G.7 PRE-FEASIBILITY STUDY OF PHNOM PENH INDUSTRIAL AREA SITE-6

G.7.1 Development Framework

(1) Prospective Investors by Category of Industry and Lot Size

Considering the Phnom Penh Industrial Area (the Site-6 selected an appropriate site in the chapter 7 of the main text and called hereinafter PIA) locates near the Phnom Penh International Airport, the airport based category of industry is planned to establish in PIA. The number of the electric appliance, jewelry, and light industry of sports goods and toy manufacturers is designed to be double of the Sihanoukville Industrial Area The distribution plan of factory lot in the PIA can be designed as shown in **Table G-19**. 78 lots for the manufacturer with the total lot area of 118 ha can be developed in the PIA.

Table G-19 Planned Number of Investors by Category of Industry and Lot Size for the PIA

ISIC Code	The category of Industry	Planned Num of FDI Demand							Plot Demand (ha)
		−2500 ㎡	2500㎡	5000㎡	1 ha	2 ha	2ha−	Total	
311-312	Food manufacture		1	1	1	1	1	5	7.8
321	Textiles		1		3	1	1	6	9.3
322	Wearing apparel except footwear		1	1	1	1		4	3.8
332	Furniture and fixture					1		1	2.0
3412	Containers and boxes of paper		2	2			2	6	9.5
3522	Drugs and medicines			2	1	1		4	4.0
3523	Soap and cleaning preparations, perfumes,			1	1	2		4	5.5
355	Rubber products			2		2		4	5.0
361	Pottery, china and earth ware		1	1		1	1	4	6.8
383	Electrical machinery, apparatus, appliance			5	12	11	5	33	56.5
3901	Jewellery and related articles			2				2	1.0
3901	Sporting and athletic goods		2					2	0.5
3909	Toys and other manufacturing industries		1			1	1	3	6.3
	Total	0	9	17	19	22	11	78	117.8

Source: JST

(2) Development Demand

The development of the PIA with the factory area of 118 ha, will induce approximately 14,000 job opportunities as shown in **Table G-20**. Approximately 8,800 m3/day water, 13.7 kW electricity, and 410 telephone lines will be necessary to provide the efficient infrastructure.

Table G-20 Employment Induced and Infrastructure Demand for the PIA

ISIC Code	The category of Industry	Plot Demand (ha)	Num of Employee		Water Demand		Electricity Demand		Telephone Demand	
			Employee /ha	Employee	m^3/ha	m^3/day	W/m^2	kW	line/ factory	lines
311-312	Food manufacture	7.8	100	800	300	2,330	8	600	5	25
321	Textiles	9.3	150	1,400	100	930	8	700	5	30
322	Wearing apparel except footwear	3.8	500	1,900	50	190	8	300	5	20
332	Furniture and fixture	2.0	50	100	40	80	8	200	5	5
3412	Containers and boxes of paper	9.5	70	700	50	480	8	800	5	30
3522	Drugs and medicines	4.0	100	400	100	400	10	400	5	20
3523	Soap and cleaning preparations, perfumes,	5.5	100	600	150	830	10	600	5	20
355	Rubber products	5.0	100	500	150	750	10	500	5	20
361	Pottery, china and earth ware	6.8	100	700	50	340	8	500	5	20
383	Electrical machinery, apparatus, appliance	56.5	100	5,600	40	2,250	15	8,140	5	165
3901	Jewellery and related articles	1.0	150	200	40	40	8	100	5	10
3901	Sporting and athletic goods	0.5	150	100	50	30	8	0	5	10
3909	Toys and other manufacturing industries	6.3	150	900	20	130	8	500	5	15
	Utility/facility			100		10		360		20
	Total	117.8	119	14,000	75	8,790	12	13,700	5	410

Source: JST

G.7.2 Land Use Plan

The development principles of the Sihanoukville Port Free Zone as explained in I.2.2 is also applied to the PIA. Following is additional ideas for PIA.

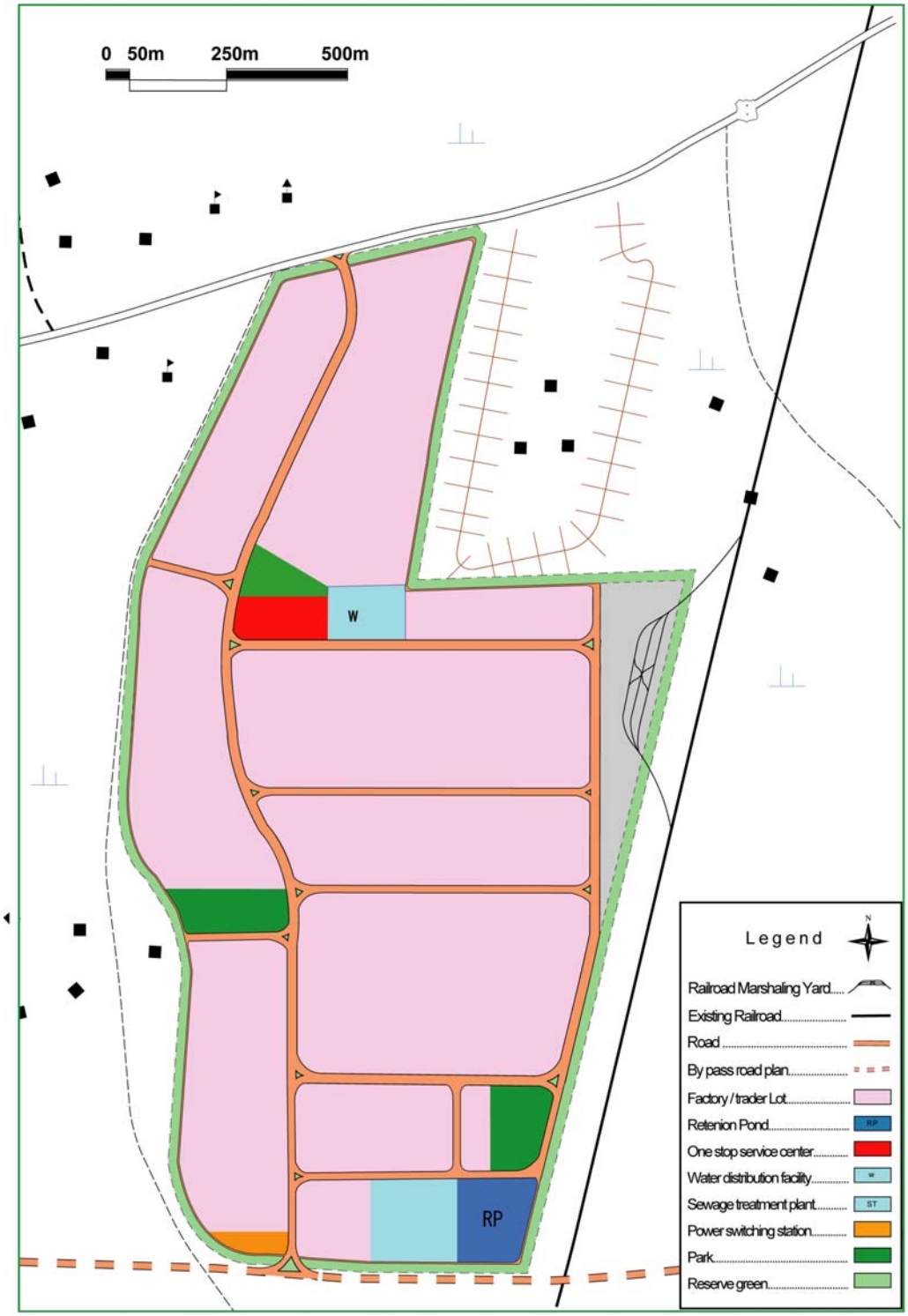
- The site has the locational advantage by direct connection to Route 4 and proximity to the Phnom Penh International Airport.
- The outstanding industrial zone with the well designed landscape and facilities should be developed in the western suburb of prospering new industrial area of the capital.

110 ha of the factory, 69.9% of the total area, can be provided as shown in **Table G-21**, while the road, utilities and parks with respective area of 9.3 ha, 11.0 ha and 25.0 ha will be necessary to attract FDI.

Table G-21 Land Use Plan of Expansion Area of PIA

Item	ha	%	Remarks
1 Factory/trader lot	109.73	69.9%	
2 One stop service center	2.00	1.3%	
3 Road	9.27	5.9%	Roads of access, main/submain,
4 Utility	11.00	7.0%	Water pump station, power
5 Others	25.00	15.9%	Park ad reserve green
Total	157.00	100.0%	

Source: JST



The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-23 Land Use Plan of PIA**
Japan International Cooperation Agency (JICA)	

G.7.3 Water Supply Facility

(1) General Conditions

1) Water Resources Potential

Water supply capacity in/around the project area is very limited. Mean annual rainfall at Phnom Penh city and Kampong Spueu city are around 1,370 mm and 1,170 mm, respectively. Isohyetal map of mean annual rainfall in Cambodia is shown in **Figure G-24**.

Mean monthly rainfall is shown in **Figure G-25**. Near the project site, it is considerable that the Prek Thnot River is a major water source for the proposed Phnom Penh Industrial Area (PIA). However, the river flow of the Prek Thnot River is almost dried up in the dry season as shown in **Table G-22**. 80% reliable monthly flow in March at Anlong Touk station (C.A.=3,650 km^2) of the Prek Thnot River is only 0.2 m^3/sec. In the Prek Thnot River, between the Anlong Touk station and near the project area, there are some intake facilities for the water supply system to the Kampong Spueu and for irrigation. Therefore, downstream stretch of those water intake, the river flow will be dried up in dry season.

Further, the groundwater potential in the Phnom Penh and Kampong Spueu area is very low. The average yield of existing wells indicates at only 50 ~ 70 m^3/day as shown in **Table G-23**.

It is very difficult to supply water such as large demand of around 10,000 m^3/day (= 0.1 m^3/day) for the proposed Industrial Area by groundwater or rivers (without Mekong River) in this area.

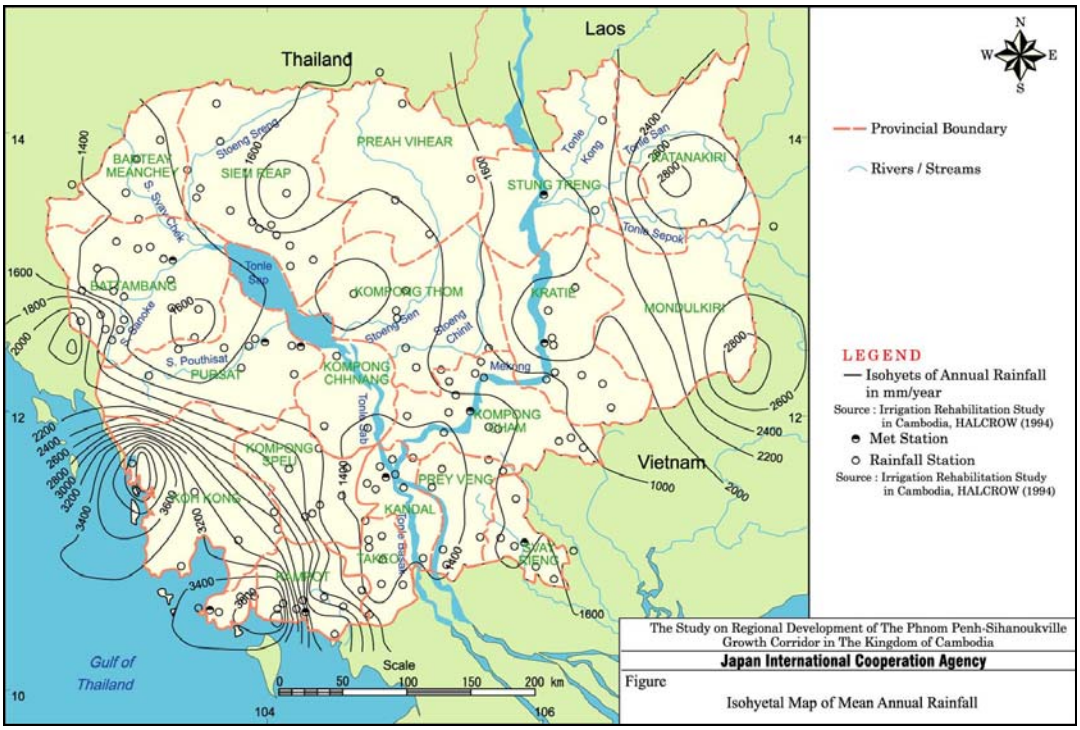
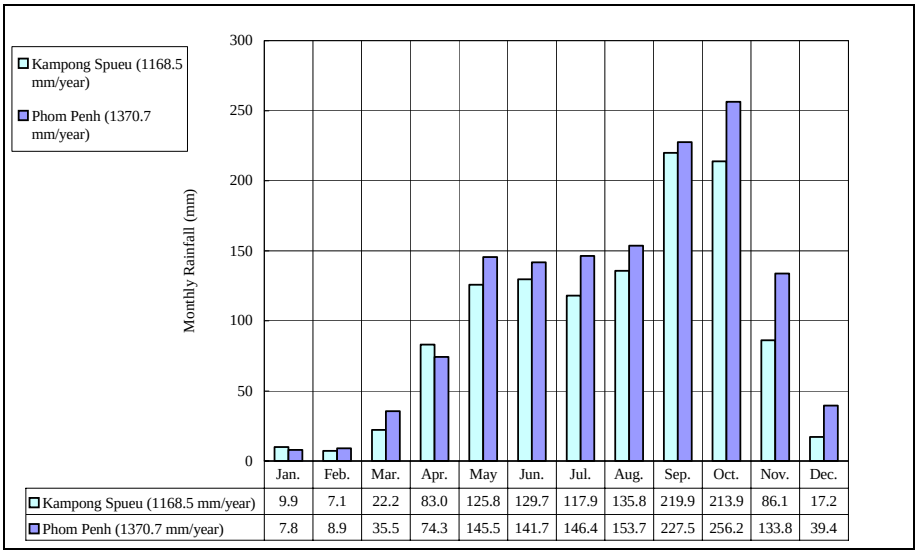


Figure G-24 Isohyetal Map of Mean Annual Rainfall in Cambodia



	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Kampong Spueu (1168.5 mm/year)	9.9	7.1	22.2	83.0	125.8	129.7	117.9	135.8	219.9	213.9	86.1	17.2
Phom Penh (1370.7 mm/year)	7.8	8.9	35.5	74.3	145.5	141.7	146.4	153.7	227.5	256.2	133.8	39.4

Figure G-25 Mean Monthly Rainfall in Study Area

Table G-22 Mean and 80% Reliable Monthly Discharge at Key Stations

River / Station (C.A. km^2) (Province)		Monthly Discharge (m^3/sec)												Annual
		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	(m^3/s)
Mekong / Phnom Penh (663,000) (Phnom Penh)	Mean	3,450	2,380	1,980	1,890	2,800	9,510	21,660	33,370	37,680	24,420	11,400	6,200	13,062
	80%	3,011	2,150	1,728	1,717	2,121	7,104	13,865	25,375	32,551	16,342	8,445	4,363	9,907
Prek Thnot / Anlong Touk (3,650) (Kampong Spueu)	Mean	2	1	1	3	16	26	35	67	105	141	44	8	37
	80%	1.7	0.4	0.2	0.7	6.8	2.1	15.1	23.9	46.7	63.0	7.9	2.7	29

Source: Irrigation Rehabilitation Study in Cambodia, Mekong Secretariat, Halcrow, (1994).

Table G-23 Average Yield of Well near the Project Area

Province	Major Hydrogeological Divisions	Range of Yield (m^3/day)	**Average Yield (m^3/d)**	Range of Well Depth (m)	Ave. Depth (m)
Phnom Penh	Basement Rock, Alluvium	2.4 ~ 960 *1) 1.5 ~ 20 *2)	**50.5** *1)	8.1 ~ 100 *1)	28.5 *1)
(Northern) Kandal	Bedrock Aquifer	10 ~ 15 *2)	**12.5** *2)		
Kampong Spueu	Basement Rock, Alluvium	2.4 ~ 1900 *1) 0 ~ 15 *2)	**70.5** *1)	6 ~ 100 *1)	28.3 *1)

Source *1): Database of Well, Ministry of Rural Development, UNICEF, (1980).
*2): Optimal yield. The Study on Groundwater Development in Southern Cambodia, JICA, (2002).

2) Present Water Supply System in Kampong Spueu City

About 65% of the population in the service area of the Phnom Penh, and 29% of in the Kampong Spueu town have access to piped water supply at present.

As shown in the **table** below, the plant capacity of existing water supply systems in Phnom Penh City and Kampong Spueu town are 120,000 m^3/day and 1,400 m^3/day respectively. Supply capacity of the Kampong Spueu city is not enough in the dry season due to dried up of the Prek Thnot River.

Table G-24 Plant Capacity and Future Plan of Urban Water Supply Systems in Phnom Penh and Kampong Spueu

Province	District	Design Capacity (m^3/d)	Present Capacity (2002) (m^3/d)	Daily Average Production (m^3/d)	Rate of Facility Utilization (2002) (%)	Water Tariff (Riel/m^3)	Water Production Cost (Riel/m^3)	Present Water Demand (m^3/d)	Water Source	Capacity of Water Source	Type of Treatment Plant *1)	Distri-bution System
Phnom Penh	Peri-Urban	235,000 (2003)	120,000			350			River (Mekong, Tonle Sap, Bassac)	Enough	SD	Pump
Kampong Spueu	Chbar Mon (U)	1,400	1,300	550	42%	1,500	1,125	> 550	Prek Thnot River	Limited (Dry Season)	SD	Gravity

Source : MIME; PPWSA; JICA Expert Report; Dept. of IME of Kampong Speu Province; SWSA.
Note *1) SD: Flocculation and Sedimentation Basin Type

3) Present Water Supply System in Phnom Penh

The Phnom Penh Water Supply Authority (PPWSA) is the responsible organization for the water supply in the Phnom Penh City, while the Municipality of Phnom Penh (MPP) is responsible for the management of urban water resources.

The Municipality's water supply system, which was constructed between 1895 and 1960, has deteriorated profoundly. Decades of civil war destroyed the city's infrastructure, and the water supply capacity shrank from 155,000 m^3/day in the 1960s to a paltry 63,000 m^3/day by 1992. That was because not only of destruction of the facilities and also its poor maintenance during the war, lack of spare parts equipment and other materials and shortage of power supply.

With the assistance of external funding and internal reforms, the PPWSA has been transformed into an efficient, self-financed, autonomous organization with a committed and enthusiastic workforce; a computerized billing system of customers, thereby improving customer collections; and earning revenues more than sufficient to cover maintenance and operating costs.

Water coverage now encompasses 100% of the inner-city of Phnom Penh and is being expanded to surrounding districts, giving priority on the urban poor communities. The bill collection has risen to 99% in 2002 (from 40% in 1993), and the city's water infrastructure has been invested a new 600 km distribution network, replacing the old 280 km network.

Table G-25 Improvement of Water Supply System in Phnom Penh

Items	1992	Early 2000	End of 2001
Population	About 700,000	About 1,050,000	
Served Population	About 130,000	About 330,000	
Connected Households	About 20,000		74,945
Coverage	35%	60%	
Treatment Capacity	56,000 m^3/day	120,000 m^3/day Phum Prek : 100,000 m^3/d Cham Carmorn : 20,000 m^3/d	120,000 m^3/day Phum Prek : 100,000 m^3/d Cham Carmorn : 20,000 m^3/d
Distribution Pipe Length	280 km		517.6 km
Service Hour	Intermittent, 12 hr/d	Stable, 24 hr/d	Stable, 24 hr/d
Supply Pressure	Almost 0	0 ~ 10 m	> 20 m
Water Quality	Undrinkable	Improved	Improved
Equipped Meter Ratio	12%	99.5%	99.99%
Collection Ratio	40%	91.7%	96.78%
Leakage Ratio	> 70%		23%

Source: PPWSA

By 2004 it is predicted that the water supply capacity in the city will increase to

235,000 m3/day, making it possible to supply reliable and safe drinking water to all Phnom Penh's 1 million inhabitants.

Table G-26 Water Treatment Capacity Plan of PPWSA

Items	End of 2001	March, 2003 (Plan)
Treatment Capacity	120,000 m^3/day Phum Prek : 100,000 m^3/d Cham Carmorn : 20,000 m^3/d	235,000 m^3/day Phum Prek : 150,000 m^3/d Cham Carmorn : 20,000 m^3/d Chruoy Chang War: 65,000 m^3/d
Distribution Pipe Length	517.6 km	733.0 km

Source: PPWSA

Master plan of Phnom Penh water supply system was prepared in 1993 by JICA. The estimated water demand and the water development plan of the master plan are shown in **Figure G-26**.

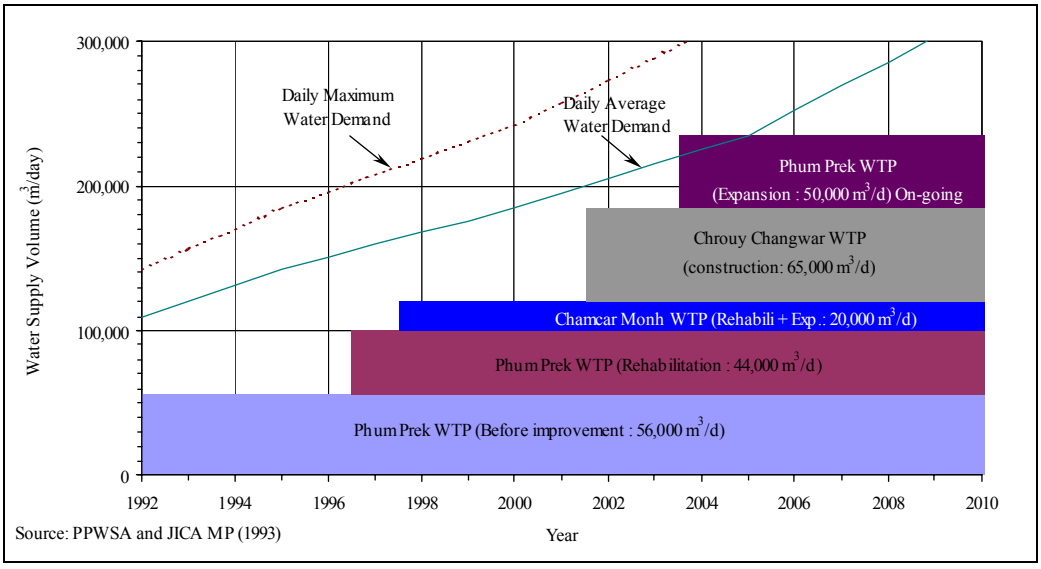


Figure G-26 Water Demand and Development Plan of PPWSA by Master Plan

Based on the master plan (1993), the water supply capacity of the PPWSA will be not enough to daily average water demand after 2005. It will be required to construct of additional water treatment system to meet the future water demand.

4) Outline of Water Supply to Phnom Penh Industrial Area (PIA)

As described above, it is very difficult to supply water for the PIA by groundwater or rivers (without Mekong River) in thie vicinity. Therefore, following development alternatives are considerable as water source for proposed PIA.

Alternative-1 : water supply from new developing of own water intake at Mekong River (Tonle Sap or Tonle Basak rives).

Alternative-2 : water supply from PPWSA. Connecting to existing water supply pipeline of PPWSA.

The Alternative-1 has several disadvantages on cost and water rights. In this case, it is necessary to construct of long-distance pipeline with around 16 km from the PIA site to Tonle Sap or Tonle Basak rives, and own intake facilities and treatment facilities. Alternative-2, on the other hand, requires the increase of

supply and treatment capacity of PPWSA.

In this study, the water supply to the PIA is planned to connect pipeline to the PPWSA system (Alternative-2) in consideration of the cost performance. Basic concept of the water supply for the PIA is summarized as follows.

- PIA is planned to connect existing water supply pipeline of PPWSA at Prey Pring Choung (confluence of National Road No.4 and No.3) near the Phnom Penh International Airport.
- Connecting pipeline will be constructed by PIA.
- Due to use of treated water of PPWSA, disinfection facilities such as flocculation basin, sedimentation basin, rapid sand filters or chemical input facilities, etc. are not planned to construct in PIA.

(2) Design Conditions

1) Water Demand

Water supply facility for the PIA is comprised of connection pipelines from existing PPWSA water supply pipeline, receiving wells, distribution reservoir, distribution pumps, elevated tanks and water distribution pipes. The average daily water demand for the PIA is estimated at 8,790 m^3/day.

2) Design Discharge

The design flow rate for the PIA is assumed as follows.

Table G-27 Design Conditions of Water Supply Facilities for the PIA

Items	Water Flow	Remarks
Daily average water demand	8,790 m^3/day	
Daily average water consumption	10,548 m^3/day	Unaccounted water ratio = 20%
Daily maximum water consumption	12,658 m^3/day	Daily fluctuation factor = 1.2
Hourly maximum water consumption	1,319 m^3/hr	Hourly fluctuation factor = 2.5

The capacity of distribution pumps and distribution pipes in the supply area is designed taking the consideration of the fire-fighting water (extinguishing water) of 1.0 to 1.5 m^3/min in addition to the ordinary water consumption. Thus, the maximum water consumption (MWC) including the fire-fighting water is shown as follows.

MWC= 22.0 m^3/min (or 1,319 m^3/hr) + 1.5 m^3/min = 23.5 m^3/min

3) Design Criteria

Design criteria for the water supply facilities in PIA are used of same criteria for SIA-4 as descried in the **Section G.5.3**.

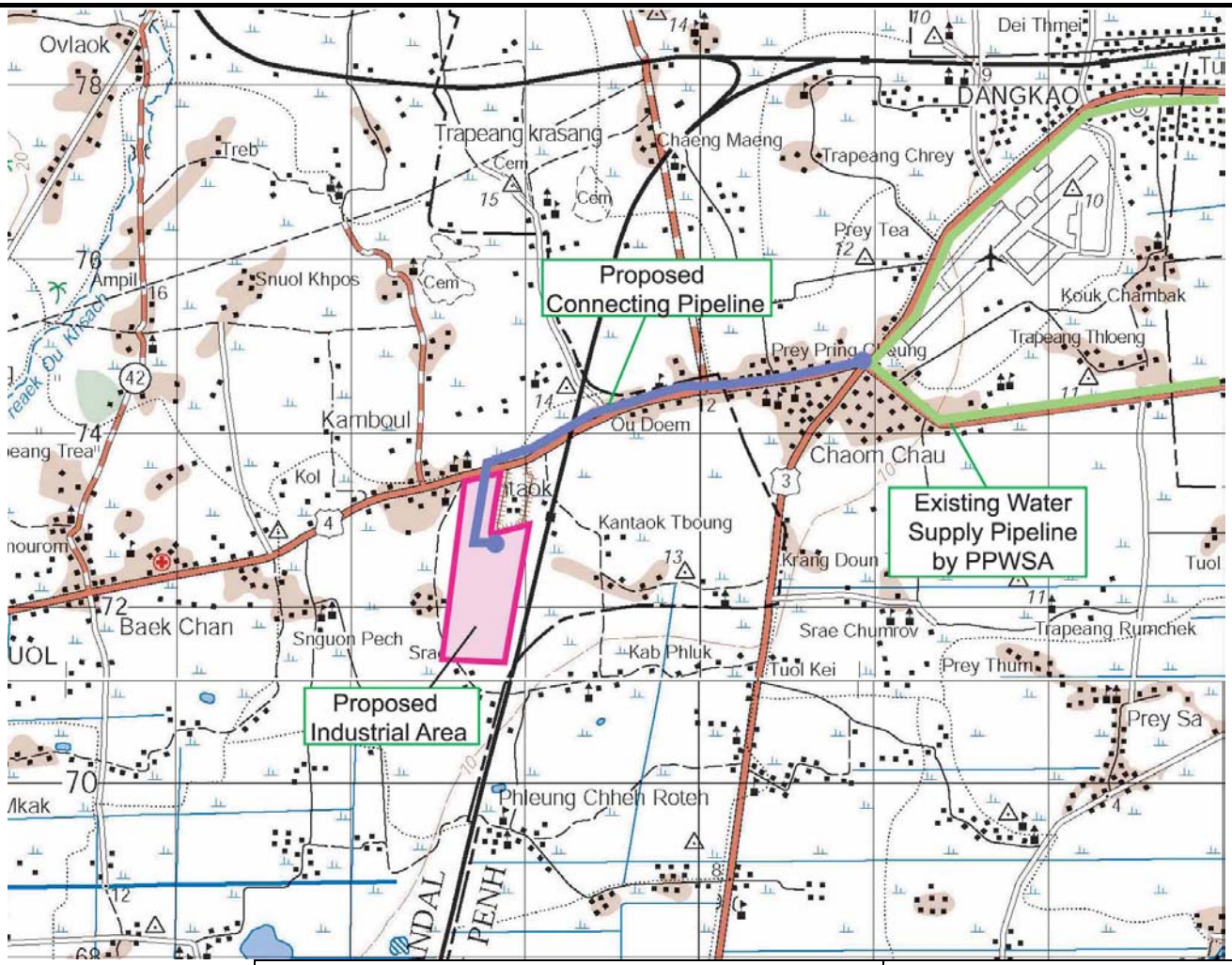
4) Specifications

Location map of proposed connecting pipeline is shown in **Figure G-27**. The water distribution network plan in the PIA are designed as shown in **Figures G-28**.

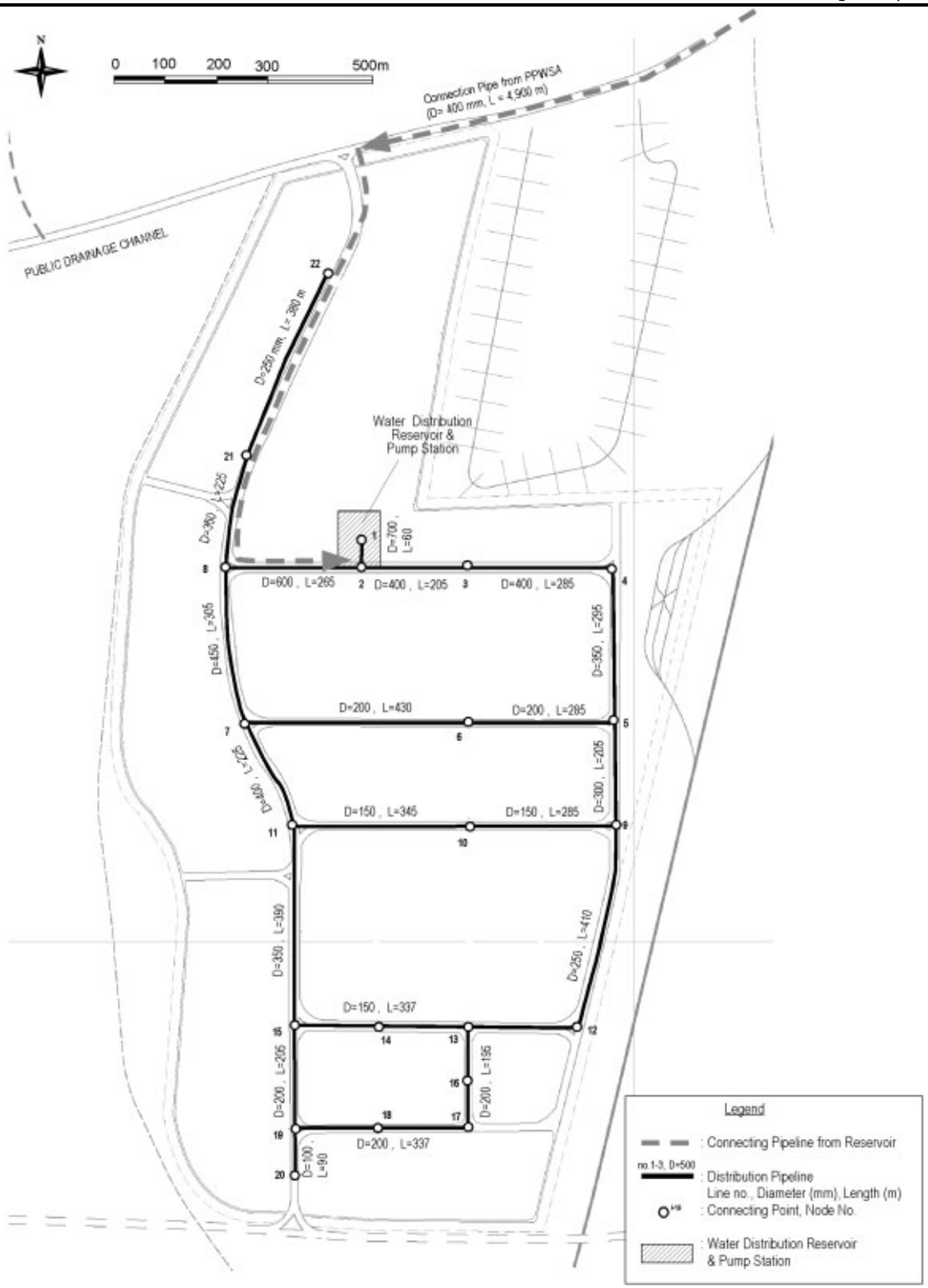
Proposed water supply system for the PIA is shown in the **table** below.

Table G-28 Proposed Water Supply System for PIA

Items	Specifications
1. Connecting Pipeline	
Pump	4.6 m^3/min x H 20 m x 8 kW x 4 sets (including 1 standby)
Pump House	5 m x 12 m x 1 sites
Electric Power	From EDC electric distribution line
Connecting Pipeline	DIP 400 mm Dia. x Total 4,900 m Length
2. Distribution Facility	
Receiving Well	H 3.0 m x W 2.27 m x L 2.27 m x 2 wells = V 2.0 m^3
Elevated Tank	Total Vol.=192 m^3 (30 minutes of maximum hourly Q)
	H = 15 m (LWL =EL.20m), Depth =4 m x DiG.8 m x 1 tank.
Pump Station	5 m x 5m = 25 m^2 x 1 house
Distribution Pump	4.6 m^3/min x H 25 m x 10 kW x 7 sets (including 1 standby)
Transformer	1 set
Distribution Pipeline	PVC 100 - 150 mm Dia. x Total 1,057 m Length
	DIP 200 - 700 mm Dia. x Total 4,702 m Length



The Study on Regional Development of The Phnom Penh - Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-27 Proposed Connecting Pipeline to Existing PPWSA Water Supply Pipe**
Japan International Cooperation Agency (JICA)	



The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-28 Distribution Network Plan (PIA)**
Japan International Cooperation Agency (JICA)	

G.7.4 Drainage

(1) Design Considerations

The ground of the site will be reclaimed at the level higher than the surface of the National Road No.4, so that the site is not submerged even in the heavy rain, based on the past flooding history. The total area of drainage basin is 157 ha. The drainage consisting of stormwater channels, a retention pond and a stormwater discharge system will be furnished to drain out rainwater.

Existing public open channels, which will be used for the discharge of stormwater in the region, have been only partially provided along the National Road No.4, at present. It is essential that the connection works of those public channels to the Tnaot River be completed until the due time.

(2) Design Conditions

To calculate the rainfall, the following rainfall formula for 5-year return (probability of once in five years), which was established in the "Study on Drainage Improvement and Flood Control in the Municipality of Phnom Penh" (JICA, 1999), has been applied.

$$I_{rain} = 5000 \times (60T + 31.4)^{-0.98}$$

Where,

I_{rain} : Hourly rainfall (mm/h)

T : Duration time (h)

The calculation result of this formula is shown in **Figure I.2.5-2**.

(3) Design Criteria

The same criteria as the PIA described in the section I.2.5 have been applied.

(4) Specifications

1) Stormwater Channel

Stormwater channels, which are of open channel with opposite trapezoidal shape and of earth- constructed with stone lining, will be installed along the roads to collect and transport stormwater as shown in **Figure G-29**. The channels to be installed are described as follows:

- Stormwater Channels:	Small Size (2 - 3m Width)	Total length 1,240m
- Stormwater Channels:	Medium Size (4 - 6m Width)	Total length 4,120m
- Stormwater Channels:	Large Size (7 - 10m Width):	Total length 4,080m
		Overall length 9,440m

2) Retention Pond

A retention pond, as shown below, will be constructed to reduce the peak flow of stormwater discharge from the site.

- Retention Pond:	1 unit	110m Width x 110m Length x 5.5m Depth ($46,000m^3$ Volume)

3) Discharge System of Stormwater

Stormwater will be discharged into the public drainage channel along the National Road No.4 through an open channel by pumps, as described below:

- Discharge pump: 2 units 8.9 m^3/sec x 4 mH
- Open channel: 8m Width, Length 2,600m

G.7.5 Sewerage

(1) General Considerations

In the same manner as the PIA described in the section I.2.6, the total pollution load to be generated has been estimated at:

	BOD (kg/day)	SS (kg/day)
- Total pollution loads:	4,003	3,570

Treated wastewater will be discharged into the Tnoat River thorough embedded pipes, as shown in **Figure G-30**.

(2) Design Conditions

The flowrate of wastewater to be generated from factories has been estimated in the same manner as the PIA described in the section I.2.6.

- Daily Average Flow:	(m^3/day)	8,700
- Daily Maximum Flow:	(m^3/day)	10,450
- Hourly Maximum Flow:	(m^3/hr)	1,090

The quality of wastewater to be generated and treated wastewater has been set in the same manner as the PIA, as follows:

		Incoming Wastewater	Treated Wastewater
- pH:		5 - 9	5 - 9
- BOD:	(mg/l)	460	less than 80
- SS:	(mg/l)	410	less than 80

(3) Design Criteria

The same criteria as the PIA described in the sector I.2.6 has been applied.

(4) Specifications

1) Sewers

Sewers of hume concrete pipe, which are embedded under the roads, are used to collect and transport wastewater by gravity, and manholes and collection pipes will be attached to sewers at necessary locations. The major specifications of sewers are described as follows:

- Sewers:	Small Size (200 - 300mm Dia)	Total length 950m
- Sewers:	Medium Size (400 - 600mm Dia)	Total length 7,750m
- Sewers:	Large Size (700 - 1000mm Dia)	Total length 1,060m
		Overall length 9,760m

The layout of sewerage is shown in **Figure G-31**.

2) Wastewater Treatment Plant (WWTP)

A WWTP employing the process of "Oxidation Ditch" will be constructed to purify wastewater to the level to meet the water quality set by the Cambodian Government. A sludge treatment system and other auxiliary facilities as described below will accompany the WWTP:

- Grit chamber:	1 unit	Reinforced concrete-constructed, square shape Attached by: Influent pump (3 units including 1 standby) Influent screen (i unit)
- Oxidation ditch:	3 units	Reinforced concrete-constructed, 4 m Width x 80 m Length x 3.5 m Depth x 4 pass Attached by: Aeration Roater (3 units)
- Settling basin:	3 units	Reinforced concrete, circular shape, 22m Dia x 4m Depth Attached by: Sludge return pump (4 units including 1 unit) Sludge collector (3 units)
- Sludge treatment system:	1 unit	Mechanical dehydration type Attached by: Sludge thickener (1 unit) Sludge dehydrator (3 unit)
- Other appurtenances:		Chlorination basin (1 unit) Operation and supervision building (1 unit) Power receiving and control boards (1 unit)

3) Discharge of Treated Water

A treated water discharge system will serve to transport treated water and to discharge into the Tnaot River by the following system:

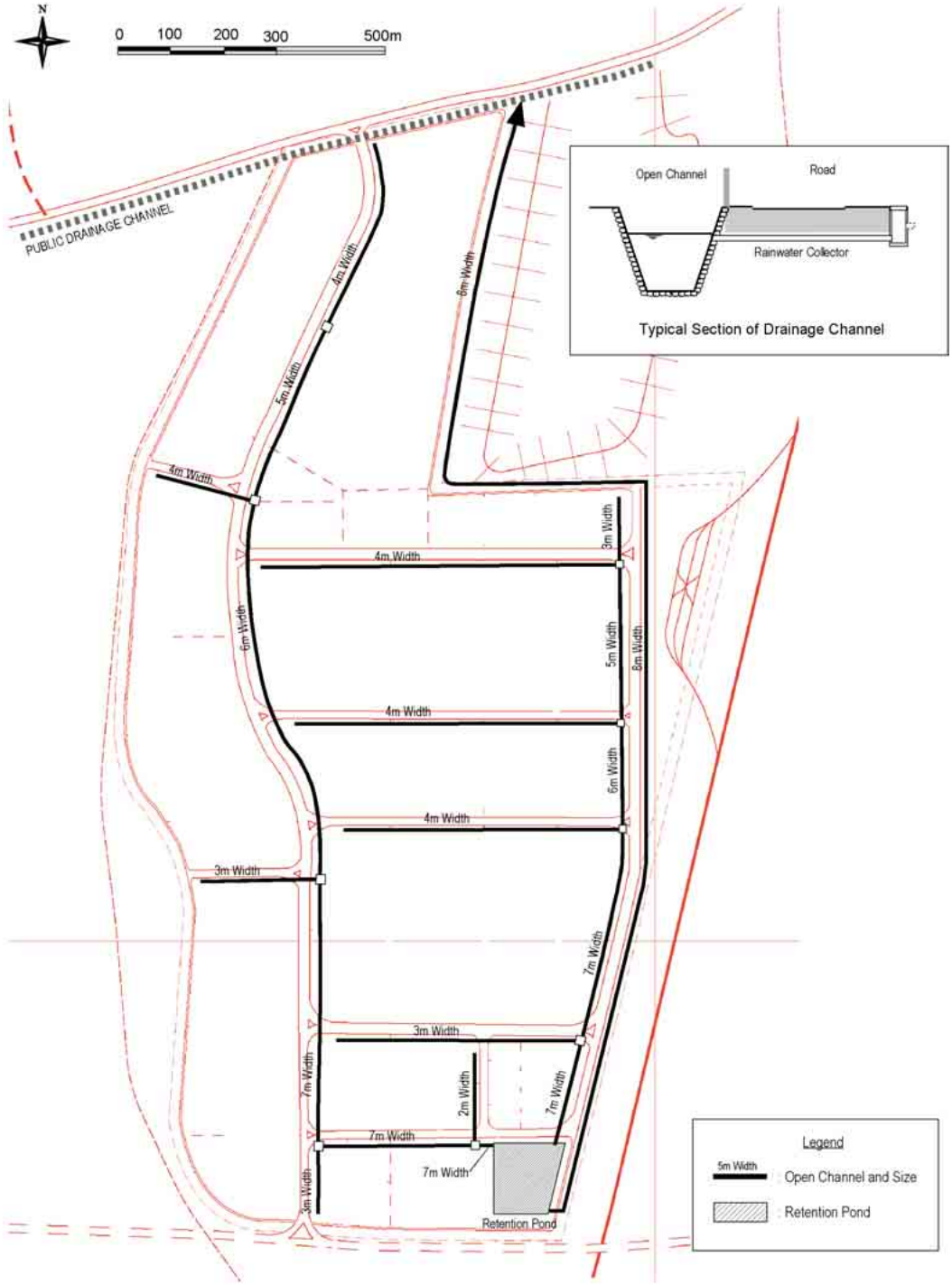
- Treated water basin:	1 unit	Reinforced concrete, square shape Attached by: Discharge pump (3 units including 1 standby)
- Discharge pipe:		Size 500mm Dia, Embedded cast iron Length 4,700m

G.7.6 Solid Waste Management

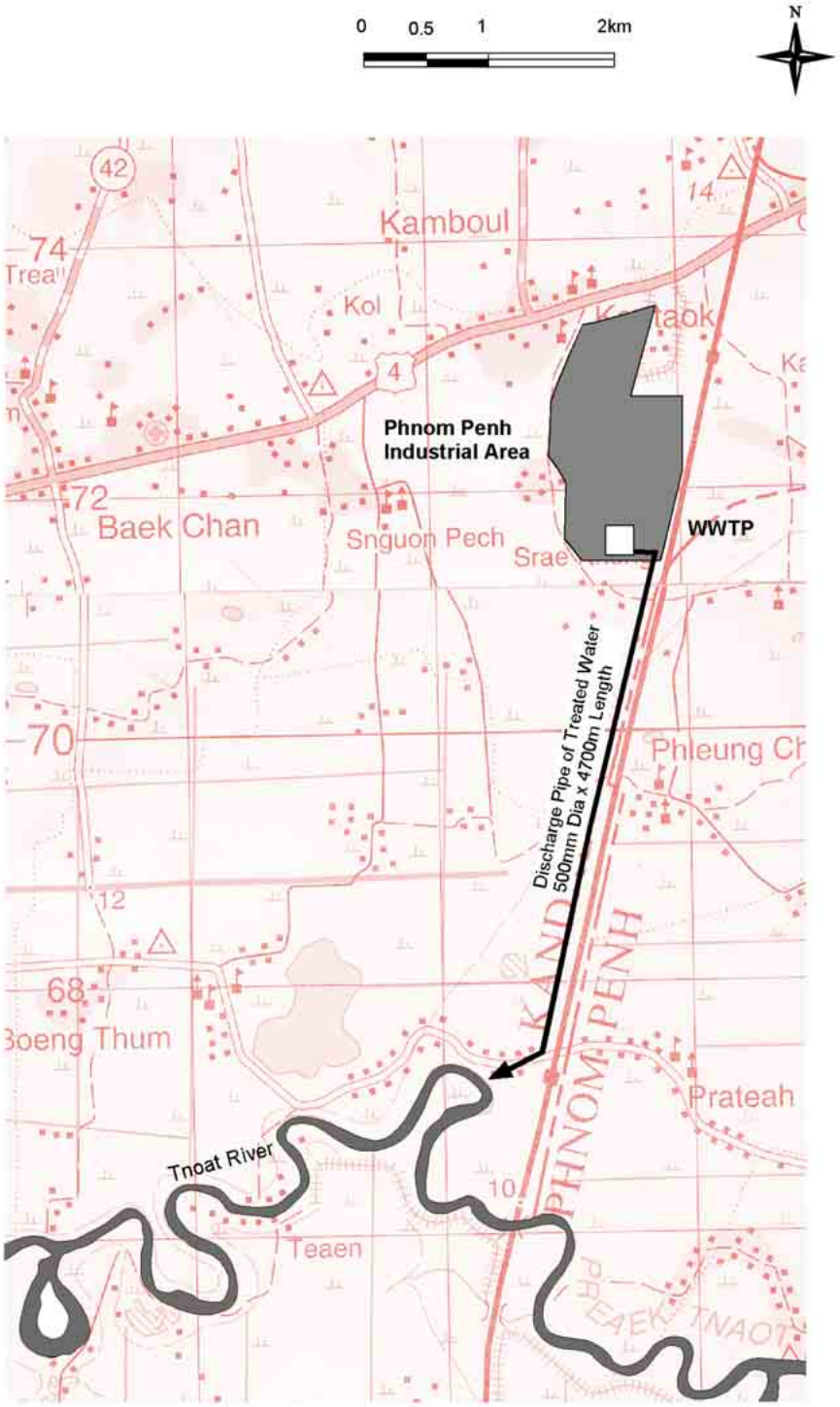
In the same manner as the PIA described in the section I.2.7, the solid waste amount to be discharged has been estimated as follows:

	Units	Solid Waste Discharged from Factories				WWTP Sludge
		Combustible	Non-Combustible	Toxic Waste	Total	
- Discharged Solid Waste:	(ton/day)	25.8	14.2	0.3	40.3	10.7

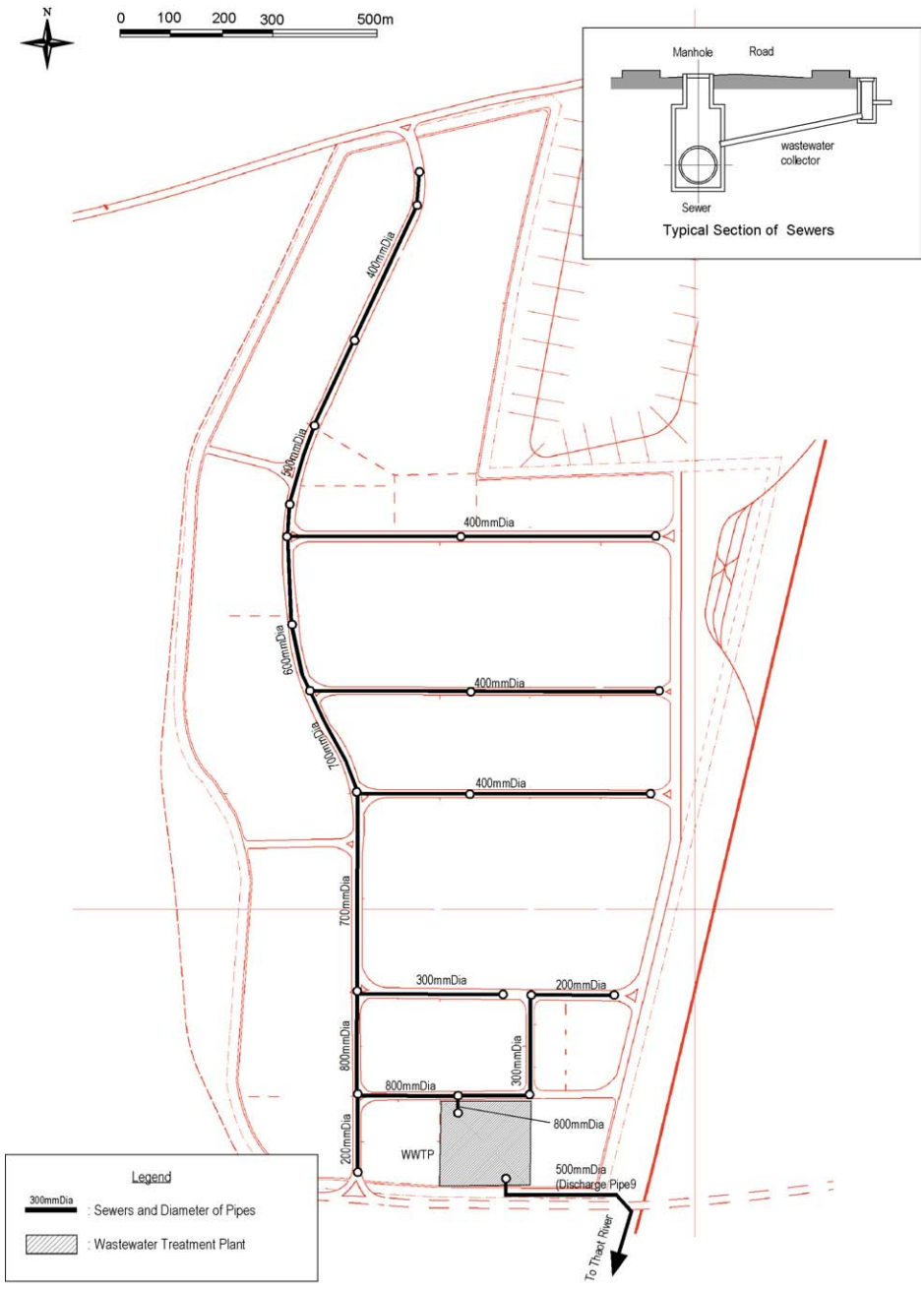
After being transported by sub-contractors of each factory, all solid waste to be discharged from the site except toxic waste will be disposed of at the existing public landfill being used exclusively for industrial wastes in Kamboul.



The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-29 Layout of Drainage for PIA**
Japan International Cooperation Agency (JICA)	



The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-30 Discharge Pipe of Treated Wastewater for PIA**
Japan International Cooperation Agency (JICA)	



The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-31 Layout of Sewerage for PIA**
Japan International Cooperation Agency (JICA)	

G.7.7 Power Supply

(1) General Considerations

1) Situation of EDC Power Supply System in Phnom Penh

EDC projects that the interconnecting transmission line between Phnom Penh and Vietnam will be established in 2006 or 2006 to import power from Vietnam. At that time, it is anticipated that the stable and sufficient power sources will be secured from this developed transmission line, as mentioned in the sub-clause I.2.8.1 (3).

According to the report of Feasibility Study of Transmission Link between Southern Region of Cambodia, under the financial assistance of WB, West Phnom Penh Grid Substation will be established at 2km away from the industrial area. This Grid Substation must be a mine power source in western Phnom Penh City.

2) Outline of Power Supply to Phnom Penh Industrial Area

The industrial area is expected to be developed in 2006 with the forecasted peak demand of 13.7 MW.

Study Team recommends that two (2) special feeders of 22 kV distribution line from the grid substation should be established to feed the power particularly to this area. These 22kV distribution feeders shall not be used for other purpose rather than supply to this area.

The location of West Phnom Penh Grid Substation and the route map of transmission line are shown in **Figure G-32**.

(2) Design Conditions and Criteria

For design of electricity supply to this area, Study Team postulates that the West Phnom Penh Grid Substation will be constructed at the place as shown in **Figure G-32**.

Regarding the basic design conditions and criteria, the same matters mentioned in the sub-clause I.2.8.2 shall be supported.

(3) Specifications

In this pre-feasibility study on the industrial area, the basic design on the following facilities is proposed in the subsequent clause.

(a) Transmission line between the grid substation and on-site substation

(b) On site substation in the industrial area

(c) Distribution facilities in the industrial area

In addition to these items, some works, such as increase of feeder bays and transformer capacity in grid substation, etc. may be necessary for EDC facilities.

1) Transmission line between the grid substation and switching station

In consideration of this demand and the transmission length, 22kV underground cable line is proposed.

Two (2) circuits are proposed in order to secure the high reliability of power supply.

The following design is proposed for the transmission line:

(a) Line Voltage : 22 kV

(b) No. of circuit : 2 circuits

(c) Line Length : Approximately 2 km

(d) Cable type : XLPE 240 mm^2 triplex, Al. conductor

(e) Cable depth : 0.8 mm depth by direct burying
(Protection pipe shall be used, burying under the roads.)

(f) Details of cable burying : EDC Design Standard shall be applied.

2) Switching Station

For the purpose of receiving the power from the West Phnom Penh Grid Substation, a switching station is recommended to be set up in the industrial area as shown in **Figure G-33**. The switching station also has the functions of switching 22kV feeders and measuring the energy consumption in all the area. For the general design image of the switching station, refer to **Figure I.2.8-4**.

(a) Line Voltage : 22 kV

(b) Rated current of bus-bar : 630 A

(c) Type : In door cubicle type

(d) Arrangement of 22 kV Switchgear

- 22 kV incoming cubicl : 2 sets
- 22 kV outgoing cubicle with circuit breaker : 4 sets
- 22kV metering unit : 4 sets

3) Distribution Network

Figure G-33 shows the route map of 22kV distribution line in the area.

Ring main unit (RMU) is placed on 22kV distribution lines at the boarders of every two consumers, to distribute the electricity to one or two customer(s) at this point. Besides, these units will function as an on/off switching on 22kV feeder circuit.

The basic design of 22kV distribution network in the area is summarized below:

(a) Line Voltage : 22 kV

(b) Line length : Approximately 10.7 km

(d) Cable type : Rated voltage 24kV (50Hz)
240 mm^2 XLPE triplex cables,
Al. conductor

(e) Burying method : 0.8 mm underearth by direct burying
(Protection pipe shall be used when burying under the roads.)

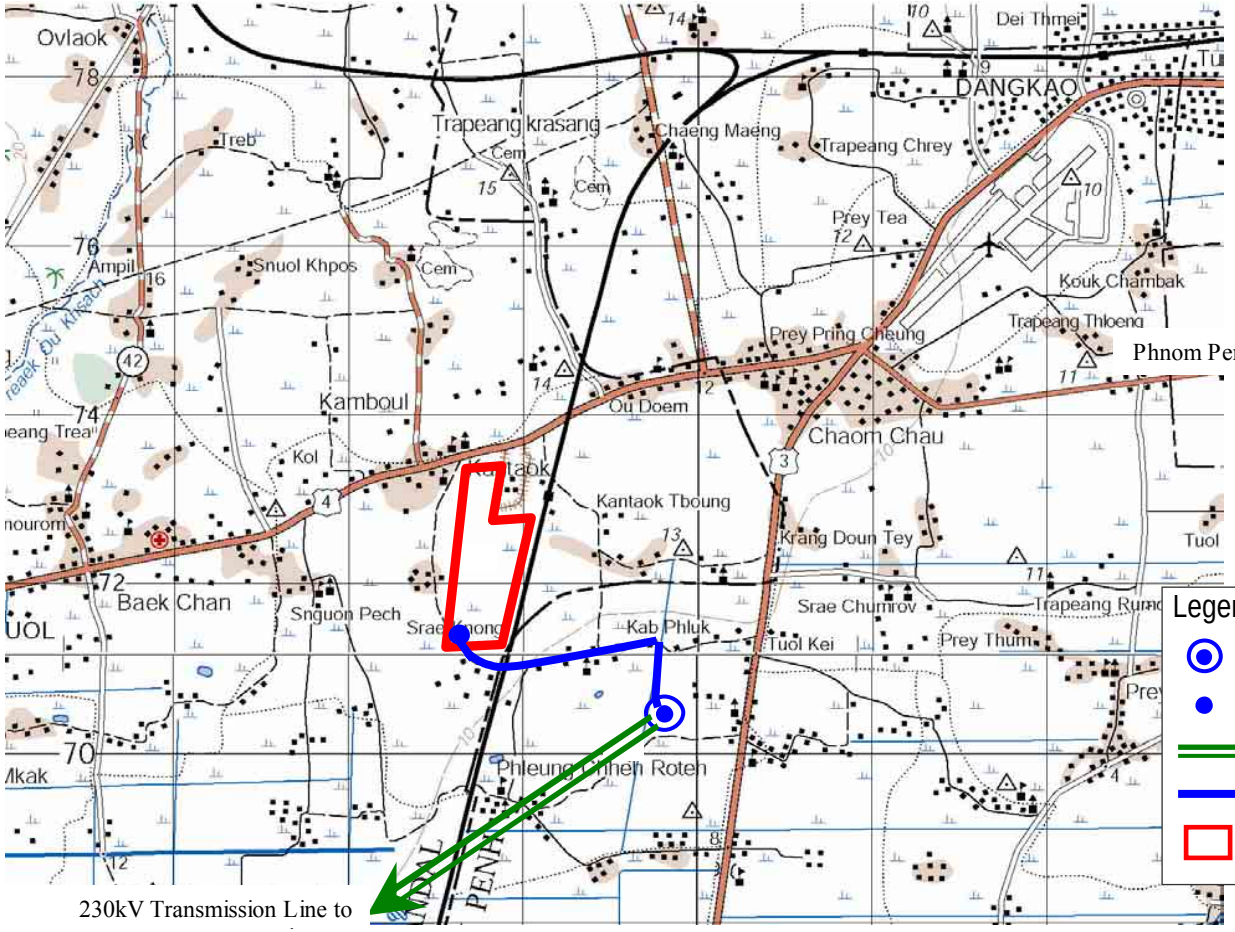
(f) Ring main unit : Outdoor cubicle type or indoor type(In case indoor type, small building shall be constructed.)
The ring main units will be installed at the boarders of every two consumers.

(g) Operation system : Manual Operation

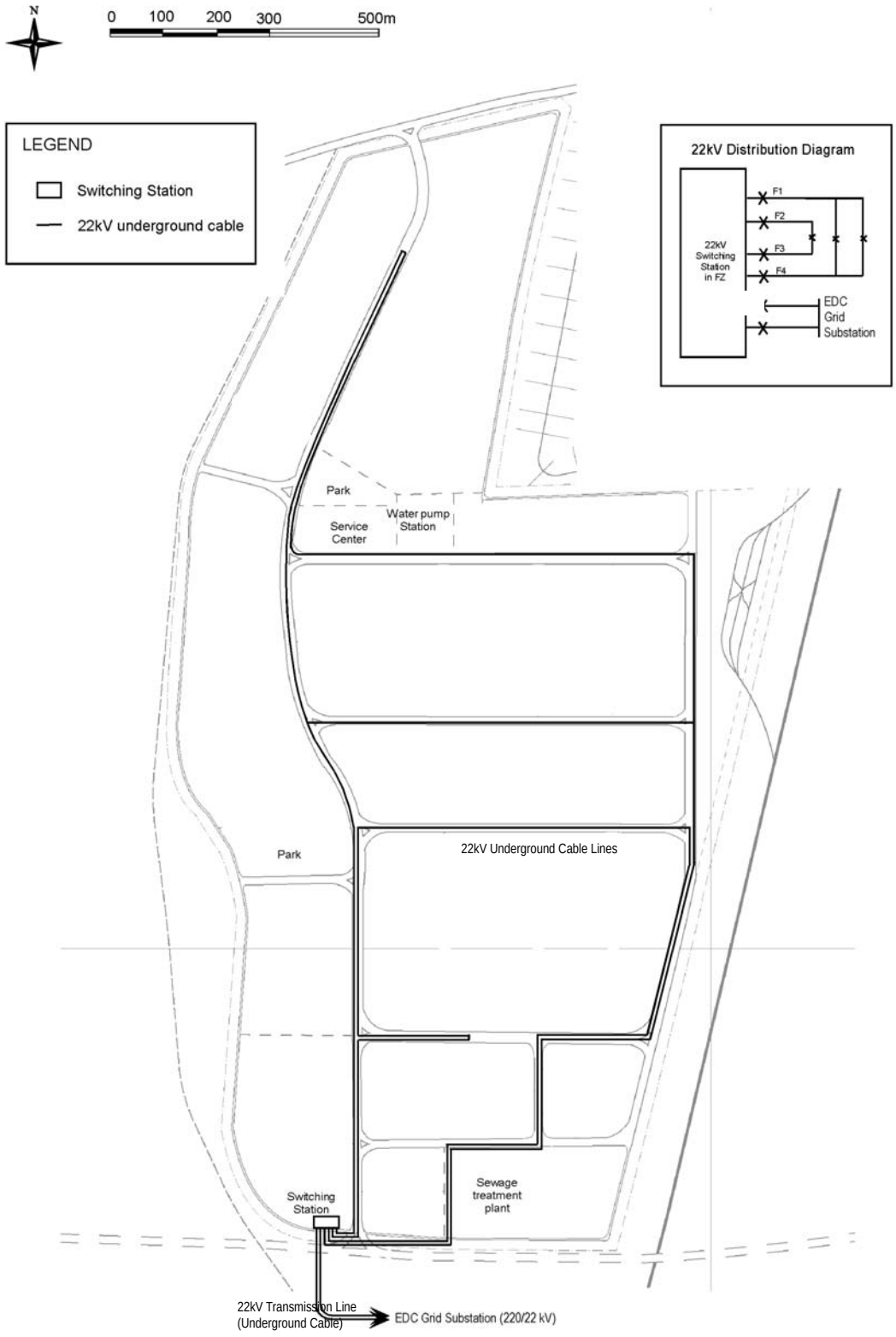
(h) Street lighting system

- Transformer : 22/0.4kV, 50kVA, 3 stations
- Underground cable : 0.6/1.0 kV, XLPE 2 x 25 mm^2
  Cable length: approx. 20 km
- Other accessory : Distribution board, watt-hour meter, switching timer, circuit breaker, etc.
- Station transformer in the substation will also used for power supply to street lighting.

(i) EDC Design Standard shall be applied.



The Study on Regional Development of The Phnom Penh - Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-32 Transmission Line from Grid Substation to PIA**
Japan International Cooperation Agency (JICA)	



The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-33 Route Map of 22kV Distribution Line for PIA**
Japan International Cooperation Agency (JICA)	