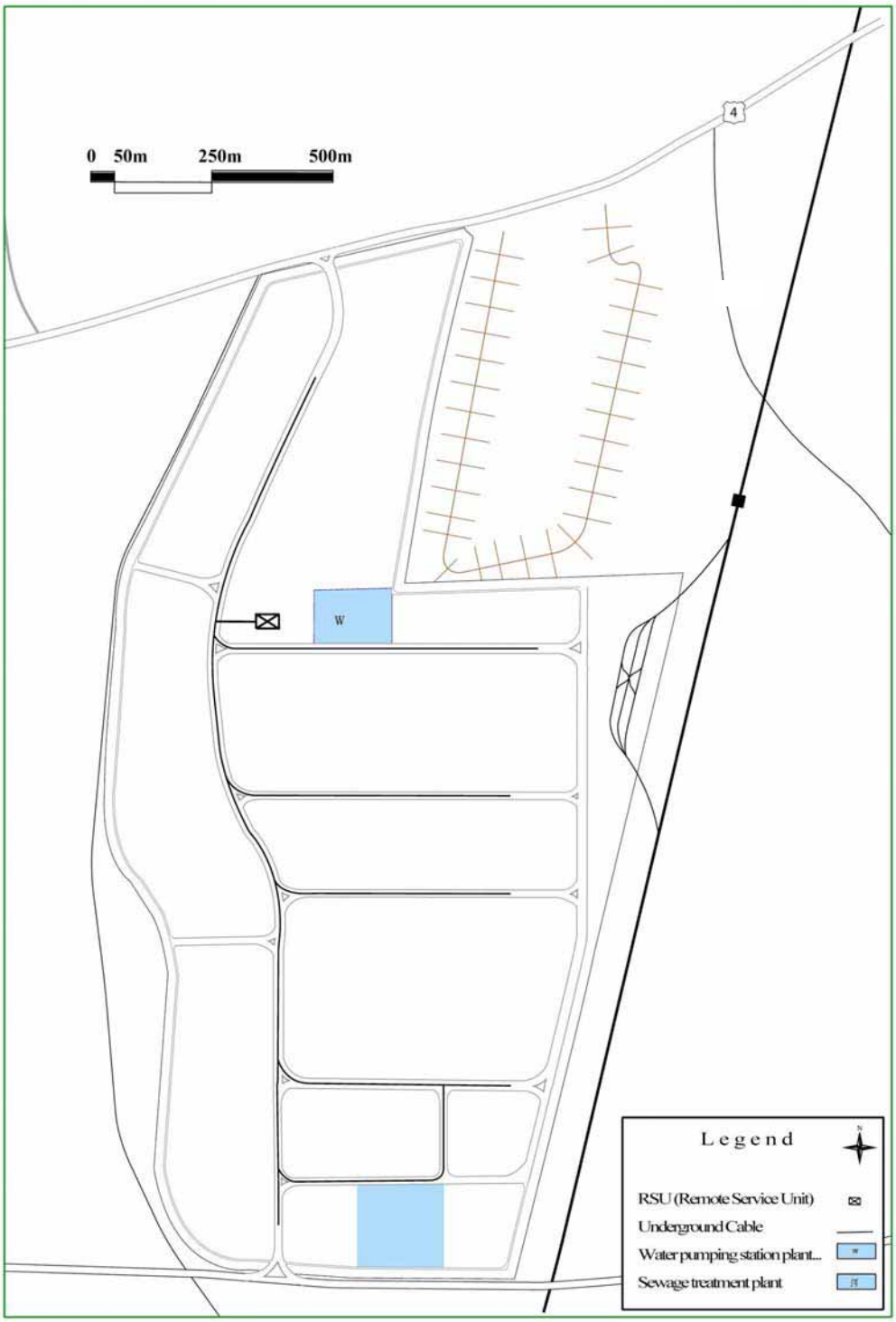
G.7.8 Telecommunication

In the Phnom Pen Area, the access network has been installed by the MPTC. The OF is laid down to the Pochenton International Airport where the RSU of 800 lines is installed. The subscribers to connect to the RSU remain less than 200 in the year 2001 so the capacity of the switch is 300 to 400 lines.

The demand of the tenanted industry in site-6 is projected as 390 lines in 2008. There are two ways to cope with the demand: one is to extend the access cable from the RSU in the airport and the other is that the RSU will be installed in the site-6 and to connect to the LS by OF. The subscribers in the area around the airport will be considered to increase so the Study Team adopt to newly install the RSU in the site.

At the network plan in the zone, since the companies tenanted in the site-6 will adopt the computerized shipping and accepting order for products, parts, and components, the enough capacity for data communication should be considered.

The network in the zone is shown as following the **Figure G-34**.



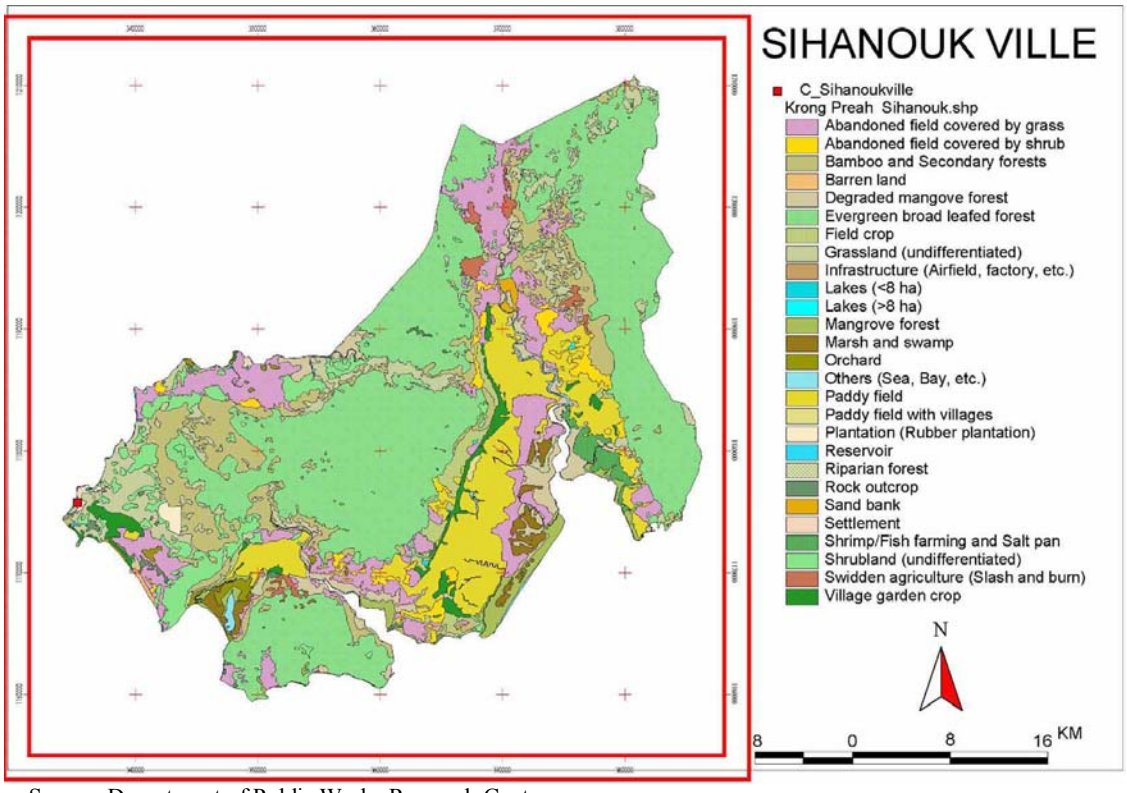
The Study on Regional Development of The Phnom Penh-Sihanoukville Growth Corridor in The Kingdom of Cambodia	**Figure G-34 Plan of Telecommunication Facility of PIA**
Japan International Cooperation Agency (JICA)	

G.8 APPENDICES OF IEE

(1) Appendix 1: Natural Environment of Sihanoukville

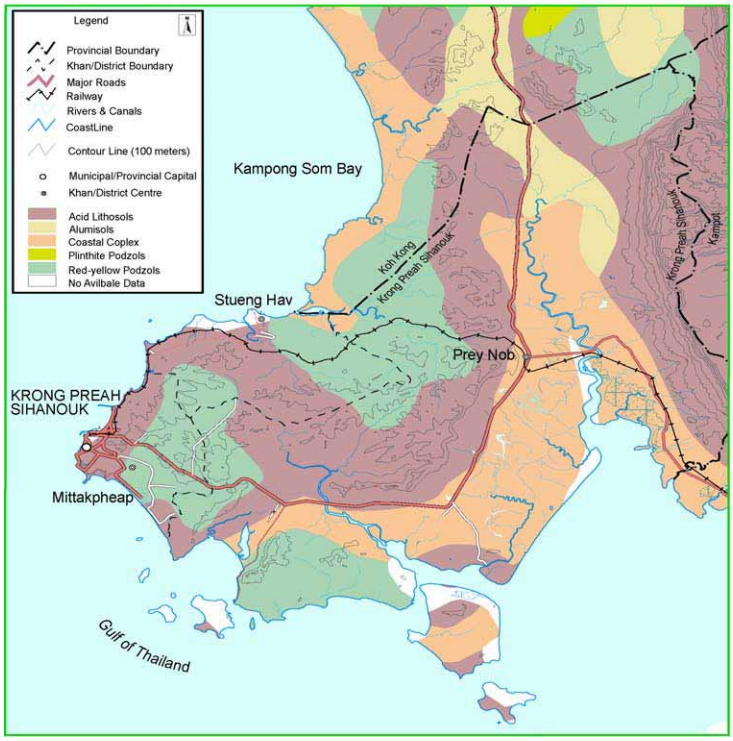
Sihanoukville is located 224 km southwest of Phnom Penh on the coast of the Gulf of Thailand and covers an area of 868km^2 of which about two-third is classified as mountain or hilly land with the highest peak of 327 m (Phnom Mousna Mountain) and one-third is flatland including wetlands and 24 islands. Topography of Sihanoukville changes from east to west: outskirts of sandstone massif of the Elephant Mountains in the east to mud flat/sandy bottom in the west with the plain area in its center. The coastline of Sihanoukville is 119.5 km long, about a quarter of national total, of which 35 km is sand beach and remaining 84.5 km is rock, mud and mangrove forest. Sihanoukville has a deep-water port, the only national deep-water port in Cambodia.

Figure G-35 shows the current land use of Shihanoukville. The land of Sihanoukville was originally covered by large forest area. However, the pattern of land use has been changing because of the expansion of urban area since early 1960s. According to the study conducted by Danida, the current ratio by land use categories is as follows; forest land 65.05%, agricultural land 27.49%, inundated land 3.42%, housing land 3.42%, and vacant land 0.54%. Soils are mainly consisted of acid lithosols, coastal ponzols and red-yellow podzols, as shown in **Figure G-36**.



Source: Department of Public Works Research Center

Figure G-35 Current Land Use of Sihanoukville



Source: JICA Study Team (Original Source: Physical Framework Plan-Sihanoukville, MOE & Danida, April 2002)

Figure G-36 Soil and Topography of Sihanoukville

The municipal center of Sihanoukville is on the headland of the peninsula and surrounded by the beaches on three sides. The topography of the municipal center is moderately hilly and about 10 m above the sea level with the highest point 130 m. The center covers an area of 88.92km^2 and the current ratio by land use categories is as follows; residential/commercial area is 16.8km^2 or 19% of the total area, industrial area 10km^2 or 11%, tourist area 6.5km^2 or 6.3%, recreational area 3.5km^2 or 4%, port area 1.5km^2 or 1.7%, and protected area and others 51.5km^2 or 57%[10].

Climate of Sihanoukville comes under tropical monsoon. **Table G-29** shows the average monthly temperature in Sihanooukville. As shown in **Table G-29**, the average maximum temperature is above 32 Celsius from March to July, while the average minimum temperature is below 24 Celsius from January to February and in December. The highest average maximum temperature is 32.6 Celsius recorded in April and May, while the lowest average minimum temperature is 21.5 Celsius recorded in January in the period from 1997 to 2001. Judging from the average mean temperature, April and May are the hottest months in the year round, but the temperatures of this season in Sihanoukville are lower than the temperatures of the Greater Capital Area.

[10] The calculation is based on the study conducted by the Fraser Thomas.

Table G-29 Average Temperature in Sihanoukville (average of year 1997 to 2001)

(Unit: Celsius)

Province \ Month		Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Sihanoukville	Average Minimum	22.4	23.9	24.2	25.5	25.6	24.9	24.2	24.1	24.4	24.1	24.0	23.2
	Average Mean	26.3	27.3	28.2	28.7	28.8	28.3	28.0	27.1	27.1	26.9	27.0	26.6
	Average Maximum	30.3	31.5	33.1	32.6	32.6	32.5	32.5	31.2	30.2	30.5	30.5	30.2

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Sihanoukville receives the highest volume of rainfall in the study area. The annual rainfall in Sihanoukville is 3097.7 mm in 2002 and 3112.3 mm on the five-year average. As **Table G-30** shows, the annual precipitation varies every year, but the volumes are above 2,000 mm throughout past six years. The rainy season is from May to November. As shown in **Table G-31**, the precipitation is especially high from June to September. The highest monthly rainfall volume in the past six years is 962.8 mm recorded in Aug. 2000. On the other hand, the period from January to April and December is dry season. The average monthly precipitation is lower from January to March and in December. Localized torrential downpours during rainy season sometimes cause floods. The monsoon flows from southwest during rainy season and from northwest during dry season[11].

Table G-30 Change of Annual Rainfall volume in Sihanoukville (1997-2002)

(Unit: mm)

1997	1998	1999	2000	2001	2002	Average (1997-2002)
2291.1	2749.4	3734.0	3476.5	3324.8	3097.7	3112.3

Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Table G-31 Average Monthly Rainfall Volume in Sihanoukville*

(Unit: mm)

Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
30.9	38.9	96.3	169.9	281.6	442.5	564.7	651.9	370.2	284.6	152.6	28.1

*Average of the 1997 to 2002 monthly rainfall volumes
Source: Department of Meteorology, Ministry of Water Resource and Meteorology

Sihanoukville has 32 small rivers and streams that flow into the Gulf of Thailand with the water levels increasing and decreasing depending on the volume of rainfall. The Prek Teouksap and Prek Kampong Smach are relatively big among these rivers. Domestic waste and wastewater from the factories are discharged to the rivers with no treatment and the effluent affects the marine ecosystem.

Mangrove forests are the prevailing ecosystem in Sihanoukville, and some of the best remnant coral reefs in the Gulf can be observed in the coastal waters. However, this valuable marine ecosystem has been degrading by several factors, such as inadequate management of waste and wastewater.

[11] According to the record of the meteorological station in the Sihanoukville airport, strong wind had been rarely observed during the period from 1863 to 1979. The strongest wind observed is 9 m/s.

(2) Appendix 2: Information on the resettlement

Following things have been explained by the PAS regarding the resettlement.

1) Land provided as compensation

The 2 to 2.5 hector land prepared by the PAS as the compensation is located in the east side of the national railway and in the north east of the village Phum Tamei (**Figure G-37**). A garment factory is close to the land. The land was empty as of February in 2003 and will be completely purchased by the PAS, since they have already put the deposit money for the purchase.

2) Entitlement to receive the compensation

Followings were explained by the PAS. The 138 families were clarified their entitlement to receive the compensation at first by the commune chiefs, and their land ownership statuses were not considered as a condition to the entitlement. As a result, the families both having certificates at the commune level and not having any documents were entitled. The cut-off day for the entitlement was explained as the year 2000.

After the development plan of the PAS was revealed, some families purposely came to live in the area subject to the resettlement in order to receive the compensation, so that the PAS do not have an intention to provide these families with the compensation, even to negotiate with them.

3) Process to obtain consent from the residents

The consultation between the PAS and the resident was said to have begun in about July in 2002 according to the explanation by the PAS as of October in 2002. The PAS explained their development plan to the municipality and the lower level of administration, then village chiefs had meetings with their villagers to explain the development plan. After this explanation, when a head of the families agreed to resettle, the PAS obtained an agreement with his/her fingerprints to which one page of design plan of the house to be provide as the compensation was attached (**Figure G-38**).

It was expected by the PAS that the 138 families, after the resettlement, will be able to obtain the land title for the land without having difficulties thanks for the clearness of their possession of the land if they will register the title by themselves.

However, it was explained as of February in 2003 that approximately 50 of the 138 families had expressed their wishes to sell back the houses with the land, which would be provided as the compensation, to the PAS. The PAS agreed to buy the houses with the land, and the price will be negotiable.

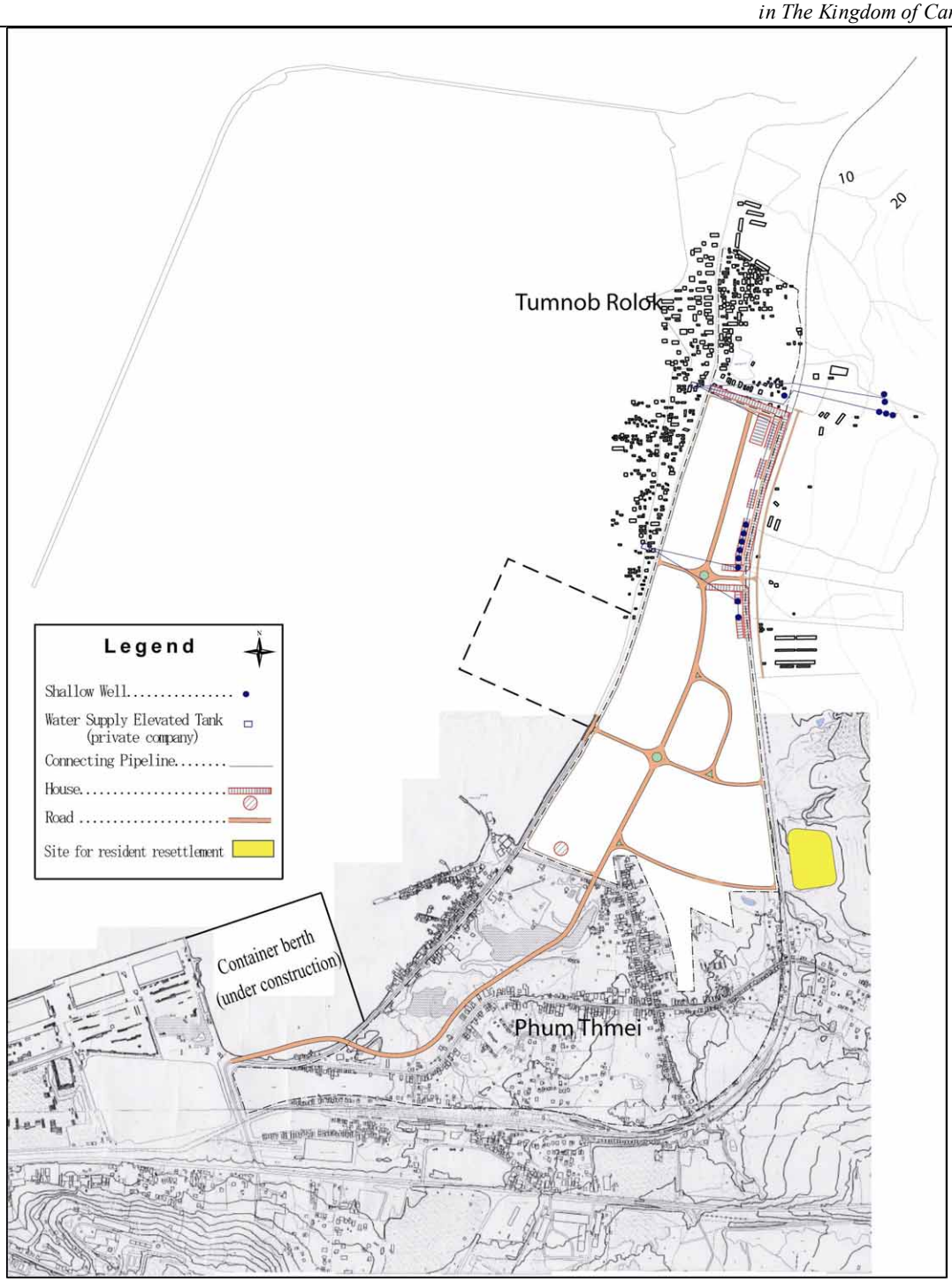


Figure G-37 Location of the site for resident resettlement, existing houses and water supply facilities

4) Budget for the resettlement

Board of Director of the PAS agreed "the rule of regulation of the resettlement plan" in December 2002 and the budget for the resettlement would be prepared.

5) Resettlement Schedule

1. Pre-construction process: February to March 2003
2. Construction of new houses April to June 2003

3. Move of the people July 2003

(3) Appendix 3: Points to be further clarified regarding the resettlement

1) Location of the house to be resettled and entitled to the compensation

Location of each house of the 138 families to be resettled and entitled to the compensation has not been clearly identified. How many families among the 138 belonging to Tonob Prolok village and how many to Phum Tamei village have not been indicated. Instead, most of them were said to belong to Tonob Prolok, and only small number of families to Phum Tamei village.

Among the 138 families, there were groups of the houses within the land fenced by the PAS as the FZ site and those in the right of way of the National Railroad along the west end of the fenced land as of February in 2003 (**Figure G-38**). It was explained by the PAS that the boundary between the right-of-way for the National Railroad of 25 meters from the axis and the land of the PAS exists on the 25 meter point and that the National Railroad authority would settle the relocation issues regarding to the houses in the right-of-way. However, some of these houses were entitled to receive the compensation from the PAS and agreed to move the designated land, while clear indication of the houses subject to the resettlement has not been made as stated above.

2) Total number of population to be resettled

Total number of population of the 138 families have not been grasped by the PAS.

3) The cut-off date

The cut-off date for the entitlement to the compensation was allegedly in 2000 on one hand, but some families was not necessarily given the entitlement based on the cut-off date.

4) Consideration of present scale of the house and land

It has not been clarified how the present sizes of the house and land of the 138 families were reflected in the content of compensation. While the 138 families are supposed to receive a same size of house constructed on same size of land, existing houses inside the FZ site and the land on which they stand differ in their size.

5) Restoration of livelihood

As some families among the 138 families are operating small business at their houses, there may be negative impact on their business from the resettlement. However, the measures and prospects to restore their income to the pre-resettlement level have not been clear. Particularly, those families taking advantages of the present location of their houses in their business or having extra facilities for their business have high potentiality to get negative impacts. For example, running small business to sell food to factory workers at the house front of the factory. However, since the

locations of the houses of the 138 families have not been identified, locations of the houses of these families also have not been identified.

6) Process to obtain the consent from the 138 families

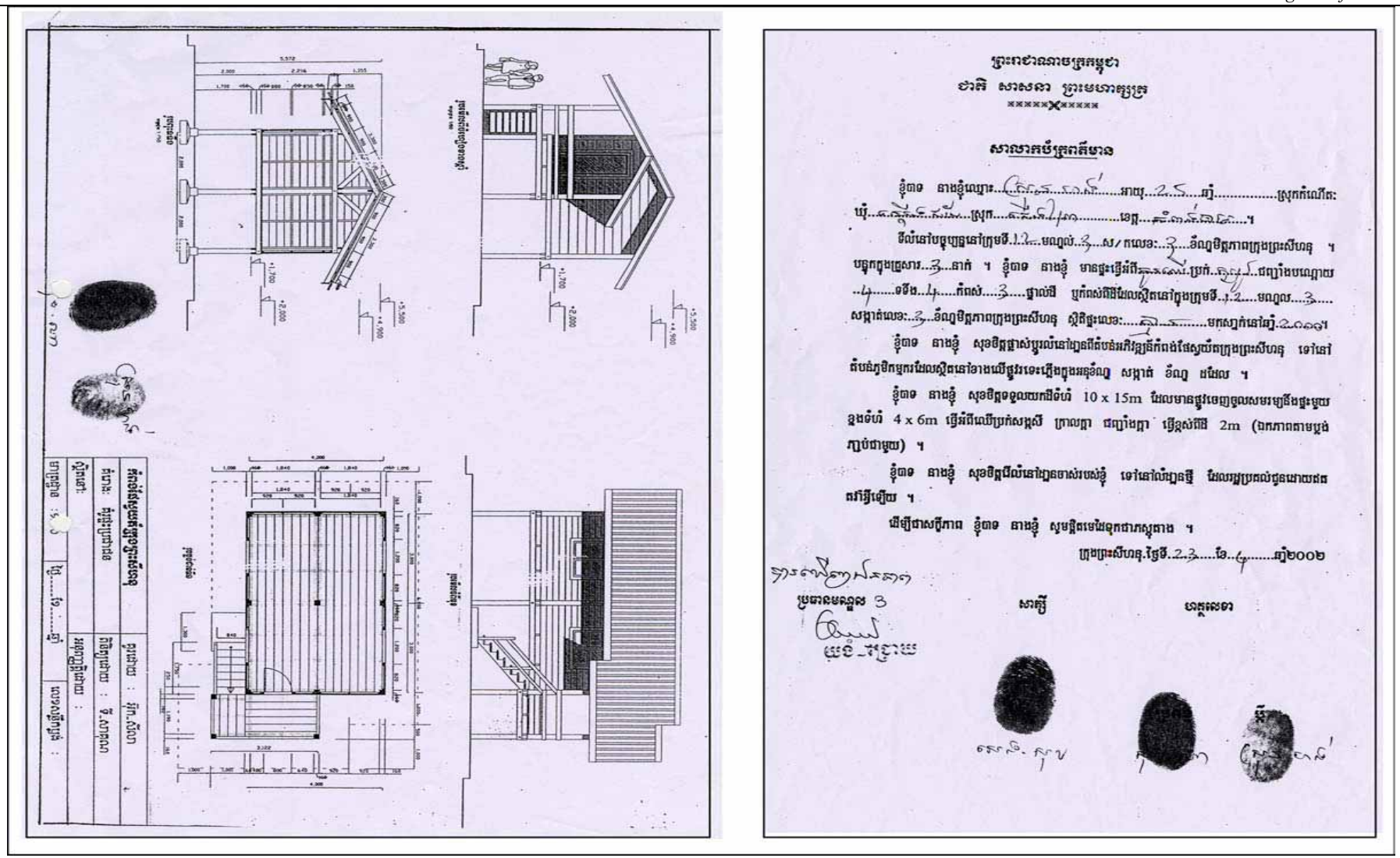
The consultation on the resettlement between the PAS and the administration was said to have begun in about July in 2002. Then village chiefs were said to have had meetings with the residents subject to the resettlement to explain things relating resettlement. With regard to the process to obtain the consent form the 138 families, such things as timing of the village meetings, their places and attended individuals, contents of the explanation, etc. require more clarification.

7) Measures to deal with the so-called new comers.

It was explained that some families had purposely began to live in the FZ site relatively recently to receive the compensation, but plans and measures to deal with them prior to the construction have not been decided by the PAS.

8) Basic infrastructure in the land where the families will resettle

Basic infrastructure in the land where the families will resettle was said to be developed by the PAS, however, some points regarding to this are required to be more concrete, because the resettlement is planed to be conducted in July 2003. According to the PAS, means to supply water for short time will be secure, through their digging new wells in the resettled land by their own budget or by support from NGO, if any NGO will support. It is expected by the PAS that future-extended water pipe by the Provincial Department of Transportation, Public Work will also cover the resettled houses.



ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

សាលាកថាំក្រុតតីមាន

ខ្ញុំបាទ នាងខ្ញុំឈ្មោះ.....អាយុ.....ឆ្នាំ.....ស្រុកកំណើត:
ឃុំ.....ស្រុក.....ខេត្ត.....។

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.....ទទឹង.....កំពស់.....ផ្ទាល់ដី ឬកំពស់ពីដីដែលស្ថិតនៅក្នុងក្រុមទី.....មណ្ឌល.....
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តំបន់ភូមិកម្មករដែលស្ថិតនៅខាងឃើញផ្លូវរទេះភ្លើងក្នុងអនុខណ្ឌ សង្កាត់ ខណ្ឌ ដដែល ។

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ខ្នងទំហំ 4 x 6m ធ្វើអំពីឈើប្រក់សង្កសី ក្រាលក្បា ជញ្ជាំងក្បា ធ្វើខ្ទង់ពីរ 2m (ឯកភាពតាមប្តង់
ភ្ជាប់ជាមួយ) ។

ខ្ញុំបាទ នាងខ្ញុំ សុខចិត្តជីលំនៅឋានចាស់របស់ខ្ញុំ ទៅនៅលំនៅឋានថ្មី ដែលរដ្ឋប្រគល់ជូនដោយឥត
តវ៉ាអ្វីឡើយ ។

ដើម្បីជាសក្ខីភាព ខ្ញុំបាទ នាងខ្ញុំ សូមផ្តិតមេដៃខ្មុកជាភស្តុតាង ។

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ប្រធានមណ្ឌល ៣ សាក្សី ហត្ថលេខា

Figure G-38 Document indicate consent for resettlement from the resident

(4) Appendix 4: Economic situations of Tumnob Rolok and Phum Tamei villages

1) Tumnob Rolok: Village No.3, (Commune No.1)

Population: 7,450 (women: 3,742, men: 3,708)

Family: 1,535

A. Economic situations

Among the newly immigrated people, some of those who were not engaging in fishery are working as daily-wage construction/port workers, and their income is lower than that of fishery laborers. The port workers earn 7,000 to 8,000 Riel per day.

The daily-wage construction workers earn approximately from 6,000 to 7,000 Riels per day. They need to be mobile to look for a job even if they have a house and family members, thus, they and their family members are vulnerable in many ways. For example, children of such workers studying to Sakura School have often been trusted to their relatives and neighbors when their parent(s) is/are away from home to look for employment and work elsewhere. These school children are often not able to receive appropriate care and often absent from the school.

Factory workers are also living in the village, but as qualifications for working for garment, textile, and shoes factories such as educational background, age, etc. are not necessarily fit to the people, large portion of them seem to work for fish processing factories which require simpler manual labor. The factory workers in the area were said to earn US$30 to US$50 monthly, but this amount is insufficient for a family to live for one month.

In addition to these occupational groups, there are families operating small business at their houses. Variety of shops and a small market exist in the village: grocery shops, drug stores, shops providing services such as barber hops, rental video shops, etc. Daily necessities are said to be almost available. Their income level apparently differs by the scale of their business, but details are unknown.

B. Past resettlement plan

There was a plan to resettle the people to a village in Stueng Hav district (a village named Tumnob Rolok, this name is the same as the village concerned in this IEE) but this plan has not been completed yet. It was alleged that only a part of the people moved, the rest remained.

2) Phum Tamei: Village No.1, Commune No.3

Population: 2,186 (women: 1,274, men:912)

Family: 506

This village has been known as a red light place and attracted port workers, fishermen, tourists, and construction workers, etc. The number of the Commercial Sex Workers (CSWs) increased in at the occasion of the UNTAC operation. At the beginning, the police as well as the governor of the municipality tried to stop the sex industry. It was alleged that approximately 30 brothels, 20 some Karaoke Bars, a few massage parlors/guest houses existed, and approximately 160 Direct Sex Workers working for brothels and 160 Indirect Sex Workers working for Karaoke Bars and restraints in 2000. The CSWs are not only Cambodians, but also Vietnamese, and Cambodians who lived in south area of Vietnam. Owners of brothels are both Cambodians and Vietnamese.

Although the sex industry largely contributed to the economy of the village, other business such as small shops selling groceries, clothes, and so forth exist, even there is a small market in the village. The village is also a place for people working as fishery laborers at Tumnob Rolok village to live, including those who newly immigrated.

(5) Appendix 5: Special Assistance for Project Implementation (SAPI) by JBIC fro prevention of HIV infection

JBIC has been implementing preventive activities against HIV infection under their SAPI for the “Sihanoukville Port Urgent Rehabilitation Project”, considering high possibility of increases in incidents of HIV infection in the area through inflows of the construction workers for the port extension. This is regarded as a proactive response to the recent situations of HIV/AIDS in Sihanoukville municipality, and to avoid wasting the past endeavors by the relevant entities, since the ratio of people with HIV among the direct CSWs had been at 57.3 per cent prior to the past”100% condom promotion and went down to 22 per cent in 2000.

(6) Appendix 6: Location and Condition of Coral Reefs in Sihanoukville

No.	Location	Situation
1	Koh Pos (Pos island)	Most coral reefs are located in the northern part of the island. The area is full of different kinds of coral reefs such as Kantuykandol, Snengpreh, and water black wood.
2	Koh Tres (Tres island)	Khathna, Katuykandor and Chha-oengmon coral reefs are found in the north-western part of the island.
3	Koh Chanlus (Chanlus island)	In the western area of the island, Kantuykandor, Chha-oengmon and Phkardoung coral reefs are found.
4	Koh Krobeiy (Krobeiy island)	Coral reefs are found in various rears around the island.
5	Koh Ruseiy (Ruseiy island)	Mixed types of coral reefs grow in the western part of the island.
6	Koh Takiev (Takiev island)	In the northern part of the island, there are Phkardoung and Kantuykandol coral reefs and the north-western part, Kantuykandol, Pharkhatna and Phkadoung coral reefs are found, Plenty of coral reefs are found in northern area of the island.
7	Koh Sromouch (Sromouch island)	Most coral reefs grow in the eastern part of the island such as Phkakhatna. Kantuydoung (few) and water wood.
8	Koh Thas (Thas island)	In the southern part, Snengproh coral reefs are found. In addition, mixed types of coral reefs are found in northwestern part of the island.
9	Rangs of Koh Rong (Rong islands)	There are plenty of Snengpreh and Chho-oengmon coral reefs are found in "Koh Nhor".
10	Rangs of koh Rong Sanloem islands	Coral reefs are found in north. There are plenty of Kontuykandol and Phakadoung coral reefs.
11	Koh Pring (Pring island)	Mixed types of coral reefs are found in the north-east.
12	Koh Tang (Tang island)	In the northeastern part, coral reefs are identified.
13	Koh Thei (Thei island)	In the west of the island, there are plenty of Phakuchay and Snengproh coral reefs.
14	Koh Doung (Doung island)	Fewer coral reefs are found around the island.
15	Koh Veal (Veal island)	Around the island, there are some coral reefs.
16	Koh Puovai(Puovai island)	Coral reefs are found a round the island.
17	Koh Khundor (Khundor island)	Coral reefs are found around the islands. This island is located in the northern part of Pring island.
18	Koh Trongoul (Trongoul island)	
19	Pory Machouv (Machouv estuary)	Coral reefs are found in frond of the estuary
20	O Cheuteal estuary	Different types of coral reefs but there are not many
21	Ta Muong estuary	Different types of coral reefs but there are not many
22	Kampenh estuary	In the north, Kantuykandol coral reefs are found and few coral reefs are in the east.
23	Koh Poh beach	Located in the west of the restaurant are different types of coral reefs and fewer Snengproh coral reefs.

Source: State of Environment Report Sihanoukville, April 2002, MOE & Danida

(7) Appendix 7: Change of the Amount of Coastal Fish Catch and the Number of Fishing Boat

	Coastal Fish Catch (ton)	Fishing Boat with 11-30 HP	Fishing Boat over 30HP
1991	8,300	546	220
1992	8,600	720	187
1993	8,560	522	163
1994	8,650	656	177
1995	9,150	646	174
1996	10,100	682	167
1997	10,000	654	150
1998	14,400	665	185
1999	16,800	855	245
2000	16,500	838	282

Source: State of Environment Report Sihanoukville, April 2002, MOE &

(8) Appendix 8: Maximum allowable standard of pollution substance for immobile sources in ambient air

No.	Paraneters		Maximum level of discharge
1	Particulate in smoke of :		
	Incinerator		0.4/m^3
	Heating metal		400mg/m^3
	Bad stone, Lime, cement manufacturing		400mg/m^3
	Asphalt concrete plant		500mg/m^3
	Other sources		
2	Dust:		
	Containing silica (Sio $_2$)		100mg/m^3
	Containing sasbestos		27ug/m^3
	Chemical inorganic substace		
3	Aluminum	Al	(dust)300mg/m3
			;(Al)50mg/m3
4	Ammonia	NH_3	100mg/m^3
5	Antimony	Sb	25mg/m^3
6	Arsenic	As	20ug/m^3
7	Berylium	Be	10mg/m^3
8	Chloride	Cl	20mg/m^3
9	Hydrogen chloride	HCl	200mg/m^3
11	Hydrogen sulfide	H_2S	2mg/m^3
12	Cadmium	Cd	1mg/m^3
13	Copper	Cu	(dust)300mg/m^3
			(Cu)20mg/m^3
14	Lead	Pb	(dust)100mg/m^3
			(Cu)20mg/m^3
15	Zinc	Zn	30mg/m^3
16	Mercury	Hg	0.1mg/m^3
17	Carbon monoxide	CO	1000mg/m^3
18	Sulfur dioxide	SO_2	500mg/m^3
19	Nitrogen oxide	NO_x (all category)	1000mg/m^3
20	Nitrogen oxide	NO_x (emitted HNO_3 product)	2000mg/m^3
21	Sulfaric Acid	H_2SO_4	35mg/m^3
22	Acetic Acid	HNO_3	70mg/m^3
23	Sulfur trioxide	SO_3	35mg/m^3
24	Phosphoric Acid	H_3PO_4	3mg/m^3
	Chemical organic substance		
25	Acetylene tetra bromide $CHBr_2CHBr_2$		14mg/m^3
26	Acrolein	CH_2=CHCHO	1.2mg/m^3
27	Aniline	$C_6H_6NH_2$	19mg/m^3
28	Benzidine	$NH_2C_6H_4C_6H_4NH_2$	None
29	Benzene	C_6H_6	80mg/m^3
30	Chloro benzyl	$C_6H_5CH_2Cl$	5mg/m^3
31	Butyl amine	$CH_3(CH_2)_2CH_2NH_2$	15mg/m^3
32	Cresol (o-,m-,p-)	$CH_3C_6H_4OH$	22mg/m^3
33	Chloro benzene	C_6H_5Cl	350mg/m^3
34	Chloroform	$CHCl_3$	240mg/m^3
35	Chloropicrin	CCl_3NO_2	0.7mg/m^3
36	0-dichlorobenzene	$C_6H_4Cl_2$	300mg/m^3
37	1-1-dichloro ethane	$CHCl_2CH_3$	400mg/m^3
38	Di methyl sulfate	$(CH_3)_2SO_4$	0.5mg/m^3
39	Di methyl hydrazine	$(NH_3)NNH_2$	1mg/m^3
40	Di nitro benzene (o-,m-,p-)$C_6H_4(NO_2)_2$		1mg/m^3
41	Ethylene diamine	NH_2CH_2-CH_2NH_2	30mg/m^3
42	EthyleneChlorohydrin CH_2ClCH_2OH		16mg/m^3
43	Ethylene oxide	CH_2OCH_2	20mg/m^3
44	Formaldehyde	HCHO	6mg/m^3
45	Methyl Acrylate	CH_2=$CHCOOCH_3$	35mg/m^3
46	Methanol	CH_3OH	260mg/m^3
47	Methyl Bromide	CH_3Br	80mg/m^3
48	Monomethylaniline	$C_6H_5NHCH_3$	9mg/m^3
49	Nitro Benzene	$C_6H_5NO_2$	5mg/m^3
50	Nitroglycerine	$C_6H_5(NO_2)_3$	5mg/m^3
51	Nitrotoluene	$NO_2CH_4CH_3$	30mg/m^3
52	Phenol	C_6H_5OH	19mg/m^3
53	Phenelhydrazine	$C_6H_5NHNH_2$	22mg/m^3
54	Pyrindine	C_5H_5N	30mg/m^3
55	Pyrene	$C_{16}H_{10}$	15mg/m^3
56	Quinone	$C_6H_4O_2$	0.4mg/m^3
57	Styrene	C_6H_5CH=CH_2	420mg/m^3
58	1,1;2,2-tetrachloroethane $Cl_2HCCHCl_2$		35mg/m^3
59	Tetrachloromethane	CCl_4	65mg/m^3
60	Toluene	$C_6H_5CH_3$	750mg/m^3
61	Tetranitromethane	$C(NO_2)_4$	8mg/m^3
62	Toluidine	$CH_3C_6H_4NH_2$	22mg/m^3
63	Toluidine-2,4-D-isocyanate $CH_3C_6H_3(NCO)_2$		0.7mg/m^3
64	Trichloro ethylene	$ClCH$=CCl_2	110mg/m^3
65	Xylidine $(CH_3)_2C_6H_3NH_2$		50mg/m^3
66	Vinylchloride	CH_2=CHCl	150mg/m^3

(9) Appendix 9: Effluent standard for pollution sources discharging wastewater to public water areas or sewer

No.	Parameters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	Pubic water area and sewer
1	Temperature	^{o}C	<45	<45
2	pH	mg/l	6 -'9	5 -'9
3	BOD_5 (5days at 200C	mg/l	<30	<80
4	COD	mg/l	<50	<100
5	Total Suspendied Solids	mg/l	<50	<20
6	Total Dissolved Solids	mg/l	<1000	<200
7	Grease and Oil	mg/l	<5.0	<15
8	Detergents	mg/l	<5.0	<15
9	Phenols	mg/l	<0.1	<1.2
10	Nitrate (NO_3)	mg/l	<10	<20
11	Chlorine (free)	mg/l	<1.0	<2.0
12	Chloride (ion)	mg/l	<500	<700
13	Sulphate (as SO_4)	mg/l	<300	<500
14	Sulphide (as Sulphur)	mg/l	<0.2	<1.0
15	Phosphate (PO_4)	mg/l	<3.0	<6.0
16	Cyanide (CN)	mg/l	<0.2	<1.5
17	Barium (Ba)	mg/l	<4.0	<7.0
18	Arsenic (As)	mg/l	<0.10	<1.0
19	Tin (Sn)	mg/l	<2.0	<8.0
20	Iron (Fe)	mg/l	<1.0	<20
21	Boron (B)	mg/l	<1.0	<5.0
22	Manganese (Mn)	mg/l	<1.0	<5.0
23	Cadmium (Cd)	mg/l	<0.1	<0.5
24	Chromium $(Cr)^{-6}$	mg/l	<0.2	<1.0
25	Chromium $(Cr)^{-6}$	mg/l	<0.05	<0.5
26	Copper (Cu)	mg/l	<0.2	<1.0
27	Lead (Pb)	mg/l	<0.1	<1.0
28	Marcury (Hg)	mg/l	<0.002	<0.05
29	Nickei (Ni)	mg/l	<0.2	<1.0
30	Selenium (Se)	mg/l	<0.05	<0.5
31	Silver (Ag)	mg/l	<0.1	<0.5
32	Zinc (Zn)	mg/l	<1.0	<3.0
33	Molybdenum (Mo)	mg/l	<0.1	<1.0
34	Ammonia (NH_3)	mg/l	<5.0	<7.0
35	DO	mg/l	>0.2	>1.0
36	Polychlorinated Byphemyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<0.150	<200
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachioride	mg/l	<3	<3
40	Hexachioro benzene	mg/l	<2	<2
41	DTT	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01
44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.5	<2.5
47	Hexachloro butadiene	mg/l	<03	<03
48	Chloroform	mg/l	<1	<1
49	1.2 Dichloro ethylene	mg/l	<02.5	<02.5
50	Trichloro ethylene	mg/l	<01	<01
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyciohexene	mg/l	<2	<2

(10) Appendix 10: Maximum permitted noise level in public and residential area (dB(A))

No.	Area	Period of time		
		From 6h AM to 18h	From 18h to 22h	From 22h to 6h AM
1	Quiet areas - Hotels - Libraries - School - Kindergarten	45	40	35
2	Residential area: - Hotels - Administration office - House	60	50	45
3	Commercial and service areas and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	50

G.9 DETAILED DEVELOPMENT COST

Table G-32 Development Cost of SPFZ

Table I.6-5 Development Cost of Sihanoukville Port Free Zone

Item	unit	Q'ty	Unit price	Amount (1,000$)			Alternative amount (1,000$)		Remarks
				Foreign	Local	Total	Internal	external	
1 Land acquisition	m^2	429,000	0			**0**	0	0	PAS land
2 Construction				**7,057**	**6,858**	**13,915**	**13,915**	**0**	
(1) Land grading				**322**	**2,896**	**3,218**	**3,218**		
1) Land preparation	m^2	429,000	0.5	21	193	215	215		
2) Cut/fill work	m^3	600,600	5.0	300	2,703	3,003	3,003		42.9hax(EL3.7m-EL2.3m)=600,600m3
(2) Road				**920**	**753**	**1,672**	**1,672**		
1) Access road	m^2	12,600	23	159	130	290	290		Pavement, sidewalk, electric pole, etc.
2) Main internal road	m^2	18,500	18	183	150	333	333		
3) Sub main internal road	m^2	27,500	17	257	210	468	468		
4) Patrol road	m^2	12,100	10	67	54	121	121		
5) Flyover to port	LS	1	436,000	240	196	436	436		
6) Others	m^2	2,500	10	14	11	25	25		Connection to existing factory (500m)
(3) Utility				**5,573**	**3,084**	**8,657**	**8,657**	**0**	
1) Water supply system							2,016		
a Water intake system (deep wells)	LS	1	1,167,000	642	525	1,167	1,167		Deep well, connecting pipeline, pumps, etc.
b Distribution system	LS	1	849,400	603	246	849	849		Distribution pipeline, pump station, etc.
2) Sewerage system							2,769		
a Sewer		1	513,000	359	154	513	513		
b Sewage treatment plant		1	1,487,000	1,056	431	1,487	1,487		
c Outfall facility		1	769,000	692	77	769	769		
3) Power supply system							1,182		
a Power generator						0			Purchasing EDC electricity outside
b Distribution line		1	783,000	697	86	783	783		Switching station, 22 kV line, etc.
c Others		1	399,000	355	44	399	399		Street lighting, etc.
4) Drainage system	LS	1	1,849,000	555	1,294	1,849	1,849		Open ditch, sand sedimentation pond, etc
5) Telecommunication	LS	1	280,000	252	28	280	280		Exchange station, F/O cable
6) Solid waste disposal system							561		
a Sanitary land fill site		1	212,000	21	191	212	212		
b Garbage truck		1	150,000	143	8	150	150		
c Related facility		1	199,000	199	0	199	199		
(4) Others				**242**	**126**	**368**	**368**		
1) One stop service center	m^2	600	500	225	75	300	300		
2) Park	m^2	11,500	5	14	43	58	58		
3) Others	LS	1	10,000	3	8	10	10		Fence, gate, green, etc.
3 Administration cost	LS			141	137	278	278	0	2% of construction cost
Subtotal				7,198	6,995	14,193	14,193	0	
4 Engineering cost	LS			720	700	1,419	1,419	0	10% of subtotal
5 Physical contingency	LS			792	769	1,561	1,561	0	10% of subtotal+engineering cost
Total				**8,709**	**8,464**	**17,174**	**17,174**	**0**	
				29.7$/m2	28.9$/m2	58.6$/m2	58.6$/m2	0.0$/m2	salable/rental area is 29.3 ha
6 VAT	LS								10% of total
7 Grand total				8,709	8,464	17,174	17,174	0	
				29.7$/m2	28.9$/m2	58.6$/m2	58.6$/m2	0.0$/m2	

Note: Compensation and relocation cost of 138 residents is not inclusive.
Price escalation is not inclusive.

Table G-33 Development Cost of SIA Site-4

Table I.6-6 Development Cost of Sihanoukville Industrial Area (Site 4)

Item	unit	Q'ty	Unit price	Amount (1,000$)	Alternative amount (1,000$)		Remarks
					Internal	external	
1 Land acquisition	m^2	1,580,000	8	**12,640**	12,640	0	Private land
2 Construction				**43,438**	**43,438**	**0**	
(1) Land grading				**3,950**	**3,950**		
1) Land preparation	m^2	1,580,000	0.5	790	790		
2) Cut/fill work	m^3	1,580,000	2.0	3,160	3,160		158hax1m ave=1,580,000m3
(2) Road				**1,922**	**1,922**		
1) Access road	m^2	0	23	0	0		Pavement, culvert, etc.
2) Main internal road	m^2	57,750	18	1,040	1,040		
3) Sub main internal road	m^2	51,000	17	867	867		
4) Other road	m^2	1,500	10	15	15		
(3) Utility				**36,809**	**36,809**	**0**	
1) Water supply system					18,814	0	
a Water intake system (reservoir)	LS	1	14,792,000	14,792	14,792		1/2 cost of reservoir development & connecting pipeline
b Water tretament facility	LS	1	2,306,000	2,306	2,306		Disinfection, ditribution reservoir,
c Distribution system	LS	1	1,716,400	1,716	1,716		Distribution pipeline, pump station,
2) Sewerage system					5,348		
a Sewer		1	2,448,000	2,448	2,448		
b Sewage treatment plant		1	2,900,000	2,900	2,900		
3) Power supply system					7,091		
a Substation facilities		1	5,100,000	5,100	5,100	0	Substation in IA & transmission line
b Distribution line		1	1,140,000	1,140	1,140		
c Others		1	851,000	851	851		Street lighting, etc.
4) Drainage system	LS	1	5,080,000	5,080	5,080		Open ditch, discharge channel, etc.
5) Telecommunication	LS	1	476,000	476	476		Exchange station, F/O cable
6) Solid waste disposal system				0			disposal by factory basis
(4) Others				**757**	**757**		
1) One stop service center	m^2	1,000	500	500	500		
2) Park	m^2	47,400	5	237	237		
3) Others	LS	1	20000	20	20		Fence, gate, green, etc.
3 Administration cost	LS			1,122	1,122	0	2% of construction cost
Subtotal				44,559	44,559	0	
4 Engineering cost	LS			4,456	4,456	0	10% of subtotal
5 Physical contingency	LS			4,902	4,902	0	10% of subtotal+engineering cost
Total				**66,557**	**66,557**	**0**	
				60.3$/m2	60.3$/m2	0.0$/m2	salable/rental area is 110.34 ha
6 VAT	LS			5,392	5,392	0	10% of total
7 Grand total				**71,949**	**71,949**	**0**	
				65.2$/m2	65.2$/m2	0.0$/m2	

Note: Price escalation is not inclusive.

Table G-34 Development Cost of SIA Site-6

Table I.6-7 Development Cost of Sihanoukville Industrial Area (Site 6)

Item	unit	Q'ty	Unit price	Amount (1,000$)	Alternative amount (1,000$)		Remarks
					Internal	external	
1 Land acquisition	m^2	1,800,000	1	**1,800**	1,800	0	Private land
2 Construction				**43,702**	**43,702**	**0**	
(1) Land grading				**4,500**	**4,500**		
1) Land preparation	m^2	1,800,000	0.5	900	900		
2) Cut/fill work	m^3	1,800,000	2.0	3,600	3,600		180hax1m ave=1,800,000m3
(2) Road				**2,580**	**2,580**		
1) Access road	m^2	29,400	23	676	676		Pavement, culvert, etc.
2) Main internal road	m^2	44,100	18	794	794		
3) Sub main internal road	m^2	65,300	17	1,110	1,110		
(3) Utility				**35,832**	**35,832**	**0**	
1) Water supply system					18,112	0	
a Water intake system (dam)	LS	1	13,218,400	13,218	13,218		1/2 cost of reservoir development & connecting pipeline
b Water tretament facility	LS	1	2,960,000	2,960	2,960		Disinfection, ditribution reservoir,
c Distribution system	LS	1	1,933,400	1,933	1,933		Distribution pipeline, pump station,
2) Sewerage system					5,823		
a Sewer		1	2,436,000	2,436	2,436		
b Sewage treatment plant		1	3,387,000	3,387	3,387		
3) Power supply system					7,692		
a Substation facilities		1	5,600,000	5,600	5,600	0	Substation in IA & transmission line
b Distribution line		1	1,264,000	1,264	1,264		
c Others		1	828,000	828	828		Street lighting, etc.
4) Drainage system	LS	1	3,729,000	3,729	3,729		Open ditch, discharge channel, etc.
5) Telecommunication	LS	1	476,000	476	476		Exchange station, F/O cable
6) Solid waste disposal system				0			disposal by factory basis
(4) Others				**790**	**790**		
1) One stop service center	m^2	1,000	500	500	500		
2) Park	m^2	54,000	5	270	270		
3) Others	LS	1	20000	20	20		Gate, green, etc.
3 Administration cost	LS			910	910	0	2% of construction cost
Subtotal				44,612	44,612	0	
4 Engineering cost	LS			4,461	4,461	0	10% of subtotal
5 Physical contingency	LS			4,907	4,907	0	10% of subtotal+engineering cost
Total				**55,780**	**55,780**	**0**	
				44.8$/m2	44.8$/m2	0.0$/m2	salable/rental area is 124.38 ha
6 VAT	LS			5,398	5,398	0	10% of total
7 Grand total				**61,178**	**61,178**	**0**	
				49.2$/m2	49.2$/m2	0.0$/m2	

Note: Price escalation is not inclusive.

Table G-35 Development Cost of PIA

Table I.6-8 Development Cost of Phnom Penh Industrial Area

Item	unit	Q'ty	Unit price	Amount (1,000$)	Alternative amount (1,000$)		Remarks
					Internal	external	
1 Land acquisition	m^2	1,570,000	5	**7,850**	7,850	0	Private land
2 Construction				**33,142**	**33,142**	**0**	
(1) Land grading				**8,635**	**8,635**		
1) Land preparation	m^2	1,570,000	0.5	785	785		
2) Cut/fill work	m^3	1,570,000	5.0	7,850	7,850		157hax1m ave=1,570,000m3
(2) Road				**1,799**	**1,799**		
1) Access road	m^2	29,400	23	676	676		Pavement, culvert, etc.
2) Main internal road	m^2	46,500	18	837	837		
3) Sub main internal road	m^2	16,800	17	286	286		
(3) Utility				**21,788**	**21,788**	**0**	
1) Water supply system					4,110	0	
a Water intake system	LS	1	1,817,700	1,818	1,818		from PNPwater Authority
b Distribution system	LS	1	2,292,000	2,292	2,292		Distribution pipeline, pump station,
2) Sewerage system					6,951	0	
a Sewer		1	2,708,000	2,708	2,708		
b Sewage treatment plant		1	2,764,000	2,764	2,764		
c Discharge facility		1	1,479,000	1,479	1,479		
3) Power supply system					2,076	0	
a Power generator		1		0			Purchasing EDC electricity outside
b Distribution line		1	1,462,000	1,462	1,462		
c Others		1	614,000	614	614		Street lighting, etc.
4) Drainage system	LS	1	8,175,000	8,175	8,175		Open ditch, retention pond, etc.
5) Telecommunication	LS	1	476,000	476	476		Exchange station, F/O cable
6) Solid waste disposal system				0			
(4) Others				**920**	**920**		
1) One stop service center	m^2	1,000	500	500	500		
2) Park	m^2	80,000	5	400	400		
3) Others	LS	1	20000	20	20		Gate, green, etc.
3 Administration cost	LS			820	820	0	2% of construction cost
Subtotal				33,961	33,961	0	
4 Engineering cost	LS			3,396	3,396	0	10% of subtotal
5 Physical contingency	LS			3,736	3,736	0	10% of subtotal+engineering cost
Total				**48,943**	**48,943**	**0**	
				41.5$/m2	41.5$/m2	0.0$/m2	salable/rental area is 117.8 ha
6 VAT	LS			4,109	4,109	0	10% of total
7 Grand total				**53,053**	**53,053**	**0**	
				45.0$/m2	45.0$/m2	0.0$/m2	

Note: Price escalation is not inclusive.

Table G-36 Development Cost of SPIA

Table I.6-9 Development Cost of Sihanoukville Port Industrial Area

Item	unit	Q'ty	Unit price	Amount (1,000$)	Alternative amount (1,000$)		Remarks
					Internal	external	
1 Land acquisition	m^2	559,000	0	**0**	0	0	PAS land
2 Construction				**14,876**	**14,876**	**0**	
(1) Land grading				**4,230**	**4,230**		
1) Land preparation	m^2	559,000	0.5	280	280		
2) Cut/fill work	m^3	790,000	5.0	3,950	3,950		55.9hax(EL3.7m-EL2.3m)=790,000m3
(2) Road				**1,184**	**1,184**		
1) Access road	m^2	17,430	23	401	401		Pavement, sidewalk, electric pole, etc.
2) Main internal road	m^2	12,600	18	227	227		
3) Sub main internal road	m^2	25,800	17	439	439		
4) Patrol road	m^2	11,800	10	118	118		
(3) Utility				**9,369**	**9,369**	**0**	
1) Water supply system					3,664		
a Water intake system (deep wells)	LS	1	2,518,500	2,519	2,519		Deep well, connecting pipeline, pumps, etc.
b Distribution system	LS	1	1,145,400	1,145	1,145		Distribution pipeline, pump station,
2) Sewerage system					1,453		
a Sewer		1	482,000	482	482		
b Sewage treatment plant		1	971,000	971	971		
c Outfall facility		1	0	0	0		
3) Power supply system					1,585		
a Power generator		1		0		0	Purchasing EDC electricity outside
b Distribution line		1	1,167,000	1,167	1,167		
c Others		1	418,000	418	418		Street lighting, etc.
4) Drainage system	LS	1	2,569,000	2,569	2,569		Open ditch, sand sedimentation pond, e
5) Telecommunication	LS	1	98,000	98	98		Exchange station, F/O cable
6) Solid waste disposal system				0			
(4) Others				**94**	**94**		
1) One stop service center	m^2		500	0	0		
2) Park	m^2	16,700	5	84	84		
3) Others	LS	1	10,000	10	10		Fence, gate, green, etc.
3 Administration cost	LS			298	298	0	2% of construction cost
Subtotal				15,174	15,174	0	
4 Engineering cost	LS			1,517	1,517	0	10% of subtotal
5 Physical contingency	LS			1,669	1,669	0	10% of subtotal+engineering cost
Total				**18,360**	**18,360**	**0**	
				46.0$/m2	46.0$/m2	0.0$/m2	salable/rental area is 39.9 ha
6 VAT	LS					0	10% of total
7 Grand total				**18,360**	**18,360**	**0**	
				46.0$/m2	46.0$/m2	0.0$/m2	

Note: Compensation and relocation cost of residents is not inclusive.
Price escalation is not inclusive.

Table G-37 Compensation Cost for 138 Households Resettlement for SPFZ

Table I.6-10 Compensation Cost for 138 Households Resettlement for the Development of Sihanoukville Port Free Zone

Item	unit	Q'ty	Unit price	Amount (1,000$)	Alternative amount (1,000$)		Remarks
					Internal	external	
1 Land acquisition	m^2	20,000	5	**100**	100	0	Private land: already purchased by PAS
2 Construction				**382**	**382**	**0**	
(1) Land grading				**10**	**10**		
1) Land preparation	m^2	20,000	0.5	10	10		
2) Cut/fill work	m^3	0	5.0	0	0		
(2) Road				**10**	**10**		
1) Access road	m^2	1,700	6	10	10		6mx280=1,700m2
(3) Utility				**86**	**86**	**0**	
1) Water supply system					30	0	
a Water intake system	LS	1	10,000	10	10		
b Distribution system	LS	1	20,000	20	20		Distribution pipeline, pump station,
2) Sewerage system					14	0	
a Septic tank		138	100	14	14		
3) Power supply system					17	0	
a Distribution line	m	1,700	10	17	17		
4) Drainage system	m	500	50	25	25		Open ditch
(4) House				**276**	**276**		
1) Substitution House	LS	138	2000	276	276		
3 House relocation cost	LS			10	10	0	
Subtotal				392	392	0	
4 Engineering cost	LS			39	39	0	10% of subtotal
5 Physical contingency	LS			43	43	0	10% of subtotal+engineering cost
Total				**574**	**574**	**0**	
6 VAT	LS			47	47	0	10% of total
7 Grand total				621	621	0	
				0.5$/m2	0.5$/m2	0.0$/m2	

Note: Price escalation is not inclusive.

G.10 PRELIMINARY DEVELOPMENT PLAN OF TOEK SAP RESERVOIR FOR WATER SUPPLY IN SIHANOUKVILLE

G.10.1 General Conditions

Mean annual rainfall at the Sihanoukville is huge volume at around 3,400 mm/year. However, water supply potential in the Sihanoukville is very limited. The river flow is almost dried up in the dry season, and the groundwater potential is not high in the Sihanoukville province. The shallow well and the deep well yields only 58 m^3/day[12] and 480 m^3/day - 720 m^3/day[13] respectively.

G.10.2 Present Water Supply System in Sihanoukville

Present water supply system in the Sihanoukville City was initially designed and constructed in 1958 by France. After that, 1st expanding and rehabilitation project was conducted by Soviet in 1989, with installing of pump and generators. The World Bank and UNDP conducted the 2nd expanding and rehabilitation project including pumps from 1993 to 1995.

Only the municipality center is served by piped water system in Sihanoukville presently. The Sihanoukville Water Supply Authority (SWSA) under the Water Supply Office of Department of Industry, Mines and Energy operates the system.

The source of the Sihanoukville water supply system is small shallow lake (13 ha), "Boeng Prek Tup", located 3 km south west of the city, close to its southern foreshore. The water level of the lake is originally maintained by a small weir with a crest level of around 3.5 m above sea level. The lake has an estimated catchment area of 270 ha. The lake is full during the wet season (from May to October), but during the dry season (from November to April) the level drops by as much as 3 m (almost dried up).

The plant capacity of the water supply system in the Sihanoukville is only 3,000 m^3/day and the service ratio is reported at only 13% (1,400 households) of the population in the service area in 2002. Presently the typical dry-season yield of the lake is approximately 2,200 m^3/day, which is inadequate to serve the water demand of the Sihanoukville.

The expansion project (funded by World Bank) is on going to make the capacity 6,000 m^3/day (service ratio of 50% for 4,000 households) by increasing capacity of existing reservoir "Lake Boeng Prek Tup" and development of additional 3 wells as summarized below.

- Project Period : 1999 - 2002
- Budget : 3.95 million US$ (World Bank)

[12] Source : UNICEF & Ministry of Rural Development.
[13] Source : Sihanoukville Water Supply Authority (SWSA), WB, 2002.

1.00 million US$ (Government of Cambodia)

4.95 million US$ TOTAL

- Water Source and Supply Capacity:

  1) Lake Boeng Prek Tup: Catchment Area = 270 ha.
  V = 290,000 m3 (original capacity, 2001)
  V = 400,000 m^3(rehabilitated, 2002)
  Supply Capacity (Lake) = 4,000 m^3/day (2002)

  2) Groundwater (Well) : 3 wells (newly installed in 2002)
  Production well No.1 Yield = 600 m^3/day
  Production well No.2 Yield = 720 m^3/day
  Production well No.3 Yield = 480 m^3/day
  Supply Capacity (Well) = 1,800 m^3/day

- Capacity of Treatment Plant : Max.= 8,000 m^3/day, Average = 6,000 m^3/day
- Service Ratio :
  Oct. 2002 (existing) : 1,400 household
  end of 2003 (Plan) : 4,000 household

G.10.3 Review of Earlier Study of Water Demand forecast in Sihanoukville

Future water demand projections for the Sihanoukville water supply system by earlier studies are shown in the Table below.

Table G-38 Future Water Demand Projections by Earlier Studies

Estimated by (m^3/day)		2000	2005	2010	2015	2020
Sogreah Ingenierie	Low Scenario	9,934	14,464	18,243	20,369	
	Medium Scenario	10,372	17,486	25,018	32,184	
	High Scenario	10,922	21,299	36,110	48,694	
Fraser Thomas (Pre-F/S, 1994)		10,000	21,440	37,500	80,000	
Parsons ES (1999)	Low Scenario				16,800	21,700
	High Scenario				47,200	60,800

Source : Cambodia Urban Water Supply Project, SWSA, (WB Credit), Report on Long-term Water Supply, Parsons, (1999)

The difference of demand projections between the Fraser Thomas and Sogreah is mostly depends on an optimistic assumption of the growth of tourism used by Fraser Thomas. Parsons ES estimated the future water demand of Central Sihanoukville by following method.

- Present Population (1999) : 55,000
- Annual Population Growth Rate : 5.2 % (last 20 years averaged)
- Projected Population : 118,000 (2015), 152,000 (2020)
- Domestic Consumption : 100 - 200 [little/capita/day]

- Commercial/Industrial/Tourism Demand : 30% - 50% of domestic demand

G.10.4 Updating of Water Demand Forecast in Sihanoukville

In this study, future water demand of the Sihanoukville City is estimated by using updated data/information. As the future water demand in the Sihanoukville City at 2020 level is projected at 86,000 m^3/day in this Study. It is included the water demand for 2-sites of proposed industrial area (IA). There will be a substantial imbalance between in the water supply capacity and demand (see **Table G-39** and **Figure G-39**). Water sources are not sufficient to supply water to the large demands with the development of the reservoir in this area.

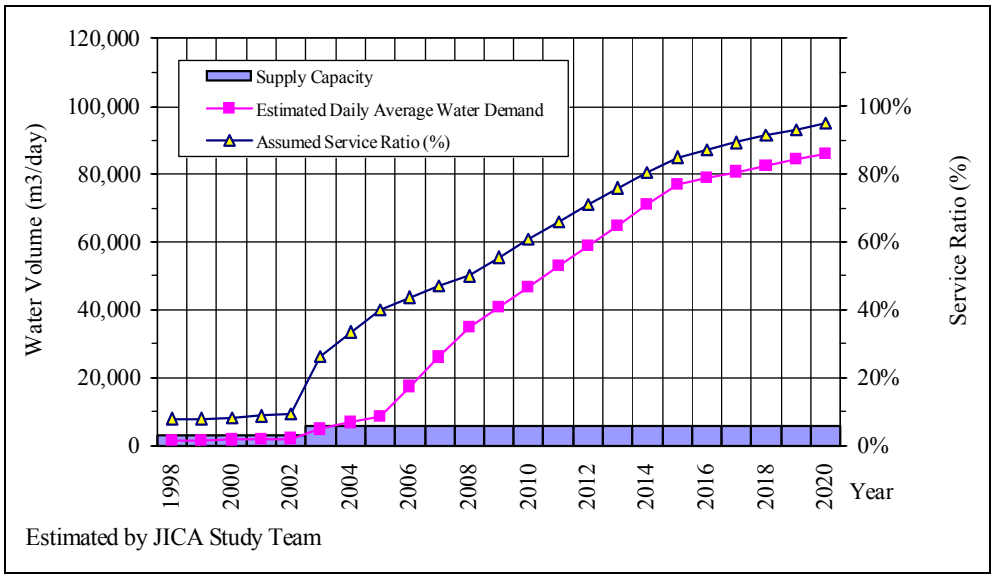


Figure G-39 Water Demand Projection of Sihanoukville Water Supply System

Table G-39 Water Demand Projection of Sihanoukville Water Supply System

Description	District		Unit		1998 Census (March)	2003 *3)	2005 *1)	2008 *2)	2015 *2)	2020 *3)
Population	**Krong Preah Sihanouk Total**	**TOTAL**	**persons**	*1)	**155,690**	***203,966***	**219,943**	***249,000***	***318,000***	***367,300***
	Mittakpheap District (Khan)	**Sub-Total**	**persons**	*1)	**67,440**	***88,352***	**95,272**	***107,859***	***121,673***	***140,536***
	(Central Sihanoukville)	Urban	persons	*1)	66,723	*87,412*	94,259	*106,712*	*120,379*	*139,041*
		Rural	persons	*1)	717	939	1,013	1,147	1,294	1,494
	Prey Nob District (Khan)	**Sub-Total**	**persons**	*1)	**75,142**	***98,442***	**106,153**	***120,177***	***135,569***	***156,586***
	Stueng Hav District (Khan)	**Sub-Total**	**persons**	*1)	**13,108**	***17,172***	**18,518**	***20,964***	***23,649***	***27,316***
Household	**Krong Preah Sihanouk Total**	**TOTAL**	**HH**	*1)	**28,015**	***1,133,515***	**41,498**	***1,319,722***	***1,685,428***	***1,946,722***
Average HH Size					5.6	*5.6*	5.3	*5.3*	*5.3*	*5.3*
Population in the Service Area (Urban Area of Mittakpheap)			persons		66,723	87,412	94,259	106,712	120,379	139,041
Population in the Service Area (Rural Areas of Mittakpheap)		50%	persons		-	-	-	573	647	747
Total Population in the Service Area			**persons**		**66,723**	**87,412**	**94,259**	**107,285**	**121,026**	**139,789**
No. of Connection (HH) in Service Area			HH		946	4,120	*199,832*	*284,310*	*545,230*	*703,847*
No. of Connection (Pop.) in Service Area			**persons**		***5,257***	***22,896*** *5)	***37,704*** *5)	***53,643*** *5)	***102,872*** *5)	***132,799***
Service Ratio			%		7.9%	26.2% *4)	*40.0%* *4)	*50.0%* *4)	*85.0%* *4)	*95.0%*
Unit Water Consumption per person (capita) per day			l/c/d		*6)* 135	*6)* 135	135 *7)*	*150* *7)*	*200* *7)*	*200*
Domestic Water Demand of Connecting HH			**m^3/d**		**710**	**3,091**	**5,090**	**8,046**	**20,574**	**26,560**
Industrial Water Demand (Beer Brewery)			m^3/d	*8)	300	300	300	*1,700*	*1,700*	*1,700*
Industrial Water Demand (Proposed FZ)			m^3/d	*9)	0	0	0	9,500	21,920	21,920
W.Supply for Combined Sycle Electric Power Station (Plan)			m^3/d	*10)	0	0	0	195	195	195
W.Supply for EDC			m^3/d	*10)			100	100	100	100
Other Commercial/Industrial W.Demand Ratio to Domestic W.D.			%	*12)	*5%*	*5%*	*10%*	*30%*	*30%*	*30%*
Other Commercial/Industrial W.Demand			m^3/d		35	155	509	2,414	6,172	7,968
Water Demand for Supply to Ship (Sihanoukville Port)			m^3/d	*17)			500	650	1,000	1,250
Commercial/Industrial W.Demand Sub-Total			**m^3/d**		**335**	**455**	**1,409**	**14,559**	**31,087**	**33,133**
Annual Total No. of Tourists Forcasted (Domestic)			pers./yr	*13)	*62,287*	85,251	103,891	131,430	200,886	*250,498*
Annual Total No. of Tourists Forcasted (International)			pers./yr	*13)	*21,827*	31,699	76,467	137,608	305,703	*425,771*
Average Satay Days (Domestic)		75%	days	*14)	*1.5*	*1.5*	*1.5*	*1.5*	*1.5*	*1.5*
Average Satay Days (International)			days		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*
Unit Water Consumption of Tourist (Domestic)			l/c/d	*16)	*150*	*150*	*150*	*250*	*250*	*250*
Unit Water Consumption of Tourist (International)			l/c/d	*16)	*300*	*300*	*300*	*500*	*500*	*500*
Water Demand of Tourist (Domestic)			m^3/d		38	53	64	135	206	257
Water Demand of Tourist (International)			m^3/d		36	52	126	377	838	1,166
Tourist Water Demand (Hotel) (Potential)			m^3/d		**74**	**105**	**190**	**512**	**1,044**	**1,424**
Restaurant Water Demand			m^3/d	*18)	**37.6**	**52.4**	**84.6**	**129.4**	**250.1**	**336.2**
Sub-Total			m^3/d		**112**	**157**	**274**	**641**	**1,294**	**1,760**
Connection Rate of Hotels			%		10%	20%	50%	75%	95%	95%
Tourist Water Demand for Piped Water System Sub-Total			**m^3/d**		**11**	**31**	**137**	**481**	**1,229**	**1,672**
Sub-Total Water Demand			**m3/d**		**1,056**	**3,577**	**6,636**	**23,086**	**52,891**	**61,365**
Contingency		25%	m^3/d					5,772	13,223	15,341
Water Leakage Ratio in System			%		35%	35%	30%	25%	20%	15%
Water Leakage in System			m^3/d		370	1,252	1,991	5,772	10,578	9,205
TOTAL DAILY AVERAGE WATER DEMAND			**m^3/d**		**1,430**	**4,830**	**8,630**	**34,700**	**77,000**	**86,000**
Supply Capacity of SWSA			m^3/d		**3,000**	**6,000**	**6,000**	**6,000**	**6,000**	**6,000**
Deficit (Required New Creation Water)			**m^3/d**		**1,570**	**1,170**	**-2,630**	**-28,700**	**-71,000**	**-80,000**

Source : JICA Study Team.

Notes) *1) : Estimated population in 2005 : Souce: Physical Framework Plan Sihanoukville, Environmental Management in theCoastal ~ Cambodia, MOE and DANIDA, Apr.2002.
*2) : Estimated population in 2008 and 2015 : Souce: General Population Census of Cambodia 1998, Report 6 - Population Projections 2001-2021.
*3) : Population in 2000 and 2002 are estimated by using 1998 and 2005 data.

G.10.5 Review of Alternative Water Supply Sources

In 1994, the potential alternatives of the water for Sihanoukville in long-run was studied by Fraser Thomas. The ten-(10) alternatives sources considered were identified.

- Lake Boeng Prek Tup (increased capacity)
- Oil Refinery Lake - Stung Hav District
- Groundwater - Sihanoukville area
- Phum Riem - Groundwater Reserves
- Phum Riem - Lake Boeng Thom Angkep
- Lake at "Sokha"
- Groundwater further afield
- Prek Toek Sap - Lower reaches
- Prek Toek Sap - Upper reaches
- Other rivers

Location of the ten-(10) alternative sources are indicated in **Figure G-4**.

Table G-40 summarized major factor considered earlier in evaluating each of the ten-(10) potential alternative sources.

The study by Fraser Thomas confirmed that the upper reaches of the Prek Toek Sap River is the only resource in consideration of the dry season yield.

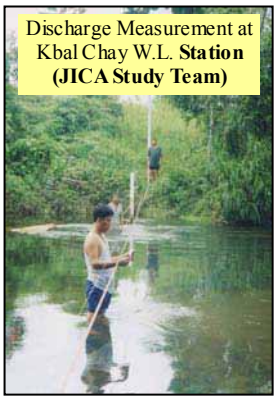
Table G-40 Alternative Water Supply Sources for Sihanoukville Comparative Attributes (from Fraser Thomas, 1994)

Potential Alternative Source	Considerations Made
Lake Boeng Prek Tup	• Present supply lake • Capacity inadequate for long-term demand • Lowering of lake bed will give little increased storage at a high cost
Oil Refinery Lake - Stung Hav District	• Supply old refinery • Smaller than Boeng Prek Tup and shallower (approx. 1.5 meter) • Capacity inadequate for long-term demand
Groundwater - Sihanoukville area	• Groundwater reserves will alleviate immediate (short-term) shortfall • Refurbishment of 3 existing wells and construction of 4 wells will provide sustainable yield of 2000 m3/day for individual supplies • Additional groundwater wells on northern side of groundwater divide could provide upwards of a further 2000 m3/day • Groundwater supplies lack capacity for long-term demand
Phum Riem - Groundwater Reserves	• Inadequate yield for long-term demand • Local supply capability only
Phum Riem - Lake Boeng Thom Angkep	• Poor water quality • Inadequate capacity for future long-term demand • Draw-off could impact on adjacent agricultural activities
Lake at "Sokha"	• Water quality poor • Present drainage outlet for large portion of city storm-water and drainage • Lake will always be subject to deleterious discharges • Inadequate capacity for future long-term demand
Groundwater further afield	• Inadequate capacity to meet future demand • Draw-off would impact on other public private wells • High cost to develop and transmit • (relative to quantity of resource)
Prek Toek Sap - Lower reaches	• Water reported to be brackish • Subject to likely industrial discharge and pollutants • Considerable distance (22 km) from Sihanoukville
Prek Toek Sap - Upper reaches	• Undeveloped catchment and clean resource • Relatively close (around 10 km) to Sihanoukville • Adequate capacity for anticipated future demand (and more) • Dam will be required - but future unit cost will be lower than present pumped supplies • Potential for current development with hydro electric generation
Other rivers	• None with sufficient capacity other than Prek Toek Sap, in close proximity to Sihanoukville • Brackish water (Prek Thama Rung) • Alternative sources 35 km (Stung Kampong Smach of Prey Nob) to 100 km (Kamcahy River at Kampot, etc.) or more from Sihanoukville

Source : Fraser Thomas (1994)

G.10.6 Flow of Prek Toek Sap River

An automatic rain gauge, water level and staff gauges were installed at around 200m upstream of the Kbal Chay waterfall in the Prek Toek Sap River by Department of Water Resources and Meteorology, Sihanoukville on 16 February, 2001. Catchment area of the Kbal Chay water level station is at 52.5 km^2. The location map is shown in **Figure G-5**.


Discharge Measurement at Kbal Chay W.L. **Station (JICA Study Team)**

There was no discharge measurement or stage-flow-rating curves in this station. The JICA Study Team conducted the discharge measurement (see **Table G-41**) and the river cross-section survey (see **Table G-42**) on 26-28 September 2002. The observed daily mean gauge height at the Kbal Chay water level station is shown in **Table G-43**. The stage-flow-rating curve for the Kbal Chay water level station is established by using the *Manning*'s formula (assumed n=0.06 and I=1/700) and observed discharge as shown below.

[Stage-Flow Rating Curve for Kbal Chay W.L. station]

$$Q = 9.437 \times (H - 1.034)^2$$

where, Q : Discharge [m^3/sec]

H : Gauge Height of Staff Gauge [m]

Table G-41 Observed Discharge at Kbal Chay W.L. Station

Obs. Date / Time	Gauge Height (m)	Discharge (m^3/sec)
26 Sep.2002 15:40	1.86	6.30
28 Sep.2002 15:40	1.80	5.36
16 Feb.2003 16:00	1.27	0.09

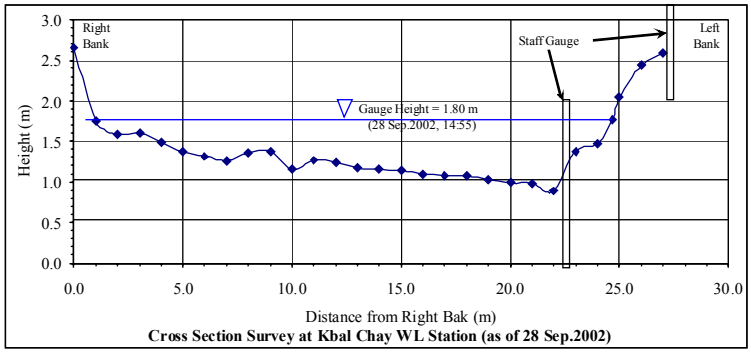
Source : JICA Study Team

Table G-42 Cross Section Survey Data at Kbal Chay W.L. Station

Name of River : Kbal Chay River (Upper Preaek Tuek Sab River)
Location : Kbal Chay Water Level Station, Stung Hav District, Sihanoukville around 200 m upstream from Kbal Chay Water Fall
Operation of WL : Department of Water Resources and Meteorology, Sihanoukville
Observed Date : 28 September, 2002 14:40 ~ 14:55
Gauge Height (m) = 1.80 C.A. =52.52 km^2

No.	Note	Distance from Bank (m)	Distance of Section (m)	Water Depth (m)	Cross Section for Staff Gauge (m)
0		**0.0**	0.0	-	**2.66**
1	Right Bank	**1.0**	1.0	0.190	**1.75**
2		**2.0**	1.0	0.340	**1.59**
3		**3.0**	1.0	0.410	**1.61**
4		**4.0**	1.0	0.425	**1.50**
5		**5.0**	1.0	0.545	**1.37**
6		**6.0**	1.0	0.595	**1.32**
7		**7.0**	1.0	0.645	**1.27**
8		**8.0**	1.0	0.550	**1.36**
9		**9.0**	1.0	0.520	**1.38**
10		**10.0**	1.0	0.735	**1.16**
11		**11.0**	1.0	0.610	**1.27**
12		**12.0**	1.0	0.630	**1.25**
13		**13.0**	1.0	0.690	**1.18**
14		**14.0**	1.0	0.700	**1.15**
15		**15.0**	1.0	0.710	**1.14**
16		**16.0**	1.0	0.740	**1.10**
17		**17.0**	1.0	0.760	**1.07**
18		**18.0**	1.0	0.755	**1.07**
19		**19.0**	1.0	0.780	**1.04**
20		**20.0**	1.0	0.825	**0.99**
21		**21.0**	1.0	0.820	**0.98**
22	Staff Gauge	**22.0**	1.0	0.910	**0.89**
23		**23.0**	1.0	0.400	**1.38**
24		**24.0**	1.0	0.310	**1.47**
25	Left Bank	**24.7**	0.7	0.000	**1.77**
26		**25.0**	0.3	-	**2.05**
27		**26.0**	1.0	-	**2.44**
28		**27.0**	1.0	-	**2.59**

JICA Study Team



Cross Section Survey at Kbal Chay WL Station (as of 28 Sep.2002)

Using the daily gauge height record and above rating curve, the daily discharge is calculated as shown in **Table G-44** and **Figure G-6**.

During the observed period from February 2001 to August 2002, a minimum discharge was observed at 0.11 m^3/sec in 17 February, 2001, while a maximum daily mean discharge was observed at 69.6 m^3/sec in 17 August, 2001. **Figure G-40** shows the flow-duration curve at the Kabl Chay station.

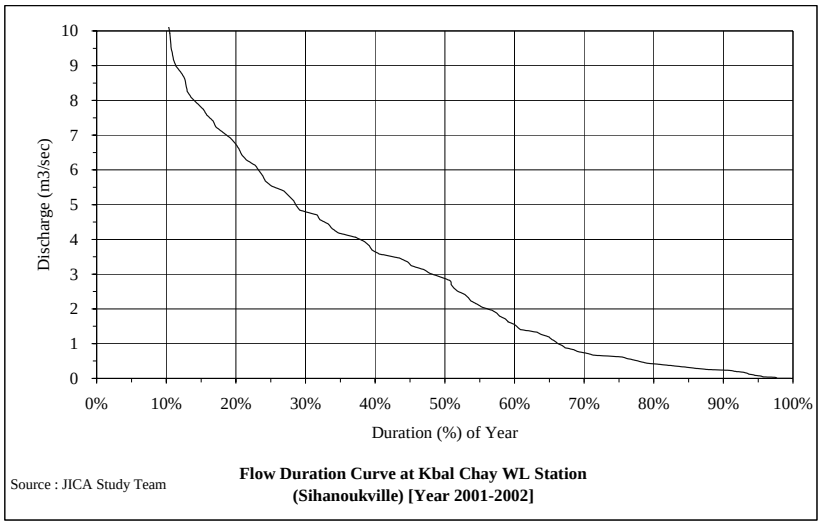


Figure G-40 Flow Duration Curve at Kbal Chay W.L. Station (2001-2002)

According to the above flow-duration curve, following specific discharges are able to read.

50% (183 Days of the Year) = 2.81 m^3/sec (5.35 m^3/sec/100 km^2)

80% (292 Days of the Year) = 0.40 m^3/sec (0.76 m^3/sec/100 km^2)

85% (310 Days of the Year) = 0.33 m^3/sec (0.62 m^3/sec/100 km^2)

90% (329 Days of the Year) = 0.23 m^3/sec (0.44 m^3/sec/100 km^2)

95% (347 Days of the Year) = 0.07 m^3/sec (0.13 m^3/sec/100 km^2)

The river discharge during the dry season in the Sihanoukville area is quite limited. As described above, future water demand in the Sihanoukville City will reach to 86,000 m^3/day (= 0.99 m^3/sec). It is difficult to use this river without any reservoir for the water supply in Sihanoukville City.

Therefore, it is strongly requested to make a reservoir in the Prek Toek Spa River for the water supply in the Sihanoukville as soon as possible.

Table G-43 Daily Gauge Heigh at Kbal Chay W.L. Station (Prek Toek Sap River)

Station : Kbal Chhay W.L. Station **C.A. =52.52 km^2**
Location : Preak Tuek Sub River, Sihanoukville (around 200 m upstream from Kbal Chya water fall)
Year : 2001 **Unit : m**

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1			1.15	1.10	1.40	1.55	2.25	1.65	2.10	1.95	1.82	1.45
2			1.13	1.10	1.40	1.65	2.12	2.20	1.96	1.84	1.79	1.46
3			1.13	1.15	1.40	1.65	2.65	1.85	1.91	1.79	1.81	1.54
4			1.13	1.15	1.30	1.75	2.21	1.75	1.85	1.76	1.73	1.49
5			1.12	1.30	1.30	1.65	2.55	2.10	2.10	1.75	1.73	1.45
6			1.12	1.30	1.30	1.55	2.21	2.01	1.94	1.89	1.71	1.45
7			1.13	1.10	1.30	1.60	2.30	1.90	1.85	1.86	1.71	1.44
8			1.13	1.10	1.32	1.65	2.16	1.80	1.80	1.81	1.68	1.44
9			1.10	1.09	1.25	1.60	2.00	1.85	1.80	2.11	1.65	1.41
10			1.10	1.04	1.30	1.65	1.80	2.01	1.75	2.09	1.64	1.42
11			1.10	1.04	1.27	1.75	1.80	2.18	1.79	1.95	1.63	1.42
12			1.10	1.03	1.50	1.60	1.90	2.14	1.76	2.04	1.64	1.42
13			1.16	1.02	1.85	1.60	1.70	2.40	1.74	1.89	1.62	1.44
14			1.50	1.02	1.80	1.60	1.75	2.02	1.70	1.86	1.62	1.46
15			1.30	1.02	1.90	1.55	1.70	2.00	1.70	1.90	1.61	1.41
16		1.30	1.20	1.21	1.95	1.60	1.60	3.00	1.69	1.84	1.58	1.41
17		1.20	1.20	1.30	1.75	1.50	1.60	3.75	1.75	1.96	1.56	1.40
18		1.14	1.20	1.20	1.60	1.60	1.70	2.70	1.68	1.83	1.52	1.42
19		1.18	1.39	1.10	1.30	1.98	1.70	2.33	1.64	2.06	1.54	1.42
20		1.19	1.42	1.02	1.75	1.65	1.70	2.10	1.63	1.85	1.52	1.40
21		1.20	1.50	1.02	1.65	1.60	1.65	3.10	1.93	1.87	1.53	1.30
22		1.18	1.42	1.02	1.55	2.21	1.70	2.70	1.75	1.83	1.52	1.38
23		1.18	1.30	1.03	1.50	2.31	1.70	2.40	1.73	1.92	1.51	1.37
24		1.18	1.30	1.03	1.40	2.21	1.62	2.07	1.75	2.27	1.51	1.37
25		1.17	1.20	1.04	1.50	2.46	1.60	2.02	1.73	1.87	1.50	1.35
26		1.17	1.20	1.04	1.45	2.30	1.60	1.93	1.91	1.83	1.49	1.36
27		1.17	1.20	1.04	1.55	2.65	1.65	1.97	*1.93*	2.16	1.49	1.36
28		1.15	1.25	1.80	1.60	2.45	1.70	2.10	1.96	1.96	1.48	1.36
29			1.30	1.60	2.00	2.55	1.32	2.40	1.91	1.88	1.47	1.35
30			1.20	1.50	1.75	2.11	1.70	2.01	1.84	1.92	1.47	1.34
31			1.10		1.65		1.80	2.10		1.91		1.34
Average		**1.19**	**1.22**	**1.15**	**1.53**	**1.85**	**1.85**	**2.21**	**1.82**	**1.92**	**1.60**	**1.41**
Max.		**1.30**	**1.50**	**1.80**	**2.00**	**2.65**	**2.65**	**3.75**	**2.10**	**2.27**	**1.82**	**1.54**
Min.		**1.14**	**1.10**	**1.02**	**1.25**	**1.50**	**1.32**	**1.65**	**1.63**	**1.75**	**1.47**	**1.30**

Year : 2002 **Unit : m**

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.34	1.28	1.24	1.21	1.42	1.64	1.74	1.73				
2	1.34	1.28	1.24	1.20	1.42	1.62	1.71	1.73				
3	1.34	1.27	1.24	1.20	1.42	1.66	1.70	1.80				
4	1.33	1.27	1.24	1.21	1.38	1.69	1.71	1.88				
5	1.33	1.27	1.24	1.21	1.42	1.69	1.68	1.78				
6	1.32	1.26	1.23	1.21	1.41	1.82	1.77	2.31				
7	1.32	1.26	1.23	1.19	1.71	1.72	1.85	2.47				
8	1.32	1.25	1.23	1.19	1.47	1.67	1.67	2.09				
9	1.31	1.25	1.22	1.19	1.44	1.65	1.69	1.99				
10	1.31	1.25	1.20	1.18	1.62	1.62	1.65	1.91				
11	1.31	1.25	1.20	1.18	1.81	1.61	1.64	1.48				
12	1.30	1.25	1.19	1.42	1.65	1.66	1.64	2.14				
13	1.30	1.25	1.21	1.32	1.60	1.69	1.63	2.36				
14	1.30	1.24	1.20	1.27	1.62	1.61	1.68	2.01				
15	1.30	1.24	1.20	1.45	1.56	1.61	1.95	1.94				
16	1.30	1.23	1.21	1.32	1.52	1.62	1.96	1.90				
17	1.30	1.23	1.20	1.38	1.52	1.76	1.78	1.97				
18	1.31	1.23	1.20	1.34	1.56	1.80	1.78	2.18				
19	1.33	1.22	1.39	1.28	1.55	1.66	1.72	2.10				
20	1.31	1.22	1.22	1.26	1.51	2.20	1.73	3.15				
21	1.44	1.22	1.20	1.24	1.51	1.94	1.69	2.80				
22	1.36	1.22	1.24	1.26	1.53	2.30	1.70	2.20				
23	1.34	1.25	1.28	1.54	1.49	2.24	1.66	2.03				
24	1.32	1.24	1.25	1.47	1.57	1.93	1.64	1.97				
25	1.30	1.23	1.26	1.62	2.30	2.23	1.65	1.91				
26	1.30	1.22	1.28	1.75	2.40	1.90	1.62	1.88				
27	1.29	1.21	1.25	1.70	1.81	1.89	1.61	1.86				
28	1.29	1.21	1.23	1.57	1.75	1.86	1.72	1.93				
29	1.29		1.23	1.47	1.69	1.81	1.89	1.95				
30	1.29		1.23	1.42	1.66	1.77	2.11	1.79				
31	1.28		1.22		1.66		1.78	2.20				
Average	**1.32**	**1.24**	**1.23**	**1.34**	**1.61**	**1.80**	**1.73**	**2.05**				
Max.	**1.44**	**1.28**	**1.39**	**1.75**	**2.40**	**2.30**	**2.11**	**3.15**				
Min.	**1.28**	**1.21**	**1.19**	**1.18**	**1.38**	**1.61**	**1.61**	**1.48**				

Source : Meteorology and Hydrology office, Department of Water Resources and Meteorology, Sihanoukville

Table G-44 Calculated Daily Discharge at Kbal Chay W.L. Station

Station : Kbal Chhay W.L. Station **C.A.= 52.52 km^2**
Location : Preak Tuek Sub River, Sihanoukville (around 200 m upstream from Kbal Chya water fall)

Year : 2001 **Unit : m^3/sec**

Day	Jan 1	Feb 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12
1			0.13	0.04	1.26	2.51	13.95	3.58	10.72	7.92	5.83	1.63
2			0.09	0.04	1.26	3.58	11.13	12.83	8.09	6.13	5.39	1.71
3			0.09	0.13	1.26	3.58	24.64	6.28	7.24	5.39	5.68	2.42
4			0.09	0.13	0.67	4.84	13.05	4.84	6.28	4.97	4.57	1.96
5			0.07	0.67	0.67	3.58	21.69	10.72	10.72	4.84	4.57	1.63
6			0.07	0.67	0.67	2.51	13.05	8.99	7.75	6.91	4.31	1.63
7			0.09	0.04	0.67	3.02	15.13	7.08	6.28	6.44	4.31	1.56
8			0.09	0.04	0.77	3.58	11.96	5.54	5.54	5.68	3.94	1.56
9			0.04	0.03	0.44	3.02	8.81	6.28	5.54	10.93	3.58	1.33
10			0.04	0.00	0.67	3.58	5.54	8.99	4.84	10.52	3.47	1.41
11			0.04	0.00	0.53	4.84	5.54	12.39	5.39	7.92	3.35	1.41
12			0.04	0.00	2.05	3.02	7.08	11.54	4.97	9.55	3.47	1.41
13			0.15	0.00	6.28	3.02	4.19	17.61	4.70	6.91	3.24	1.56
14			2.05	0.00	5.54	3.02	4.84	9.17	4.19	6.44	3.24	1.71
15			0.67	0.00	7.08	2.51	4.19	8.81	4.19	7.08	3.13	1.33
16		0.67	0.26	0.29	7.92	3.02	3.02	36.48	4.06	6.13	2.81	1.33
17		0.26	0.26	0.67	4.84	2.05	3.02	69.61	4.84	8.09	2.61	1.26
18		0.11	0.26	0.26	3.02	3.02	4.19	26.19	3.94	5.98	2.23	1.41
19		0.20	1.20	0.04	0.67	8.45	4.19	15.85	3.47	9.93	2.42	1.41
20		0.23	1.41	0.00	4.84	3.58	4.19	10.72	3.35	6.28	2.23	1.26
21		0.26	2.05	0.00	3.58	3.02	3.58	40.28	7.58	6.60	2.32	0.67
22		0.20	1.41	0.00	2.51	13.05	4.19	26.19	4.84	5.98	2.23	1.13
23		0.20	0.67	0.00	2.05	15.37	4.19	17.61	4.57	7.41	2.14	1.07
24		0.20	0.67	0.00	1.26	13.05	3.24	10.13	4.84	14.42	2.14	1.07
25		0.17	0.26	0.00	2.05	19.19	3.02	9.17	4.57	6.60	2.05	0.94
26		0.17	0.26	0.00	1.63	15.13	3.02	7.58	7.24	5.98	1.96	1.00
27		0.17	0.26	0.00	2.51	24.64	3.58	8.27	7.58	11.96	1.96	1.00
28		0.13	0.44	5.54	3.02	18.92	4.19	10.72	8.09	8.09	1.88	1.00
29			0.67	3.02	8.81	21.69	0.77	17.61	7.24	6.75	1.79	0.94
30			0.26	2.05	4.84	10.93	4.19	8.99	6.13	7.41	1.79	0.88
31			0.04		3.58		5.54	10.72		7.24		0.88
Average		**0.23**	**0.45**	**0.46**	**2.80**	**7.51**	**7.19**	**14.86**	**5.96**	**7.50**	**3.16**	**1.34**
Max.		**0.67**	**2.05**	**5.54**	**8.81**	**24.64**	**24.64**	**69.61**	**10.72**	**14.42**	**5.83**	**2.42**
Min.		**0.11**	**0.04**	**0.00**	**0.44**	**2.05**	**0.77**	**3.58**	**3.35**	**4.84**	**1.79**	**0.67**

Year : 2002 **Unit : m^3/sec**

Day	Jan 1	Feb 2	Mar 3	Apr 4	May 5	Jun 6	Jul 7	Aug 8	Sep 9	Oct 10	Nov 11	Dec 12
1	0.88	0.57	0.40	0.29	1.41	3.47	4.70	4.57				
2	0.88	0.57	0.40	0.26	1.41	3.24	4.31	4.57				
3	0.88	0.53	0.40	0.26	1.41	3.70	4.19	5.54				
4	0.83	0.53	0.40	0.29	1.13	4.06	4.31	6.75				
5	0.83	0.53	0.40	0.29	1.41	4.06	3.94	5.25				
6	0.77	0.48	0.36	0.29	1.33	5.83	5.11	15.37				
7	0.77	0.48	0.36	0.23	4.31	4.44	6.28	19.46				
8	0.77	0.44	0.36	0.23	1.79	3.82	3.82	10.52				
9	0.72	0.44	0.33	0.23	1.56	3.58	4.06	8.62				
10	0.72	0.44	0.26	0.20	3.24	3.24	3.58	7.24				
11	0.72	0.44	0.26	0.20	5.68	3.13	3.47	1.88				
12	0.67	0.44	0.23	1.41	3.58	3.70	3.47	11.54				
13	0.67	0.44	0.29	0.77	3.02	4.06	3.35	16.59				
14	0.67	0.40	0.26	0.53	3.24	3.13	3.94	8.99				
15	0.67	0.40	0.26	1.63	2.61	3.13	7.92	7.75				
16	0.67	0.36	0.29	0.77	2.23	3.24	8.09	7.08				
17	0.67	0.36	0.26	1.13	2.23	4.97	5.25	8.27				
18	0.72	0.36	0.26	0.88	2.61	5.54	5.25	12.39				
19	0.83	0.33	1.20	0.57	2.51	3.70	4.44	10.72				
20	0.72	0.33	0.33	0.48	2.14	12.83	4.57	42.25				
21	1.56	0.33	0.26	0.40	2.14	7.75	4.06	29.43				
22	1.00	0.33	0.40	0.48	2.32	15.13	4.19	12.83				
23	0.88	0.44	0.57	2.42	1.96	13.73	3.70	9.36				
24	0.77	0.40	0.44	1.79	2.71	7.58	3.47	8.27				
25	0.67	0.36	0.48	3.24	15.13	13.50	3.58	7.24				
26	0.67	0.33	0.57	4.84	17.61	7.08	3.24	6.75				
27	0.62	0.29	0.44	4.19	5.68	6.91	3.13	6.44				
28	0.62	0.29	0.36	2.71	4.84	6.44	4.44	7.58				
29	0.62		0.36	1.79	4.06	5.68	6.91	7.92				
30	0.62		0.36	1.41	3.70	5.11	10.93	5.39				
31	0.57		0.33		3.70		5.25	12.83				
Average	**0.76**	**0.42**	**0.38**	**1.14**	**3.64**	**5.86**	**4.74**	**10.63**				
Max.	**1.56**	**0.57**	**1.20**	**4.84**	**17.61**	**15.13**	**10.93**	**42.25**				
Min.	**0.57**	**0.29**	**0.23**	**0.20**	**1.13**	**3.13**	**3.13**	**1.88**				

Source : JICA Study Team
Gauge height from Department of Water Resources and Meteorology, Sihanouk Ville

G.10.7 Considerable Reservoir Sited in Prek Toek Sap River

Within the Prek Toek Sap River, following 3-sites are considerable to make a reservoir by topographic conditions.

Site No.	Name of Proposed Reservoir	Location	C.A. (km^2)	Note
Site-1	Upper Prek Toek Sap Reservoir	Around 2.5 km downstream from Kbal Chay Waterfall	65.28	SWSA, WB, 1999 Study
Site-2	Alternative-2	Around 4 km downstream from Kbal Chay Waterfall	73.37	Alternative Site
Site-3	Toek Sap Reservoir	Around 6 km downstream from Kbal Chay Waterfall	87.58	New proposed site (JICA Study Team)

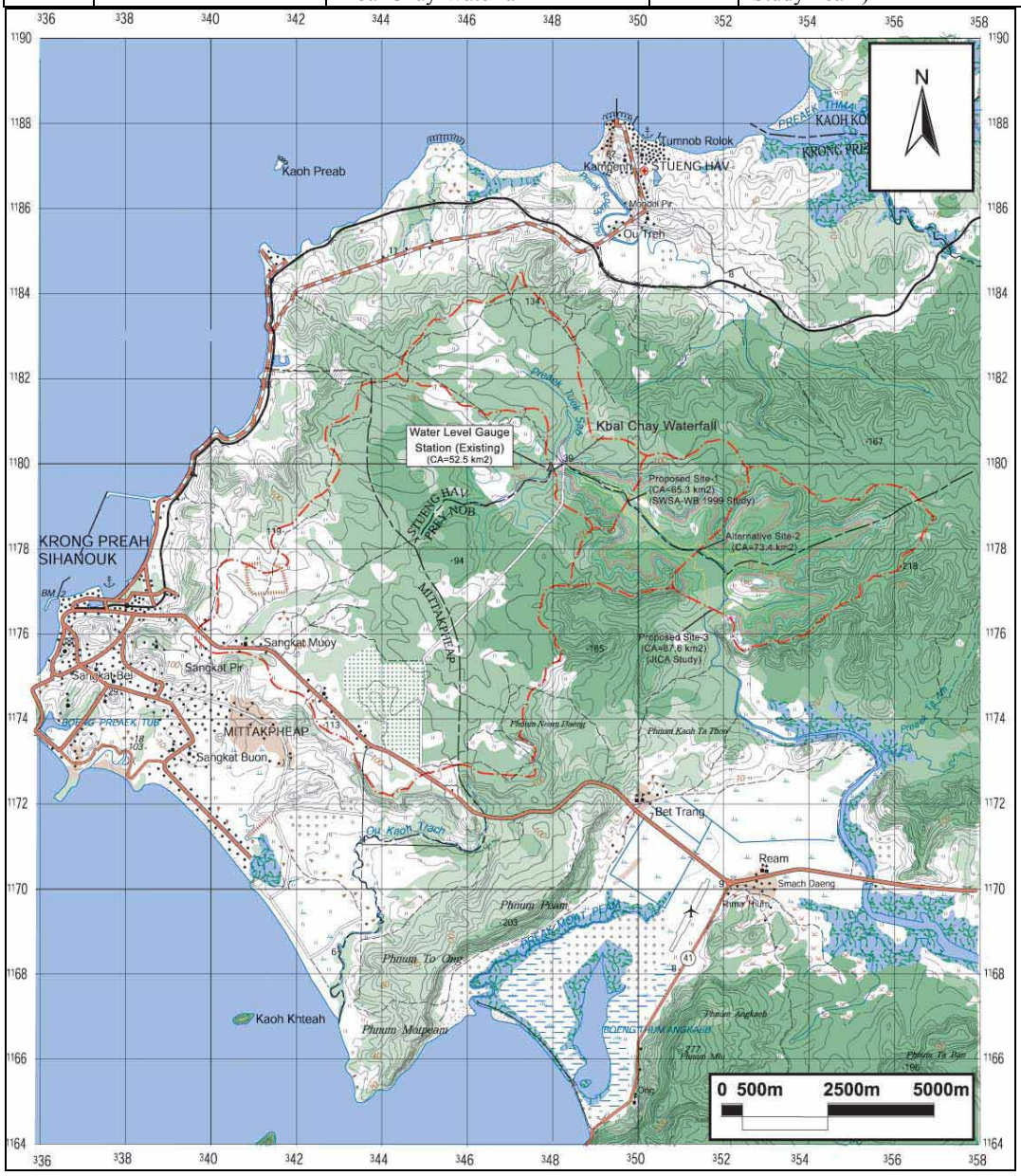


Figure G-41 Considerable Reservoir Sites in Toek Sap River (Sihanoukville)