SUPPORTING E

SEWERAGE PLAN

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CHAPTER 1 PRESENT CONDITION OF WASTEWATER SEWERAGE SYSTEM

1.1 REVIEW OF VIETNAM REVISED MASTER PLAN

The volume of wastewater that will generated from the entire area of Hoa Lac High-tech Park (HHTP) has been estimated by the VN Revised M/P and is shown in Table E.1.1 below. HHTP is divided by the Lang-Hoa Lac Express (LHLE) into two areas. In the Hoa Lac Area (north of the LHLE), the average wastewater volume of 25,850m^3/day has been estimated. The length of the sewer in this part will be about 22km, with the pipe diameter ranging from 200mm to 500mm. Ten (10) intermediate pumping stations are planned to be constructed in the Hoa Lac Area (north of the LHLE). In the Northern Phu Cat, Area (south of the LHLE) the average wastewater volume of 8,000m^3/d has been estimated The length of the sewer in this part will be about 13km, with the pipe diameter ranging from 300mm to 800mm.

Table E.1.1 Wastewater Yield Forecast

Land Use		VN Revised M/P: Area (ha)			Daily Average Wastewater Yield (m^3/d)		
		Total	Stage 1	Stage 2	Total	Phase 1	Phase 2
1	Software Park	75.9	44.0	31.9	803	431	372
2	Research & Development	229.0	132.8	96.2	1,393	731	662
3	High-tech Industrial	549.5	226.3	323.2	22,255	9,165	13,090
4	Education & Training	108.0	50.0	58.0	732	306	426
5	Center of High-tech City	50.0	50.0		727	727	0
6	Mixed Use	87.7	48.5	39.2	157	157	0
7	Houses & Offices	42.0	42.0		3,158	3,158	0
8	Housing Complex	26.0	12.4	13.6	4,531	1,904	2,627
9	Amenity	110.0	110.0		7	7	0
10	Amusement	33.5	33.5		51	51	0
11	Infrastructure	115.5	115.5		0	0	0
12	Lake & Buffer	117.0	117.0		0	0	0
13	Greeneries/Trees	42.0	42.0		0	0	0
Total		1,586.0	1,024.0	562.0	33,814	16,637	17,177
In Round Number					33,850	16,650	17,200

Source: VN Revised M/P

The following issues were confirmed after discussion with HHTP-MB:

- Domestic and Industrial Wastewater (Qsh): 90% of water supply.
- Gray water generated from commercial and public water uses: 10% of Domestic and Industrial Wastewater (Qsh).
- Operation and Maintenance (O&M) of the sewerage facilities: conducted by HHTP-MB.

1.2 PRESENT CONDITIONS OF WASTEWATER SEWERAGE DEVELOPMENT

1.2.1 Wastewater Sewer System

Wastewater sewer line having a length of 11km has been approved for the early stage of Stage-1 (2015) of the Project. However, only limited part of sewerage has been installed in the area such as around approved intermediate pumping stations. The approved sewers are shown in Table E.1.2 and Figure E.1.1 below. PVC (Polyvinyl chloride) pipe has been adopted for wastewater sewer line.

Table E.1.2 Step-1 of Stage-1 Approved Wastewater Sewer Line

Route No. of Road	Diameter (mm) of Sewer	Length (m)
Road B	D200, 300	2,143
Road C	D200, 400	1,691
Road A	D300, 400, 500	5,866
Road D	D300	1,316
Total		11,016

Source: HHTP-MB

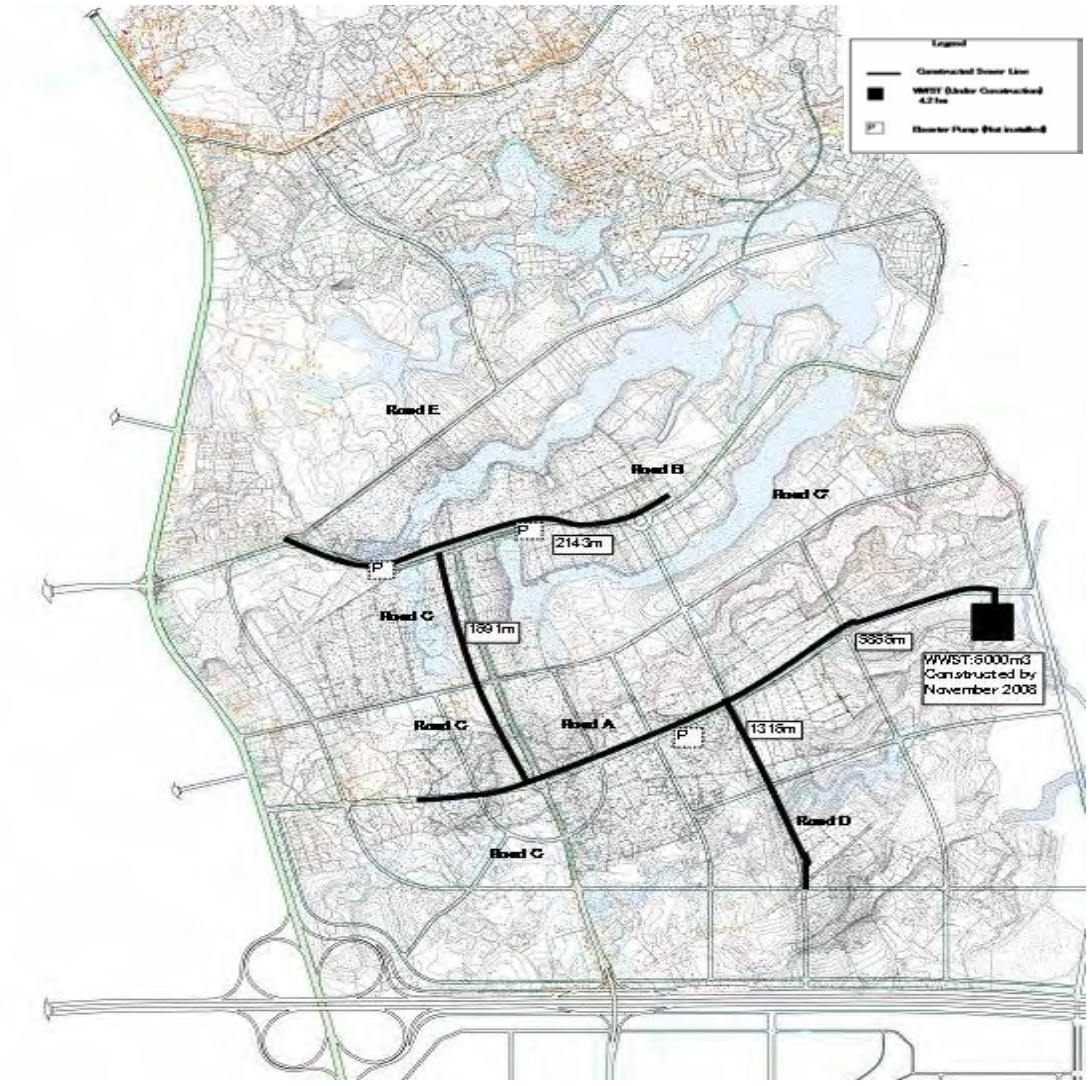


Figure E.1.1 Present Condition for Sewerage System

1.2.2 Wastewater Treatment Plants

The implementation plan for wastewater treatment plant (WWTP) as mentioned in the VN Revised M/P is shown in Table E.1.3 below.

Table E.1.3 Wastewater Treatment Plant Implementation Plan in the HHTP

Wastewater Treatment Plant	Hoa Lac Area (m^3/d)	Northern Phu Cat Area (m^3/d)	Total (m^3/d)
Stage 1 (2015)	16,650		16,650
- WWTP No.1 (under construction)	6,000		
- WWTP No.1 (Expansion)	10,650		
Stage 2 (2020)	9,350	8,000	17,350
- WWTP No.1 (Expansion)	9,350		
- WWTP No.2		8,000	
Total	26,000	8,000	34,000

Source: VN Revised M/P

A wastewater treatment plant having a capacity of 6,000m^3/d was recently implemented and its construction works were completed by end of 2008, as shown in Figure E.1.2. An activated sludge process with neutralization and coagulation sedimentation has been applied to treat wastewater generated from early stage of Stage-1 (2015) in the Hoa Lac Area. The total construction cost was about VND 73 billion. In addition, the HHTP-MB has already acquired the land area of 4.2ha that will be required for construction of WWTP No.1. This will treat the generated wastewater from the Hoa Lac Area.

Figure E.1.2 Implementation Status of Water Treatment Plants

1.2.3 Issues and Strategy

By the examination of the present conditions in the Hoa Lac area (north of LHLH), the following problems and constraints were identified for planning of the sewerage system:

- In the VN Revised M/P the elevation of main road were not found suitable for wastewater collection system. However, in principle the land use plan cannot be changed as the VN Revised M/P has already been approved by the Prime Minister of Vietnam and has been adopted as a general plan.
- It is necessary that unit water demand and unit wastewater yield shall be reviewed since consistency between unit demand of water supply and unit wastewater yield is not in correspondent to the VN Revised M/P.
- It is of concern that the ratio of wastewater yield to water supply is low i.e. 67 %.
- The O&M of sewerage facilities including wastewater treatment plant is to be conducted by HHTP-MB. However, the O&M system including wastewater fare collection has not planned in the VN Revised M/P.
- According to the land leveling plan of the VN Revised M/P, the ten (10) numbers of intermediate pump stations are planned for construction in the Hoa Lac area (north of LHLH).However, the emergency power supply for the intermediate pump stations during the electric power failure has not been planned in the VN Revised M/P.
- The land leveling plan for the land reclamation in the Hoa Lac area (north of LHLH) will

be altered in order to avoid the construction of the intermediate pump stations.

- As for the some part of existing sewerage inventories which are remained partly constructed, they can't meet revised volume of wastewater and shall be reconstructed.
- As the existing plan was designed to convey wastewater by pressure system directly to wastewater treatment plant from a distance, the certain areas especially the area adjacent to wastewater treatment plant and sewerage system need to be revised.

The sewerage system plan is proposed under the following conditions and strategy:

- The unit wastewater yield in the Hoa Lac area (north of LHLH) has been modified corresponding to the unit water demand as proposed by JICA Study Team.
- Ratio of wastewater yield as proposed by the VN Revised M/P has to be kept.
- The design criteria to set up the sewerage facilities should meet the Vietnamese Standards.
- It is proposed to be establishing proper structure for the O&M of the drainage and sewerage facilities including wastewater treatment plant.

CHAPTER 2 FRAMEWORK OF SEWERAGE DEVELOPMENT PLAN

2.1 BASIC CONCEPTS

The basic concepts adopted for the development of sewerage plan in the Hoa Lac Area are briefly described below:

2.1.1 Target Year

The year 2020 has been set as a target completion year for the HHTP project. This has been set coordinating with Hanoi's integrated city planning including LHLE, prepared by Vietnamese government.

2.1.2 Project Area

The project area of about 1,268ha in Hoa Lac in Hanoi province has been determined by the VN Revised M/P for the Hoa Lac area (north of LHLE). However, total area of about 1,036ha has been estimated for F/S of the Hoa Lac area which excludes the area allocated for Amenity zone and Stage-2 (2020) of High-tech Industrial zone.

2.1.3 Design Population

The JICA Study Team estimated the total population of about 188,559 in the Hoa Lac Area and the details are mentioned in Table E.2.1.

Table E.2.1 Design Population

Description	Stage 1 (2015)	Stage 2 (2020)	Total
1. Area (ha)	980.8	287.2	1,268.0
2. Population in Total	11,8468	70,091	188,559
1) Daytime Population	53,328	36,606	98,625
2) Nighttime Population	65,140	33,485	98,625

Source: JICA Study Team

2.1.4 Sewerage Collection System

Separated system has been adopted for the collection of wastewater in the Hoa Lac Area. The toxic and hazardous wastewater which is usually discharged from commercial and industrial facilities shall be treated and disposed by each respective developer prior to discharging it to sewerage system.

2.1.5 Wastewater Treatment Method

Conventional activated sludge method is recommended for wastewater treatment in the Hoa Lac Area.

2.1.6 Design Wastewater Yield

Based on daily average water supply as proposed by JICA Study Team, the total design wastewater yield of about 30,900m^3/d (21,800m^3/d for Stage-1 (2015) and 9,200m^3/d for Stage-2 (2020)) has been estimated and the details are mentioned in Table E.2.2.

Table E.2.2 Wastewater Yield in Hoa Lac Area

Name of Development Zone	Average Water Supply (m3/d)						Average Wastewater Yield (m3/d)				
	Classification	Unit	Unit Demand	Total	Stage 1 (2015)	Stage 2 (2020)	Classification	Collection Ratio (%)	Total	Stage 1 (2015)	Stage 2 (2020)
1 Software Park	Commercial	lpcd	76.0	978.9	664.2	314.6	Commercial	90.0	881.0	597.8	283.2
2 R&D	Commercial	m3/ha	22.0	5,013.8	2,919.4	2,094.4	Commercial	90.0	4,512.4	2,627.5	1,885.0
3 Hi-tech Industrial	Industrial	m3/ha	45.0	10,422.0	8,883.0	1,539.0	Industrial	90.0	9,379.8	7,994.7	1,385.1
4 Education & Training				3,732.5	711.9	3,020.5			3,126.0	596.2	2,529.7
	Domestic (Q4)	lpcd	150.0	2,592.0	494.4	2,097.6	Domestic (Q4)	90.0	2,332.8	445.0	1,887.8
	Commuter	lpcd	24.0	622.1	118.7	503.4	Commuter	90.0	559.9	106.8	453.1
	Public	% of Q4	10.0	259.2	49.4	209.8	Public	0.0	0.0	0.0	0.0
	Commercial	% of Q4	10.0	259.2	49.4	209.8	Commercial	90.0	233.3	44.5	188.8
5 Center of hi-tech City				1,440.6	1,440.6	0.0		90.0	1,230.4	1,230.4	0.0
	Domestic (Q5)	lpcd	150.0	735.0	735.0	0.0	Domestic (Q5)	90.0	661.5	661.5	0.0
	Commuter	lpcd	76.0	558.6	558.6	0.0	Commuter	90.0	502.7	502.7	0.0
	Public	% of Q5	10.0	73.5	73.5	0.0	Public	0.0	0.0	0.0	0.0
	Commercial	% of Q5	10.0	73.5	73.5	0.0	Commercial	90.0	66.2	66.2	0.0
6 Mixed Use				1,754.2	938.4	815.9		90.0	1,476.1	789.6	686.5
	Domestic (Q6)	lpcd	150.0	1,140.8	610.2	530.6	Domestic (Q6)	90.0	1,026.7	549.2	477.5
	Commuter	lpcd	76.0	385.3	206.1	179.2	Commuter	90.0	346.8	185.5	161.3
	Public	% of Q6	10.0	114.1	61.0	53.1	Public	0.0	0.0	0.0	0.0
	Commercial	% of Q6	10.0	114.1	61.0	53.1	Commercial	90.0	102.7	54.9	47.7
7 Houses & Offices				6,146.7	6,146.7	0.0		90.0	5,071.1	5,071.1	0.0
	Domestic (Q7)	lpcd	150.0	5,122.3	5,122.3	0.0	Domestic (Q7)	90.0	4,610.0	4,610.0	0.0
	Public	% of Q7	10.0	512.2	512.2	0.0	Public	0.0	0.0	0.0	0.0
	Commercial	% of Q7	10.0	512.2	512.2	0.0	Commercial	90.0	461.0	461.0	0.0
8 Housing Complex				6,244.4	3,370.9	2,873.5		90.0	5,151.6	2,781.0	2,370.7
	Domestic (Q8)	lpcd	150.0	5,203.7	2,809.1	2,394.6	Domestic (Q8)	90.0	4,683.3	2,528.1	2,155.1
	Public	% of Q8	10.0	520.4	280.9	239.5	Public	0.0	0.0	0.0	0.0
	Commercial	% of Q8	10.0	520.4	280.9	239.5	Commercial	90.0	468.3	252.8	215.5
9 Amenity				9.9	9.9	0.0		90.0	8.9	8.9	0.0
	Domestic (Q9)	lpcd	45.0	9.9	9.9	0.0	Domestic (Q9)	90.0	8.9	8.9	0.0
	Public	% of Q9	0.0	0.0	0.0	0.0	Public	0.0	0.0	0.0	0.0
	Commercial	% of Q9	0.0	0.0	0.0	0.0	Commercial	90.0	0.0	0.0	0.0
10 Amusement				4,551.1	4,097.9	453.2		90.0	67.2	67.2	0.0
	Greening	l/m2/d	1.5	498.0	498.0	0.0	Greening	0.0	0.0	0.0	0.0
	Swimming Pool	%	10.0	906.4	453.2	453.2	Swimming Pool	0.0	0.0	0.0	0.0
	Domestic	lpcd	45.0	74.7	74.7	0.0	Commercial	90.0	67.2	67.2	0.0
	Public	l/m2/d	13.1	3,072.0	3,072.0	0.0	Public	0.0	0.0	0.0	0.0
11 Traffic & Infrastructure				0.0					0.0	0.0	0.0
12 Lake & Buffer				0.0					0.0	0.0	0.0
13 Greeneries/Trees				0.0					0.0	0.0	0.0
Total				41,913.0	31,679.8	10,233.2			30,904.5	21,764.4	9,140.1
Average Ratio of Wastewater Yield to Water Supply									73.7%		

Source: JICA Study Team

As the result of reviewing the VN Revised M/P, wastewater yield of 30,905m^3/day has been proposed for sewerage plan in the Hoa Lac area. Comparison of wastewater yields between the VN Revised M/P and JICA Study Team is presented in Table E.2.3.

Table E.2.3 Comparison of Wastewater Yields

Description	VN Revised M/P	JICA Study Team	Differences
Daily Average Water Demand (m^3/d)	38,495	41,913	3,418
Daily Average Wastewater Yield (m^3/d)	25,850	30,905	5,055
Average Ratio of Wastewater Yield to Water Supply (%)	67	74	-

Source: JICA Study Team

2.2 DESIGN WASTEWATER FLOW

Design wastewater flow was determined for formulating the sewerage development plan as described below:

2.2.1 Daily Average Wastewater Flow (DAWF)

Daily average wastewater flow (DAWF) will be 90% of daily average water supply for

Domestic, Industrial and Commercial Uses and the unit yield for each category is as follows:

Classification of Wastewater	Unit Yield
1. Domestic wastewater	
1) Residents	135.0 (l/c/d)
2) Non-residents	68.4 (l/c/d)
3) Non-residents for Education & Training zone	21.6 (l/c/d)
2. Industrial/Commercial wastewater	
1) High-tech Industrial zone	40.5 (m^3/ha/d)
2) Research & Development zone	19.8 (m^3/ha/d)
3) Amenity and Amusement zones	40.5 (l/c/d)
3. Commercial wastewater for general purpose	10% of Domestic use

Daily average wastewater flow (DAWF) for each development zone is summarized and is shown in Table E.2.4.

Table E.2.4 Daily Average Wastewater Flow (DAWF) by Zone

Land Use	Area (ha)			DAWF(m3/day)		
	Stage1(2015)	Stage2(2020)	Total	Stage1(2015)	Stage2(2020)	Total
1. Software Park	43.7	20.7	64.4	658	311	969
2. R&D	132.7	95.2	227.9	2,890	2,073	4,964
3. High-tech Industrial	197.4	34.2	231.6	8,794	1,524	10,318
4. Education & Training	20.6	87.4	108.0	656	2,783	3,439
5. Center of hi-tech City	49.0	0.0	49.0	1,353	0	1,353
6. Mixed Use	45.2	39.3	84.5	869	755	1,624
7. Houses & Offices	41.9	0.0	41.9	5,578	0	5,578
8. Housing Complex	12.2	10.4	22.6	3,059	2,608	5,667
9. Amenity	110.0	0.0	110.0	10	0	10
10. Amusement	33.2	0.0	33.2	74	0	74
11. Traffic & Infrastructure	147.1	0.0	147.1	0	0	0
12. Lake & Buffer	117.0	0.0	117.0	0	0	0
13. Greeneries/Trees	30.8	0.0	30.8	0	0	0
Total	980.8	287.2	1,268.0	23,941	10,054	33,995

Source: JICA Study Team

Daily average wastewater flow (DAWF) that has been estimated based on the classification of type of water uses is shown in Table E.2.5.

Table E.2.5 Daily Average Wastewater Flow (DAWF) Classified by Water Use Type

Unit: m3/day

Land Use	Stage1(2015)					Stage2(2020)					Total				
	Domestic	Commercial	Industrial	Ground	Total	Domestic	Commercial	Industrial	Ground	Total	Domestic	Commercial	Industrial	Ground	Total
1. Software Park	0	598	0	60	658	0	283	0	28	311	0	881	0	88	969
2. R&D	0	2,627	0	263	2,890	0	1,885	0	188	2,073	0	4,512	0	451	4,964
3. High-tech Industrial	0	0	7,995	799	8,794	0	0	1,385	139	1,524	0	0	9,380	938	10,318
4. Education & Training	445	151	0	60	656	1,888	642	0	253	2,783	2,333	793	0	313	3,439
5. Center of hi-tech City	662	569	0	123	1,353	0	0	0	0	0	662	569	0	123	1,353
6. Mixed Use	549	240	0	79	869	477	209	0	69	755	1,027	449	0	148	1,624
7. Houses & Offices	4,610	461	0	507	5,578	0	0	0	0	0	4,610	461	0	507	5,578
8. Housing Complex	2,528	253	0	278	3,059	2,155	216	0	237	2,608	4,683	468	0	515	5,667
9. Amenity	0	9	0	1	10	0	0	0	0	0	0	9	0	1	10
10. Amusement	0	67	0	7	74	0	0	0	0	0	0	67	0	7	74
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	8,794	4,976	7,995	2,176	23,941	4,520	3,235	1,385	914	10,054	13,314	8,210	9,380	3,090	33,995

Source: JICA Study Team

2.2.2 Groundwater Infiltration (GIF)

Groundwater infiltration and unexpected surface water intrusion shall be considered when designing the capacity of the sewerage collection system. Groundwater infiltration including unexpected surface water intrusion is experientially assumed to be 10% to 20% of DAWF. In this study, considering the following factors, the rate of 10% of DAWF has been proposed.

1) Sub-surface geological conditions: clay and silt with low permeability.
2) Static groundwater level: deeper than 3m after land reclamation to meet 100 years of

Return Period (or as for detailed information, refer to the Geological Survey Report of Data Book 2).

3) Pipe installation method and materials: PVC pipe with collar joints.

2.2.3 Daily Maximum Wastewater Flow (DMWF)

The following formula is adopted to estimate Daily Maximum Wastewater Flow (DMWF):

$DMWF = k_d \cdot DAWF$

Where,
DAWF : Daily Average Wastewater Flow
k_d : Daily Peak Flow Factor

By comparing the daily peak flow factors of the following major cities in the world, the daily peak flow factor (k_d) of 1.20 has been adopted.

- Tokyo : 1.25 to 1.5 or data on water consumption pattern
- Bangkok : 1.20
- Manila : 1.20
- Jakarta : kd = 4.02・(0.0864Q)-0.154, Q: DAWF (l/sec)
- Saigon : 1.25

Daily Maximum Wastewater Flow (DMWF) classifying the different water uses in various zones has been estimated and mentioned in Table E.2.6. These estimates will be applied during the preparation of plan and design of wastewater treatment plant.

Table E.2.6 Daily Maximum Wastewater Flow (DMWF)

Unit: m3/day

Zone	Stage 1					Stage 2					Total				
	Domestic	Commercial	Industrial	Ground	Total	Domestic	Commercial	Industrial	Ground	Total	Domestic	Commercial	Industrial	Ground	Total
1. Software Park	0	717	0	60	777	0	340	0	28	368	0	1,057	0	88	1,145
2. R&D	0	3,153	0	263	3,416	0	2,262	0	188	2,450	0	5,415	0	451	5,866
3. High-tech Industrial (CN1)	0	0	9,594	799	10,393	0	0	1,662	139	1,801	0	0	11,256	938	12,194
4. Education & Training (DT)	534	182	0	60	775	2,265	770	0	253	3,289	2,799	952	0	313	4,064
5. Center of hi-tech City	794	683	0	123	1,600	0	0	0	0	0	794	683	0	123	1,600
6. Mixed Use	659	289	0	79	1,026	573	251	0	69	892	1,232	539	0	148	1,919
7. Houses & Offices	5,532	553	0	507	6,592	0	0	0	0	0	5,532	553	0	507	6,592
8. Housing Complex	3,034	303	0	278	3,615	2,586	259	0	237	3,082	5,620	562	0	515	6,697
9. Amenity (GF)	0	11	0	1	12	0	0	0	0	0	0	11	0	1	12
10. Amusement (TD)	0	81	0	7	87	0	0	0	0	0	0	81	0	7	87
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	10,553	5,971	9,594	2,176	28,294	5,425	3,881	1,662	914	11,882	15,977	9,852	11,256	3,090	40,176

Source: JICA Study Team

2.2.4 Hourly Maximum Wastewater Flow (HMWF)

The hourly maximum wastewater flow (HMWF) is usually estimated by the following formula:

$HMWF = k_h \cdot DMWF + GIF$

Where,
DMWF : Daily Maximum Wastewater Flow
k_d : Hourly Peak Flow Factor

By comparing the hourly peak flow factor that has been applied in the following countries in Asia, the hourly peak flow factor (k_d) of 1.56 (x1.30 of DMWF factor 1.20) has been adopted:

- Japan : 1.30 to 1.80 or Babbit formula (1.25 to 5.0)
- Malaysia : Babbit formula = 4.7・P-0.11, P: Design Population (unit: 1000)
- Philippines : Babbit formula = 2.2 – 0.3・log P , P: Design Population (unit: 1000)

The hourly maximum wastewater flow (HMWF) will be applied for planning and design of wastewater collection sewer line and conduit pipe of wastewater treatment plant. HMWF

classifying the different water uses in various zones is summarized in the Table E.2.7.

Table E.2.7 Hourly Maximum Wastewater Flow

Unit: m3/day

Land Use	Stage1 (2015)					Stage2 (2020)					Total				
	Domestic	Commercial	Industrial	Ground	Total	Domestic	Commercial	Industrial	Ground	Total	Domestic	Commercial	Industrial	Ground	Total
1. Software Park	0	933	0	60	992	0	442	0	28	470	0	1,374	0	88	1,462
2. R&D	0	4,099	0	263	4,362	0	2,941	0	188	3,129	0	7,039	0	451	7,491
3. High-tech Industrial	0	0	12,472	799	13,271	0	0	2,161	139	2,299	0	0	14,632	938	15,570
4. Education & Training	694	236	0	60	990	2,945	1,001	0	253	4,199	3,639	1,237	0	313	5,189
5. Center of hi-tech City	1,032	887	0	123	2,042	0	0	0	0	0	1,032	887	0	123	2,042
6. Mixed Use	857	375	0	79	1,311	745	326	0	69	1,140	1,602	701	0	148	2,450
7. Houses & Offices	7,192	719	0	507	8,418	0	0	0	0	0	7,192	719	0	507	8,418
8. Housing Complex	3,944	394	0	278	4,616	3,362	336	0	237	3,935	7,306	731	0	515	8,552
9. Amenity	0	14	0	1	15	0	0	0	0	0	0	14	0	1	15
10. Amusement	0	105	0	7	112	0	0	0	0	0	0	105	0	7	112
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	13,718	7,762	12,472	2,176	36,129	7,052	5,046	2,161	914	15,173	20,770	12,808	14,632	3,090	51,302

Source: JICA Study Team

Summary of various types of wastewater flow are summarized in Table E.2.8.

Table E.2.8 Summary of Wastewater Yield

Unit: m3/day

Zone	Stage 1 (2015)			Stage 2 (2020)			Total		
	DAWF	DMWF	HMWF	DAWF	DMWF	HMWF	DAWF	DMWF	HMWF
1. Software Park	658	777	992	311	368	470	969	1,145	1,462
2. R&D	2,890	3,416	4,362	2,073	2,450	3,129	4,964	5,866	7,491
3. High-tech Industrial	8,794	10,393	13,271	1,524	1,801	2,299	10,318	12,194	15,570
4. Education & Training	656	775	990	2,783	3,289	4,199	3,439	4,064	5,189
5. Center of hi-tech City	1,353	1,600	2,042	0	0	0	1,353	1,600	2,042
6. Mixed Use	869	1,026	1,311	755	892	1,140	1,624	1,919	2,450
7. Houses & Offices	5,578	6,592	8,418	0	0	0	5,578	6,592	8,418
8. Housing Complex	3,059	3,615	4,616	2,608	3,082	3,935	5,667	6,697	8,552
9. Amenity	10	12	15	0	0	0	10	12	15
10. Amusement	74	87	112	0	0	0	74	87	112
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0
Total	23,941	28,294	36,129	10,054	11,882	15,173	33,995	40,176	51,302
Nominal Design Flow	**24,000**	**28,300**	**36,200**	**10,100**	**11,900**	**15,200**	**34,000**	**40,200**	**51,400**

DAWF: Daily Average Wastewater Flow, DMWF: Daily Maximum Wastewater Flow, HMWF: Hourly Maximum Wastewater Flow

Source: JICA Study Team

2.3 PLANNED WASTEWATER QUALITY

2.3.1 Wastewater Yield

Based on the unit water consumption rates of domestic, commercial and industrial waters, wastewater yield has been estimated and is shown in Table E.2.2. This is based on the assumption as also had been descried earlier that the generation rate of wastewater will be 90% of total water consumption. The unit water consumption rates and unit wastewater yields are summarized in Table E.2.9.

Table E.2.9 Unit Water Consumption Rates and Unit Wastewater Yields

Category		Unit	Unit Water Supply Amount	Generation Rate	Unit Wastewater Amount	Remarks
Domestic		lcpd	150	90%	135.0	Applied to Residents
Commercial	Commuters & Guests	lcpd	76	90%	68.4	Applied to General Commuters
		lcpd	45	90%	40.5	Specially applied to Amenity, Amusement
		lcpd	24	90%	21.6	Specially applied to Education and Training
	Residential Workers	lcpd	15	90%	13.5	10% of Domestic Water
	Activities	m^3/ha	22	90%	19.8	Specially applied to R&D
Industrial		m^3/ha	45	90%	40.5	Applied to High-tech Industrial Zone

Source: JICA Study Team

2.3.2 Unit Pollutant Load and Wastewater Quality

The wastewater discharged from polluters, such as houses and industries, always fluctuates in quality and quantity. Due to this fluctuation, even if the daily BOD loading data is available, then also it cannot entirely represent the acceptable BOD loading for planning. However, in Hanoi, not enough biochemical data of wastewater components discharged from polluters is available. As a result, it is difficult to analyze and conclude the acceptable BOD loadings specific to HHTP. Considering this, the planned wastewater quality is determined based on results of the earlier conducted studies, such as the JICA Study on Urban Drainage and Wastewater Disposal System in Hanoi City and the JICA Study on Environmental Improvement for Hanoi City. In addition, Japanese data was also analyzed for estimate purpose.

(1) Unit Pollutant Load

Table E.2.10 presents the pollutant load per capita in torrid and/or temperate countries.

Table E.2.10 Pollutant Load per Capita in Torrid/Temperate Countries

Name of Area	BOD (Unit: g/c/d)	SS (Unit: g/c/d)
Indonesia: Jakarta	30	-
India	30 - 45	67
S.E. Asia	43	-
Kenya	23	-
Zambia	36	-
JAPAN	50 - 60	40
UK	50 - 59	62
USA	45 - 78	-
USA: Met. California (Combined System)	48	41
Developing Countries (WHO)	40	-
Vietnam: Hanoi* (Data from Previous Study Reports)	40 - 100	-

Source: Technical Guideline for Urban Drainage and Wastewater Disposal in Developing Countries, 1993 by IDI in Japan and *: Data from the previous study reports in Hanoi

The planned wastewater quality for 2015 and 2020 is determined as follows:

1) Domestic wastewater: 60gpcd (gram per capita day) of BOD in consideration of Table E.2.10.
2) Commercial Wastewater: 100mg/L of BOD. This has been estimated by utilizing and comparing with the available data from the earlier conducted studies in Hanoi and Domestic Water & Wastewater Standards for Demand Projection in Japan as presented in Table E.2.11.
3) Industrial Wastewater: 200mg/L of BOD based on analyzed data of industrial wastewater in Japan as shown in Table E.2.12.

Table E.2.11 Domestic Water and Wastewater Standards for Demand Projection in Japan

CLASSIFICATION	BUILDING TYPES	QUANITIES OF Water Demand *1	QUANITIES OF DOMESTIC WASTEWATER *2	
			FLOW	BOD (mg/l)
Residential	Private Homes	160-250L/ca/d	200/m2/d	200
	Apartment	160-250L/ca/d	10L/m2/d	200
	Building	(0.16persons/m2)	m2=Floor Area	
Schools	Grade Schools	40-50L/pupil/day	50L/pupil/d	180
	High Schools	80L/pupil/day	60L/pupil/d	180
	Universities	100-200L/pupil/day	60L/pupil/d	180
		160/L/Teacher/day	60L/pupil/d	180
Commercial Building	Office	100-200L/ca/d	15L/m2/d	150-200
	Department	3L/visitor/d	30L/m2/d	150
	Stores	100L/clerk/d		
	Shopping Center	100L/ca./d (Capital: 0.16 Person/m2)	15L/m2/d	150
	Supermarkets	40L/ca./d	15L/m2/d	150
	Restaurants	65L/ca./d	110-260L/m2/d	240-450
	Drug Stores			
	Banks	120L/ca./d	15L/m2/d	150-200
Institutions	Hospitals	>1000L/bed/d	100-130/bed/d	150-320
		8L/visitor/d		
		120-160/Staff/d		
	Clinics	8L/visitor/d	25L/m2/d	300
		120L/staff/d		
Hotel, etc.	Hotels	250-300L/bed/d	30L/m2/d	200
		120L/staff/d		
	Coffee shop	30L/ca./d		
Industrial Buildings	Factories	Survey required	Survey required	Survey required
	Warehouses	Domestic Water 60 -140L/worker/d (Worker:0.1-0.3/m2)	60-100Lca./d	150-300
Miscellaneous	Parking Service Area			
	* Toilet	50L/ca./d	820L/card/d	300
	* Canteen	15L/ca./d	170L/card/d	350
	Public Toilet	50L/ca./d	2400L/chamber pot	260
	Miscellaneous			

*1 Source: Building Standard in Japan

*2 Source: Domestic Wastewater Standard - JIS A3302, April 1, 1988, JAPAN

Table E.2.12 Industrial Wastewater Quality & Typical Treatment in Japan

Industry	BOD PPM	COD PPM	SS PPM	PH	Typical Treatment
1. Food					
Processing	1,000 - 2,700	430 - 2,700	450 - 800	1 - 14	A.S
Dairy Products	250	170	200	65 - 11	A.S
Seasoning	340 - 2,300	109 - 11,900	76 - 4,250	6 - 8	A.S
Milling	1,900	1,600	2,400	6 - 8	OF + A.S
Soft Drink	340	330	370	9 - 12	A.S
Alcoholic Drink	490 -1,700	127 - 1,400	88 - 776	8 - 11	A.S
Frozen	410	170	200	-	A.S
Confectionery	860	780	610	6 - 8	OF + A.S
Feed/Fertilizer	1,200	480	25	-	A.S
Cooking Oil	4,400	3,100	2,600	1 - 7	OF + A.S
Others	450 - 2,400	450 - 1,200	450 - 1,200	6 - 8	A.S
2. Spinning	20 - 300	30 - 610	15 - 630	3, 5 - 9	A.S
Tex tile	60	30	100	6 - 8	A.S
Garment	10	10	30	6 - 8	A.S
Dyeing	200 - 300	160 - 450	80 - 200	3 - 11	C.D
3. Chemical					
Organic Chemical	300 - 600	460 - 870	100 - 150	1 - 13	N.T + A.S/C.S
Plastic/Rubber	10	20	50	-	N.T + A.S
Petro - Chemical	20 - 200	20 - 200	20 - 100	1 - 13	OF + A.S / G.S
Others	500	500	30	-	A.S / C.D
4. Wood/Furniture	10	10	30 - 40	-	A.S
5. Glass/Ceramic	3 - 10	1 - 13	30 - 20,000	7 - 9	C.S / F.M
6. Cement/Concrete	8 - 30	7 - 17	200 - 1,400	9 - 14	N.T
7. Metal product	20 - 360	20 - 360	20 - 560	2 - 8	N.T / C.S
8. Plate	-		30 - 150	1 - 6	N.T / C.D
9. Pulp/Paper	300	250	180	7 - 9	A.S / C.S
10. Machinery	10	30	100	-	OF + A.S / C.D
11. Automobile	50	90	100	-	OF + A.S / C.D
12. Electronics	10	30	100	-	OF + A.S / C.D
13. Miscellaneous	5	10	40	6 - 8	A.S

Source: Gridline of Industrial Wastewater Treatment Method in Japan
A.S : Activated Sludge Method F.M : Filter Method
C.S : Coagulated Sedimentation N.T : Neutralization Treat
O.F : Oil Floating C.D : Chemical Treat

In order to estimate design pollutant load for wastewater treatment plant, the unit pollutant load as per the different activities were calculated for the Hoa Lac Area and is summarized in the Table E.2.13

Table E.2.13 Unit Pollutant Loads and Design Wastewater Qualities

Category			Unit Wastewater Amount		Unit Pollutant Load /Water Quality			Remarks
			Unit	Value	Unit	BOD	SS	
Domestic			lcpd	135.0	gpcd	60.0	75.0	
Commercial	Commuters & Guests	Type 1	lcpd	68.4	gpcd	30.0	37.5	Applied to General Commuters
		Type 2	lcpd	40.5	gpcd	20.0	25.0	Specially applied to Amenity, Amusement
		Type 3	lcpd	21.6	gpcd	10.0	12.5	Specially applied to Education and Training
	Resident Workers	Type 4	lcpd	13.5	gpcd	-	-	Included in Domestic Load
	Activities	Type 5	m3/ha	19.8	mg/L	100	125	Specially applied to R&D
Industrial			m3/ha	40.5	mg/L	200	250	Applied to Hi-tech Industrial Zone

Source: JICA Study Team

(2) Characteristics of Sewerage

The comparison of the characteristics of sewerage among the Torrid and Temperate countries as shown Table E.2.14 will assist in finalizing the design wastewater quality for the Hoa Lac Area.

Table E.2.14 Characteristics of Sewerage in Torrid/Temperate Countries

Location	BOD	SS	TDS	Chloride	NH-N
Kenya (Nairobi)	448	550	503	50	67
Kenya (Nakuru)	940	662	611	62	72
India (Kodungaiyur)	282	402	1,060	205	30
Peru (Lima)	175	196	1,187	163	76
Israel (Herzliya)	285	427	1,094	163	76
USA (Allentown)	213	186	502	96	12
UK (Yeovil)	324	321	-	315	29

Source: Technical Guideline for Urban Drainage and Wastewater Disposal in Developing Countries, 1993 by IDI in Japan and *: Data from the previous study reports in Hanoi

2.3.3 Design Wastewater Quality

The design wastewater quality is estimated by applying unit pollutant loads to specific wastewater flow at DAWF condition.

(1) Design Pollutant Load for Domestic Wastewater Flow (DAWF)

Table E.2.15 BOD Loading of Domestic Wastewater (DAWF)

Land Use	Unit	Unit Amount	Applied Population (persons)			Pollutant Load (kgBOD/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D			0	0	0	0	0	0
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training	gpcd	60.0	3,296	13,984	17,280	198	839	1,037
5. Center of hi-tech City	gpcd	60.0	4,900	0	4,900	294	0	294
6. Mixed Use	gpcd	60.0	4,068	3,537	7,605	244	212	456
7. Houses & Offices	gpcd	60.0	34,149	0	34,149	2,049	0	2,049
8. Housing Complex	gpcd	60.0	18,727	15,964	34,691	1,124	958	2,081
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total	-	-	65,140	33,485	98,625	3,908	2,009	5,918

Source: JICA Study Team

Table E.2.16 SS Loading of Domestic Wastewater (DAWF)

Land Use	Unit	Unit Amount	Applied Population (persons)			Pollutant Load (kgSS/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D			0	0	0	0	0	0
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training	gpcd	75.0	3,296	13,984	17,280	247	1,049	1,296
5. Center of hi-tech City	gpcd	75.0	4,900	0	4,900	368	0	368
6. Mixed Use	gpcd	75.0	4,068	3,537	7,605	305	265	570
7. Houses & Offices	gpcd	75.0	34,149	0	34,149	2,561	0	2,561
8. Housing Complex	gpcd	75.0	18,727	15,964	34,691	1,405	1,197	2,602
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total	-	-	65,140	33,485	98,625	4,886	2,511	7,397

Source: JICA Study Team

(2) Design Pollutant Load for Commercial Wastewater (DAWF)

a) Wastewater Generated from Workers and Guests

Table E.2.17 BOD Loading of Commercial Wastewater of Workers & Guests (DAWF)

Land Use	Unit	Unit Amount	Applied Population (persons)			Pollutant Load (kgBOD/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park	gpcd	30.0	8,740	4,140	12,880	262	124	386
2. R&D			0	0	0	0	0	0
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training	gpcd	10.0	4,944	20,976	25,920	49	210	259
5. Center of hi-tech City	gpcd	30.0	7,350	0	7,350	221	0	221
6. Mixed Use	gpcd	30.0	2,712	2,358	5,070	81	71	152
7. Houses & Offices			0	0	0	0	0	0
8. Housing Complex			0	0	0	0	0	0
9. Amenity	gpcd	20.0	220	0	220	4	0	4
10. Amusement	gpcd	20.0	1,660	0	1,660	33	0	33
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total	-	-	25,626	27,474	53,100	651	405	1,056

Source: JICA Study Team

Table E.2.18 SS Loading of Commercial Wastewater of Workers & Guests (DAWF)

Land Use	Unit	Unit Amount	Applied Population (persons)			Pollutant Load (kgSS/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park	gpcd	37.5	8,740	4,140	12,880	328	155	483
2. R&D			0	0	0	0	0	0
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training	gpcd	12.5	4,944	20,976	25,920	62	262	324
5. Center of hi-tech City	gpcd	37.5	7,350	0	7,350	276	0	276
6. Mixed Use	gpcd	37.5	2,712	2,358	5,070	102	88	190
7. Houses & Offices			0	0	0	0	0	0
8. Housing Complex			0	0	0	0	0	0
9. Amenity	gpcd	25.0	220	0	220	6	0	6
10. Amusement	gpcd	25.0	1,660	0	1,660	42	0	42
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total	-	-	25,626	27,474	53,100	814	506	1,320

Source: JICA Study Team

b) Wastewater Generated from Residential Workers

Table E.2.19 BOD Loading of Commercial Wastewater of Residential Workers (DAWF)

Land Use	Unit	Unit Amount	Applied Population (persons)			Pollutant Load (kgBOD/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D			0	0	0	0	0	0
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training	gpcd	0.0	3,296	13,984	17,280	0	0	0
5. Center of hi-tech City	gpcd	0.0	4,900	0	4,900	0	0	0
6. Mixed Use	gpcd	0.0	4,068	3,537	7,605	0	0	0
7. Houses & Offices	gpcd	0.0	34,149	0	34,149	0	0	0
8. Housing Complex	gpcd	0.0	18,727	15,964	34,691	0	0	0
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total			65,140	33,485	98,625	0	0	0

Source: JICA Study Team

Table E.2.20 SS Loading of Commercial Wastewater of Residential Workers (DAWF)

Zone	Unit	Unit Amount	Applied Population (persons)			Pollutant Load (kgSS/day)		
			Stage 1	Stage 2	Total	Stage 1	Stage 2	Total
1. Software Park			0	0	0	0	0	0
2. R&D			0	0	0	0	0	0
3. High-tech Industrial (CN1)			0	0	0	0	0	0
4. Education & Training (DT)	gpcd	0.0	3,296	13,984	17,280	0	0	0
5. Center of hi-tech City	gpcd	0.0	4,900	0	4,900	0	0	0
6. Mixed Use	gpcd	0.0	4,068	3,537	7,605	0	0	0
7. Houses & Offices	gpcd	0.0	34,149	0	34,149	0	0	0
8. Housing Complex	gpcd	0.0	18,727	15,964	34,691	0	0	0
9. Amenity (GF)			0	0	0	0	0	0
10. Amusement (TD)			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total			65,140	33,485	98,625	0	0	0

Source: JICA Study Team

c) Wastewater Generated from Commercial Activities

Table E.2.21 BOD Loading of Commercial Wastewater of Commercial Activities (DAWF)

Land Use	Unit	Unit Amount	Wastewater Amount (m3/day)			Pollutant Load (kgBOD/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D	mg/l	100	2,627	1,885	4,512	263	188	451
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training			0	0	0	0	0	0
5. Center of hi-tech City			0	0	0	0	0	0
6. Mixed Use			0	0	0	0	0	0
7. Houses & Offices			0	0	0	0	0	0
8. Housing Complex			0	0	0	0	0	0
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total			2,627	1,885	4,512	263	188	451

Source: JICA Study Team

Table E.2.22 SS Loading of Commercial Wastewater of Commercial Activities (DAWF)

Land Use	Unit	Unit Amount	Wastewater Amount (m3/day)			Pollutant Load (kgSS/day)		
			Stage1 (2015)	Stage2 (2020)	Total	Stage1 (2015)	Stage2 (2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D	mg/l	125	2,627	1,885	4,512	328	236	564
3. High-tech Industrial			0	0	0	0	0	0
4. Education & Training			0	0	0	0	0	0
5. Center of hi-tech City			0	0	0	0	0	0
6. Mixed Use			0	0	0	0	0	0
7. Houses & Offices			0	0	0	0	0	0
8. Housing Complex			0	0	0	0	0	0
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total			2,627	1,885	4,512	328	236	564

Source: JICA Study Team

d) Total Pollutant Load of Commercial Wastewater

Table E.2.23 BOD Loading of Commercial Wastewater (DAWF)

Land Use	Pollutant Load (kgBOD/day)		
	Stage1(2015)	Stage2(2020)	Total
1. Software Park	262	124	386
2. R&D	263	188	451
3. High-tech Industrial	0	0	0
4. Education & Training	49	210	259
5. Center of hi-tech City	221	0	221
6. Mixed Use	81	71	152
7. Houses & Offices	0	0	0
8. Housing Complex	0	0	0
9. Amenity	4	0	4
10. Amusement	33	0	33
11. Traffic & Infrastructure	0	0	0
12. Lake & Buffer	0	0	0
13. Greeneries/Trees	0	0	0
Total	914	593	1,507

Source: JICA Study Team

Table E.2.24 SS Loading of Commercial Wastewater (DAWF)

Land Use	Pollutant Load (kgSS/day)		
	Stage1(2015)	Stage2(2020)	Total
1. Software Park	328	155	483
2. R&D	328	236	564
3. High-tech Industrial	0	0	0
4. Education & Training	62	262	324
5. Center of hi-tech City	276	0	276
6. Mixed Use	102	88	190
7. Houses & Offices	0	0	0
8. Housing Complex	0	0	0
9. Amenity	6	0	6
10. Amusement	42	0	42
11. Traffic & Infrastructure	0	0	0
12. Lake & Buffer	0	0	0
13. Greeneries/Trees	0	0	0
Total	1,142	741	1,884

Source: JICA Study Team

(3) Design Pollutant Load of Industrial Wastewater (DAWF)

Table E.2.25 BOD Loading of Industrial Wastewater (DAWF)

Land Use	Unit	Unit Amount	Wastewater Amount (m3/day)			Pollutant Load (kgBOD/day)		
			Stage1(2015)	Stage2(2020)	Total	Stage1(2015)	Stage2(2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D			0	0	0	0	0	0
3. High-tech Industrial	mg/l	200	7,995	1,385	9,380	1,599	277	1,876
4. Education & Training			0	0	0	0	0	0
5. Center of hi-tech City			0	0	0	0	0	0
6. Mixed Use			0	0	0	0	0	0
7. Houses & Offices			0	0	0	0	0	0
8. Housing Complex			0	0	0	0	0	0
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total			7,995	1,385	9,380	1,599	277	1,876

Source: JICA Study Team

Table E.2.26 SS Loading of Industrial Wastewater (DAWF)

Land Use	Unit	Unit Amount	Wastewater Amount (m3/day)			Pollutant Load (kgBOD/day)		
			Stage1(2015)	Stage2(2020)	Total	Stage1(2015)	Stage2(2020)	Total
1. Software Park			0	0	0	0	0	0
2. R&D			0	0	0	0	0	0
3. High-tech Industrial	mg/l	250	7,995	1,385	9,380	1,999	346	2,345
4. Education & Training			0	0	0	0	0	0
5. Center of hi-tech City			0	0	0	0	0	0
6. Mixed Use			0	0	0	0	0	0
7. Houses & Offices			0	0	0	0	0	0
8. Housing Complex			0	0	0	0	0	0
9. Amenity			0	0	0	0	0	0
10. Amusement			0	0	0	0	0	0
11. Traffic & Infrastructure			0	0	0	0	0	0
12. Lake & Buffer			0	0	0	0	0	0
13. Greeneries/Trees			0	0	0	0	0	0
Total			7,995	1,385	9,380	1,999	346	2,345

Source: JICA Study Team

(4) Summary of Design Pollutant Load

Design pollutant loads of BOD and SS are summarized in Tables E.2.27 and E.2.28 respectively.

Table E.2.27 Summary of Pollutant Load: BOD (DAWF)

Unit: kgBOD/day

Land Use	Stage1(2015)				Stage2(2020)				Total			
	Domestic	Commercial	Industrial	Total	Domestic	Commercial	Industrial	Total	Domestic	Commercial	Industrial	Total
1. Software Park	0	262	0	262	0	124	0	124	0	386	0	386
2. R&D	0	263	0	263	0	188	0	188	0	451	0	451
3. High-tech Industria	0	0	1,599	1,599	0	0	277	277	0	0	1,876	1,876
4. Education & Training	198	49	0	247	839	210	0	1,049	1,037	259	0	1,296
5. Center of hi-tech City	294	221	0	515	0	0	0	0	294	221	0	515
6. Mixed Use	244	81	0	325	212	71	0	283	456	152	0	608
7. Houses & Offices	2,049	0	0	2,049	0	0	0	0	2,049	0	0	2,049
8. Housing Complex	1,124	0	0	1,124	958	0	0	958	2,081	0	0	2,081
9. Amenity	0	4	0	4	0	0	0	0	0	4	0	4
10. Amusement	0	33	0	33	0	0	0	0	0	33	0	33
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0	0	0	0
Total	3,908	914	1,599	6,421	2,009	593	277	2,879	5,918	1,507	1,876	9,301

Source: JICA Study Team

Table E.2.28 Summary of Pollutant Load: SS (DAWF)

Unit: kgSS/day

Land Use	Stage1(2015)				Stage2(2020)				Total			
	Domestic	Commercial	Industrial	Total	Domestic	Commercial	Industrial	Total	Domestic	Commercial	Industrial	Total
1. Software Park	0	328	0	328	0	155	0	155	0	483	0	483
2. R&D	0	328	0	328	0	236	0	236	0	564	0	564
3. High-tech Industria	0	0	1,999	1,999	0	0	346	346	0	0	2,345	2,345
4. Education & Training	247	62	0	309	1,049	262	0	1,311	1,296	324	0	1,620
5. Center of hi-tech City	368	276	0	643	0	0	0	0	368	276	0	643
6. Mixed Use	305	102	0	407	265	88	0	354	570	190	0	761
7. Houses & Offices	2,561	0	0	2,561	0	0	0	0	2,561	0	0	2,561
8. Housing Complex	1,405	0	0	1,405	1,197	0	0	1,197	2,602	0	0	2,602
9. Amenity	0	6	0	6	0	0	0	0	0	6	0	6
10. Amusement	0	42	0	42	0	0	0	0	0	42	0	42
11. Traffic & Infrastructure	0	0	0	0	0	0	0	0	0	0	0	0
12. Lake & Buffer	0	0	0	0	0	0	0	0	0	0	0	0
13. Greeneries/Trees	0	0	0	0	0	0	0	0	0	0	0	0
Total	4,886	1,142	1,999	8,026	2,511	741	346	3,599	7,397	1,884	2,345	11,626

Source: JICA Study Team

The total amount of wastewater and pollutant load in the Hoa Lac Area is shown in Table E.2.29.

Table E.2.29 Summary of Wastewater Yield and Wastewater Quality

Item		Type	Unit	Stage 1(2015)	Stage 2(2020)	Total
Design Wastewater Amount		Domestic Wastewater	m^3/day	8,794	4,520	13,314
		Commercial Wastewater	m^3/day	4,976	3,235	8,210
		Industrial Wastewater	m^3/day	7,995	1,385	9,380
		Ground Water	m^3/day	2,176	914	3,090
		Total	m^3/day	23,941	10,054	33,995
Pollutant Load	BOD	Domestic Wastewater	kgBOD/day	3,908	2,009	5,918
		Commercial Wastewater	kgBOD/day	914	593	1,507
		Industrial Wastewater	kgBOD/day	1,599	277	1,876
		Total	kgBOD/day	6,421	2,879	9,301
	SS	Domestic Wastewater	kgSS/day	4,886	2,511	7,397
		Commercial Wastewater	kgSS/day	1,142	741	1,884
		Industrial Wastewater	kgSS/day	1,999	346	2,345
		Total	kgSS/day	8,026	3,599	11,626
Influent Quality	BOD		mg/L	268	286	274
	SS		mg/L	335	358	342

Source: JICA Study Team

By comparing the characteristics of sewerage in the Torrid and Temperate countries as shown in Table E.2.14, the average values of influent wastewater quality with 274mg/L of BOD and 342mg/L of SS as mentioned above has been considered reasonable for further planning and design purpose.

2.4 WATER BODY OF THE HOA LAC AREA

Currently, there are the four water bodies: the Tan Xa Lake, Dua Gai stream, Vuc Giang stream and Tick River exist in the Hoa Lac area. It is likely that with a development of sewerage plant in the Hoa Lac area, the quality of the water bodies will be improved immensely. It is thus necessary for sewerage development plan to encompass HHTP and its water body with an aim to achieve the set goals and meet requirements by the target year of 2020.

The initial environmental and water quality examination were carried out for the river and the three water bodies i.e. Tan Xa Lake, Vuc Giang stream and Tick River. After the development of sewerage in the Hoa Lac area, the discharged wastewater from the Hoa Lac area can be in flowed to the Tick River via the Vuc Giang stream. This means that the water quality of the Tan Xa Lake and Dua Gai stream will be improved by implementation of HHTP project.

2.4.1 Estimation of Required Wastewater Treatment Level

The current as well as future treated wastewater form the Hoa Lac area will be discharged to the Tic River via the Vuc Giang stream. According to TCVN 5942-2005: Environmental Quality Standard for River's Water, these rivers belongs to Class B category. Thus, after the confirmation of the river water quality during low flow and the environmental quality standards for river water in Vietnam, the required wastewater treatment level has been estimated by the following formula:

$$(Q \cdot x + q \cdot F)/(Q + q) = M$$

$$R = (E - x)/E$$

Where,

Q	: Wastewater discharge out of HHTP (m^3/day)
E	: Wastewater quality as BOD level (mg/L)
q	: Low flow of river (m^3/day)
F	: River water quality of low flow as BOD level (mg/L)
x	: Required wastewater treatment level of BOD (mg/L)
M	: Maximum acceptable level of BOD (25mg/L for Class B)
R	: Required removal efficiency (%)

The estimation of required wastewater treatment level and removal efficiency are presented in Table E.2.30.

Table E.2.30 Required Wastewater Treatment Level

Item	Vuc Gaing Stream			Remarks
	Point 7	Point 8	Point 9	
Q (m3/day)	33,995	33,995	33,995	DAWF
E (mg/L)	274	274	274	On average
q (m3/day)	277,000	363,000	171,000	Assumed Value by Topo Survey
F (mg/L)	12	12	12	Surveyed Data on Oct.2008
M (mg/L)	25	25	25	Class B of TCVN 5942-2005
x (mg/L)	130.93	163.81	90.39	
R (%)	52.14	40.12	66.96	Assumed Value

Source: JICA Study Team

In order to minimize the environmental impact to the water bodies, wastewater treatment level of BOD and removal efficiency are required to be in the range of 40 to 67 %.

2.4.2 Confirmation of Effluent Quality

The conditions of water body that were identified for planning the wastewater treatment plant are as follows:

1) Treated wastewater is discharged from HHTP to the Tic River via the Vuc Giang stream.
2) According to TCVN 5945-2005: Discharge Standard for Industrial Wastewater, the Tic River and the Vuc Giang stream belong to Class B. This is mainly due to no water resource downstream of the rivers.
3) The Class B will be applied for planning the wastewater treatment plant of HHTP and its effluent standards are shown in Table E.2.31.

Table E.2.31 Effluent Standard

Key Parameter	Unit	Class A	Class B	Class C
Temperature	^oC	40	40	50
pH	-	6~9	5.5~9	5-9
BOD_5	mg/L	20	50	100
SS	mg/L	50	100	200

Class A: Discharging to a water basin used for water supply purpose.
Class B: Discharging to a water way used for transport irrigation, washing purposes.
Class C: Discharging to a sewer
Source: TCVN5945-2005

Effluent discharged from developers in HHTP for the wastewater treatment plant is determined based on the following:

1) Generally Class C will be applied as shown in Table E.2.32 for developers in HHTP, and effluent from wastewater Treatment plant will be applied Class B.
2) Wastewater of developers is discharged to the wastewater treatment plant via sewer pipes.
3) Factories will treat wastewater before discharging it into sewer.
4) Separated sewer without septic tanks is recommended. As a result, effluent quality at affordable rates will be raised to the capability of treatment plant.

2.4.3 Proposed Influent and Effluent Quality

The following influent and effluent wastewater qualities are proposed as shown in Table E.2.32. These were proposed considering the minimization of environmental impact to water bodies in HHTP, meeting the environmental quality standard and the effluent standard in Vietnam.

Table E.2.32 Proposed Influent and Effluent Qualities

Item		Unit	Stage 1(2015)	Stage 2(2020)	Total
Design Daily Average Wastewater		m3/d	26,327	9,244	35,571
Influent Quality	BOD	mg/L	268	278	271
	SS	mg/L	336	347	339
Effluent Quality (Based on Criteria)	BOD	mg/L	50	50	50
	SS	mg/L	100	100	100
Target Effluent Quality WWTP(Yearly Average)	BOD	mg/L	20	20	20
	SS	mg/L	20	20	20
Target Removal Rate	BOD	%	92.5	92.8	92.6
	SS	%	94.0	94.2	94.1

Source: JICA Study Team

CHAPTER 3 PROPOSED WASTEWATER SEWERAGE PLAN

3.1 DESIGN CONSEPT AND CRITERIA

3.1.1 Design Concept

The proposed design concepts for the development of wastewater sewerage system within the Study area are as follows:

1) To apply the following regulations and standards corresponding to the;
   - Vietnamese Revised Master Plan (VN Revised M/P) for the Hoa Lac High-Tech Park (HHTP)
   - Design Standard for Works of Sewerage and Drainage System in Vietnam (1989)
   - Environment Protection Law in Vietnam (1994)
   - Guidance for Environmental Impact Assessment (1993)
   - Environmental Quality Standard for River's Water (TCVN 5942-2005)
   - Discharge Standard for Industrial Wastewater (TCVN5945-2005)
   - Decree of the Government on Urban Underground Construction (No. 41/2007/ND-CP, 2003)
   - Building Code of Vietnam (Decision No. 682/BXD-CSXD, 1996)
   - Sewerage Law in Japan (1983)
   - Water Pollution Control Law in Japan (1983)
   - Building Standard Law in Japan (1983)
   - Japan Sewerage Works Association Standards (1984)
2) To harmonize with the existing infrastructures as constructed by HHTP-MB.
3) To adopt a separated sewer system for the collection of wastewater.
4) To take adequate measures against environmental pollution as per the local conditions.

3.1.2 Design Criteria

(1) Design Flow

Wastewater sewerage system in the Hoa Lac area (north of LHLE), including sewers and wastewater treatment plant, in principle shall be designed based on the design flow as follows (detail on design flow is described in the subsection 2.2):

Table E.3.1 Applied Design Flow for Designing Sewerage Facilities

Sewerage System	Facilities	Design Flow
Sewerage System	Sewer	HMWF
	Intermediate Pumping Station	HMWF
Treatment Plant	Influent Pipe	HMWF
	Primary Treatment	DMWF
	Secondary Treatment	DMWF
	Pumping Station	HMWF
	Effluent Pipe	HMWF

Note: HMWF= Hourly Maximum Wastewater Flow, DMWF= Daily Maximum Wastewater Flow

(2) Sewers

For gravity sewer system, the hydraulic design of sewers is based on Manning's formula, as given below:

$Q = A \cdot V$
$V = (1/n) \cdot R^{2/3} \cdot I^{1/2}$
Where,
Q: Wastewater discharge (m^3/sec)
A: Sectional area of pipe (m^2)
V: Mean velocity (m/sec)
n : Roughness coefficient
R: Hydraulic radius (m)
I : Hydraulic gradient

The hydraulic design of sewers adopted the following criteria:

a) Roughness Coefficient: 0.015

Considering the long term operation and the roughness coefficient of RC pipe as used for Vietnamese products, the roughness coefficient of 0.015 will be adopted.

b) Allowable Flow Velocity: 0.6 - 3.0m/sec

In order to avoid any sedimentation and keep consistency with the onsite road gradient as much as possible, the minimum velocity should not be less than 0.6m/sec. In addition, to prevent the pipe from eroding, the maximum velocity shall not exceed 3.0m/sec.

c) Allowance of Sewer Capacity

The allowance of pipe capacity to design flow for wastewater sewer is applied at 100% of flow rate of generated wastewater to the capacity of designed pipe.

The allowance is generally applied while selecting the sewer pipes. This is done to accommodate any unexpected flow fluctuations or to prevent the pipes against the putrefaction of sewerage.

d) Minimum Size of Sewer: 250mm (for gravity sewer)

The minimum size of pipe to be selected will be 250mm to secure the workability of maintenance and operation for gravity system. The minimum of 150mm will be applied to pressure system.

e) Depth of Earth Covering: 1.5 - 7.0m

To prevent any damage or collapse of the pipes, the minimum earth covering is determined as 1.5m. However, in order to minimize the construction cost and alleviate any risks of difficulty and dangers during construction works, the maximum depth of earth covering should not exceed 7.0m.

f) Maximum Manhole Interval

Manhole shall be located at the places where there is occurrence of change in flow direction or pipe gradient or diameter. In addition, manholes will also occur at the originating point of sewer pipeline and junction points of pipes. The maximum manhole interval of 50m has been adopted for HHTP.

Table E.3.2 Maximum Interval between Manholes

Diameter of Connecting Pipe (mm)	Interval of Manholes (m)	Remarks
150 ~ 300	20	
400 ~ 600	40	
700 ~ 1,000	60	
1,200 ~	100	Interval can be extended where required

g) Connection of pipes: Pipe crown connection

A pipe crown connection is recommended in view of the reliability of hydraulic characteristics. This will allow the smooth design flow rate and will prevent any escalation of backwater elevation during maximum flow condition.

Pressure system sewer with intermediate pumping stations will also be applied as this will lower the escalating construction cost and will avoid any difficulty during construction works. In general, this system is used for the gravity sewer lines which are laid at a depth of more than 7.0 m from ground level and for those sewers that will cross river channels and attached to bridge structures.

The adopted materials of sewer pipes for use will be RC (Reinforced Concrete) pipes for gravity sewer system and DCIP (Ductile Cast Iron Pipe) for pressure pipe.

(3) Intermediate Pumping Station

The intermediate pumping stations are preliminarily designed by HMWF for lifting and transporting wastewater. During this study, required capacities and location of pumping stations area were reviewed. This was done by following the revised wastewater flow that has been calculated during hydraulic analysis of the sewerage system. The design of necessary pumping facilities will be based on the following criteria:

a) Number of pumps

Considering the guidelines of Japanese standards, the requirement for the following number of pumps is recommended:

Design flow (m3/sec)	≦0.5	: 2 -3 units (one is appointed as standby)
	0.5 -1.5	: 3 -5 units
	> 1.5	: 4 -6 units

b) Diameter of suction pump unit

The diameter of the suction pumps shall be calculated by the following formula:

$D = 146 \cdot (Q/V)^{1/2}$

Where,

D: Diameter of suction pump (mm)
Q: Discharge capacity of pump (m^3/min)
V: Flow velocity in suction pipe (1.5 – 3.0 m/sec)

In the case of HMWF being less than $0.5m^3$/sec, a manhole-type intermediate pumping station following the below criteria is allowable:

- Minimum diameter of pump suction: 80mm
- Type of pump: Vertical detachable submersible pump
- Grit chamber and screen are not necessary
- Diameter of suction pump unit

c) Location of pumping stations

Underground type will be applied to all of pumping stations with submersible pumping units. The pumping stations will be located beneath the sidewalks or adjacent to the green area that has been allocated for road facilities.

(4) Wastewater Treatment Plant

Although wastewater treatment can involve various methods as shown in Table E.2.12 for

treatment of domestic and industrial wastewater, an activated sludge process is recommended for the treatment of the generated wastewater in HHTP. This is mainly because as biodegradable wastewater will be collected and treated via the centralized wastewater treatment plant and toxic/hazardous wastewater will be individually treated on-site by respective developer. Following the "Pollutants Pay Principle" developers has to develop and establish the wastewater treatment facilities and treat wastewater prior to disposing it into sewerage.

The activated sludge process also has several established methods, such as a conventional activated sludge process, an oxidation ditch process, a modified aeration process and a coagulated sedimentation process. To select the most suitable process for HHTP, these methods shall be compared from view points of; i) reliability and experiences in Vietnam, ii) workability with the operation and maintenance (O&M), iii) required cost of construction and O&M, iv) required sludge disposal and volume of excess sludge, and v) required land acquisition.

Considering the advantages of conventional activated sludge process over other processes in terms of reliability, experiences of O&M in Vietnam and the required land acquisition, the conventional activated sludge process with coagulated sedimentation will be adopted. This will be applied to the existing treatment plant with a capacity of 6,000m^3/day for Step-1 of Stage-1 (2015) in the Hoa Lac Area. The proposed general design criteria and necessary facilities for the conventional activated sludge process are as follows:

- Design flow: DMWF as stated above (1)
- Design inflow and effluent water quality: refer to Sections 2.3 and 2.4
- Inflow average wastewater quality : 274 mg/L for BOD, 342 mg/L for SS
- Target Effluent quality : 20 mg/L for BOD, 20 mg/L for SS
- Removal ratio : 93% for BOD, 94% for SS
- Grit chamber: see the above (4)
- Aeration tank
- BOD - SS loading : 0.2 ~ 30 kg/SS kg･day
- MLSS (Mixed Liquor Suspended Solids) : 1,500 ~ 2,000 mg/L
- Aeration time : 6 ~ 8 hours
- Return sludge ratio : 20 ~ 40 %
- Aerobic solid retention time : 2 ~ 4 days
- Number of tank : 2 tanks or more

1) Inlet Chamber and Main Pumping Facilities

The constructed wastewater treatment plant was implemented by HHTP (hereinafter called as the WWTP) and was designed to accept full amount of wastewater via pressure pipe lines sent through intermediate pumping stations. As the inlet elevation of influent sewer is very shallow, by gravity it makes the flow of wastewater very difficult from the neighboring industries and facilities.

Therefore newly constructed inlet chamber with main pumping facilities are necessary to accept all the generated wastewater in HHTP including from the neighboring area of the wastewater treatment plant. This will be able to distribute the wastewater to the WWTP.

- Capacity of Pumping Facilities : 51,400m^3/day (HMWF)

2) Inlet Chamber and Main Pumping Facilities

- Number of grit chambers : at least 2 units
- Bottom slop of grit chamber : 1/100 ~ 2/100
- Mean velocity : 0.3 m/sec
- Retention period : 30 ~60 sec
- Depth of sand pit : 30 cm or deeper

- Surface loading : 1,800 m^3/m^2/day for wastewater

3) Settling Tank

- Surface loading : 20 ~ 30 m^3/m^2/day
- Settling time : 2.5 hours or longer
- Weir loading : 150 m^3/m/day
- Number of tan : 2 tanks or more
- Depth of tank : 1.5 ~ 2.5 m

4) Chlorination Tank

Contact time is more than 15 minutes.

5) Sludge Thickener

- Type of thickener : Gravity Thickener
- Moisture content of excess sludge : 99.3 ~ 99.5 %
- Moisture content of thickened sludge : 98.0 ~ 98.5 %
- Solid loading : 30 ~ 50 kg/m^2/day
- Number of tank : 1 tank or more

6) Sludge Dewatering facilities

Mechanical dewatering process is recommended considering environmental condition in HHTP. The following criteria are adopted:

- Type of dewatering : Screw press dewatering process
- Daily operation time : 6 hours/day
- Solid content capture ratio : 95.0%
- Water content of dewatered sludge : 76.0%
- Chemical feeding ratio : 0.8 ~ 1.2%

(5) Effluent Standard

The Class B is applied in principle for planning the sewerage system as shown in Table E.3.3.

Table E.3.3 Discharge Standard for Industrial Wastewater: TCVN 5945-2005

No.	Parameter	Unit	Limits		
			A	B	C
1	Temperature	^oC	40	40	45
2	pH	-	From 6 to 9	From 5,5 to 9	From 5 to 9
3	Smell	-	Doesn't have bad smell		-
4	Color, Co-Pt at pH = 7		20	50	-
5	BOD_5 (20^oC)	mg/L	30	50	100
6	COD	mg/L	50	80	400
7	Suspended Solid	mg/L	50	100	200
8	Arsenic	mg/L	0.05	0.1	0.5
9	Mercury	mg/L	0.005	0.01	0.01
10	Lead	mg/L	0.1	0.5	1
11	Cadmium	mg/L	0.005	0.01	0.5
12	Chrome (VI)	mg/L	0.05	0.1	0.5
13	Chrome (III)	mg/L	0.2	1	2
14	Bronze	mg/L	2	2	5
15	Zinc	mg/L	3	3	5
16	Nickel	mg/L	0.2	0,5	2

No.	Parameter	Unit	Limits		
			A	B	C
17	Manganese	mg/L	0.5	1	5
18	Iron	mg/L	1	5	10
19	Tin	mg/L	0.2	1	5
20	Cyanide	mg/L	0.07	0.1	0.2
21	Phenol	mg/L	0.1	0.5	1
22	Mineral oil	mg/L	5	5	10
23	Animal and vegetable oil & fat	mg/L	10	20	30
24	Residual Chlorine	mg/L	1	2	-
25	PCBs	mg/L	0.03	0.01	-
26	Chemical pesticide: organic Phosphorus	mg/L	0.3	1	
27	Chemical pesticide: organic Chlorine	mg/L	0.1	0.1	-
28	Sulphur / Sulfur	mg/L	0.2	0.5	1
29	Fluoride	mg/L	5	10	15
30	Chloride	mg/L	500	600	1000
31	Ammoniac (as N) Ammonia	mg/L	5	10	15
32	Total Nitrogen	mg/L	15	30	60
33	Total Phosphor	mg/L	4	6	8
34	Coliform	MPN/100 mL	3,000	5,000	-
35	Biological test (Bioassay)	-	Alive 90% among 100% of fishes after 96 hours in wastewater		-
36	Gross of α radioactive activity	Bq/L	0.1	0.1	-
37	Gross of β radioactive activity	Bq/L	1.0	1.0	-

Note
A: Discharging to a water basin used for water supply
B: Discharging to waterway used for transport, irrigation, washing
C: Discharging to a sewer
Parameter limits and maximum allowable concentrations of pollutants in industrial effluents/ waste water

3.2 DEFINITION OF PROPOSED WASTEWATER SEWERAGE PLAN

The proposed wastewater sewerage plan should be able to cope well with the variety of public facilities and services, functional zones and environmental requirements particular to HHTP. In this chapter, the wastewater sewerage plan for the Hoa Lac area is proposed on the basis of the above mentioned design concept and criteria. The overall wastewater sewerage plan in the Hoa Lac area is shown in Figure E3.1.

3.2.1 Wastewater Collection Sewer System

(1) Summary of Concept and Criteria for Wastewater Sewer

The design concept and criteria for the wastewater sewerage system in the Hoa Lac area (north of LHLE) are summarized below:

1) Concept of wastewater sewerage system plan

Design period	: The year of 2020
Planning area	: 1,268ha of Hoa Lac area (north of LHLE)
Design population	: 188,559
Daily average wastewater flow	: 90% of average water supply

(DAWF)
Groundwater infiltration (GIF) : 10% of DAWF
Daily maximum wastewater flow (DMWF) : 1.20 times of DAWF
Hourly maximum wastewater flow (HMWF) : 1.56 times of DMAF
Design wastewater flow : Hourly Maximum Design Flow (HMWF) as follows

Unit: m^3/d

Item	Stage 1(2015)	Stage 2(2020)	Total
DAWF	24,000	10,100	34,000
DMWF	28,300	11,900	40,200
HMWF	36,200	15,200	51,400

Wastewater collection system : Separate system

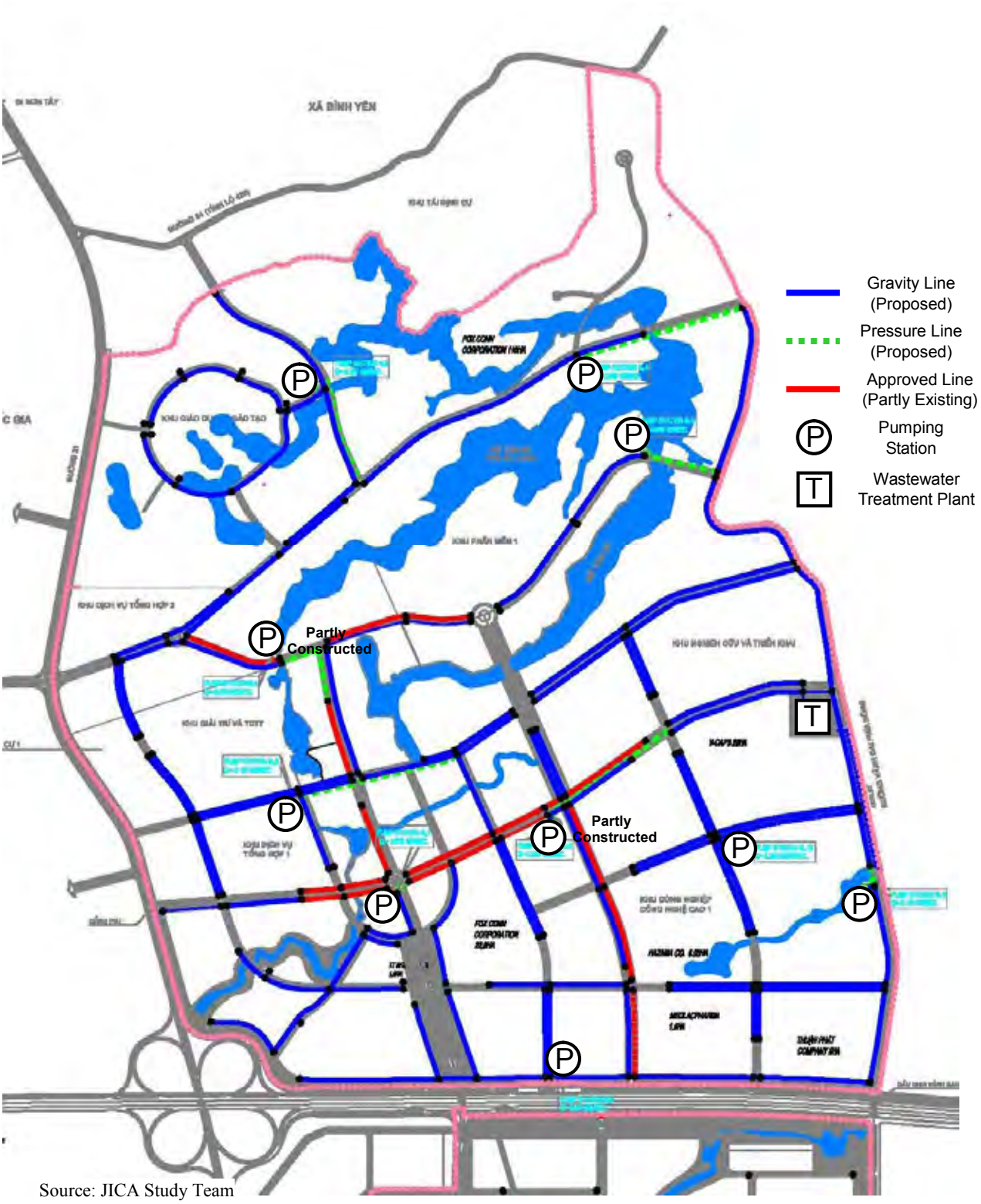
2) Design criteria for wastewater collection sewer

The hydraulic design has been based on the following criteria:

Allowable flow velocity	: 0.6 ~3.0m/sec.
Minimum size of sewer	: D250 mm for gravity sewer (D150 mm for pressure sewer)
Allowance of sewer capacity	: 100 % extra of design flow rate
Minimum earth covering	: 1.5m for gravity sewer, 0.7m for pressure pipe under sidewalk
Maximum manhole interval	: 50m
Pipe connection method	: Pipe crown connection
Material of sewer	: RC pipe for gravity sewer, DCIP for pressure sewer
Intermediate pumping station	: 2 ~ 3 pumps (1 unit for standby) in case of less than $0.5m^3/s$ of hourly maximum wastewater flow

(2) Proposed Wastewater Collection System

The resultant hydraulic design of the wastewater collection system is given in flow calculation sheet. The table specifies the details such as the designated pipe number, commanding area of pipe, pipe length, diameter, design discharge, velocity, etc. The required intermediate pumping stations are calculated and are shown in Table E.3.4. The specification and number of the intermediate pumping stations required are summarized below:



Source: JICA Study Team

Figure E.3.1 Layout Plan of the Sewerage Network

Table E.3.4 Specification of Intermediate Pumps

No.	Name	Capacity (m^3/s)	Submersible Pumping Unit					Head (m)	Remarks
			Diameter (mm)	Output (kw)	Nos				
					Duty	Standby	Total		
1	Pumping Station No.1	0.053	150	11	1	1	2	12.7	Partly Constructed
2	Pumping Station No.2	0.037	150	11	1	1	2	16.9	
3	Pumping Station No.3	0.304	350	22	2	1	3	9.1	Partly Constructed
4	Pumping Station No.4	0.048	150	7.5	1	1	2	8.8	
5	Pumping Station No.5	0.019	150	5.5	1	1	2	7.1	
6	Pumping Station No.6	0.161	200	22	2	1	3	12.7	
7	Pumping Station No.7	0.079	200	11	1	1	2	8.0	
8	Pumping Station No.8	0.051	150	5.5	1	1	2	5.5	
9	Pumping Station No.9	0.112	200	7.5	2	1	3	7.0	
10	Pumping Station No.10	0.026	150	5.5	1	1	2	4.7	

Source: JICA Study Team

The total length of sewer for the Hoa Lac area is about 48,800m (excluding the existing sewer and the sewer to be implemented by developers in High-tech Industrial Zone (the length of 4,831m)) and their diameters varies from 250mm to 1,350mm for gravity sewers and from 2x150mm to 2x600mm for pressure sewers and is shown in Table E.3.5.

Table E.3.5 Proposed Wastewater Collection Facilities

Item	Description	Unit	Proposed			Implemented by Developer
			Total	E&T Zone*	Other Zones	
Pipe	RC250,Gravity	m	27,457	1,878	25,579	3,170
	RC300,Gravity	m	3,220	0	3,220	578
	RC350,Gravity	m	1,762	220	1,542	0
	RC400,Gravity	m	2,184	0	2,184	0
	RC450,Gravity	m	3,239	0	3,239	0
	RC500,Gravity	m	743	0	743	578
	RC600,Gravity	m	2,831	0	2,831	505
	RC700,Gravity	m	808	0	808	0
	RC800,Gravity	m	1,251	0	1,251	0
	RC1000,Gravity	m	797	0	797	0
	RC1350,Gravity	m	770	0	770	0
	Subtotal	m	45,062	2,098	42,964	4,831
	2xDCIP150,Pressure	m	343	0	343	0
	2xDCIP200,Pressure	m	520	0	520	0
	2xDCIP250,Pressure	m	1,246	0	1,246	0
	2xDCIP300,Pressure	m	78	0	78	0
	2xDCIP350,Pressure	m	89	0	89	0
	2xDCIP400,Pressure	m	762	0	762	0
	2xDCIP600,Pressure	m	701	0	701	0
	Subtotal	m	3,739	0	3,739	0
	Total	m	48,801	2,098	46,703	4,831
Manhole	1.2 m x 1.2 m, H=4.0m	nos	875	27	848	119
	1.2 m x 1.2 m, H=7.0m	nos	133	24	109	0
	1.4 m x 1.4 m, H=4.0m	nos	16	0	16	0
	1.4 m x 1.4 m, H=7.0m	nos	31	0	31	0
	1.6 m x 1.6 m, H=4.0m	nos	34	0	34	0
	1.6 m x 1.6 m, H=7.0m	nos	4	0	4	0
	Total	nos	1,093	51	1,042	119
Intermediate Pumping Station	Q: ~0.050m3/sec	nos	4	0	4	0
	Q: 0.051~0.100m3/sec	nos	3	0	3	0
	Q: 0.101~m3/sec	nos	3	0	3	0
	Total	nos	10	0	10	0

*Education & Training Zone

Source: JICA Study Team

3.2.2 Wastewater Treatment Plant

(1) Summary of Concept and Criteria for Wastewater Treatment Plant

1) Concept of wastewater treatment plant

Design period	: The year of 2020
Planning area	: 1,268ha of Hoa Lac area (north of LHLE)
Design population	: 188,559
Calculation of pollutant load	: Daily average wastewater flow (DAWF) as follows
Design for plant	: Daily maximum wastewater flow (DMWF) as follows
Design for influent/effluent facilities	: Hourly maximum wastewater flow (HMWF) as follows

Unit: m^3/d

Item	Stage 1(2015)	Stage 2(2020)	Total
DAWF	24,000	10,100	34,000
DMWF	28,300	11,900	40,200
HMWF	36,200	15,200	51,400

Wastewater quality discharged from commercial and industrial zone : Assumed as follows

BOD (Commercial)	: 100 mg/L on average
(Industrial)	: 200 mg/L on average
SS (Commercial)	:125 mg/L on average
(Industrial)	:150 mg/L on average
Total nitrogen	: 10 mg/L on average
Heavy metals	: Not acceptable
Toxic and hazardous	: Not acceptable

Receiving water body : Tick River (Class B of TCVN 5945-2005)

Treated wastewater will be discharged from HHTP to the Tic River via the Vuc Giang stream that belongs to Class B according to TCVN 5945-2005: Discharge Standard for Industrial wastewater. Although the Class B is applied for the planning of the wastewater treatment plant in HHTP, treated wastewater quality in HHTP is recommended to be of higher level as it will follow the proposed design criteria.

2) Design criteria for wastewater treatment plant

Design flow	: DMWF ($42,200m^3$/day in total)
Inflow average wastewater quality	: 274mg/L of BOD, 342mg/L of SS on average
Effluent average wastewater quality	: 20mg/L of BOD, 20mg/L of SS on annual average
Removal ration	: 93% of BOD, 94% of SS on annual average
Wastewater Treatment Process	: Conventional activated sludge process
Grit chamber	: Surface loading of $1,800m^3/m^2 \cdot$day
Aeration tank	: BOD-SS loading of 0.2 ~ 0.4kg/SS kg・day
Settling tank	: Surface loading of 20 ~$30m^3/m^2 \cdot$day
Chlorination tank	: Contact time of more than 15 minutes
Thickener	: Solid loading of 30 ~$50kg/m^2 \cdot$day
Digestion tank	: Digestion time of 30 days
Dewatering	: Screw press dewatering process

(2) Proposed Wastewater Treatment Plant

The existing wastewater treatment plant implemented by HHTP-MB and newly expanded wastewater treatment plant proposed by JICA Study Team are located to the northeast of the High-Tech Industry zone in the Hoa Lac area (north of LHLE) as shown in Figure E.3.1. Proposed system flow diagram of the conventional activated sludge process for the wastewater treatment plant is presented in Figure E.3.2. Layout plan of the proposed wastewater treatment plant is illustrated in Figure E.3.3. Following the design criteria as described in the subsection

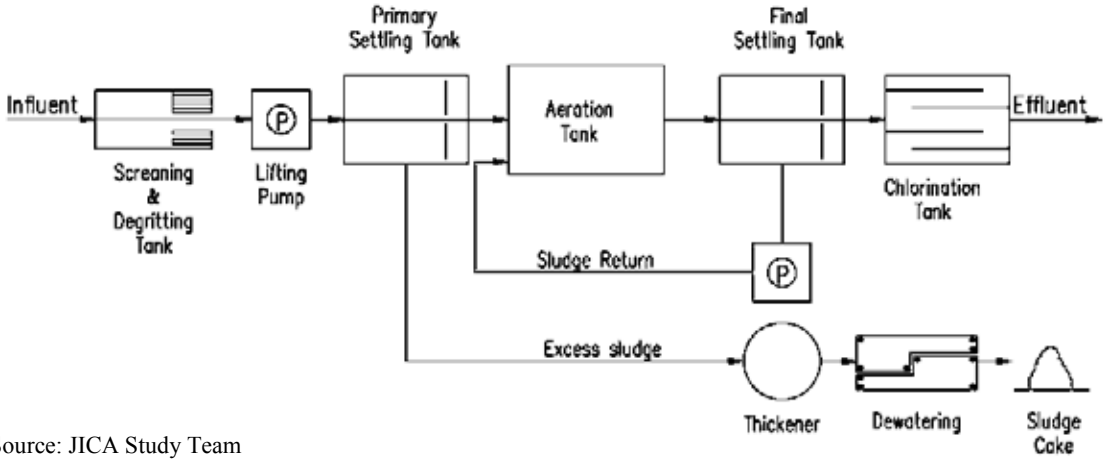
3.1.2, the proposed wastewater treatment plant is designed and its details are presented in Table E.3.6.

Table E.3.6 Proposed Facilities of Wastewater Treatment Plant

Item		Unit	Existing	Proposed				Total
			Stage 1(2015)	Stage 1(2015)	Stage2(2020)		Subtotal	
					Step 1	Step 2		
Design Flow Rate		m^3/d	6,000	17,100	11,400	5,700	6,000	6,000
Nominal Capacity		m^3/d	6,000	6,000	6,000	6,000	-	-
Number of Units		nos	1	3	2	1	6	7
Total Capacity		m^3/d	6,000	18,000	12,000	6,000	36,000	42,000
Sand Basin	Length	m	2.1	8.5	-	-	-	-
	Breadth	m	5.7	1.5	-	-	-	-
	Depth	m	5.9	1.1	-	-	-	-
	Number	nos	1	2	-	-	2	3
Primary Settling Tank	Length	m	6.2	16.0	16.0	16.0	-	-
	Breadth	m	6.2	4.0	4.0	4.0	-	-
	Depth	m	2.9	3.0	3.0	3.0	-	-
	Number	nos	5	6	4	2	12	17
Aeration Tank	Length	m	29.0	45.0	45.0	45.0	-	-
	Breadth	m	18.5	8.0	8.0	8.0	-	-
	Depth	m	4.4	6.0	6.0	6.0	-	-
	Number	nos	2	3	2	1	6	8
Final Settling Tank	Length	m	29.0	37.5	37.5	37.5	-	-
	Breadth	m	8.0	4.0	4.0	4.0	-	-
	Depth	m	4.4	3.0	3.0	3.0	-	-
	Number	nos	2	6	4	2	12	14
Chlorination Tank	Length	m	5.4*8nos	17*3nos	17*3nos		-	-
	Breadth	m	1.0	2.0	2.0		-	-
	Depth	m	2.1	2.0	2.0		-	-
	Number	nos	1	1	1		2	3
Sludge Thickener	Method		Chemical	Gravity Thickener			-	-
	Diameter	m	-	10.0	-	-	-	-
	Depth	m	-	2.5	-	-	-	-
	Number	nos	L/S	2	-	-	2	3
Sludge Dewatering	Type		Mechanical Dewatering				-	-
			Centrifugal	Filter Press Dewatering			-	-
	Number	nos	6	3	2	-	5	11

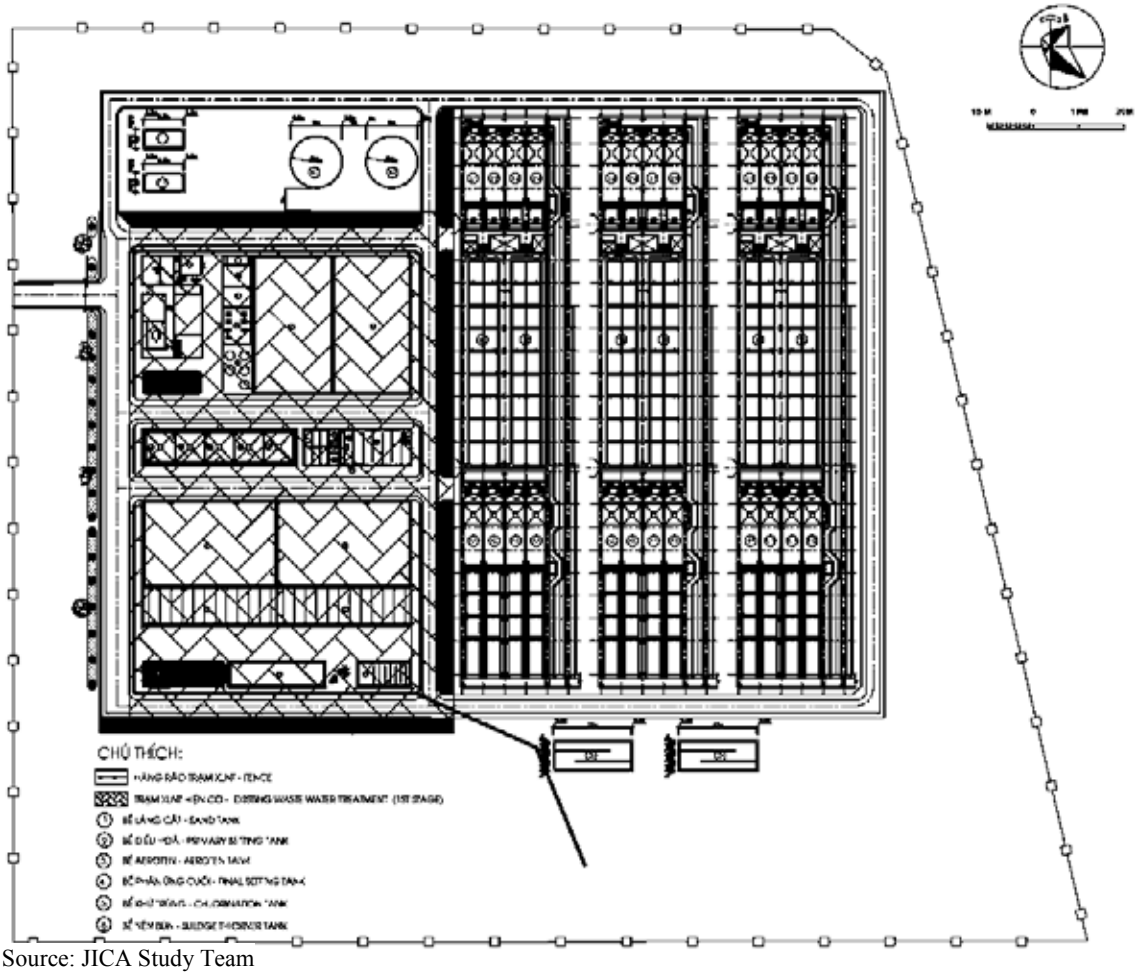
Source: JICA Study Team

After the completion of a full-scale treatment plant in 2020, it is recommended that a single, centrally located laboratory should be constructed which can provide lab services to all wastewater treatment plants operated by HHTP-MB.



Source: JICA Study Team

Figure E.3.2 Flow Diagram of Conventional Activated Sludge Process



Source: JICA Study Team

Figure E.3.3 General Layout Plan of Wastewater Treatment Plant

3.2.3 Summary of Wastewater Sewerage Project

The required facilities for the wastewater treatment in the Hoa Lac area are identified and shown in Table E.3.7.

Table E.3.7 Proposed Wastewater Sewerage Project

Item	Description	Unit	Proposed			Other Project
			Total	E&T Zone*	Other Zones	
Pipe	RC250-600,Gravity	m	41,436	2,098	39,338	4,831
	RC700-900,Gravity	m	2,059	0	2,059	0
	RC1000-1350,Gravity	m	1,567	0	1,567	0
	RC1350,Gravity	m	0	0	0	0
	Subtotal	m	45,062	2,098	42,964	4,831
	2xDCIP150-300,Pressure	m	2,187	0	2,187	0
	2xDCIP350-600,Pressure	m	1,552	0	1,552	0
	Subtotal	m	3,739	0	3,739	0
	Total	m	48,801	2,098	46,703	4,831
Manhole	1.2 m x 1.2 m	nos	3,220	0	3,220	578
	1.4 m x 1.4 m	nos	2,184	0	2,184	0
	1.6 m x 1.6 m	nos	743	0	743	578
	Total	nos	6,147	0	6,147	1,156
Intermediate Pumping Station	Q: ~0.050m3/sec	nos	4	0	4	0
	Q: 0.051~0.100m3/sec	nos	3	0	3	0
	Q: 0.101~m3/sec	nos	3	0	3	0
	Total	nos	10	0	10	0
Wastewater Treatment Plant	Existing Unit (Step 1 Project)	m3/day	0			6,000
	Expansion Treatment Units	m3/day	36,000		36,000	
	Total	m3/day	36,000	0	36,000	6,000

*Education & Training Zone: To be developed under "Area Development"
Source: JICA Study Team

3.3 INSTITUTIONAL ASPECTS

3.3.1 Staff Member for the Wastewater Sewerage System

Considering that the staff members in PMU have no experience with flood control, wastewater collection and treatment operations, the organization of HHTP-MB, especially PMU, shall be reinforced as per the sewerage and drainage facilities. HHTP-MB lacks the qualified personnel to operate and maintain flood control and sewerage infrastructure. The organization for the Operation and Maintenance (O&M) of the sewerage and drainage system along with O&M of the wastewater treatment plant should be established as soon as possible. The training to staff members is also required. This will assist them in acquiring and/or upgrading their skills relevant for the operation and maintenance of the plant.

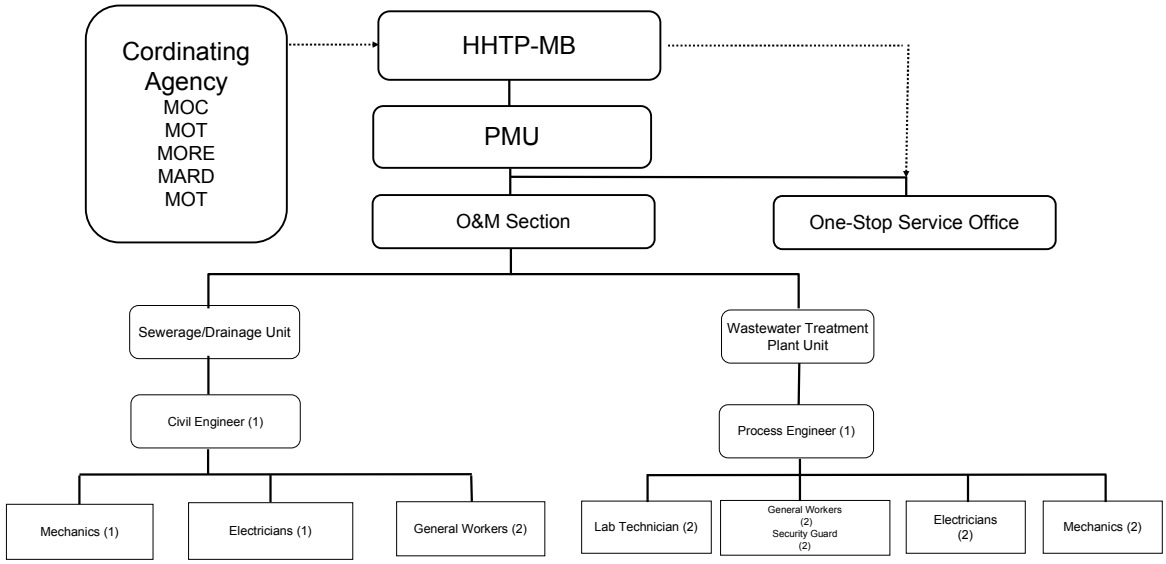
The implementation of wastewater treatment will create a need to hire qualified and knowledgeable operators and engineers as well as trained mechanics and electricians. It is therefore important that HHTP-MB act quickly to hire and train technical personnel.

After completion of the project construction works, all the sewerage and drainage facilities, including the wastewater treatment plant, will be operated and maintained by PMU under HHTP-MB.

The following institutional aspects are taken into account to reinforce the project implementation organization and establish the operation and maintenance (O&M) mechanism for the storm water drainage system in HHTP. Figure C.3.2 shows the proposed structure for

O&M organization. Main activities for operation and maintenance are;

- Operation of the relay pumping station, treatment plant, and regulating gate, and their maintenance,
- Regular patrolling of the wastewater collection, storm water collection sewers, drainage canals, streams, lake and retention pond,
- Seasonal maintenance and rehabilitation of levees, revetments, etc., and
- Measurement and monitoring of water level, flow discharge and water quality.



Source: JICA Study Team

Figure E.3.4 Proposed O&M Organization for Sewerage and Drainage Sector

For the O&M of the all facilities related to sewerage and drainage system, staff of 16 persons that includes 2 engineers, 9 technicians/operators, and 6 workers will be required. The details are shown in Table E.3.8.

Table E.3.8 Required Staff Members for O&M

Position	For Facilities implemented for Stage 1 (Sewerage, WWTP, Drainage)	For Expanded Facilities for Stage 2 (Sewerage & Drainage System)	Total
	2010-2015	2015-2020	
Civil Engineer	-	1	1
Process Engineer	1	-	1
Process Operators	1	-	1
Mechanics	2	1	3
Electricians	2	1	3
Lab technicians	2	-	2
General Workers	2	2	4
Security Guard	2	-	2
Total	12	4	16

WWTP: Wastewater Treatment Plant

Source: JICA Study Team

3.3.2 Laboratory and Equipment for O&M of the Wastewater Treatment Plant

Operational control of wastewater treatment system will require frequent sampling and laboratory analysis to monitor:

- Influent wastewater characteristics
- Effluent characteristics
- Performance of the treatment systems and
- Operating adjustments to various stages of the treatment process

The Wastewater treatment plant will therefore need to be supported properly by means of equipped laboratory and a team of technicians. The laboratory with the following monitoring equipment will be located at the wastewater treatment plant as shown in Table E.3.9.

Table E.3.9 List of Required Equipment for Laboratory

No.	Item
1	Water sampling Kit
2	pH & DO(Dissolved Oxygen) Meter
3	ORP (Oxidation-Reduction Potential) Meter
4	Chemicals and Equipment for determination of BOD
5	Chemicals and Equipment for determination of COD (Chemical Oxygen Demand)
6	Equipment for determination of SS, TSS, VSS
7	Chemicals and Equipment for determination of Nitrogen, Phosphorus, n-Hexane Extract
8	Mobile flow meter
9	Pick-up truck, 1 ton for field services

Source: JICA Study Team

3.3.3 Estimation of Annual O&M Costs for Sewerage and Drainage System

Operation and maintenance (O&M) of the drainage system is recommended to be executed together with the sewerage system. For the proposed drainage and sewerage project, the ratio of annual O&M cost to the direct construction cost of sewer system and wastewater treatment plant is proposed to be 0.5% and 2% respectively. Annual O&M costs for wastewater sewer system, wastewater treatment plant and drainage system are estimated about VND 800,000,000 per year (equivalent to JPY 5,200,000 per year), VND 11,800,000,000 per year (JPY 75,500,000 per year), VND 11,000,000,000 per year (JPY 70,400,000 per year) respectively. In general, in most of the developed countries, the O&M cost for drainage and sewerage system is recovered by beneficiaries. Thus, in order to secure the O&M cost, the sewerage levy-based system shall be established prior to implementation of the sewerage system. It is recommended that sewer charges by means of prorating the O&M cost to the development area should be collected from the developers for each functional zone.

3.4 RECOMENDATION

3.4.1 Structural Measures

1) The wastewater sewerage plan will be conducted by considering the harmonization with the existing infrastructures as constructed by HHTP-MB.
2) The existing sewer with intermediate pumping stations will be utilized effectively.
3) Although the Tic River belongs to Class B according to TCVN 5945-2005, the wastewater discharged from HHTP, considering the social and environmental conditions of HHTP and

its suburb shall be treated with Class A level at an annual average of 20mg/L of BOD.

4) Biodegradable wastewater shall be collected and treated via the centralized wastewater treatment plant and following the ”Pollutants Pay Principle”, the toxic/hazardous wastewater shall be treated on-site by respective developers.
5) The wastewater treatment plant shall be constructed stage by stage. This will also be able to incorporate the implementation of sewerage network and amount of acceptable wastewater generated from the area.

3.4.2 Non-Structural Measures

1) The organization of O&M for the sewerage and drainage system including the wastewater treatment plant will be established as soon as possible.
2) It is important for the HHTP-MB to take quick actions to hire and train technical personnel for treatment plants.
3) In order to secure the O&M cost, the sewerage levy-based system should be established, prior to the implementation of the sewerage system.
4) In order to meet allowable influent wastewater quality of the centralized wastewater treatment plant (WWTP No.1), the investor guideline will be required by the developers so as to provide the pre-treatment facilities to the wastewater at each functional zone.

SUPPORTING F

POWER SUPPLY PLAN

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CHAPTER 1 PRESENT CONDITIONS OF POWER SUPPLY SYSTEM

1.1 PRESENT CONDITIONS OF POWER SUPPLY SYSTEM

1.1.1 Internal Area of HHTP

The existing transmission network within HHTP is shown in the Figure F1.1.1. At present, 2cct (circuit) of the transmission line between Xuan Mai S/S (substation) and Soy Tay S/S is passing adjacent to the HHTP, and 1cct out of the two transmission lines is connected to Thach That S/S (25MVA×1unit). The S/S is supplying power to HHTP. From this S/S, the voltage of 110kV is stepped down to 22kV and is supplied to HHTP through underground cables and is shown in the red line in the Figure F.1.1

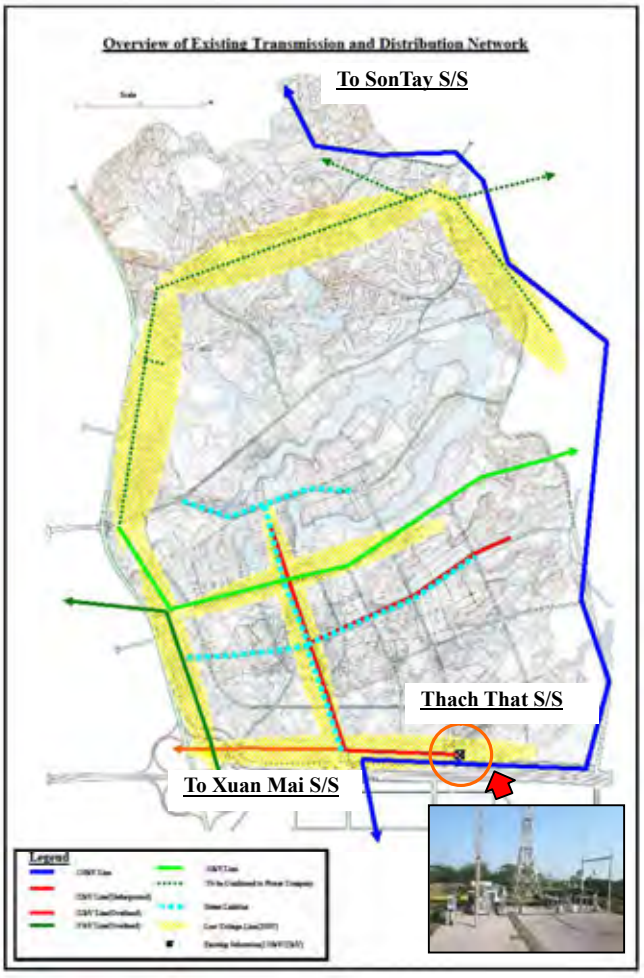


Figure F.1.1 Overvew of Existing Network

Currently, a 35kV overhead transmission line that crosses the western area of the HHTP has been stepped down to 10kV. It supplies power to the neighboring houses and the existing consumers such as factories.

At present, HHTP has constructed 22kV of underground supplying facilities. Thach That S/S (110kV/35kV/22kV, 25MVA×1) by means of cables supplies electric power to the existing tenants and the streets light. During November 2008, out of the total capacity of 25MVA, the peak demand of 5.9MW was recorded at Thach That S/S. However, this recorded demand also includes some demand that has been consumed outside of HHTP.

It is reported that the existing electrical facilities within HHTP is managed by Thach That branch office of Ha Tay Power Company, for which the name “Ha Tay” is commonly used. The power charges from the tenants are collected by the branch office as shown Figure F.1.2.

Figure F.1.2 Thach That Branch Office

1.1.2 External Area of HHTP

As of November 2008, Figure F.1.3 shows the status of existing transmission network surrounding HHTP. It is confirmed that 1cct from Xuan Mai S/S has been connected to Thach That S/S and is supplying electric power to the HHTP.

Meanwhile, Son Tay S/S is connected directly to Xuan Mai S/S without linking to Thach That S/S. 1cct among 2cct from Xuan Mai S/S is not connected to the Son Tay S/S, and the line is being operated as a standby use.

Under these circumstances, in case if some accident takes place in Hoa Binh P/S, then the transmission to the entire area of the present High Tech will be disconnected and will be black out.

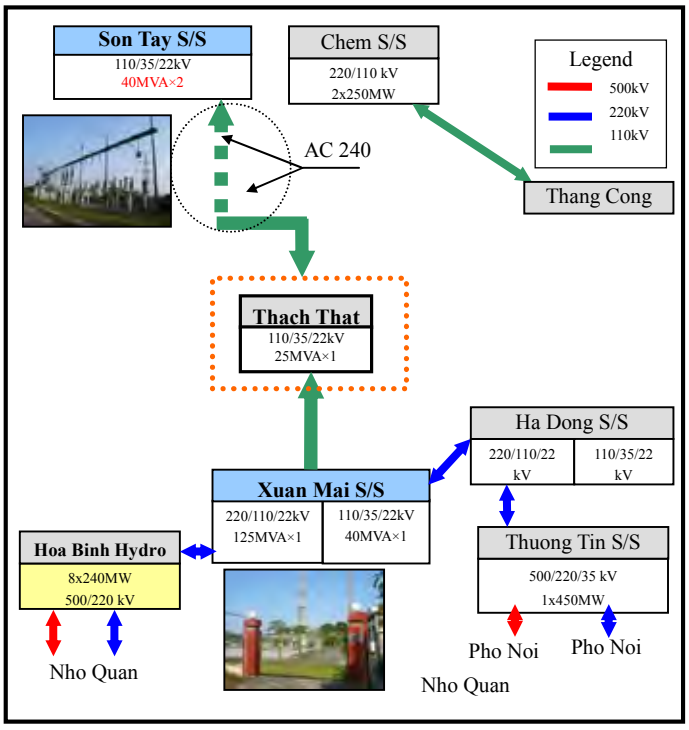


Figure F.1.3 Overvew of Existing Transmission Networlk Surrounding HHTP

It is reported that for the time being, the Thach That S/S is expected to supply the power to the existing tenants. Even though the current capacity of the Thach That S/S seems to have enough margins of reserve but considering the future development and the expected risen demand, in future the S/S won't be able to ensure the sufficient supply of power to the entire area. In addition, in terms of the reliability of the network, capacity and Nos. of transmission lines also need to be reinforced.

1.2 DEVELOPMENT PLAN

At present, three plans exist: i) JICA Updated M/P; ii) VN Revised M/P; and iii) Plan prepared by Ha Tay Province with the Department of Industry and Trade. These plans are described below:

1.2.1 JICA Updated M/P

The JICA Updated M/P implemented in 2007 and has introduced two development plans: i) Alternative-1and ii) Alternative-2. The each alternative plan is summarized in Figure F.1.4 and F.1.5.

As the development progresses, both of the alternatives (Alternative-1 and Alternative-2) plans recommend the

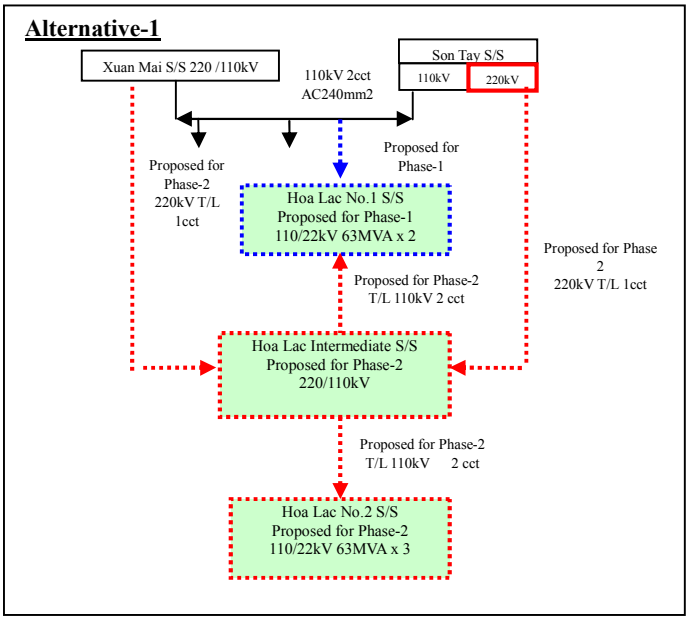


Figure F.1.4 JICA Updated M/P (Alternative-1)

construction of three substations: i) Hoa Lac No.1 S/S, ii) Hoa Lac No.2 S/S, and iii) Hoa Lac Intermediate S/S for supply to Hoa Lac and Northern Phu Cat Area.

In addition, both of the plans insist on the necessity of supply through 220kV transmission lines from Son Tay and Xuan Mai S/S.

The major difference among the two alternative development plans of the JICA Updated M/P is the development schedule of Hoa Lac Intermediate 220/110kV S/S.

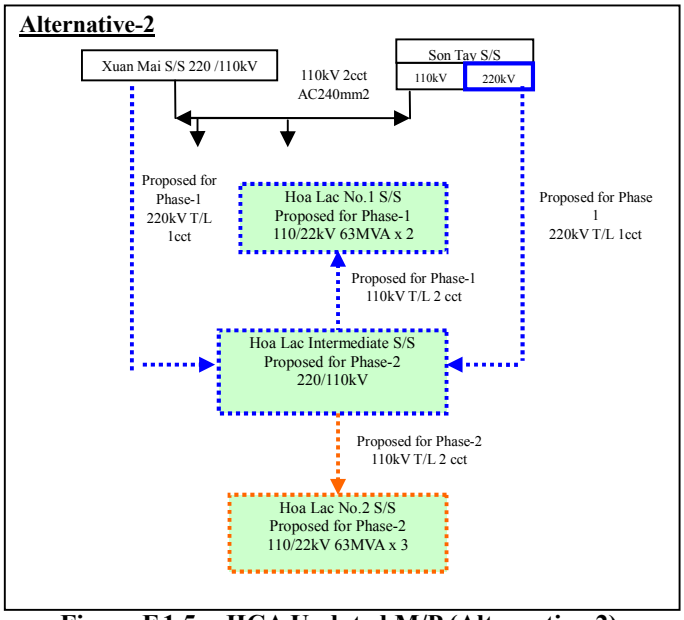


Figure F.1.5 JICA Updated M/P (Alternative-2)

Alternative-1 plans the construction of the Hoa Lac No.1 110/22kV S/S during Stage-1 (2015) with an assumption of a demand of about 60MVA from 810ha. Thereafter, during Stage-2 (2020), Alternative-1 plans for the construction of Hoa Lac Intermediate 220/110kV S/S and Hoa Lac No.2 110/22kV S/S. On the other hand Alternative-2, plans for the construction of all three S/S i.e. Hoa Lac No.2 S/S and Hoa Lac Intermediate S/S during early stage of Stage-1 (2015).

In the M/P, the plan of Alternative-1 mentioned as more recommendable one than Alternative-2.

1.2.2 VN Revised M/P

VN Revised M/P was prepared based on JICA Updated M/P. As a result, it is similar plan to the Alternative-1 of JICA Updated M/P is suggested. The VN Revised M/P is shown in the Figure F.1.6 and F.1.7.

During stage-1(2015), Hoa Lac No.1 S/S with 3 units of 63MVA transformers is to be built. One of three transformers is to be installed as a standby use. During Stage-2 (2020), it follows the Alternative-1 plan of JICA Updated M/P and plans for the construction of Hoa Lac No.2 and Hoa Lac Intermediate S/S in the Phu Cat area.

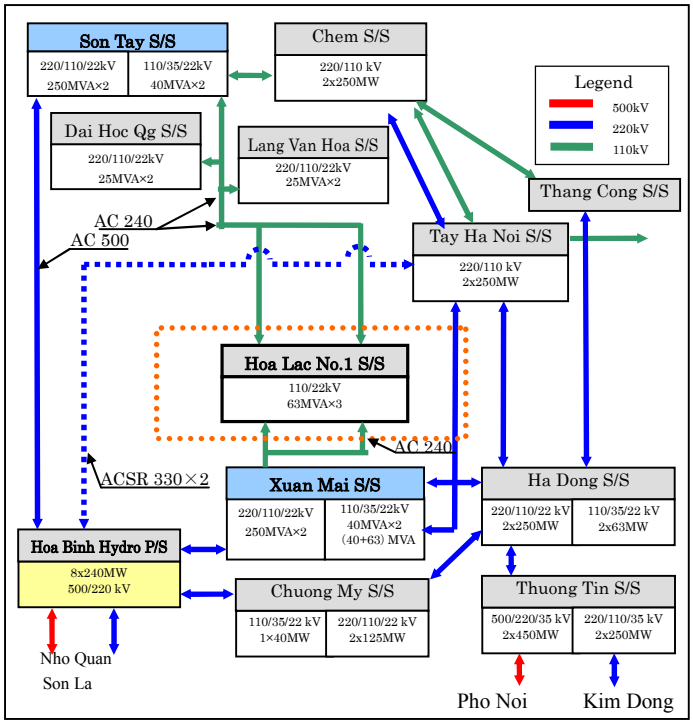


Figure F.1.6 VN Revised M/P (first stage 2015)

However, the capacity of the transformer to be installed differs between JICA Updated M/P and VN Revised M/P. For Hoa Lac No.1 S/S, VN Revised M/P indicates installation of 3 units of 63MVA and for Hoa Lac No.2 S/S,

the M/P suggest for the installation of 2 units of 40MVA. For Hoa Lac Intermediate 220/110kV S/S, installation of 2 units of 125 or 250MVA is planned.

The most remarkable similarity between them is that both plans strongly recommends for the necessity of construction of Hoa Lac Intermediate 220/110kV S/S and connection of 220kV transmission line to the substation.

But, in the VN Revised M/P, 220kV transmission line is to be connected to Tay Ha Noi S/S from Hoa Binh Hydro P/S, and it is planned that during stage-2 (2020), 220kV transmission will be branched from the middle of the lines.

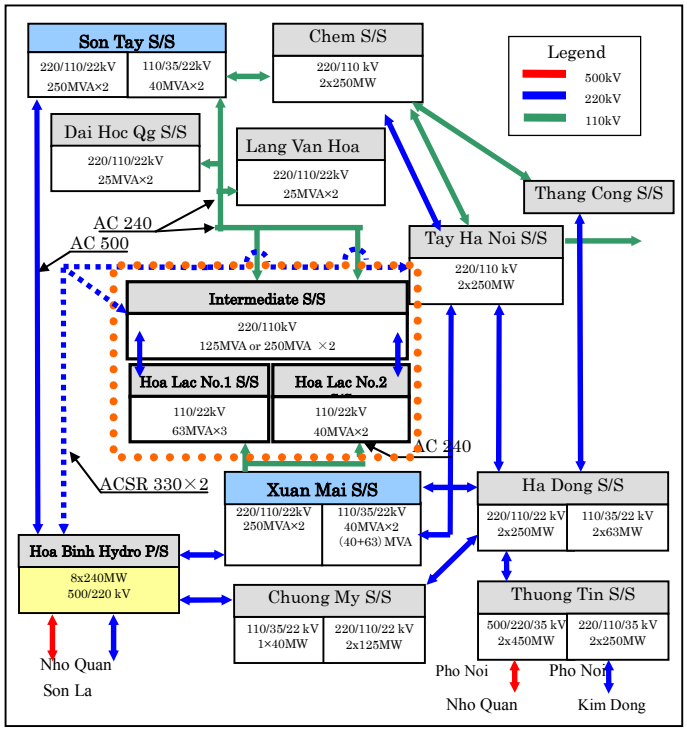


Figure F.1.7 VN Revised M/P (stage2: 2020)

1.2.3 Plan prepared by Ha Tay Province

There is another power supplying plan for HHTP, which was prepared by Ha Tay Province and approved by the Department of Industry and Trade. However, it plans till 2015 only. The plan is shown in Figure F.1.8.

This plan recommends construction of two substations in and around HHTP: i) Thac That S/S (63MVA×2) and ii) Phu Cat S/S (40MVA×2). It is deemed that the capacity of these substations will cover the future demand of neighboring resident area.

But, in this supply plan, a standby use transformer has not been planned. In addition, as this plan was prepared without referring to the VN Revised M/P which has been approved by the prime minister, it didn't consider the power supply from 220kV transmission lines.

In January 2009, the meeting aims to explain existing three plans was held with the Department of Industry and Trade, which is responsible for regional supply plans. They understood the differences among

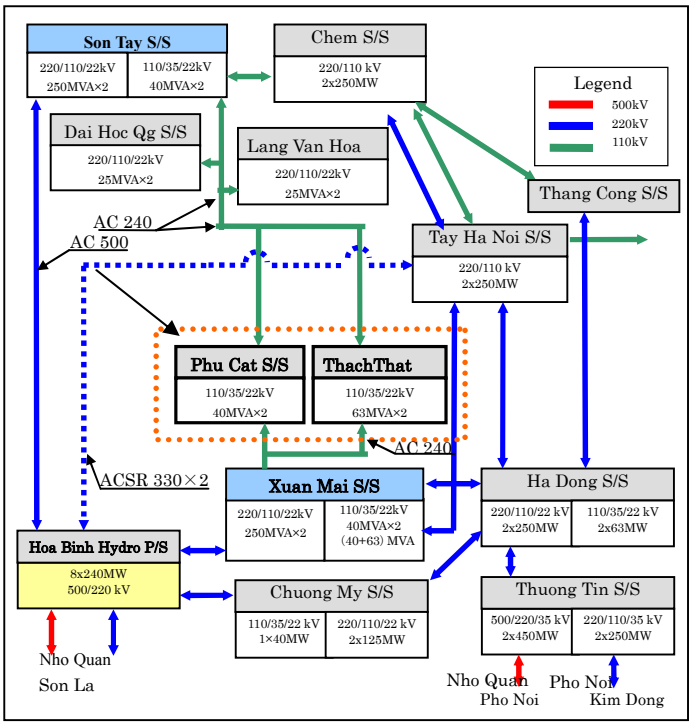


Figure F.1.8 Plan prepared by Ha Tay Province (-2015)

the three plans and the importance of the construction of 220kV transmission line. As the VN Revised M/P has already been approved by the prime minister, they also agreed to incorporate the VN Revised M/P into their regional development plan.

1.3 ISSUES ON DEVELOPMENT OF HHPT

The issues for existing electrical facilities in HHTP are listed below:

Present issues
- In case accident takes place in Hoa Binh P/S or Xuan Mai S/S, then no electricity can be supplied from Thach That S/S to HHTP.
- It is confirmed that the old 35kV and 10kV distribution lines exist in HHTP and these distribution line were adopted old standard of the voltage class.
- 22kV underground cable has been already installed by the HHTP in order to supply power to the existing tenants and for street lightings. However, in addition to electrical facilities such as underground cable and distribution panel, the technical tunnels are also not well-organized and the utilization of such facilities for future development purposes is not recommended.

In the meantime, present issues for the development can be summarized as follows:

Issues for development
- Electrical facilities are being developed on their own without considering the VN Revised M/P and JICA M/P. In fact the electrical facilities were constructed without any technical planning and were constructed in accordance with the increase of tenants.
- Thach That S/S does not have enough capacity to cover the demand for future development.
- In spite of the fact that VN Revised M/P was approved by the prime minister, HHTP didn't informed the Power Supply Plan as mentioned in the M/P to the Ministry of Industry and Trade which is responsible for planning of the power supply. Ministry of Industry and Trade follows the Vietnamese procedure to formulate a plan based on the information received from the respective regional government. In this background, two power supply plans co-exist; one is VN Revised M/P approved by the prime minister, the other is a plan prepared by the Han Tay Province.
- HHTP doesn't have enough number of suitable engineers within their organization who can operate and maintain even the existing electrical facilities of the entire Park. Thus, it is deemed indispensable for HHTP to reinforce the implementation capacity by supplementing the technical personnel even though other entity such as a power company plan, design and operates.

Based on the issues as mentioned above, electrical facilities to attain reliable supply are planned for the development of HHTP.

CHAPTER 2 FRAMEWORK OF POWER SUPPLY DEVELOPMENT PLAN

2.1 BASIC CONCEPTS

2.1.1 Plan Concept and Design Criteria

HHTP is a high tech park, which requires more reliabile supply networks with an application of the some of the state of the art facilities. For bets results, the facilities in HHTP have to be operated without any power interruption than the current existing electrical facilities in Vietnam. Therefore, it is prerequisite for the power entites such as EVN and the related power company to have better understandings for the developments and improving the external transmission network as per the priority and progress of the development in HHTP.

The reliability of the power supply system does not depend on only one component but it is entirely dependent on the entire system. A failure of any of the components could cause the failure of whole system. Considering this, the exclusive use of 110kV transmission lines for HHTP is one of the feasible possible solution to guarantee reliabile power suppy in HHTP. However, considering the simple configuration of the 220kV systems, its reliability is much higher than that of the 110kV systems. In general, this is because of the few number of long distance connections of 220kV transmission lines to substations Thus, in order to enable high reliability in the power system, it is recommeneded to adopt 220kV transmission line as a supplying transmission line. Such construction was also planned in VN Revised M/P.

One of the indexes in electrical supply reliability is appraised by N-1 conditions. The conditions is that power supply has to be provide guarantee that one of the electrical components such as a generator or transmission line or transformer is out of service. For this supply plan, N-1 conditions will be applied. This will ensure guarantee for reliability. For the development of power supply in HHTP, the following criteria were adopted for the design.

Criteria	Strategy
a)To follow N-1 conditions that are used as an index to measure electrical supply reliability	- To secure at least 2cct of 110kV transmission line that can meet the entire demand through 1cct despite of any occurrence of accidents in the transmission line. - To install a standby transformer so as to provide uninterrupted continuous power even if any of the transformers fails. - To install double looped distribution system inside HHTP.
b)To follow recommendation mentioned in PDP 6th made by Vietnam	- To adopt the recommendation of PDP 6th (the national power development plan in the period of 2006 -2015, perspective up to 2025).
c)To achieve easy maintenance	- To adopt open loop Ring Main Unit distributing system that is widely applied especially in the industrial park consisting of Japanese companies in Vietnam.

2.1.2 Concept for Power Supply inside HHTP

The following items will be focused in the power supply design.

1) Supply Reliability
2) Environmental Friendliness
3) Easy Maintenance

The measures to attainin the concept of effective power supply system within HHTP are as follows:

(1) Supply Reliability

One standby transformer is to be installed. This will ensure uniterrupted power supply during maintenance, change- over of the operation or if any accidents happens.

In order to ensure reliability without any serious interruption of the power supply, for the distribution systems inside Hoa Lac Hi-Tech Park, the distribution feeders will be doubled along with the installation of standby transformer. The double feeding network will be also laid looped and for operation purpose the loop will be operated openely. However, in case if some accidents takes place than the loop will be closed, and power will be supplied from the other direction.

(2) Environmental Friendliness

Giving importance to the aesthetic view and creation of friendly environment in the Hi-Tech Park, all cables are planned to be laid underground including low voltage distribution line. In the distributing substation, a housing type distribution substation that has switching equipment has been planned for installation.

(3) Easy Maintenance

Simplicity for the maintenance of electrical facilities is an important element for a person or organization to undertake O&M works. In terms of reliability and simplicity, the open loop Ring Main Unit distributing system is widely used especially in industrial park. With such wide use of this system, large pool of engineers having a sound knowledge and experience about open loop Ring Main Unit distribution system are available.

2.1.3 External Conditions for Development

To meet external conditions so as to guarantee the quality power supply and to implement HHTP development in accordance with the schedule, as explained above, understanding and cooperation for the development of HHTP is prerequisite in the development process. For this purpose, the following external conditions should be satisfied by the concerned Vietnamese authorities for the supply to Hoa Lac area.

1) Without any linkage to other S/S in between, 110kV transmission lines from Xuan Mai S/S and Son Tay are required to be used exclusively for the power supply to HHTP. In case if one line fails then another line can cover the entire demand of the HHTP.
2) Until the 110kV transmission line reach a maximum capacity, another 110/22kV S/S as suggested by VN Revised M/P should be developed. This can supply power to Phu Cat area.
3) To ensure the uninterrupted and continuously power supply to HHTP even during O/M or installations of the transformers, the power company should continuously have discussion with HHTP engineer and should establish an optimal operation procedure.
4) In order to strengthen the power supply network for HHTP, 220kV transmission line is expected to be connected from Hoa Binh P/S and Hoai Duc 220kV transmission line that is planned in VN Revised M/P.
5) Considering load breaking capacity of the equipment, the power companies shall connect each 110/22kV and 220/110kV that are planned to be constructed in Northern Phu Cat Area as specified in the VN Revised M/P.

The above 1), 2) and 3) are inevitable to guarantee the quality of power supply to HHTP.

2.1.4 Development Area for the Study

Development area for the power supply design for the F/S is 1,036ha and is shown in Figure F.2.1.

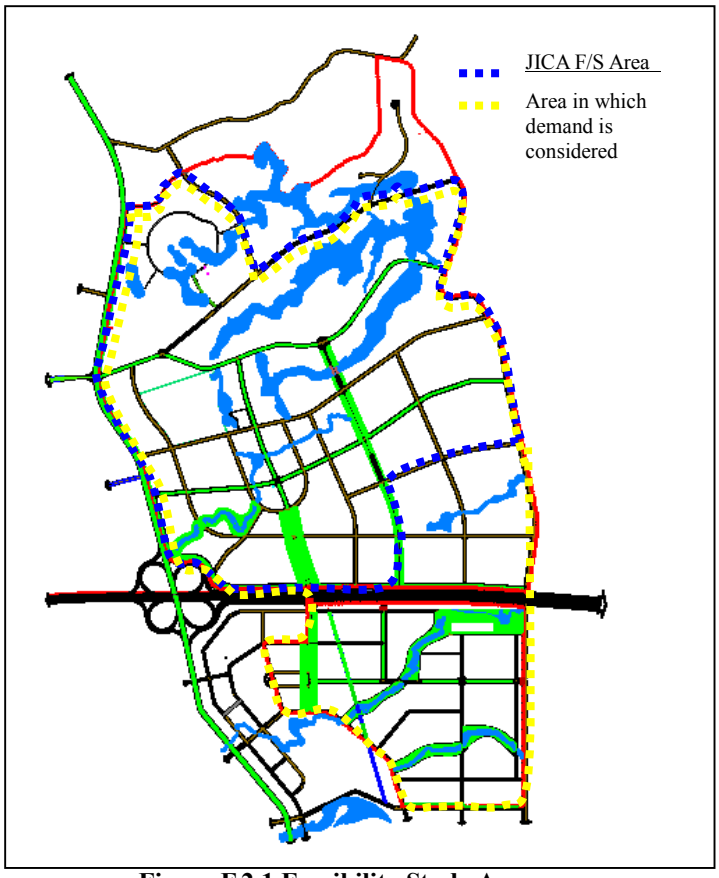


Figure F.2.1 Feasibility Study Area

The scope of study for the JICA F/S is indicated by the blue dotted lines as shown in the Figure F.2.1. However for designing the electrical facilities and to estimate power demand, the coverage area as shown by yellow doted line was considerd. It is to be noted that the design of a substation to step down the voltage and supply power and distribution feeders in Northern Phu Cat were excluded.

2.1.5 Proposed Design Standards and Conditions

The design standards and conditions that were adopted are as follows:

(1) Design Standards

1) International Electro-technical Commission (IEC)
2) International Organization for Standardization (ISO)
3) Vietnam Electrical Installation Code (Socialist Republic of Vietnam, Ministry of Electricity)
4) Vietnamese Construction Standards and Regulations (Ministry of Construction)
5) Japanese Industrial Standards (JIS)
6) Standard of Japanese Electrical Technical Committee (JEC)

7) Other applicable standards or codes

(2) Design Condition

1) Frequency: 50Hz
2) Maximum ambient temperature: 45°C
3) Minimum ambient temperature: 10°C
4) Maximum humidity: 95%
5) Altitude: ≤ +10m MSL
6) Maximum wind velocity: 40m/sec
7) Seismic factor: 0.15G

2.2 DEMAND PROJECTION

2.2.1 General

The Table F.2.1 shows power demand projections as mentioned in VN Revised M/P and JICA Update M/P. These projcetions are done for each zone located within the Hoa Lac and Northern Phu Cat area. Both of the M/P estimates alomost the same amount of demand for the enitre development area. The VN Revised M/P adopted a designated Vietnamese regulation and used unit demand method in their projection. As the the result of demand value were finally reviewed from the standpoint of actual consumption and practical use, the applied unit demand value were found to be smaller. However, the values of the unit demand as set for each zone were judged to be appropriate and are applicable except for the unit demand for Hi-Tech industry zone. Thus, learning from the past exeperinces of actual consumptions in the similar projects to Hi-Tech industry zone, it is recommended that the set unit demand should be altered to 400kVA/ha.

Table F.2.1 Demand Projections of VN Revised M/P and JICA Updated M/P

Land Use	Vietnam Revised M/P: Area (ha)							JICA Updated M/P: Area (ha)							Deference (ha)
	Total			Stage1(2015)		Stage2(2020)		Total			Phase1(2015)		Phase2(2020)		
	ha	kVA	kVA/ha	ha	kVA	ha	kVA	ha	kVA	kVA/ha	ha	kVA	ha	kVA	
1 Software park	75.9	**5,472.0**	**72.1**	44.0	3,168	31.9	2,304	75.0	**1,180**	**15.7**	45.0	675	30.0	505	0.90
2 R&D	229.0	**16,488.0**	**72.0**	132.8	9,562	96.2	6,926	145.0	**2,775**	**19.1**	70.0	1,260	75.0	1,515	84.00
3 Hi-tech Industrial	549.5	**153,860.0**	**280.0**	226.3	63,364	323.2	90,496	340.0	**156,000**	**458.8**	140.0	39,200	200.0	116,800	209.50
4 Education & Training	108.0	**9,072.0**	**84.0**	50.0	4,200	58.0	4,872	95.0	**3,040**	**32.0**	55.0	1,540	40.0	1,500	13.00
5 Center of hi-tech City	50.0	**7,000**	**140.0**	50.0	7,000		0	50.0	**8,500**	**170.0**	40.0	3,600	10.0	4,900	0.00
6 Mixed Use	87.7	**8,770**	**100.0**	48.5	4,850	39.2	3,920	100.0	**14,000**	**140.0**	75.0	9,450	25.0	4,550	-12.30
7 Houses & Offices	42.0	**4,410**	**105.0**	42.0	4,410		0	50.0	**2,700**	**54.0**	15.0	788	35.0	1,912	-8.00
8 Housing Complex	26.0	**2,730**	**105.0**	12.4	1260	13.6	1,470	20.0	**1,150**	**57.5**	0.0	0	20.0	1,150	6.00
9 Amenity	110.0	**770**	**7.0**	110.0	770		0	110.0	**320**	**2.9**	100.0	100	10.0	220	0.00
10 Amusement	33.5	**469**	**14.0**	33.5	469		0	60.0	**1,260**	**21.0**	20.0	240	40.0	1,020	-26.50
11 Infrastructure	115.5	**809**	**7.0**	115.5	809		0	140.0	**5,880**	**42.0**	110.0	2,310	30.0	3,570	-24.50
12 Lake & Buffer	117.0	-	-	117.0	-		-	245.0	-	-	140.0	-	105.0	-	-128.00
13 Tree	42.0	-	-	42.0	-		-	0.0	-	-	0.0	-	0.0	-	42.00
14 Reserved Area								180.0					180.0		-180.00
Total	1,586.0	**209,850.0**	**132.3**	1,024.0	99,862	562.0	109,988	1,610.0	**196,805**	**122.2**	810.0	59,163	800.0	137,642	-24.00

2.2.2 Demand Projection for HHTP

Necessary power demand has been reviewed for an area of 1,268ha of Hoa Lac area that includes an area of 1,036ha of JICA F/S. In addition, power demand for an area of 318ha of Northern Phu Cat area has also been reviewed. Thus based on the calculation for demand projection as shown in Table F.2.2, the total demand has been estimated for the Hoa Lac area as shown in Table F.2.3.

Table F.2.2 Detailed Calculation of Demand Projection for Hoa Lac Area

	Land Use	Area (ha) for F/S		Area (ha) Total	kVA/ha
	Hoa Lac Area		**kVA**		
1	Software park	64.4	4,643	64.4	**72.1**
2	R&D	227.9	16,409	227.9	**72.0**
3	Hi-tech Industrial	114.7	92,640	231.6	**400.0**
4	Education & Training	108	9,072	108	**84.0**
5	Center of hi-tech City	49	6,860	49	**140.0**
6	Mixed Use	84.5	8,450	84.5	**100.0**
7	Houses & Offices	41.9	4,400	41.9	**105.0**
8	Housing Complex	22.6	2,373	22.6	**105.0**
9	Amenity	0	770	110	**7.0**
10	Amusement	33.2	465	33.2	**14.0**
11	Traffic & Infrastructure	146.6	1,030	147.1	**7.0**
12	Lake & Buffer	112.4	-	117	**-**
13	Greeneries/Trees	30.8	-	30.8	**-**
Sub-total		1036	**147,111**	1,268	

Source: JICA Study Team

Table F.2.3 Demand Projection for Hoa Lac Area

	ha	**kVA**
Hoa Lac Area (including 1,036 ha)	1,268	147,111
F/S Scope Area	1,036	99,578

Source: JICA Study Team

In addition, the demand for Northern Phu Cat area has also been estimated and is shown in Table F.2.4 and F.2.5.

Table F.2 4 Detailed Calculation of Demand Projection for Northern Phu Cat Area

	Land Use	Area (ha) for F/S		Area (ha) Total	kVA/ha
	Northern Phu Cat Area		**kVA**		
1	Software park	0.0	786	10.9	**72.1**
2	R&D	0.0	0	0.0	**72.0**
3	Hi-tech Industrial	0.0	115,600	289.0	**400.0**
4	Education & Training	0.0	0	0.0	**84.0**
5	Center of hi-tech City	0.0	0	0.0	**140.0**
6	Mixed Use	0.0	240	2.4	**100.0**
7	Houses & Offices	0.0	0	0.0	**105.0**
8	Housing Complex	0.0	273	2.6	**105.0**
9	Amenity	0.0	0	0.0	**7.0**
10	Amusement	0.0	0	0.0	**14.0**
11	Traffic & Infrastructure	0.0	13	1.9	**7.0**
12	Lake & Buffer	0.0	-	0.0	**-**
13	Greeneries/Trees	0.0	-	11.2	**-**
Sub-total		0.0	**116,912**	318.0	

Source: JICA Study Team

Table F.2.5 Demand projection for Northern Phu Cat Area

	ha	**kVA**
Northern Phu Cat Area	318	116,912

Source: JICA Study Team

With the above estimates, the total combined demand for Hoa Lac Area and Northern Phu Cat Area is approximately 264MVA as shown in Table F.2.6,

Table F.2.6 Total Demand Projection

Area	**Assumed Demand (MVA)**
Hoa Lac Area	147 MVA
Northern Phu Cat Area	117 MVA
Total	264 MVA

Source: JICA Study Team

CHAPTER 3 PROPOSED POWER SUPPLY PLAN

3.1 GENERAL

This Chapter proposes necessary projects to attain reliable power supply to Hoa Lac Hi-Tech Park.

To meet the demand of the area of 1,268ha of Hoa Lac, an additional capacity of more than 134MVA will be required in addition to the current receiving capacity of a substation. To meet this additional demand, one exclusive substation with the transformer should be constructed. It should follow the set criteria and the installation of the number of unit of the transformers/sub stations for the given area should also consider that some of the power in addition to 1,036ha also required to be supplied to other areas such as Phu Cat area as also being planned in VN Revised M/P. The Table F.3.1 shows Necessary capacity of substation for Hoa Lac area.

Table F.3.1 Necessary capacity of substation for Hoa Lac Area (1,268ha)

Area	Assumed Demand (MVA)	Recommended Capacity Installation
Hoa Lac Area	134MVA (147MVA divided by 1.1 of diversity factor). See Supporting Report.	63MVA×3units(one unite for standby)

Source: JICA Study Team

As in Vietnam, a capacity of 63MVA is commonly applied as the unit capacity of transformer as recommended in the VN Revised M/P. Therefore, in terms of manufacturing and procurement, the unit capacity seems appropriate and thus to meet the capacity is recommended for installation.

3.2 PROPOSED POWER SUPPLY SYSTEM

3.2.1 Power supply scenario for HHTP

As per the progress of the development, all the overhead transmission lines like 10kV and 35kV that are crossing HHTP need to be dismantled. The installed 22kV underground cable need to be moved or dismantled so as to ensure proper routes for other facilities such as communication line and water pipes, drainage pipes. After adjustment or removal of the existing inappropriate facilities, newly planed electrical facilities will be developed or improved.

Figure F.3.1 shows the Development Scenario for the entire Hoa Lac and Northern Phu Cat area. In order to enable reliable power supply to Hoa Lac Area, the following (1), (2) and (3) projects are inevitable for power supply to HHTP.

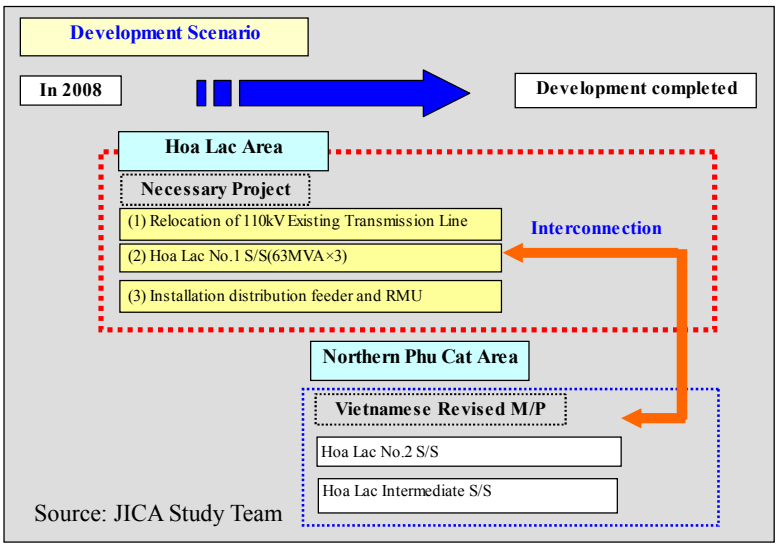


Figure F.3.1 Development Scenario for HHTP

3.2 2 Proposed Power Supply Network Plan

Recommended power supply method within HHTP is shown in Figure F.3.2. The receiving substation named Hoa Lac No.1 S/S, should be installed with three (3) units of transformers. Two (2) of the transformers shall operate regularly. Another one transformer shall be used as standby. Usually, disconnecting switches are opened, and status of looped distribution feeders is open. In case of emergency, the disconnecting switches are closed and electric power will be supplied from the other route.

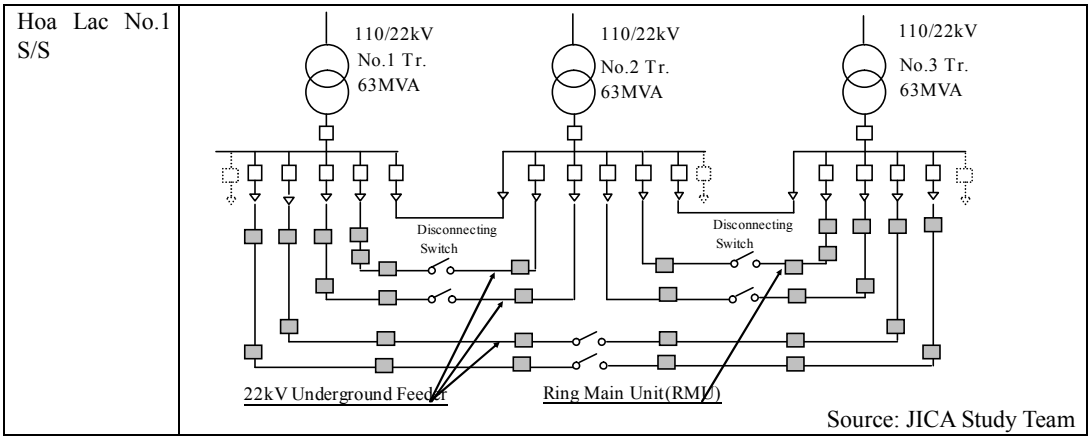
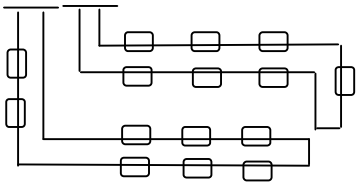
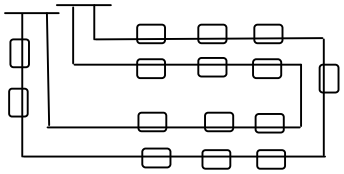


Figure F.3.2 Recommended Configuration of Supplying System

The voltage of 22kV for power supply to HHTP has been adopted. The supply system is designed adopting RMU (ring main unit) network. In the RMU network, there are two types of supplying systems as shown in Figure F.3.3. Considering the reliability, it is proposed that Ring Loop system should be adopted.

	Parallel Loop	Ring Loop
Configuation		
Merit/ Demerit	When loads are concentrated to one loop, it is impossible to shift some loads to another loop.	When loads are concentrated to one loop, some loads can be shifted to another loop with an application of short cable extention. <better>
Reliability	Since cables of the same loop are running in parellel with narrow clearance in some part , in case of accident, the faulted cable may affect another cable of the same loop.	Since cables of the same loop are not running in parellel, during accident the faulted cable will not affect another cable of the same loop. <better>
Cost	Total cable length is nearly same	Total cable length is nearly same
Evaluation	Not Recommendable	Recommendable

Source: JICA Study Team

Figure F.3.3 Comparison of Looping Installation

3.2.3 Proposed Substation Plan

To meet the projected demand for Hoa Lac area, Hoa Lac S/S with 3 units of 63MVA transformers should be installed adjacent to the existing Thach That S/S. The location of the construction is shown in Figure F.3.4 and F.3.7. Necessary dimension for Hoa Lac No.1 is approximately 3,025m^2 (55m × 55m).

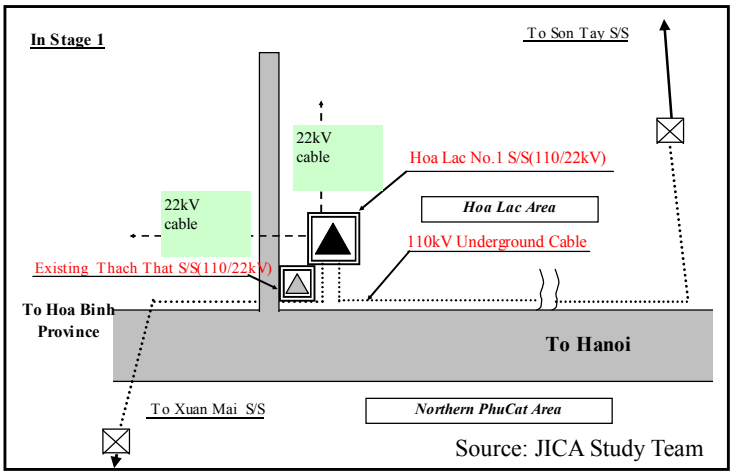


Figure F.3.4 Location of Hoa Lac No.1 S/S

3.2.4 Design for Power Supply Facilities

The following projects should be implemented to supply power to Hoa Lac Area.

(1) Relocation of over head transmission line to underground cable

Relocation of 110kV overhead transmission line to underground cables should be implemented as existing transmission line will disturb the development of the adjacent area to the lines. In addition, there is also a regulation in Vietnam which specifies that all of transmission lines less than 220kV in a new development have to be laid underground. The location of the relocation and the Section layout are shown in Figure F.3.5 and F.3.6. Specification and quantity of equipment is shown in Table F.3.2.

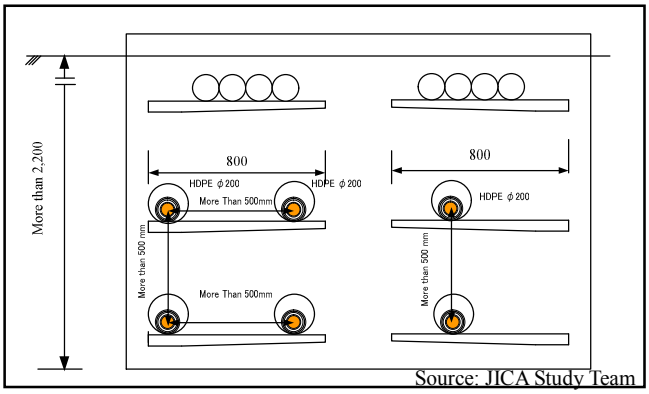


Figure F.3.5 Layout of 110kV Underground Cable

Table F.3.2 Specification and Quantity of Equipment for Relocation of Transmission Line

Facilities to be installed	Specification	Quantity
Dismantlement of existing transmission line	110kV 2cct	Approx. 5km
Underground cable	110kV XLPE 300×3×2cct Non-flammable	Approx. 5km(length of the cable approx. 30km)
Cable accessory	For overhead line and transformer	1 lot
Pipe	HDPE φ200	30km
Manholes		1 lot

Source: JICA Study Team

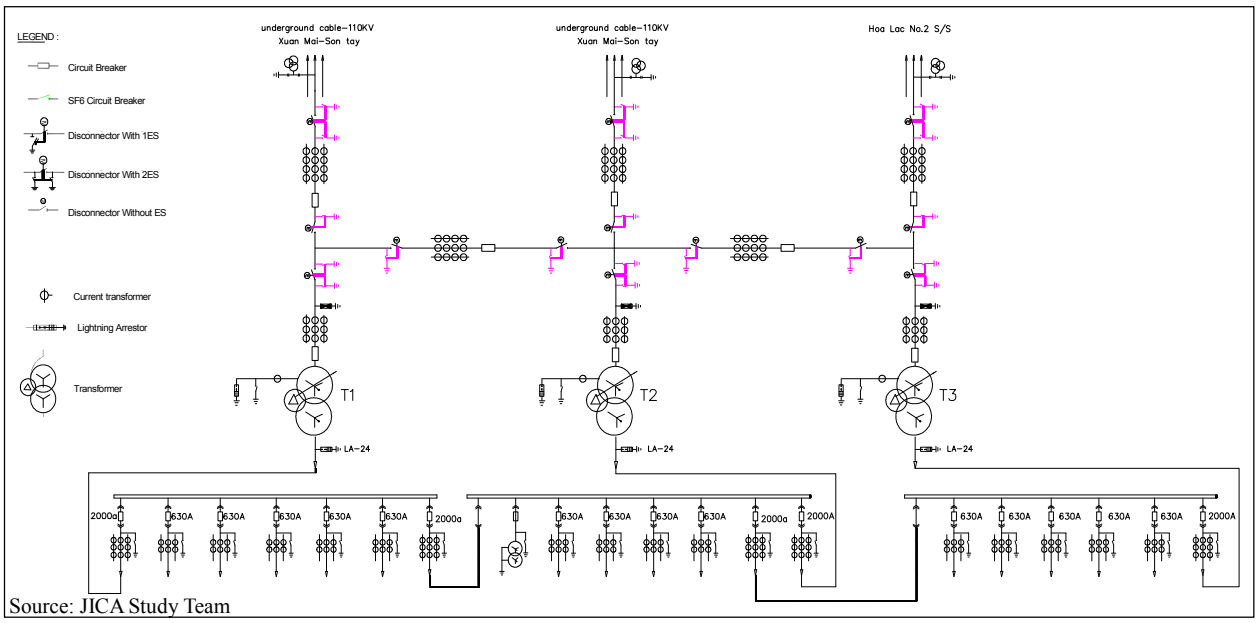
(2) Construction of Hoa Lac 110/22kV No.1 S/S

Configuration of electrical equipment in Hoa Lac No.1 S/S is shown in Figure F.3.6.

To enable the maintenance without any power interruption, circuit breakers and disconnecting switches will be installed to section off bus bar between transformers.

In Japan, transmission line with 2cct normally operates 1cct of the line as regular use and another is kept for back-up use. Thus, in order to enhance reliability and enable relatively easier maintenance of the equipment, the 2cct of transmission line should be secured. A double bus bar

system is sometimes applied for bus bar system of substations. However, in caparison to single bus bar system, the double bus system need more space for installation along with additional numbers of disconnecting switches, bus and supporting structures. Therefore to apply this system as recommendable one, it is necessary to have deliberations on network operation with the surrounding transmission lines of the power companies and should be in accordance with the status of regional plans made by the concerned authorities.



Source: JICA Study Team

Figure F.3.6 Configuration of Electrical Equipment for Hoa Lac No.1 S/S

Specification and quantity of equipment is shown in Table F.3.3.

Table F.3.3 Specification and Quantity of Equipment for Hoa Lac No.1 S/S

Facilities to be installed	Specification	Quantity
Power Transformer	110/22kV, 63MVA	3 units
Disconnecting switch	123kV, 3-pole	13 units
Circuit Breaker	123kV, 3-phase,Ourdoor-use	8 units
22kV distribution cubicle	Incoming and Outgoing 630A, Bus section 2000A	20 units
Control house	Monitoring system, DC supply system, and station use generator	1 lot
Miscellaneous		1 lot

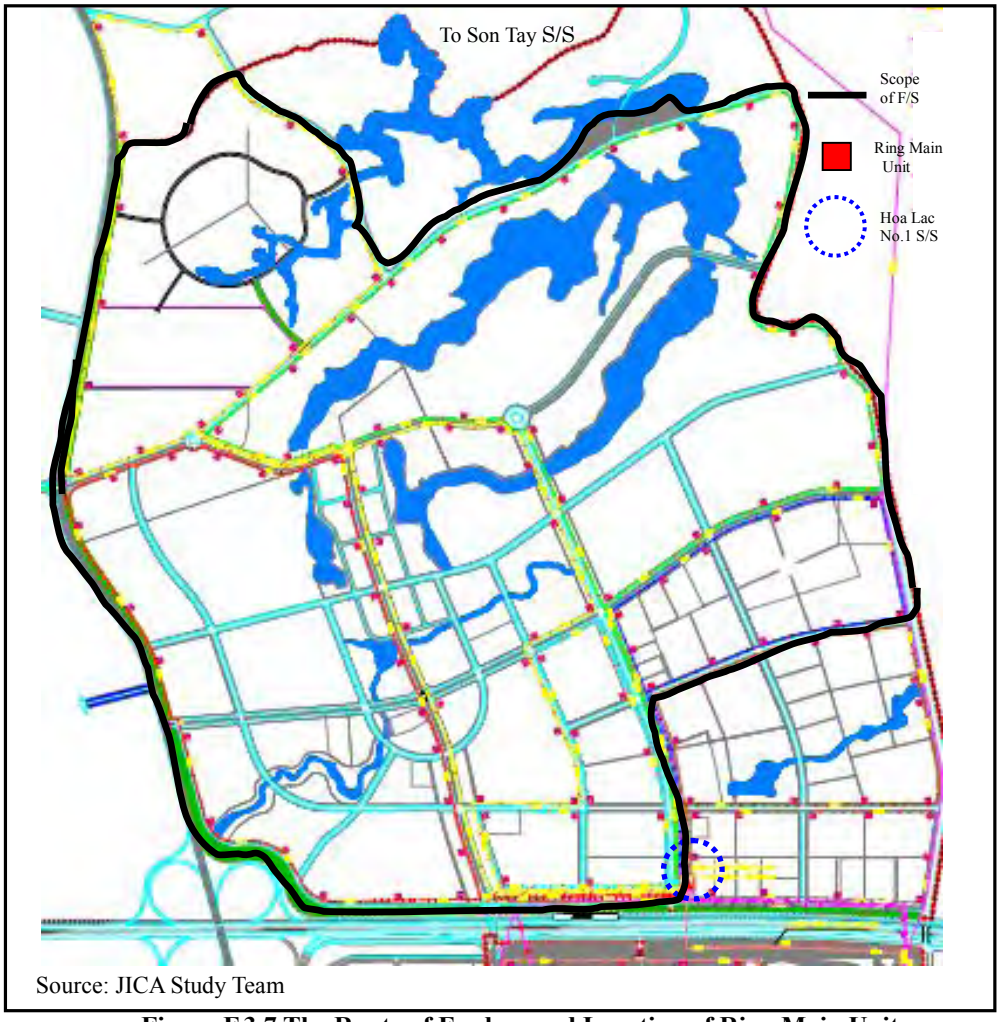
Source: JICA Study Team

(3) Installation of feeders and Ring Main Unit (RMU)

From Hoa Lac No.1 S/S onwards, it is necessary that 14 distribution lines of 22kV along with other infrastructures in the buffer zone should be installed at technical ditches along the roads. The cable to be installed applies to the specification of 24kV-Cu/XLPE/DSTA/PVC.

The route of feeders and location of Ring Main Unit is shown Figure F.3.7. The detailed location of Ring Main Unit is shown in Drawing PS-DN-01.

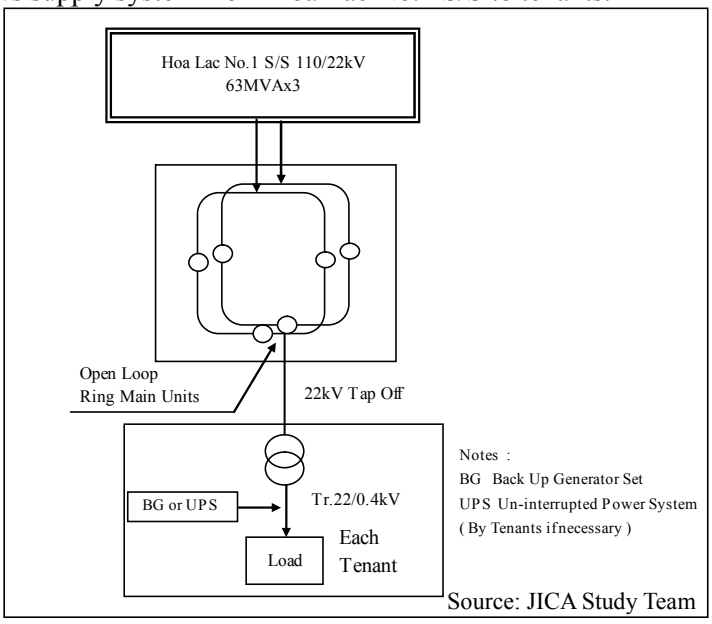
Each plant is supplied from the Ring Main Unit which is integrated in the distribution line. One Ring Main Unit will have some incoming and outgoing feeders for the tenant's lots lying side by side, and each feeder has a load breaking switch or circuit breaker with protection relay for ready tapping without interruption of the distribution line.



Source: JICA Study Team

Figure F.3.7 The Route of Feeders and Location of Ring Main Unit

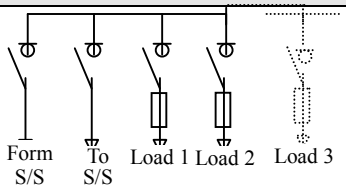
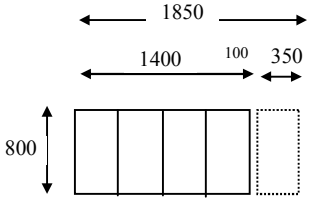
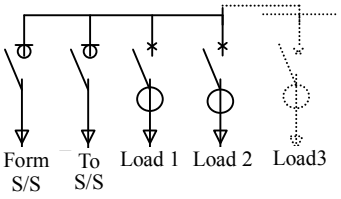
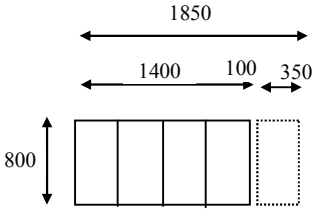
Figure F.3.8 shows supply system from Hoa Lac No.1 S/S to tenants.



Source: JICA Study Team

Figure F.3.8 Supply System from Hoa Lac No.1 S/S to Tenants

RMUs for some lots, which have a possibility to be divided into smaller lots, will have provision for expansion so as to accommodate additional feeder. Figure F.3.9 shows types of RMU necessary to be installed for this supply networks.

	Single Line Diagram	Dimension RMU (Top View)
FSx2+Ex RMU (Fuse Switch Feeder x 2) Expandable		
CBx2+Ex RMU (Circuit Breaker Feeder x 2) Expandable		

Source: JICA Study Team

Figure F.3.9 Type of RMU

Specification and quantity of equipment is shown in Table F.3.4.

Table F.3.4 Specification and quantity of equipment for Ring Main Unit network

Facilities to be installed	Specification	Quantity
No. of feeder	22kV Cable installed in technical ditch	14 feeders
Distribution cable	24kV-Cu/XLPE/DSTA/PVC Non-flammable	Approx. 75km
Cable accessory	24kV-Cu/XLPE/DSTA/PVC	1 lot
Pipe	Steel Pipe	Approx. 75km
Miscellaneous		1 lot
Ring Main Unit	Compartment	119 units
	No. 1 loop	22 units
	No. 2 loop	29 units
	No. 3 loop	10 units
	No. 4 loop	25 units
	No. 5 loop	11units
	No. 6 loop	11 units
	No. 7 loop	11 units

Source: JICA Study Team

3.2.5 Operation and Management Structure

Operation and maintenance for Hoa Lac No.1 S/S will be undertaken by a branch office of the Hanoi power company for PMU of HHTP. Also, RMU with distribution feeder will be maintained by the power company. Developers that will move in HHTP will make contracts with the power company on behalf of tenants and will pay the collected power charges amount from tenants to the power company.

3.3 RECOMMENDATION

The implementation of the following recommendations will be the major base for the development of effective, efficient and reliable power supply system.

(1) The external conditions as mentioned in Chapter 2 will be reviewed by the Vietnamese

related authorities on every occasion for drawing up regional transmission network and supply plans. Therefore, the associated trunk configuration of the Hoa Lac S/S for the reliability of power supply should be reviewed in accordance with the regional transmission network and supply plan.

(2) The 110 kV transmission lines from Xuan Mai and Son Tay should be used exclusively for the power supply to HHTP without any linkage to other S/S in between, unless there is a plan that another 110kV transmission line will be connected and supply power to Hoa Lac No.1 S/S.

(3) Until the 110kV transmission line reach to its maximum capacity, another 110/22kV S/S as suggested by VN Revised M/P should be developed. This will supply power to Phu Cat area.

(4) It is important for PMU of HHTP to have a regular meeting so as to establish an optimal operation procedure for the Hoa Lac No.1 S/S.

(5) Considering that it is nearly impossible for the existing Thach That branch office of the power company to continuously implement, operate, maintain the electrical facilities, and collect power charges from HHTP, the power companies will need to reinforce their personnel capacity. It is highly recommended that PMU of HHTP should monitor the proper assignment and capacity of the personnel for O&M for the Hoa Lac No.1 S/S and other facilities within HHTP.

(6) To enhance reliability of power supply to Hoa Lac Area, the following plans are expected to be implemented by Vietnamese side.

1) In order to strengthen the power supplying network for HHTP, 220kV transmission line is expected to be connected to Hoa Binh P/S and Hoai Duc 220kV transmission line. The same has also been planned by VN Revised M/P.

2) Considering breaking capacity of the equipment, the power companies shall connect every 110/22kV and 220/110kV that has been planned for construction in Northern Phu Cat area by the VN Revised M/P.

SUPPORTING G

TELECOMUNICATIONS PLAN

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CHAPTER 1 PRESENT CONDITION OF TELECOMMUNICATION SYSTEM

1.1 REVIEW OF THE VIETNAM REVISED MASTER PLAN

The telecommunication plan of the Vietnam Revised Master Plan (VN Revised M/P) for the Hoa Lac High-Tech Park (HHTP) consist of trunk cables and branch cables for the telephone systems within HHTP. In the VN Revised M/P, the telephone subscriber demand has been estimated as shown in table below.

Table G.1.1 Telephone Subscriber Demand within the HHTP in the VN Revised M/P

No.	Land Use	Area (ha)	Norm Numbers of Telephone/ha	Subscriber
1	Software Park	76	30	2,280
2	R&D Zone	229	30	6,870
3	High-tech Zone	550	2	1,100
4	Education and training Zone	108	4	432
5	Centre Zone	50	30	1,500
6	Mix-use Zone	88	30	2,640
7	Office and Housing Complex	42	30	1,260
8	Residential Zone	26	400	10,400
9	Amenity zone	110	2	220
10	Sport and Entertainment Zone	34	2	68
11	Green Zone	42	-	-
Total				26,770

Source: VN Revised M/P

Development plan of the telecommunication system was proposed on the basis of the demand for telephone subscriber and is as follows:

Table G.1.2 Development Plan of the Telecommunication System in VN Revised M/P

No.	Constructing items	Unit	Volume	
			Stage 1(2015)	Stage 2(2020)
1	500-pair-cable distributing frame	frame	26	40
2	1000-pair-cable distributing frame	frame	10	10
3	500/1000-pair-cables	km	21.8	29.0

Source: VN Revised M/P

The demand forecasting in the VN Revised M/P only covers the demand telephone line. It was not considered the requirement for other telecommunication and information services such as internet, data communication and multimedia service for which lines have to be provided to the end-user. In addition, the telecommunication network system was not considered in detail the planning of the wireless system. Following issues are listed in the telecommunication plan of VN Revised M/P.

- An information and communication service that has to be provided within HHTP has not been examined in detail.
- Telecommunication subscriber demand and network traffic demand based on the information and communication services as mentioned above have not been calculated.
- Telecommunication network system including wireless system has not been examined.
- Telecommunication development plan for piping system has also not been planned.

Thus considering the above reasons and to introduce fascinating telecommunication system

matching the future image of HHTP, there is an urgent need to update the telecommunication plan from the existing VN Revised M/P.

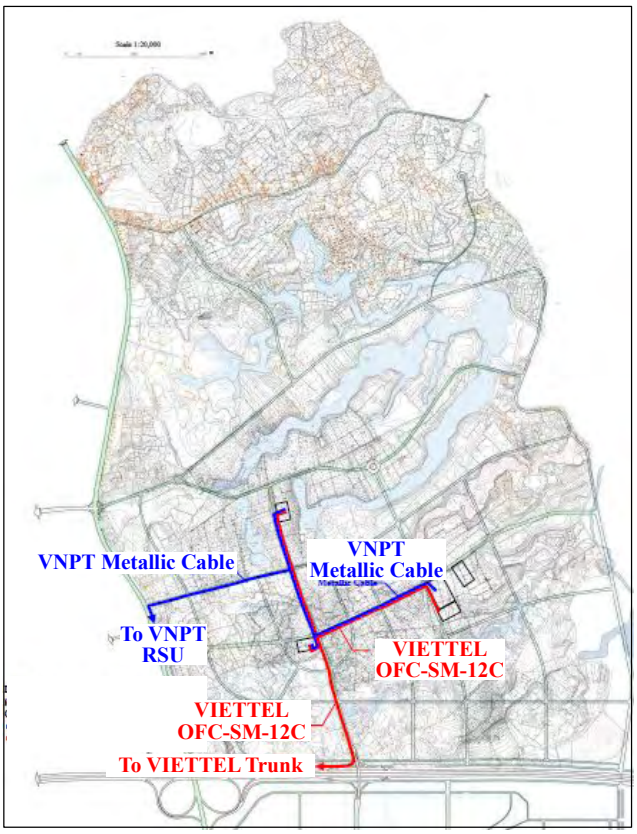
1.2 PRESENT STATUS OF TELECOMMUNICATION NETWORK

1.2.1 Telecommunication Infrastructure within HHTP

After the introduction of fair competition in the telecommunications sector in 1998, telecommunication carriers and providers licensed by the Ministry of Information and Communications (MIC) have provided telecommunication services in Vietnam. The Vietnam Post and Telecommunication (VNPT) is a state-owned company under MIC. VNPT is the market leader in the telecommunications sector. VIETTEL Corporation (VIETTEL), under the control of the Ministry of National Defense (MOND), has the next largest market share in Vietnam.

HHTP Management Board (HHTP-MB) has made agreements with VIETTEL and VNPT for comprehensive coordination in developing the information technology infrastructure in the HHTP. Both communication carriers are allowed to construct and install infrastructure such as optic fiber cables, mobile base stations, etc. and to provide telecommunication services to the customers.

The telecommunication network in the HHTP has been developed by VNPT and VIETTEL. However, at present only 100 pairs of aerial metallic cables and optic fiber cables are temporarily installed. Figure G.1.1 below shows the present development status of the telecommunication network in the HHTP.

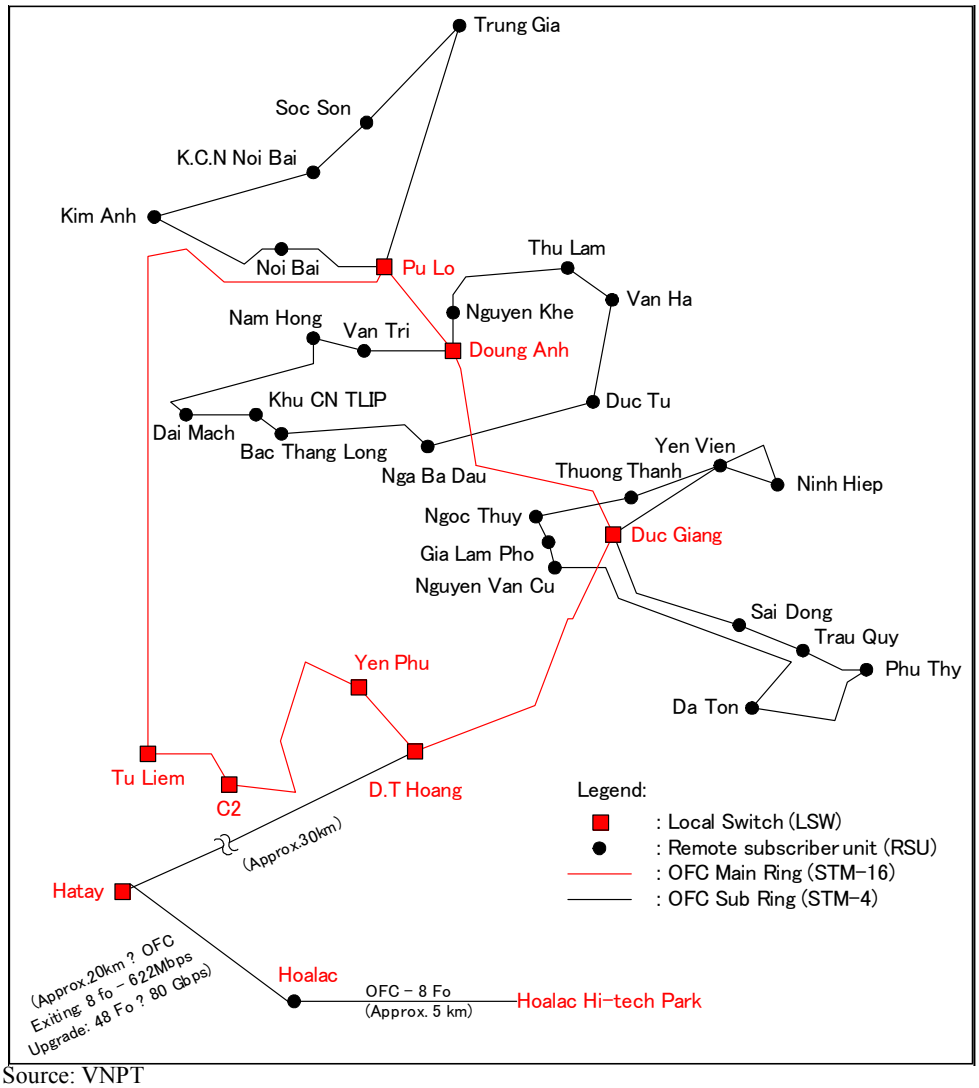


Source: JICA Study Team

Figure G.1.1 Present Status of the Telecommunication Network in the HHTP

1.2.2 Trunk Telecommunication Network in the Northern Part of Vietnam (Hoa Lac - Hanoi)

The telecommunications carrier trunk network between Hoa Lac and Hanoi is centered on the Hoa Lac Remote Subscriber Unit (RSU) located outside the HHTP. The Hoa Lac RSU is connected to Hanoi by a main ring network through the Ha Tay Local Switch (LSW). An STM-4 (622Mbps) optic fiber network system has been utilized for the network linking between Hoa Lac RSU and Ha Tay LSW. Even though the existing network does not have necessary high reliability due to its network topology and capacity, this trunk network link is planned for an expansion to a total capacity of 80Gbps, VNPT supplied a network diagram for the northern part of Vietnam, as shown in Figure G.1.2 below. Basically, STM-16 (2.4Gbps) optic fiber network are applied for Hanoi main ring network. However, STM-64 (10Gbps) optic fiber network system has also been used for some parts of the network.



Source: VNPT

Figure G.1.2 Network Diagram in the Northern Part of Vietnam

1.2.3 Present Status of International Line

There are two international lines in Vietnam. Both use submarine optic fiber cables. One line connects Danang with Taiwan and Hong Kong, and has a capacity of 565Mbps. The other line connects Vung Tau to other countries. Apart from these existing international communication lines, the America & Asia Gateway (AAG) will be built in 2009. AAG international line will be

connected with America and Asian countries by submarine cable with 1Tbps and the international repeater station will be established at Vung Tau.

1.3 TECHNICAL TRENDS IN TELECOMMUNICATION SECTOR

Regarding the technical trends in telecommunication sector, the latest global standards such as NGN (Next Generation Network) and Wi-MAX (Worldwide Interoperability for Microwave Access) have already been introduced in Vietnam. VNPT are developing a backbone network system for NGN and intend to commence the provision of end-user services in 2009.

As for Wi-MAX, which is expected as the next generation wireless access system, MIC have issued a trial license to communication carriers and pilot projects have been conducted by the carriers. The period of license issuance for actual Wi-MAX operation will be determined in 2009, when the trial licenses will expire.

CHAPTER 2 FRAMEWORK OF TELECOMMUNICATION DEVELOPMENT PLAN

2.1 BASIC CONCEPTS

2.1.1 Evaluation of the Existing Telecommunication System

Existing telecommunication system within HHTP is configured with temporal aerial metallic and optic fiber cables, and can not cover future demand, as mentioned in Chapter 1. The underground pipe for telecommunication network to meet the demand shall be planned on the basis of the HHTP-MB policy.

Meanwhile, at present the carrier's trunk network surrounding project area does not have enough high reliability and capacity. Since strengthening of the trunk network highly depends on the intention of the communication carriers, it is strongly recommended to upgrade the network topology and capacity between Hoa Lac area and Hanoi city.

2.1.2 Evaluation of the VN Revised M/P

The telecommunication plan of VN Revised M/P only covers communication trunk and branch cables, and dose not consider the provision of the information and communication services and the telecommunication network system including a wireless system, telecommunication pipe, etc. Therefore, to achieve an effective, efficient and fascinating telecommunication system within HHTP, the modification and updating of the telecommunication plan from VN Revised M/P is required.

2.1.3 Basic Planning Concepts of Telecommunication System

Establishment of attractive telecommunication system will be one of key items for the promotion of the development of HHTP. The telecommunication system will be essential tool to accelerate Research & Development, promote advanced high-tech manufacturing and commercialization, advance human resources development, and to provide business incubation. The planning of telecommunication system is proposed in consideration of the following basic concepts.

- Fascinating information services such as mega data transfer, teleconference, video on demand, security service, etc. will be provided to all end-users within the HHTP and matching the future image of HHTP.
- In order to offer attractive services, telecommunication system needs to introduce the Next Generation Network (NGN) which can provide high reliable, safety and seamless communications. Latest wired communication system using optic fiber technologies and advanced wireless mobile access system will be supplied as the user network access services.
- Above telecommunication systems shall be provided to the end-users as the final goal. However, from the view point to keep network connectivity within and outside of HHTP, operation license regulation of telecommunication system, etc., it is recommended that these telecommunication systems should be constructed, operated and maintained by the communication carriers themselves. In other words, the project shall cover optic fiber cable, telecommunication pipe and antenna tower which will enable the carriers to install the telecommunication systems smoothly.

2.2 NETWORK TRAFFIC DEMAND FORECASTING

2.2.1 General Conditions

The telecommunication demands for the following within HHTP are calculated in this section.

1) Number of telecommunication subscriber
2) Total network traffic demand

The telecommunication demands are estimated on the basis of the following conditions:

(1) Target year

The target year of 2020 has been set for forecasting the telecommunication demand. This will be able to cover the future network traffic demand.

(2) Land use, population and estimated number of households

The development area and population of each development zone that will be utilized for the demand forecasting are based on the results of calculation done by the JICA Study Team. However, in the calculation, the number of households and offices within the project area are not estimated. For the demand forecasting, the current land use allocation and maximum floor level as defined in the VN Revised M/P are used to calculate the number of homes and offices. As a result, by considering an average lot area of 1 home or 1 office in each zone, the number of household of each zone are estimated and is shown in Table G.2.1 below.

Table G.2.1 Assumed Number of Households

Land Use	Development Area (ha)	Average Lot Area (ha/lot)	Assumed Number of Homes and Offices		
			Number of Lots	Maximum Floor Level	Number of Homes, Companies, Institutions
1 Software Park	64.4	2.01	32	5	1,600
2 R&D	227.9	8.23	28	5	28
3 Hi-tech Industrial	231.6	4.29	55	5	55
4 Education & Training	108.0	28.33	4	10	4
5 Center of the Hi-tech City	49.0	2.22	23	30	690
6 Mixed Use	84.5	1.77	48	20	966
7 Houses & Offices	41.9	0.50	84	15	8,820
8 Housing Complex	22.6	0.50	47	15	9,870
9 Amenity	110.0	110.00	1	2	1
10 Amusement	33.2	1.00	34	3	34
Total					22,068

(3) Estimation of telecommunication subscribers

On the basis of the assumed number of homes, enterprises and institutions, the estimate for the numbers of subscriber are calculated. The density of subscribers of 1 subscriber/household as also defined in the VN Revised M/P has been followed. Considering the differences of user network demand, the number of home users, broadband users (companies, factories or other middle users) and ultra-fast broadband users (institutions, universities or other heavy users) are estimated respectively.

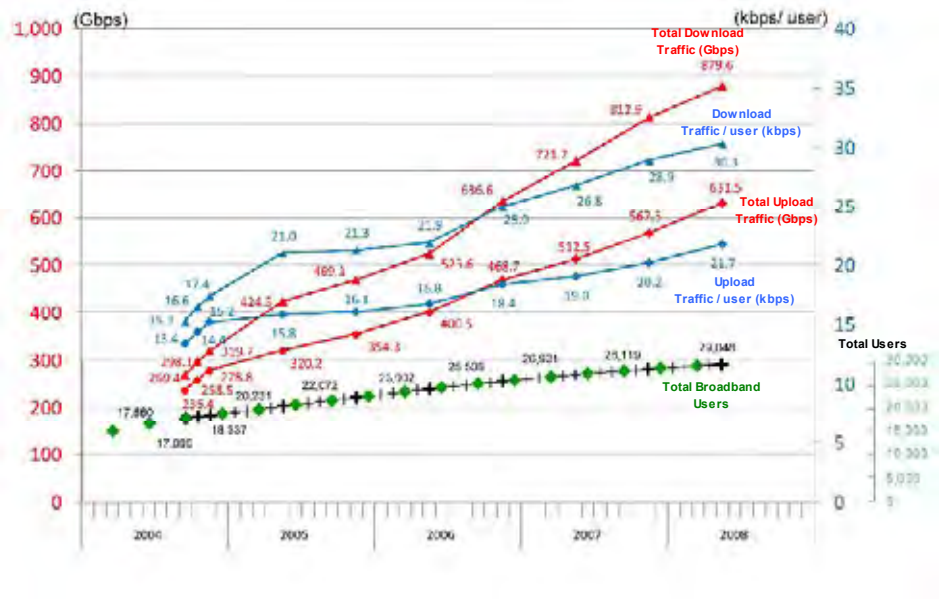
(4) Network traffic demand forecasting

In general, it is difficult to estimate the accurate network traffic demand as the demand is highly dependent on the quality and its service contents used by respective end-user, which in general changes year by year. However, for this estimation, the total network traffic demand within the HHTP has been calculated considering the following conditions.

1) The forecast for the network traffic demand for the voice communications that

includes FAX and VoIP will be based on the telephone subscriber demand as has been estimated in the VN Revised M/P. The unit traffic volume of voice communication is calculated as 64kbps/line, which is equivalent to ITU-T G.711.

2) The network traffic demand for data and multimedia communications will be forecasted based on the average traffic statistics data of broadband users in Japan and is shown in the Figure G.2.1 below. The unit traffic volume/broadband user is calculated as 52kbps/user (Download traffic: 30.3kbps, Upload traffic: 21.7kbps).



Source: https://www.soumu.go.jp

Figure G.2.1 Traffic Average of Broadband User in Japan

In addition, the network traffic for office network system (2Mbps/com), university network (60Mbps/univ) and STI network for satellite image dissemination (100Mbps) are also estimated.

3) From the above statistics data, an annual increment of the network traffic for broadband users is about 20%. Thus, to satisfy the future network traffic, the same annual increment has been taken into account while forecasting the increase in demand for next 10 years

4) Considering the collision and other factors, in general, the throughput of communication network on IP is around 50% of the network capacity. The traffic demand has been estimated considering such network efficiency.

2.2.2 Estimated Number of End Users

The estimated number of end-users is shown in Table G.2.2. The total amount of the end-users within the HHTP has been estimated around 22,000 users that consist of 9,380 home users, 12,358 broadband users and 358 ultra-fast broadband users.

Table G.2.2 Estimated Number of End-Users

No	Land Use	Estimated Number of End Users			Total (Users)
		Home Users	Broadband Users	Ultrafast Broadband Users	
1	Software Park	-	1,440	160	1,600
2	R&D	-	28	28	56
3	Hi-tech Industrial	-	55	-	55
4	Education & Training	-	-	4	4
5	Center of the Hi-tech City	-	621	69	690
6	Mixed Use	-	869	97	966
7	Houses & Offices	4,410	4,410	-	8,820
8	Housing Complex	4,935	4,935	-	9,870
9	Amenity	1	-	-	1
10	Amusement	34	-	-	34
Total		9,380	12,358	358	22,096

2.2.3 Traffic Demand Forecasting

The total network traffic demand in the HHTP has been forecasted on the basis of the conditions. The network traffic demand in each development zone has been estimated with a total forecast of 27Gbps or more and is shown in the table below. This forecasted traffic demand indicates to the necessity of strengthening of the carrier's trunk network capacity in all areas including within, outside and in between of the HHTP.

Table G.2.3 Forecasted Network Traffic Demand

Land Use	Network Traffic	Estimated Number of Telephone Line (line)	Estimated Number of Broadband Users (users)	Forecasted Network Traffic (Mbps)	
1 Software Park	TEL/FAX, VoIP Use	1932	1,600	247	4,313
	Broadband, Other Use			4,065	
2 R&D	TEL/FAX, VoIP Use	6837	56	875	4,885
	Broadband, Other Use			4,009	
3 Hi-tech Industrial	TEL/FAX, VoIP Use	463	55	59	420
	Broadband, Other Use			360	
4 Education & Training	TEL/FAX, VoIP Use	432	4	55	529
	Broadband, Other Use			474	
5 Center of the Hi-tech City	TEL/FAX, VoIP Use	1470	690	188	2,363
	Broadband, Other Use			2,175	
6 Mixed Use	TEL/FAX, VoIP Use	2535	966	324	3,627
	Broadband, Other Use			3,303	
7 Houses & Offices	TEL/FAX, VoIP Use	1257	8,820	161	4,931
	Broadband, Other Use			4,770	
8 Housing Complex	TEL/FAX, VoIP Use	9040	9,870	1,157	6,495
	Broadband Use			5,338	
9 Amenity	TEL/FAX, VoIP Use	220	1	28.2	29
	Broadband Use			0.5	
10 Amusement	TEL/FAX, VoIP Use	66	34	8	27
	Broadband Use			18	
Total					27,618

2.3 END-USER SERVICES

2.3.1 General

In recent years, telecommunication services and applications demanded by end-users become more multifaceted, such as data communication and multimedia services represented by internet, video conference, IPTV, conventional voice/fax communication etc. Considering this demand, these information services shall be offered not only under wired communication but also with mobile network environment. Furthermore, considering the features of HHTP and requirement

of mega data transfer services such as images and CAD data, the necessary security services and applications will be offered to protect from cyber terrorism, e-education, telemedicine or other specific applications.

In this section, key end-user services to be provided within HHTP are examined.

2.2.2 End-user Services to be provided in HHTP

(1) Voice Communication/FAX

As a minimum requirement to telecommunication system, it is indispensable to provide high quality voice communication services without any further delay. VoIP (Voice over Internet Protocol) securing QoS (Quality of Service) and required service level as well as conventional PSTN voice/fax shall be supplied to all end-users within HHTP.

(2) Internet Access Service

An internet access service as represented by electronic mail (e-mail), web page browsing and search is currently one of most important tools for social interaction and activities. As of June 2008, 5.8 million end-users have utilized the internet access services in Vietnam according to Vietnamese Internet Center Stats, and it is expected that the subscribers will continue to increase. The telecommunication network within HHTP shall satisfy such increased internet access demands.

Meanwhile, as the Internet Service Providers (ISP) such as VNPT, VIETTEL and FPT are planning to build their data center to exchange internet user access, establishment of further high capacity backbone network will be required in HHTP.

(3) Office Network System (WAN)

Provision of high capacity and reliable Wide Area Network (WAN) needs to be provided in HHTP so as to enable a good connectivity of the offices in the HHTP area with head office or other branch offices. The stabilized network to handle highly confidential information and quality guaranteed network will be needed, because some companies have plans to build their data center in HHTP. Furthermore, WAN network connecting with international line will be necessary for foreign-financed companies.

(4) Mega Data Transfer Service

The computer network in each enterprise often requests to deliver large files like images and CAD data which cannot be sent by e-mail. To meet these demands, introduction of mega data transfer services which let users to send, receive and track large files on-demand is recommended. As an example, the mega data transfer services such as YousendIt is one of the most famous services in the world. Through this service, the sender by entering the recipient's e-mail addresses can transfer a file size of up to 20GB. Later, the recipients receive an e-mail notification with a URL address that allows them to download the file. The mega data transfer services will be required for High-tech enterprises in the HHTP.

(5) Videoconference

The videoconference service is interactive telecommunication technologies which allow persons at two or more locations to interact face-to-face via video and audio transmissions simultaneously using camera sets and microphones. Two types of videoconference service,

pear-to-pear services in private offices and multi-point services that involve several sites using the server system can currently be introduced. ITU H.320 for PSTN, ITU H.324 for IP network and ITU H.324 for mobile communications are major standards for videoconference system. At present this technology is used for mundane applications such as business meeting, telemedicine or any kinds of remote meeting. Considering the importance, such telecommunication network system will be required so as to equip offices and industries in HHTP with multimedia services.

Video Conference Image

(6) IPTV

IPTV service provides digital television broadcasting over telecommunication network using IP technology. Following types of the IPTV service has been developed:

- TV rebroadcast
- Video on Demand (VoD)

The IPTV service can provide various television contents such as ground-based and satellite re-broadcasting as well as VoD services which broadcast any video stream depending on individual request from the user. The telecommunication network system will also be required to offer IPTV service matching the future image of HHTP.

(7) Triple/Quattro Play Services

Triple play service is to supply integrated three communication contents, 1) internet access, 2) television broadcast and 3) VoIP, which earlier were provided separately, over a single IP broadband connection. A quadruple play service combines the triple play service with wireless service provisions. From standpoint of end-users, provision of such integrated communication services will be important.

(8) Security Service

In the computer network environment, during these days it has been absolutely imperative to prevent the cyber attack or any other risks on the system. In general, the network security service consists of following 4 components:

- Firewall: to interrupt unintended communications
- IDS (Intrusion Detection System): to detect illegal users or impersonation
- Malware Protection: to check and eliminate malicious programs or communications
- Authentication System: to allow only authenticated communications

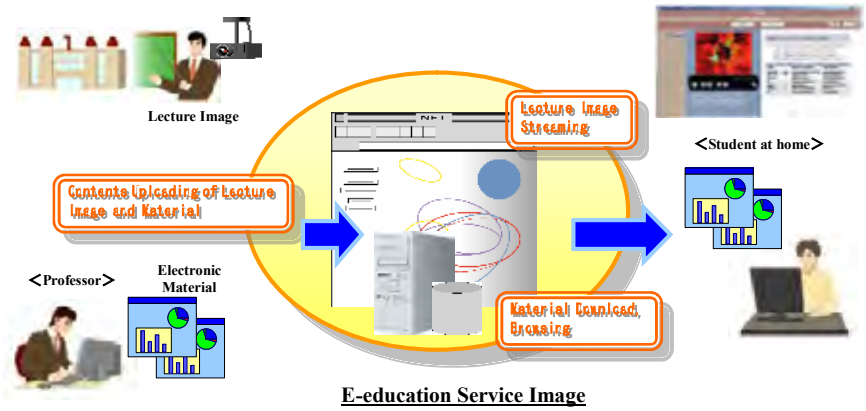
Provision of the security service as well as network quality control will be indispensable for the telecommunication system in order to offer reliable and stabilized communications to end-users.

(9) E-education

E-education (distance education) is one of new information services using internet, computer network and video image technology aiming to offer education to students who are not physically available on the site. Following kinds of E-education services have been introduced and deployed in the developed countries.

- Lecture material upload and download services through internet
- Lecture image streaming services
- Discussion, educational guidance between professors and students at remote area via interactive communications

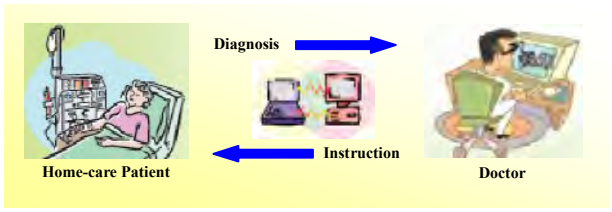
The good telecommunication system will be base to offer such E-education services. It is required in the HHTP as this will be major source to connect and send information to advanced educational field.



E-education Service Image

(10) Telemedicine

Telemedicine is an application for clinical medicine where medical information, consultation procedures or examinations is transferred through the telecommunication system for to remote medical locations. The telemedicine is mainly used for two purposes, home medical care service and medical support for remote physician. The telemedicine offers the medical support for the physicians who stay in isolated communities. By using telecommunication system such as teleconference technologies or remote advanced diagnosis enables them or remote clinics to connect to central medical center for further support or guidance. As NIHE and other medical institutions are planned for construction in the HHTP, it is required to establish such network system which can facilitate the telemedicine services.



Home Medical Care Service Image

Medical Support Service Image

(11) Satellite Image Dissemination Service

Hoa Lac Space Center (HLSC) is under consideration for the construction in R&D zone. The Satellite base station will be established in HLSC to obtain and distribute the images from satellite. These images will be utilized for agriculture, disaster monitoring and prediction, environment monitoring, and so on. To disseminate the image data to users in the country through internet, high throughput communication line with a speed of at least 20 to 100Mbps will be needed between HLSC and Hanoi. The telecommunication network of the HHTP will be required to provide high capacity broadband communications between HHTP and Hanoi to meet these demands.

2.2.3 Beneficiary of End-User Services

The beneficiaries/expected end-users of the end-user services and applications that will be provided within the HHTP are summarized in Table G.2.4 below. These information services will be provided to all end-users within the HHTP.

Table G.2.4 End-User Services and Expected Beneficiaries

End-User Services and Applications		Description	Expected End-Users
Audio/Data Communications	Voice Communication/FAX	High quality Voice over IP (VoIP) as well as conventional PSTN voice/fax communication will be provided to end-users.	Home, Office, Institution
	Internet Access Service	An internet access service offers end-users electronic mail (e-mail), web page browsing and search, and is currently one of most important tools for social interaction and activities.	Home, Office, Institution (IXP/ISP)
	Office Network System (WAN)	Wide Area Network (WAN) to be connected the offices in the HHTP with head office or other branch offices.	Office, Institution
	Mega Data Transfer Service	Mega Data transfer services let users send, receive and track large files such as images and CAD data on-demand.	Office, Institution
Multimedia Communications	Videoconference	The videoconference service is interactive telecommunication technologies which allow two or more locations to interact face-to-face via video and audio transmissions simultaneously.	Office, Institution
	IPTV	IPTV service is to provide digital television broadcasting over telecommunication network using IP technology. (1)TV rebroadcast type, (2)Video on Demand (VoD) type of the IPTV service can be introduced.	Home
	Triple/Quattro Play Services	Triple play service offers integrated three communication contents, internet access, television broadcast and VoIP over a single IP broadband connection. Quadruple play service combines the triple play service with wireless service provisions.	Home
Others	Security Service	To prevent cyber attack and any other risks on the computer system or for network quality contorl, providion of security service over IP netwrok will be required.	Home, Office, Institution
	E-education	E-education is a new approch to take lessons from remote area using internet, computer, video image and high capacity network.	University
	Telemedicine	Telemedicine is an application of clinical medicine where medical information is transferred using Internet videoconference equipment, etc. for the purpose of consulting, and remote medical procedures or examinations.	Medical Institution
	Satellite Image Dissemination Service	To disseminate the image data from satellite to users in the country through internet with high throughput communication line for agriculture, disaster monitoring and prediction, environment monitoring etc.	STI

2.4 FINAL GOAL OF TELECOMMUNICATION NETWORK AND SYSTEM

2.4.1 Basic Policies of Proposed Telecommunication System

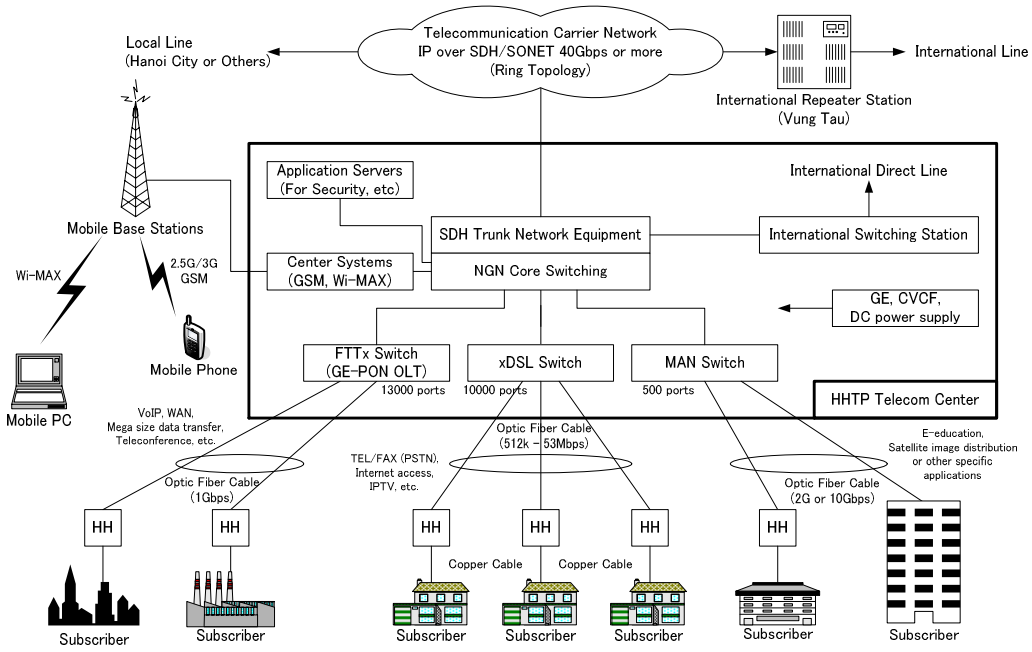
To offer the attractive end-user services as mentioned above, telecommunication system will be required to provide high reliable, safety and seamless communications in both wired and wireless communication environments. The telecommunication system within HHTP shall be planned considering the following basic policies.

- High capacity broadband communications to provide various end-user services with high capacity broadband network.
- Reliable and stabilized communications to provide continuous communications, 24 hours a day, 365 days a year.
- High mobility communications enables to communicate anywhere at home, office or outdoor.
- Seamless communication environment secures network connectivity to all areas such as within, outside or in between of the HHTP or wired and wireless communication.
- High level security system to prevent cyber attack or any other kind of risks.
- Worldwide standard adoption.
- Scalable network system keeping future expandability.

In order to satisfy the above basic policies, provision of telecommunication system based on the Next Generation Network (NGN) is recommended.

2.4.2 Expected Overall System Configuration

Expected overall telecommunication system in the HHTP is illustrated as Figure G.2.2.



Source: JICA Study Team

Figure G.2.2 Proposed Overall Telecommunication System Configuration

The main features of the proposed telecommunication system are summarized below.

- The telecommunication network based on the latest NGN standard with enough network capacity will be introduced. An introduction of NGN will also contribute in reducing the network construction costs.
- The telecom center with the network switching and server systems that will provide various end-user services are need to be installed within the HHTP.
- Depending on the end-user demands, the three types of wired communications i.e. xDSL network for home users, FTTx network for office users, and MAN network for heavy users will be provided. All these wired networks will utilize optic fiber technologies.
- Two types of mobile communications i.e. mobile phone use and mobile computer access use will be established. As for the mobile phone system, in addition to the existing 2.5G GSM (Global System for Mobile Communications), an advanced 3G GSM which is one of latest mobile communication standard in Vietnam will be introduced. Furthermore, to realize the good mobility computer access environment, wireless broadband computer access system such as Wi-MAX will be introduced.
- To upgrade the linkages between inside and outside of HHTP, high capacity network facilities connecting the carrier's trunk line and international switching station will be installed in the telecom center.

2.4.3 Wired Communication System

(1) xDSL Network

xDSL is a contraction of digital subscriber line, which is one of the wired communication technologies that provides digital data transmission with a capacity from 512Kbps to 52Mbps over the wires of existing telephone network or optic fiber cable. Types of xDSL network and their main characteristics are summarized as follows.

Table G.2.5 Type of the xDSL Network

xDSL Technologies	SHDSL	ADSL	VDSL
1. Standard	ITU-T G991	ITU-T G992	ITU-T G993
2. Uplink/Downlink	Symmetry	Asymmetry	Symmetry, Asymmetry
3. Network Capacity	～2Mbps	～1Mbps (Uplink) ～9Mbps (Downlink)	～2Mbps (Uplink) ～52Mbps (Downlink)
4. Transmission Range	～7km	～5km	～1.5km

The xDSL network supplies the home users with conventional telephone (PSTN), internet access, IPTV, and so on. Considering the demand forecast, the xDSL network facilities to be able to provide the services to around 10 thousands users will be required in the HHTP.

(2) FTTx Network

"Fiber to the x" (FTTx) is a collective term for any network architecture that uses optic fiber to connect directly to homes, condominiums, buildings. FTTx allows delivery of broadband services with a capacity of 1.2Gbps or more and is suitable as the telecommunication system for high-tech enterprises or organizations. Following two kinds of FTTx network technologies have been developed to date. The typical FTTx network configuration is shown as Figure G.2.3.

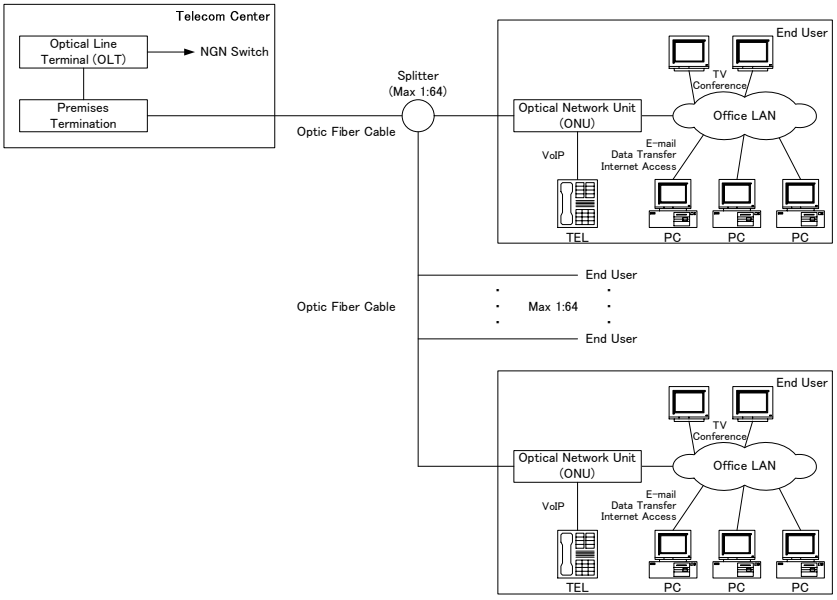


Figure G.2.3 Typical FTTx Network Configurations

The FTTx network offers the office users with VoIP, WAN, videoconference, mega size data transfer, and other data and multimedia services. Around 12 thousands of FTTx users are expected in the HHTP.

(3) MAN Network

Metropolitan Area Network (MAN) can provide 2G or 10Gbps interactive ultra-fast broadband services and can connect user access network directly to the carrier network core-switch. The IP over SONET/SDH and Gigabit/10Gigabit Ethernet will be applied as the MAN technical standards. The MAN network offers specific applications such as E-education, satellite image dissemination service and ISP provider service. MAN network image is illustrated in Figure G.2.4 below**.**

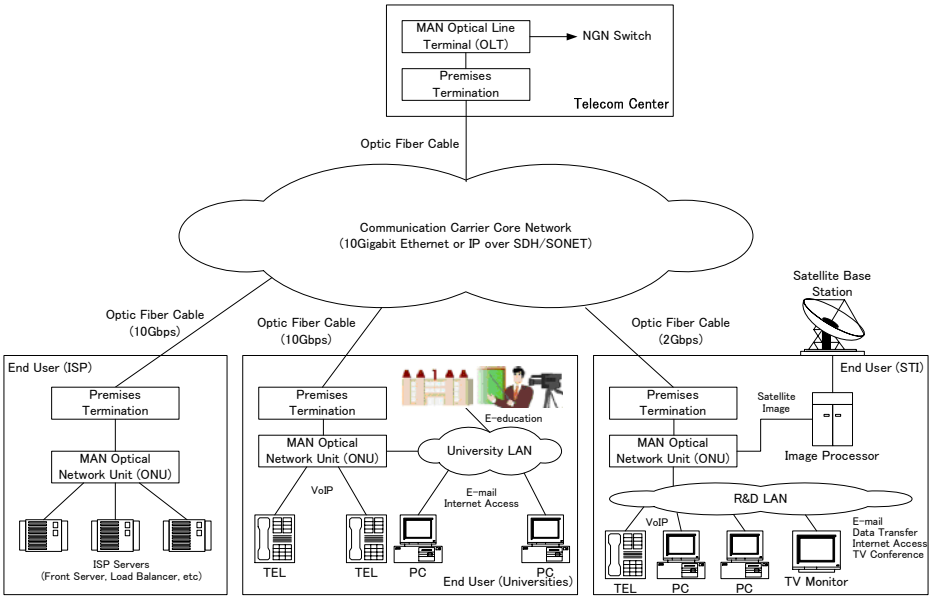


Figure G.2.4 MAN Network Image

2.4.4 Wireless Communication System

(1) Mobile Phone Network

Regarding the mobile phone network, currently 2.5 generation (2.5G) GSM is being commonly used in Vietnam. Adding to this, at the end of 2008, MIC have issued the license to the carriers to operate third generation (3G) GSM. Therefore, along with existing 2.5G GSM cellular phone system, soon latest 3G GSM will be introduced in HHTP. Figure G.2.5 illustrates the typical 2.5G/3G GSM network configurations. The mobile phone system consists of base station subsystem and control center system installed in the telecom center. Both voice and packet services will be provided in the system.

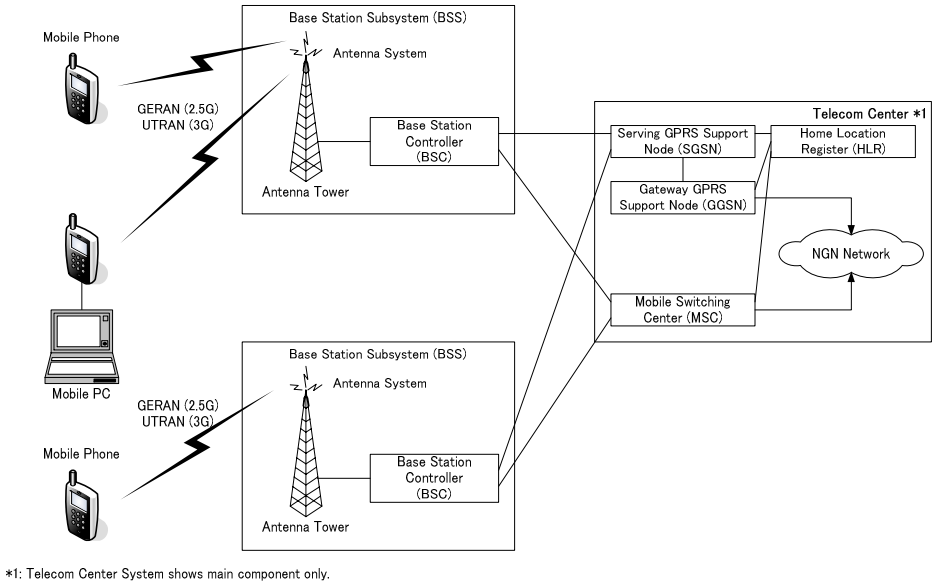


Figure G.2.5 Typical 2.5G/3G GSM Network Configurations

(2) Wireless Access Network

In order to realize the good mobility computer access environment in HHTP, in addition to mobile phone network, wireless access system shall also be introduced. Wireless LAN (Wi-Fi) and Wi-MAX are major wireless computer access systems and the comparison of both systems is summarized in the table below.

Table G.2.6 Comparison of Wireless Access Network

Wireless Computer Access System	Wireless LAN (Wi-Fi)	Wi-MAX
1. Standard	IEEE 802.11 b/g, a	IEEE 802.16
2. Coverage Distance	100m	2～10km
3. Transmission Speed	11Mbps / 54Mbps	63Mbps
4. Frequency Band	2.4 GHz Band	2.5～5.8 GHz Band
5. Bandwidth	20MHz	3.5～20MHz
6. Mobility Performance	-	120 km/h

Consideration its advantages, the Wi-MAX have been recommended as wireless computer access standard. In comparison to Wi-Fi, the Wi-MAX can cover wide-range distance (2-10km) and can provide tens times of transmission speed (bit-rate up to 63Mbps) similar to the current GSM. In addition, it also has a good mobility performance (over 120km/h).

2.4.5 Telecom Center

The telecom center will be established to install the network facilities, application servers and network security system, and so on. NGN network shall be adopted to provide high capacity, wired and wireless seamless, highly stabilized and reliable network system to the end users. To meet the estimated and future demand within and surrounding project area, the network facilities with enough capacity will be installed in the HHTP. The network facilities shall be connected with trunk line located outside HHTP which will be strengthened its capacity and topology. International switching station will be installed for the exclusive use in HHTP. The main facilities shall be of redundant composition so as to secure good reliability with a reliable power supply through CVCF, DC power supply, generator back-up system.

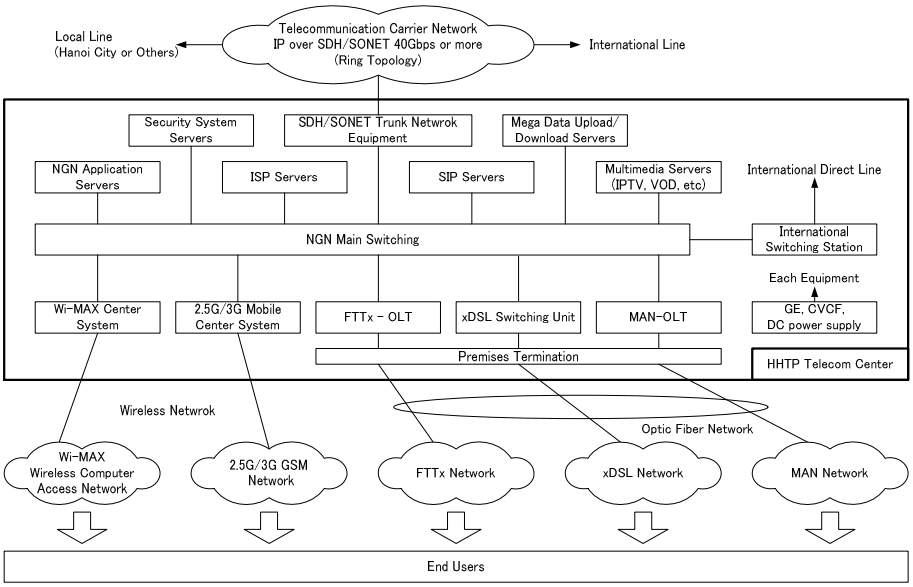


Figure G.2.6 Telecom Center System Image

2.5 PROPOSED REALISTIC TELECOMMUNICATION PLAN

The final goal will be to provide the telecommunication services and systems complied with NGN standard as described above to all end-users in HHTP. However, considering the following three view points, it seems that the construction and operation of the telecommunication system by HHTP-MB is not a realistic approach.

(1) Firstly, the important point is to secure the communication system interface between inside and outside of the HHTP. Telecommunication network in HHTP will not be only used for communication within HHTP but will also be used for the external communication such as to Hanoi, other major cities or foreign countries. It means that telecommunication system within HHTP should keep the interface with the communication carriers system. Generally, it is difficult to ensure the interface between different vender facilities. Therefore, if the network system within HHTP is provided by HHTP-MB then it may not be able to connect with carrier's network. To avoid such risk, it is proposed to install the network system by the carriers themselves.

(2) Second view point is license to operate telecommunication system. As a general rule, anyone cannot provide telecommunication services to users, if they do not have license issued by MIC. This regulation is not only true for Vietnam but it is one of the common adopted rules all around the world. Thus, HHTP-MB cannot operate and maintain telecommunication system. The carriers must operate and maintain the telecommunication system within HHTP.

(3) Thirdly, the point is about the agreement made between HHTP-MB and the communication carriers. As per the agreement signed between HHTP-MB and VNPT on Aug 2008, VNPT is committed to invest in telecommunication system within HHTP that includes the telecom center with an estimated total investment of about USD 117 million. Thus, it is considered that this invest amount is enough to develop entire telecommunication system within HHTP.

For this reason, the demarcation of the telecommunication system within the HHTP is proposed as follows.

Table G.2.7 Proposed Demarcation Plan of the Telecommunication System

No.	Item	HHTP-MB Side	Communication Carrier
1.	Construction		
(1)	Wired Communication		
1)	Telecommunication Pipe	○	
2)	Optic Fiber Cable	○ (Initial Stage)	○
3)	Carrier's Trunk Network System		○
4)	Network System (xDSL, FTTx, MAN)		○
(2)	Wireless Communication		
1)	Network System (GSM, Wi-MAX)		○
2)	Antenna Tower and Base Station House	○	
(3)	Telecom Center		
1)	Building		○
2)	Server System		
3)	Power Supply System, Others		○
2.	Operation & Maintenance		
1)	Operation		○
2)	Maintenance		○

An application of a state-financed project will be required for the installation of optic fiber cable, telecommunication pipes and the antenna towers including the base station houses. This will facilitate the carriers in smooth installation of the telecommunication systems. Other communication facilities will be provided by the communication carriers.

CHAPTER 3 PROPOSED TELECOMMUNICATION PLAN

3.1 PROPOSED TELECOMMUNICATION INFRASTRUCTURES

3.1.1 Telecommunication Pipe and Optic Fiber Cable

As mentioned earlier too that considering the cost merit advantages of optic fiber cable over metallic cables, the optic fiber cable will be used for all telecommunication network For the security and landscape purpose, the entire telecommunication cables will be installed underground.

As for protection of the cable, four (4) telecommunication pipes for each zone will be laid in the technical ditch installed along the road (under pathway). One telecommunication pipe will be utilized by one carrier and one pipe will be kept as spare. In other words, three carriers can utilize the three pipes (one will be kept as spare). Typical installation plan of piping system is shown in Figure G.3.1 below.

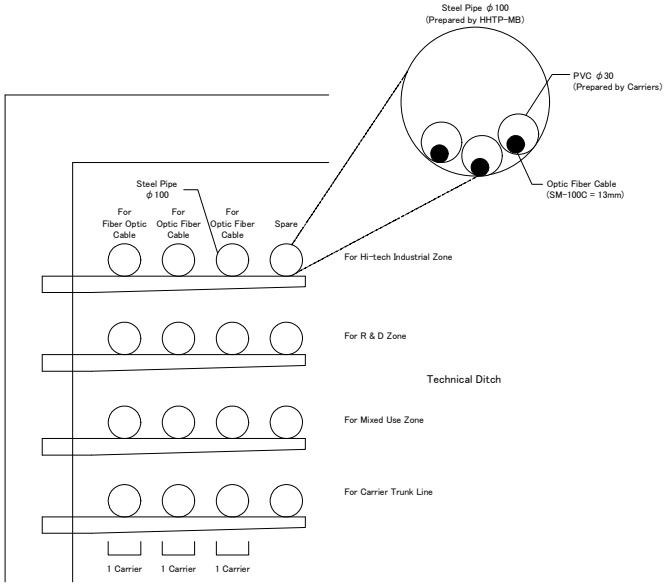


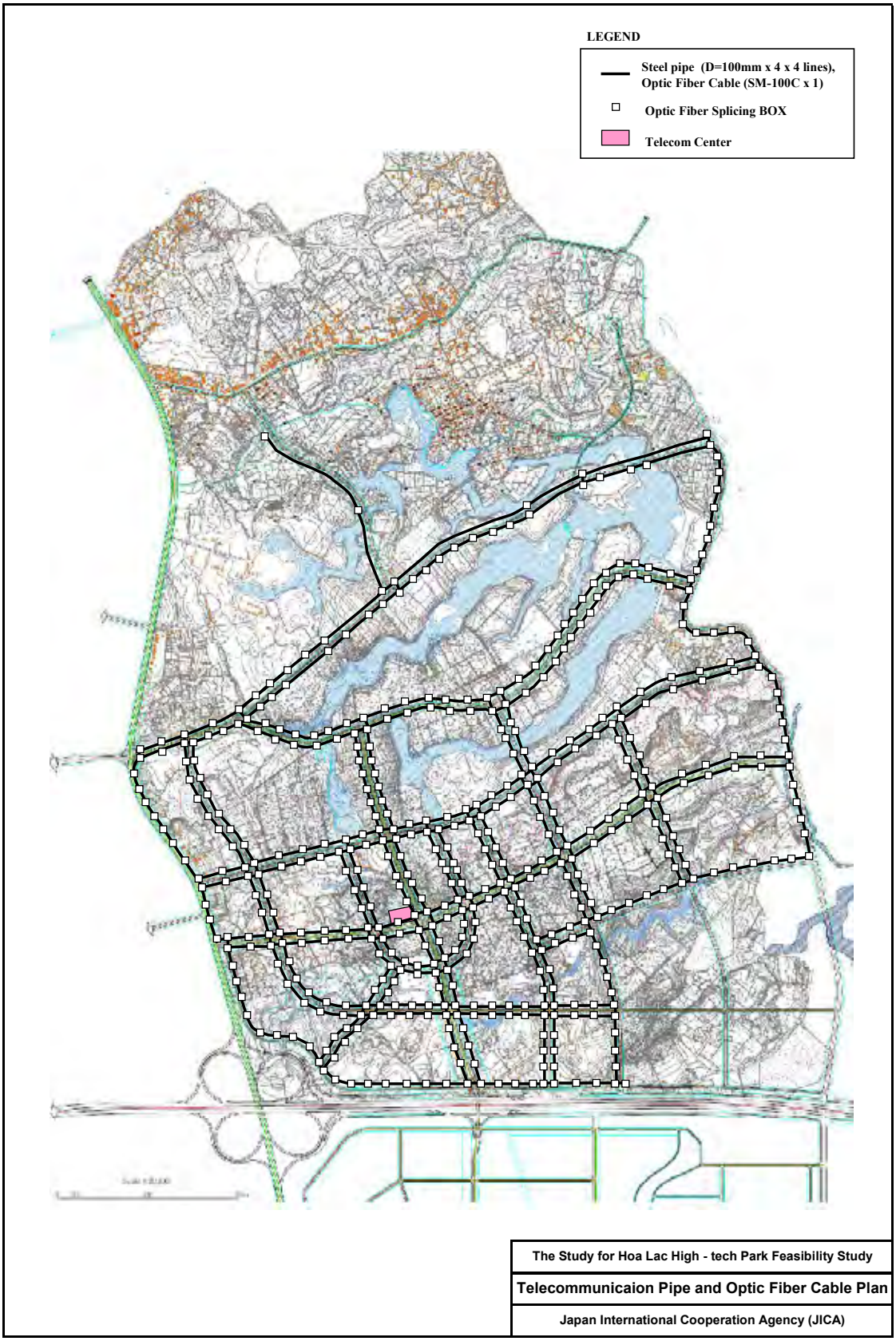
Figure G.3.1 Typical Installation Plan of Telecommunication Pipe

From the results of demand forecasting, required number of optic fiber cores for one development zone has been calculated as maximum 300 cores. Considering the diameter of optic fiber cables, φ100 steel pipe shall be adopted for telecommunication pipe.

Meanwhile, in consideration of the telecommunication demand at initial stage, one (1) optic fiber cable with 100 cores are planned to be installed in the telecommunication pipe. In order for easy connection with end-user's building, the interval of the optic fiber splicing box should not be less than 100m. Figure G.3.2 shows the telecommunication pipe and optic fiber cable plan. Estimated quantities for the telecommunication pipe and optic fiber cable are summarized as follows:

Table G.3.1 Estimated Quantities of the Telecommunication Pipe and Optic Fiber Cable

Item	Description	Unit	Quantity
1. Conduit	Steel Pipe D=100mm x 4 x 4	km	61
2. Optic Fiber Cable	SM-100C	km	64
3. Optic Fiber Splicing Box		unit	500



Source: JICA Study Team

Figure G.3.2 Proposed Telecommunication Pipe and Optic Fiber Cable Plan

3.1.2 Antenna Tower and Base Station House

An introduction of common antenna tower shared with the wireless communication carriers is recommended. Such mechanism will avoid damage to the aspect and radio disturbance into SPI satellite system.

As per the results of discussions held with the carriers, coverage area of wireless base station in general is about 1km diameter in the inner city area and about 5km diameter in suburbs. In this study, the locations of antenna towers are planned in such a way so that one base station covers a diameter of about 2km. The newly antenna tower will be built at appropriate places in consideration of the existing antenna tower locations. The Figure G.3.3 shows proposed locations of mobile base station and their coverage area.

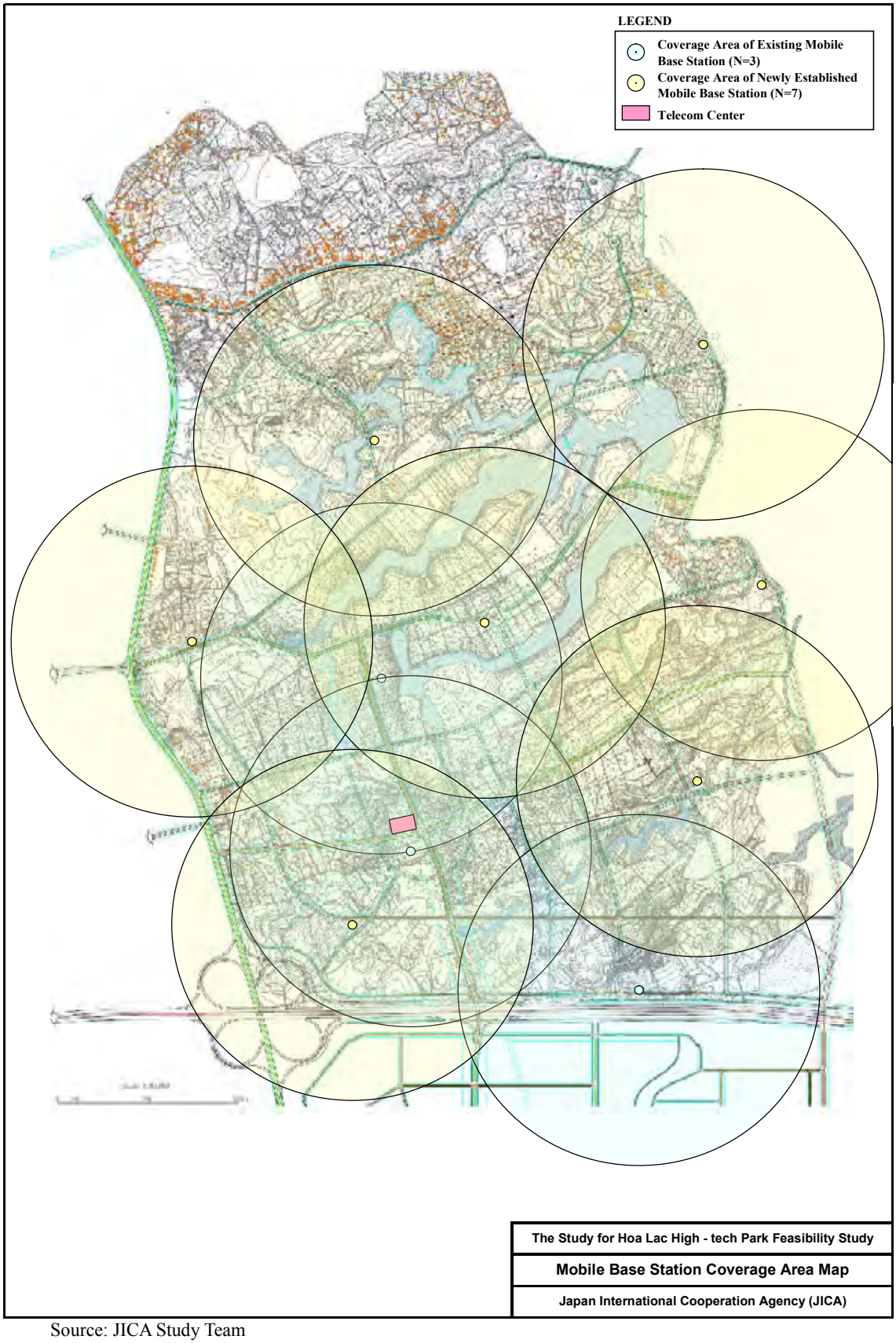
Total quantities of newly installed antenna tower will be seven (7) and main component of antenna tower system is shown in Table G.3.2 below.

Table G.3.2 Estimated Quantities of the Antenna Tower

Item	Description	Unit	Quantity
1.Antenna Tower	4-legged self supporting steel tower, H=50m	unit	7
2.Base Station House	4m x 4m	unit	7

Source: JICA Study Team

The base station house with enough space to install wireless communication equipment by the carriers will also be supplied by the project. Considering the cost estimate, the height of antenna tower is set at 50m. However, the detailed plan will be reviewed during the preparation of the detailed design.



Source: JICA Study Team

Figure G.3.3 Mobile Base Station Coverage Area Map

3.2 COST ESTIMATES

Cost breakdown of direct construction cost as proposed for the telecommunication infrastructures is shown in Table G.3.3 below.

Table G.3.3 Direct Cost Breakdown of the Telecommunication Plan

1 VDN = 0.0064 JPY

No.	Item	Description	Unit	Q'ty	Unit Price		Amount		Equivalent in (JPY)
					(JPY)	(VND)	(JPY)	(VND)	
1	Steel pipe (D=100, n=16)	D=100mm x 4 x 4 lines	m	61,064	9,551	13,430,986	583,222,264	820,149,729,104	5,832,180,530
2	Optic Fiber Cable	SM-100C	m	63,564	120	168,750	7,627,680	10,726,425,000	76,276,800
3	Optic Fiber Splicing Box		unit	500	8,000	11,250,000	4,000,000	5,625,000,000	40,000,000
4	Antenna Tower	4-legged Self-supporting Steel Tower H=50m	unit	7	2,776,228	3,904,071,300	19,433,596	27,328,499,100	194,335,990
5	Mobile Base Station House	4m x 4m	unit	7	42,529	59,806,998	297,703	418,648,986	2,977,057
Total							614,581,243	864,248,302,190	6,145,770,377

Source: JICA Study Team

3.3 IMPLEMENTATION SCHEDULE

The overall implementation schedule for the proposed telecommunication infrastructure along with the related project schedule of communication carrier's is tentatively presented in Table G.3.4. This has been prepared in discussion with the carrier. The schedule includes time for a detailed design, procurement, construction works and a commissioning test. The carrier has an intention to establish the telecom center during 2011. Therefore, early construction of the telecommunication infrastructures will be required.

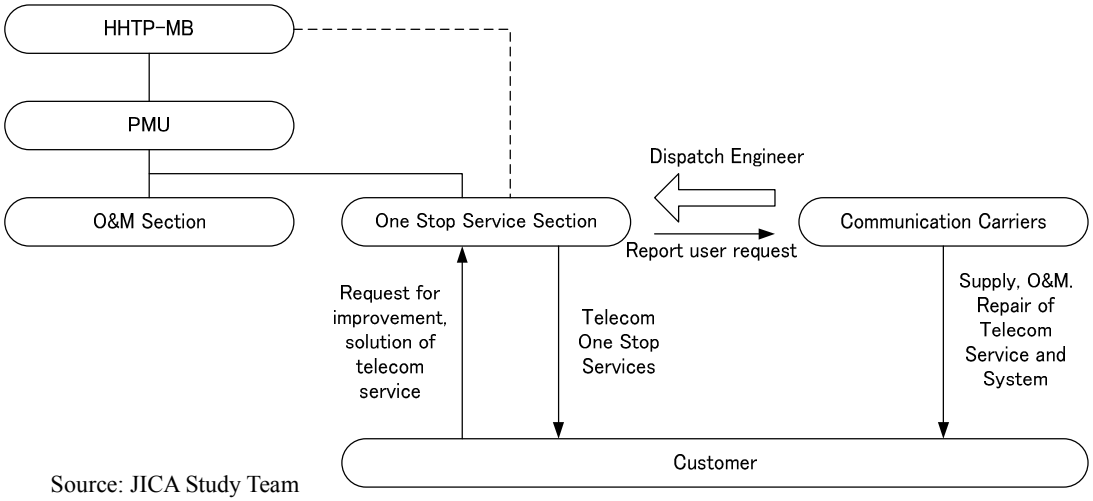
Table G.3.4 Implementation Schedule of the Telecommunication

Stage	Item	2008	2009	2010	2011	2012	2013	2014	2015
ODA Scheme (Telecommunication Pipe & Antenna Tower)									
1. Design	(1) Feasibility Study								
	(2) Appraisal Mission & Concurrence								
	(3) Loan Agreement			▲					
	(4) Consultant Procurement								
	(5) Detailed Design								
	(6) Tender Process								
2. Construction	(1) Contract Agreement						▲		
	(2) Construction								
	(3) Completion								▲
Carriers (Telecommunication System)									
1. Within HHTP	(1) Data Center								
	(2) Wired Network					Temporary Network			
	(3) Wireless Network					Temporary Network			
2. Outside HHTP	(1) Improvement of HHTP-Hanoi Line			Depends on the progress of Lang-Hoalac Expressway					
	(2) Strengthening of International Line								
	(3) NGN Backbone Network	Backbone				Expansion			
3. Related Project	(1) AAG (Asia America Gateway) Project								
	(2) 3G Mobile System		Pre-Project	Actual Operation					
	(3) Wi-MAX								

Source: JICA Study Team

3.4 INSTITUTIONAL ASPECTS

As stated earlier too, HHTP-MB will not operate and maintain telecommunication system due to the telecommunication regulations, and the carriers will operate and maintain the system within HHTP. However, considering that HHTP-MB doesn't have the telecommunication engineer and to realize the telecommunication system, certain immediate remedial actions are required. Thus, it is recommended that one stop service structure should be established where experts/engineers can work. Dispatching engineers from the carriers to one stop service section will be required to realize the telecommunication system. Figure G..3.4 below shows the proposed organization for the O&M of telecommunication services.



Source: JICA Study Team

Figure G.3.4 Proposed Organization of Telecommunication O & M

3.5 RECOMMENDATION

3.5.1 Structural Measures

1) Information services and telecommunication system complied with the NGN standard will be provided to entire end-users within the HHTP.

2) The latest wired communication system, xDSL, FTTx and MAN using optic fiber technologies, and advanced wireless mobile access system, GSM and Wi-MAX will be supplied as the user network access services.

3) Upgrading of the network between the project area and Hanoi along with the up gradation of the international line by the carriers is strongly recommended.

3.5.2 Non-Structural Measures

1) It is important to coordinate timely, carefully with the carriers about their telecommunication system implementation program.

2) Early construction of the telecommunication infrastructures is required. This will facilitate the carriers in smooth installation of the telecommunication system.

3) The establishment of the one stop service organization for the O&M of the telecommunication system is needed.

SUPPORTING H

SOLID WASTE MANAGEMENT PLAN

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CHAPTER 1 PRESENT CONDITION OF SOLID WASTE MANAGEMENT

1.1 PRESENT CONDITION OF SOLID WASTE MANAGEMENT IN THE STUDY AREA

1.1.1 Domestic Waste

There are 3 communes in the Study Area; Thach Hoa, Tan Xa and Ha Bang. According to the Vietnam Revised Master Plan (hereinafter called as VN Revised M/P), total population in HHTP area is about 7,500 persons and total of 2.25 tons of domestic solid waste is generated per day.

As a result of site inspection and interview survey with few residents and commune offices, it seemed that except for some households that are located along the main roads such as the Lang-Hoa Lac Expressway (LHLE) and National Route 21A, there is no collection service for domestic waste in the Study Area. As a result, residents throw their waste away to the nearby space and often burn it in uncontrolled manner. However, the households located along the main roads do segregate and store recyclable materials such as plastics, bottles and cans in their back yards and sells them to junk buyers. Some of the pictures of the domestic solid waste management in the Study Area are shown in Figure H.1.1.

Solid waste disposal in a household's backyard

Solid waste disposal in open space

Onsite burning of domestic waste

Storage of recyclable materials

Figure H.1.1 Scenery of Domestic Waste Disposal in the Study Area

1.1.2 Office/Commercial Waste

So far, only 2 offices are in operation in HHTP, which are the Hoa Lac Service Center and the HHTP MB office. The waste discharged from these offices is non-hazardous such as papers, plastics and yard waste, etc. The amount of the waste generated from these offices is about 2 to 3m^3/day.

These offices have their own clues to clean up their offices and they collect the discharged waste from the dust boxes placed in the offices every day. After collecting waste, by means of carts they dump the waste in the temporary dumping site located in the Study Area. The temporary dumping site is located in the Study Area and is about at a distance of 1km from these 2 offices. In the temporary dumping site, the clues after dumping the waste aside the road, burn it in uncontrolled manner. The pictures of the office waste management in the Study Area are shown in Figure H.1.2.

Transportation of waste by the clue

Open dumped office waste

Open dumped office waste

Uncontrolled burning in dumping site

Figure H.1.2 Scenery of Office Waste Collection and Disposal in the Study Area

1.1.3 Industrial Waste

Currently, the NOBLE and OETEK industry in High-tech industrial zone and KIM COUNG industry in Center of high-tech city are in operation in HHTP.

(1) NOBLE

NOBLE Electronics Vietnam Co., Ltd. is a manufacturing company which produces electronic and mechanical parts, IC and optical fiber terminals.

The types of waste discharged from the factory are cardboard boxes, plastic trays, package material of the parts of products, fingerstalls, wipe clothes, photocopy papers used in manufacturing process, and other waste such as kitchen waste as generated from the restaurant serving the workers. Excluding the kitchen waste, the amount of waste discharged in the factory is about 2,500kg/month. The kitchen waste is managed by food supplier and currently is being utilized for feeding livestock. The industrial wastes are segregated at the source and transferred to the waste management company in Hanoi City. Among these wastes, the valuables are sold to the waste management company with a rate of about 1,600 VND/kg for cardboard box, 7,000 - 8,000 VND/kg for plastic tray and package, about 2,200 VND/kg for photocopy paper and about 500 VND/kg for low quality wood packages.

On the other hand, for the recycling purpose there is an arrangement of transferring the inferior quality manufactured products to the waste management company in Ho Chi Minh City. These inferior products do not contain any hazardous substances. However, so far NOBLE has never transferred their inferior products to the waste management company as the amount of generated inferior products is quite few in numbers.

Therefore, almost all the waste in the factory is reused or recycled and only a few miscellaneous residuals are disposed. The amount of disposed waste is about $3m^3$/month.

(2) OETEK

OE TEK Inc. Vietnam Co., Ltd. is a manufacturing company which produces optical fiber.

The types of waste discharged from the factory are plastic cover for the fiber, photocopy papers and other residuals. Except for the photocopy papers which are being kept in the factory for recycling purpose, all generated waste is transported and disposed to the temporary dumping site in the Study Area. The amount of waste discharged from the factory is about 5kg/week.

(3) KIM CUONG

KIM CUONG Media Joint-Stock Company has been established in cooperation with VITTEL. It is a customer service center for telecommunication services.

The types of waste discharged from the office are photocopy paper, ballpoint pen, and other residuals. Photocopy papers are sold to junk buyers for recycling purpose and ballpoint pens are refilled and reused in the office. As a result the Clue's of Hoa Lac Service Center collects the residuals and disposes it to the temporary dumping site in the Study Area. The amount of the residual is about $1m^3$/day.

1.2 PRESENT CONDITION OF SOLID WASTE MANAGEMENT IN FORMER HA TAY PROVINCE

1.2.1 Overview of Solid Waste Management in Former Ha Tay Province

According to ADB report (2006)[1], it has been estimated that during 2003 former Ha Tay province generated 1,244 tons of solid waste a day. The distributions of the waste components are shown in Table H.1.1. Within this total, urban areas such as Ha Dong Town generated about 164 tons/day and Son Tay Town about 110 tons/day. Two companies were responsible for waste collection in urban areas and they were able to collect about 70% of the total generated waste.

[1] ADB, GEF and UNEP (2006) "National Performance Assessment and Subregional Strategic Environment Framework in the Greater Mekong Subregion"
http://www.rrcap.unep.org/sef/doc_pub/Vietnam%20Case%20Studies.pdf (cited:2008/11/19)

However, in recent years, it has been noticed that the waste generation of medical waste and industrial waste is steadily rising. In the rural areas, waste tends to be dumped in temporary landfills without even meeting the minimum environmental standards.

Table H.1.1 Components of Solid Waste in Former Ha Tay Province

Components of waste	Proportion (%)
Organic waste	80
Inorganic waste	7
Plastics	3
Other substance	10

Source: DONRE of Ha Tay Province (2005)
"Report on present status of environment
in Ha Tay Province in 200Source: DONRE of Ha Tay Province (2005)
"Report on present status of environment
in Ha Tay Province in 2004"

1.2.2 Outline of Existing Solid Waste Management Companies

There are 3 solid waste management companies in former Ha Tay Province; i) Ha Dong Urban Environment Joint-Stock Company (hereinafter called as Ha Dong URENCO), ii) Son Tay Urban Construction and Environment Joint-Stock Company (hereinafter called as Son Tay URENCO), and iii) Xuan Mai Urban Environment Company (hereinafter called as Xuan Mai URENCO). As for the 4 rural districts in former Ha Tay Province; i) My Duc District, ii) Phu Xuyen District, iii) Thong Tin District, and iv) Ung Hoa District, each District People's Committee is in charge for the management of solid waste.

Beside this, there is a recycling plant in former Ha Tay Province, which is operated by Seraphin Green Environment Technology Joint-Stock Company (Seraphin Company). This plant is treating the waste received from Ha Dong URENCO and Son Tay URENCO.

On the other hand, Hanoi Urban Environment Company (hereinafter called as Hanoi URENCO) is the main solid waste management company in Hanoi City.

Table H.1.2 shows the list of areas for which respective solid waste company is in charge for waste collection. Table H.1.3 shows the list of waste treatment facilities in Hanoi City and the location of the facilities is shown in Figure H.1.3.

Table H.1.2 Collection Areas in Charge for each Solid Waste Management Company

Solid waste management company	Collection areas in charge
Ha Dong URENCO	Ha Dong Town, Hoai Duc District and Thanh Oai District. (1 town and 2 districts in former Ha Tay Province)
Son Tay URENCO	Son Tay Town, Ba Vi District, Dan Phuong District and Phuc Tho District. (1 town and 3 districts in former Ha Tay Province)
Xuan Mai URENCO	Chuong My District (including Xuan My District Town), Quoc Oai District and Thach That District. (3 districts in former Ha Tay Province)
Hanoi URENCO	Ba Dinh District, Hoan Kiem District, Dong Da District and Hai Ba Trung District. (4 districts in Hanoi City)

Source: JICA Study Team

Table H.1.3 Waste Treatment Facilities in Hanoi City

Waste treatment facility	Target waste	Location	Operating company
Sanitary landfill	Ordinary waste	Xuan Son, Son Tay	Son Tay URENCO
Recycling plant	Ordinary waste (recyclable waste)	Xuan Son, Son Tay	Seraphin Company
Sanitary landfill	Ordinary waste	Nam Son, Soc Son	Hanoi URENCO
Composting plant	Ordinary waste (organic waste, fecal sludge)	Tay Mo, Tu Liem	Hanoi URENCO
Medical waste incinerator	Medical waste	Tay Mo, Tu Liem	Hanoi URENCO
Hazardous waste treatment facility	Hazardous waste	Nam Son, Soc Son	Hanoi URENCO

Source: JICA Study Team

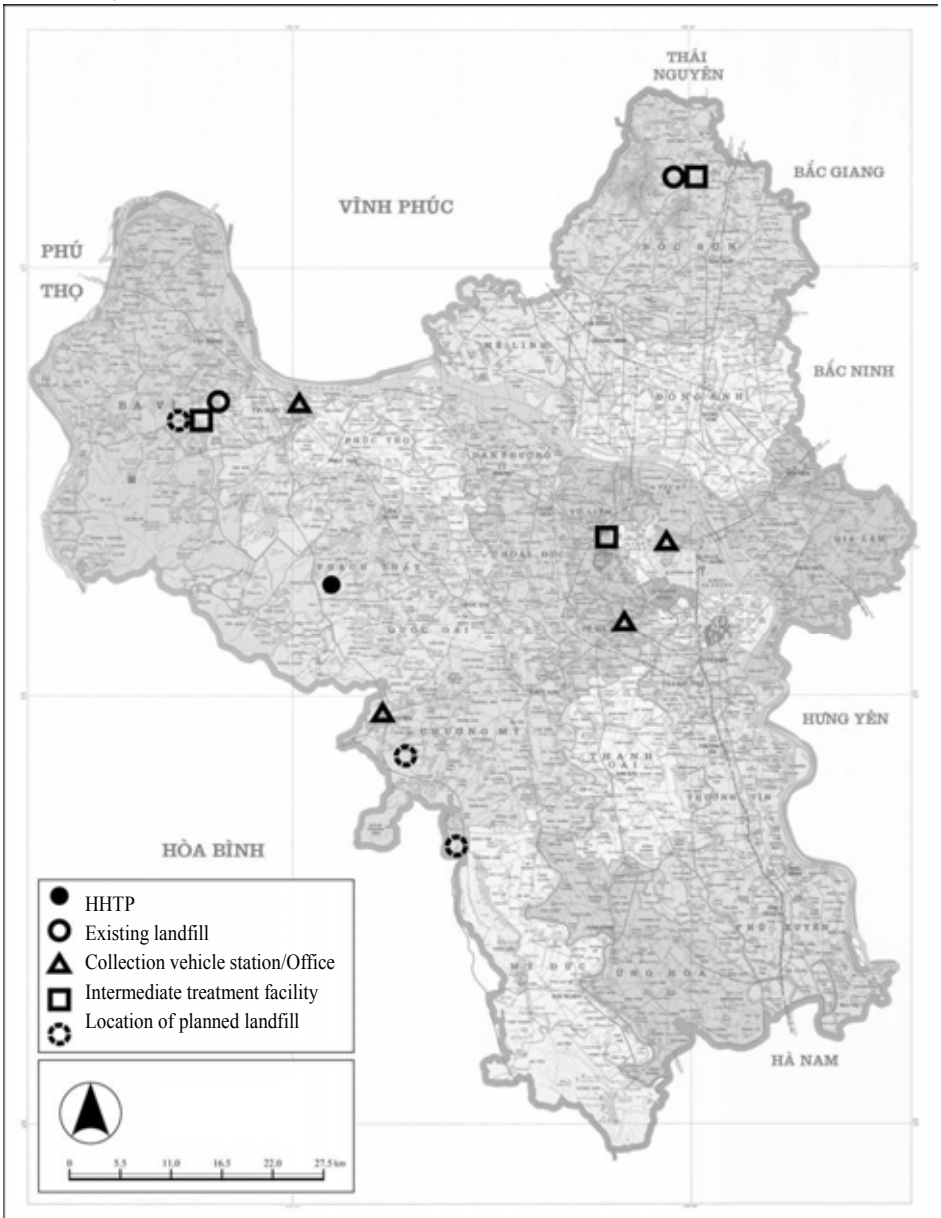


Figure H.1.3
Location of Solid Waste Management Facilities in Hanoi City

(1) Ha Dong URENCO

Ha Dong URENCO is a joint-stock company in which government shares an investment of 51% in the company's stock. Earlier Ha Dong URENCO belonged to Ha Tay People's Committee but now it belongs to Hanoi People's Committee (hereinafter called as HPC). Ha Dong URENCO collects mainly domestic waste from 1 town and 2 districts as shown in Table H.1-2 and the total amount of waste collected is about 150 ton/day. The office of Ha Dong URENCO is located in Ha Dong Town with a workforce of about 400 workers. It has about 30 collection vehicles. The some of pictures of Ha Dong URENCO office is shown in Figure H.1.4.

Ha Dong URENCO office


Collection vehicles garage in the office

Figure H.1.4 Ha Dong URENCO Office

From 2001 till 2008, Ha Dong URENCO used to dispose their collected waste to the basins in Hoa Lac Airport which is located in Thach That District. However, now this operation has been stopped. Considering that Ha Dong URENCO can't operates in landfill sites for waste treatment, now the collected waste is being transported and disposed in Nam Son Landfill that is being operated by Hanoi URENCO and Xuan Son Landfill that is being operated by Son Tay URENCO.

However, Ha Dong URENCO is planning to construct 24 ha waste treatment complex in Tran Phu Commune, Chuong My District, which will contain sanitary landfill, incinerator and recycling facilities.

(2) Son Tay URENCO

Son Tay URENCO is a joint-stock company in which the government shares an investment of 36% in the company's stock. Earlier Son Tay URENCO belonged to Ha Tay People's Committee but now it belongs to HPC. Son Tay URENCO collects mainly domestic waste from 1 town and 3 districts as shown in TableH.1-2. The amount of waste collected is about 200 ton/day. The office of Son Tay URENCO is located in Son Tay Town with a workforce of about 300 workers. It has 8 collection vehicles. The pictures of Son Tay URENCO office is shown in Figure H.1.5.

Son Tay URENCO office

Collection vehicles garage in the office

Figure H.1.5 Son Tay URENCO Office

The Xuan Son Landfill in Xuan Son Commune, Son Tay Town with an area of 4ha is the landfill site which is being operated by Son Tay URENCO. Xuan Son Landfill is divided into 10 blocks and it is equipped with concreting and liner sheets to control the seepage. The landfill also has a leachate treatment facility which operates on the principle of aeration, chemical treatment and a truck scale. However, such treatment facility was not in operation when JICA Study Team inspected the site. The treated water is displaced to the ground outside the landfill site. The operation of Xuan Son Landfill started in 1998 and currently 8 out of 10 blocks are already filled. As a result, Son Tay URENCO is planning to expand the landfill to an area of 10 ha. The construction work for expansion will start from 2009. In addition to this, Son Tay URENCO also has a new 13ha landfill plan in Tan Linh Village, Ba Vi District. The pictures of Xuan Son Landfill are shown in Figure H.1.6 and H.1.7.

Figure H.1.6 Xuan Son Landfill

Operating landfill block

Filled landfill block with cover soil

Unloading work of Compactor truck

Landfill operation machineries

Leachate treatment facility

Aeration tank

Figure H.1.7 Scenery of Xuan Son Landfill (1/2)

Settling tank

Tanks for chemical treatment

Drainage pipe for treated water

Truck scale

Figure H.1.7 Scenery of Xuan Son Landfill (2/2)

(3) Xuan Mai URENCO

Xuan Mai URENCO is a private company which is licensed by the government to collect domestic waste from 4 districts as shown in Table H.1.2. The amount of waste collected is around 200 ton/day.

Xuan Mai URENCO office

Collection vehicle in the office

Figure H.1.8 Xuan Mai URENCO office

The office of Xuan Mai URENCO is located in Xuan Mai District Town in Chuong My District with a workforce of about 60 workers. It has 20 collection vehicles. The pictures of Xuan Mai URENCO office are shown in Figure H.1.8 above.

The Tan Tien Landfill in Tan Tien Commune, Chuong My District is a temporary landfill site and is operated by Xuan Mai URENCO. The landfill site is located at the foot of Thoong Mountain. The pictures of Tan Tien Temporary Landfill are shown in Figure H.1.9 and H.1.10.

Currently, the Tan Tien landfill is a temporary open dumping site without any liner sheets or leachate treatment facility. As a result, the landfill does not receive any waste and the collected waste is transported for disposal in Xuan Son Landfill which is being operated by Son Tay URENCO.

Xuan Mai URENCO is planning to improve the landfill with sanitary equipments in an area of 8ha. In addition to this, incinerator and recycling facility will be also introduced. The construction work is scheduled to start from 2009 and the plan has already been approved by the government.

Open dumped solid waste

Open dumped solid waste

Open dumped solid waste

Landfill operation machinery

Figure H.1.9 Scenery of Tan Tien Temporary Landfill

Figure H.1.10 Tan Tien Temporary Landfill

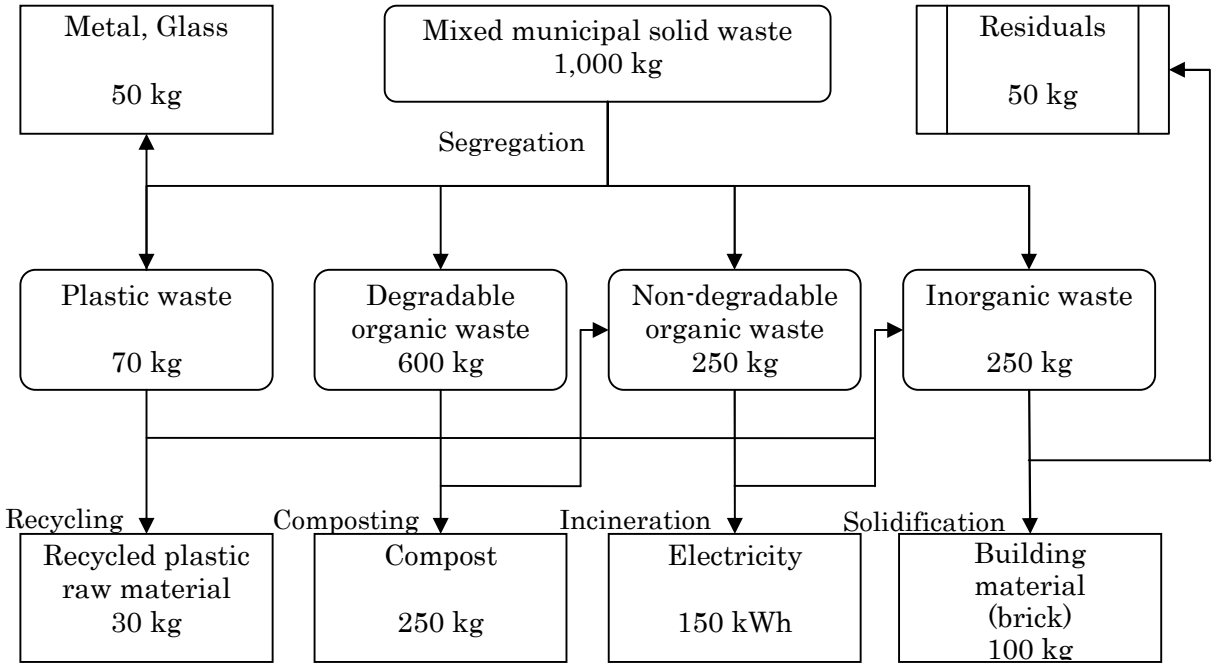
(4) Seraphin Company

Seraphin Company[2] is a solid waste treatment company and operates two recycling plants in Vietnam. Since December 2005, the company operates the Son Tay Recycling Plant that is spread in an area of 3 ha in Xuan Son Commune, Son Tay Town.

The treatment capacity of Son Tay Recycling Plant is about 100 ton/day and it receives municipal solid waste from Ha Dong URENCO and Son Tay URENCO.

After receiving municipal solid waste in the plant, mixed solid waste is segregated and pre-treated in 4 categories by manpower and mechanical equipments such as conveyer belts, screens and fans. Plastic wastes are dried, grinded, melted and formed to plastic raw material. Degradable organic waste is quality controlled and is fermented to produce compost. Non-degradable organic waste is dried, grinded and incinerated to generate electricity. Inorganic waste is dried, grinded and mixed with adhesives and addictives to form it to the building material (bricks). Metals and glasses segregated during the process are sold out for recycling purpose. The other left residuals are disposed to Xuan Son landfill operated by Son Tay URENCO. The flowchart and material balance of recycling process is shown in Figure H.1.11.

[2] Company's website:
http://greenseraphin.com/index.php?option=com_content&task=view&id=116&Itemid=55
(last cited on Dec. 11, 2008)



Source: Seraphin Green Environment Technology JSC

Figure H.1.11 Flowchart and Material Balance of Seraphin Recycling Plant

Seraphin Company along with a planning to expand the area of the Son Tay Recycling Plant to 12ha and is also going to establish medical and industrial waste incinerator with heat recovery. The company is now making application to HPC for the realization of this plan.

(5) Hanoi URENCO

Hanoi URENCO is a government owned company which belongs to HPC. Hanoi URENCO collects domestic waste from 4 districts as shown in Table H.1.2 above. Hanoi URENCO also collects industrial waste, medical waste, fecal sludge and construction waste. The amount of waste collected by Hanoi URENCO is shown in Table H.1.4. The office of Hanoi URENCO is located in Ba Dinh District with a workforce of about 3,000 workers. It has 114 collection vehicles. The pictures of Hanoi URENCO office are shown in Figure H.1.12.

Table H.1.4 The amount of waste collected by Hanoi URENCO

Unit: t/day

Type of solid waste	Amount of collected waste
Domestic solid waste	1,900
Organic waste	100
Industrial solid waste	150
Medical solid waste	3
Fecal sludge	100
Construction waste	270

Source: The project for implementation support for 3R initiative in Hanoi City, JICA

Hanoi URENCO office

Hanoi URENCO office

Figure H.1.12 Hanoi URENCO Office

The waste treatment facilities operated by Hanoi URENCO are shown in Table H.1.5.

Table H.1.5 Waste Treatment Facilities Operated by Hanoi URENCO

Waste treatment facility	Location	Target waste
Nam Son Landfill	Nam Son	Domestic waste
Cau Dien Composting Plant	Tay Mo	Organic waste
Nam Son Industrial Waste Treatment Facility	Nam Son	Hazardous waste
Cau Dien Medical Waste Incinerator	Tay Mo	Medical waste
Phu Minh Construction Waste Dumping Site	Phu Minh	Construction waste

Source: The project for implementation support for 3R initiative in Hanoi City, JICA
Hanoi URENCO

Nam Son Landfill is a sanitary landfill for domestic solid waste spread in an area of 54ha. It is equipped with the truck scale, the liner sheet, the soil covering and the leach ate treatment facility. The capacity of the landfill is 15 million ton and it is likely that it will achieved by 2020. In other words it is planned for closure in 2020. Considering this, Hanoi URENCO is planning to expand the capacity of the landfill with additional area of 47ha. The pictures of Nam Son Landfill are shown in Figure H.1.13.

The organic waste from some markets and households is transported to Cau Dien Composting Plant and is fermented and matured to produce compost. Fecal sludge collected by Hanoi URENCO is also treated by the composting plant as a component coordinator. The amount of compost product are produced is about 20 ton/day. The products are sold to farmers for agricultural use. The quality of compost meets Vietnamese quality requirement for compost products. The pictures of Cau Dien Compost Plant are shown in Figure H.1.14.

Compactor truck

Truck scale

Leachate treatment facility

Landfill block

Figure H.1.13 Scenery of Nam Son Landfill

Sorting machine

Segregation by workers

Fermentation and maturation

Product compost

Figure H.1.14 Scenery of Cau Dien Compost Plant

Besides, Hanoi URENCO is the only company in Hanoi City who has the license for transportation, treatment and disposal of hazardous waste, which is stipulated in the Regulation on Management of Hazardous Waste (Decision No. 155/1999/QD-TTg). The hazardous waste is treated and disposed in Nam Son Industrial Waste Treatment Facility which has incinerator, concrete shell landfill, chemical and physical treatment system and solidification and stabilization system. It is also equipped with safekeeping storage of hazardous waste. The current treatment capacity of the facility is 300 ton/day.

Moreover, medial waste from hospitals is transported to Cau Dien Medical Waste Incinerator and construction waste is transported to Phu Minh Construction Waste Dumping Site that has an area of 14ha.

CHAPTER 2 PROPOSED SOLID WASTE MANAGEMENT PLAN

2.1 SOLID WASTE GENERATION PROJECTION

2.1.1 Projection of Solid Waste Generation and Collection Ratio

The Vietnam Building Code (QCVN:01/2008/BXD), which was issued in parallel with Decision No.04/2008/QD-BXD, regulates domestic solid waste generation per capita. The collection ratio is determined according to the classification of cities under Decree No.72/2001/ND-CP. Domestic solid waste generation and collection ratios for each classification of city are shown in Table H.2.1.

As the population density of the HHTP is projected to be 12,079 person/km^2 in Stage-1 (2015) and 14,871 person/km^2 in Stage-2 (2020), the HHTP's urban management level is assumed as Grade I for both Stage-1 (2015) and Stage-2 (2020). Therefore, setting a unit rate of 1.3 kg/person/day for waste generation and a collection ratio of 100% has been adopted for domestic waste.

Table H.2.1 Domestic Solid Waste Generation and Collection Ratio

Class of city	Solid waste generation rate (kg/person/day)	Solid waste collection ratio (%)	Population density criteria (person/km^2)
Special, I	1.3	100	> 12,000
II	1.0	≥95	> 10,000
III, IV	0.9	≥90	> 6,000
V	0.8	≥85	> 2,000

Note: Criteria for class of cities is given in Decree No.72/2001/ND-CP.
Source: Vietnam Building Code (QCVN:01/2008/BXD)

The office and industrial waste generation rates are estimated roughly in the VN Revised M/P. However, these rates are dependent on the characteristics of the type of enterprise and/or activity undertaken by each tenant.

The VN Revised M/P estimated that the office waste generation rate would be 20 % of the domestic waste generation rate, i.e. 0.26 kg/staff/day. As for industrial waste the VN Revised M/P estimated a generation rate of 0.3 ton/ha/day for manufacturing factory, and this has been adopted for the High-tech Industrial Zone. Estimated generated waste and collection ratios for domestic, office and industrial waste of the HHTP are shown in Table H.2.2.

Table H.2.2 Estimated Solid Waste Generation Rate and Collection Ratio in the HHTP

Land Use		Domestic Waste		Office Waste		Industrial Waste	
		WGR (kg/person/day)	WCR (%)	WGR (kg/staff/day)	WCR (%)	WGR (t/ha/day)	WCR (%)
1	Software Park	-	-	0.26	100	-	-
2	Research and Development Zone	-	-	0.26	100	-	-
3	High-tech Industrial Zone	-	-	-	-	0.3	100
4	Education and Training Zone	1.3	100	0.26	100	-	-
5	Center of High-tech City	1.3	100	0.26	100	-	-
6	Mixed Use Zone	1.3	100	0.26	100	-	-
7	Residential and Office Zone	1.3	100	-	-	-	-
8	Housing Complex Zone	1.3	100	-	-	-	-
9	Amenity Zone	-	-	0.26	100	-	-
10	Amusement and Sport Zone	-	-	0.26	100	-	-

Note: WGR: Waste Generation Rate, WCR: Waste Collection Ratio.
Source: JICA Study Team

2.1.2 Projection of Solid Waste Generation Quantity

Based on the population and area projection for the HHTP, and the estimated solid waste generation rate and collection ratio, the future amount of solid waste that will be generated by and collected from the HHTP was predicted, as shown in Table H.2.3.

The estimated amount of waste generated in the HHTP is 152.6 ton/day in Stage-1(2015) and 215.1 ton/day in Stage-2(2020). As collection ratio is assumed to be 100% for all kind of waste the amount of generated and collected solid waste are equal.

Table H.2.3 Predicted Amount of Generated and Collected Solid Waste in the HHTP

Unit: t/day

Land Use		Stage 1 (2015)				Stage 2 (2020)			
		Domestic	Office	Industrial	Total	Domestic	Office	Industrial	Total
1	Software Park	-	2.3	-	2.3	-	3.3	-	3.3
2	Research and Development Zone	-	2.1	-	2.1	-	3.6	-	3.6
3	High-tech Industrial Zone	-	-	59.2	59.2	-	-	69.5	69.5
4	Education and Training Zone	4.3	1.3	-	5.6	22.5	6.7	-	29.2
5	Center of High-tech City	6.4	1.9	-	8.3	6.4	1.9	-	8.3
6	Mixed Use Zone	5.3	0.7	-	6.0	9.9	1.3	-	11.2
7	Residential and Office Zone	44.4	-	-	44.4	44.4	-	-	44.4
8	Housing Complex Zone	24.3	-	-	24.3	45.1	-	-	45.1
9	Amenity Zone	-	0.1	-	0.1	-	0.1	-	0.1
10	Amusement and Sport Zone	-	0.4	-	0.4	-	0.4	-	0.4
	Total	84.7	8.7	59.2	152.6	128.2	17.4	69.5	215.1

Source: JICA Study Team

2.1.3 Projection of Solid Waste Generation Quality

As for the domestic and office waste generated in the HHTP, the supposed components of the waste are organics, paper, textiles, plastics, rubber, leather, wood, hair, feathers, metal, glass, etc. and mostly ordinary waste. However, part of the domestic and office waste may contain hazardous waste such as used batteries and household chemicals, although though the quantity of such hazardous waste will likely be quite small.

As for the industrial waste, the three (3) tenants (NOBLE, OETEK and KIM CUONG) which have already started their operation in the HHTP do not discharge any hazardous waste from their business activities. However, in the future, there is a possibility that the HHTP will receive tenants who may generate hazardous waste from their business activities.

According to the development plan of the HHTP, the National Institute of Hygiene and Epidemiology (NIHE), which is under the control of the Ministry of Health, has a plan for setting up an International Bio-Medicine Center in the Research and Development Zone of the HHTP. Therefore, there is a possibility that NIHE will generate infectious waste.

In addition, some other institutes in the Research and Development Zone and the Education and Training Zone may discharge some hazardous and/or infectious waste from their activities.

Moreover, as wastewater treatment plants will be set up in the HHTP, sewage sludge will be generated from these plants.

2.2 PLAN CONCEPT AND DESIGN CRITERIA

2.2.1 Solid Waste Management Facilities

The Vietnam Building Code (QCVN: 01/2008/BXD) regulates the minimum distance between waste treatment facilities and other buildings as follows:

- Sanitary landfill for organic and inorganic solid waste: 1,000m
- Inorganic solid waste landfills: 100m
- Solid waste treatment plants (gasification, composting): 500m

Considering the above regulation and the efficiency of the solid waste management system in Hanoi City, the solid waste generated in the HHTP should be treated and disposed of in existing facilities outside the HHTP, together with the solid waste from surrounding area of the HHTP.

2.2.2 Solid Waste Management Companies

To ensure adequate solid waste management in the HHTP, solid waste generators should make contracts with local solid waste management companies that have the capacity, technical competence and experience required for appropriate solid waste management. Candidate solid waste management company is URENCO, which is responsible for solid waste collection, transportation, treatment and disposal services in Hanoi City. An appropriate solid waste management system could be applied by URENCO, considering the characteristics of each kind of waste.

2.2.3 Solid Waste Management Collection Fee

The fee for ordinary waste collection services is regulated by the government. Table H.2.4 shows the stipulated collection fee in the former Ha Tay Province.

On the other hand, the fee for hazardous waste collection services will be decided by contracts between hazardous waste generators, and hazardous waste transport and treatment companies.

The entrusted solid waste management companies shall collect the fee directly from households and enterprises. Therefore, the staff from entrusted solid waste management company (URENCO) may periodically visit their customers in the HHTP to collect the corresponding fees for their service.

Table H.2.4 Fee for Ordinary Solid Waste Collection Services in the former Ha Tay Province

No	Type of waste	Collection fee
1	Individuals and families	
	- Ha Dong Town, Son Tay Town	2,000 VND/person/month
	- Districts	1,000 VND/person/month
	- Communes	500 VND/person/month
2	Small business	50,000 VND/unit/month
3	Schools and kindergartens	50,000 VND/unit/month
4	Offices of enterprises, administrative office	
	- Office less than 30 workers	60,000 VND/unit/month
	- Office less than 50 workers	80,000 VND/unit/month
	- Office more than 50 workers	100,000 VND/unit/month
5	Restaurants, hotels, etc.	200,000 VND/unit/month
6	Factories, hospitals, manufacturers, markets, train stations, car stations	120,000 VND/m^3-waste

Source: Decision No.2262/2006/QD-UBND

2.2.4 Solid Waste Management at the Generation Source

All solid waste generators in the HHTP have to make efforts to reduce the amount of waste generation caused by their activities. The waste generators will be encouraged to segregate their waste into categories suitable for recycling and other treatment, as stipulated in the Law on Environmental Protection (LEP) and Decree No.59/2007/ND-CP on solid waste management.

According to the Regulation on Management of Hazardous Waste (Decision No. 155/1999-QD-TTg), hazardous waste must be packed and stored safely at the source, marked with a sign, and isolated from ordinary waste and other hazardous waste. This must be done before transferring the waste to hazardous waste transport and treatment companies.

In addition, infectious waste and sewage sludge should be handled separately, as these waste needs careful consideration for transportation and treatment.

2.3 PROPOSED SOLID WASTE MANAGEMENT PLAN

2.3.1 Ordinary Solid Waste

Ordinary solid waste from the domestic, business, service, public, and industrial sectors of the HHTP will be left out for collection in suitable containers, typically garbage bins. Such ordinary waste shall be collected, transported, treated and disposed by the nominated contractor (URENCO).

To reduce the amount of waste disposed of in landfills and minimize the impact to surrounding environment, measures for recycling should be considered. If the feasibility of recycling technology is confirmed, and good segregation of the recyclable waste is guaranteed, recyclable waste could be treated in the Son Tay Recycling Plant operated by Seraphin Company and the Cau Dien Composting Plant operated by Hanoi URENCO. Plastic and inorganic waste will be recycled and used as a plastic raw material and as a building material (e.g. bricks) in the Son Tay Recycling Plant. Organic waste will be recycled by converting it to compost in the Son Tay Recycling Plant and/or the Cau Dien Composting Plant.

Non-recyclable waste should be disposed of in sanitary landfill which has appropriate facilities for preventing environmental pollution. The existing sanitary landfills in Hanoi City are the Xuan Son Landfill (operated by Son Tay URENCO) and the Nam Son Landfill (operated by Hanoi URENCO). However, the Nam Son Landfill is about 70 km away from the HHTP and it is already receiving a large quantity of waste from the urban area of Hanoi City. Therefore, it is assumed that the non-recyclable ordinary solid waste from the HHTP will be transported to and disposed of in the Xuan Son Landfill, which is 20 km away from the HHTP.

2.3.2 Hazardous Solid Waste

The hazardous solid waste will be mainly generated by manufacturing companies in the High-tech Industrial Zone. In addition, institutes in the Research and Development Zone and the Education and Training Zone may generate some hazardous waste. Furthermore, part of the domestic waste may contain hazardous waste such as used batteries and household chemicals. Accordingly, hazardous waste generators will be obliged to minimize the generation of hazardous waste and must segregate their hazardous waste at the source.

As for the collection, transportation, treatment and disposal of hazardous waste, only organizations or individuals licensed by Ministry of Natural Resource and Environment (MONRE) or Department of Natural Resources and Environment (DONRE) may handle hazardous waste. This is in accordance with the LEP and Regulation on Management of Hazardous Waste (Decision No.155/1999-QD-TTg).

In Hanoi City, only Hanoi URENCO has licenses for the transportation, treatment and disposal of hazardous waste. Hanoi URENCO has licenses for the transportation of hazardous waste (No.1-2-3-4-5-7.001.V) and licenses for the treatment and disposal of hazardous waste (No.1-2-3-4-5-7.001.V). These licenses were issued by MONRE on 27 June 2007.

Therefore, the hazardous waste generated in the HHTP should be transported, treated and disposed in Nam Son Industrial Waste Treatment Facility by Hanoi URENCO.

Hazardous waste generators in the HHTP must register their operations with DONRE and periodically report on hazardous waste management in order to obtain registration. In addition, the registered companies must keep files and diaries of hazardous waste management work undertaken at their sites and are subject to inspection by DONRE. The management of hazardous waste shall be controlled and monitored by a manifest system, as stipulated in Circular No.12/2006/TT-BTNMT.

2.3.3 Infectious Waste

The National Institute of Hygiene and Epidemiology (NIHE) plans to set up an International Bio-Medicine Center in the Research and Development Zone of the HHTP. NIHE may generate infectious waste from their research activities. In addition, some other institutes in the Research and Development Zone and the Education and Training Zone may generate infectious solid waste.

Medical waste, including infectious waste, generated in Hanoi City is incinerated in the Cau Dien Medical Waste Incinerator that is operated by Hanoi URENCO. Therefore, the infectious waste from the HHTP could also be transported to this facility and incinerated there by Hanoi URENCO or treated by NIHE them self.

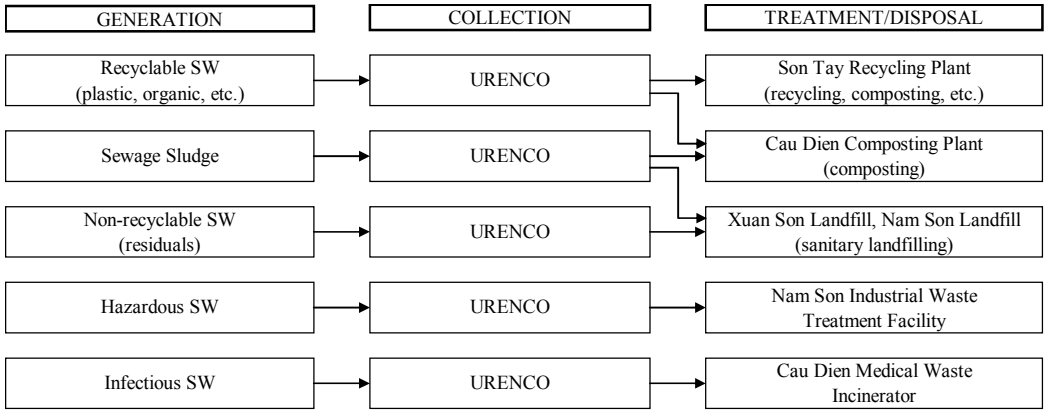
2.3.4 Sewage Sludge

Sewage sludge will be generated by the wastewater treatment plants in the HHTP. The amount of sludge that will be generated is estimated to be about 50 ton/day.

As the fecal sludge generated in Hanoi City is utilized in the Cau Dien Composting Plant, the sewage sludge from the HHTP could also be transported to the Cau Dien Composting Plant for utilization. If the quality of the sludge does not meet the standards set by the Cau Dien Composting Plant, it should be transported and disposed of in sanitary landfill, the same as ordinary solid waste.

2.3.5 Proposed Solid Waste Management System

The proposed solid waste management system for the HHTP is summarized in Figure H.2.1.



Note: SW: Solid waste
Source: JICA Study Team

Figure H.2.1 Flow Chart of Proposed Solid Waste Management System for the HHTP

As for the future development plan of solid waste management facilities in the former Ha Tay Province, the former Ha Tay People's Committee made decisions approving the land acquisition for the following projects:

- Waste treatment complex (sanitary landfill, incinerator and recycling facility) in Tran Phu Commune, Chuong My District, with an area of 24.2ha
  (Decision No. 929/2006/QD-UBND)
- Sanitary landfill in Tan Linh Village, Ba Vi District, with an area of 12.9ha
  (Decision No.1512/2006/QD-UBND)
- Waste treatment complex (sanitary landfill, incinerator and recycling facility) in Tan Tien Commune, Chuong My District, with an area of 8.4ha
  (Decision No.1201/2008/QD-UBND)

In addition, Hanoi URENCO is planning to expand the capacity of the Nam Son Landfill with an additional area of 47ha.

As Ha Tay Province has now merged into Hanoi City, the development plan for solid waste management facilities may be revised by the Hanoi People's Committee (HPC). Therefore, in order to improve the quality of solid waste management and to minimize environmental impact, the solid waste management system for the HHTP will need to be reviewed and revised in accordance with the revised solid waste management plan for Hanoi City.

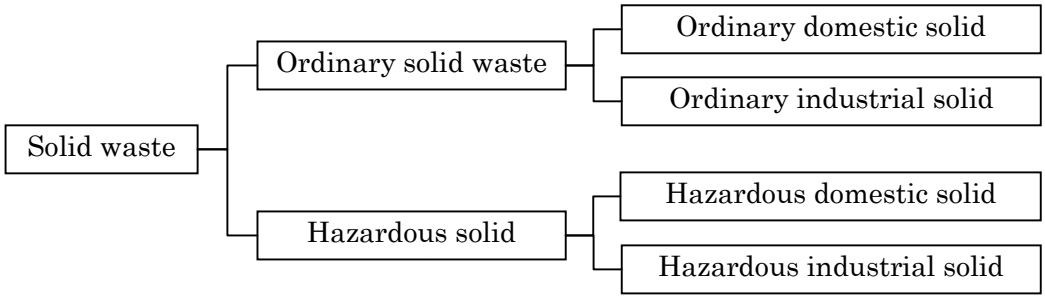
2.4 RECOMMENDATION

1) HHTP-MB shall make a general agreement with URENCO for solid waste management in the HHTP.
2) In accordance with the agreement between HHTP-MB and URENCO, all tenants in the HHTP shall make contracts with URENCO to entrustment that company with solid waste collection, treatment and disposal, in compliance with relevant legislation.
3) Tenants in the HHTP shall periodically report the status of solid waste management in their sites (quantity and quality of generated waste, method of storage at source, etc.) to HHTP-MB.
4) Tenants who generate hazardous waste shall submit photocopies of the "Registration book for owners of hazardous waste sources" granted by DONRE and their "Report on hazardous waste management" to DONRE, as stipulated in Circular No.2002/2006/TT-BTNMT.
5) Enterprises that generate a kind of hazardous waste which Hanoi URENCO is incapable of collecting/transporting and treating/disposing cannot move into the HHTP.

CHAPTER 3 RESPONSIBILITIES OF SOLID WASTE GENERATORS

3.1 CLASSIFICATION OF SOLID WASTE

In Vietnam, waste is defined in the Law on Environmental Protection (52/2005/QH11) (hereinafter called as LEP) as "substances in the solid, liquid or gaseous form discharged from production, business, service, daily life or other activities" and hazardous waste is defined as "waste containing elements that are toxic, radioactive, inflammable, explosive, abrasive, contagious, poisonous or otherwise harmful". Besides this, in Decree No.59/2007/ND-CP on solid waste management, solid waste is defined as waste in solid form discharged from production, business, service, domestic or other activities. Generally, the ordinary and hazardous solid waste discharged from domestic activities, households, public places is called as domestic solid waste, and solid waste discharged from industrial production, business and service activities and others is commonly called as industrial solid waste. Hence, solid waste shall be classified by waste generators and characteristic of waste as shown in Figure H.3.1.



Source: JICA Study Team

Figure H.3.1 Classification of Solid Waste

3.2 RESPONSIBILITIES OF SOLID WASTE GENERATOR REGULATED IN CONCERNED LEGISLATIONS

All the solid waste generators in HHTP have to follow the concerned legislation on solid waste management in Vietnam, i.e. the Law on Environmental Protection (LEP) and the Regulation on Management of Hazardous Waste (Decision No. 155/1999-QD-TTg), etc.

The LEP regulations on waste management in Chapter 8 and general provisions on solid waste management are as follows:

- Waste management responsibilities
  Organization and individuals engaged in waste-generating activities shall be responsible for reducing, reusing and recycling waste so as to minimize the quantity of waste to be incinerated or discarded. Source, quantities, properties of waste must be identified to ensure application of appropriate treatment methods and procedures to each kind of waste.
- Collection and disposal of expired and discarded products
  Owners of production, business and service establishments shall be responsible for recovering expired or discarded products such as radioactive sources; batteries and accumulators; electronic and electric equipments; lubricants, grease and packages hard to discompose; drugs and chemicals; tubes and tire; and other products decided by the Prime Minister.
- Recycling of waste
  Waste must be sorted at source into categories suitable for recycling, disposal, incineration, and burial.

The Regulation on Management of Hazardous Waste (Decision No. 155/1999-QD-TTg) specifies the detail for the hazardous waste management. In addition it also specifies the responsibilities to the hazardous waste generators, which are as follows:

- Hazardous waste generators must register their operations with MONRE/DONRE to obtain registration numbers.
  (The application form for hazardous waste generator is shown in Figure H.3-2)
- Hazardous waste generators must periodically report on hazardous waste management to MONRE/DONRE and maintain the files and diaries of hazardous waste management at the sites. These are subject to inspection by MONRE/DONRE.
  (The reporting form for hazardous waste generator is shown in Figure H.3-3)
- Minimize and classify hazardous waste right from its discharge source.
- Pack hazardous waste according to its category and in proper packing or container, which satisfy requirements. In addition, the sign and mark thereon must be clear as prescribed by competent state agencies.
- Keep hazardous waste safely within their production and/or business areas before transferring such hazardous waste to collectors, transporters, keepers, treatment companies and disposers. The hazardous waste keeping must satisfy the following requirements:
  - Satisfy the hazardous waste management requirement as prescribed by MONRE/DONRE (fences, signboards and other guaranty measures) at the hazardous waste keeping areas,
  - Not placing hazardous waste together with non-hazardous waste, and isolate it from other hazardous waste, and
  - Having plans for incident prevention and combat to ensure safety in the storing areas.
- When hazardous waste generators are incapable of collecting, transporting, treating or disposing hazardous waste arising at their own establishments by themselves, they shall have to sign contracts with hazardous waste collectors, transporters, treatment companies and disposers.
- Hazardous waste shall be transferred only to the licensed collectors, transporters, keepers, treatment companies and disposers.
- To fill and sign on part I of hazardous waste document (manifesto sheet) and request the collectors and transporters to fill and sign on part II of the manifesto sheet. Six (6) copies for each manifest sheet shall be made. The hazardous waste source generator should keep 1 copy; the other 5 copies shall be handed to the collector and transporter.
  (The concept of manifesto system for hazardous waste management is shown in Figure H.3.4 and manifest sheet is shown in Figure H.3.5.)
- Inspect and confirm hazardous waste in the course of collection, transportation, keeping, treatment and disposal of such HW to/at the places or establishments as specified in the contracts.
- Explain and provide relevant documents to the competent state agencies when they are subject to inspection by such agencies.

Application for Registration Book of owners of hazardous waste sources
***

..... (1) .....

THE SOCIALIST REPBLIC OF VIETNAM
Independence – Freedom - Happiness

(Place), date (day/month/year)

APPLICATION FOR
REGISTRATION BOOK OF OWNER OF HAZARDOUS WASTE SOURCES
(Or Application for modification of the Registration Book of hazardous waste sources)

To: ..... (2) .....

1. General information:

Name of the owner of hazardous waste sources (organization/individual):
Office address:
Telephone: Fax: E-mail:
Account number: at:
ID number (for individual): date of issue: place of issue:
Business registration No.: date of issue: place of issue:
Name of establishment that generates hazardous waste:
Type of establishment:
Address of the establishment:
Telephone: Fax: E-mail:
Name of contact person:
Code of hazardous waste management (in case applying for modification of the Registration Book):

2. Production information:

(i) List of raw materials/chemicals and the average amount used in one month:

No	Raw material/chemical	Amount(kg)

(ii) List of products and average monthly production yield:

No	Name of products	Production yield (kg/month)

3. Waste information:

(i) Average amount of hazardous waste generated in one month:

No	Name of waste	State of existence (solid/liquid/sludge)	Amount (kg)	Code of hazardous waste
	Total			

(ii) Average amount of other waste generated in one month:

No	Name of waste	State of existence (solid/liquid/sludge)	Amount (kg)
	Total		

4. Names of staff involving in hazardous waste management:

No	Name	Qualification	Job title	Remarks
	Total			

5. List of documents and papers attached:

-
-

I undertake that the above provided information is truthful. I request the DONRE to grant (or modify) the Registration Book of Owner of hazardous waste sources.

..... (3) .....
(Signature, name, title, seal)

Note:
(1) Name of the applying organization (for organization);
(2) DONRE of the respective province where apply for registration book;
(3) Individual applying for registration book, the head or authorized person of the organization applying for Registration Book.

Source: Circular No.12/2006/TT-BTNMT

Figure H.3.2 Application Form for Hazardous Waste Generators

Reporting Form of Hazardous Waste Owner
***

NAME OF OWNER
(in case of organization)

THE SOCIALIST REPBLIC OF VIETNAM
Independence – Freedom - Happiness

(Place), date (day/month/year)

REPORT ON HAZARDOUS WASTE MANAGEMENT
OF HAZARDOUS WASTE OWNER
(from date ... /... /..... to ... / ... /.....)

To: Department of Natural Recourses and Environmental of Province/City

1. General information:
Name of the hazardous waste owner:
Address of the owner's office:
Telephone: Fax: E-mail:
Name of the establishment (if available):
Address of the establishment:
Telephone: Fax: E-mail:
Code of Hazardous Waste Management:
2. General situation on hazardous waste generation and hazardous waste management over last 6 months:
3. Hazardous waste management plan for coming 6 months:
4. Other matters:

On behalf of hazardous waste owner
(Signature, full name, position, seal)

Annex: Inventory of hazardous wastes and other wastes over last 6 months
a. Inventory of hazardous wastes:

Name of hazardous waste	Code	Volume (kg)	Measures for treatment and disposal*	Hazardous waste carrier (V1, V2) and Hazardous waste treater/disposer (X)	Note
				V1: Name and code of hazardous waste management V2: Name and code of hazardous waste management X: Name and code of hazardous waste management	
Total Volume					

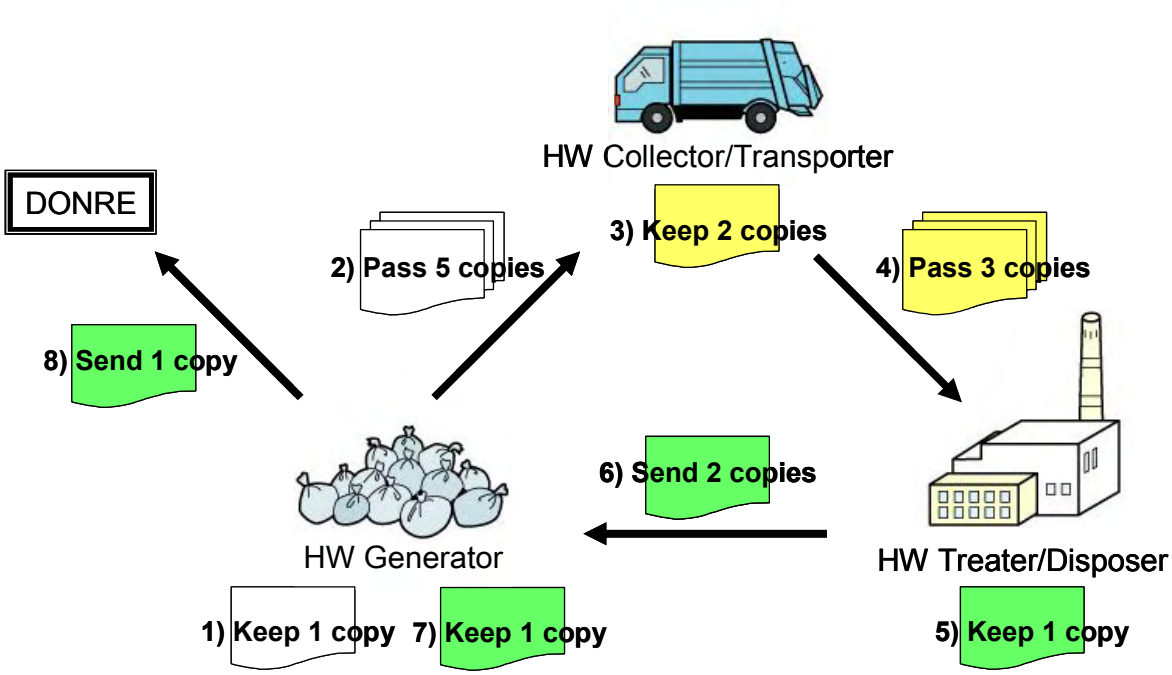
* Notation (symbol) of measures of treatment and disposal for each kind of hazardous waste: Collect/recycle (TT); Neutralize (TH); Separate/extract/filter… (PT); Oxygenate (OH); Precipitate (KT); Harden/stabilize/transform into glass... (HR); Cement furnace (XM); Specialized furnace (TD); Biological method (SH); Bury (CL); Others (name of method).

b. Inventory of other wastes (non-hazardous):

Name of waste	Volume (kg)	Measures for treatment and disposal*	Name, address of waste treatment and disposal operator's establishment	Note
Total Volume				

Source: Circular No.12/2006/TT-BTNMT

Figure H.3.3 Reporting Form for Hazardous Waste Generators



Note: 1) HW generator prepares 6 copies of HW manifesto sheet, fills in necessary information and keeps 1 copy,

2) HW generator passes 5 copies of HW manifesto sheet to HW collector/transporter,

3) HW collector/transporter fills in necessary information and keeps 2 copies,

4) HW collector/transporter passes 3 copies of HW manifesto sheet to HW treatment company/disposer,

5) HW treatment company/disposer fills in necessary information and keeps 1 copy,

6) HW treatment company/disposer sends 2 copies of HW manifesto sheet to HW generator,

7) HW generator keeps 1 copy of HW manifesto sheet and confirms the completion of HW management, and

8) HW generator sends 1 copy of HW manifest sheet to DONRE and report the completion of HW management.

HW: hazardous waste

Source: JICA Study Team

Figure H.3.4 Concept of Manifest System for Hazardous Waste Management

Department of Natural Resources and Environment — Hazardous waste records
No.

1. Name of hazardous waste owner:
Hazardous waste management code:
Address of owner's office: Telephone:
Address of owner's establishment: Telephone:

2a. Name of first hazardous waste carrier:
Hazardous waste management code:
Address of owner's office: Telephone:
Address of owner's establishment: Telephone:

2b. Name of second hazardous waste carrier:
Hazardous waste management code:
Address of owner's office: Telephone:
Address of owner's establishment: Telephone:

3. Name of hazardous waste treatment and disposal operator:
Hazardous waste management code:
Address of owner's office: Telephone:
Address of owner's establishment: Telephone:

4. Declaration of hazardous waste to be transferred (use more paper sheets if needed) — Sheet No out of sheets

No	Name of hazardous wastes	Existing status			Code	Amount (kg)	Measures of treatment and disposal
		Solid	Liquid	Sludge			

Write down (symbol) hazardous waste treatment and disposal measures: Collect/recycle (TT); Neutralize (TH); Separate/extract/filter... (PT); Oxygenate (OH); Precipitate (KT); Harden/stabilize/transform into glass (HR); Cement furnace (XM); Specialized furnace (TĐ); Biological method (SH); Bury (CL); Others (name of method)

5. Hazardous waste export: yes no Importing country Port
Number of means: Exporting country Port

6. Confirmation of the record of hazardous waste in term of amount and type as declared in Clause 4

6.1. Full name of the receiver who is on behalf of the first carrier Signature	Date	Month	Year
6.2. Full name of the receiver who is on behalf of the second carrier Signature	Date	Month	Year
6.3. Full name of the receiver who is on behalf of the treatment and disposal operator Signature	Date	Month	Year

7. Confirmation of the hazardous waste owner that he declared exactly all information required in Clause 1 – 4 (or 5) together with the hazardous waste treatment and disposal operator.	8. Confirmation of the hazardous waste treatment and disposal operator that he treated and disposed safely all hazardous waste using measures as declared in Clause 4
(Signature, full name, position, seal) dd/mm/yy	(Signature, full name, position, seal) dd/mm/yy

Note: Copies 1&5: Hazardous waste owner; Copies 2&3: Hazardous waste carrier(s);
Copy 4: Hazardous waste treatment and disposal operator; Copy 6: DONRE
Source: Circular No.12/2006/TT-BTNMT

Figure H.3.5 Form of Manifest Sheet for Hazardous Waste Management

3.3 LIST OF HAZARDOUS WASTE WHICH HANOI URENCO HAS LICENSE FOR TRANSPORTATION, TREATMENT AND DISPOSAL

Enterprises that discharge kind of hazardous waste which Hanoi URENCO is incapable to collect/transport and treat/dispose shall not be allowed to move or establish in HHTP.

The list of hazardous waste which Hanoi URENCO is capable to transport, treat and dispose is shown in Table H.3.1.

Table H.3.1 List of Hazardous Waste which Hanoi URENCO has License for Transportation, Treatment and Disposal (1/4)

No.	Name of hazardous waste	Status	Permitted quantity (kg/year)	Code of hazardous waste	Types of specialized vehicles and transportation plan	Specialized equipment and vehicles, plan for treatment and disposal	Treatment and disposal standard
1	Hazardous mud	Mud	10,000,000	010101, 010102, 010103, 020201, 010304, 010305, 010307, 010407, 020301, 020302, 020303, 020401, 020501, 020701, 020702, 020703, 030108, 030208, 030408, 030608, 030708, 040101, 040205, 050306, 050503, 050705, 050801, 051001, 051101, 051102, 060102, 060103, 060105, 070104, 070105, 070109, 070309, 080102, 080202, 100203, 110802, 120601, 120602, 120605, 120606, 120903, 120904, 150213, 190902	Packed in pp package or contained in 200 liter drum. Transported by specialized close vehicle or tank.	Water separation, solidification, stability, landfill, industrial waste shell.	TCVN 7629-2007
2	Waste lubricant and mixture of lubricant water		1,000,000	010409, 080205, 120203, 150205, 170101, 170104, 170105, 170106, 170201, 170202, 170203, 170204, 170301, 170302, 170303, 170304, 170305, 170601, 170602, 170703, 190207, 190208, 190209	Contained 200 liter drum. Transported by specialized close vehicle or tank.	Water separation, residue removal lubricant collection and recycle. Water is treated through waste water treatment. Residue is disposed by incinerator.	TCVN 5945-2005 TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
3	Waste acid solution		5,000,000	020101, 020102, 020103, 020104, 020105, 020106, 040102, 070101, 070102, 160102	Contained 200 liter drum. Transported by specialized close vehicle or tank.	Chemical treatment	TCVN 5945-2005 (Column B)
4	Waste base solution		5,000,000	020201, 020202, 070103, 160103	Contained 200 liter drum. Transported by specialized close vehicle or tank.	Chemical treatment.	TCVN 5945-2005 (Column B)

Table H.3.1 List of Hazardous Waste which Hanoi URENCO has License for Transportation, Treatment and Disposal (2/4)

No.	Name of hazardous waste	Status	Permitted quantity (kg/year)	Code of hazardous waste	Types of specialized vehicles and transportation plan	Specialized equipment and vehicles, plan for treatment and disposal	Treatment and disposal standard
5	Organic plant protection chemicals Wood protection substance and other waste bio seed		50,000	010501, 121101, 140103, 140101, 160105	packed in pp package or contained in 200 liter drum. Transported by specialized close vehicle or tank	Chemical and Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
6	Chemical substance and mixture of laboratory waste. Hazardous chemical substance		30,000	030210, 130202, 190301, 190302, 190502, 190503	Packed in pp package or contained in 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
7	Ash residue emitted from furnace		500,000	040201, 050201, 050204, 120105	Packed in pp package or contained in 200 liter drum. Transported by specialized close vehicle.	Solidification, stability.	TCVN 7629-2007
8	Activated carbon after use		20,000	021102	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
9	Non-halogen solvent		400,000	030103, 030203, 030303, 030403,030503, 030603, 030703, 070302, 070303, 070304, 080101, 080102, 080103, 080104, 080105, 080205, 100101, 100201, 160101, 170803, 190103	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle or tank.	Chemical extraction and collection of refined solvent	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
10	Waste paint, color powder, printing ink		800,000	080101, 080102, 080103, 080104, 080105, 080201, 080202, 080203, 080204, 080205	Packed in contained 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
11	Colloidal, plastic chemical		200,000	080301, 160109	Packed in contained 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007

Table H.3.1 List of Hazardous Waste which Hanoi URENCO has License for Transportation, Treatment and Disposal (3/4)

No.	Name of hazardous waste	Status	Permitted quantity (kg/year)	Code of hazardous waste	Types of specialized vehicles and transportation plan	Specialized equipment and vehicles, plan for treatment and disposal	Treatment and disposal standard
12	Color and dye containing hazardous substance		100,000	100202, 030105	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
13	Waste neon, fluorescent		10,000	010601, 160106	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle.	Sulfurization and landfill.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
14	Electronic circuit, capacitor		80,000	150104, 150204, 160103, 160113, 190201, 190202, 190203, 190204, 190205, 190206, 190601, 190602, 190603	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle	Chemical treatment and incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
15	Chrome, nickel, tm, bronze, zinc, metal residue		20,000	050301, 050302, 050303, 050304, 050305, 110401, 110402, 150208	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle.	Primary treatment and recycle.	
16	Waste package, container, rug, contaminated with waste substance		100,000	030106, 180101, 180102, 180201	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
17	Outdated animal food but no identification of hazardous element		20,000	190301, 190302	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle.	Landfill or Incineration	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
18	Waste electrolytic battery		50,000	050703, 160112, 190601, 190602, 190603, 190604	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle.	Chemical treatment and landfill.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
19	Saw dust, chip, left timber, plank, fiber containing hazardous elements		50,000	090001, 160114	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle	Incineration	TCVN 5939-2005, TCVN 6560-1999, TCVN 7629-2007

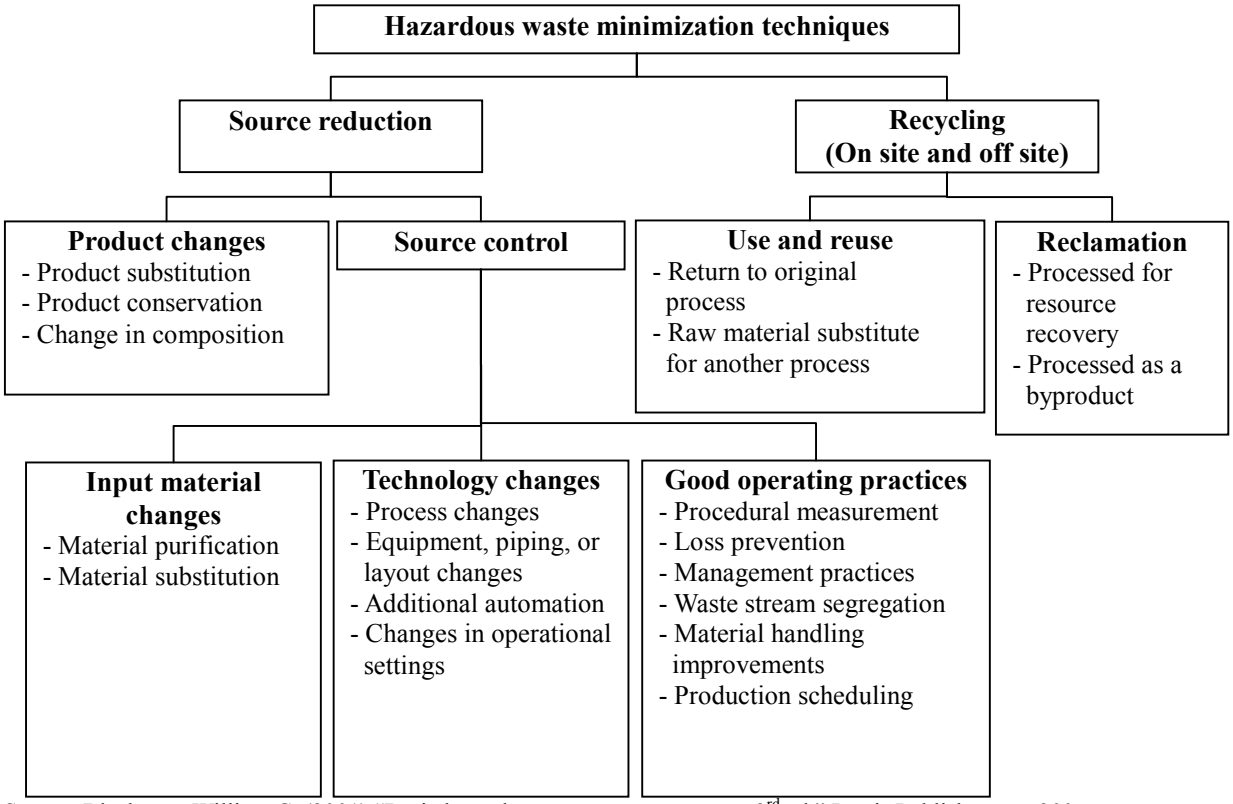
Table H.3.1 List of Hazardous Waste which Hanoi URENCO has License for Transportation, Treatment and Disposal (4/4)

No.	Name of hazardous waste	Status	Permitted quantity (kg/year)	Code of hazardous waste	Types of specialized vehicles and transportation plan	Specialized equipment and vehicles, plan for treatment and disposal	Treatment and disposal standard
20	Substances containing hazardous elements		20,000	020806, 021001, 030409, 030509, 070110, 140106, 190702	Packed in pp package or contained 200 liter drum. Transported by specialized close vehicle.	Chemical treatment and Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
21	Equipment, waste emission component containing hazardous elements		50,000	150109, 150214, 160113	Packed in pp package or contained in 200 liter drum. Transported by specialized close vehicle.	Washing, plastic and metal recovery. Waste water treatment.	TCVN 5945-2005 (Column B)
22	Leather dust		200,000	100102	Packed in pp package or contained in 200 liter drum. Transported by specialized close vehicle.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
23	Oil and hazardous contaminated metal waste		80,000	110401, 110402	Packed in contained 200 liter drum. Transported by specialized close vehicle	Washing, metal recovery. Clean water at standard level.	TCVN 5945-2005 (Column B)
24	Plant protection over stored or outdated		50,000	140104, 021101, 021102, 021103, 021104	Packed in contained 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
25	Waste package for plant protection		30,000	140105	Packed in contained 200 liter drum. Transported by specialized close vehicle or tank.	Incineration.	TCVN 5939-2005 TCVN 6560-1999 TCVN 7629-2007
26	Waste cleaning liquid contaminated with chemical substances		200,000	070106, 070203, 080104, 120703	Packed in contained 200 liter drum. Transported by specialized close vehicle.	Chemical treatment.	TCVN 5945-2005 (Column B)
27	Electric, electronic component		50,000	050214, 160113	Packed in contained 200 liter drum. Transported by specialized close vehicle.	Washing, metal recovery. Clean water at standard level.	TCVN 5945-2005 (Column B)
	TOTAL		**24,110,000**				

Source: License for transportation of hazardous waste (No.1-2-3-4-5-7.001.V)
License for treatment & disposal of hazardous waste (No.1-2-3-4-5-7.001.X)

3.4 GENERAL PRINCIPLE FOR HAZARDOUS WASTE MANAGEMENT

On the hazardous solid waste management, the first priority should be given to the reduction of hazardous waste generation by means of "clean technology". Changing the processes of production and the compositions of products are examples of such technology. The concept of hazardous waste minimization proposed by U.S. EPA is shown in Figure H.3.6. The second priority should be given to the recovery and recycle of generated hazardous solid waste. Here, hazardous waste generators should examine the possibility of utilizing potential hazardous waste in their production processes. Only after such efforts to reduce, recover and recycle hazardous waste, inevitably discharged hazardous waste should be treated appropriately by taking measures to prevent environmental pollution.



Source: Blackman, William C. (2001) "Basic hazardous waste management – 3rd ed." Lewis Publishers, pp.200.

Figure H.3.6 Hazardous Waste Minimization Techniques

With reference to hazardous waste treatment, off-site recovery and recycling should be considered at first and then measures for innocuous treatment and stabilization must be examined. For example, organic compounds can mainly be treated by thermo chemical process under appropriate condition and metals can be treated by recovery, recycling and/or solidification technology to achieve stabilization. And finally, the hazardous waste for which it is difficult to apply innocuous and stabilizing treatment, it must be stored and controlled strictly. At this stage, hazardous waste manifesto system has to be applied strictly. Table H.3.2 shows comparison of main hazardous waste treatment technology.

Table H.3.2 Comparison of Main Hazardous Waste Management Treatment Technology

	Incineration/ Thermal decomposition	Fusion (Melt)	Solidification/ Stabilization	Land filling/ Control
Elimination/attenuation effect of hazardous characteristics	Basically high	Very high	High for metals	Low for volatile matters Difficult for liquid
Applicable hazardous waste	Combustible waste oil Waste acid/alkali Trichloroethylene, etc. Infectious waste	Incineration fly ash of municipal solid waste Waste asbestos Infectious waste	Incineration fly ash of municipal solid waste Waste asbestos Waste containing heavy metals Waste acid/alkali (neutralization)	Treatment residuals Solidified/stabilized materials
Actual result/proof	Decomposition effect is not confirmed in a part of components	In the process of confirmation on actual result level	Many actual results except for chelates	Many example of practice
Possibility of material recovery	Energy and acid	Energy, metals and construction materials	Partially for construction materials	None
Cost for the present	Medium ~ High	Medium ~ High	Medium	Low ~ Medium
Affective environmental media	Atmosphere	Atmosphere	Surface and ground water	Surface and ground water
Problems	Confirmation of elimination rate is necessary. Substituting indicator is necessary. Attention to incomplete combustion products and sub-products	Difficulty in operation Safety measure for high temperature operation Integration to material recovery is desired	Imperfect prevention of liquation Weathering and depletion	Long term stability of construction Life span of liner
Inapplicable waste	In combustible organic materials Highly heavy metals concentrated waste	Almost applicable	Organic materials	Materials reactive with liner Toxic materials which are mobile, persistent and accumulative

Source: Takatsuki and Sakai (1993) "Hazardous waste – from the viewpoint of clean, cycle and control"
Chuo Shuppan co., ltd. (in Japanese)

SUPPORTING I

PROJECT IMPLEMENTATION PLAN

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CHAPTER 1 COST ESTIMATE

1.1 PROCUREMENT PACKAGE PLAN

The features of the Project are described in the associated chapters. The project is linear in nature, covers vast rural areas and requires huge earthmoving works of more than ten million cubic meters for land reclamation in coordination with the presently ongoing works in the Project area.

Considering these factors, along with its huge magnitude, limited accesses to the construction sites and the need for the speedy completion, implementation under one or two contracts packages seems to be non-feasible solution.

As a result, the packaging and programming of the works were carried out as an iterative process. The first step was to subdivide the overall scheme into elements and prioritize them based on the requirements.

Under the infrastructure scheme, the preliminary priority has been given to the following:

1) Connection of the roads should be made to the existing roads to facilitate the early start of infrastructural works that has been planned for later.
2) Drainage, water supply and sewerage.
3) Power supply and telecommunication.
4) Land reclamation.

Based on the above preliminary priority, the contract packages for the HHTP Development system were arranged into the following components:

Contract CP-1A	Major infrastructure development under local competitive bidding (LCB)	
	Road length:	20.5km 6 and 6 bridges
	Drainage pipe line	27.9km and Tan Xa Lake protection
	Water supply line	64.0km
	Sewerage collecting line	51.5km
	Telecommunication line	61.1km, 40m high antenna
Contract CP-1B	Zone land embankment under local competitive bidding (LCB)	
	Excavation:	1.0 million m^3
	Embankment:	10.1 million m^3
	(excluding road embankment section)	
Contract CP-2	Wastewater treatment plant under international competitive bidding (ICB)	
	Wastewater treatment plant:	36,000m^3/day
	(Conventional activated mechanical sludge process type)	
Contract CP-3	Power supply system under local competitive bidding (LCB)	
	Relocation of overhead transmission line:	5.1km
	Power transformer 63MVA:	3 units

On the other hand, the GOV is expected to arrange the internal transport system in the Park for the following:

Contract CP-4	Internal transport system under local competitive bidding (LCB)	
	Procurement of middle bus:	7 units
	Procurement of large bus:	27 units

1.2 PROJECT COST

1.2.1 Terms of Estimation

The estimates of the project cost were prepared through iterative process, based on the estimated unit costs and the following basic conditions:

a) Price level at the end of December 2008
Unit prices of construction resources were estimated based on the announcement of construction price index in the quarter-2, 2008.

b) Exchange rate
USD 1 = JPY 104.91

VND 1 = JPY 0.0064

c) Unit costs were mostly estimated on the basis of local currency. The portions of the estimated unit costs were allocated to 10% foreign currency and 90% local currency.
Unit cost of imported material and equipment/plant were estimated with reference to the prevailing cost in Japan and is allocated into 80% for foreign currency portion and 20% for local currency portion.

d) Import duties at the rate of 5% of CIF Hai Phong Port prices of the costs while procuring plants and equipment from abroad.

e) Tax for contract at the rate of 10% of the contract amount

f) Administration cost for the GOV was assumed to be 2% of the sum of direct construction cost and engineering service expenses.

g) Price escalations were assumed to be 1.7% for foreign currency and 7.4 % for local currency by referring to the similar projects in Vietnam and foregoing index in the second quarter of 2008.

h) Physical contingency is assumed to be 10 %.

i) Value Added Tax (VAT) is 10 % of full expenditure of Infrastructure scheme portion.

The estimates of the project cost excluding interests during construction were tentatively prepared through iterative process and the result of the project cost is summarized below:

Table I.1.1 Summary of Project Cost (Infrastructure Scheme Portion)

Component	Total (JPY)
I. Infrastructure Scheme Portion	
Project Direct Construction Cost	**31,041,941,000**
1)Price Escalation	18,306,981,000
2)Physical Contingency	4,934,892,000
Total Construction Cost	**54,283,814,000**
Engineering Service Fee	**3,540,387,000**
1)Price Escalation	995,601,000
2)Physical Contingency	453,599,000
Total Engineering Service Cost	**4,989,587,000**
Total of Infrastructure Scheme Portion	**59,273,401,000**

Source: JICA Study Team

Table I.1.2 Summary of Project Cost (Other scheme portion)

Component	Total (JPY)
II. Other scheme portion	
Internal Transport System (Procurement) CP-4	**348,000,000**
1)Price Escalation	246,266,000
2)Physical Contingency	59,427,000
Total Procurement Cost	**653,693,000**
1)Land Acquisition	4,480,000,000
2)Price Escalation	764,053,000
3)Physical Contingency	524,405,000
Total Land Acquisition Cost	**5,768,458,000**
1)Administration cost	1,185,468,000
2)VAT	5,927,340,000
3)Import Tax	578,161,000
Total of Other Scheme Portion	**14,113,119,000**
TOTAL PROJECT COST	**73,386,520,000**

Source: JICA Study Team

It is to be noted that the land acquisition and compensation cost were derived from the following sources:

- Approved amount for land acquisition project for HHTP Development by Ha-Tay province.
- Achieved compensation of land acquisition and re-settlement for HHTP Development.

1.3 CONSTRUCTION COST

During the feasibility study for Hoa Lac High-tech Park Development, estimates of the project costs were prepared by following the below three steps:

1) First step was to collect the following for the reference for cost data:
   - Guide for formulation and management of works construction investment expenditures published in July 2007.
   - Construction price index in Hanoi to estimate preliminary project cost and to review for cost estimate.
2) Second step was to prepare unit costs in compliance with set Vietnamese standard and criteria.
3) Third step to prepare project cost through iterative process.

In view of the lack of readily available data a considerable effort was made to collect and derive the base data. Such derived base data was used as the base for the cost estimate.

With an objective to estimate cost and collect cost data of wastewater treatment plant and optic fibre cables and antenna towers for telecommunication system, the approach were made not only to Vietnamese suppliers but also to foreign suppliers.

In order to find a practical cost so as to match with the maximum degree of accuracy as much as possible at this feasibility study level, unit cost analysis were attempted. This was done by referring to the collected and derived cost data from the recent tender documents of similar projects.

Lump sum costs were also estimated on the basis of the collected cost data, experiences, engineering judgement and standard criteria available in Japan. Based on the experiences, the

costs of preparatory works were estimated at 5% of the total expenditure combined with foreign currency and local currency portions of the direct construction cost.

The cost estimate of the above works were carried out by reviewing the cost with reference to the costs of similar projects and accordingly the estimated cost were arranged into the respective contract packages as discussed earlier.

As mentioned above, the construction costs are largely divided into two portions; one is Infrastructure scheme portion and other is other scheme portion. Further, the Infrastructure scheme portion was sub-divided into four (4) components, while other scheme portion was divided into two (2) components as mentioned below:

Table I.1.3 Construction Cost

Contract Package	Infrastructure	Cost (JPY)
I. Infrastructure Scheme Portion		
CP-1A	**Major infrastructure development**	
	1) Preparatory works	745,751,000
	2) Tan Xa Lake protection and green areas	109,266,000
	3) Road and transportation system	6,819,567,000
	4) Drainage system	2,307,005,000
	5) Water supply	884,045,000
	6) Sewerage	420,242,000
	7) Telecommunication	2,804,880,000
	8) Technical Ditch	1,570,020,000
	9) Soil Disposal	58,737,000
	Sub-total CP-1A	**15,719,513,000**
CP-1B	**Zone land embankment**	
	1) Preparatory works	330,743,000
	2) Land reclamation	6,614,845,000
	3) Soil Disposal	484,193,000
	Sub-total CP-1B	**7,429,781,000**
CP-2	**Wastewater treatment plant**	
	1) Preparatory works	181,244,000
	2) Sewerage treatment plant	3,624,872,000
	Sub-total CP-2	**3,806,116,000**
CP-3	**Power supply**	
	1) Preparatory works	194,597,000
	2) Power supply	3,891,934,000
	Sub-total CP-3	**4,086,531,000**
	Total (CP-1A, 1B, 2 and3)	**31,041,941,000**
II. Other Scheme Portion		
CP-4	**Internal transport system**	
	1) Procurement of middle bus	36,960,000
	2) Procurement of large bus	311,040,000
	Sub-total CP-4	**348,000,000**
Land Acquisition and compensation		**4,480,000,000**
	Total (CP-4, Land Acquisition)	**4,828,000,000**

Source: JICA Study Team

It is to be noted that cost data for the procurement of buses is based on the local competitive bidding and was collected from a supply based in Hanoi city in January 2009.

1.4 ENGINEERING SERVICE COST

Based on the implementation schedule, the proposed engineering services the cost estimate were prepared on the basis of following:

- Tentative Terms of Reference (TOR) for the engineering services were prepared based on the experience of past similar projects in Vietnam.
- The assignment schedule for engineering staff was prepared based on the construction time schedule.
- Billing rate was assumed from the rates commonly used for international aid projects in Vietnam.
- Technical assistance, so called soft components, was also included in the proposal so that the local government staff can not only be able to manage effectively the project Implementation and investment promotion but can also enhance coordination structure among HHTO-MB, developer and supplier.
- Considering the importance of this, it is strongly recommended that the Project Manager should be nominated for a full time position for the project during the implementation stage. This will allow him/her to assist and advise the local government staff to strengthen or capacity building in their respective organizations.

Summary of the assumed TOR is listed below:

Table I.1.4 Summary of Terms of Reference (TOR)

1.	**DESIGN STAGE**
A.	**STUDY REVIEW WORKS**
1.A.1	Review of Previous Related Studies
1.A.2	Review and Update Data
1.A.3	Preparation of Necessary Project Document
B.	**DETAILED DESIGN WORKS**
1.B.1	Field Investigation 1) Geotechnical Investigation 2) Water Quality Sampling Survey 3) Hydrological Analysis for 3 rivers (Dua Gai, Vuc Gang and Tich) 4) Inventory Survey for existing constructed work items 5) Properties Survey for compensation 6) Environmental Monitoring Survey
1.B.2	Determination of Design Standard and Criteria
1.B.3	Detailed Design Works
1.B.4	Bill of Quantity and Specifications
1.B.5	Construction Plan and Schedule
1.B.6	Cost Estimate
1.B.7	Pre-qualification Documents
1.B.8	Tender Documents
1.B.9	Environmental Monitoring and Management Program
C.	**TECHNICAL ASSISTANCE (SOFT COMPONENTS) during DESIGN STAGE**
1.C.1	Empowerment and Assistance for Project Implementation
1.C.2	Empowerment and Assistance for Investment Promotion
1.C.3	Enhancement of Coordination Structure of HHTP-MB, Developer and Supply
2.	**PRE-CONSTRUCTION STAGE**
2.1	Pre-Qualification
2.2	Assistance in Tender
2.3	Assistance in Contract Award
3.	**CONSTRUCTION SUPERVISION STAGE**
3.1	Preparatory Works/Mobilization
3.2	Preparation of Construction Drawings and Specifications
3.3	Check of the Contractor's Drawings and Specifications
3.4	Check of Construction Plan
3.5	Control of Quantity and Quality

3.6	Monitoring and Control of Work Progress
3.7	Environmental Monitoring during Construction Period
3.8	Control of Payment
3.9	Supervising Preparation of As-built Drawings and Completion Report
3.10	Supervising Preparation of Operation and Maintenance Manuals
3.11	Final Inspection and Completion Certificate
3.12	Assistance in Institutional Development
3.13	OJT based Transfer of Technical Knowledge

Source: JICA Study Team

In line with the assumed TOR as above, the competent engineers are required to provide input to each stage as mentioned below:

Table I.1.5 Assumed Required of Engineer's Inputs

Engineering Stage	Foreign Engineer (Man-Month)	Local Engineer (Man-Month)
1. Design Stage	206	352
2. Pre-Construction Stage	15	27
3. Construction Supervision Stage	350	2,074
4. Soft-Component Services	39	
5. Project Manager/Project Implementation Adviser	117	
TOTAL	**727**	**2,453**

Source: JICA Study Team

Based on the above assumption of requirement of competent engineers' input, the engineering service fees for design works, pre-construction and construction supervision were estimated in total to JPY 3.54 billion. This comprises about JPY 2.36 billion as foreign engineers' fee and JPY 1.18 billion as local engineers' fee. The total engineering fee corresponds to about 11.4% of the total direct construction cost.

1.5 IMPLEMENTATION SCHEDULE

The project duration has been set for ten years with a starting date of January 2011 for the preparation of detail design. This time has been set considering the requirements of time for project loan procedure, procedures for selection of consultant and contractors, and earthmoving works of more than ten million cubic meters for land reclamation.

Presently, five access roads were considered available and passable to the earthmoving fleets surrounding the private lands. Though, heavy earthmoving fleets were preferred for such large quantities of land reclamation works, but the existing bridges across these access roads appear that they would not be able to bear any heavy loads of more than 20 ton. Thus, considering this the combination of equipment with medium loading and hauling capacity will need to be adopted for use.

This preliminary ranking gave priority to the access to the infrastructure construction sites in coordination with the ongoing works in the Project area as mentioned above.

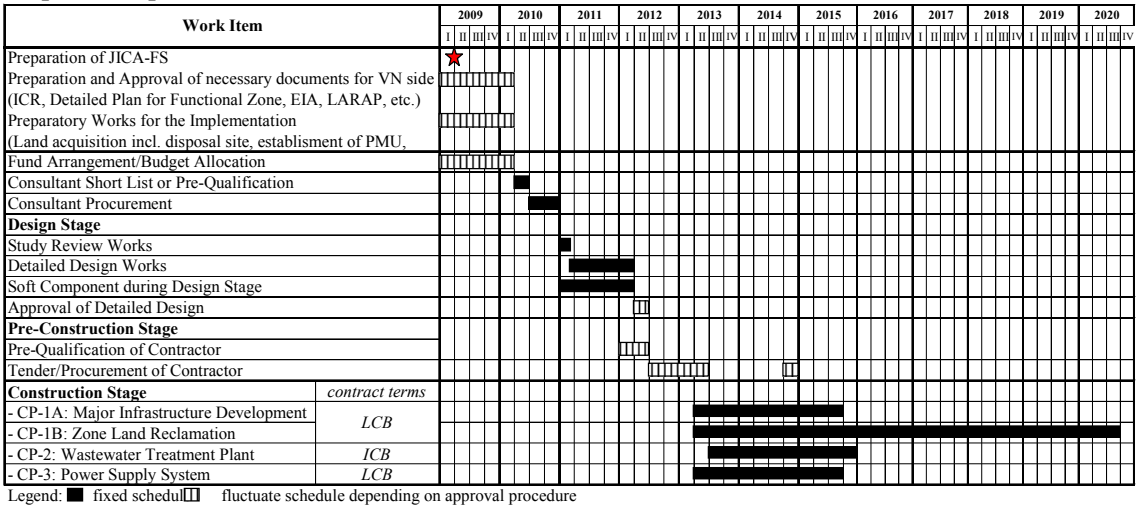
Considering all of the conditions above, but not limited to, it was tentatively envisaged that the stages of the detailed design, pre-construction bidding and construction would be implemented during the following periods:

- Detailed design from January 2011 till end of March 2012
- Pre-qualification and bidding from January 2012 till end of June 2013
- Construction from April 2013 till end of the year 2020

From the available past rainfall data ranging from 1975 to 1985 as collected from Ba Tha rainfall gauging station, the annual workable days for the earthmoving works less than 3mm amount of daily rainfall works out to be approximately 240 days. In the rainy season dump trucks for hauling soil materials to the land reclamation sites are assumed to be subjected to uncertain floundering to a standstill or little progress. In principle, the working hours were set 8 hours per day and 48 hours per week. Work period for land preparation work, which is mainly soil transportation from the outside is estimated based on the following condition.

- Volume of move soil: 10,240,000m^3
- Work day: 240 day/year
- Working hours: 8 hr/day
- Work car (20 ton): 36 car/day
- Move volume each car: 10 m^3/car
- Trip 2 times/hr
- Work year 7.5 years

Proposed implementation schedule is shown below.



Legend: ■ fixed schedul▯ fluctuate schedule depending on approval procedure
sources: JICA Study Team

Figure I.1.1 Proposed Implementation Schedule

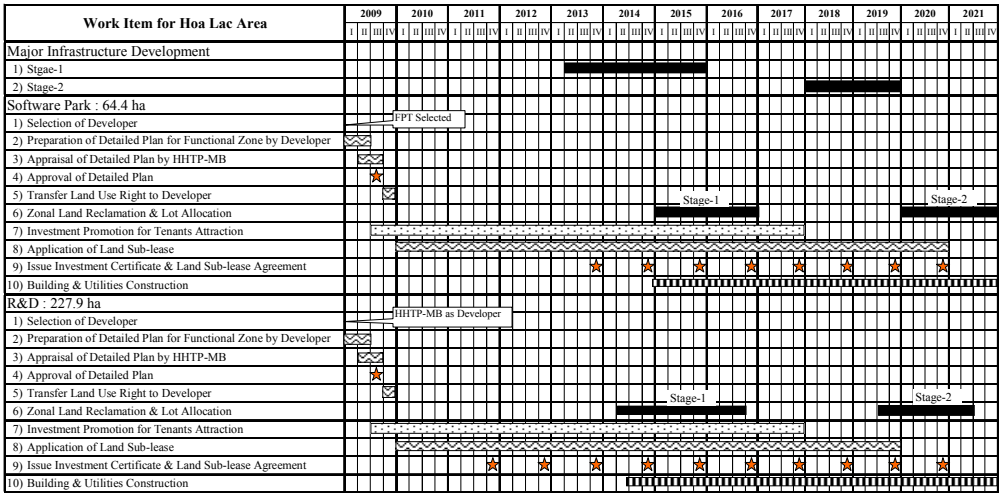


Figure I.1.2 Proposed Functional Zone Development Schedule of Hoa Lac Area (1/2)

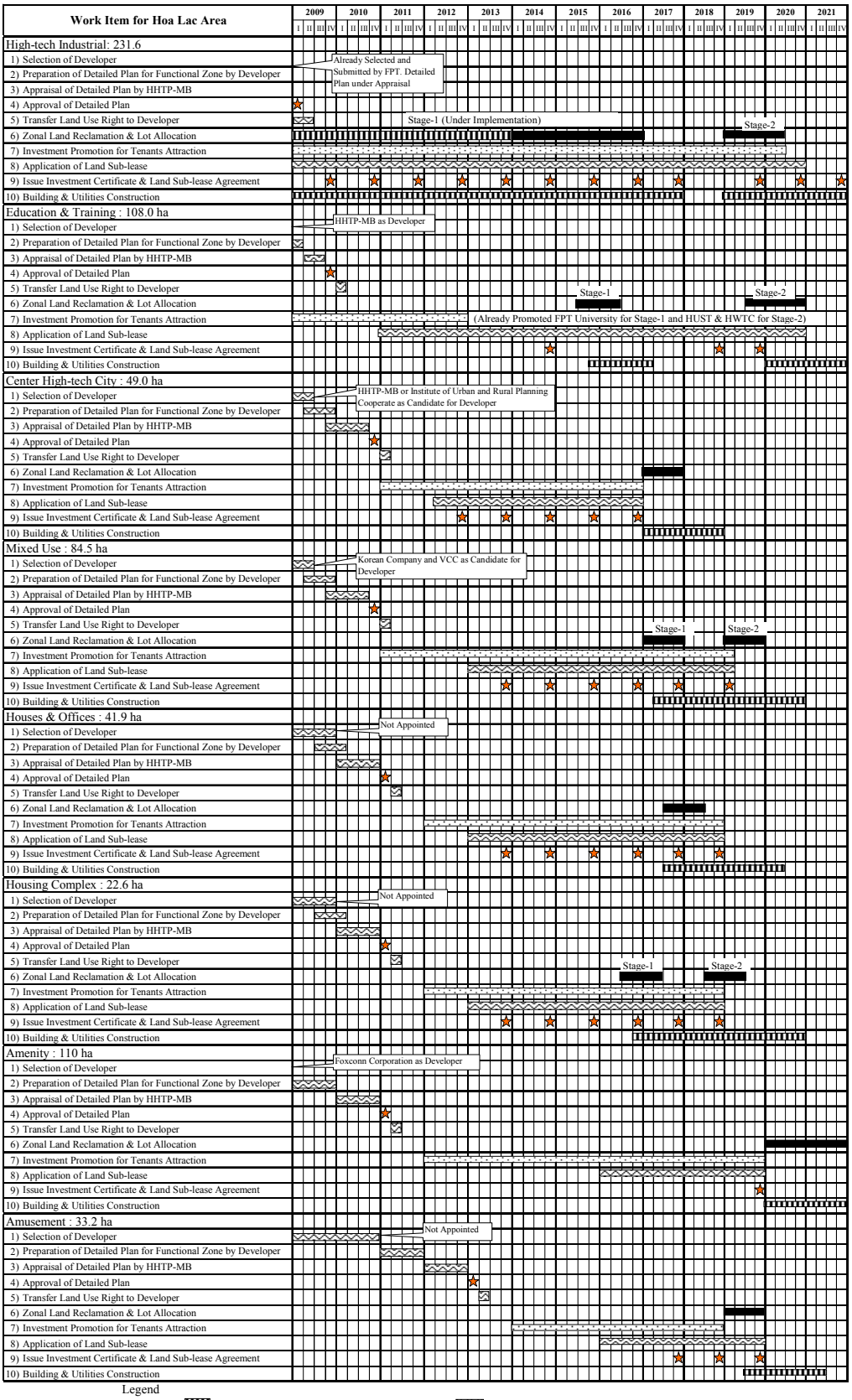


Figure I.1.2 Proposed Functional Zone Development Schedule of Hoa Lac Area (2/2)

CHAPTER 2 FINANCIAL EVALUATION

2.1 GENERAL

Financial evaluation is conducted to examine financial viability of the project and also to examine expected cost and revenue in order to secure sustainability of HHTP operation, and for the HHTP-MB to be able to consider their financial plan including subsidy to be proposed to the government. The result of financial evaluation is shown in the form of "Financial Internal Rate of Return (FIRR)", B-C, B/C and "cash flow table".

Financial evaluation is generally conducted from the point of view of a project. For the case of the HHTP development, the implementing agency is the HHTP-MB. However, as there is no clear regulation regarding rate of fees (land lease, O&M), cost recovery, and demarcation of revenue between the HHTP-MB and developers, the financial evaluation is conducted from the point of view of implementing agency which is the HHTP-MB.

It is also important to know that since the HHTP-MB is a governmental organization the HHTP-MB is not allowed to make profit from HHTP operation. In case the profit is made, the HHTP-MB has to return the profit to the GOV.

2.2 METHODOLOGY OF FINANCIAL EVALUATION

2.2.1 Basic Assumption for Financial Evaluation

Since cost recovery policy has not been decided, financial evaluation were conducted for two cases, particularly for cash flow analysis as shown below.

Case 1: **Cost recovery of investment is not considered**, that is, investment cost is not covered by operation revenue. Financial analysis is conducted for operation revenue and O&M and administration cost.

Case 2: **Cost recovery of investment is considered**, that is, investment cost is integrated in the financial evaluation.

2.2.2 Revenue Calculation

(1) Operation revenue

Based on industrial estate management in Vietnam and management strategy of the HHTP-MB, operation revenue needed for HHTP operation are defined by following two items.

- **Land lease (infrastructure use fee)**: collected from tenant and developer for using HHTP infrastructure. The HHTP-MB has a plan to charge land lease so as to provide infrastructure in HHTP. Since land lease can be paid through one time payment or installment payment, for financial evaluation installment payment is applied.
- **O&M fee (infrastructure management fee)**: charged for use of O&M of basic infrastructure in HHTP. Main infrastructure that the HHTP-MB has to maintain is road, drainage, waste water treatment plant, and common space (green area).

(2) Presumption of revenue calculation

Since regulation on financial arrangement has not been finalized, presumption is set for revenue calculation. Expected revenue from HHTP operation is calculated based on the following presumptions.

General presumption

- The area covered for revenue calculation is 1,036ha in the Hoa Lac area, which is equivalent to the Study Area.
- Revenue is calculated separately for the zones to be developed by HHTP-MB and private developers. This is mainly because of difference in land lease rate, fee collection mechanism and implementation schedule.
- Land lease from zones to be developed by the HHTP-MB will be transferred to the HHTP-MB from tenants directly. Land lease from zones to be developed by developer will be transferred from developer to HHTP-MB after the deduction of developer's share from the land lease as collected from tenants.
- For the calculation of HHTP-MB revenue, it is assumed that 20% of the land lease in the zones to be developed by private developer is transferred to the HHT-MB (estimated based on the information in JICA Updated M/P). Following figure shows revenue mechanism assumed for financial evaluation.

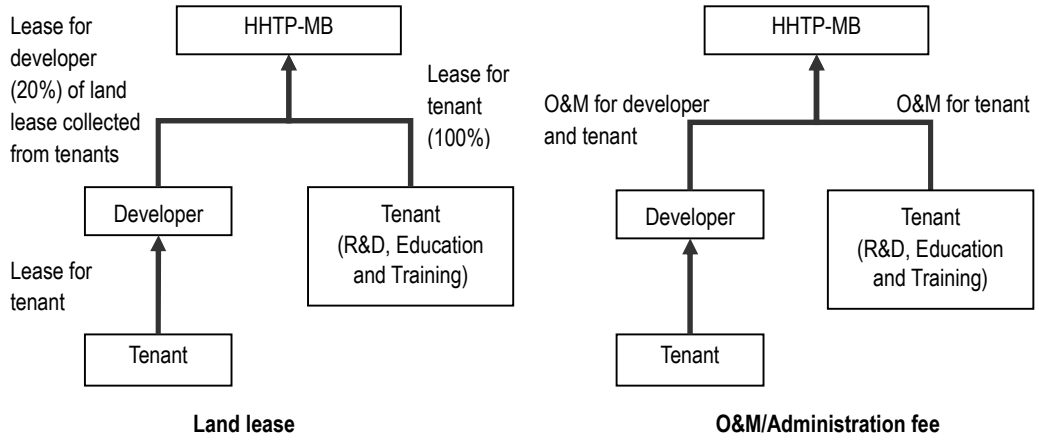


Figure I.2.1 Revenue Collection Mechanism

- Revenue generation schedule is calculated based on land reclamation schedule, that is, when tenants can start their operation in the land reclaimed area or in other words after the completion of land reclamation.
  - For zones to be developed by the HHTP-MB, land reclamation is scheduled from 2014 to 2021, so the operation of tenants expects to start after 2014.
  - For zones to be developed by private developer, land reclamation is assumed to be completed by 2018. As of 2009, a part of land has already been prepared, so tenants can start operation from 2010. Following table shows assumption for land reclamation schedule.

Table I.2.1 Assumption of Land Reclamation Schedule

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
(i) Area to be developed by HHTP-MB												
Area to be developed (%)	-	-	-	-	13	13	13	13	13	13	13	13
Cumulative (%)	-	-	-	-	13	25	38	50	63	75	88	100
Area to be developed (ha)	-	-	-	-	39.9	79.9	119.8	159.7	199.6	239.6	279.5	319.4
(ii) Area to be developed by Private												
Area to be developed (%)	6	6	13	13	13	13	13	13	13	-	-	-
Cumulative (%)	6	12	25	38	50	63	75	88	100	-	-	-
Area to be developed (ha)	21.1	42.3	88.0	132.1	176.1	220.1	264.1	308.1	352.2	-	-	-

Calculation of area where land lease can be charged

- Among the land use plan, the area occupied by the infrastructure, lake, buffer zone, green/tree has been deducted from revenue generating area as lease fee can not be charged for these areas.
- Among the total area to be developed for each zone, 10% of the area is deducted as infrastructure and common area where lease can not be charged. Following table shows the result of assumption of those areas from which lease can be charged.

Table I.2.2 Assumption for Area that Lease can be Charged

	Area by Zone (Hoa Lac Area) (ha)		
	Total Area	**Zone Can be Leased**	**Area Can Charge Lease**
1 Zone to be developed by HHTP-MB			
1-1 R&D	227.9	227.9	205.1
1-2 Education and training	78.0	78.0	70.2
1-3 Center for High-Tech City (Start up center)	49.0	49.0	44.1
1-4 Infrastructure	146.6	0.0	0.0
1-5 Lake and buffer (including Tan Xa & canal)	112.4	0.0	0.0
1-6 Green/Tree	30.8	0.0	0.0
Sub-Total	**644.7**	**354.9**	**319.4**
2 Zone to be developed by private developer			
2-1 Software park	64.4	64.4	58.0
2-2 High-tech industry	114.7	114.7	103.2
2-3 Education and training (30ha)	30.0	30.0	27.0
2-4 Mixed use	84.5	84.5	76.1
2-5 Houses & Offices	41.9	41.9	37.7
2-6 Housing complex	22.6	22.6	20.3
2-7 Amenity	0.0	0.0	0.0
2-8 Amusement	33.2	33.2	29.9
Sub-Total	**391.3**	**391.3**	**352.2**
Total	**1,036.0**	**746.2**	**671.6**

Source: JICA Study Team

Fees calculation

- Land lease were calculated by referring to current applicable land lease in the industrial estate in Hanoi and surrounding areas and to the contract term between developer and tenants in HHTP. The land lease is set low compared with the rate charged to other industrial estate in order for HHTP to be competitive to attract investors. Land lease ranges from USD 0.4/m^2/year to USD 1.4m^2/year. Considering the location of HHTP, the land lease has to be kept lower than USD 1/m^2/year.
- O&M fee is calculated at 15% of land lease by referring to land lease in the industrial estate in Hanoi and surrounding areas. Since price escalation affects the cost of O&M, price escalation is applied at annual rate of 7.4% for every five (5) years.
- The fees used for financial evaluation is listed in the table below.

Table I.2.3 Estimated Fees

	Zones to be developed by Private Developer	**Zones to be developed by HHTP-MB**
Land lease	USD 0.80/m^2/year (20% of lease considered HHTP-MB revenue)	USD 0.60/m^2/year
O&M fee (infrastructure management)	USD 0.12/m^2/year USD 0.13/m^2/year (after 05 years) USD 0.14/m^2/year (after 10 years) USD 0.15/m^2/year (after 15 years) USD 0.16/m^2/year (after 20 years)	USD 0.09/m^2/year USD 0.10/m^2/year (after 05 years) USD 0.11/m^2/year (after 10 years) USD 0.12/m^2/year (after 15 years) USD 0.13/m^2/year (after 20 years)

Source: JICA Study Team

2.2.3 Cost Calculation

(1) Operating cost

Costs are calculated by applying a ratio of construction cost and revenue. The operating cost required for HHTP operation is shown below.

- **O&M cost (Operation and Maintenance) for basic infrastructure**: the cost required for operating and maintaining basic infrastructure including roads, common space and sewerage treatment plant, lights, drainage, and other infrastructure.
- **HHTP-MB management cost**: The cost is required for the HHTP-MB facility maintenance, HHTP-MB staff, and activity including human resources development and support for science and research activity such as Start-Up Center.

(2) Presumption of cost calculation

Expected revenue from HHTP operation is calculated based on the following condition.

1) O&M cost is calculated by applying a ratio of the construction cost which was already developed by the HHTP-MB and to be developed by ODA. Since price escalation affects the cost of O&M, price escalation is applied at annual rate of 7.4% for every five (5) years.
   - O&M cost of basic infrastructure is calculated at 0.5% of investment cost. Such rate is usually applied for O&M of infrastructure (same rate is used in JICA Updated M/P).
     - O&M cost for the portion to be developed by ODA is calculated based on the

construction cost JPY 31.0 billion (USD 295.9 million) which is calculated in the Study.

- ・ O&M for the portion that HHTP-MB has constructed is calculated based on cumulative expenses until 2008. HHTP-MB has already spent about VND 1,000 billion (USD 60 million) for the infrastructure and the necessary studies required for the development of HHTP.

- O&M cost of wastewater treatment plant is calculated at 2% of construction cost. Such rate is usually applied for O&M of wastewater treatment plant.
- HHTP-MB management cost is calculated based on the HHTP-MB budget. In 2007, approximately VND 8,280 million (USD 500,000) is spent on the HHTP-MB management and considering the in future HHTP will be developed, it has to be increased.

2) O&M cost is required as infrastructure is developed.

- O&M of ODA portion of the construction cost is calculated based on implementation schedule. A part of O&M will be required from 2014 onwards. From 2021 onwards when construction is expected to be competed, full O&M is required.
- O&M of the HHTP-MB portion of construction assumes to start from 2010 as some of the infrastructure has already been constructed.

3) ODA loan condition is calculated based on Yen loan condition, which is assumed as shown below.

- Interest rate: 1.3%
- Loan periods: 30 years
- Grace period: 10 years (It is to be noted that the interest payment shall be made during the loan period)
- Total loan amount is estimated to be JPY 34.5 billion (USD 329.6 million) which is consist of JPY 31.0 billion (USD 295.9 million) for construction and JPY 3.5 billion (USD 33.7 million) for Engineering Service. This amount along with the land acquisition and compensation amount (JPY 4.5 billion or USD 42 million) has been used as ODA portion of investment cost for FIRR analysis.

2.3 FINANCIAL INTERNAL RATE OF RETURN (FIRR) ANALYSIS

Based on the cost and revenue calculated above, price escalation has been deducted for FIRR calculation. FIRR can not be calculated. FIRR calculation result is shown in the table below.

Net Present Value (NPV) analysis is also conducted. NPV calculated at discount rate of 4.15% (2007 Treasury Bill Rate). NPV of cost and revenue is USD 389 million (JPY 40.9 billion) and USD 42 million (JPY 4.4 billion), respectively. B-C is USD -347 million (JPY 36.4 billion) and B/C is 0.11.

Table I.2.4 FIRR and NPV

(US$ 1000)

	Cost				Revenue	Profit/Loss
Year	Investment	O&M	Administration	Total Cost		
~2009	60,339	353	500	61,192	0	-61,192
2010	34,163	353	500	35,016	59	-34,956
2011	8,541	353	500	9,394	118	-9,275
2012	8,436	353	500	9,289	247	-9,042
2013	3,374	353	500	4,227	370	-3,858
2014	82,498	831	500	83,828	769	-83,060
2015	108,142	1,559	500	110,200	1,167	-109,033
2016	89,626	2,209	500	92,336	1,566	-90,770
2017	10,219	2,255	500	12,974	1,965	-11,009
2018	10,219	2,301	500	13,020	2,364	-10,657
2019	10,219	2,347	500	13,066	2,639	-10,427
2020	10,219	2,393	500	13,112	2,915	-10,198
2021	0	2,393	500	2,893	3,190	297
2022	0	2,393	500	2,893	3,190	297
2023	0	2,393	500	2,893	3,190	297
2024	0	2,393	500	2,893	3,190	297
2025	0	2,393	500	2,893	3,190	297
2026	0	2,393	500	2,893	3,190	297
2027	0	2,393	500	2,893	3,190	297
2028	0	2,393	500	2,893	3,190	297
2029	0	2,393	500	2,893	3,190	297
2030	0	2,393	500	2,893	3,190	297
2031	0	2,393	500	2,893	3,190	297
2032	0	2,393	500	2,893	3,190	297
2033	0	2,393	500	2,893	3,190	297
2034	0	2,393	500	2,893	3,190	297
2035	0	2,393	500	2,893	3,190	297
2036	0	2,393	500	2,893	3,190	297
2037	0	2,393	500	2,893	3,190	297
2038	0	2,393	500	2,893	3,190	297
2039	0	2,393	500	2,893	3,190	297
2040	0	2,393	500	2,893	3,190	297
2041	0	2,393	500	2,893	3,190	297
2042	0	2,393	500	2,893	3,190	297
2043	0	2,393	500	2,893	3,190	297
2044	0	2,393	500	2,893	3,190	297
2045	0	2,393	500	2,893	3,190	297
2046	0	2,393	500	2,893	3,190	297
2047	0	2,393	500	2,893	3,190	297
2048	0	2,393	500	2,893	3,190	297
2049	0	2,393	500	2,893	3,190	297
Total	435,994	85,065	20,500	541,559	106,688	—
NPV				389,680	42,372	
Discount rate	4.15%				IRR	—
					B-C	-347,309
					B/C	0.11

2.4 CASH FLOW ANALYSIS

Based on the condition as mentioned above, cash flow analysis was conducted. Cash flow has been conducted for 40 year period which is a typical contract period of typical industrial estate. The result of cash flow analysis is summarized below.

(1) Cash flow without investment cost recovery

- Expected revenue is around USD 3.5 million when HHTP is in full operation. The cost, however, becomes higher because price escalation has to be integrated. Considering that the lease rate has to be kept low for strategic reasons, it is difficult to raise land lease. Thus, land lease can not be raised to cover O&M cost and price escalation. As a result, loss becomes bigger each year.
- In order for the HHTP-MB to conduct an appropriate level of O&M, government funds, such as subsidy needs to be allocated to cover the O&M cost.

(2) Cash flow with investment cost recovery

- Revenue is limited so the revenue can not cover investment cost.
- Loan repayment is summarized as follows. During the grace period, interest payment is USD 4.3 million/year. When capital payment starts, loan payment will increase to USD 18.8 million/year. Considering annual revenue is around USD 3.5 million which should also cover O&M cost, loan payment by HHTP operation revenue is difficult.
- In order for the cash balance to improve, the GOV also has to consider allocating fund for construction of infrastructure development, which will reduce burden of interest payment of ODA loan.

Table I.2.5 Cash Flow Table (1/2)

(US$)

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
1	**Revenue**																				
	1.1 Zone to be developed by private developer																				
	1.1.1 Land lease (infrastructure use fee)	169,000	338,000	704,000	1,057,000	1,409,000	1,761,000	2,113,000	2,465,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000
	1.1.2 O&M fee (infrastructure management)	25,000	51,000	106,000	158,000	227,000	284,000	340,000	397,000	454,000	488,000	488,000	488,000	488,000	488,000	524,000	524,000	524,000	524,000	524,000	563,000
	Total Revenue from Zone by private developer	194,000	389,000	810,000	1,215,000	1,636,000	2,045,000	2,453,000	2,862,000	3,271,000	3,305,000	3,305,000	3,305,000	3,305,000	3,305,000	3,341,000	3,341,000	3,341,000	3,341,000	3,341,000	3,380,000
	Revenue to be transferred to HHTP-MB	**59,000**	**119,000**	**247,000**	**369,000**	**509,000**	**636,000**	**763,000**	**890,000**	**1,017,000**	**1,051,000**	**1,051,000**	**1,051,000**	**1,051,000**	**1,051,000**	**1,087,000**	**1,087,000**	**1,087,000**	**1,087,000**	**1,087,000**	**1,126,000**
	1.2 Zone to be developed by HHTP-MB																				
	1.2.1 Land lease (infrastructure use fee)	0	0	0	0	240,000	479,000	719,000	958,000	1,198,000	1,437,000	1,677,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000
	1.2.2 O&M fee (infrastructure management)	0	0	0	0	39,000	77,000	116,000	154,000	193,000	249,000	290,000	332,000	332,000	332,000	357,000	357,000	357,000	357,000	357,000	383,000
	Total Revenue from Zone by HHTP-MB	**0**	**0**	**0**	**0**	**279,000**	**556,000**	**835,000**	**1,112,000**	**1,391,000**	**1,686,000**	**1,967,000**	**2,248,000**	**2,248,000**	**2,248,000**	**2,273,000**	**2,273,000**	**2,273,000**	**2,273,000**	**2,273,000**	**2,299,000**
2	**Operation Cost**																				
	2.1 O&M of basic infrastructure																				
	2.1.1 O&M of infrastructure (road, open space)	285,000	285,000	285,000	285,000	663,000	1,134,000	1,520,000	1,570,000	1,619,000	1,792,000	1,845,000	1,845,000	1,845,000	1,845,000	1,981,000	1,981,000	1,981,000	1,981,000	1,981,000	2,127,000
	2.1.2 O&M of utility (wastewater treatment plant)	68,000	68,000	68,000	68,000	229,000	541,000	852,000	852,000	852,000	915,000	915,000	915,000	915,000	915,000	983,000	983,000	983,000	983,000	983,000	1,056,000
	Total O&M cost	353,000	353,000	353,000	353,000	892,000	1,675,000	2,372,000	2,422,000	2,471,000	2,707,000	2,760,000	2,760,000	2,760,000	2,760,000	2,964,000	2,964,000	2,964,000	2,964,000	2,964,000	3,183,000
	2.2 HHTP-MB management	**500,000**	**537,000**	**577,000**	**620,000**	**666,000**	**715,000**	**768,000**	**825,000**	**886,000**	**952,000**	**1,022,000**	**1,098,000**	**1,179,000**	**1,266,000**	**1,360,000**	**1,461,000**	**1,569,000**	**1,685,000**	**1,810,000**	**1,944,000**
	Total Operation Cost	**853,000**	**890,000**	**930,000**	**973,000**	**1,558,000**	**2,390,000**	**3,140,000**	**3,247,000**	**3,357,000**	**3,659,000**	**3,782,000**	**3,858,000**	**3,939,000**	**4,026,000**	**4,324,000**	**4,425,000**	**4,533,000**	**4,649,000**	**4,774,000**	**5,127,000**
4	**Financial Condition of the HHTP-MB (without loan)**																				
	(1) Revenue	59,000	119,000	247,000	369,000	788,000	1,192,000	1,598,000	2,002,000	2,408,000	2,737,000	3,018,000	3,299,000	3,299,000	3,299,000	3,360,000	3,360,000	3,360,000	3,360,000	3,360,000	3,425,000
	(2) Cost	853,000	890,000	930,000	973,000	1,558,000	2,390,000	3,140,000	3,247,000	3,357,000	3,659,000	3,782,000	3,858,000	3,939,000	4,026,000	4,324,000	4,425,000	4,533,000	4,649,000	4,774,000	5,127,000
	(3) Profit/Loss	-794,000	-771,000	-683,000	-604,000	-770,000	-1,198,000	-1,542,000	-1,245,000	-949,000	-922,000	-764,000	-559,000	-640,000	-727,000	-964,000	-1,065,000	-1,173,000	-1,289,000	-1,414,000	-1,702,000
	(4) Cumulative profit/loss	-794,000	-1,565,000	-2,248,000	-2,852,000	-3,622,000	-4,820,000	-6,362,000	-7,607,000	-8,556,000	-9,478,000	-10,242,000	-10,801,000	-11,441,000	-12,168,000	-13,132,000	-14,197,000	-15,370,000	-16,659,000	-18,073,000	-19,775,000
5	**Loan payment**																				
	Interest payment		4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,096,251	3,904,798	3,710,856	3,514,394	3,315,377	3,113,772	2,909,547	2,702,667
	Capital payment		0	0	0	0	0	0	0	0	0	0	14,538,142	14,727,137	14,918,590	15,112,532	15,308,995	15,508,012	15,709,616	15,913,841	16,120,721
	Total payment		4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	4,285,247	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388
6	**Cash Balance with loan repayment**	-794,000	-5,056,247	-4,968,247	-4,889,247	-5,055,247	-5,483,247	-5,827,247	-5,530,247	-5,234,247	-5,207,247	-5,049,247	-19,382,388	-19,463,388	-19,550,388	-19,787,388	-19,888,388	-19,996,388	-20,112,388	-20,237,388	-20,525,388
7	**Government budget allocation (annual)**	794,000	5,056,247	4,968,247	4,889,247	5,055,247	5,483,247	5,827,247	5,530,247	5,234,247	5,207,247	5,049,247	19,382,388	19,463,388	19,550,388	19,787,388	19,888,388	19,996,388	20,112,388	20,237,388	20,525,388
	Government budget allocation (cumulative)	794,000	5,850,247	10,818,493	15,707,740	20,762,987	26,246,234	32,073,480	37,603,727	42,837,974	48,045,220	53,094,467	72,476,855	91,940,244	111,490,632	131,278,020	151,166,409	171,162,797	191,275,185	211,512,574	232,037,962

Table I.2.5 Cash Flow Table (2/2)

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
1	**Revenue**																				
	1.1 Zone to be developed by private developer																				
	1.1.1 Land lease (infrastructure use fee)	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000	2,817,000
	1.1.2 O&M fee (infrastructure management)	563,000	563,000	563,000	563,000	605,000	605,000	605,000	605,000	605,000	650,000	650,000	650,000	650,000	650,000	698,000	698,000	698,000	698,000	698,000	750,000
	Total Revenue from Zone by private developer	3,380,000	3,380,000	3,380,000	3,380,000	3,422,000	3,422,000	3,422,000	3,422,000	3,422,000	3,467,000	3,467,000	3,467,000	3,467,000	3,467,000	3,515,000	3,515,000	3,515,000	3,515,000	3,515,000	3,567,000
	Revenue to be transferred to HHTP-MB	**1,126,000**	**1,126,000**	**1,126,000**	**1,126,000**	**1,168,000**	**1,168,000**	**1,168,000**	**1,168,000**	**1,168,000**	**1,213,000**	**1,213,000**	**1,213,000**	**1,213,000**	**1,213,000**	**1,261,000**	**1,261,000**	**1,261,000**	**1,261,000**	**1,261,000**	**1,313,000**
	1.2 Zone to be developed by HHTP-MB																				
	1.2.1 Land lease (infrastructure use fee)	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000	1,916,000
	1.2.2 O&M fee (infrastructure management)	383,000	383,000	383,000	383,000	411,000	411,000	411,000	411,000	411,000	441,000	441,000	441,000	441,000	441,000	474,000	474,000	474,000	474,000	474,000	509,000
	Total Revenue from Zone by HHTP-MB	**2,299,000**	**2,299,000**	**2,299,000**	**2,299,000**	**2,327,000**	**2,327,000**	**2,327,000**	**2,327,000**	**2,327,000**	**2,357,000**	**2,357,000**	**2,357,000**	**2,357,000**	**2,357,000**	**2,390,000**	**2,390,000**	**2,390,000**	**2,390,000**	**2,390,000**	**2,425,000**
2	**Operation Cost**																				
	2.1 O&M of basic infrastructure																				
	2.1.1 O&M of infrastructure (road, open space)	2,127,000	2,127,000	2,127,000	2,127,000	2,284,000	2,284,000	2,284,000	2,284,000	2,284,000	2,453,000	2,453,000	2,453,000	2,453,000	2,453,000	2,634,000	2,634,000	2,634,000	2,634,000	2,634,000	2,829,000
	2.1.2 O&M of utility (wastewater treatment plant)	1,056,000	1,056,000	1,056,000	1,056,000	1,134,000	1,134,000	1,134,000	1,134,000	1,134,000	1,218,000	1,218,000	1,218,000	1,218,000	1,218,000	1,308,000	1,308,000	1,308,000	1,308,000	1,308,000	1,405,000
	Total O&M cost	3,183,000	3,183,000	3,183,000	3,183,000	3,418,000	3,418,000	3,418,000	3,418,000	3,418,000	3,671,000	3,671,000	3,671,000	3,671,000	3,671,000	3,942,000	3,942,000	3,942,000	3,942,000	3,942,000	4,234,000
	2.2 HHTP-MB management	**2,088,000**	**2,243,000**	**2,409,000**	**2,587,000**	**2,778,000**	**2,984,000**	**3,205,000**	**3,442,000**	**3,697,000**	**3,971,000**	**4,265,000**	**4,581,000**	**4,920,000**	**5,284,000**	**5,675,000**	**6,095,000**	**6,546,000**	**7,030,000**	**7,550,000**	**8,109,000**
	Total Operation Cost	**5,271,000**	**5,426,000**	**5,592,000**	**5,770,000**	**6,196,000**	**6,402,000**	**6,623,000**	**6,860,000**	**7,115,000**	**7,642,000**	**7,936,000**	**8,252,000**	**8,591,000**	**8,955,000**	**9,617,000**	**10,037,000**	**10,488,000**	**10,972,000**	**11,492,000**	**12,343,000**
4	**Financial Condition of the HHTP-MB (without loan)**																				
	(1) Revenue	3,425,000	3,425,000	3,425,000	3,425,000	3,495,000	3,495,000	3,495,000	3,495,000	3,495,000	3,570,000	3,570,000	3,570,000	3,570,000	3,570,000	3,651,000	3,651,000	3,651,000	3,651,000	3,651,000	3,738,000
	(2) Cost	5,271,000	5,426,000	5,592,000	5,770,000	6,196,000	6,402,000	6,623,000	6,860,000	7,115,000	7,642,000	7,936,000	8,252,000	8,591,000	8,955,000	9,617,000	10,037,000	10,488,000	10,972,000	11,492,000	12,343,000
	(3) Profit/Loss	-1,846,000	-2,001,000	-2,167,000	-2,345,000	-2,701,000	-2,907,000	-3,128,000	-3,365,000	-3,620,000	-4,072,000	-4,366,000	-4,682,000	-5,021,000	-5,385,000	-5,966,000	-6,386,000	-6,837,000	-7,321,000	-7,841,000	-8,605,000
	(4) Cumulative profit/loss	-21,621,000	-23,622,000	-25,789,000	-28,134,000	-30,835,000	-33,742,000	-36,870,000	-40,235,000	-43,855,000	-47,927,000	-52,293,000	-56,975,000	-61,996,000	-67,381,000	-73,347,000	-79,733,000	-86,570,000	-93,891,000	-101,732,000	-110,337,000
5	**Loan payment**																				
	Interest payment	2,493,098	2,280,804	2,065,751	1,847,901	1,627,220	1,403,670	1,177,214	947,813	715,431	480,027	241,564									
	Capital payment	16,330,290	16,542,584	16,757,638	16,975,487	17,196,168	17,419,718	17,646,175	17,875,575	18,107,957	18,343,361	18,581,825									
	Total payment	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388	18,823,388									
6	**Cash Balance with loan repayment**	-20,669,388	-20,824,388	-20,990,388	-21,168,388	-21,524,388	-21,730,388	-21,951,388	-22,188,388	-22,443,388	-22,895,388	-23,189,388	-4,682,000	-5,021,000	-5,385,000	-5,966,000	-6,386,000	-6,837,000	-7,321,000	-7,841,000	-8,605,000
7	**Government budget allocation (annual)**	20,669,388	20,824,388	20,990,388	21,168,388	21,524,388	21,730,388	21,951,388	22,188,388	22,443,388	22,895,388	23,189,388	4,682,000	5,021,000	5,385,000	5,966,000	6,386,000	6,837,000	7,321,000	7,841,000	8,605,000
	Government budget allocation (cumulative)	252,707,350	273,531,738	294,522,127	315,690,515	337,214,903	358,945,292	380,896,680	403,085,068	425,528,456	448,423,845	471,613,233	476,295,233	481,316,233	486,701,233	492,667,233	499,053,233	505,890,233	513,211,233	521,052,233	529,657,233

2.5 CONCLUSION

Conclusion for financial evaluation is summarized below.

- Since land lease has to be kept low to maintain competitiveness and to attract investors, revenue is limited. As the result the generated revenue will not be able to cover O&M cost and investment cost. The HHTP development should be financed by the GOV fund including finance by ODA assistance.
- The government subsidy is needed to support the O&M cost when tenants are not fully located and revenue can not cover O&M cost.
- Since the government has been allocating budget to the HHTP-MB for HHTP development (VND 498, 000 million or USD 30 million in 2008), the government should keep allocating the budget for HHTP development in order to support HHTP development cost and O&M cost.
- Lease contract between the HHTP-MB and developer/tenants have to be prepared as soon as possible so that all stakeholders can examine their financial plan. In addition, HHTP-MB should also prepare detailed financial plan so as to examine how much subsidy or public money is needed.

CHAPTER 3 ECONOMIC EVALUATION

3.1 GENERAL

The HHTP development will generate economic effects in many fields which will enhance socio-economic condition not only in the Hoa Lac area but also in entire Vietnam. The economic evaluation is conducted by describing expected impact to the economy qualitatively, thus, Economic Internal Rate of Return (EIRR) is not calculated. The economic benefit has been defined as the impact of HTTP operation.

3.2 EXPECTED ECONOMIC BENEFIT

Expected economic benefits can be defined as; (i) promotion of industry and high-tech industry development, (ii) promotion of high technology through R&D, education, and (iii) promotion of economic development in surrounding area.

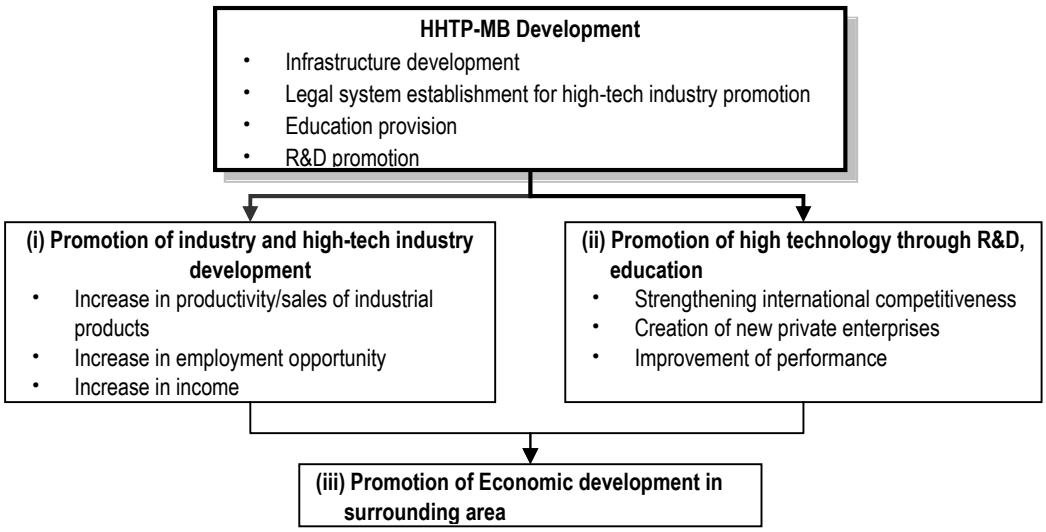


Figure I.3.1 Composition of Benefit

(1) Industry and high tech-industry development

Promotion of industry and high-tech industry development is composed of; (i) increase in land productivity, (ii) creation of job opportunity, and (iii) increase in income and is discussed below.

(i) Increase in land productivity

Before HHTP was developed, the area was mainly used as an agricultural area with a main use for cassava and paddy. Productivity of land is expected to increase as the land will be converted from agricultural use to industrial use. This will add high value to the land. In addition, population density of the HHTP area will increase accordingly with the development of HHTP and thus will contribute to increase in productivity of the land.

(ii) Increase employment opportunity

The target population of the Hoa Lac area in HHTP is 188,559 of which 89,934 is considered as daytime working population. As prior to the planned development of HHTP, the area was predominately a agricultural land with a very limited employment opportunity. With the development of HHTP, it is envisaged that it will generate economic activity along with new employment opportunity to approx. 89,934 population.

Unlike other industrial estate, one of important aspect of HHTP is to support human resources development. This will train people to acquire technical and professional skills that can finally be utilized for the development works in HHTP. Considering this, the creation of job opportunity and contribution of HHTP is much greater than any typical ordinary industrial estate development.

(iii) Increase in income

Income for the manufacturing sector and science and technology sector is higher than that for agricultural sector. As per the data from General Statistics Office, the income from manufacturing sector is 50% higher then the income from agricultural sector. Similarly, the income from science and technology sector is 43% higher than agriculture sector. Thus considering this, any shift of employment from agriculture sector to industry or science and technology sector will lead to rise in income level.

Table I.3.1 Average Monthly Income (2007)

Sector	**Monthly Income** (thousand VND)	**Difference** (%)
Agriculture	1,398	
Manufacturing	2,101	+50
Science and technology	2,155	+43

Source: General Statistics Office

(2) Promotion of high technology through R&D, education

As mentioned above, R&D and education is one of important activities for supporting and promoting high tech industry in Vietnam. Expected benefit of R&D, education is summarized below:

- The installation of high-tech machinery and equipment will strengthen the international competitiveness among all industries.
- Creation of new private enterprises.
- Creation of job opportunity through the creation of new high-tech industries.
- Increase of export of high-tech products.
- Improvement of performance, quality, international competitiveness of industrial products in entire Vietnam caused by the influence of high technologies.

(3) Promotion of economic development in surrounding area

HHTP development will bring close to 200,000 day/night population and industry. It is expected that this will have the positive impact in the surrounding area too. As HHTP activities will be supported by many sectors such as housing, commercial, services and supporting industry, it is likely that this will lead to the acceleration of economic activities and thus will result in increase in GRDP (Gross Regional Domestic Products).

In addition, development of HHTP which promote industrial development along with a development of residential area will also contribute in mitigating the congestion from Hanoi.

3.3 CONCLUSION

Conclusion from economic evaluation is summarized below:

- Promotion of industry expects to contribute to job creation and income increase.
- Synergetic effects can be maximized by executing R&D and education along with infrastructure development and promotion of industrial development.
- HHPT development should be implemented along with R&D and human resources development which will not only contribute in promotion of industrial development and promotion of high-tech industries in HHTP area but will also lead the economic development in the surrounding areas too.

SUPPORTING J

SOCIAL AND ENVIRONMENTAL CONSIDERATION

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CHAPTER 1 SOCIAL ASPECTS

1.1 LAND ACQUISITION AND RESETTLEMENT

1.1.1 Plan of Resettlement and Compensation

(1) Decision of Former Ha Tay Province relating Land Acquisition and Resettlement for HHTP Project

Relevant government decisions for land acquisition and resettlement for HHTP project are listed in Table J.1.1. Projects of land acquisition and resettlement for HHTP project have been authorized in Ha Tay Province. These projects have been taken over by new Hanoi after the merger of these two provinces (Ha Tay Province and Hanoi).

Table J.1.1 Decisions of Former Ha Tay Province related to Land Acquisition and Resettlement for HHTP Project

Year	No	Description
2002	1777	Approval of alternative of land acquisition compensation of 200 ha in HHTP belonging to land area of communes namely Ha Bang, Tan Xa, Thach Hoa in Thach That District
2006	2214	Approval of 600ha stage 1(2015)- Step2 Land Acquisition Compensation & Assistance Project of Hoa Lac High Tech Park in Thach That District
2007	1889	Detailed plan on construction of resettlement area in south of Road 84 HHTP Thach That, location Van loi hamlet, Binh Yen commune Thach That
	2423	Investment project and bidding plan of resettlement area in south of 420 (previously road 84) HHTP Thach That Stage1 (2015) (land reclamation and land acquisition)
2008	137	Economic and technical report and plan of bidding for construction of cemetery in Binh Yen, Thach That
	139	Plan on bidding for construction of cemeteries in Quay mountain (group 6 & 7) and cemeteries in Cay Sua field (Group 8) Tan Xa commune, Thach That
	1488	Investment project and bidding plan for construction of technical infrastructure of resettlement area in south of 420 (previously road 84) HHTP Thach That Stage1 (2015)
	2940	Project on compensation and land acquisition assistance early stage of Stage2 HHTP, Thach That district

Source: prepared by JICA Study Team by referring to the decisions of Ha Tay Province

(2) Procedure of Land Acquisition and Resettlement

After merger of Ha Tay Province into Hanoi City, compensations for land acquisition and resettlement for the project are to be implemented following the regulation of Hanoi City and the National Government. Hanoi People's Committee has issued the decision dated 29 September 2008 for the regulation of compensation, assistance and resettlement in Hanoi area. The HHTP project needs to refer to and follow this regulation from January 2009 onwards.

Procedure of land acquisition is illustrated in Table J.1.2.

Table J.1.2 Procedure of Land Acquisition and Clearance

No	Works	Done by	Approved by
1	Approval of investment acceptance	Investor + consultant (if any)	Provincial People's Committee (PCC)
2	Master plan 1/2000 or 1/500	Investor + consultant	PPC
3	Basic design and certificate of investment	Investor + consultant	PPC
4	Decision of land clearance	Investor + district governors	PPC
5	Set up board of land acquisition and site clearance	Investor + district governors	PPC
6	Making documentation of land acquisition and site clearance (investigation of households, preparation of inventory)	board of land acquisition and site clearance + investor	PPC
7	Compensation to households and site clearance	board of land acquisition and site clearance + investor	
8	Land handing over to investor	board of land acquisition and site clearance + investor	PPC

(3) Authorized Projects of Land Acquisition and Resettlement

Currently, there are two projects of land acquisition in Hoa Lac area which are the authorized decisions as given in Table J.1.3. As compared to the schedule as mentioned in the approval decision, delay in schedule has been observed in the progress of the project in of Stage 1 (2015) - Step 2.

Table J.1.3 On-going Projects of Land Acquisition for Hoa-Lac Area

Project	Relevant Decision	Targeted Area (ha)	Completion date targeted in Decisions	Amount investment in Decision (mil. VND)	Acquired Area (ha)
Stage 1(2015) -Step2	No./2214 QD-UBND/2006	600	June 2008	794,379	395.5
Stage 2(2020) - Step1	No.2940/ QD-UBND/2008	369 (excl. water surface 111)	2008-2010	359,995	0
Total	-	969	-	1,154,374	395.5

Note: Acquired area; as of December 31, 2008
Source: PMU of Industrial and small scale industrial group and development and investment, Hanoi City

(4) Profile of the Affected People by the HHTP Project

The study area consists of parts of three communes i.e. Thach Hoa, Tan Xa and Ha Bang Commune in Thach That District. As shown in Table J.1.4, number of households to be resettled in the study area accounts to 1,200. Number of households including the one's who will be compensated without resettlement accounts to 1,714. According to interview survey the size of household in this area is about 3.8 person/household. The number of people to be resettled has been estimated to about 4,600.

The profile of local household who would receive compensation due to the project is shown in TableJ.1.5. All household interviewed owns their house and agriculture land. Most of them are dependent on income from agriculture including sales from rice, corn and vegetables. According to the interview survey in the Study, as for water use, it was confirmed that all of them use well water for domestic use and canal for irrigation purpose.

People interviewed strongly expect some job opportunity and skill training. While household who owns land, majority are in the favors "house for house, land for land" as the way of compensation. Not a few households preferred the way of "compensation in cash only".

Table J.1.4 Number of Households for Resettlement and Compensation

Commune	Households to be resettled		Household to be compensated	
	Study Area	HHTP area	Study Area	HHTP area
Thach Hoa	933	1,134	959	1,097
Tan Xa	129	413	540	1,029
Ha Bang	-	0	-	65
Binh Yen	138	138	215	215
Phu Cat	-	37	-	59
Total	1,200	1,722	1,714	2,465

Source: PMU of Industrial and small scale industrial group and development and investment, Hanoi City

Table J.1.5 Profile of Local Households (Result of Interview Survey)

Information about		Quantity	Unit	%
How long have your family been living in this locality?	Ancestral (before two general)	200	Households	44
	Only a generation ago	250	Households	56
	Recently migrated	0	Households	0
Family structure	Nuclear family	120	Households	27
	Extended family	313	Households	70
	No answer	17	Households	4
Type of house	Single detached 1-storey	371	Households	82
	Single detached 2-storey	68	Households	15
	Apartment/ Row house	0	Households	0
	Shanty	11	Households	2.44
Maintenance condition	Very good	69	Households	15
	Good	113	Households	25
	So-so	268	Households	60
Housing ownership	Self-owned	450	Households	100
Number of household by owned land type	Agriculture	450	Households	100
	Orchid	447	Households	99
	Pond	44	Households	10
Average area owned	Ownership	2,553	m2	-
	Land affected by project	2,315	m2	-
Kind of plant	Paddy	340	Households	76
	Paddy and vegetable	135	Households	30
	Paddy and corn	14	Households	3
	Paddy, vegetable and corn	71	Households	16
Average income from the sale of crops	Rice	16.77	Mil VND/yr/ household	-
	Corn	0.85	Mil VND/yr/ household	-
	Vegetable	0.73	Mil VND/yr/ household	-
	Others	0.01	Mil VND/yr/ household	-
Type of raising	Livestock	369	Households	82
	Poultry birds	406	Households	90
	Aquiculture	38	Households	8
Average income from the sale of raising animal	Cattle	12.50	Mil VND/yr/ household	-
	Poultry	4	Mil VND/yr/ household	-
	Fish	2.70	Mil VND/yr/ household	-
	Others	0.91	Mil VND/yr/ household	-
Energy use for cooking purpose	Electricity	0	Households	0
	Wood	282	Households	63
	Kerosene	0	Households	0
	Coal	58	Households	13
	Gas	274	Households	61
Energy use for lighting purpose	Electricity	450	Households	100
	Wood	0	Households	0
	Gas	0	Households	0
	Kerosene	40	Households	9
	Coal	0	Households	0
	Candle	28	Households	6

Source: Interview survey by JICA Study Team

Table J.1.6 Preference and Opinions of Local People to HHTP Project

Question			Households	%
Views towards the HHTP project				
		Like the project	259	56
		Dislike the project	212	47
References for compensation, resettlement and rehabilitation				
Type of compensation package	Payment in cash only		193	43
	Land for land		104	23
	House for house		39	9
	House for house and land for land		229	51
Reason why you prefer cash on compensation	To purchase land		66	15
	To build house		130	29
	To pay debt		60	13
	To start business		62	14
Kind of resettlement	Resettle by self in the nearby locality		118	26
	Resettle as community if the project offers this option in the nearby locality		254	56
	Resettle as individual outside the locality		2	0.4
Kind of rehabilitation opportunities / benefits	Employment		306	68
	Skill training		235	52
	Soft loan		211	
Problems arise when implementing the project				
Society	Social evil		132	29
	Housing movement, upsetting living and learning habits		268	60
	Environmental pollution		174	39
Economy	Losing production land leading unemployment		275	61
	Income reduction from agricultural production		179	40
	Losing food lead the price high		36	8
	Impacting on health		15	3
Advantages of the project				
Having money to pay debt of house building			122	27
Creating favorable business environment			59	13
Having capital to invest in business and learning			228	51
Better income and life			86	19
Better new resettlement position			125	28
Training profession and creating jobs			124	28
Suggestion for damage reduction				
No land acquisition			4	1
Use only low efficiency land for the implementation of project			12	3
Supporting financially to households			114	25
Better resettlement position			91	20
Training profession, creating jobs			187	42
Reasonable compensation price			297	66
Reduce pollution			11	2
Measure of social evil reduction			14	3
Policy applied for moved households			26	6
Not letting the project being suspend			13	3
Impact on the whole region				
Negative	Economy	Reducing income from agricultural activity	165	37
		Unemployment	199	44
		Losing land of housing and production	195	43
	Society	Social evil	96	21
		Upset activities	161	36
	Polluted environment			26
Positive	Economy	Developing	209	84
		Favorable business condition	62	14
		Having money to pay debts and invest in business	124	28
		Creating job	82	18
	Society	Developed people's cultural standard	79	18
Suggestion to the project	Putting the project into land of weak production effect		3	1
	Treating pollution		75	17
	Creating jobs		213	47
	Quickly executing		106	24
	Ensuring the life in line with the law		92	20
	Reasonable compensation		96	21
	Attracting much more investors to the high-tech Park		20	4

Source: Interview survey by JICA Study Team

1.1.2 Progress of Resettlement, Land Acquisition and Compensation

(1) Progress of Land Acquisition

The total area of 595.5ha has been acquired in Hoa Lac area by the end of year 2008. The total area acquired for HHTP project is 826.5ha which includes 231.0ha of land acquired in the northern Phu Cat area.

Currently, the PMU of 'Industrial and Small-Scale Industrial Group Development and Investment' under Hanoi City is in-charge of land acquisition for the project. The PMU coordinates with relevant organizations such as Thach That district land acquisition and compensation board for these projects as per the schedule given by the decisions.

The record of land transfer to HHTP-MB from the PMU is shown in the following table. During 2007 and 2008, a total of about 395.5ha of land has been handed over to HHTP-MB.

Table J.1.7 Land Acquired and Transferred to HHTP-MB in 2007 and 2008

Date	Thach Hoa (m^2)	Tan Xa (m^2)	Ha Bang (m^2)	Total transferred areas (m^2)
3rd April 2007	181,131.23	122,782.80	269,084.44	571,998.47
29th June 2007	98,121.10	249,592.70	93,831.30	441,545.10
6th Sep 2007	0.00	204,960.70	411,692.20	616,652.90
14th Dec. 2007	55,182.80	507,282.60	462,861.00	1,025,326.40
26th Nov. 2008	327,692.60	542,714.60	428,864.50	1,299,271.70
Total	662,127.73	1,627,333.40	1,666,333.44	3,954,794.57

Note: Figures in the table include part of Hoa Lac area which is excluded from the Study Area
Source: PMU of Industrial and Small-scale industrial Group and Development and Investment, Hanoi City

(2) Progress of Resettlement

Table J.1.8 shows the progress of resettlement of local households due to HHTP development. It has been estimated that more than 1,700 household need to be resettled to complete land acquisition of HHTP area as approved by Vietnamese Government.

Table J.1.8 Resettlement of household caused by HHTP Project

Commune	Up to 2004	Yr 2005	Yr 2006	Yr 2007	Yr2008	Total
Thach Hoa	175	0	0	0	0	175
Tan Xa	0	0	0	0	0	0
Ha Bang	0	0	0	0	0	0
Binh Yen	0	0	0	0	0	0
Phu Cat	0	0	0	113	17	130
Total	175	0	0	113	17	305

Source: PMU of Industrial and Small-scale industrial Group and Development and Investment, Hanoi City

Resettlement areas have been developed for allocation of these household. Table J.1.9 gives an outline of the development of resettlement areas for the allocation household by HHTP developments. Necessary infrastructure such as roads, supply of utilities (water, electricity, telecommunication, etc.), schools, medical center, pagoda, market, etc. are considered and to be developed inside the area.

Table J.1.9 Resettlement Area for the Affected Households in Hoa Lac Area

Area	Number of households can be accommodated	Description
7.8 ha	161	In operation.
36.05 ha	653	Authorised by Decision of Ha Tay Province. Construction work is on-going. It is unofficially targeted to complete construction of infrastructure by June 2009.
24 ha	350	Not authorized by official document. Under planning.

Source: PMU of Industrial and Small-scale industrial Group and Development and Investment, Hanoi City

In addition to the resettlement of household, the cemeteries of the local communities that are authorized by Province and implemented by commune authorities will be relocated. Resettlements of three cemeteries have been approved by Province in 2008 and two more cemeteries are going to be relocated for land acquisition purpose. However, the relocation of cemeteries is sensitive issue for local residents and their concern's related to cemeteries relocation was heard in the stakeholder meeting during the Study.

(3) Settled Compensations

The number of households compensated for the HHTP project is given in Table J.1.10. It is understood that compensations for the affected people is progressing every year. However, the same doesn't hold true for resettlement. The resettlement of local households has not shown considerable achievement.

Table J.1.10 Household Compensated for Land Acquisition in HHTP Project

Commune	Up to 2004	Yr2005	Yr 2006	Yr 2007	Yr2008	Total
Thach Hoa	119	131	35	217	101	603
Tan Xa	0	0	0	346	355	701
Ha Bang	457	0	445	1,216	0	2,118
Binh Yen	0	0	0	0	0	0
Phu Cat	1	0	132	265	23	421
Total	577	131	612	2,044	479	3,843

Source: PMU of Industrial and Small-scale industrial Group and Development and Investment, Hanoi City

(4) Issues during Land Acquisition and Compensation

As shown above, remarkable progress was not seen in last 4 years in resettlement of local residents from Hoa Lac area. One of the major reasons is that the necessary infrastructure has not yet been developed for the household's including from Hoa Lac area that will be relocated in the resettlement areas. Till such time it is not done, the affected people cannot be resettled.

Thus considering the current situations with lack of practical land acquisition and resettlement plan, it is natural and is one of the major reasons for non-release of advance compensations to the affected people.

With reference to compensation in the past, although the following facts were found in the Study according to the PMU of Industrial and Small-scale industrial Group and Development and Investment, Hanoi City, no official grievance has been recorded for compensation as implemented by the PMU. It is suggested for the organizations that are linked with land acquisition to consider the social aspects of the HHTP projects and pay sufficient attentions to mitigate impacts to local residents.

1) Households who were refused for compensation, appealed for the compensation value to

new Hanoi City.

2) Some households wants to relocate to other places from the allocated resettlement area where firstly developed and has been in operation.
3) Some people were not fully satisfied with the location of relocated cemeteries. They did not feel that it is right location for the cemeteries.

It has been more than 10 years now since the official announcement of the project by the Government. During these years, HHTP project has been recognized by all concerned people and organizations and additionally people also didn't protested or expressed their strong objection against the project. Considering all this, it can be said that people have accepted and actually are wondering the reason for the delay in implementation of the HHTP project.

1.2 CONDITIONS OF COMPENSATION

1.2.1 Decision to Declare Value of Compensation

Both Hanoi City, and formerly Ha Tay Province form time to time were uses to issue decisions and announces the value of compensation for land and property that has been acquired or cleared for the government projects. These values were decided based on the type of property, land use, etc. Based on these decisions, the organization responsible for land acquisition investigates the conditions of local people in the target area and calculates the amount of compensation that will be paid to the people. Decisions of former Ha Tay Province to declare these values from 2006 to 2008 are listed in Table J.1.11. The Table J.1.12 describes what type of assets can be compensated according to relevant decisions in Vietnam.

Table J.1.11 Decisions to Declare Values of Compensation in Former Ha Tay Province

Year	No	Description
2006	289	Regulation on compensation, support and resettlement when the land is recovered by the State on the land area of Ha Tay
2007	494	Issuance of Price List for compensation, support to land acquisition on housing, architecture objects, trees, fruit crops in Ha Tay
	2404	Promulgation of land price of all types of land in Ha Tay province in 2008
2008	370	Issuance of the Unit Price List on compensation and assistance for Land Acquisition to houses, architectural objects, trees and secondary crops in the territory of Ha Tay Province.
	1101	Issuance of the Unit Price List on compensation and assistance for Land Acquisition of houses, architectural objects in the territory of Ha Tay Province

Source: prepared by JICA Study Team by referring to the decisions of Ha Tay Province

Table J.1.12 Compensation for the Affected Asset by Governmental Projects

Asset	Compensation	Ways of compensation
House, building, graves	Yes	Monetary compensation
Land (agriculture, aquaculture pond)	Yes	Monetary compensation
Resettlement	Yes	Resettlement area and money to construct new house
Crops, orchard, trees	Yes	Monetary compensation
Domestic animals	No	The reason is that domestic animals can be transferred to money before land acquisition
Livelihood, job opportunity	Yes	Monetary compensation. Amount is rather small. HHTP-MB is coordinating with local authorities and developers to prioritize employment of local residents in Hoa Lac area

Source: prepared by JICA Study Team by referring to the decision of Ha Tay Province and interview to Thach That District Land Acquisition and Compensation Board

1.2.2 Value of Land Acquisition

Although the value for compensations for new Hanoi has not been issued (as of end of January 2009), it is expected the value applicable for Hanoi in 2009 will be higher than that was compensated in past in the former Ha Tay Province. Table J.1.13 gives comparison of values of compensation between new Hanoi City and former Ha Tay Province.

Table J.1.13 Conditions of Compensation between New Hanoi City and Former Ha Tay Province

ID	Work	New Hanoi City	Former Ha Tay Province
I	Compensation		
1	Residential land	Value is defined annually by the PC. New prices may be higher than ones of Former Ha Tay Province.	Defined annually by the PPC.
2	Cultivation land	Value is defined annually by the PC. New prices may be higher than ones of Former Ha Tay Province. The price shall be around 56,200 VND/m^2 to 165,000 VND/m^2 depending on kind of land.	To be defined annually by the PPC. Highest price was 54,000 VND/m^2. (decision 2404/2007/QĐ-UBND dated 11 Dec. 2007)
II	Supporting policies	(Decision 18/2008/QD-UBND dated 29 Sep. 2008 by Hanoi PPC)	(Decision 289/2006/QD-UBND dated 20 Feb. 2006 by Ha Tay PPC)
1	Supporting to re-establish living condition and working	35,000 VND/m^2	Max 3,000 VND/m^2
2	Supporting to change and getting new jobs	30,000 VND/m^2	Max 15,000 VND/m^2
3	Bonus when doing handing over land on time	3,000 VND/m^2	3,000 VND/m^2
4	Supporting to cultivation land located at the same lot with residential land	To be compensated with price: Up to 50% of residential price (if having legal documentation). Up to 30% of residential price (if not have legal documentation).	Nothing.
III	Resettlement	160m^2 resettlement land/household for areas.	For HHTP, following decision 1329/QD-UBND dated 27 Jul. 2007 by Ha Tay PPC: 300m^2/household.

Source: prepared by JICA Study Team according to relevant decisions

1.2.3 Criteria of Right to Receive Compensation for Resettlement of Household

The conditions that have to be satisfied by household to be eligible and apply for the compensation due to the resettlement of his/her household are described in Table J1.1.14.

Table J.1.14 Conditions required for Resettlement of Household of HHTP

1. Household whose land is to be acquired for the HHTP project.
2. Household who hold the legal certificate for land user that shall be issued by relevant authority before June, 2nd 1997, when the M/P of HHTP project was announced by Government.
3. Household on the project site must be inhabitants along with the family at the time of effective date of land compensation.

1.2.4 Compensation of Livelihood

The affected people need to take care of their livelihood by themselves after compensation for land acquisition and resettlement although they can receive some amount of compensation for support of their living. While compensation for resettlement and land acquisition has been

conducted in accordance with relevant regulations in Vietnam, it is obvious that local residents would not be able to continue agriculture on the compensated land which was once their source of income and livelihood.

The HHTP-MB has explained that MB would coordinate with local authorities as well as with the developers in HHTP to offer job opportunities to the local people. However, the exact numbers of employees has not been clear. In addition, it does not seem that local people residing in the surrounding area of HHTP have enough capacity to engage in high-tech industries or in R&D fields.

Although HHTP-MB is considering that local authorities may employ these people if job opportunities as provided by developers would not enough to cover all people who have lost their earning based on agriculture or other livelihood means. To realize this, consideration has to given to provide skill training to local people so that they can be employed by the developers.

1.3 ASSISTANCE OF HOLDING STAKEHOLDER MEETING

1.3.1 Rationale of the Stakeholder Meeting

(1) JICA Guidelines for Environmental and Social Considerations

It is illustrated in JICA Guidelines for Environmental and Social Considerations to hold stakeholder meeting three times during the course of the feasibility study assisted by JICA.

JICA considers the environmental and social impacts when implementing cooperation projects, and JICA owns JICA Guidelines for Environmental and Social Considerations. Its objectives are to encourage the recipient governments to take appropriate considerations for environmental and social factors. The Government should also ensure that JICA's support for examination of environmental and social considerations are conducted following the guidelines. The guidelines outline's the JICA's responsibility and procedures, and requirements for the recipient governments to facilitate achievement of their objectives.

(2) Agreement in the Minutes f the Meeting

As for the Study of HHTP, it was agreed and stated in the Minutes of the Meeting signed on May 15, 2008 between both Japan and Vietnam Governments that the Vietnamese side shall comply with Vietnamese relevant laws, regulations and standards as well as the JICA guidelines for environmental and social considerations.

(3) Public Consultation in EIA in Vietnam

Letters describing perception of the concerned communes and other organizations toward the project have to be attached to EIA report according to the circular No. 08/2006/TT-BTNMT section 3.2. It was conceived that discussion in the stakeholder meetings could be helpful to supplement description of the people's awareness on the project.

1.3.2 Plan of the Stakeholder Meetings during the Study

HHTP-MB has held stakeholder meeting three (3) times during the Study. An outline of the meetings is shown in Table J.1.15. The Feasibility Study and the social and environmental consideration survey were explained as regulated by the JICA Guidelines for social and environmental considerations. Invitees were decided based on the discussion with HHTP-MB. As manners of public consultation in Vietnam were applied, invitation letters were delivered by

HHTP-MB to all attendees. As it was not considered practical to invite general public to such kind of meetings, thus for this occasion, representative of communes, districts, local authority were invited.

The first meeting was held in November 2008 that introduced the HHTP project, as well as the Study. Representatives of four (4) communes in the HHTP project area (excluding northern Phu Cat Area) attended the meeting and gave their comments. In December 2008, the second meeting was held that explained the progress of the Study. In February 2009, developments of infrastructure studied in the Study and conceived environmental impact were explained in the third meeting.

Table J.1.15 Stakeholder Meetings

	1st	2nd	3rd
Date	November 14, 2008	December 5, 2008	February 6, 2009
Purpose	Explanation of the HHTP project and social and environmental consideration survey.	Explanation of progress of study and social and environmental consideration survey.	Explanation of result of F/S study and social and environmental consideration.
Attendances	Representatives of communes and concerned authorities HHTP-MB, JICA Study Team	Representatives of communes and concerned authorities HHTP-MB, JICA Study Team	Representatives of communes, residents, concerned authorities HHTP-MB, JICA Study Team
Venue	Start-up center of the HHTP	Start-up center of the HHTP	Start-up center of the HHTP

Source: JICA Study Team

1.3.3 Preparation of the Material for the Stakeholders Meeting

Handout and presentation materials were prepared for stakeholder meetings. Since the explanations in the meeting were mostly related with the Study, JICA Study Team provided necessary information and data for the preparation of these materials.

In the meetings, these materials were explained by HHTP-MB and subcontractors of the Study in Vietnamese so that attendees could understand the materials.

1.3.4 Discussion in Stakeholder Meetings

In the meetings, attendants freely discussed the issues related to the HHTP project. The comments from communes in the first meeting in November 2008 are shown in Table J.1.16.

In the third meeting, attendants showed concerns about impact from wastewater treatment plant which was explained as one of infrastructures, and job opportunities which was expected to be provided by the HHTP development. Regarding impacts from the wastewater treatment plant, HHTP-MB promised appropriate operation of the plant with compliance with the relevant laws and regulations. It was also considering provision of work opportunities and vocational training to mitigate the issue raised by local people.

Table J.1.16 Opinions of Communes from the 1st Stakeholder Meeting

	Representative of Tan Xa Commune
1	What is the Amenity Zone? And, what is it for?
2	The issues of any substance, whether organic, inorganic, botanical, or microbial, that is used to destroy insects, must receive special attention; otherwise, the local residents will be adversely affected.
3	Representative of Ha Bang commune.
4	Over 90% of the farmers here are seriously affected in terms of job opportunities.
5	Local residents, in view of resettlement, wish to be given new accommodation, which should be equal to or better than the old one.
6	Decision No.621, Ha Bang must deliver 40 ha in the cemetery area with approximately 5,000 graves for the project. This work actually encountered many difficulties due to the faith of local residents who want to bury their deceased relatives in high-land area.
7	Representative of Thach Hoa Commune.
8	The problem of local residents losing jobs must also be resolved.
9	Within a few years, the price of everything has increased considerably. However, there is no change in the compensation price.
10	Regarding the social-environmental issues, the sampling locations for the environment survey should be equally distributed, expanding to muddy areas. It is recommended that inter-regional views should be taken into consideration in the environmental survey.
11	It is suggested to promulgate the regulations on environment management, explicitly referring responsibilities for individuals, organizations causing pollution. For instance, LISOHAKA Company discharged untreated solid waste, causing serious pollution.
12	Representative of Binh Yen Commune.
13	Criteria for resettlement needed to adjust in order to satisfy with the current conditions. From 1998 to the present (10 years), the number of households has undergone great change. Previously, there was one household, now two or three households have been built.
14	As regulated, families whose land is acquired by 30% will be entitled with a substitution land which can be used for service activities. However, those families encountered many difficulties in asking for legal documents to receive this land. Up to now, no households here have been provided with the service land. At present, the Government has decided no longer to provide the service land for the satisfied local residents but to increase the compensation price, causing displeasure for them.

Source: JICA Study Team

CHAPTER 2 ASSISTANCE OF EIA STUDY

2.1 INTRODUCTION

The law on environmental protection of Vietnam requires the following projects to conduct EIA study and to prepare EIA report.

1. Nationally important projects
2. Projects utilizing the national reserve areas, national parks, historical relics, cultural relics, natural relics and landscapes or affecting them
3. Projects affecting the river basins, coastal areas, protection areas of eco-system
4. Projects on constructing infrastructures in economy area, industrial park, new technological industrial area, export processing zone, and craft villages
5. Construction projects in new urban center and congested residential areas
6. Projects with large scale use of groundwater and natural resources
7. Other projects with potential risks and affects on environment

As the EIA study shall be in accordance with the feasibility study, under the Study, JICA Study Team supports the HHTP-MB to conduct EIA study in the technical aspects.

At the time of the JICA study for updated Master Plan in 2007, it was confirmed that Strategic Environmental Impact Assessment was not required for HHTP project.

2.2 EIA PROCEDURE FOR THE PROJECT

2.2.1 Competent Authority to EIA of HHTP Project

The competent authority for appraisal of EIA of projects on building infrastructure for concentrated production, business, and service area of more than 200ha is MONRE which is stipulated in Appendix II attached to Decree No.80/2006/ND-CP.

While official procedure will be started after preparation and submission of EIA report by the project proponent, one staff was assigned to the working group member of the Study to cooperate with the JICA Study Team. Since the revised VN M/P has been approved by Prime Minister, all governmental agencies have recognized the significance of the HHTP project. It is not foreseen that the competent authority, MONRE, will cause any obstacles in the procedure as far as the EIA study and report by HHTP-MB satisfies the requirements of EIA.

2.2.2 EIA Procedure

A procedure of approval of EIA begins with the submission of EIA report by the project proponent as illustrated in Figure J.2.1.

After the submission of EIA report, the HHTP-MB needs to take care corresponding with the MONRE to obtain approval.

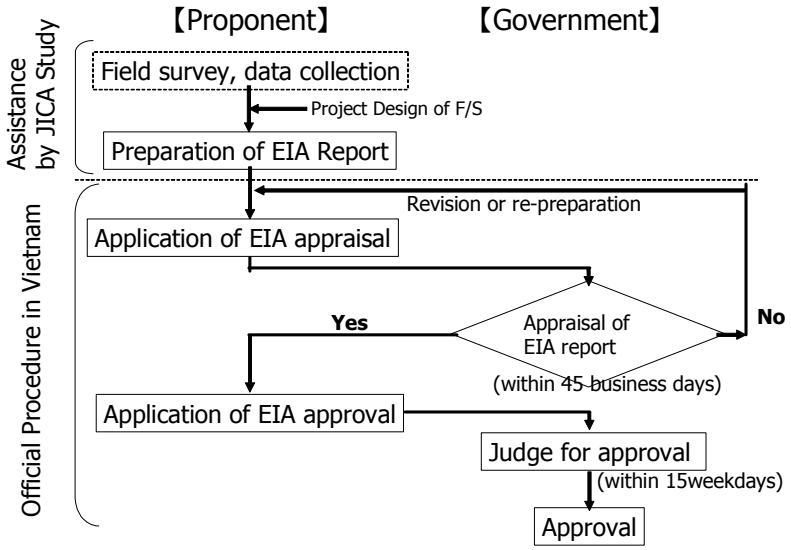


Figure J.2.1 Relation between Procedure of EIA Approval and Assistance by the JICA Study

Source: Prepared by JICA Study Team according to Circular No.08/2006/TT-BTNMT, Decree No.80/2006/ND-CP

2.2.3 Table of Contents of EIA

The Circular No. 05/2008/TT-BTNMT which instructs EIA and Strategic Environmental Impact Assessment was issued on December 8, 2008. The structure of EIA report is shown in Appendix 4 attached to the Circular.

The following table gives new contents of EIA report. The EIA report of HHTP followed this table of contents.

Table J.2.1 Table of Contents of EIA Report

Foreword	
Chapter 1	Summary description of Master Plan of HHTP project and project implementing location
Chapter 2	Environmental and Socio – Economic conditions of the project area
Chapter 3	Assessment of Project Impact on Environment
Chapter 4	Mitigation Measures on Environmental Impact to Prevent and Cope with Environmental Problems
Chapter 5	Environmental Management and Monitoring Program
Chapter 6	Public Consultation

Source: Prepared according to Appendix 4 attached to Circular No. 05/2008/TT-BTNMT dated December 8, 2008

2.3 ENVIRONMENTAL IMPACT OF THE PROJECT

2.3.1 Scope of the EIA Study

Scope of the EIA study is to be in accordance with the scope of the feasibility study. In this context, the scope of EIA study is to anticipate the environmental impacts that can be caused the development of the proposed infrastructures.

The result of EIA study will be compiled as a report and be submitted to MONRE for evaluation as illustrated in Figure J.2.1.

2.3.2 Scoping of Environmental Aspects

It is anticipated that activities accompanying the project might cause negative environmental impacts. Activities in the project to be considered in EIA are listed in Table J.2.2. Based on the

potential impact by these activities, environmental aspects are identified as shown in Table J.2.3. These aspects were considered and environmental impacts are evaluated in the EIA study.

Table J.2.2 Activities in the project considered in EIA

Phase	Activity
Pre construction phase	Land acquisition
	Resettlement of people and assets
Construction phase	Alteration of land use
	Alteration of topography
	Operation of heavy equipment for construction
	Traffic of construction vehicle
	Disposal of residual soil and waste
Operation phase	Increase and concentration of population and traffic
	Discharge and operation of wastewater treatment plant
	Drainage for storm water

Source: JICA Study Team

Table J.2.3 Scoping of Anticipated Environmental Impacts in the Project

Phase	Activity	Physical environment							Ecological environment					Socio-economic environment					Others			
		Air Quality	Water quality	Noise	Waste	Soil contamination	Subsidence	Odor	Flora, fauna, ecosystem	Hydrology	Ground water	Rain runoff	Topography and geology	Resettlement	Living and livelihood	Sanitation	Heritage	Landscape	Impacts during construction	Accident	Traffic accident	Global warming
Pre construction	Land acquisition													A	A							
	Resettlement of people and assets													A			B					
Construction	Alteration of land use								B	B					B			B				
	Alteration of topography						B			B			B					B	B			
	Operation of heavy equipment for construction	B		B															B			
	Traffic of construction vehicle	B		A															A		B	
	Disposal of residual soil and waste				A	A													A			
Operation	Increase and concentration of population and traffic	B	B	B	B															B	B	B
	Discharge and operation of wastewater treatment plant		B	B	B			B			B				B				B	B		
	Drainage for rainwater											A			B							

Note: A= Significant impact is anticipated B= Moderate impact is anticipated

Source: JICA Study Team

2.3.3 Summary of EIA

The assessments of environmental impact of the project are summarized as follows.

Table J.2.4 Summary of Environmental Impact Assessment

Phase	Item	Environmental impact of the project
Pre Construction	Resettlement	1,200 households will be forced to be resettled by the development in F/S area. These households will be able to maintain their lives in local community after the implementation of resettlement, as the investor is preparing resettlement area.
	Living and livelihood	1,714 households will be affected by the land acquisition of the project. These households' livelihood will be affected as many households will not be able to continue their current occupation (mainly farming). Thus the investor is required to prepare land acquisition plan to compensate for affected households according to the project implementation schedule.
	Heritage	There are no historic relics and cultural assets in the area affected by the land acquisition. The investor is required to take residents intention into consideration when resettling cemetery in the project area.
Construction	Air Quality	Air quality in surrounding area will get worse temporary by the air pollutant discharged from construction vehicles and heavy equipment. It is considered that the concentration of air pollutant will not be high locally as topography condition in surrounding area is gentle. Impact of dust discharged in construction will be mitigated by washing vehicles and watering at the site.
	Water quality	It is necessary to equip facility to prevent water pollution by wastewater and sewage from construction workers. It is necessary to equip adequate facility to prevent water pollution by oil leakage from construction machineries and vehicles.
	Noise	Noise will be increased by moving of construction vehicle to site. However, impact on residents' living condition will be limited as most of construction vehicles will use main roads for movement. Noise from operation of construction machineries may affect residents' living condition. Consideration for noise mitigation is necessary by taking resettlement schedule into account when implementing construction work.
	Waste	Residual materials in construction and solid waste from construction workers will not cause impact by appropriate treatment of waste.
	Soil contamination	It was found by the field survey that the soil in project area was contaminated. Adequate measure for treatment and disposal will decrease environmental impact. The investor is required to consult with the concerned agencies and ensure safe disposal of soil from site.
	Flora, fauna and ecosystem	Growing area and habitat for plants and animal will be decreased by alteration of land use. On the other hand, Tan Xa Lake will be preserved as much as possible. As it was confirmed by the field survey that almost all species found in project area was also found in surrounding area, environmental impact on ecosystem will not be significant.
	Hydrology	It is judged development plan will not cause significant impact on hydrology as improvement of river system and retention of rainwater is considered in drainage planning.
	Ground water	Excavation work for construction of sewer pipe and wastewater treatment will reach in aquifer. However, condition of groundwater will not be affected by these excavation works.
	Topography and geology	Topography of project area is gentle and construction work of the project will not change the current topographic condition significantly.
	Sanitation	The HHTP-MB will pay attention to keep sanitary condition of the site as well as the surrounding area. Therefore serious impact is not anticipated.
	Landscape	The landscape plan will contribute to developing new landscape of the high-tech park while current scenery at the area will be lost. Consistency in landscaping will be kept in the park and the landscape will impress people who will visit, work and reside.

Phase	Item	Environmental impact of the project
	Accident	Investor will try to prevent accident during construction work by adequate construction supervision. If explosive bomb is found, investor will inform to concerned organization and treat adequately.
	Traffic accident	Construction vehicles will be regulated to drive only on main roads and to refrain from travelling on living space of local residents. Development of LHLE will distinguish the travelling route for residents from travelling routes for construction vehicles.
Operation	Air Quality	Transportation of vehicles will increase in accordance with increase of human movement by the project operation. Emission of air pollutant will be reduced by introducing circulating public bus. Besides, JICA Study recommends introducing electrically electric car.
	Water Quality	The discharged wastewater from the F/S area will be treated by a wastewater treatment plant and discharged to the environment. This will abide the water quality environmental standards. Therefore water quality in surrounding environment will not be affected by the project. Developers must comply with the requirement for wastewater discharge as specified in the guidelines.
	Noise	Increase of traffic and transport vehicles will increase in accordance with increase of human movement by the project operation. Traffic jam and noise will be mitigated by introducing circulating public bus.
	Waste	All tenants in the park will have contracts with URENCO and solid waste generated in the park will be transported and disposed adequately outside the park. Developers must comply with the requirement for solid waste management as specified in the guidelines.
	Odor	Wastewater treatment plant, which may cause odor is proposed in High-tech industrial zone. To minimize bad odour and any negative impact on residents, sewage sludge will be dehydrated and treated adequately outside of the park.
	Rain runoff	Rain runoff will increase as per the development of the HHTP. However, impact on surrounding area will be decreased by the improvement of retention capacity of rainwater.
	Living and livelihood	Employment opportunity will increase by the project operation.
	Accident	It is necessary to prevent accident by adequate operation of each functional zone and facilities operated by the HHTP-MB.
	Traffic accident	Traffic demand will increase in accordance with increase of human movement and progress of the project operation. Security of passengers and smoothness of traffic will be ensured by introducing circulating bus system.
	Global warming	Transportation of vehicles will increase in accordance with increase of human movement and progress of the project operation. The amount of carbon dioxide generated by these vehicles is estimated to be about 26,000 ton/year.

CHAPTER 3 SOCIAL AND ENVIRONMENTAL CONDITION SURVEYS

3.1 INTRODUCTION

3.1.1 Survey Items

Knowledge of the social and environmental conditions of project site and its surrounding area is essential for understanding the quality of the present environment and to assess project impact for the EIA.

Since some data of environment conditions were not available, the following field surveys were conducted under the Study. As for social conditions, it was analyzed through interviews with the concerned agencies and the resettlement survey during the Study.

1) Water quality (surface water, groundwater)
2) Air quality
3) Noise
4) Soil and sediment
5) Flora and fauna
6) Social condition (interview survey)

3.1.2 Survey Period

Surveys for environmental parameters i.e. water, air, noise, soil, sediment, flora and fauna were conducted in two seasons (October in rainy season, December in dray season) to observe the fluctuation as per the seasons.

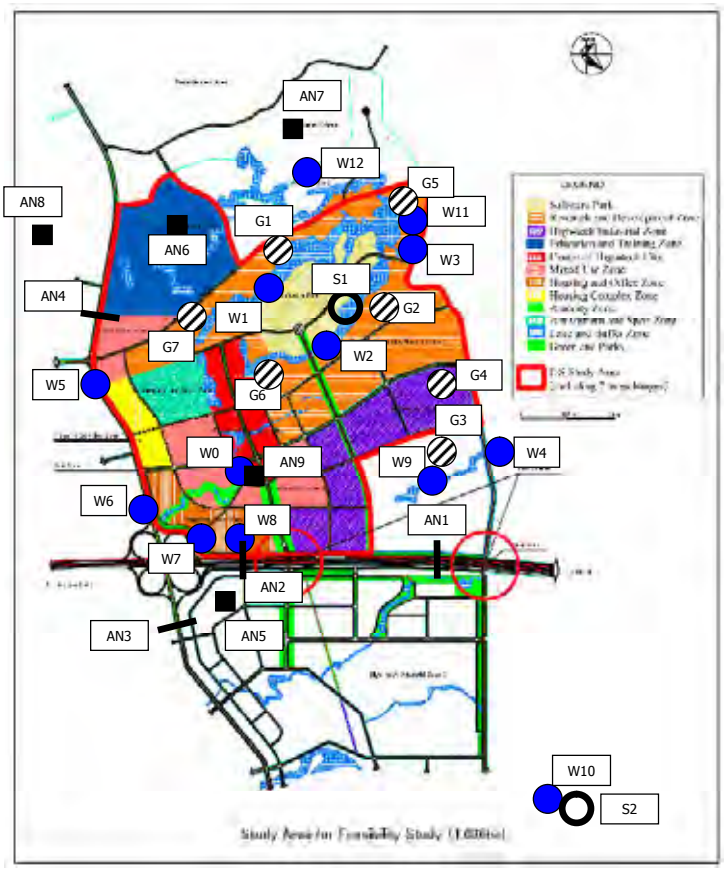
3.1.3 Survey Location

Survey locations and area were decided in such a way so as to have better understanding of the present situation of environmental parameters. These are shown in Table J.3.1 and Figure J.3.1. Sampling points for ground water and soil were increased during the dry season. As contamination of soil was found in the survey as conducted during rainy season, it was necessary to know the extent of area contaminated. As for groundwater, it was planned to know the quality of groundwater in dry season on the eastern side of the project site.

Table J.3.1 Location of Survey

Survey Item	No	Name of Location
Surface water quality	W1	Surface water at Tan Xa Lake 1
	W2	Surface water at Tan Xa Lake 2
	W3	Surface water at Tan Xa Lake 3
	W4	Trung Lu Lake (outlet of HHTP)
	W5	Stream inlet to HHTP
	W6	Stream inlet to HHTP- Km 16+500, Son Tay - Xuan Mai
	W9	Trung Lu Lake
	W10	Tich river
Groundwater quality	W0	Groundwater at HHTP Start-up center of HHTP
	W7	Bore well, 40 m depth
	W8	Dug well, around 15 m depth
	W11	Dug well water sample with depth less than 15 m on the Eastern side of the HHTP area
	W12	Bore well with depth 40m m on the Eastern side of the HHTP area
Sediment	S1	Tan Xa lake
	S2	Tich river
Soil	G1	Near Tan Xa Lake 1
	G2	Near Tan Xa Lake 2
	G3	Near Trung Lu Lake 1
	G4	Near Pump station 1
	G5	Near Pump station 2
	G6	Near Trung Lu Lake 2
	G7	Hamlet 8, Thach Hoa Commune
Air quality, Noise	AN1	Km28, Lang-Hoa Lac high way-Hamlet 2,Thach Hoa commune
	AN2	Km 29+500, Lang Hoa Lac Highway, Hamlet 5 -Thach Hoa commune
	AN3	National No 21 (to Xuan Mai)
	AN4	National No 21 (to Son Tay). Hamlet 8, Thach Hoa commune
	AN5	Residential area planed in HHTP development
	AN6	Education zone planed in HHTP development
	AN7	Resettlement area of HHTP
	AN8	Opposite HHTP area, Hamet 9-Thach Hoa commune.
	AN9	Start-up center of HHTP
Social condition (interview survey)	-	Thach Hoa commune, Tan Xa commune, Ha Bang commune

Source: JICA Study Team



Water Quality:
W1-W2: Tan Xa Lake
W3: Tan Xa Lake (outlet from HHTP)
W4: Trung Lu (outlet from HHTP)
W5-W6: Stream (inlet into HHTP)
W7-W8: Existing well
W9: Trung lu Lake W10: Tich Riverl
W11-W12: Existing well
W0: Start-up center

Air quality, Noise level:

Air quality and noise level along road
AN1-AN2: Lang Hoa Lac High way
AN3-AN4: National Highway 21

Ambient air and noise level
AN5: Residential and office zone
AN6: Education and training zone
AN7: Resettlement area
AN8: Surrounding residential area
AN9: Start-up center of HHTP

Sediment:
S1: Tan Xa Lake
S2: Tich river

Soil:
G1: Near Tan Xa Lake
G2: Near Tan Xa Lake
G3: Near Trung Lu Lake
G4: Near pump station
G5: Near pump station
G6: Near Trung Lu Lake
G7: Hamlet8, Thach Hoa Commune

Source: JICA Study Team

Figure J.3.1 Location Map of Field Survey of Environment

3.1.4 Environmental Standard

Relevant TCVN is applied for each physical and chemical parameters of environment such as water quality, air quality, noise and soil. The TCVN of sediment has not been stipulated in Vietnam.

Applicable TCVN for the results of environmental survey are shown in the following tables.

Table J.3.2 Standard of Quality of Surface Water (TCVN5942-1955)

No	Parameter	Unit	Standard Value	
			Class A	Class B
1	pH	-	6 – 8.5	5.5 - 9
2	BOD5 (20oC)	mg/l	< 4	< 25
3	COD	mg/l	>10	>35
4	DO	mg/l	> 6	> 2
5	SS	mg/l	20	80
6	As	mg/l	0.05	0.1
7	Ba	mg/l	1	4
8	Cd	mg/l	0.01	0.02
9	Pb	mg/l	0.05	0.1
10	Cr (VI)	mg/l	0.05	0.05
11	Cr (III)	mg/l	0.1	1
12	Cu	mg/l	0.1	1
13	Zn	mg/l	1	2
14	Mg	mg/l	0.1	0.8
15	Ni	mg/l	0.1	1
16	Fe	mg/l	1	2
17	Hg	mg/l	0.001	0.002
18	Sn	mg/l	1	2
19	NH4-N	mg/l	0.05	1
20	F	mg/l	1	1.5
21	NO3-N	mg/l	10	15
22	NO2-N	mg/l	0.01	0.05
23	CN	mg/l	0.01	0.05
24	Phenol	mg/l	0.001	0.02
25	Oil and grease	mg/l	None	0.3
26	Detergent	mg/l	0.5	0.5
27	Coliform	MPN/100ml	5000	10000
28	Total chemical pesticide (excluding DDT)	mg/l	0.15	0.15
29	DDT	mg/l	0.01	0.01
30	Total α	Bq/l	0.1	0.1
31	Total β	Bq/l	1.0	1.0

Note: Column A is applied for surface water used for domestic purposes after regulated treatment.
Column B is applied for surface water used for other purposes.
Source: TCVN5942-1955

Table J.3.3 Standard of Quality of Ground Water (TCVN 5944-2005)

No	Parameter	Unit	Standard Value
1	pH	-	6.5 - 8.5
2	Color	Pt - Co	5 - 50
3	Hardness (CaCO3)	mg/l	300 - 500
4	TS	mg/l	750 - 1500
5	Arsenic	mg/l	0.05
6	Cd	mg/l	0.01
7	Cl-	mg/l	200 - 600
8	Pb	mg/l	0.05
9	Cr (VI)	mg/l	0.05
10	CN-	mg/l	0.01
11	Cu	mg/l	1.0
12	F-	mg/l	1.0
13	Zn	mg/l	5.0
14	Mg	mg/l	0.1 - 0.5
15	NO3-	mg/l	45
16	Phenol	mg/l	0.001
17	Fe	mg/l	1 - 5
18	SO4-	mg/l	200 - 400
19	Hg	mg/l	0.001
20	Se	mg/l	0.01
21	Fecal coliform	MPN/100 ml	Negative
22	Coliform	MPN/100 ml	3

Source: TCVN5944-2005

Table J.3.4 Ambient Air Quality Standard (TCVN 5937-2005)

Parameters	Mean value in 1h	Mean value in 8hrs	Mean value in 24hrs	Mean value in 1 year
SO2	350	-	125	50
CO	30,000	10,000	-	-
NO2	200	-	-	40
TSP	300	-	200	140
PM10	-	-	150	50

Source: TCVN 5937-2005

Table J.3.5 Standard of Noise (TCVN 5949-1998)

No	Area	Time		
		6:00- 18:00	18:00- 22:00	22:00- 6:00
1	Especially quiet areas (such as hospitals, libraries, schools)	50	45	40
2	Resident areas, hotels, accommodations, administrative agencies..	60	55	45
3	Commercial and service areas	70	70	50
4	Manufacturing areas located in the resident areas	75	70	50

Note: Unit of noise level: dB(A)
Source: TCVN 5949-1998

Table J.3.6 Standard of Soil Contamination

Parameter	Agricultural land	Forest	Relic land	Commercial area	Industrial area
As	12	12	12	12	12
Cd	2	2	5	5	10
Cu	50	70	70	100	100
Pb	70	100	120	200	300
Zn	200	200	200	300	300

Note: Unit mg/kg-dry soil
Source: TCVN 7209-2002

3.2 RESULT OF PHYSICAL AND CHEMICAL PARAMETERS OF SURVEY

3.2.1 Result of Water Quality Survey

The result of survey of surface water indicated that the surface water in the Study Area is slightly polluted with the presence of high concentration of $NH4^{+}$-N (ammonium nitrogen) and biological index (Total Coliform). It is assumed that factors such as discharge of untreated domestic wastewater, the wastewater discharge by the handicraft activities from the nearby households, and discharge from companies could deteriorate water quality.

Table J.3.7 Surface Water Quality in Rainy Season

No	Parameter	Unit	Results								TCVN 5942-1995 Column B
			W1	W2	W3	W4	W5	W6	W9	W10	
1.	pH	-	6.8	7.1	6.9	7.2	6.2	6.4	6.6	7.2	5.5-9
2.	BOD_5	mg/l	8	16	18	12	7	6	9	16	< 25
3.	COD	mg/l	19	22	29	24	14	9	23	29	< 35
4.	SS	mg/l	9	12	23	7	29	11	14	23	80
5.	As	mg/l	0.004	0.007	0.010	0.002	<0.001	<0.001	<0.001	0.006	0.1
6.	Cd	mg/l	0.003	0.008	0.003	<0.001	0.0002	0.0002	0.0002	0.004	0.02
7.	Pb	mg/l	0.013	0.017	0.023	0.001	0.004	0.005	0.007	0.024	0.1
8.	Cr(VI)	mg/l	0.0008	0.0012	0.0014	0.0009	0.0032	0.0024	0.0029	0.0031	0.05
9.	Cr(III)	mg/l	0.0003	<0.0001	<0.0001	<0.0001	0.0018	0.0021	0.0027	<0.0001	1
10.	Cu	mg/l	0.116	0.123	0.097	0.098	0.029	0.121	0.066	0.097	1
11.	Zn	mg/l	0.289	0.321	0.272	0.002	0.077	0.004	0.003	0.166	2
12.	Ni	mg/l	0.017	0.021	0.113	0.224	0.231	0.352	0.117	0.160	1
13.	Fe	mg/l	0.600	0.621	0.577	0.680	2.170	1.770	1.121	1.150	2
14.	Hg	mg/l	<0.0001	<0.0001	<0.0001	0.0003	<0.0001	<0.0001	<0.0001	0.0002	0.002
15.	Sn	mg/l	0.0001	0.0007	0.0002	0.0031	0.0013	0.0009	0.0026	0.0008	2
16.	NH_4^+-N	mg/l	1.527	1.648	1.712	1.396	0.266	0.553	0.611	1.383	1
17.	NO_3^--N	mg/l	0.035	0.038	0.037	0.451	0.111	0.485	0.442	0.897	15
18.	NO_2^-- N	mg/l	0.007	0.012	0.014	0.016	0.004	0.025	0.036	0.051	0.05
19.	CN^-	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
20.	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
21.	Oil and Grease	mg/l	0.11	0.12	0.11	0.07	0.06	0.09	0.010	0.06	0.3
22.	Coliform	MPN /100 ml	2,400	2,400	2,400	13,000	2.4×10^4	9,000	10,000	90,000	10,000
23.	Total chemical plant protection (except DDT)	mg/l	0.000006	0.000006	0.000006	0.000017	0.000022	0.000019	0.000015	0.000038	0.15
24.	DDT	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.01
25.	Total Alpha	Bq/l	0.01	0.02	0.01	0.01	0.03	0.02	0.03	0.03	0.1
26.	Total Beta	Bq/l	0.02	0.02	0.02	0.02	0.01	0.03	0.02	0.04	1.0
27.	Total P	mg/l	0.31	0.29	0.33	0.65	0.72	0.51	0.42	0.59	-
28.	Total N	mg/l	3.1	3.6	4.2	3.8	5.0	3.2	3.8	3.5	-
29.	Cl^-	mg/l	8	9	12	7	4	3	5	6	
30.	Mn	mg/l	0.074	0.023	0.044	0.003	0.054	0.176	0.103	0.097	0.8
31.	PCBs	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-

Note: Shaded column means value do not satisfy TCVN

Source: JICA Study Team

Table J.3.8 Surface Water Quality in Dry Season

No	Parameters	Unit	Result								TCVN 5942-1995 Column B
			W1	W2	W3	W4	W5	W6	W9	W10	
1.	pH	-	7.6	7.4	7.7	7.8	6.4	6.8	7.6	6.9	5.5-9
2.	BOD_5	mg/l	11	13	19	6	3	11	9	15	< 25
3.	COD	mg/l	17	20	25	12	7	16	17	29	< 35
4.	SS	mg/l	18	16	20	9	35	14	23	17	80
5.	As	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.012	0.1
6.	Cd	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
7.	Pb	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.1
8.	Cr(VI)	mg/l	0.0003	0.0009	0.0022	0.0009	0.0017	0.0028	0.0032	0.0029	0.05
9.	Cr(III)	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	0.006	0.011	0.0012	0.0014	1
10.	Cu	mg/l	0.123	0.117	0.102	0.029	0.072	0.029	0.065	0.058	1
11.	Zn	mg/l	0.023	0.014	0.117	0.006	0.032	0.018	0.012	0.138	2
12.	Ni	mg/l	0.009	0.013	0.007	0.009	0.112	0.231	0.065	0.036	1
13.	Fe	mg/l	0.193	0.177	0.273	1.17	1.78	1.32	1.326	1.236	2
14.	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.002
15.	Sn	mg/l	0.0002	0.0003	0.0002	0.0026	0.0017	0.0011	0.0032	0.0009	2
16.	NH_4^+-N	mg/l	0.439	0.512	0.447	0.155	0.332	0.277	0.515	0.612	1
17.	NO_3^--N	mg/l	0.015	0.027	0.011	0.035	0.214	0.113	0.347	0.689	15
18.	NO_2^-- N	mg/l	<0.001	0.009	0.008	<0.001	0.002	0.013	0.022	0.016	0.05
19.	CN^-	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
20.	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
21.	Oil and grease	mg/l	0.08	0.18	0.17	0.14	0.09	0.13	0.08	0.16	0.3
22.	Coliform	MPN /100ml	2200	2400	3600	3000	12000	7000	6200	4200	10,000
23.	Total chemical plant protection (except DDT)	mg/l	0.000005	0.000003	0.000007	0.000021	0.000017	0.000023	0.000024	0.000033	0.15
24.	Total Alpha	Bq/l	0.02	0.02	0.01	0.01	0.04	0.02	0.02	0.04	0.1
25.	Total Beta	Bq/l	0.02	0.02	0.02	0.02	0.01	0.03	0.02	0.04	1.0
26.	DDT	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.01
27.	Total P	mg/l	0.61	0.33	0.57	0.53	0.46	0.64	0.48	0.73	-
28.	Organic Phosphorus	mg/l	0.29	0.32	0.41	0.27	0.32	0.39	0.23	0.42	-
29.	Total N	mg/l	1.7	2.2	1.9	2.0	2.4	2.9	3.2	3.4	-
30.	Cl^-	mg/l	6	8	7	12	17	8	7	11	-
31.	Mn	mg/l	<0.001	0.008	0.011	0.009	0.017	0.065	0.087	0.114	0.8
32.	Animal oil	mg/l	0.32	0.26	0.13	0.35	0.22	0.28	0.14	0.41	-
33.	Vegetable	mg/l	0.11	0.23	0.17	0.12	0.18	0.21	0.17	0.26	-
34.	PCBs	mg/l	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	-

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

The result of the ground water survey indicated that most of parameters satisfied the standard values as shown in TCVN 5944- 1995. However, during the rainy season, the value of Coliform at W8 was 800 times higher than the standard. In addition, during the dry season, the Coliform index at W8, W11, W12 was 4 to 6.6 times higher than the standard. In general, the

underground water in the area is relatively pure and can be used for domestic water supply after some heat treatment, such as boiling.

Table J.3.9 Ground Water Quality in Rainy Season

No	Parameter	Unit	Results			TCVN 5944-2005
			W0	W7	W8	
1.	pH	-	7.4	6.5	4.9	6.5-8.5
2.	Color	Pt/Co	9.9	18.1	137.2	5-50
3.	Turbility	NTU	0	0.70	0.25	-
4.	Hardness	$mgCaCO_3/l$	109.6	89.2	107.2	300-500
5.	TS	mg/l	180	110	162	750-1500
6.	As	mg/l	0.002	<0.001	<0.001	0.05
7.	Cd	mg/l	< 0.001	< 0.001	< 0.001	0.01
8.	Cl^-	mg/l	4	4	48	200-600
9.	Pb	mg/l	< 0.001	< 0.001	< 0.001	0.05
10.	Cr	mg/l	0.004	0.008	0.006	0.05
11.	CN^-	mg/l	<0.001	<0.001	<0.001	0.01
12.	F^-	mg/l	0.12	0.14	0.13	1
13.	Zn	mg/l	0.027	0.024	0.028	5
14.	NO_3^--N	mg/l	0.358	0.373	8.671	45
15.	Phenol	mg/l	< 0.001	< 0.001	< 0.001	0.001
16.	Fe	mg/l	0.743	0.370	0.213	1-5
17.	NO_2^--N	mg/l	<0.001	<0.001	0.014	-
18.	SO_4^{2-}	mg/l	1.7	<1	8.9	200-400
19.	Hg	mg/l	0.0004	<0.0001	<0.0001	0.001
20.	E.Coli	MPN/100ml	-	-	300	-
21.	Coliform	MPN/100ml	2	4	2,400	3
22.	NH_4^+-N	mg/l	<0.020	0.198	0.392	-
23.	S^{2-}	mg/l	0.0016	0.0254	0.0027	-
24.	Mn	mg/l	0.003	0.005	0.033	0.1-0.5

Note: 1. N.D. Not detected 2. Shaded column means value do not satisfy TCVN
Source: JICA Study Team

Table J.3.10 Ground Water Quality in Dry Season

No	Parameter	Unit	Results					TCVN 5944-2005
			W0	W7	W8	W11	W12	
1.	pH	-	7.1	6.8	6.4	6.8	6.6	6.5-8.5
2.	Odor	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
3.	Color	Pt/Co	6	12	36	21	13	5-50
4.	Turbility	NTU	0	0.3	0.2	0	0	-
5.	Hardness	$mgCaCO_3/l$	103	96	124	23	12	300-500
6.	TS	mg/l	228	132	156	178	216	750-1500
7.	As	mg/l	< 0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.05
8.	Cd	mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.01
9.	Cl^-	mg/l	5	6	24	5	8	200 - 400
10.	Pb	mg/l	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.05
11.	Cr(VI)	mg/l	< 0.001	< 0.001	0.006	0.002	0.002	0.05
12.	CN^-	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
13.	Cu	mg/l	0.015	0.033	0.011	0.023	0.008	1.0
14.	F^-	mg/l	0.13	0.11	0.17	0.23	0.13	1
15.	Zn	mg/l	0.032	0.026	0.029	0.006	0.006	5
16.	NO_3^--N	mg/l	0.235	0.218	5.478	0.575	0.423	45
17.	Phenol	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
18.	Fe	mg/l	0.921	0.547	0.415	0.081	0.093	1-5
19.	NO_2^--N	mg/l	<0.001	0.003	0.021	< 0.001	< 0.001	-
20.	SO_4^{2-}	mg/l	2	<1	4.8	<1	<1	200 - 400
21.	Hg	mg/l	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.001

No	Parameter	Unit	Results					TCVN 5944-2005
			W0	W7	W8	W11	W12	
22.	E.Coli	MPN/100ml	-	-	300	-	-	-
23.	Coliform	MPN/100ml	2	0	12	20	12	3
24.	NH_4^+-N	mg/l	0.034	0.107	0.226	0.043	0.056	-
25.	S^{2-}	mg/l	0.0021	0.032	0.0012	0.0032	0.0016	-
26.	Cr(III)	mg/l	0.002	0.003	0.005	0.003	0.003	
27.	Mn	mg/l	0.011	0.009	0.028	<0.001	0.004	0.1-0.5

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

3.2.2 Result of Air Quality Survey

The results of the survey showed that the air quality surrounding the Study Area is polluted by dust, which might be caused by traffic. The values relating to dust, specifically TSP (Total Suspended Particulates) and PM_{10} (Particulate Matter smaller than 10 μm), observed along National Road 21 and LHEE has exceeded the limit as specified by TCVN 5937-2005. One of the major causes for dust may be due to construction works that is going around the HHTP area. It is likely that these construction activities may be deteriorating the air quality, especially the concentration of particles in the ambient air. On the other hand, the values of SO_2 (sulfur dioxide), CO (carbon monoxide) and NO_2 (nitrous oxide) did not indicated any serious polluted conditions. It was observed that the air quality in the rainy season was generally better than that in the dry season.

Table J.3.11 Air Quality in Rainy Season

Unit: mg/m^3

Parameter	AN1	AN2	AN3	AN4	AN5	AN6	AN7	AN8	AN9	TCVN 5937-2005
SO_2	0.0030	0.0035	0.0029	0.0022	0.0050	0.0044	0.0053	0.0060	0.0052	0.35
CO	3.771	3.785	4.585	3.771	4.442	3.914	3.342	4.714	2.842	30
NO_2	0.0022	0.0028	0.0026	0.0030	0.0028	0.0026	0.0037	0.0040	0.0016	0.2
TSP	5.194	0.544	2.515	3.889	12.537	0.308	0.751	0.312	0.103	0.3
PM10	0.160	0.164	0.149	0.162	0.179	0.0618	0.099	0.053	0.100	0.15

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

Table J.3.12 Air Quality in Dry Season

Unit: mg/m^3

Parameter	AN1	AN2	AN3	AN4	AN5	AN6	AN7	AN8	AN9	TCVN 5937-2005
SO_2	0.0082	0.0123	0.0084	0.0138	0.0102	0.0099	0.0105	0.0097	0.0061	0.35
CO	5.43	6.70	7.1	5.64	8.011	5.119	5.339	5.213	3.617	30
NO_2	0.023	0.0183	0.0226	0.0171	0.0209	0.0077	0.0085	0.0067	0.0028	0.2
TSP	7.128	3.83	4.73	6.38	16.32	1.247	2.321	1.036	0.160	0.3
PM10	0.230	0.336	0.267	0.412	0.368	0.109	0.117	0.047	0.112	0.15

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

3.2.3 Result of Noise Survey

The survey results showed that the noise level, quantified by LAeq (noise level equivalent, "A" weighted), at AN1, AN2, AN3 and AN4 is almost as high as the standard for manufacturing areas, which allows relatively loose value (e.g. 75dB(A) for 6:00-18:00, 70dB(A) for 18:00-22:00, 50dB(A) for 22:00-6:00) among four areas defined in TCVN5949-1998. The result at AN5 indicated that this location was affected due to traffic, similar to the four points along National Road 21 and LHLE. At other points, namely AN6, AN7, AN8 and AN9, these were recognized as residential areas in terms of the noise environment according to the relevant TCVN.

Table J.3.13 Noise Level in Rainy Season

No			Noise level Leq (dB(A))		
			6:00- 18:00	18:00- 22:00	22:00- 6:00
1	AN1	Km28, Lang-Hoa Lac high way - Hamlet 2,Thach Hoa commune	74	68	57
2	AN2	Km 29+500-Lang Hoa Lac Highway, Hamlet 5-Thach Hoa commune	70	62	54
3	AN3	National No 21 (to Xuan Mai)	76	70	58
4	AN4	National No 21 (to Son Tay). Hamlet 8, Thach Hoa commune	72	60	51
	TCVN: Manufacturing area		75	70	50
5	AN5	Residential area of HHTP	72	59	47
6	AN6	Education zone of HHTP	56	44	35
7	AN7	Resettlement area	58	48	41
8	AN8	Opposite HHTP area, Hamlet 9- Thach Hoa commune.	62	56	46
9	AN9	Start-up center	52	49	38
	TCVN: Resident areas, hotels, accommodations, administrative agencies		60	55	45

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

Table J.3.14 Noise Level in Dry Season

No			Noise level Leq (dB(A))		
			6:00- 18:00	18:00- 22:00	22:00- 6:00
1	AN1	Km28, Lang-Hoa Lac high way - Hamlet 2,Thach Hoa commune	78	72	61
2	AN2	Km 29+500-Lang Hoa Lac Highway, Hamlet 5-Thach Hoa commune	74	71	62
3	AN3	National No 21 (to Xuan Mai)	77	72	57
4	AN4	National No 21 (to Son Tay). Hamlet 8, Thach Hoa commune	74	61	52
	TCVN: Manufacturing area		75	70	50
5	AN5	Residential area of HHTP	72	59	47
6	AN6	Education zone of HHTP	56	44	35
7	AN7	Resettlement area	58	48	41
8	AN8	Opposite HHTP area, Hamlet 9- Thach Hoa commune.	62	56	46
9	AN9	Start-up center	58	47	40
	TCVN: Resident areas, hotels, accommodations, administrative agencies		60	55	45

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

3.2.4 Result of Soil and Sediment Survey

The result of soil analysis in the rainy season during November 2008 revealed the existence of soil contamination with copper and arsenic. In the dry season, the number of sampling points was increased by 4 locations to check the broad extent of the contamination area. The result of survey in the dry season indicated that a concentration of copper was relatively high, as the

value of copper in three of the four samples exceeded the standard for agricultural land. Considering the land use in the survey site, it is assumed that source of these contaminations might come from the natural origins.

Table J.3.15 Results of Soil Survey in Rainy Season

Parameter	Unit	Results			TCVN 7209-2002
		G1	G2	G3	Agricultural land
pH_{KCl}	-	3.9	4.0	3.9	-
Cu	mg/kg	120	149	163	50
Pb	mg/kg	123	110	143	70
Cd	mg/kg	0.03	0.06	0.12	2
Zn	mg/kg	177	198	139	200
Fe	mg/kg	66,900	59,320	67,102	-
As	mg/kg	18	12	11	12

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

Table J.3.16 Results of Soil Survey in Dry Season

Parameter	Unit	Results							TCVN 7902-2002
		G1	G2	G3	G4	G5	G6	G7	
pH_{KCl}	-	3.7	3.9	3.9	3.6	3.6	3.8	4.1	-
Cu	mg/kg	58.9	68.7	54.2	43.4	56.8	66.0	57.3	50
Pb	mg/kg	42	54	14.6	10.6	13.8	17.3	14.7	70
Cd	mg/kg	0.02	0.18	0.75	0.34	0.34	0.40	0.36	2
Zn	mg/kg	56.7	92.6	83.8	72.4	94.0	118	49.3	200
Fe	mg/kg	6,6900	59,320	44,600	60,920	37,200	51,600	42,156	-
As	mg/kg	18	12	9.8	11.2	7.2	9.3	7	12

Note: Shaded column means value do not satisfy TCVN
Source: JICA Study Team

The concentrations of iron and manganese in sediment were rather high compared to values in TCVN 5949-1998, while there is no standard for sediment in Vietnam. It is supposed that heavy metals from upper river source might have accumulated in sediments of Tan Xa Lake and Tich River.

Table J.3.17 Results of Sediment Survey

Parameter	Unit	S1		S2	
		Rainy season	Dry season	Rainy season	Dry season
pH_{KCl}	-	7.1	7.2	6.8	7.1
Pb	mg/kg	39	24	150	72
Cd	mg/kg	< 0.03	0.05	0.15	0.13
Zn	mg/kg	183	101	1080	989
Cu	mg/kg	84	27	150	121
Fe	mg/kg	26.040	32.032	12.660	13.760
Mn	mg/kg	285	116	1674	536
As	mg/kg	12	8	60	32
Total organic chlorinated pesticide	mg/kg	0.0184	0.0092	0.0211	0.0036

Source: JICA Study Team

3.3 FLORA AND FAUNA SURVEY

3.3.1 Survey Methodology

Two methods were mainly adopted for the survey. One was a field trip, which included investigation of the site and interviews with local people. The other was a literature study which utilized information available in existing documents.

The survey periods of site investigations were as follows:
1) 10th October, 2008 to 18th October, 2008
2) 22nd November, 2008 to 28th November, 2008

3.3.2 Result of Survey

As a result of flora, 286 species were listed. Listed species of flora contains wild and cultivated species. They are widely spreading, and continuously regenerating. The summary of the result of survey of fauna is illustrated in Table J.3.18. This result in Table illustrated that plantation in forest is the richest habitat for vertebrate animals in the project area. Species listed in this habitat are not only restricted within this habitat but it appears they also move to near habitats depending on the seasons and environmental conditions. The fishes composition in the water-bodies of HHTP area consist of 45 species belong to 16 families, 6 orders.

Threatened species whose existences were observed and implied in the survey are shown in Table J.3.19. While existences of some of the species were only be concluded through the interview with local people. The conservation of the threatened species should be considered during the project implementation.

Table J.3.18 Summary of Fauna in the Study Area

Classification	Planted forest area	Agricultural area	Residential area	Aquatic habitat	Total
Mammalia	11	6	13	0	30
Aves	50	43	41	18	152
Reptilia	16	11	12	3	42
Amphibia	1	8	7	7	23
Fish	0	0	0	45	45
Total	78	68	73	28	292

Source: JICA Study Team

Table J.3.19 Threatened Species in the Study Area

No	Scientific name	Reference				Remarks
		ND32/2006	SDVN/2007	IUCN 2008	CITES 2008	
Plant						
1.	*Erythrofleum fordii Oliv*	IIA				Observed
Aves						
2.	*Otus bakkamoena*				II	Observed
3.	*Glaucidium cuculoides*				II	Observed
4.	*Milvus migrans*				II	Observed
5.	*Spilornis cheela*	IIB			II	Observed
Reptilia						
6.	*Elaphe radiata*	IIB	VU			Observed
7.	*Ptyas korros*		EN		II	Observed
8.	*Ptyas mucosus*	IIB	EN			Observed
9.	*Bungarus fasciatus*	IIB	EN		II	Interview
10.	*Bungarus multicinctus*	IIB			II	Interview
11.	*Naja naja*		EN		II	Observed
12.	*Pyxidea mouhoti*			VU	II	Interview
Fish						
13	*Elopichthys bambusa*		VU			Interview
Total		6	6	1	9	

Note: Criteria of threaten species
1. ND32/2006: Governmental Decree No 32/2006/ND-CP:
   IIA/IIB: Limit of exploitation and use
2. SDVN/2007: Red Data Book of Vietnam 2007: EN: Endangered; VU: Vulnerable
3. IUCN2008: Red list 2008: VU: Vulnerable
4. CITES2008: the Convention on International Trade in Endangered Species of Wild Fauna and Flora: Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled.

Source: JICA Study Team

3.4 INTERVIEW SURVEY

The following information was collected from local authorities and through an interview survey with local residents.

1) Number of households to be resettled and compensated
2) Characteristics of local households, such as family structure, livelihood, property
3) Preference for the HHTP project

In the interview survey, the sampling number was set to three (3) communes located in the Study Area, as shown in Table J.3.20. Considering the number of households to be resettled, it was intended that about 20% of households who will be resettled will be interviewed during the survey.

Results of survey were described in Section 1.1.1 (4) as "Profile of the affected people by the HHTP Project".

Table J.3.20 Number of Samples for the Interview Survey

Commune	Number of Sample (household)
Tach Hoa	250
Tan Xa	100
Ha Bang	100
Total	450

Source: JICA Study Team