.9
NPV	US$ million	-945.9	-78.3	-30.2	-83.2	-1,069.2
B/C	-	0.29	0.62	0.81	0.27	0.39

Source: HAIDEP Study Team

(2) Financial Evaluation at Current Price

The project of UMRT Line 2 was also evaluated from the standpoint of the special project company (SPC) which operates the project and represents an investor group For this purpose, the income statement and the cash flow are forecasted in current price, taking into consideration inflation, interest payment, tax payment and then depreciation of assets.

Main assumptions for the analysis are as follows.

(i) Domestic inflation rate is assumed at 4.2%, taking the average in the past five years;

(ii) The project is financed with the SPC's own capital equivalent to 30% of the total investment inclusive of interest payment during construction period and the other 70% with a long-term loan;

(iii) The terms of the loan are 8.0% of annual interest rate and 25 years of repayment with grace period for construction;

(iv) The corporate income tax is 30%;

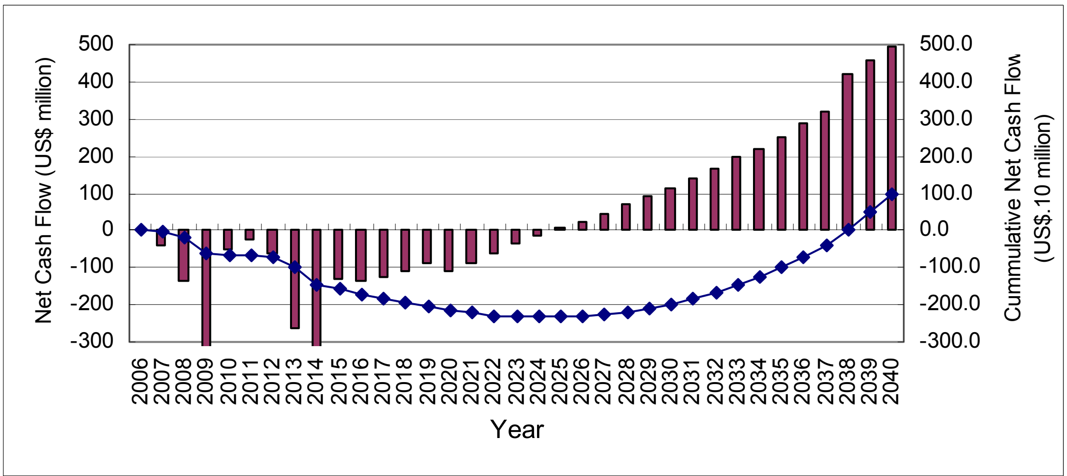
(v) Depreciation period is 30 years for infrastructure and 10 years for toll collection equipment;

(vi) Financial costs are assumed as follows:

- Arrangement fee: 0.5% of loan amount at commitment
- Commitment fee: 0.3% annually on outstanding loan amount
- Agent fee is regarded as included in annual operating cost.

Based on these assumptions, a nominal cash flow of the project was tabulated and the project FIRR and Equity FIRR were estimated based on the net cash flow as shown in Figure 9.2.4. The cumulative cash flow will not become positive for 25 years after opening Phase 1 which shows the project is not commercially sustainable.

Figure 9.2.4 Cash Flow of UMRT Line 2 (Phase 1–4) at Current Price



Source: HAIDEP Study Team

The project FIRR at current price is not improved much because the effect of inflation is cancelled by tax payment. The equity IRR is slightly lower than the project IRR as the interest rate is higher than the project FIRR.

Table 9.2.6 Project FIRR and Equity FIRR at Current Price

Phase	Project Evaluation		Evaluation from Investor's Standpoint	
	Project FIRR	Project NPV	Equity FIRR	Equity NPV
	%	US$ Million	%	US$ Million
Entire Project	4.6	-1,197.6	3.2	-846.5
Phase 1	2.7	-953.9	-0.4	-813.4
Phase 2	9.0	-49.3	12.7	17.5
Phase 3	11.1	-2.4	13.9	37.4
Phase 4	-0.2	-113.3	-	-90.8

Source: HAIDEP Study Team

Table 9.2.7 shows the profit and loss of the company (ie SPC) managing the UMRT Line 2, for the entire project (Phase 1 to 4) and the Phase 1 only. In both cases, the project cannot be judged profitable. However, revenue can cover at least annual O&M cost inclusive of depreciation cost except first several years. Therefore, the project can be possibly managed by the private sector if the infrastructure is developed by the public sector.

Table 9.2.7 Pro-forma Profit and Loss of UMRT Line 2 SOC

Phase	Item	2015	2020	2025	2030	2035	2040
Entire Project (Phase 1-Phase 4)	Revenue	105.0	314.5	430.1	588.3	804.6	1100.3
	Expenditure						
	- Maintenance Cost	46.6	94.7	116.3	142.9	175.6	215.7
	- Operation Cost	19.9	46.3	58.0	72.6	90.8	113.7
	- Depreciation	55.0	97.9	86.6	77.8	52.4	32.6
	Operating Income	-16.5	75.5	169.2	295.0	485.8	738.4
	Interest Payment	110.8	174.7	131.9	89.0	46.1	12.9
	Net Profit before Tax	-127.3	-99.2	37.3	206.1	439.7	725.5
	Corporate Tax	0.0	0.0	11.2	61.8	131.9	217.7
	Net Profit after Tax	-127.3	-99.2	26.1	144.2	307.8	507.9
	(Repayment)	60.2	60.2	60.2	60.2	60.2	0.0
Phase 1	Revenue	105.0	142.7	194.0	263.8	358.6	487.5
	Expenditure						
	- Maintenance Cost	46.6	57.2	70.3	86.3	106.1	130.3
	- Operation Cost	19.9	24.9	31.2	39.0	48.8	61.1
	- Depreciation	55.0	55.0	43.7	43.7	18.3	18.3
	Operating Income	-16.5	5.6	48.9	94.8	185.4	277.8
	Interest Payment	110.8	86.7	62.6	38.5	14.5	0.0
	Net Profit before Tax	-127.3	-81.1	-13.7	56.2	170.9	277.8
	Corporate Tax	0.0	0.0	0.0	16.9	51.3	83.3
	Net Profit after Tax	-127.3	-81.1	-13.7	39.4	119.7	194.5
	(Repayment)	60.2	60.2	60.2	60.2	60.2	0.0

Source: HAIDEP Study Team

10 CONCLUSION

1) Planning

(i) Prior to the operation of UMRT Line 2, a priority bus transit (PBT) can precede its operation. Once UMRT Line 2 comes online, the PBT buses can be assigned either as feeder service or to other routes without wastage of investment in PBT.

(ii) The UMRT Line 2 will be implemented in phases with the following schedules:

- Phase 1: Tu Liem to Thuong Dinh by 2013
- Phase 1a: Tu Liem to bach Khoa by 2013 (optional)
- Phase 2: Nam Thang Long to Tu Liem and Thuing Dinh to Ha Dong by 2016
- Phase 3: Nam Thang Long to Thai Phu by 2018
- Phase 4: Thai Phu to Noi Bai

(iii) The vertical alignment of Phase 1 will be underground, while other phases will need to be further studied, but with the following considerations:

- Noi Bai to Thai Phu-underground below the proposed second runway
- Thai Phu to Hai Noi-to be studied further
- Hai Boi to Nam Thang Long (Red River Crossing)-elevated or underground
- Tu Liem to Thanh Xuan-underground within Ring Road 2.5
- Thanh Xuan to Ha Dong-at-grade or elevated

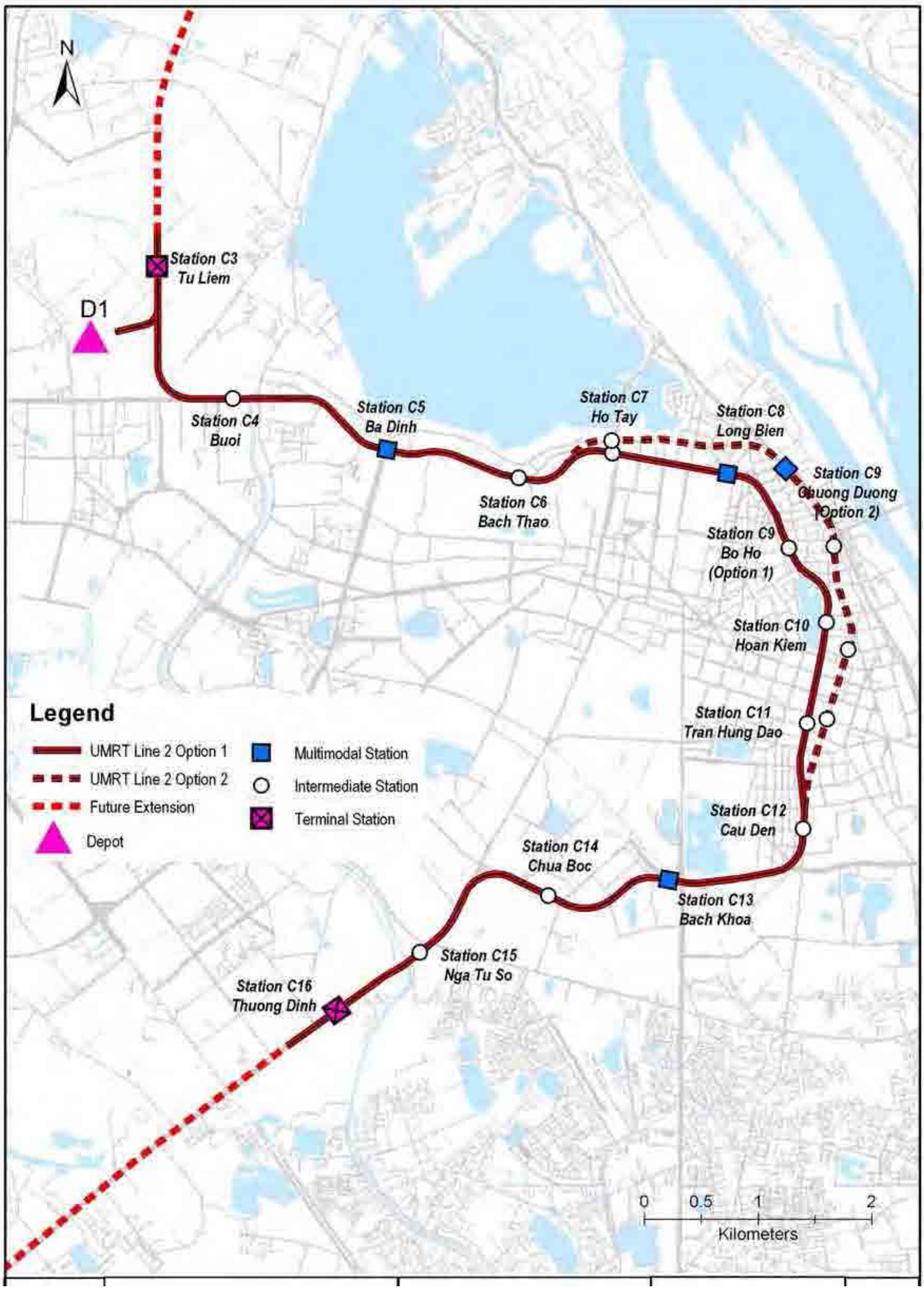
(iv) After a review of several candidate horizontal alignments, two options are recommended as shown in Figure 10.1.1.

(v) Key station development concepts are proposed for the following stations along UMRT Line 2:

- Hai Boi Station integration with the Van Tri Lake New Town Urban Center
- Nam Thang Long integration with CIPUTRA Housing Estate Area
- Tu Liem Station integration with the New Government Center Development Area
- Ba Dinh Station integration with the West Lakeside Development Area
- Long Bien Station as a transportation hub
- Bo Ho Station as the gateway to the Ancient Quarter
- Hoan Kiem Station as the Hoan Kiem Lake Gateway
- Tr. Hung Dao Station as the French Quarter Gateway
- Bach Khoa Station integration with Bach Khoa University and a the Thong Nhat Park Gateway
- Thuong Dinh Station integration with urban renewal and development of Thuong Dinh Area
- Thanh Xuan Station integrarion with urban renewal development of Xuan Bac and Xuan Nam Area

(vi) An Express Airport Service is proposed to serve Noi Bai Airport with a recommended Hanoi City Terminal at Hoan Kiem Station. A limited stop rail service is recommended.

Figure 10.1.1 Proposed Horizontal Alignment Options



Source: HAIDEP Study Team

(vii) The proposed main depot is recommended at Tu Liem, with future satellite depots at Ha Dong and Thai Phu.

(viii) The Administration and Operations Control Center is proposed to be located at Tu Liem Depot area.

(ix) The fare level that will maximize revenue was proposed. The revenue maximizing fare was estimated to be as follows: US$ 0.20 for the first 4.0 kms and US$ 0.05 per kilometer over the first 4.0 kms.

(x) The estimated ridership of UMRT Line 2 is as follows:

- 2014: 575,000 passengers per day (start of Phase 1)
- 2016: 832,000 passengers per day (start of Phase 2)
- 2018: 1,012,000 passengers per day (start of Phase 3)
- 2020: 1,130,000 passengers per day (start of Phase 4)

2) Engineering

(i) It is proposed that the UMRT tunnel (Phase 1) will be twin tunnels, catering to up-line and down-line rails respectively.

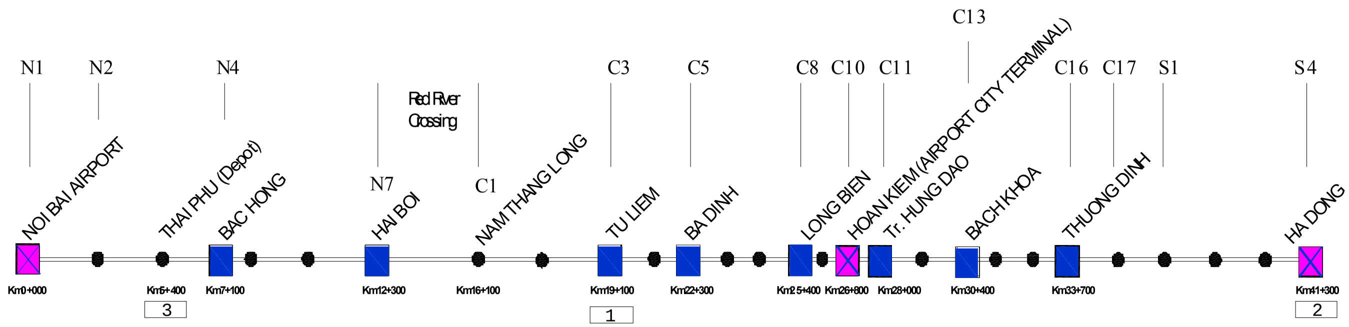
(ii) Key operations facilities are proposed along the UMRT tunnel (Phase 1) (see Figure 10.1.2).

(iii) It is proposed that the tunnel will be constructed using MixShield Tunnel Boring Machine.

(iv) For the UMRT Line 2 Phase 3, a crossing across the Red River is necessary. Two options are examined, i.e. bridge crossing and tunnel crossing. Ultimately the choice will consider the vertical alignment of the sections approaching the Red River. Nonetheless, considering cost implications it is preliminarily recommended to utilize a bridge crossing.

(v) Generally it is proposed that station layout will use center platforms. Stations plans and sections are indicatively proposed in the report, considering terminal, multimodal and intermediate station designs

Figure 10.1.2 Operations Facilities



Operations Facility	Key	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Terminal stations	TS	TS	TS				TS				TS	TS				TS	6
Multimodal interchange	MM	MM		MM		MM		MM	MM	MM	MM	MM	MM			MM	10
Intermediate Stations	INT	INT	INT		INT		INT	INT	INT INT	INT	INT	INT INT	INT INT	INT INT	INT INT		17
Airport Station	APT	APT				APT		APT			APT						4
Crossover (double turnout)	XT	XT	XT				XT	XT			XT		XT			XT	7
Turnback track	TBT	TBT														TBT	2
Emergency siding/pocket track	ES					ES		ES			ES		ES				4
Tunnel Portal	TP		TP			TP		TP					TP				4
Emergency Services access	ESA	ESA		ESA		ESA	ESA	ESA		ESA		ESA			ESA		8
Cross passage	CP	CP				CP				CP		CP					4
Ventilation shaft	VS	VS				VS	VS	VS	VS	VS	VS VS	VS	VS				10
Tunnel drainage sumps	DS	DS	DS			DS	DS	DS (2)	DS	DS	DS DS	DS	DS				11
Administration Building	ADB							ADB									1
Operations Control Centre	OCC							OCC									1
Depot & vehicle storage	D		D3					D1								D2	3
Infeed substation	ISS		ISS					ISS								ISS	3
Traction substation	TSS	TSS	TSS	TSS		TSS	TSS	TSS	TSS	TSS		TSS	TSS		TSS	TSS	12
Flood gate	FG	FG	FG			FG	FG	FG (2)		FG			FG				8

Source: HAIDEP Study Team

3) Transit Operations and Maintenance

(i) It is proposed that UMRT Line 2 will be based on 6-car trains with minimum headway of two minutes

(ii) UMRT Line 2 will have the following train requirements:

- 18 x 6 trains (Phase 1) by 2020, with 3.25 minutes headway
- 28 x 6 trains (Phase 2) by 2020, with 3.00 minutes headway
- 36 x 6 trains (Phase 3) by 2020, with 2.75 minutes headway
- 37 x 6 trains (Phase 4) by 2020, with 2.75 minutes headway
- 51 x 6 trains (Phase 4) by 2040, with 2.00 minutes headway (max)

(iii) The proposed rolling stock is outlined as follows:

- Metro-type
- Capacity of 285 pax/car (design) and 375 pax/car (crush)
- Longitudinal seats
- 4-sets of external bi-parting doors
- Max speed of 100 kph
- Max. gradient = 3%
- Min. horizontal track curvature in depot = 140 meters
- Driving cabins at both ends of the train

(iv) The depots shall be developed to be able to meet the following demand:

- Phase 1: 108 cars
- Phase 2: 168 cars
- Phase 3: 216 cars
- Phase 4: 222 cars
- Phase 4: 306 cars (max)

4) Construction and O&M Cost

(i) Construction cost of the UMRT Line 2, including civil works, workshop/depot, railway system, and rolling stock is estimated as follows:

- Phase 1: US$1.4 billion
- Phase 1a: US$ 1.1 billion
- Phase 2: US$ 326 million
- Phase 3: US$ 326 million
- Phase 4: US$ 320 million
- Grand Total of US$ 2.4 billion

(ii) Operation and Maintenance Cost of the UMRT Line 2 including staff, energy, spares, insurance and taxes, and other is estimated as follows:

- Phase 1 (2020): US$14.0 million/ yr
- Phase 1a (2020): US$11.2 million/ yr
- Phase 4 (2020): US$24.0 million/ yr
- Phase 4 (2040): US$28.1 million/ yr

5) Environment and Social Considerations

(i) Major negative environmental and social impacts:

- Resettlement, land acquisition and demolition of some parts in the Ancient Quarter if the cut and cover method is implemented, are the most significant negative impacts.
- In the construction phase, a number of negative impacts on physical environment are expected, such as vibration, noise, air pollution, water pollution, erosion and sedimentation; and negative environmental impacts associated with temporary roads, stockpiles, etc. However, most of these impacts are temporary and can be mitigated.
- There exist some expected significant but unknown negative impacts, eg. impacts of construction works to Hoan Kiem lake ecosystem; effect of the project on probable underground buried historical remains, etc. that need more detail study in the FS phase.

(ii) A full EIA in the FS phase is important and necessary.

6) Implementation Plan

(i) Based on the funding shortage of the Government of Vietnam it is contemplated that ODA funding will be utilized at least for UMRT Line 2 Phase 1. Thus treatment of ODA is a deciding factor in the organizational set-up for UMRT Line 2.

(ii) The proposed implementation model for UMRT Line 2 is as follows:

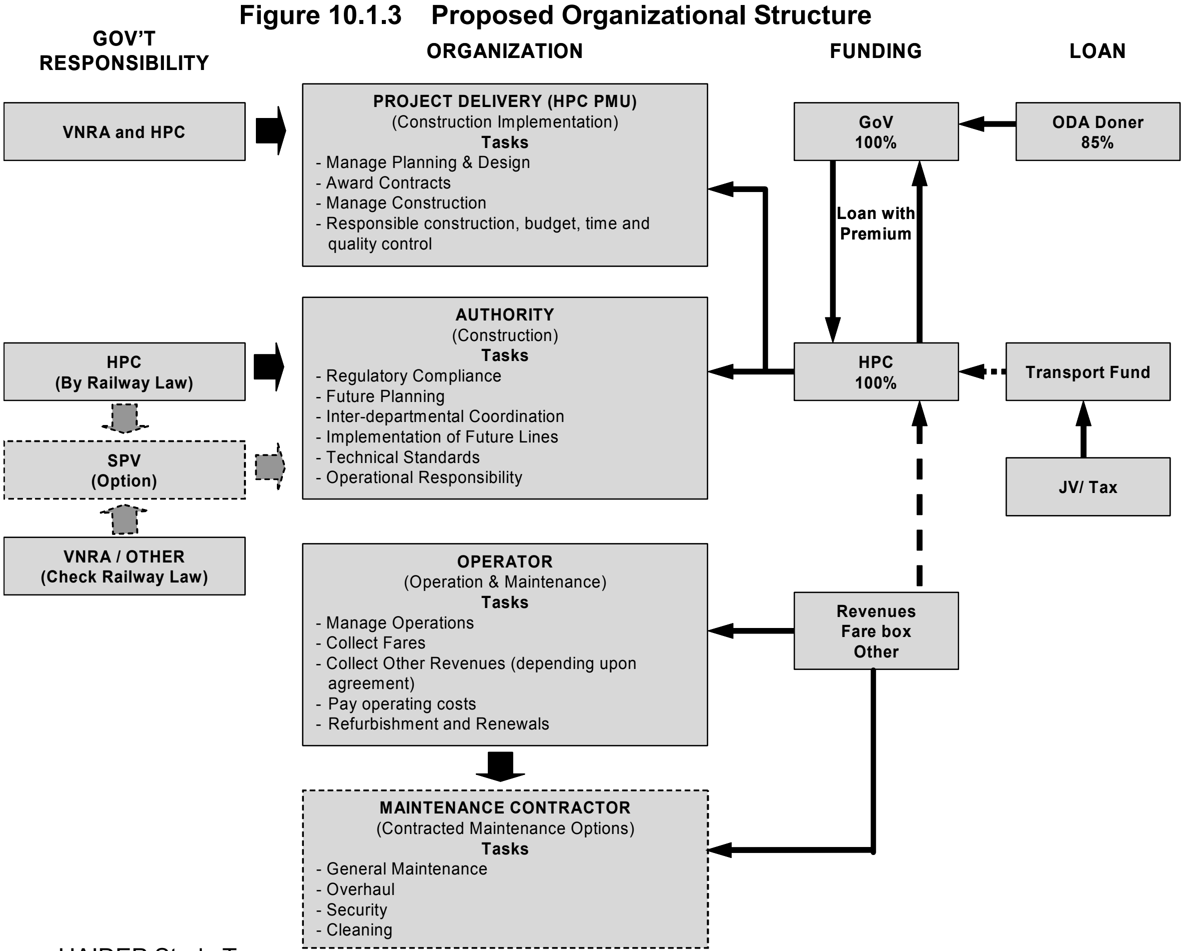
- The proposed implementation model shall start with a single implementation body strongly backed up by the government which is also active on the railway related property development.
- As the experience and know-how for the railway business accumulate, the structure shall move towards a clear separation of regulatory function and service provision function (operation) by introducing competition among the private sector players in service provision. Meanwhile, the public sector will maintain control over the public transport network development and effective integration of urban development.
- For the first stage, it is recommended that the Hanoi City create a Mass Transit Authority which will design, build, finance and operate the whole UMRT Line 2 System with active involvement in the railway related property development along the corridor.

(iii) The proposed organizational structure of UMRT Line 2 is shown in Figure 10.13.

(iv) Considering the current institutional capability and setup, it is necessary that the institutional framework of UMRT Line 2 evolve with the project along with the phasing of the project from preparation to stable operation phase. The proposed transition is illustrated in Figure 10.1.4.

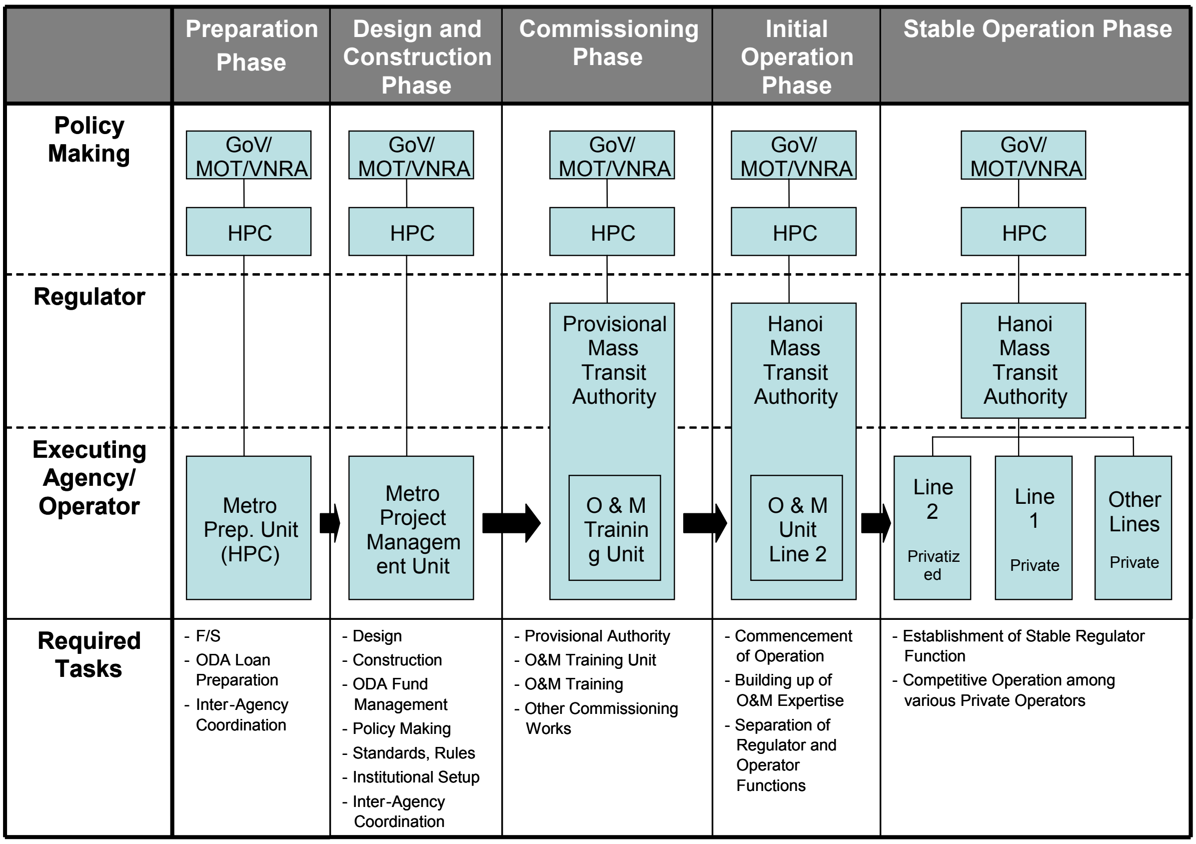
(v) The target opening year of Phase 1 is 2013, which means that the schedule for this Phase is very tight. Efficient processing of the ODA loan and measures to shorten the time for design and construction is required. Figure 10.1.5 outlines the implementation schedule for UMRT Line 2 Phase 1.

Figure 10.1.3 Proposed Organizational Structure



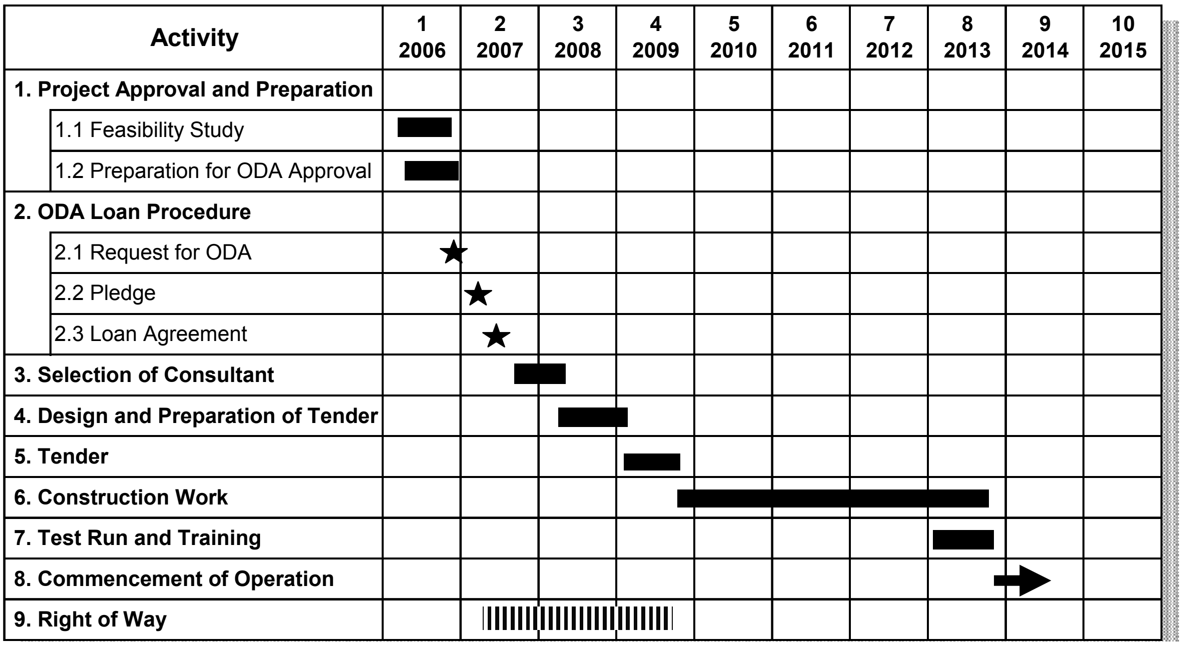
Source: HAIDEP Study Team.

Figure 10.1.4 Transition of Institutional Setup



Source: HAIDEP Study Team

Figure 10.1.5 Project Schedule for Phase 1



Source: HAIDEP Study Team

(vi) Integrated rail and urban development will be important for UMRT Line 2, considering the many potential areas for development along its corridor. Thereby these potentials need to be coordinated and be made as a fundamental strategy to enhance the viability of UMRT Line 2.

7) Evaluation

(i) The economic evaluation of UMRT Line 2 shows the robust economic viability of UMRT Line 2 with the following indicators:

- EIRR = 22.5%
- NPV = US$ 3.8 billion
- B/C = 3.6

(ii) The financial evaluation of UMRT Line 2 shows low indicators, indicating the requirement of government support.

- FIRR (at constant price) = 3.9%
- FIRR (at current price) = 4.6%

(iii) All phases of UMRT Line 2 are financially unviable with FIRR (at constant price) as follows:

- Phase 1: 1.0%
- Phase 2: 6.9%
- Phase 3: 9.7%
- Phase 4: - 1.1%