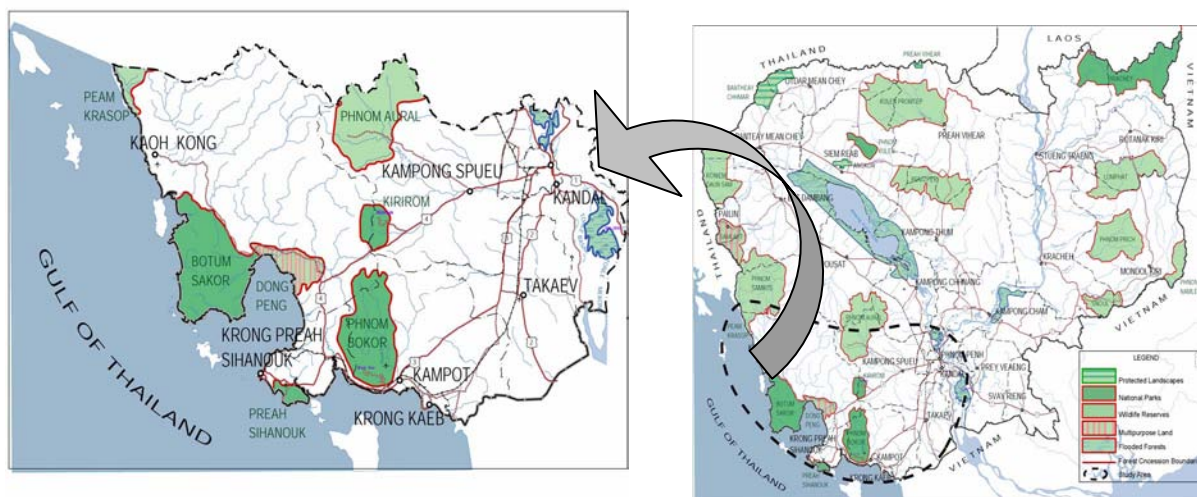


L.2.2 Protected Areas (PAs)

(1) Present Situation of the PAs in the Study Area

Twenty-three areas were designated as protected areas based on the Royal Decree in 1993 and classified into four categories in Cambodia¹². The total area of then designated PAs is 3,327,200 ha and accounts for about 18% of the national land. The locations of these protected areas are shown in **Figure L-8**. In addition, some of the existing protected areas are designated as UNESCO Men and Biosphere (MAB Reserve) or Ramsar Site¹³. The central portion of the Cardamom Mountains (1 million ha) has been protected since 2001 and some portions of the Cardamoms are proposed as the World Heritage Site. The MOE has the responsibility for the management of the PAs, but the MAFF and other relevant agencies were also given conservation function by the subsequent laws. The MAFF has set up two gene pool conservation areas, thirteen Fish Sanctuaries and some wildlife reserves. In line with the decentralization policy, some provincial governments have proposed to establish PAs for their management. As of year 2002, Cambodia has 29 protected areas covering about 4.5 million ha, or one-quarter of the country's land mass¹⁴.



Source: JICA Study Team

Figure L-8 Protected Areas in Cambodia and the Study Area

According to the report “A National Biodiversity Prospectus” published by the International Union for the Conservation of Nature and Natural Resources (IUCN) and the Ministry of Environment (MOE), the area of Cambodia is divided into seven biodiversity conservation regions based on biological resources, geology, soils, etc. One of the biodiversity conservation regions is the southwestern coastal ranges and marine zone (hereafter referred to as the South-West Cluster PAs) that is located in the

¹² Four categories are wildlife sanctuary, national park, protected landscape, and multiple-use management area. There are seven national parks, ten wildlife sanctuaries, three protected landscapes and three multiple-uses areas.

¹³ The Tonle Sap multiple-use area was approved as the MAB Reserve, and the portions of the Tonle Sap multiple-use area, the Peam Krasop wildlife sanctuary and the middle stretches of the Mekong River were designated as Ramsar sites.

¹⁴ Cambodian Daily dated November 15, 2002

Study Area. This region is considered to be one of the three highest priority regions for biodiversity conservation in Cambodia and includes four national parks, Phnom Bokor National Park, Kirirom National Park, Ream National Park, and Kep National Park. These PAs also have popular tourism and recreational sites. The outline of these four national parks is shown in **Table L-15**.

Besides the South-West Cluster PAs, there are four protected areas in the study area, the Botum Sakor National Park, the Peam Krasop Wildlife Sanctuary, the Dong Peng Multi-Use Area and the Phnom Aural Wildlife Sanctuary (the former three are located in Kaoh Kong and the latter is in Kampong Spueu.). As mentioned above, the central portion of Cardamoms, which is located in Kaoh Kong, links these four protected areas and contains exceptionally high biodiversity and many of globally threatened species, has been also protected.

Except the above-mentioned protected areas designated by the Royal Decree in 1993, the catchment area of 6,202 ha in Kabal Chhay watershed of Sihanoukville is designated as a protected area for securing drinking water by the MAFF based on the sub-decree 76 issued in 1997, and no economic activity is allowed in the Kbal Chhay area by the letter of enforcement issued in 1998.

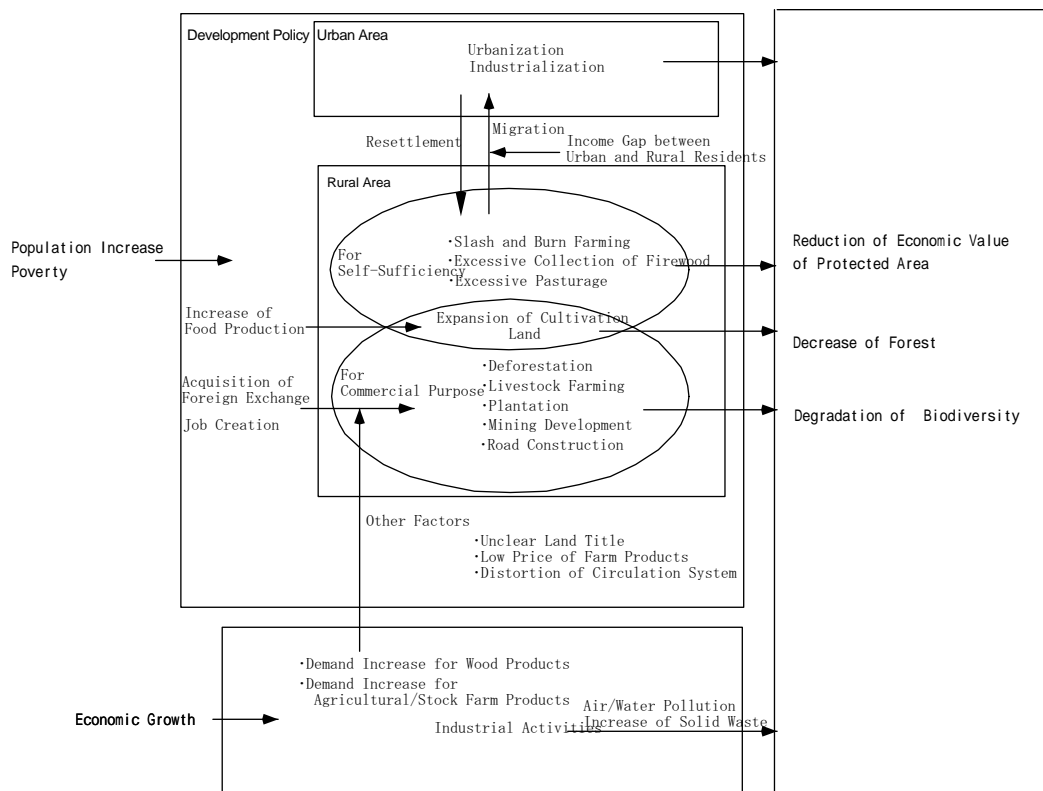
Table L-15 Outline of the South-West Cluster Protected Areas

Name of Protected Area	Area (ha)	Location	Characteristics
1 Kep National Park	5,000	Kampot	The park includes coastal mountain ranges and two islands. Both the mainland and the islands have lowland tropical rainforest. Sand beaches extend eastward to the Kep Bay and surround the Tonsay Island. Mangrove forests and coral reefs inhabit around the island. It is estimated that 47% of the land in the Park is considerably modified.
2 Kirirom National Park	35,000	Kampong Spueu	The park is composed of natural and semi-natural vegetation and has well-known Pinus Merkusii forest of 13,000 ha, the largest in Cambodia. The park is a habitat of number of endangered species, such as tiger, sun bear, Banteng cattle and Eld's deer. New species of rhinoceros was reported in 1994. There is a small tea plantation (1,500 ha) in the park.
3 Phnom Bokor National Park	140,000	Kampot	The park rises northward from the coast and reaches altitude of above 1,100 m. The park has high precipitation since it is the only high mountain area in the coastal zone. The park is a habitat of number of internationally endangered species, such as tiger, leopard, Asian elephant and so on. The park has both low and medium altitude vegetation formations and waterfalls. It is estimated that 97% of the park area is natural or semi-natural, and only 3% of the land is modified.
4 Ream National Park	21,000	Sihanoukville	The park has the large Prek Toek Sap estuary that is a habitat of mangrove and rear mangrove forests. A hillock in the west of the river is covered by lowland and evergreen forests. The park has two uninhabited island (total area is 6,000 ha) in the southeast. Sea grass beds and coral reefs are found along the coasts of the mainland and islands. It is estimated that about one third of the park land is considerably modified.

Source: JICA Study Team

(2) Issues on the PAs

The South-West Cluster PAs support the subsistence needs of local people living near or in the PAs, and the local people have few alternative income sources but to solely depend on the forest resources for making their living. In other words, the PAs are under threat from a wide range of pressures accure from the livelihoods of the local people and other factors as shown in **Figure L-9**¹⁵. The pressures will be intensified in the future since the population growth rate is high, about 3%, in the communes and the immigrants to the communes are increasing.



Source: JICA Study Team

Figure L-9 Mechanism of Environmental Degradation of PAs

As shown in **Table L-16**, more than 124,000 people live in the 23 communes adjacent to the South-West Cluster PAs. The poverty ratio in the communes is high¹⁶. The local people illegally utilize portions of the PAs on a year-round basis for hunting, gathering activities, and slash-and-burn agriculture. These illegal activities have not been reduced in spite of the reinforcement of the PA patrolling systems. The forest resources used by the local people include firewood, wild food, wild animals, medical herbs, materials for construction, fibers and other non-timber forest products (NTFPs¹⁷).

¹⁵ One of the reasons that the local people depend on the forest resource is that vast areas of cultivated land have been abandoned being obstructed by mines and become non-productive due to the war.

¹⁶ Household income is estimated less than \$1/day.

¹⁷ For example, NTFPs in the Bokor National Park are fruits from Sam Rong and Khos, rattans, Vor Romiet, resin and bamboo.

In the Bokor National Park, illegal activities mostly involve the collection of Samrong nuts, logging of blackwood and luxury timbers, and wildlife poaching¹⁸. In several cases, wealthy locals or military/police officers hire the poachers¹⁹. There are established markets for the forest products from the PAs (for example, about 98% of local people and 65% of residents in Phnom Penh depend on wood or charcoal as their fuel source.). Land encroachment in the form of slash and burn land clearing continues along the border of the park, and the situation is serious especially in the southern border of the park. In some cases, influential locals insist claim on large portion of the land beside the park border and pay local people to develop the area.

The accumulated volume of small-scale activities for resource exploitation in the PAs has already reached at unsustainable level. However, the local people have not been aware of unsustainability of their activities since they are focusing on the high direct benefits gained from the PAs rather than indirect or option values that the PAs have.

Table L-16 Population of Communes Adjacent to the South-West Cluster PAs

Protected Area	Number of Commune	Number of Household	Population
Kep National Park	5	5,600*	30,000*
Kirirom National Park	2	2,952	14,433
Phnom Bokor National Park	11	9,652	50,212
Ream National Park	5	5,322	29,727
Total	23	23,526	124,372

* Estimation

Source: Ministry of Planning, 2002

As shown in **Figure L-10**, the South-West Cluster PAs have a variety of economic values including not only tangible values but also option values for the future utilization. Besides the values for household subsistence or cash income, the PAs contribute to basic socio-economic services and government revenues. For example, tourism in the Bokor National Park contribute to make revenues of more than \$10,000 per year, and the mangrove areas in the Ream National Park have environmental protection function, such as storm protection, prevention of erosion and carbon absorption, the value equivalent to \$176/ha per year²⁰. The loss and degradation of the South-West Cluster PAs lead to the loss of production and consumption opportunities, as well as non-monetary benefits. Thus, these economic values and the importance of sustainable forest resource utilization needs to be recognized by local people as well as central and provincial government, and the economic values the PAs have need to be considered on the policy making process and reflected into the PA management plans.

Further, the development plans for the area close to the PAs need to be implemented by making negative impact on the PAs minimum, or the plan should be canceled if severe negative impact is anticipated by implementing the plan since the PAs embrace

¹⁸ Targets of the hunting are wild pig, hog badger, deer, pangolin, python, monitor lizard and turtle.

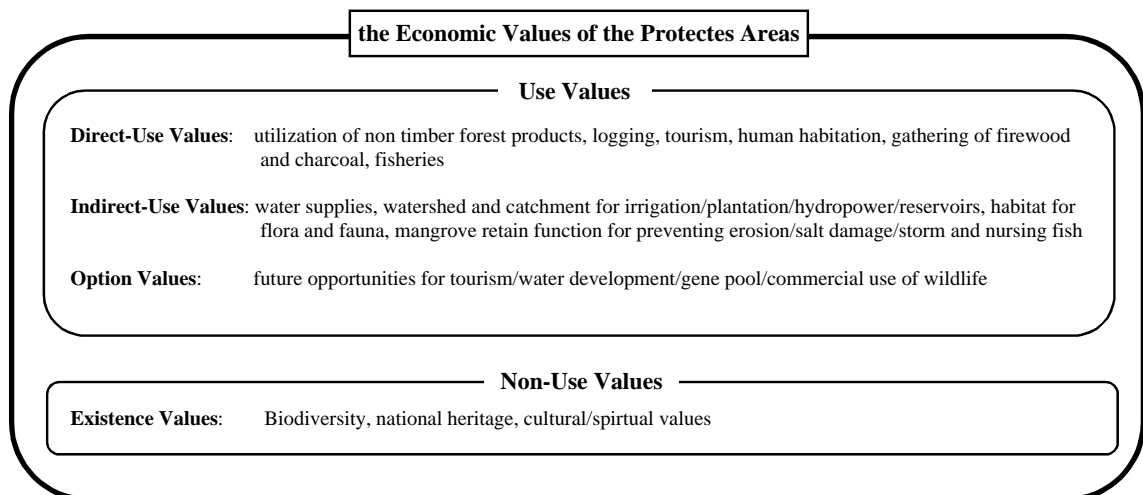
¹⁹ According to the WildAid, the poachers are paid an average of 5,000 Riel per of sawn wood.

²⁰ ICEM, Bokor, Kirirom, Kep and Ream National Parks, Cambodia: Case Studies of Economic and Development Linkages, April 2002, p22

a great diversity of habitats which support diverse communities of animals, plants and marine resources (the details of the biodiversity is described below).

In addition, the following issues frequently pointed out by various organizations need to be addressed to improve management systems of the PAs:

- Confusion and overlapping regarding the institutional arrangement and authority: several ministries are involved in the PAs conservation since the mandates are shared by the sector agencies.
- Lack of resources and institutional capacities of MOE
- Negative impact from large-scale commercial logging: the PAs are usually surrounded by the forest concessions, therefore the illegal activities inside the PAs are often masked.
- Low priority to the issue of the PAs protection by the local governments
- Lack of ownership in the relevant communes on the planning process
- Difficulties on enforcing zoning plans of the Ream and Bokor National Parks



Source: JICA Study Team

Figure L-10 Economic Values of the Protected Areas

L.2.3 Biodiversity

(1) Present Condition of Biodiversity

Cambodia exhibits rich tropical biodiversity, a characteristic common to the South-East Asia, and contains areas of relatively intact habitats and populations of globally threatened species. According to “Cambodia’s Biodiversity Status Report 2001”, approximately 70 species of terrestrial mammal (35 out of 70 species are listed by IUCN as globally endangered species), over 500 species of bird, 843 species of fish (486 species of freshwater fish and 357 species of seawater fish), 28 species of reptiles listed on the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) and 2,308 species of seed plants have been recorded in

Cambodia.

As mentioned above, the study area embraces some protected areas that contain a great diversity of habitats which support diverse communities of animals and plants.

The Cardamom Mountains provide various natural habitats for a range of rare and endangered species of plant and animal. According to the survey conducted by the Fauna and Flora International in 2000, over 30 species of large mammals, 30 species of small mammals, over 100 species of birds, 64 species of reptiles, 30 species of amphibians and various plants and insects were discovered in a short period of time in a tiny fraction of the Cardamoms, and many of species are the ones that have not been recorded in Cambodia. Globally threatened species, such as tiger, Asian elephant, Asiatic wild dog, gaur, pileated gibbons, Siamese crocodile, elongated tortoise and numerous hornbills and green peafowl, inhabit in relatively large numbers.

The South-West Cluster National Parks also contain a variety of habitats, each with their own characteristic wildlife communities. The Bokor National Park is known to embrace populations of internationally endangered species of mammals similar to the ones discovered in the Cardamom Mountains. Malayan sun bears (*Helarctos malayanus*) and Javan rhino (*Rhinoceros sondaicus*) have also been discovered in the past years. According to the ADB study in 2000, 223 species of birds were recorded, of which 19 species are globally or regionally significant, and 12 are newly recorded species in Cambodia. In addition, Sphagnum bogs, Podocarpus forest and number of unusual shrubs inhabit in the Bokor National Park. The Kirirom National Park also contains same kind of endangered species found in the Bokor National Park. The park is famous for enclosing large area of *Pinus merkusii* forest. The Ream National Park embraces extensive mangrove areas, and sea grass beds and coral reefs are found along the coastline of the mainland and islands in the park.

As shown in **Figure L-11**, Mangrove forests are found in many portions of land along the coastal zone stretching Kampot, Sihanoukville and Kaoh Kong. *Avicennia officinalis* and *Rhizophora apiculata* hold a majority, but *Bruguiera cylindrica* and *Xylocarpus granatum* can also be found. As mangrove forests support a wide range of essential ecological functions, such as providing breeding/nursery ground for fish and crustaceans, habitat for migratory birds, the coastal zone contains a wide range of fishery resources as well as number of large waterfowl species, such as milky stork and lesser adjutant²¹. In addition, four species of marine mammal (marine dolphin, irrawaddy dolphin, Chinese white dolphin and Dugong) and three species of turtle (hawksbill turtle, green sea turtle and olive ridley turtle) have been reported. Coral reefs are also found in the islands and estuaries of the coastal zone and 67 species of hard coral reef and 17 species of soft coral reef have been recorded. Locations of coral reefs in Sihanoukville are shown in **Table L-17** and **Figure L-11**.

²¹ Commercially valued species of fish include catfish, mackerel, mullet, large headed hairtail, snapper, sardine, striped snakehead murrel, shrimp, blue swimming crab, rock and mud crab and lobster. Two endangered species of fish, giant catfish and trey trasak are reported.

Table L-17 Location and Condition of Coral Reef 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 Phkakatna. 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



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

Figure L-11 Location of Coral Reefs and Sea Grasses in Sihanoukville

(2) Issues on Biodiversity

As mentioned above, the levels of human disturbance and exploitation pressure on natural resources have been raised in the study area. New road construction going through the Cardamom Mountains by the logging companies will help illegal loggers and poachers to extend the access to intact areas up to the present. Illegal hunting of various species of animals for personal consumption has already been evident, and commercial trade of endangered mammals is increasing in the South-West Cluster National Parks. Illegal logging in the protected areas causes negatively impact on preservation of biodiversity. As shown in **Table L-18**, mangrove forests have been degraded in coastal zone because of the various reasons, such as charcoal production

from mangrove forests and conversion of mangrove swamps to shrimp farming ponds. Coral reefs have also been deteriorated owing to degradation of water quality, coral digging for sale, dynamite fishing and so on.

The causes of biodiversity degradation vary, but mainly stem from the human related activities. As the poverty ratio is high in the rural districts of the study area, the local people exploit natural resources surrounding them to supplement low incomes. Then, population growth accelerates pressure of exploitation. To prevent the situation from worsening, the issues in common with conservation of the PAs need to be addressed in addition to establishment or reinforcement of reliable monitoring systems.

In addition, any large scale development plans need to be implemented holding nature conservation in great account, especially in the coastal zones where scarce, fragile but valuable marine resources, such as coral reefs and mangrove forests, are inhabited. If it is anticipated that preventive action itself is not enough to mitigate negative impact on the biodiversity, the development plan should be cancelled or alternative plan should be considered.

Table L-18 Change of Mangrove Forest Area (1970 to 1996/97)

(Unit: ha)

Province/Municipality	Before 1970	1992/93	1996/97
Kampot	7,600	7,900	2,997
Kaoh Kong	16,000	63,700	57,582
Sihanoukville	17,400	13,500	12,256

Source: Mangrove Forest Resources and Local Communities, Jan. 1995, and Forest Cover Statistics 1998, DFW

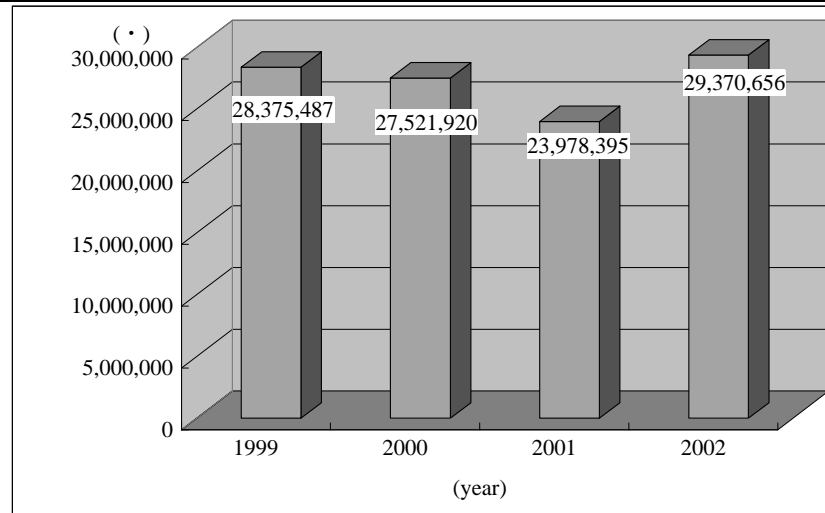
L.3 PRESENT CONDITION OF LIVING ENVIRONMENT IN THE STUDY AREA

L.3.1 Wastewater

(1) Wastewater Treatment in the Study Area

1) Domestic Wastewater

Figure L-12 shows the change of discharged wastewater volume in Cambodia. The volume has been fixed in the past four years. Domestic wastewater accounts for more than 80% of the total volume. Therefore, taking measures to appropriately treat domestic waste is crucial to prevent water quality from degrading



Source: MOE/DPCWSQMO Report 2002

Figure L-12 Change of Wastewater Volume in Cambodia (1999-2000)

In the urbanized area of the Greater Capital Area, drainage systems for surface water and sewage are combined. The drainage system mainly consists of drainage networks, storage basins and pumping stations. Trabek, Toul Sen and Salang are major drainage open-channels. In addition, there are some drainage open-channels in Touk Kork, Tompun and Pochentong East. These channels are clogged up with refuses and sediments in many parts. Sewer networks with a length of approximately 200 km covers the center of the urbanized area, but the most part of sewer pipes are clogged with rubbishes and sediments. The runoff collected through the sewer pipes and channels run to and stored in the storage basins, such as Boeng Trabek and Boeng Tompun, for retention and purification, then discharged into the Tonle Sap River and Tonle Bassac River by pump.

Domestic wastewater is taken in septic tanks, installation of which to new building is required by the law. The effluent overflowed from the septic tank flows into the drainage system with no treatment. The effluent is diluted in the rainy season, but it directly runs into water bodies through drainage system without being diluted in dry season and raises concentration of pollutants.

Houses and buildings located outside the inner dike in the outskirts of the urbanized area are hardly connected to the drainage system. Domestic wastewater is disposed on the site through septic tank or pit latrine, or directly discharged into the ponds or streams from the houses on embankment through privies in many cases in this area. As a result, sanitary condition deteriorates in the outskirts of the Greater Capital Area. Drain system in the market place is also poor, and the poor drainage deteriorates sanitary condition around the market places.

Water qualities of the major rivers running in the Greater Capital Area are relatively good judging from the data prepared by the MOE. However, water qualities of water holes, canals, streams and lakes, which directly receive wastewater, are very low. **Table L-19** shows water qualities of some of lakes and small rivers in the Greater

Capital Area. As the **table** shows, the water qualities of two lakes, Boeng Kak and Boeng Ansaong Andaet, which receive wastewater from northern and southern regions of Phnom Penh, are especially deteriorated.

Table L-19 Water Quality of Water Body in the Grater Capital Area (Jan. 2001)

		pH	SS (mg/l)	TS (mg/l)	DO (mg/l)	Nitrate (mg/l)	Phosphate (mg/l)	BOD (mg/l)	COD (mg/l)	Grease & Oil (mg/l)	Coliform Bacter (MPN/100ml)
Reservoir Lake	Boeng Pong Peay	6.5	21.33	227.5	3.90	0.19	1.02	36.0	120.0	3.6	>1,600
	Boeng KoK	6.5	19.00	220.0	2.86	0.09	2.71	56.0	340.0	3.0	>1,600
	Boeng Ansaong Andaet	8.0	83.00	720.0	2.10	0.24	9.04	88.0	380.0	3.3	>1,600
	Standard	6.5-8.5	1.0-15.0	-	2.0-7.5	Total Nitrogen 0.1-0.6	Total Phosphorus 0.005-0.05	1.0-10.0	1.0-8.0	-	-
River	River to Boeng Cheung Aek	6.5	35.00	415.0	5.30	0.45	0.19	32.0	98.0	1.2	>1,600
	Preak Tnaot	7.0	31.67	368.0	8.80	0.50	0.29	28.0	88.0	1.8	540
	Standard	6.5-8.5	25-100	-	2.0-7.5	-	-	1.0-10.0	-	-	<5,000

Source: the Transport Master Plan of the Phnom Penh Metropolitan Area, JICA & PHN, 2001

In Sihanoukville, sewage system with a length of approximately 3.5 km is laid in the markets and houses of the municipal centers, and the additional sewer pipe with a length of 550 m is being laid. Although sewer network with total length of 100 km exists in Sihanoukville, most part of the area is not connected to the network. There are two storage basins with the function of natural water treatment in Khan Mittakpheap. One is located in Boeng Trokuon, and the other one is Ou Cheuteal. However, both of basins are not functioning well because of accumulation of sediments, land encroachment and no maintenance. As a result, wastewater flows directly into the sea. In the rural and fisheries villages, domestic wastewater is disposed on the site through pit latrine, or directly discharged into water holes, streams or sea from the houses. No data is available on water quality of water bodies receiving domestic wastewater, but it is estimated that the water qualities of water bodies and sanitary conditions nearby residences are considerably low. The low quality of water and bad sanitary condition sometimes cause waterborne diseases. Estimated discharges of water pollutants in Sihanoukville are shown in **Table L-20**.

Laying sewage pipes with a length of 43 km and improvement of Ou Cheuteal wastewater treatment basin with a area of 12 ha and the treatment capacity of 5,800 m³ is in the planning stage. These projects are expected to contribute to improve water quality of water bodies and sanitary condition. Considering the anticipated industrial development and urbanization in Sihanoukville, further improvement of domestic wastewater treatment should be required. In addition, proper management system of domestic wastewater in the rural area and fishing villages need to be developed.

Table L-20 Estimated Amount of Sewage and Water Pollutants in Kampot and Kaoh Kong (1997)

	Estimated Amount of Sewage (· /day)	BOD (ton/day)	TSS (ton/day)	Total Nitrogen (ton/day)	Total Phosphorus (ton/day)
Sihanoukville	5,544	2.77	6.10	0.50	0.14

Source: Statement of Environment Report, MOE & Danida, April 2002

In the Intermediate Area, controlling system for domestic wastewater is very poor. Although sewage networks covers some of provincial centers or big market centers to some extent, most part of the system is clogged and not functioning well because of

long time no maintenance. Domestic wastewater is disposed through septic tank or pit latrine in some cases around city centers, but it is directly discharged into the nearby water holes or streams from the houses in many cases in the rural area. The local people uses the water contaminated by their own effluents for daily life.

In Kaoh Kong, surface water drainage pipes were laid along the road in the provincial center market but there is no sewage system. Therefore, Domestic wastewater is directly discharged into sea or streams in many cases. Prek Pao, Prek Sre Ambel and small streams flowing into Stung Russei Chrum are especially contaminated by waste and wastewater. In Kampot, drainage system was constructed in the provincial center several years ago, but the system is often logged and water floods. Domestic wastewater is discharge into rivers/streams nearby residences in the rural areas, and the polluted rivers/streams flow into the sea. Water qualities of six rivers (Kampong Krongnong, Kampong Bay River, B.G.I, Kdart, Thnaot and Trapang Ampov) and two streams (Ta-Eing and Spean Khiev) are especially deteriorated by wastewater.

No data is available on water quality of waterways or water bodies near the residences in the Intermediate Area, but it is estimated that the water qualities of the streams nearby residences are considerably low. Estimated discharges of water pollutants in Kampot and Kaoh Kong are shown in **Table L-21**.

Table L-21 Estimated Amount of Sewage and Water Pollutants in Kampot and Kaoh Kong (1997)

Province	Estimated Amount of Sewage (· /day)	BOD (ton/day)	TSS (ton/day)	Total Nitrogen (ton/day)	Total Phosphorus (ton/day)
Kampot	2,713	1.50	2.65	0.22	0.06
Kaoh Kong	2,173	1.21	3.32	0.27	0.08

Source: Statement of Environment Report, MOE & Danida, April 2002

In Kampong Spueu, composting toilets have been equipped in some houses near the provincial center with the support from NGOs. Incentives should be given to increase the number of houses with composting toilets, as it contributes to improve sanitary condition in the residential area. In Kampot, construction of new wastewater treatment plant with the size of one hectare is in the planning stage. Kaoh Kong Province also has a plan to construct new wastewater treatment plant near the Koh Por Stream. Once the plants start operation, they contribute to improve water quality of water bodies presently receiving polluted water.

2) *Industrial Wastewater*

In the Greater Capital Area, big factories are located mainly on the following area; 1) in Phnom Penh: the embankment of the Boeng Tumpun, the land along the National Road 2 in Mean Chey, the land along the National Road 5 in Ruessei Kaev, the land along the Russian Road in Dangkao, and the land near the international airport in Chaom Chau, 2) in Kandal: the land along the Road 21 in Ta Khmau. There are 547 enterprises in the Greater Capital Area as of year 1999 as shown in **Table L-22**. Nearly half of the factories are garment related, and non-metallic mineral factories and food/beverage/tobacco factories account for about 20% and 17% respectively.

Table L-22 Number of Industrial Enterprises* in the Greater Capital Area

Category	Phnom Penh	Kandal	Greater Capital Area Total
Food, Beverage, Tobacco	74	23	97
Textile, Apparel, Footwear	209	22	231
Wood Products	12	8	20
Paper Products	11	3	14
Chemical Products	27	4	31
Non-Metallic Mineral	54	53	107
Basic Metal	5	0	5
Fabricated Metal	38	3	41
Others	1	0	1
Total	431	116	547

*The number includes only the enterprises with more than 10 employees

Source: Business Directly of Cambodia 1999

Table L-23 shows the number of the MOE monitored factories with wastewater treatment plants. The installation ratio of on-site wastewater treatment facility is high among the garment factories with washing/dyeing process or the factories with chemical/hazardous waste. However, most of factories except garment factories do not have on-site wastewater treatment facilities and discharge effluents directly to the nearby water bodies or drainage system. It is noteworthy that concentrations of pollutants in wastewater discharged from the factories with on-site wastewater treatment plants are in some cases over the allowable limits set by effluent standard for pollution sources as shown in **Table L-24**.

In addition to the large-scale factories, there are many numbers of small-scale workshops in the Greater Capital Area. The amount of discharge from one workshop is small, but accumulated volume of wastewater deteriorates the quality of water bodies nearby the workshops.

Table L-23 Volume of Wastewater Discharged from Monitored Factories and Non Industrial Sources in the Greater Capital Area (2002)

Category	with Wastewater Treatment Plant	no Wastewater Treatment Plant	Total	Volume of Wastewater (• /year)		
				from Production Process		from Non Production Process
				with Treatment	Non Treatment	
Garment Factories with Washing/Dyeing Process and Chemical Use (including Food/Beverage Factories)	24	2 (under construction)	24	3,136,280	126,000	1,400
Garment Factories with Washing Process and No Chemical Use	6	7	13	172,200	149,800	41,160
Factories with Discharge of Hazardous Waste (Eastern Steel)	1	0	1	5,600	0	560
Other Factories	0	201	201	0	14,000	963,200
Industrial Source Total	31	210	241	3,314,080	289,800	1,018,920
Non Industrial Source in Phnom Penh (Household, Hospital, Hotel)	-	-	-	-	-	19,370,656
Total Volume of Wastewater Discharge				3,603,880		20,389,576
Grand Total				23,993,456		

Note: The factory related numbers includes only the data of factories monitored by MOE.

Source: MOE/DPCWSQMO Report 2002

Table L-24 Concentration of Pollutants in Wastewater Discharged from Monitored Factories

Name of Factory	First Sampling		Second Sampling		Third Sampling	
	BOD	COD	BOD	COD	BOD	COD
Tommy Textile	125	312	197	460	84	324
Roo Hsing	77	226	109	621	118	138
Standard	<80	<100	<80	<100	<80	<100

Note: Both factories have wastewater treatment plant.

Source: MOE/DPCWSQMO Report 2002

In Sihanoukville, forty-six enterprises are operating as shown in **Table L-25**. Food/beverage/tobacco enterprises and enterprises related to chemical products account for about 30%, respectively. Both of food/beverage/tobacco enterprises and enterprises related to wood products account for about 17%. According to the interview with the Department of Environment in Sihanoukville (DOE), the Angkor Brewery is the only factory that has on-site wastewater treatment plant in Sihanoukville. In the past, concentrations of pollutants in the effluent from the brewery were over the allowable limits set by effluent standard and the brewery was considered to be one of the main water pollution sources in Sihanoukville. But the concentrations are below the allowable limits now, according to the DOE (though the data on effluents from the brewery is not available). It is suspected that another factories discharge wastewater directly into the nearby drains or water bodies. Factories located in Sihanoukville are supposed to be inspected once a year by the MOE, but the data on effluents from the factories is not available. According to the report prepared by the Sihanoukville Working Group, the amount of per-day wastewater discharge from the factories is 72 m³ in Sihanoukville.

Table L-25 Number of Industrial Enterprises* in Sihanoukville

Category	Number of Enterprise
Food, Beverage, Tobacco	13
Textile, Apparel, Footwear	8
Wood Products	7
Paper Products	1
Chemical Products	14
Non-Metallic Mineral	3
Basic Metal	0
Fabricated Metal	0
Others	0
Total	46

* The number includes only the enterprises with more than 10 employees

Source: Business Directly of Cambodia 1999

In the Intermediate Area, the number of enterprises is limited as shown in **Table L-26**. However, thirteen food/beverage/tobacco factories, which are considered to use a lot of water and discharge high volume of wastewater, are located in the Intermediate Area. There are some cement and phosphate fertilizer factories, which are another main water pollution source, and both types of factories are increasing there. In addition, Kaoh Kong has a plan to construct 10 to 15 garment factories and a flour-milling factory. The number of factories equipped with on-site wastewater treatment plants is limited at this stage in the Intermediate Area, and industrial

wastewater is discharged into the nearby drains or water bodies directly in many cases.

Table L-26 Number of Industrial Enterprises* in the Intermediate Area

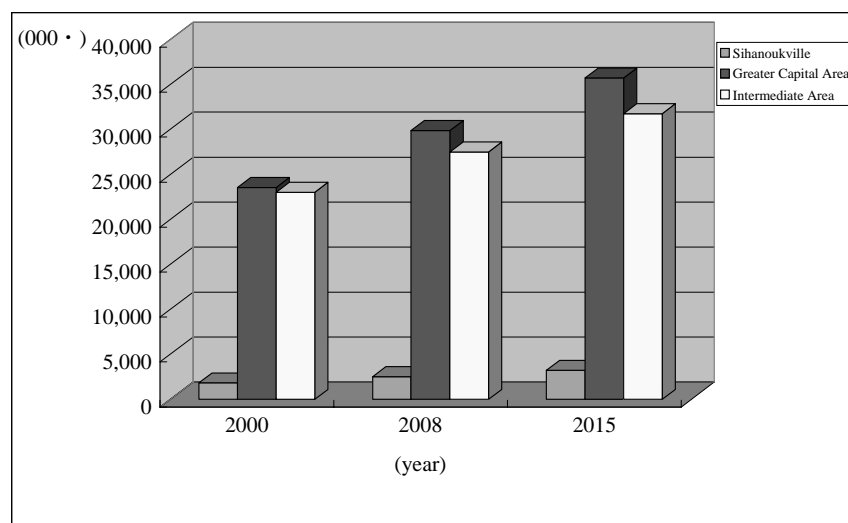
Category	Takaev	Kampong Spueu	Kampot	Kaoh Kong	Intermediate Area Total
Food, Beverage, Tobacco	7	2	3	1	13
Textile, Apparel, Footwear	0	1	0	0	1
Wood Products	2	9	2	1	14
Paper Products	0	0	0	0	0
Chemical Products	0	0	0	0	0
Non-Metallic Mineral	1	0	4	1	6
Basic Metal	0	0	0	0	0
Fabricated Metal	0	0	0	0	0
Others	0	0	0	0	0
Total	10	12	9	3	34

*The number includes only the enterprises with more than 10 employees

Source: Business Directly of Cambodia 1999

(2) Issues on Waste Water

The volume of domestic wastewater accounts for more than 80% of total volume of wastewater discharge in the study area. As shown in **Figure L-13**, it is anticipated that the volume of domestic wastewater will continue to increase in the study area. A rate of increase will be especially high in Sihanoukville and the Greater Capital Area with high population growth rate. The increase of domestic wastewater volume further deteriorates the water quality of water bodies in the study area.



Source: JICA Study Team

Figure L-13 Projection of Domestic Wastewater Volume in the Study Area

To cope with the increasing volume of domestic wastewater and to prevent deterioration of water quality, upgrading of sewer networks to safely drain both wastewater and flood water (including the possibility to provide new separate system instead of existing wastewater/surface water combined system) is imperative as the first step to improve present situation as well as downstream facilities designed to cope with both flood water and wastewater discharged from the sewer networks. In the mid to long run, construction of sewage treatment plants will be required in the Greater Capital Area. However, the construction should be deliberately planned and implemented because construction and operation/maintenance of sewage treatment

plant incurs huge costs. Upgrading of sewer networks has already started in and around the provincial/municipal center in the study area, and feasibility study for construction of centralized wastewater treatment plants has been done in Sihanoukville and the Greater Capital Area. Thus, it is expected that the situation will be improved step by step to some extent in and around provincial/municipal centers in the study area. To secure sustainable operation and maintenance of drainage system, systems for sewage fee collection and its use need to be introduced.

Introduction of low cost and recycle oriented sewage/wastewater treatment system, such as composting toilets, should be promoted in the rural area where connection to the drainage system is difficult. Introduction of this type of system need to be facilitated especially in the provinces of the Intermediate Area where construction of sewage treatment plant is financially difficult.

Regarding industrial wastewater, the number of factories monitored by the MOE is limited. As shown in **Table L-27**, 284 pollution sources, of which 264 are located in the Greater Capital Area, are monitored by the MOE on regular or irregular basis as of year 2002. The MOE have a its own laboratory for water quality analysis, but it does not have enough human resources and equipments due to short of budget²². Factories located in Sihanoukville and the Intermediate Area are rarely monitored. As pointed out above, majority of factories do not have on-site wastewater treatment plant and discharge effluents directly into the nearby drains or water bodies (no data is available regarding the quality of wastewater from factories with no wastewater treatment plants). Even the factories with on-site wastewater treatment plant sometimes discharges wastewater with over-standard concentration of pollutants. In addition, only 11 factories have received permissions of wastewater discharge from the MOE under the condition of being abided by the environmental legislation.

Judging from these situations, reinforcing MOE's law enforcement capacity and giving the MOE more power for execution of environmental legislation are the first step to reduce the volume of polluted industrial wastewater. Strict law enforcement is imperative to prevent water quality from further degrading, especially in the Greater Capital Area and Sihanoukville where extensive industrial development, including establishment of Special Promotion Zones, has already started or is expected to start soon.

Table L-27 Number of Wastewater Pollution Sources Monitored by MOE (2002)

	Province/Municipality	Number of Pollution Sources Controlled				Total
		Factory	Hospital/Clinic	Hotel	Oil Company	
In the Study Area	Phnom Penh	198	9	10	3	220
	Kandal	42	0	0	0	42
Outside the Study Area	Kampong Chhnang	1	0	0	0	1
	Siem Reab	0	0	21	0	21
Total		241	9	31	3	284

Source: MOE/DPCWSQMO Report 2002

²² The laboratory was established with the support of the U.K. Some of equipments are relatively advanced ones, but they have been rarely used as staff tend to depend on simple analysis methods.

In the Intermediate Area, wastewater from thirteen food/beverage/tobacco factories should be strictly monitored because the factories are considered to use a lot of water and discharge high volume of wastewater. In addition, Kaoh Kong also has a plan to establish 200-300 ha industrial development zone in Moudul Seima District. If the plan will be implemented, wastewater and solid waste from the zone should be strictly managed.

Concentration of pollutants in the wastewater from a factory may drop by equipping an on-site wastewater treatment plant. However, increase of wastewater volume with the increase of factories will offset the effect of pollutants reduction per factory. Thus, reducing the volume of wastewater discharge is important in addition to controlling effluent sources of industrial wastewater, reducing the volume of wastewater discharge is important. Introducing progressive charging system in proportion to the volume of discharge is one of the ways to give polluters incentive to reduce wastewater volume. Introduction of the system has possibility to accelerate recycle use of wastewater or reuse of treated wastewater.

Groundwater contamination is the emerging problem in the study area, especially in the Greater Capital Area and Takaev, the regions located on the Mekong River basin. According to the Department of Water Supply and Sanitation/Ministry of Water Resources and Meteorology, contamination by iron and heavy metal rather arsenic is the point at issue. It is considered that the ratio of ground water utilization as drinking water is relatively low in the study area, but further study needs to be conducted to prevent poisoning by groundwater contaminants in the future.

L.3.2 Solid Waste

(1) Present Condition of Solid Waste Management

Solid wastes are mainly discharged from households and markets in the study area. For example, household waste and markets waste account for 66% and 25% of total amount of solid waste respectively while industrial waste accounts for 6% in the Greater Capital Area. The situations are similar in Sihanoukville and the Intermediate Area. As a logical consequence, the ratio of organic waste to the total amount of the solid waste is more than 70%. In many cases, industrial waste and hazardous waste are dumped in the same site as household waste and market waste, though a controlled landfill site with 7 ha for industrial waste has started operation recently in the Greater Capital Area (in Kandal)²³.

²³ The landfill site is operated by private company (Sarom Trading Company). About 80 garment/textile factories contract with the company for collection and disposal of their waste.

Table L-28 Outline of Solid Waste Disposal Site in the Study Area

	Province/Municipality	Number of Dump Site	Area Used (ha)	Area Available (ha)	Note
Sihanoukville	Sihanoukville	1	6.3	5.3	size of dump site is 8ha, according to the interview
Greater Capital Area	Phnom Penh	1	6.8	1.5	1 landfill for industrial waste with 7ha
	Kandal	1	2.0	1.9	
Intermediate Area	Kampong Spueu	1	2.0	unknown	
	Kampot	1	1.0	unknown	another dumping site near the Samaki market
	Kaoh Kong	1	1.0	unknown	1 landfill with 480m3
	Takaev	1	1.0	unknown	

Source: Report on Current Situation of Solid Waste Management in Cambodia, CEA, 2001 and interviews

The conditions of dumping sites in the study area are quite inadequate. As shown in **Table L-28**, each province/municipality in the study area owns dumping site, but control system for each site is very poor. In rainy season, a pile of waste is squashed and flattened by using bulldozers, but no measures are taken to control leachate from the waste and the waste is not covered up by soil. In addition, the garbage trucks sometimes dump the waste before reaching the dumping site due to bad condition of the access road. In dry season, the waste is burned periodically to control decomposition and the proliferation of vermin. As the waste contains plastics, it is expected that dioxin is generated in the open burning process. The waste is burned depending on the aridity in rainy season.

Waste collection system also has not been sufficiently established in many cases. All provinces/municipalities in the study area consign solid waste collection and disposal to private companies or market owners. However, the number of household, markets, factories and public facilities covered by the waste collection service are limited in many cases due to insufficient number of vehicles, inappropriate condition of access road and facilities, and a lack of established fee collection system. As shown in **Table L-29**, the ratio of service coverage is low in the Intermediate Area, especially in Kampong Spueu and Takaev, while it is relatively high in urbanized areas, such as Phnom Penh and Sihanoukville.

Table L-29 The Ratio of Household Covered by Waste Collection Service in the Study Area

	Province/Municipality	Ratio of Household Covered by Waste Collection Service
Sihanoukville	Sihanoukville	60%
Greater Capital Area	Phnom Penh	85%
	Kandal	30-40%
Intermediate Area	Kampong Spueu	10-15%
	Kampot	30-40%
	Kaoh Kong	unknown
	Takaev	5%

Note: the ratio of Sihanoukville may be much lower judging from the interview with the waste service company

Source: Report on Current Situation of Solid Waste Management in Cambodia, CEA, 2001 and interviews

In the case of Sihanoukville, a private company, P.M. Rasy is consigned to collect and dispose solid waste by the municipal government. The company is responsible for

solid waste management of all districts (Khans), but the service covers Mittakpheap district only as of January 2003²⁴. The collection ratio of solid waste discharged from markets and service industry, such as hotel and restaurant, is relatively high in comparison with the waste from household and factory²⁵. According to the study conducted by Danida, the amount of solid waste collected by the company account for only 30% of the total amount of solid waste actually discharged in Sihanoukville as a whole. The company owns an 8 ha open dumping site with no enclosure and retaining wall/dike, of which 1ha has been already used. The company consigns control of the dumping site (just squash the waste and flatten the site by using bulldozers) to another company.

(2) Issues on Solid Waste

It is anticipated that the amount of solid waste discharged in the study area will increase rapidly in the near future. For example, total amount of solid waste discharged in Sihanoukville is projected to be 184 tons/day in 2008 or 2.2 times as much as the amount in 1998 and to be 476 tons/day in 2015 or 5.8 times as much as the amount in 1998 as shown in **Table L-30**.

Table L-30 Projection of Solid Waste Amount in SNV

Source of Solid Waste Discharge	1998 (Danida Report) (ton/day)	1998 (ton/day)	2008 (ton/day)	2015 (ton/day)
International Port	2.000	2.000	2.000	2.000
Household	0.450	62.276	149.400	254.400
Market	8.000	8.000	12.073	15.418
Factory (inside of FZ)	0.000	0.000	9.351	174.091
Factory (outside of FZ)	1.950	2.925	3.860	20.334
Service	2.100	2.100	2.100	2.100
Hotel & Restaurant	3.220	3.220	3.800	6.440
Store	0.625	0.625	0.625	0.625
Hospital	0.100	0.100	0.100	0.100
Clinic	0.075	0.075	0.075	0.075
Car Park	0.200	0.200	0.200	0.200
Oil Station	0.050	0.050	0.050	0.050
Total	18.770	81.571	183.633	475.833

Note 1: Amount of household waste was calculated by multiplying projected per capita waste discharge (0.4kg in 1998, 0.6kg in 2008 and 0.8 in 2015) by projected population

Note 2: Amount of waste from market was calculated based on the rate of population increase

Note 3: Amount of waste from hotel & restaurant is calculated based on the rate of employee increase

Note 4: Amount of waste from factory (outside of FZ) is calculated by adding 10% of projected waste amount discharged from factories (inside of FZ) to value of 1998

Note 5: Fixed values of 1998 (date is from Danida report) were used for the amount of waste from other sources

Source: JICA Study Team

To cope with rapid increase of solid waste amount, renovation of the existing dumping sites or construction of new landfill sites are imperative. All the existing dumping

²⁴ Small business entities are doing waste collection/disposal services in another two districts without formal permission from the municipality.

²⁵ The company collects industrial waste from seven factories (one brewery, two shoe factories, three garment factories, and a fish processing factory). Another factories are disposing by themselves without formal permission.

sites in the study area have no facilities to prevent toxic/hazardous substances contained in the waste form penetrating into the ground and contaminating the groundwater. Open burning at the dumping sites to reduce the volume of waste and to control vermin is anticipated to generate toxic chemical substances, such as dioxin. Therefore, the dumping sites should be renovated to controlled landfill sites that have at least liner facility, such as liner sheet, and leachate treatment facilities to prevent underground contamination. In addition, strictly controlled landfill sites, which are completely insulated by concrete, need to be constructed for disposal of toxic/hazardous wastes including medical waste in the near future.

The mixed waste disposal without segregation of domestic waste and hazardous/toxic waste might cause chemical reaction and generate hazardous materials. As a result, the waste might contaminate the surrounding area and groundwater. Therefore, separate collection and segregated disposal of waste are desirable, and the existing collection/disposal system needs to be renovated to accomplish segregated disposal step by step. Regarding segregated disposal, operation of above mentioned landfill site in the Greater Capital Area for industrial waste is the first step in that sense. In the future, landfill sites should be classified according to the types of waste, and standards for structure and maintenance should be set for each of the classified landfill site. Special attention needs to be paid on monitoring and management of toxic/hazardous waste including medical waste.

In the past, trans-boundary waste transfer has not been strictly and effectively controlled and managed. As a result, 3,000 tons of by-products containing mercury were brought into Cambodia, and illegal importation of solid waste from abroad has been sometimes reported²⁶. Therefore, control and monitoring on imported second hand products, such as electrical appliances, vehicles and vehicle tires, need to be reinforced, and when giving permission for importing second hand products, impact on environment should be carefully considered.

Organizational structure for solid waste management also needs to be reestablished to clear the responsible organization. Currently, MOE, MPWT and local governments are involved in solid waste management, but the responsibility of each organization is not clear under the existing system.

L.3.3 Air Pollution

(1) Air Quality in the Study Area

Although the data on ambient air quality in the study area is not available except Phnom Penh, it is assumed that the air quality in Sihanoukville and the Intermediate Area is relatively good since the number of traffic and, plants and buildings with boilers and incinerators are small in these areas. It is anticipated that the situation is worse in the Greater Capital Area in comparison with Sihanoukville and the

²⁶ For example, unusable video film and shoes were brought in from Korea.

Intermediate Area, and the obtained data verifies slightly deteriorated air quality in the Greater Capital Area.

Ambient concentrations of each air pollutant and the changes of air quality in Phnom Penh are shown in **Table L-31** and Fig.K-14 to K-17. As shown in **Table L-31**, average concentrations of each pollutants in the urban area is higher than those in the suburban area. Concentrations of NO₂, CO and SO₂ are lower than air quality standard of Cambodia, but the average total suspended particulate (TSP) concentrations are higher than the standard both in the rural and suburban areas.

Table L-31 Air Quality in Phnom Penh (January 2001)

(Unit: mg/m³)

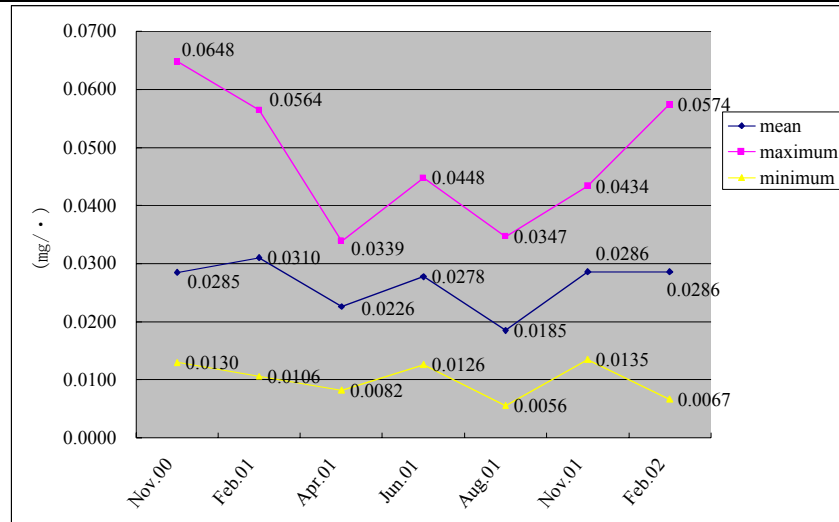
Sampling Station	NO ₂ Concentration (1 hr. Average)	CO Concentration (1 hr. Average)	SO ₂ Concentration (8 hrs. Average)	TSP Concentration (8 hrs. Average)
Suburban Area 1	0.0093	2.3067	0.0047	0.4278
Suburban Area 2	0.0177	2.3267	0.0052	0.2723
Suburban Area 3	0.0101	0.4433	0.0052	0.4042
Suburban Area 4	0.0093	0.9867	0.0044	0.2795
Suburban Area Average	0.0116	1.5159	0.0049	0.3460
Urban Area 1	0.0101	2.5033	0.0044	0.1958
Urban Area 2	0.0169	4.4167	0.0075	0.3985
Urban Area 3	0.0152	5.6667	0.0075	0.9523
Urban Area Average	0.0141	4.1956	0.0065	0.5155
Air Quality Standard	0.30	40	0.30	0.33

Note: Sampling period is from January 12 to 17, 2001

Source: the Transport Master Plan of the Phnom Penh Metropolitan Area, JICA & Municipality of PHN, 2001

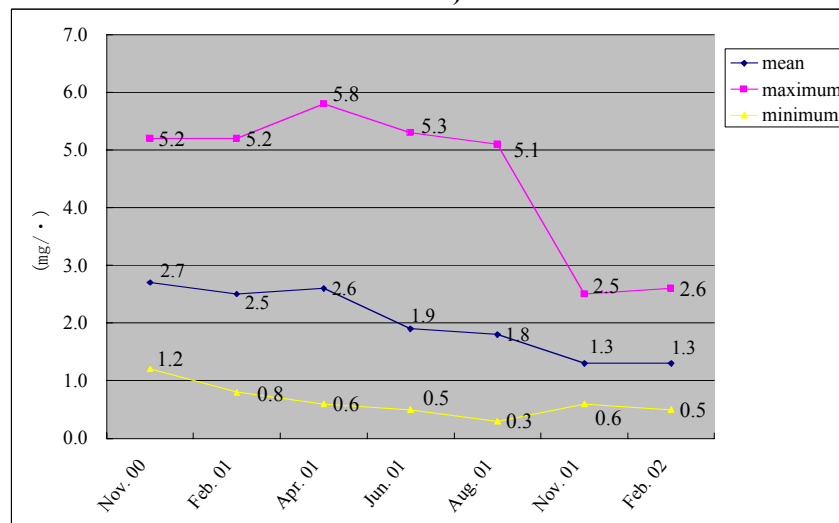
Figure L-14 and **Figure L-15** show the changes of ambient NO₂ and CO concentration from Nov. 2000 to Feb. 2002 in Phnom Penh. Both of NO₂ and CO mean concentrations shift at the level much lower than the air quality standard for 1 hr. average (0.3 and 40mg/m³, respectively). According to the study conducted by the Yokohama City University of Japan, concentrations of NO₂ and CO at the roadside sampling stations were higher than the concentrations at residential sampling stations in most cases. Thus, it is assumed that the exhaust gas from traffic is main emission source of NO₂ and CO. Both of NO₂ and CO concentrations are lower than the standard at all the roadside sampling stations, according to the results of the University study.

NO₂ concentration dropped significantly in Aug. 2001. It is assumed that the cause of this drop stems from high volume of rainfall since August is rainy season and high water solubility of NO₂. CO concentration tends to decrease. The reason is not clear, but it is presumed that the decrease of used car ratio and the improvement of fuel qualities contributed to the decrease of CO concentration.



Note: Numerical values are 48 hrs. average concentration
Source: JICA Study Team (made by using the data from Yokohama City University, School of Medicine)

Figure L-14 Change of Ambient NO₂ Concentration in Phnom Penh (from Nov. 2000 to Feb. 2002)



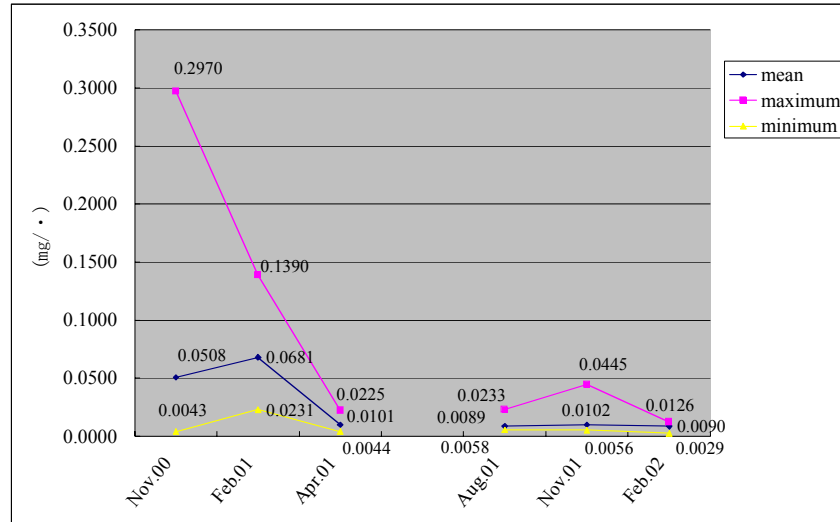
Note: Numerical values are 48 hrs. average concentration
Source: JICA Study Team (made by using the data from Yokohama City University, School of Medicine)

Figure L-15 Change of Ambient CO Concentration in Phnom Penh (from Nov. 2000 to Feb. 2002)

Figure L-16 shows the changes of ambient SO₂ concentration from Nov. 2000 to Feb. 2002 in Phnom Penh. Mean concentration of SO₂ shifts at the level much lower than the air quality standard of Cambodia for 1hr. and 8 hrs. average (0.5 and 0.3 mg/m³, respectively) and lower than the WHO standard for annual concentration (0.05 mg/m³) except Feb. 2001²⁷. Concentration level is especially low after Apr. 2001. It is assumed that small number of major SO₂ emission sources, such as heavy industry plants that are equipped with boilers/incinerators and use heavy oil, contributes to the low concentration of SO₂ in Phnom Penh.

²⁷ Maximum concentration of Nov. 2000 (0.297mg/□) was gained from the analysis of sample collected from the station near the thermal power plant.

At this stage, major SO₂ emission sources in Cambodia are thermal power plants and factories/hotels with independent power generators. As shown in **Table L-32**, SO₂ concentrations of four sampling site located near the thermal power plant are relatively higher compared with the mean concentration shown in **Figure L-16**, even though the concentration level is lower than the WHO standard for annual concentration.



Note: Numerical values are 48 hrs. average concentration

Source: JICA Study Team (made by using the data from Yokohama City University, School of Medicine)

Figure L-16 Change of Ambient SO₂ Concentration in Phnom Penh (from Nov. 2000 to Feb. 2002)

Table L-32 Ambient SO₂ Concentration around Thermal Power Stations in Phnom Penh (Unit: mg/m³)

Sampling Site	Aug. 2001	Nov. 2001	WHO Standard
Near Thermal Power Station 1	0.0045	0.0294	0.0500
Near Thermal Power Station 2	0.0186	0.0083	
Near Thermal Power Station 3	0.0092	0.0206	
Near Thermal Power Station 4	0.0103	0.0081	

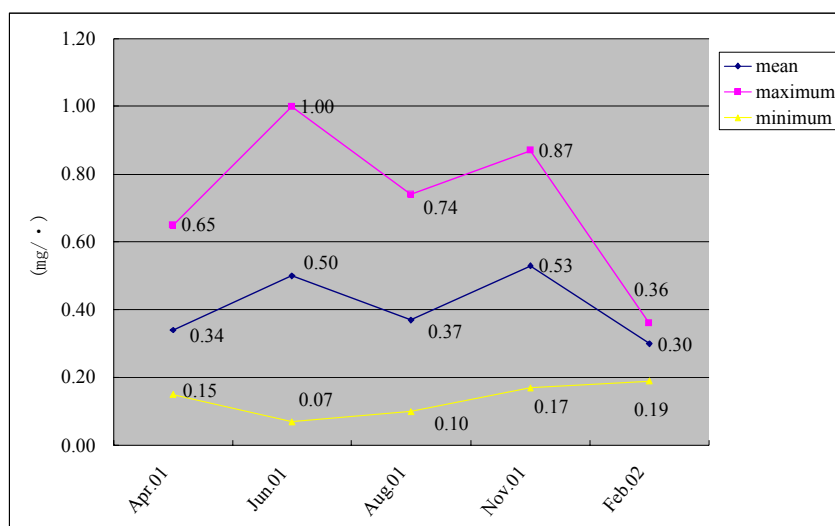
Note: Numerical values are 48 hrs. average concentration

Source: Yokohama City University, School of Medicine

As shown in **Figure L-17**, concentration of total suspended particulate (TSP) shifts at the level higher than or close to the air quality standard of Cambodia for 8 hrs. average (0.33 mg/m³). TSP concentration is higher in the roadside than in the residential area as shown in **Table L-33**. Therefore, it is assumed that TSP is mainly derived from soils on the road including unpaved roads or roads under construction, soils generated by road excavations and dusts from construction sites. No data is available regarding TSP concentration in Sihanoukville and the Intermediate Area, but the concentration may relatively high because home-use fuel is mainly firewood in these areas²⁸. Concentration of particulate matters smaller than 10 μ of diameter (PM₁₀), which believed to cause damage on human health is also high in Phnom Penh as shown in **Table L-33**.

²⁸ Ratios of firewood use as fuel in the Intermediate Area and Sihanoukville are as follows; Takaev 96.5%, Kampong Spueu 97.0%, Kaoh Kong 74.7%, Kampot 96.1%, Sihanoukville 68.7%.

As **Figure L-17** shows, TSP concentrations fluctuate depending upon the sample collection dates, but the range of fluctuation is relatively narrow. Precipitation has no significant effect to lower TSP concentration since concentration in June 2001 (rainy season) is relatively high and concentrations in Apr. 2001 and Feb. 2002 (dry season) are low. Maximum TSP concentration tends to decrease.



Note: Numerical values are 24 hrs. average concentration
Source: JICA Study Team (made by using the data from Yokohama City University, School of Medicine)

Figure L-17 Change of Ambient TSP in Phnom Penh (from Nov. 2000 to Feb. 2002)

Table L-33 Ambient PM10 and TSP in Phnom Penh

(Unit: mg/m³)

Sampling Site	PM10 (mg/m ³)		TSP (mg/m ³)	
	Aug. 2001	Nov. 2001	Aug. 2001	Nov. 2001
IMCHC*	0.118	—	0.157	—
Paillin Hotel	0.490	—	0.561	—
SVA Office**	—	0.255	—	0.327
Paradise Hotel	—	1.002	—	1.136

* International Maternal and Child Health Center

**Shanti Volunteer Association

Note1: Numerical values are 24 hrs. average concentration

Note 2: IMCHC and SVA Office are located in residential area while two hotels are located along the road

Source: Yokohama City University, School of Medicine

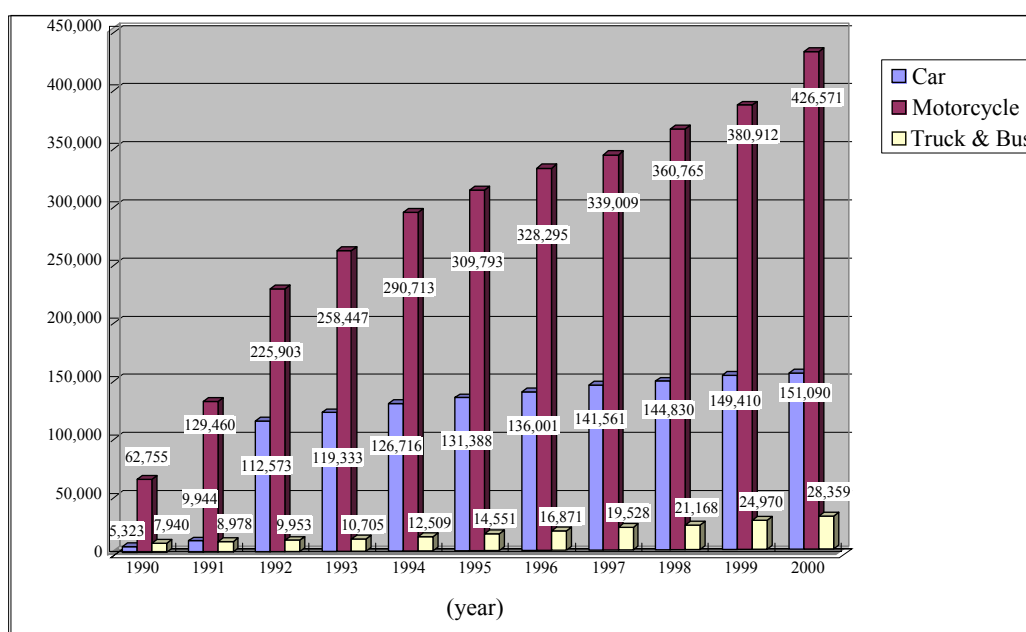
(2) Issues on Air Pollution

As mentioned above, air pollution seems to be not serious in Sihanoukville and the Intermediate Area judging from the number of pollution sources and the volume of fuel consumption. However, the situation is different in the Greater Capital Area.

High concentration of TSP is a key issue to be solved in the Greater Capital Area. Although the mechanism is not clear, epidemiological study often shows TSP, especially particulate matters smaller than 10 μ m of diameter (PM10), causes adverse effect on human health. Some study shows the correlation between cancer risk and PM emitted from diesel-engine vehicles using gas oil or from plants combusting heavy oil. Another study shows that mineral particles derived from soil cause health

damage²⁹. The former case is applied in the developed countries including Japan and the latter case need to be studied in the Greater Capital Area at this stage. Soils seems to be the main cause of high concentration of TSP, but analyzing composition of TSP and precisely determining the causes of TSP are required as the first step to conduct countermeasures to lower TSP concentration. Then, the countermeasures should be established and implemented.

As shown in **Figure L-18**, the number of truck and bus with diesel engine is increasing little by little in Cambodia, and it is predicted that the volume of truck and bud traffic will concentrate in the Greater Capital Area. Thus, PM10 emission standard of mobile sources need to be set and measures should be taken to strictly prohibit the discharge of PM over the standard to prevent health risk caused by PM in early stages. The standard should be reviewed and amended if necessary.



Source: Cambodia Statistical Yearbook 2001, National Institute of Statistics, Ministry of Planning

Figure L-18 Change of Vehicle Numbers by Type (1991-2000)

Concentrations of NO₂ and CO are lower than the standard of Cambodia and it is anticipated that the levels of both pollutants concentration do not cause health damage on residents. However, the number of car and motorcycle, main emission sources of NO₂ and CO are increasing in Cambodia as shown in **Figure L-18**. If this trend will continue, ambient concentrations of both pollutants will also go up especially in the Greater Capital Area where approximately 10% of total car and motorcycle of the country runs on 2% area of whole country land. To prevent air quality worsening, exhaust gas from motor vehicle should be strictly and effectively controlled as well as fuel quality. SO₂ concentration is also lower than the standard of the country, but emission of SO₂ from the main stationary sources, such as thermal power plants, should be regularly monitored.

²⁹ According to the IARC, mineral particle containing crystalline silica increases lung cancer risk.

Overall, effective and regular monitoring of air quality both from stationary and mobile emission sources is imperative to take any actions to control air quality under the level of the standard. Although maximum allowable standard for pollutants both from stationary and mobile emission sources have been set up, monitoring of emission gas has not been enough due to lack of budget, analytical instrument and human resources. Thus, comprehensive system for air quality monitoring need to be established by reinforcing existing Office of Air Quality, Noise and Vibration Management, and Office of Environmental Quality, Research and Laboratory in the MOE. Monitoring system for air quality need to be established in the areas where extensive industrial development is anticipated, such as Sihanoukville.

L.3.4 Landmine/Unexploded Ordnance (UXO)

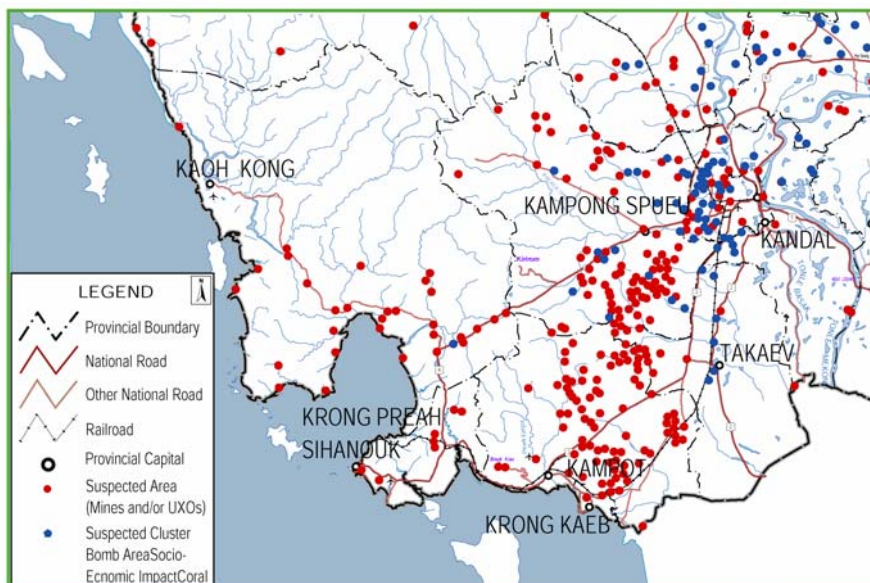
Cambodia is one of the most heavily contaminated countries by landmine and UXO in the world because of the prolonged conflicts over the last 30 years. According to survey completed in April 2002, the total area dubiously contaminated is 4,466,000 km² or about 2.5% of the total area of Cambodia³⁰. All the 24 provinces/municipalities have landmine/UXO-contaminated areas, and 6,422 villages or about 46% of total villages are affected by landmine or UXO. As shown in **Figure L-19**, the provinces in the north and northwest are severely contaminated. Kampong Spueu, Kampot and Kaoh Kong are the most contaminated provinces in the study area though the extent of contamination is lower compared with the northern and northwestern provinces.

The number of landmine/UXO casualties is decreasing year after year, as shown in **Figure L-20**, but two or more are still suffered on daily basis. In the study area, Kaoh Kong has the biggest number of casualties or 15 in year 2000, then Kampong Spueu and Kandal follow by 13 and 10, respectively. Kampot and Takaev have 8 casualties each, and Phnom Penh and Sihanoukville have 2 casualties each. Total casualty number in the study area is 59 (including 1 in Krong Kaeb) in 2000, and it is account for about 7%. Although the number of casualties is small in the study area, the threat of landmine/UXO is one of the factors that hinder socioeconomic development particularly in Kampong Speau, Kampot and Kaoh Kong.

Clearance of the contaminated land have been carried out and 166,000km² of land were cleared from 1992 to 2001³¹. With the continuing effort for clearing the contaminated areas, transparent and participatory demining planning and process are required to prevent land disputes on cleared land and to make the land used for the planned purpose.

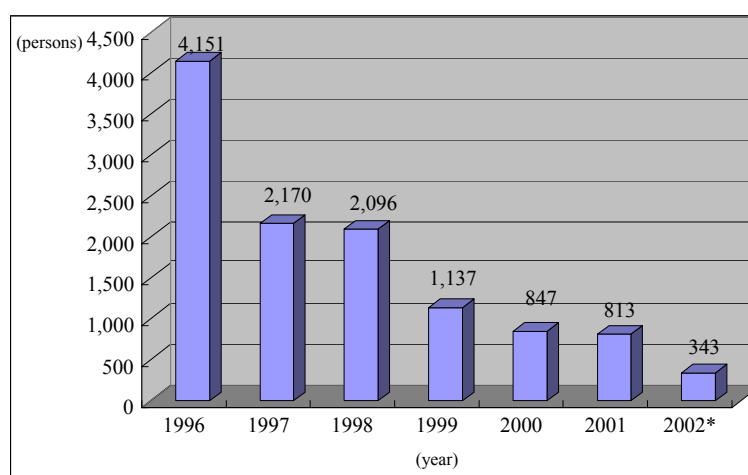
³⁰ GeoSpacial, *Cambodian National Level One Survey Statistical Profile*, May 2002

³¹ Landmine/UXO clearance has been carried out by the Cambodian Mine Action Center, HALO Trust, Mines Advisory Group, the Royal Cambodian Armed Forces, and village deminers.



Source: Cambodia National Level 1 Survey Project, CIDA, May 2002

Figure L-19 Suspected Landmine/UXO Contaminated Area in the Study Area



* data of the first 4 months

Source: HIB/CRC Cambodia Mine/UXO Victim Information System, March 2002

Figure L-20 Change of Landmine/UXO Casualties in Cambodia (1996 to 2002)

L.4 ENVIRONMENTAL ISSUES TO BE ADDRESSED IN THE STUDY AREA

L.4.1 Overall Issues

(1) Weak Enforcement of Environmental Legislation

The enforcement system for the environmental legislation has not been sufficient in Cambodia. Although environment related basic legislation have been established step by step since the enactment of the Law on Environment Protection and Natural Resource Management in 1996, the enforcement system itself cannot satisfy the purpose of the laws. Insufficient law enforcement has no effect on prevention of environmental degradation.

Effective enforcement of the environmental legislation requires institutional capacity

building both in the Ministry of Environment (MOE) and the provincial/municipal departments of environment, enactment of procedures and guidelines for law obedience, standardized pollution control system which covers wide range of pollution sources, and sufficient number of expertise. It is not until the above-mentioned factors are satisfied that the effective law enforcement becomes practicable.

To effectively and efficiently create and implement environmental policy, vertically divided present management system needs to be unified with the Ministry of Environment as a leading responsible agency.

(2) Insufficient Solid Waste and Wastewater Management

The volume of solid waste has been rapidly increasing in the provincial/municipal centers not only in Sihanoukville and the Greater Capital Area, but also in the Intermediate Area. The volume from the market place is especially big. The sub-decree on solid waste management covers all aspects of solid waste management, and the local authorities are required to establish short to long terms waste management plan by the sub-decree. However, the current condition is not satisfied the purpose of the sub-decree and the local level waste management plans have not been completed. To avoid the adverse impact on public health, the effective and proper waste management systems need to be urgently established.

Sewage treatment systems have rarely been constructed except the provincial/municipal centers, and domestic sewage is often discharged directly to the nearby drains or water bodies with no treatment. As a result, the sanitary condition is deteriorating and causing water-borne diseases in the rural areas. To make the situation improve, effective sewage treatment system need to be established.

L.4.2 Issues in Sihanoukville

(1) Necessity of Concurrent Attainment of Industrial Development/Urbanization and Environment/Natural Resource Conservation

As extensive industrial development and the following population increase/urbanization are anticipated in Sihanoukville, it is predicted that the municipality will face both industrial pollution and degradation of living environment, such as increase of domestic wastewater and solid waste discharge. Sihanoukville has beautiful coastal beaches and the Ream National Park with various natural habitats for a range of rare and endangered species of plant and animal. Anticipated industrial development and advancement of urbanization have possibilities to deteriorate rich tourism resource and valuable tropical biodiversity.

Attaining both industrial development and environment/natural resource conservation is a big challenge. Establishment of effective environmental management system is imperative, but it is not enough to prevent negative impact from industrialization and urbanization. To tackle on this challenging task, waste reduction activities with the participation of all the stakeholders are required.

L.4.3 Issues in the Greater Capital Area

(1) Degradation of Urban Environmental Quality

In the Greater Capital Area, degradation of environmental quality is becoming obvious. Volume of solid waste tends to increase and water quality of water bodies receiving wastewater is lower than the standard in many cases. Industrial development and population increase are considered to be the main factors causing the quality degradation. As industrial development and advancement of urbanization are predicted to continue in the Greater Capital Area, urban environment will be further deteriorated if no effective environmental policies were introduced.

Reinforcement of capacity for effective enforcement of environment related legislation is imperative to prevent further degradation of urban environmental quality. In addition, environmental policy, which gives incentive for reducing discharge of pollutants both from industrial pollution sources and households needs to be established and introduced.

L.4.4 Issues in the Intermediate Area

(1) Unsustainable Resource Utilization in the Protected Areas

The Intermediate Area embraces five protected areas. These protected areas embrace large forest area and provide various natural habitats for a range of rare and endangered species of plant and animal. However, the exploitation pressure on the areas is high since the park-adjacent communities are heavily dependent upon natural resources inside the protected areas as a source of income and subsistence. In addition, the number of illegal activities by wildlife dealers has not been diminished. Deterioration and loss of the protected areas lead to the reduction of the economic value the protected areas have.

Although the law on Environmental Protection and Natural Resource Management affirmed the mandate of the MOE on the protected areas, the institutional capacity to effectively manage protected areas has been weak because of the skill limitation and budget constraints. Lack of management system with local people participation is another factor to accelerate the exploitation pressure.

(2) Lack of Effective Management System for Coastal Resource Conservation

The coastal zone encompasses two provinces and two municipalities in the study area. Mangrove forestry, sea grass beds and coral reefs are found along the coastline, and this marine ecosystem supports coastal fishing grounds. Local fishermen make living by selling marine products caught in the fishing grounds. In other words, local people can continuously receive benefit from the marine ecosystem if it properly preserved.

Preservation of marine ecosystem and sustainable utilization of marine resources largely depend on the proper management, but the present management system is not

sufficient to prevent over exploitation of marine resources. In addition, the importance of marine ecosystem preservation is not widely recognized among local people. The lack of adequate management system leads to degradation of marine ecosystem and exhaustion of fishery resources. To prevent the situation from worsening, proper management system needs to be established with the participation of local people, especially in Sihanoukville where development of agro-fishery industry is expected.

L.5 STRATEGIES FOR ENVIRONMENTAL SECTOR

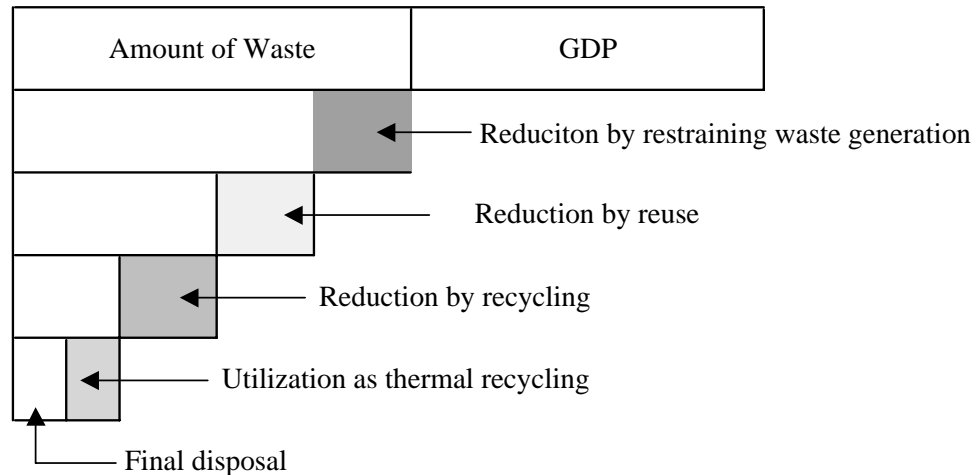
L.5.1 Sector Goal- Concurrent Attainment of Industrial Development and Environmental Conservation

In the study area, extensive industrial development and the following population increase/urbanization are anticipated, especially in the Sihanoukville and the Greater Capital Area. On the other hand, the study area is rich in natural resources and has many protected areas, which contain a variety of habitats, each with their own characteristic wildlife communities. Careful consideration needs to be given to this point, and all possible efforts should be given to mitigate negative impact by industrial development on the surrounding environment. Therefore, “concurrent attainment of industrial development and environmental conservation” should be set as a sector goal and strategies should be considered to accomplish this goal.

L.5.2 Long Term Goal

As mentioned in the above section, there are many environment related issues that need to be solved to accomplish sustainable development of the study area. Volume of solid waste and wastewater is predicted to increase in all the provinces and municipalities of the study area. Increase of waste and wastewater is imminent problem especially in Sihanoukville and the Greater Capital Area where high population growth is anticipated. Exploitation pressures on natural resources in and around the protected areas of the Intermediate Area will be intensified in the future with the anticipated increase of residents in the communed adjacent to the protected areas.

Deterioration of environmental quality and depletion of natural resources lead to a decline in the standard of living and prevent regional development. Thus, reduction of waste and wastewater, and efficient utilization of resources are imperative tasks to be undertaken in the study area. To accomplish these tasks, the study area should aim to establish model cases toward Zero-Emission society as its long-term goal (See Box 1 and 2 for the detailed explanation about Zero-Emission.). Introduction of systems for reduction, reuse and recycling of wastes is prerequisite for establishment of the Zero-Emission society as shown **Figure L-21**.



Source: "Eco-cycle society", Yuhikaku, 1997

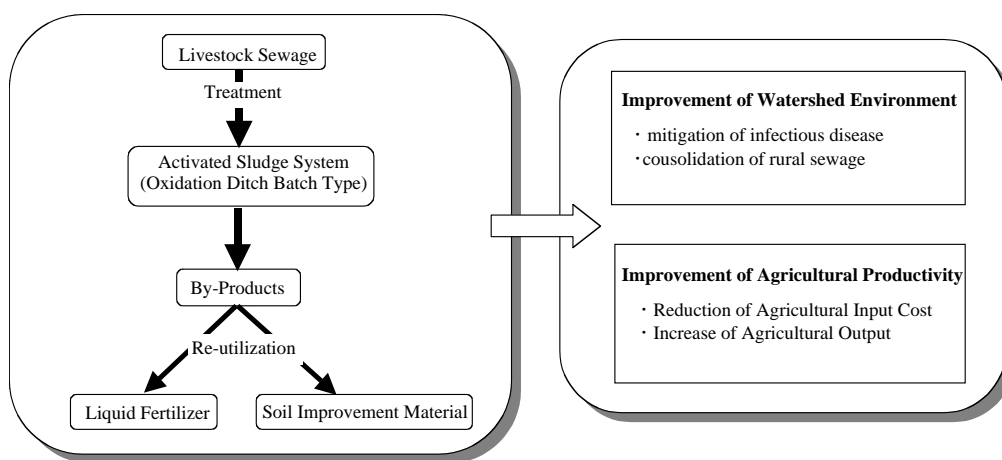
Figure L-21 Basic Concept of Waste Management

BOX 1 What is the Zero Emission Society?

The depletion of natural resources and the degradation of environment will result in the difficulty in continuing in industrial growth and improvement of quality of life. Therefore, many countries in the world are trying to implement efforts to create recycling oriented society. "Zero Emission" is a project launched by the United Nations University aiming to create the shift in the traditional concept of industry. The objective of the project is to achieve technological breakthroughs which facilitate manufacturing without any forms of waste, i.e. no waste in the water, no waste in the air, no solid waste. In other words, all inputs are to be used in the final product or should be converted into ingredients for other industries. For example, organic wastes from a brewery factory have been converted to compost or feed for stock farming or fish farming and be offered to farmers and breeders in many cases. To achieve this kind of recycling, industrial enterprises group needs to create friendly relations and partnership with the local community in environmental improvement and the waste effective utilization.

BOX 2 Zero Emission Sewage Treatment: Okinawa Model

In Okinawa Prefecture of Japan, activated sludge system called oxidation ditch batch type is widely known traditional method for sewage treatment. The system consists of a single lagoon called oxidation ditch. Treated water and sludge can be used for agricultural inputs. The treated water, containing various micro organics as well as nitrogen and phosphate, can be applied as fertilizer. The treated sludge is odorless and can be used as substitute of multi to cover and protect surface of soil. The system is also applicable to the treatment of household domestic sewage in the rural area. This traditional technology can be applicable in the area with the tropical climate though some modifications may need to be required. The equipments can be made at relatively low cost.



L.5.3 Overall Strategies

(1) Effective Enforcement of Environmental Legislation

The effective enforcement of environmental legislation is basic condition for environment and natural resource management in Cambodia. As mentioned above, several factors need to be satisfied to make the law enforcement effective.

Human resource development is one of the important factors to be accomplished by receiving technical transfer and guidance from the experienced environmental experts. The capacity building of the environment related staff at the provincial/municipal level has assumed importance in accordance with economic development at the local level, especially in the Greater Capital Area and Sihanoukville. Establishing procedures and guidelines for law enforcement is also important provided that they are in line with the actual conditions in Cambodia.

The MOE should be given more power for executing environmental laws and regulations once the organizational capacity improved enough.

L.5.4 Strategies in Sihanoukville

(1) Establishment of Strict Pollution Control System

Establishment of standardized and strict pollution control is one of the basic factors to achieve the effective enforcement of environmental legislation. To minimize negative impact caused by economic development, strict pollution control is required especially in the areas where industrial development is prominent or is anticipated. The MOE's inspection of stationary pollution sources located in Sihanoukville has been done only once a year. Although the staff of the department of environment of Sihanoukville is responsible for regular inspection on the pollution sources, capacity and power to enforce environmental legislation are limited.

In that sense, pollution monitoring and control system in Sihanoukville needs to be reinforced. Increasing the number of target factories for pollution source monitoring is the main task for strengthening pollution control with the sound monitoring system, as well as capacity building of the staff responsible for implementing the system.

(2) Upgrading of Solid Waste Management

In Sihanoukville, the volume of solid waste has been increasing with the population increase and industrial development. The municipality has an eight hectares landfill site, but the site is least-controlled type landfill. The collection and disposal of solid waste is consigned to the private company, but only 30% of discharged waste has been collected. The capacity of the company is limited at this stage, and the improvement of waste collection and management system cannot be expected in the short run.

The amount of solid waste discharged in Sihanoukville is about 80 tons in 1998. However, it is anticipated that the volume of solid waste will be about 220 tons in 2005 and 540 tons in 2008. To cope with the rapid increase of solid waste volume and to appropriately dispose of high volume of solid waste, upgrading present solid waste management system, including construction of controlled landfill site, is imperative and urgently required.

(3) Investigation of Potential for Establishment of Zero-Emission Model

Reduction of waste and wastewater both from industrial pollution sources and households is imperative in Sihanoukville, where accelerations of industrial development and population growth are anticipated. To cope with this situation, zero-emission models for industrial activities and living environment of the local people need to be established in the long run. As the first step toward establishment of zero-emission model, potential needs to be investigated by learning from the precedent cases in other countries and regions.

Seeking to zero-emission model at industrial level leads to discovery and establishment of new region-specific industry.

L.5.5 Strategies in the Greater Capital Area

(1) Reinforcement of Pollution Monitoring and Control

Monitoring of stationary pollution sources has been undertaken by the MOE, but the number of target factories and the number of monitoring itself is limited. With limited number of staff and no automatic measuring system, it is difficult to increase the number of monitoring and target pollution sources. Monitoring is done basically only for wastewater and the laboratory of MOE does not have instruments for analyzing air quality at this stage.

To restrain the predicted degradation of environmental quality, strict enforcement of environmental legislation based on accurate monitoring and reliable analysis results is imperative. Thus, the present monitoring and control system of the MOE should be reinforced steadily by educating and training staff, taking measures to keep experienced staff, utilizing existing advanced instrument effectively, and introducing equipment for air quality monitoring.

Inspection on disposal of industrial solid waste should also be reinforced in the Greater Capital Area where the operation of large-scale factories has been increasing. Further, capacity building is required to cope with the increase of hazardous or toxic materials contained in the waste

(2) Introduction of Waste and Wastewater Reduction Incentive Policy

It is difficult to reduce discharge of waste and wastewater merely by reinforcing monitoring and controlling system. In addition, the amount of waste disposal would not decrease if the amount of waste discharge keeps increasing, even if the ratio of reuse and recycling of waste improved. Thus, some types of economic measures, such as charging or taxation in proportion to the volume of wastes/pollutants discharge, need to be taken step by step to induce polluter side to reduce discharge of pollutants.

Imposing responsibility of collection and “appropriate” disposal of industrial waste on the polluters is another economic measure to reduce waste discharge and to raise recycling rate. The responsibility being discussed here is not a physical responsibility but it is a payment responsibility, and the enterprises are able to shift the physical responsibility to a third party by bearing the cost for accomplishing physical disposal. In the Greater Capital Area, waste from garment factories has been disposed with similar measure mentioned above to some extent. This type of measure should be introduced widely.

L.5.6 Strategies in the Intermediate Area

(1) Conservation and Sustainable Utilization of Natural Resources

The imperative task for preservation and sustainable utilization of natural resource is to establish appropriate management system with participation of local people. The near-sighted natural resource exploitation leads to the loss of industrial bases and

income source of the local people in the long run.

In the case of offshore fishery, management should be based on the maximum sustainable yield computed from the scientific research on fishery resources. Local communities involvement and income source diversification are especially important in the case of inshore fishery management.

To conserve natural resources in the protected areas, the economic value that the protected areas contain needs to be recognized by all the levels of stakeholders through the establishment of the community based resource management system. To prevent illegal activities in the protected areas, reinforcing surveillance network is also important.

(2) Improvement of Domestic Waste/Wastewater Management System

To cope with the increase of solid waste volume, appropriate management system on collection, transportation and disposal need to be established. Appropriate disposal of the waste is especially important to prevent negative impact on the public health. Promotion of systematic methods on reducing, reusing and recycling of waste need to be considered on the middle term basis. As municipal waste generated in provincial centers is mainly composed of organic garbage, establishment of composting and recycling system is effective.

Regarding domestic wastewater, Sewage treatment systems need to be maintained or constructed in the provincial/municipal centers. Introduction of composting toilets or other area-specific and cost effective waste treatment measures should be considered and introduced especially in the less densely populated areas. Both of the measures are expected to contribute to improve the sanitary condition of the relevant areas.

L.6 RESULTS OF INITIAL ENVIRONMENTAL EVALUATION

L.6.1 A-2 Fishery Market Development Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 10 items. The results of the scoping are shown in the following **Table L-37**.

Table L-37 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (Include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	A	A					
2 Economic Activities	B					B	B
3 Traffic and Public Facilities	C		C		C		C
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common							
7 Public Health Condition	C					C	C
8 Waste	B		B			B	B
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion							
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone	C					C	
15 Fauna and Flora	C					C	
16 Meteorology							
17 Landscape							
18 Air Pollution							
19 Water Pollution	B		C			B	
20 Soil Contamination							
21 Noise and Vibration	C					C	
22 Land Subsidence							
23 Offensive Odor	B					B	

Note : Evaluation categories:
A: Serious negative impact is expected
B: Some negative impact is expected
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).
No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-38** can be taken. Environmental Impact Assessment (EIA) needs to be conducted to study the possibility of resettlement, the impact on local economic activities, and impact of water pollution and offensive odor on the surrounding area.

Table L-38 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	• Establishment of appropriate resettlement plan
2. Traffic and Public Facilities	• Proper traffic management and control • Time arrangement for construction
3. Waste	• Appropriate construction waste management/disposal
4. Water Pollution	• Control of soil erosion • Proper management of toxic/hazardous substances and construction machinery
B. After Operation	
1. Traffic and Public Facilities	• Enlargement entrance road of the Market • Proper traffic management and control including establishment of parking lot
2. Public health	• Implementation of Community Sanitation and Health Awareness Program
3. Waste	• Establishment of appropriate waste collection/disposal system
4. Coastal Zone	• Construction of wastewater treatment plant • Effective supervision for each pollution source • Establishment of appropriate waste collection system
5. Water Pollution	• Construction of wastewater treatment plant • Establishment of adequate drainage systems • Appropriate supervision on wastewater control
6. Noise and Vibration	• Installation of acoustic wall or buffer zones if necessary
7. Offensive Odor	• Establishment of appropriate waste collection/disposal system

L.6.2 A-2 Agro-forestry Development Pilot Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 7 items. The results of the scoping are shown in the following **Table L-39**.

Table L-39 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	C	C					
2 Economic Activities	C						C
3 Traffic and Public Facilities							
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common	B	B					
7 Public Health Condition							
8 Waste	B		B				B
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion							
12 Groundwater	C	C				C	
13 Hydrological Situation							
14 Coastal Zone							
15 Fauna and Flora	C	C					
16 Meteorology							
17 Landscape							
18 Air Pollution							
19 Water Pollution	C					C	
20 Soil Contamination							
21 Noise and Vibration							
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that no serious impact is anticipated, and the negative impacts will be mitigated with basic countermeasures. However, EIA needs to be conducted to access the land title of the pilot project site.

L.6.3 Development of Sihanoukville Free Zone

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 19 items. The results of the scoping are shown in the following **Table L-40**.

Table L-40 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (Include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	A	A					
2 Economic Activities	B	B		B			C
3 Traffic and Public Facilities	B		B	B	B		C
4 Split of Communities	B	B		B			
5 Cultural Property							
6 Water Rights and Rights of Common	B	B		B			
7 Public Health Condition	C		C		C	C	C
8 Waste	B	C				B	B
9 Hazards (Risk)	C	C					
10 Topography and Geology							
11 Soil Erosion	C	C					
12 Groundwater	B		C			B	C
13 Hydrological Situation							
14 Coastal Zone	B	C				B	
15 Fauna and Flora	B	C				B	
16 Meteorology							
17 Landscape	A	C		A			
18 Air Pollution	B	C	C			B	
19 Water Pollution	B	C				B	B
20 Soil Contamination	C	C				C	
21 Noise and Vibration	B		B			C	
22 Land Subsidence	C					C	C
23 Offensive Odor	C					C	C

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-41** can be taken. However, EIA needs to be conducted for the items shown in **Table L-42** to further study some of anticipated impact.

Table L-41 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	• Establishment of appropriate resettlement plan
2. Traffic and Public Facilities	• Proper traffic management and control • Time arrangement for construction
3. Split of Communities	• Securing of alternative route with appropriate traffic control
4. Water Rights and Rights of Common	• Establishment of alternative water supply system for the residents nearby project site
5. Public Health Condition	• Providing education on sanitation and HIV infection to residents and construction workers • Construction of temporary latrine for construction staff and worker.
6. Waste	• Appropriate construction waste management/disposal
7. Hazards	• Properly designs for storm water drainage • Measure to reduce coarse substances flowing into the Port • Appropriate management of hazardous/toxic substances
8. Soil Erosion	• Using proper compacting methodology and machinerys • Land preparation should be done in dry season as much as possible
9. Groundwater	• Proper measures for prevention of groundwater contamination
10. Coastal Zone	• Proper measures for land preparation and facility construction
11. Fauna and Flora	• Proper measures for land preparation and facility construction
12. Landscape	• Indigenous tree planting to mitigate negative impact on tourists minds
13. Air pollution	• Proper covering of construction material • Sprinkle of roads in project affected area
14. Water Pollution	• Control of soil erosion • Proper management of toxic/hazardous substances and construction machinery
15. Noise and vibration	• Assure the construction equipment in good condition to minimize noise and vibration • Appropriate construction schedule/planning/management • Any construction works will be taken in daytime period. • Installation of acoustic wall or buffer zones if necessary

Environmental Items	Mitigation measures
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Enlargement entrance road of the FZ • Proper traffic management and control
2. Split of Communities	<ul style="list-style-type: none"> • Securing of alternative route with appropriate traffic control
3. Public Health Condition	<ul style="list-style-type: none"> • Providing education on sanitation and HIV infection to residents and FZ staff/employee
4. Waste	<ul style="list-style-type: none"> • Establishment of appropriate waste collection system • Construction of controlled landfill site
5. Coastal Zone	<ul style="list-style-type: none"> • Construction of wastewater treatment plant • Effective supervision for each pollution source • Establishment of appropriate waste collection system
6. Flora and Fauna	<ul style="list-style-type: none"> • Construction of wastewater treatment plant • Effective supervision for each pollution source • Establishment of an adequate waste collection system • Establishment of appropriate waste collection system
7. Air Pollution	<ul style="list-style-type: none"> • Appropriate supervision on air pollution control • Installation of pollution prevention equipment if necessary • Regular checks vehicle and associated facility for reduction of toxic gas emission
8. Water pollution	<ul style="list-style-type: none"> • Construction of wastewater treatment plant • Regularly control wastewater at outlet of the wastewater treatment plant. • Appropriate supervision on wastewater control
9. Noise and Vibration	<ul style="list-style-type: none"> • Installation of acoustic wall or buffer zones if necessary

Table L-42 Environmental items for EIA

Phase	Category	Items	Contents	
Construction Phase	Social Environment	Resettlement	• the entitlement on the compensation	
			• the detail of the compensation	
			• the infrastructure development plan for the resettlement area	
		Economic Activities	• the impact of resettlement on families running small businesses	
		Public Health Condition	• the impact on HIV infection	
After Operation	Natural Environment	Groundwater	• the impact of the construction waste disposal to the existing landfill site	
			• groundwater condition and the impact of drilling for deep wells	
	Social Environment	Economic Activities	• the impact on fishery resources and fish catch	
			Natural Environment	Groundwater
	• pumping test			
	Coastal Zone	• the detail of natural condition of coastal zone		
	Flora and Fauna	• the impact of wastewater on marine ecosystem		
	Landscape	• the impact on tourism by taking contingent valuation method		
	Pollution	Air Pollution	• wind direction, wind speed and atmospheric stability	
			• simulation of the atmospheric dispersion of pollutants	
			Water Pollution	• simulation of wastewater dispersion
• the impact of wastewater on natural condition of coastal sea and marine ecosystem				
Land Subsidence	Land Subsidence	• hydro-geological survey (groundwater capacity)		
		• pumping test		

L.6.4 Development of Phnom Penh Free Zone

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 11 items. The results of the scoping are shown in the following **Table L-43**.

Table L-43 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1	Resettlement						
2	Economic Activities						
3	Traffic and Public Facilities	B		B		B	B
4	Split of Communities						
5	Cultural Property						
6	Water Rights and Rights of Common						
7	Public Health Condition						
8	Waste	B	B			B	B
9	Hazards (Risk)	C				C	
10	Topography and Geology	C	C				
11	Soil Erosion	B	B				
12	Groundwater	C		C		C	
13	Hydrological Situation						
14	Coastal Zone						
15	Fauna and Flora						
16	Meteorology						
17	Landscape						
18	Air Pollution	B	C	C		B	
19	Water Pollution	B	C			B	B
20	Soil Contamination	C				C	
21	Noise and Vibration	B		B		C	
22	Land Subsidence						
23	Offensive Odor	C				C	

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-44** can be taken. However, EIA needs to be conducted to study detail of topography and geology, impact on groundwater during construction phase and impact of wastewater and air pollution after operation as shown in **Table L-45**.

Table L-44 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Proper traffic management and control • Time arrangement for construction
2. Waste	<ul style="list-style-type: none"> • Appropriate construction waste management/disposal
3. Hazards	<ul style="list-style-type: none"> • Properly designs for strome water drainage • Measure to reduce coarse substances flowing into the Port • Appropriate management of hazardous/toxic substances
4. Soil Erosion	<ul style="list-style-type: none"> • Using proper compacting methodology and machineries • Land preparation should be done in dry season as much as possible
5. Air pollution	<ul style="list-style-type: none"> • Proper covering of construction material • Sprinkle of land preparation area and roads in project affected area
6. Water Pollution	<ul style="list-style-type: none"> • Proper management of toxic/hazardous substances and construction machinery
7. Noise and vibration	<ul style="list-style-type: none"> • Appropriate construction schedule/planning/management • Installation of acoustic wall or buffer zones if necessary
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Proper traffic management and control
2. Waste	<ul style="list-style-type: none"> • Establishment of appropriate waste collection system • Securing appropriate waste disposal site
3. Hazards (Risk)	<ul style="list-style-type: none"> • Strict and effective control of hazardous/toxic and flammable substances
4. Air Pollution	<ul style="list-style-type: none"> • Appropriate supervision on air pollution control • Installation of pollution prevention equipment if necessary • Regular checks vehicle and associated facility for reduction of toxic gas emission
5. Water pollution	<ul style="list-style-type: none"> • Construction of wastewater treatment plant • Regular monitoring of wastewater at outlet of the wastewater treatment plant. • Appropriate supervision on wastewater control
6. Soil Contamination	<ul style="list-style-type: none"> • Strict and effective control of hazardous/toxic substances
7. Noise and Vibration	<ul style="list-style-type: none"> • Installation of acoustic wall or buffer zones if necessary
8. Offensive Odor	<ul style="list-style-type: none"> • Appropriate countermeasure should be taken by each of odor emit factory

Table L-45 Environmental items for EIA

Phase	Category	Items
Construction Phase	Natural Environment	Topography & Geology
		Groundwater
After Operation	Pollution	Air Pollution
		Water Pollution

L.6.5 Establishment of University in Sihanoukville with Faculty of Engineering

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 3 items. The results of the scoping are shown in the following **Table L-46**.

Table L-46 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (Exclude pre-construction Phase)			After Operation		
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	C	C					
2 Economic Activities							
3 Traffic and Public Facilities	C		C				
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common	C	C					
7 Public Health Condition							
8 Waste							
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion							
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone							
15 Fauna and Flora							
16 Meteorology							
17 Landscape							
18 Air Pollution							
19 Water Pollution							
20 Soil Contamination							
21 Noise and Vibration							
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that no serious impact is anticipated, and the negative impacts will be mitigated with basic countermeasures. Therefore, EIA does not need to be required.

L.6.6 J-2 Container Distribution Center Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 14 items. The results of the scoping are shown in the following **Table L-47**.

Table L-47 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	B	B					
2 Economic Activities	C	C		C			
3 Traffic and Public Facilities	B		B				C
4 Split of Communities	C	C					
5 Cultural Property							
6 Water Rights and Rights of Common	C	C					
7 Public Health Condition	C		C		C		
8 Waste	B		B				B
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion	C		C				
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone	C		C				
15 Fauna and Flora	C		C				
16 Meteorology							
17 Landscape							
18 Air Pollution	C		C				
19 Water Pollution	B		B				
20 Soil Contamination	C		C				
21 Noise and Vibration	B		B				B
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-48** can be taken. However, EIA needs to be conducted to study impact relating to resettlement, economic activities, traffic volume/control, air pollution accruing from the increase of traffic, and anticipated noise and vibration.

Table L-48 Summary of Impact Mitigation Measures

Activities/Considerations	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	<ul style="list-style-type: none"> Setting location with stakeholder participation process Appropriate land acquisition with proper means and compensation Establishment of appropriate Resettlement Action Plan (RAP)
2. Traffic and Public Facilities	<ul style="list-style-type: none"> Proper traffic management and control Time arrangement for construction
3. Water Rights and Rights of Common	<ul style="list-style-type: none"> Graps of accurate situation of the land title in the project site
4. Public Health Condition	<ul style="list-style-type: none"> Provide training on sanitary and safty to construction staff and workers Providing education on sanitaion and HIV infection to residents and construction workers Construction of temporary latrine for construction staff and worker.
5. Waste	<ul style="list-style-type: none"> Appropriate construction waste collection/disposal management
6. Soil Erosion	<ul style="list-style-type: none"> Using proper compacting methodology and machineries.
7. Costal Zone	<ul style="list-style-type: none"> Proper measures for land preparation and facility construction
8. Air pollution	<ul style="list-style-type: none"> Proper covering of construction material Sprinkle water on the project site if necessary
9. Noise and vibration	<ul style="list-style-type: none"> Appropriate construction schedule/planning/management Installation of acoustic wall or buffer zones if necessary
B. Operation and Maintenance	
1. Traffic	<ul style="list-style-type: none"> Enlargement entrance road of the CDC Proper traffic management and control
2. Public Health Condition	<ul style="list-style-type: none"> Providing education on sanitaion and HIV infection to residents and CDC staff/employee
3. Waste	<ul style="list-style-type: none"> Establishment of an adequate waste collection/disposal system
4. Air Pollution	<ul style="list-style-type: none"> Air pollution control in the surrounding of the CDC Regularly checks vehiclecle and associated facility

L.6.7 J-4 Sihanoukville Urban Transportation Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 13 items. The results of the scoping are shown in the following **Table L-49**.

Table L-49 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (Includes pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	B	B					
2 Economic Activities	C	C		C			
3 Traffic and Public Facilities	B		B				C
4 Split of Communities	C	C					
5 Cultural Property							
6 Water Rights and Rights of Common	C	C					
7 Public Health Condition	C		C		C		
8 Waste	C		C				
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion	C		C				
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone	C		C				
15 Fauna and Flora	C		C				
16 Meteorology							
17 Landscape							
18 Air Pollution	C		C				
19 Water Pollution							
20 Soil Contamination	C		C				
21 Noise and Vibration	B		B				C
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-50** can be taken. However, EIA needs to be conducted to further study impact relating to resettlement, land title, economic activities, traffic volume, public health condition, air pollution, and noise and vibration.

Table L-50 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	<ul style="list-style-type: none"> • Appropriate land acquisition with proper means and compensation • Properly development of of Resettlement Action Plan (RAP)
2. Traffic and Public Facilities	<ul style="list-style-type: none"> • Proper traffic management and control • Time arrangement for construction
3. Split of Communities	<ul style="list-style-type: none"> • Planning with minimum impact on existing community zone
4. Water Rights and Rights of Common	<ul style="list-style-type: none"> • Graps of accurate situation of the land title in the project site
5. Waste	<ul style="list-style-type: none"> • Appropriate construction waste management/disposal
6. Soil Erosion	<ul style="list-style-type: none"> • Using proper compacting methodology and machineries
7. Coastal Zone	<ul style="list-style-type: none"> • Proper measures for land preparation in the coastal zone
8. Fauna and Flora	<ul style="list-style-type: none"> • Careful route selection • Proper measures for land preparation
9. Air pollution	<ul style="list-style-type: none"> • Proper covering of construction material • Periodic sprinkle of water in the project site
10. Soil Contamination	<ul style="list-style-type: none"> • Roadbed maintenance without herbicides
11. Noise and vibration	<ul style="list-style-type: none"> • Assure the construction equipment in good condition to minimize noise and vibration • Appropriate construction schedule/planning/management
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Set up of traffic signs
2. Noise and Vibration	<ul style="list-style-type: none"> • Installation of acoustic wall or buffer zones if necessary

L.6.8 J-5 New Phnom Penh Port Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 10 items. The results of the scoping are shown in the following **Table L-51**.

Table L-51 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	B	B					
2 Economic Activities							
3 Traffic and Public Facilities	B		B				C
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common	C	C					
7 Public Health Condition							
8 Waste	B		B				C
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion	C		C				
12 Groundwater							
13 Hydrological Situation	C	C					
14 Coastal Zone							
15 Fauna and Flora	B	B			C		
16 Meteorology							
17 Landscape							
18 Air Pollution	C		C				
19 Water Pollution	C		C		B		
20 Soil Contamination							
21 Noise and Vibration	B		B		C		
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-52** can be taken. However, EIA needs to be conducted to further study impact relating to resettlement, land title, hydrological situation, fauna and flora, and water pollution.

Table L-52 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	<ul style="list-style-type: none"> • Appropriate land acquisition with proper means and compensation • Properly development of of Resettlement Action Plan (RAP)
2. Traffic and Public Facilities	<ul style="list-style-type: none"> • Proper traffic management and control • Time arrangement for construction
3. Water Rights and Rights of Common	<ul style="list-style-type: none"> • Graps of accurete situation of the land title in the project site
4. Waste	<ul style="list-style-type: none"> • Establishment of appropriate construction waste management/disposal system
5. Soil Erosion	<ul style="list-style-type: none"> • Using proper compacting methodology and machineries
6. Fauna and Flora	<ul style="list-style-type: none"> • Proper measures for land reclamaion/preparation
7. Air pollution	<ul style="list-style-type: none"> • Proper covering of construction material • Periodic sprinkle of water in the project site
8. Water Pollution	<ul style="list-style-type: none"> • Proper measures for land preparation
9. Noise and vibration	<ul style="list-style-type: none"> • Assure the construction equipment in good condition to minimize noise and vibration • Appropriate construction schedule/planning/management
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Set up of traffic signs • Appropriate traffic control
2. Waste	<ul style="list-style-type: none"> • Establishment of appropriate waste management/disposal system
3. Noise and Vibration	<ul style="list-style-type: none"> • Installation of acoustic wall or buffer zones if necessary

L.6.9 J-6 Phnom Penh Urban Transportation Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 12 items. The results of the scoping are shown in the following **Table L-53**.

Table L-53 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (Includes Pre-construction Phase)			After Operation		
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	B	B					
2 Economic Activities	C	C		C			
3 Traffic and Public Facilities	B		B				C
4 Split of Communities	C	C					
5 Cultural Property							
6 Water Rights and Rights of Common	C	C					
7 Public Health Condition	C		C		C		
8 Waste	C		C				
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion	C		C				
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone							
15 Fauna and Flora	C		C				
16 Meteorology							
17 Landscape							
18 Air Pollution	C		C				
19 Water Pollution							
20 Soil Contamination	C		C				
21 Noise and Vibration	B		B				C
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-54** can be taken. However, EIA needs to be conducted to further study impact relating to resettlement, land title, economic activities, traffic volume, public health condition, air pollution, and noise and vibration.

Table L-54 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	<ul style="list-style-type: none"> • Appropriate land acquisition with proper means and compensation • Properly development of of Resettlement Action Plan (RAP)
2. Traffic and Public Facilities	<ul style="list-style-type: none"> • Proper traffic management and control • Time arrangement for construction
3. Split of Communities	<ul style="list-style-type: none"> • Planning with minimum impact on existing community zone
4. Water Rights and Rights of Common	<ul style="list-style-type: none"> • Graps of accurate situation of the land title in the project site
5. Waste	<ul style="list-style-type: none"> • Appropriate construction waste management/disposal
6. Soil Erosion	<ul style="list-style-type: none"> • Using proper compacting methodology and machineries
7. Fauna and Flora	<ul style="list-style-type: none"> • Careful route selection • Proper measures for land preparation
8. Air pollution	<ul style="list-style-type: none"> • Proper covering of construction material • Periodic sprinkle of water in the project site
9. Soil Contamination	<ul style="list-style-type: none"> • Roadbed maintenance without herbicides
10. Noise and vibration	<ul style="list-style-type: none"> • Assure the construction equipment in good condition to minimize noise and vibration • Appropriate construction schedule/planning/management
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Set up of traffic signs
2. Noise and Vibration	<ul style="list-style-type: none"> • Installation of acoustic wall or buffer zones if necessary

L.6.10 J-7 Kampot Urban Transportation Project

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 12 items. The results of the scoping are shown in the following **Table L-55**.

Table L-55 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (Under the Construction Phase)			After Operation		
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	B	B					
2 Economic Activities	C	C		C			
3 Traffic and Public Facilities	B		B				C
4 Split of Communities	C	C					
5 Cultural Property							
6 Water Rights and Rights of Common	C	C					
7 Public Health Condition	C		C		C		
8 Waste	C		C				
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion	C		C				
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone							
15 Fauna and Flora	C		C				
16 Meteorology							
17 Landscape							
18 Air Pollution	C		C				
19 Water Pollution							
20 Soil Contamination	C		C				
21 Noise and Vibration	B		B				C
22 Land Subsidence							
23 Offensive Odor							

Note: Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-56** can be taken. However, EIA needs to be conducted to further study impact relating to resettlement, land title, economic activities, traffic volume, public health condition, air pollution, and noise and vibration.

Table L-56 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	<ul style="list-style-type: none"> • Appropriate land acquisition with proper means and compensation • Properly development of of Resettlement Action Plan (RAP)
2. Traffic and Public Facilities	<ul style="list-style-type: none"> • Proper traffic management and control • Time arrangement for construction
3. Split of Communities	<ul style="list-style-type: none"> • Planning with minimum impact on existing community zone
4. Water Rights and Rights of Common	<ul style="list-style-type: none"> • Graps of accurate situation of the land title in the project site
5. Waste	<ul style="list-style-type: none"> • Appropriate construction waste management/disposal
6. Soil Erosion	<ul style="list-style-type: none"> • Using proper compacting methodology and machineries
7. Coastal Zone	<ul style="list-style-type: none"> • Proper measures for land preparation in the coastal zone
8. Fauna and Flora	<ul style="list-style-type: none"> • Careful route selection • Proper measures for land preparation
9. Air pollution	<ul style="list-style-type: none"> • Proper covering of construction material • Periodic sprinkle of water in the project site
10. Soil Contamination	<ul style="list-style-type: none"> • Roadbed maintenance without herbicides
11. Noise and vibration	<ul style="list-style-type: none"> • Assure the construction equipment in good condition to minimize noise and vibration • Appropriate construction schedule/planning/management
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Set up of traffic signs
2. Noise and Vibration	<ul style="list-style-type: none"> • Installation of acoustic wall or buffer zones if necessary

L.6.11 K-4 Improvement of Urban Water Supply

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 12 items. The results of the scoping are shown in the following **Table L-57**.

Table L-57 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	B	B					
2 Economic Activities							
3 Traffic and Public Facilities	B		B			C	
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common	C	C		C			
7 Public Health Condition							
8 Waste							
9 Hazards (Risk)							
10 Topography and Geology	C	C					
11 Soil Erosion	C	C				C	
12 Groundwater	B		C			B	
13 Hydrological Situation	B	B		C		B	
14 Coastal Zone							
15 Fauna and Flora	A	A				B	
16 Meteorology							
17 Landscape	A	A		B			
18 Air Pollution	C		C				
19 Water Pollution	B	B				B	
20 Soil Contamination							
21 Noise and Vibration	C		C				
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by three sub-project in Takhau, Chbar Mon and Kampong Bay Town could be minimized if the mitigation measures mentioned in **Table L-58** can be taken. Therefore, EIA does not need to be conducted for these sub projects. However, the proposed reservoir construction project at Teuk Sap River in Sihanoukville is anticipated to cause some negative impact on the surrounding environment and the degrees of impacts on some of environmental items are not clear at this stage. Therefore, EIA needs to be conducted for the items shown in **Table L-59** to further study and make clear some of anticipated impact.

Table L-58 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	<ul style="list-style-type: none"> • Appropriate land acquisition with proper means and compensation • Properly development of of Resettlement Action Plan (RAP)
2. Traffic and Public Facilities	<ul style="list-style-type: none"> • Appropriate traffic management and control • Set up of traffic signs at construction site, access roads and intake structure • Time arrangement for construction
3. Topography and Geology	<ul style="list-style-type: none"> • Appropriate site selection at the planning stage
4. Soil Erosion	<ul style="list-style-type: none"> • Using proper compacting methodology and machineries • Appropriate sheeting of the construction site
5. Hydrological Situation	<ul style="list-style-type: none"> • Back-filling of trench with appropriate quality of soil
6. Fauna and Flora	<ul style="list-style-type: none"> • Utilization of fine screen materials to confine silt and sludge
7. Landscape	<ul style="list-style-type: none"> • Appropriate measures to prevent loss of aesthetic value
8. Air pollution	<ul style="list-style-type: none"> • Proper maintenance and covering of construction material • Sprinkle of roads in project affected area
9. Water Pollution	<ul style="list-style-type: none"> • Appropriate treatment of backwashing water • Utilization of fine screen materials to confine silt and sludge
10. Noise and vibration	<ul style="list-style-type: none"> • Appropriate construction schedule/planning/management • Installation of acoustic wall or buffer zones if necessary
B. After Operation	
1. Traffic and Public Facilities	<ul style="list-style-type: none"> • Placement of buoys on up and down stream of intake structure • Setting up of light at night time for safety navigation
2. Soil Erosion	<ul style="list-style-type: none"> • Bank protection measures, such as rock embankment and tree planting
3. Landscape	<ul style="list-style-type: none"> • Decorating/gardening of river bank
4. Water Pollution	<ul style="list-style-type: none"> • Establishment of leaking oil collection system • Appropriate maintenance of intake pump • Establishment of retention/sedimentation basin for wastewater from treatment plant

Table L-59 Environmental items for EIA

Phase	Category	Items
Construction Phase	Social Environment	Resettlement
		Water Rights and Rights of Common
	Natural Environment	Topography & Geology
		Groundwater
		Hydrological Situation
		Fauna and Flora
After Operation	Natural Environment	Groundwater
		Hydrological Situation
		Fauna and Flora

L.6.12 K-5 Rehabilitation of Irrigation Schemes

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 9 items. The results of the scoping are shown in the following **Table L-60**.

Table L-60 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase <small>(include pre-construction Phase)</small>		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement							
2 Economic Activities							
3 Traffic and Public Facilities	C		C				
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common							
7 Public Health Condition							
8 Waste	C		C				
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion	B	B					
12 Groundwater	C					C	
13 Hydrological Situation	B					B	
14 Coastal Zone							
15 Fauna and Flora	C		C			C	
16 Meteorology							
17 Landscape							
18 Air Pollution	C		C				
19 Water Pollution	B		B			B	
20 Soil Contamination							
21 Noise and Vibration	C		C				
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that no serious impact is anticipated, and the negative impacts will be mitigated with basic countermeasures shown in **Table L-61**. Therefore, EIA does not need to be required.

Table L-61 Summary of Impact Mitigation Measures

Environmental Items	Mitigation measures
A. Pre-Construction and Construction phase	
1. Traffic and Public Facilities	• Appropriate traffic management and control
2. Waste	• Appropriate construction waste management/disposal
3. Soil Erosion	• Appropriate design of canal embankment suitable for soil type • Construction work need to be done in dry season as much as possible
4. Air pollution	• Proper maintenance and covering of construction material • Sprinkle of roads in project affected area
5. Water Pollution	• Appropriate management/disposal of liquid waste
6. Noise and vibration	• Appropriate construction schedule/planning/management • Installation of acoustic wall or buffer zones if necessary
B. After Operation	
1. Groundwater	• Training of relevant personnel regarding appropriate utilization of chemical fertilizer, pesticide and herbicide
2. Hydrological Situation	• Appropriate intake of irrigation water
3. Water Pollution	• Training of relevant personnel regarding appropriate utilization of chemical fertilizer, pesticide and herbicide

L.6.13 L-5 220kV Transmission Line between Sihanoukville and Kampot

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 7 items. The results of the scoping are shown in the following **Table L-62**.

Table L-62 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase <small>(include pre-construction phase)</small>		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement	C	C					
2 Economic Activities							
3 Traffic and Public Facilities	C		C				
4 Split of Communities							
5 Cultural Property	C	C					
6 Water Rights and Rights of Common							
7 Public Health Condition	C					C	
8 Waste							
9 Hazards (Risk)	B					B	
10 Topography and Geology							
11 Soil Erosion							
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone							
15 Fauna and Flora							
16 Meteorology							
17 Landscape	C					C	
18 Air Pollution							
19 Water Pollution							
20 Soil Contamination							
21 Noise and Vibration	B		B				
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the negative impacts will be avoided or mitigated if the environmental mitigation measures described in **Table L-63** are taken. EIA needs to be conducted to study the possibility of resettlement and the impact of high voltage cables on public.

Table L-63 Summary of Impact Mitigation Measures

Activities/Considerations	Mitigation measures
A. Pre-Construction and Construction phase	
1. Traffic and Public Facilities	• Appropriate traffic control should be taken during construction phase
2. Cultural Property	• Assure that the project site is not in/cross the Wat or shrine compound at the planning stage.
3. Landscape	• Take into account the impact on landscape at the planning stage.
4. Noise and Vibration	• Installation of acoustic wall or buffer zones if necessary
B. Operation and After operation	
1. Public Health Condition	• Prohibition of settlement near the transmission line
2. Hazards (Risk)	• Appropriate notice should be put up near the substation and relevant facilities to prevent hazards on public

L.6.14 Project for Construction of New Power Plant and Extension of Distribution Network in Sihanoukville

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 10 items. The results of the scoping are shown in the following **Table L-64**.

Table L-64 Matrix for Scoping

Activities which may cause impacts		Overall Evaluation	Construction Phase (Includes pre-construction Phase)		After Operation			
			Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items								
1	Resettlement	B	B					
2	Economic Activities							
3	Traffic and Public Facilities	C		C				
4	Split of Communities							
5	Cultural Property							
6	Water Rights and Rights of Common	C		C				
7	Public Health Condition	C					C	
8	Waste	C		C				
9	Hazards (Risk)	B					B	
10	Topography and Geology							
11	Soil Erosion							
12	Groundwater							
13	Hydrological Situation							
14	Coastal Zone							
15	Fauna and Flora	C		C				
16	Meteorology							
17	Landscape							
18	Air Pollution	C		C			B	
19	Water Pollution	C					C	
20	Soil Contamination							
21	Noise and Vibration	C		B			C	
22	Land Subsidence							
23	Offensive Odor							

Note: Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that some adverse impacts are likely to occur during construction phase and after operation. Most of the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-65** can be taken. However, EIA needs to be conducted to study impacts of emission gas and noise/vibration on the nearby school. If it is judged by the EIA that the mitigation measures are not enough to prevent impact on the school after the operation, additional measures need to be taken.

Table L-65 Summary of Impact Mitigation Measures

Activities/Considerations	Mitigation measures
A. Pre-Construction and Construction phase	
1. Resettlement	• Fulfillment of the existing resettlement plan by the PAS
2. Traffic and Public Facilities	• Appropriate Traffic Control • Time arrangement for construction of power plant and installation of distribution line.
3. Waste	• Appropriate construction waste management/disposal
4. Air pollution	• Properly covering of construction material • Sprinkle of roads in project affected area
5. Noise and vibration	• Appropriate construction schedule/planning/management considering the impact on the school located near the project site • Installation of acoustic wall or buffer zones if necessary
B. Operation and After operation	
1. Public Health Condition	• Appropriate supervision on air pollution control • Installation of pollution prevention equipment if necessary
2. Air pollution	• Appropriate supervision on air pollution control • Installation of pollution prevention equipment if necessary
3. Water Pollution	• Appropriate measure for chlorination of the cooling water

L.6.15 L-8 Project for Capacity Extension 10 MW of EdC C5 Power Plant

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 4 items. The results of the scoping are shown in the following **Table L-66**.

Table L-66 Matrix for Scoping

Activities which may cause impacts	Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation			
		Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities	Accumulation of People and Goods
Environmental Items							
1 Resettlement							
2 Economic Activities							
3 Traffic and Public Facilities							
4 Split of Communities							
5 Cultural Property							
6 Water Rights and Rights of Common							
7 Public Health Condition	C					C	
8 Waste							
9 Hazards (Risk)							
10 Topography and Geology							
11 Soil Erosion							
12 Groundwater							
13 Hydrological Situation							
14 Coastal Zone							
15 Fauna and Flora							
16 Meteorology							
17 Landscape							
18 Air Pollution	B					B	
19 Water Pollution	C					C	
20 Soil Contamination							
21 Noise and Vibration	C					C	
22 Land Subsidence							
23 Offensive Odor							

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that a few adverse impacts are likely to occur after operation. All the anticipated negative impact caused by the project could be minimized if the mitigation measures mentioned in **Table L-67** can be taken. However, EIA needs to be conducted to study impacts of emission gas increase (SO₂) on the public because concentration of SO₂ has been relatively high in the surrounding area of the existing power plant.

Table L-67 Summary of Impact Mitigation Measures

Activities/Considerations	Mitigation measures
B. Operation and After operation	
1. Public Health Condition	<ul style="list-style-type: none"> • Appropriate supervision on air pollution control • Installation of pollution prevention equipment if necessary
2. Air pollution	<ul style="list-style-type: none"> • Appropriate supervision on air pollution control • Installation of pollution prevention equipment if necessary
3. Water Pollution	<ul style="list-style-type: none"> • Appropriate measure for chlorination of the cooling water
4. Noise and Vibration	<ul style="list-style-type: none"> • Implementation of noise reduction measures if necessary

L.6.16 M-2 Development of Optical Fiber Cable Network between Phnom Penh and Sihanoukville

The screening and scoping of environmental items, which will potentially receive impact by the project, were carried out, and it is concluded that IEE is required for 8 items. The results of the scoping are shown in the following **Table L-68**.

Table L-68 Matrix for Scoping

Activities which may cause impacts		Overall Evaluation	Construction Phase (include pre-construction Phase)		After Operation		
			Reclamation and Spatial Occupancy	Operation of Construction Equipment and Vehicles	Spatial Occupancy	Operation of Vehicles, Ships and Airplanes	Operation and Maintenance of Associated Facilities
Environmental Items							
1	Resettlement						
2	Economic Activities						
3	Traffic and Public Facilities	B		B			
4	Split of Communities						
5	Cultural Property						
6	Water Rights and Rights of Common						
7	Public Health Condition						
8	Waste						
9	Hazards (Risk)						
10	Topography and Geology						
11	Soil Erosion						
12	Groundwater						
13	Hydrological Situation						
14	Coastal Zone						
15	Fauna and Flora						
16	Meteorology						
17	Landscape						
18	Air Pollution						
19	Water Pollution						
20	Soil Contamination						
21	Noise and Vibration	C		C			
22	Land Subsidence						
23	Offensive Odor						

Note : Evaluation categories:

A: Serious negative impact is expected

B: Some negative impact is expected

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.).

No Mark: The environmental items requiring no impact assessment since the anticipated impacts are, in general, not significant.

The results of IEE indicate that no serious impact is anticipated, and the negative impacts will be mitigated with basic countermeasures shown. Therefore, EIA does not need to be required.

Table L-69 Environmental Laws and Regulation in Cambodia

Laws and Relevant Regulation	Authority
Constitution	
Royal Decree on Protected Area	
Environmental Law	Ministry of Environment
Sub-decree on the Organization and Functions of the Ministry of Environment	Ministry of Environment
Sub-decree on Water Pollution Control Ministry of Environment	Ministry of Environment
Sub-decree on Solid Waste Management	Ministry of Environment
Sub-decree on Environmental Impact Assessment	Ministry of Environment
Royal Decree on Tonlo Sap Biosphere Reserve	Ministry of Environment
Sub-decree on Air and Noise Pollution Control	Ministry of Environment
Sub-decree on Protected Areas	Ministry of Environment
Fishery Law	
Logging Ban	
Water Law	Ministry of Water Resources and Meteorology

Source: JICA Country Profile on Environment