

I.3.3 Sewerage, Sanitation and Urban Drainage

There is large difference in the level of sanitary facilities in Phnom Penh City and in other rural areas, especially in rural area. In the Phnom Penh City, 59.7% of total houses are quipped with a water-tight toilet, while in the other area the share is 19.6% in other urban areas and only 1.2% in rural areas (see **Table I.3.14**). A large share at 88.3% of houses in rural areas has no toilet facilities in the house.

Table I.3.14 Sanitary Facilities in Cambodia

Type of Sanitary	Nation	Phnom Penh	Other Urban	Rural
Covered pit latrine	3.8%	7.8%	7.4%	2.2%
Non-covered pit latrine	4.8%	6.2%	10.1%	4.0%
Water-tight toilet	6.8%	59.7%	19.6%	1.2%
Others	4.5%	4.2%	9.6%	4.2%
No toilet	80.0%	22.0%	53.3%	88.3%

Source: Socio-Economic Survey of Cambodia 1993/94, National Institute of Statistics, UNDP-ADB.

Toilet facilities within the premises are available to only a small proportion of households in the country. Among the provinces the percentage of households with this facility varied from about 4% in Kampong Speu to about 75% in Phnom Penh followed by Krong Preah Sihanouk, Koh Kong and Kandal.

Table I.3.15 Households with Toilet Facility within Premises (1998)

Province	HH have Toilet (%)
Phnom Penh	74.9
Kandal	12.3
Takao	4.3
Kampong Spueu	3.9
Kampot	8.0
Kaoh Kong	14.7
Krong Sihanouk	25.2

Source : Statistical Yearbook, 2001

Only four (4) cities, which are Phnom Penh, Kampong Speu, Kampot and Sihanoukville, have drainage/sewerage system at present in the Study area. Conditions of the sewerage in these cities are summarized below⁹.

1) *Phnom Penh*

Existing sewerage facilities in the Municipality of Phnom Penh are only the combined system (rainwater + wastewater) sewer pipe constructed from 1960s. There is no separated sewer system or a sewerage treatment plant at present, and natural lakes and swamps only stabilize wastewater.

The combined system sewer has no sufficient capacity, and local inundation accordingly occurs in many locations of the city especially along road. During rainy season, rainwater together with overflowed wastewater stagnates along lower roads and thus the water environment of the city is quite bad.

Wastewater of larger scale hotels of public facilities are treated by individual septic tanks and overflow effluent is discharged to the combined system sewer, open channels or neighboring water bodies. At individual house, only human excreta are treated by individual septic tank, while other domestic wastewater is directly

⁹ Source: Preliminary Study on Sewerage & Urban Drainage Improvement in Cambodia, Ministry of Construction-Japan, Infrastructure Development Institute-Japan, December 1999.

discharged to sewers, etc. There is a report that many of the factories discharge wastewater without any treatment. An adverse effect of heavy metals and toxic to the human bodies are worried in the city.

Wastewater of the municipality is thus discharged, some without treatment and the others with treatment by septic tanks, to water areas inside or outside of the city area. Although some natural oxidation effect can be expected in these water areas, it is not sufficient and pollution in the water area is in progress. It will be a serious environmental problem in the future no measures are taken.

Water supply facilities in the Municipality of Phnom Penh is being improved through the assistance from the World Bank, ADB, and Japan's Grant. After completion of all these projects, water supply capacity in Phnom Penh City reaches to 235,000 m³/day by the end of year 2003. Existing distribution pipes total at 425 km for 520,000 beneficiaries are scheduled to be extended to 733 km by the end of year 2003.

Necessity of the sewerage treatment systems is increasing with the increase of water supply capacity in the Phnom Penh City. Urgent implementation of necessary measure is now requested.

2) *Kampong Speu*

Drainage and sewerage facilities are not enough to drain to local rainfall and often cause inundation. Existing drainage facilities in the city are drainage pipe of total length of 500 m laid around the market and a 300 m-long open channel connecting the drainage pipe to a nearby river. The drainage from the market area is related to river without any treatment and thus water pollution is becoming a problem in the area. Inundation condition is becoming worse due to the low capacity of these existing facilities and due to the absence of drainage and sewerage facilities in the residential areas extending outside.

3) *Kampt*

Kampt City is located on coastal zone of south-west of Cambodia, 148 km from Phnom Penh and is accessible though national road No.3 and by the railway connecting Phnom Penh to Sihanoukville.

The drainage and sewerage system is very poor. Existing sewerage facilities in the Kampt are only the combined system drainage pipe. There is no sewerage treatment plant and the wastewater drained to Kampt River directly at present. The drainage pipes covered almost all main town, however, the combined system sewer has no sufficient capacity.

In the area of sounding of the Kamot market, combined system sewer pipes were rehabilitated by Social Fund of Government in 2000. There is a plan to construct of sewerage treatment plant with area of 200 x 200 m at the Ta Eng village in the Kamot City, but there is no concrete movement of survey and construction.

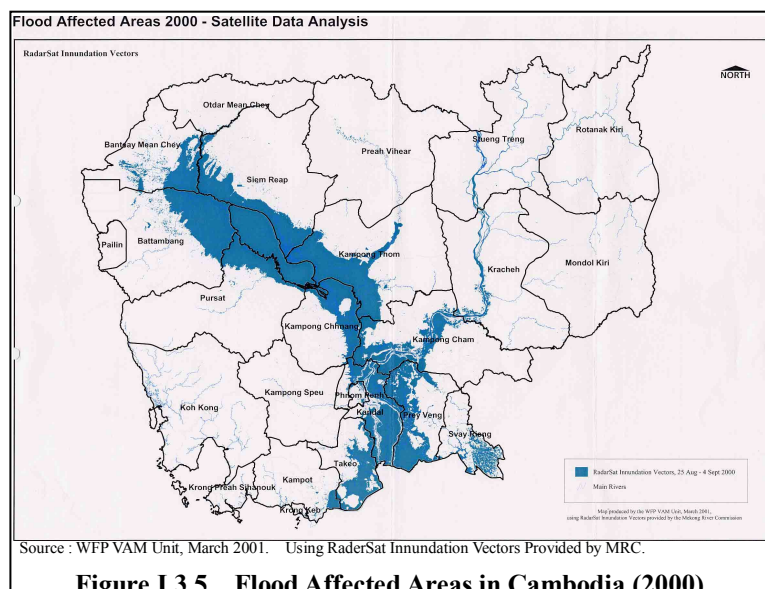
4) Sihanoukville

Sihanoukville City has a good port and beach, and is recently developing much. A combined system sewerage network with a total pipe length of 300 m, which was constructed under the role of French, has no sufficient capacity to drain storm water and domestic water due to progressing urbanization. During the rainy season, water sometimes overflow spilling sewage into the streets and around houses, destroy pavement of the road surface, and thus water environment is deteriorated. Destroying of sewerage pipes by illegal housing is recently another problem. Human excreta remain in septic tanks of pit latrines, since the city has no vacuum tracks or treatment system of the sludge. ADB proposes construction of oxidation pond of a total area of 12 ha in the downstream end of the drainage channel with a capacity of 5,700 m³/day for the drain from 3,300 households. The project will be started in 2003.

I.3.4 Flood Control

The flooding in Cambodia in year 2000 was reported as the worst in the more than 70 years. The official report compiled by the National Committee for Disaster Management (NCDM) on 16 November 2000, put the death toll at 347 (80% of whom were children). Of the 750,000 families (3,448,629 individuals) affected by flooding, about 85,000 families (387,000 individuals) has to be temporarily evacuated. Furthermore, 317,975 houses were "damaged", while 7,068 were "destroyed". Based on this NCDM report, the Council of Ministers estimates total physical and direct damage at US\$ 150 million. The inundated area of flood of 2000 is shown in the **Figure I.3.5**.

The flood of 2000 was more serious than previous recorded in Cambodia, when severe flooding in the area occurred in 1961, 1966, 1978, 1984, 1991, and 1996. There is also serious concern that rural to urban migration, changes in land use, environmental degradation and the increasing frequency of extreme climate event called "La Niña" (cold episode) will results to worsening and more frequent damaging floods in Cambodia.¹⁰



¹⁰ Source : National Committee for Disaster Management, Council of Ministers, May 2001.

Present conditions, constraints and necessary consideration for future development for flood control and drainage improvement in the major cities in the Study Area are presented hereunder.

1) Phnom Penh

Major area of the Municipality of Phnom Penh is bordered in the east end by the Sap - Mekong - Bassac River system and surrounded by road cum outer ring dikes in the north, west and south. There are a total of nine (9) drainage pumping stations to drain water in the dike outside.

Major drainage open channels in the City Core are Trabek, Toul Sen and Salang channels. These channels are in many parts clogged with debris and sediments. As a result, the flow capacities are remarkably restricted. The channels have been, from time to time, cleaned up by Department of Public Works and Transport (DPWT) using their own equipment and by subcontracting with local firms, however, the problems have not greatly been solved. It is reported that the clogging ration is 70 to 80% of the original flow areas.

Combined system sewer network had been constructed until the end of 1960s with city development. The sewer are mainly circle-shaped concrete pipes ranging 300 to 1,500 mm in diameter and the longitude gradients range from 1.500 to 1/2,000. The pipes are buried with coverings of 0.5 to 3 m, on one side in narrow to medium streets and on both sides in wide streets. A greater part of sewer pipes are choked with sediment and solid waste generated mainly by inhabitants neighboring. The choke rate is reported as 50 to 90% of their original flow capacities. Along the riverfront of Sap and Bassac rivers, sewer out-falls are found at 17 locations. Some are completerly broken and the others are clogged with sediment and wastes.

In the Municipality of Phnom Penh, part by part drainage improvement projects have been implemented by assistance of ADB, City of Paris, etc. A master plan for the entire municipality area has firstly been established by JICA¹¹ for the target year 2010, with the design scale of 5-year return period for the trunk facilities and 2-year for the minor facilities.

From the proposed drainage improvement component projects, Tompun Watershed Drainage Improvement Project has been selected for a priority project and a feasibility study has been conducted. Implementation of priority projects by Japan's Grant is presently expected.

2) Takhmao (Kandal Province)

Takhmao City is located on the right bank of the Chrouy River, a tributary of Tonle Bassac in the Kandal Province. Flooding from the Chrouy River occurs in the north-west and south-west areas of the city with inundation depth of 50 cm to 3 m and inundation period of maximum 3 months. The drainage and sewerage system is very

¹¹ The Study on Drainage Improvement and Flood Control in the Municipality of Phnom Penh, JICA, Aug. 1999.

poor and it causes inundation by local rainfall every year. Inundated water is sometimes drained by movable pump to nearby areas where another inundation occurs. Water in the drainage channel is heavily deteriorated due to the discharge of domestic wastewater.

These flooding, inundation and deteriorated water environment are the constraints that hinder the development of the town. Takhmao City is located in the proposed oyster ring road of the capital city, Phnom Penh, and accordingly infrastructure development is an important issue.

3) *Kampng Speu*

Kampong Speu is located on the banks of Prek Thnot with a catchment area of 5,200 km², and flooding water from Prek Thnot often inundates the city area and cause serious damages. Flow of the Prek Thnot often rise by a long spell of rains by the influence of typhoon as large floods happened in 1991, 1993, 1994, 2000. During the 1991 flood, inundation depth was 1 to 1.5 m in lower area of city. No measures have been taken against flooding.

Drainage and sewerage facilities are not enough to drain to local rainfall and often cause inundation. Existing drainage facilities in the city are drainage pipe of total length of 500 m laid around the market and a 300 m-long open channel connecting the drainage pipe to a nearby river. Inundation condition is becoming worse due to the low capacity of these existing facilities and due to the absence of drainage and sewerage facilities in the residential areas extending outside.

The city located at 50 km west of Phnom Penh City and thus expected to develop rapidly as a satellite city of the capital city. Development of basic infrastructure is thus indispensable, and establishment of a master plan for flood protection for the Prek Thnot River and drainage/sewerage improvement is urgent. Flood protection plan for the Prek Thnot River shall mainly by the construction of dikes along the river, but flood control effect of a dam proposed in the upstream should be taken into consideration. Drainage and sewerage plan should be established taking into account the future development of the city.

4) *Sihanoukville*

Sihanoukville City has a good port and beach, and is recently developing much. A combined system sewerage network with a total pipe length of 300 m, which was constructed under the role of French, has no sufficient capacity to drain storm water and domestic water due to progressing urbanization. During the rainy season, water sometimes overflow spilling sewage into the streets and around houses, destroy pavement of the road surface, and thus water environment is deteriorated. Destroying of sewerage pipes by illegal housing is recently another problem.

I.3.5 Hydropower

In spite of her 15,000 MW hydro-power potential, out of which only 1.0 MW at the

Rattanakiri station and 12 MW (installed capacity) at the Kirirom station¹² are generated at present as shown in the **Figure** below.

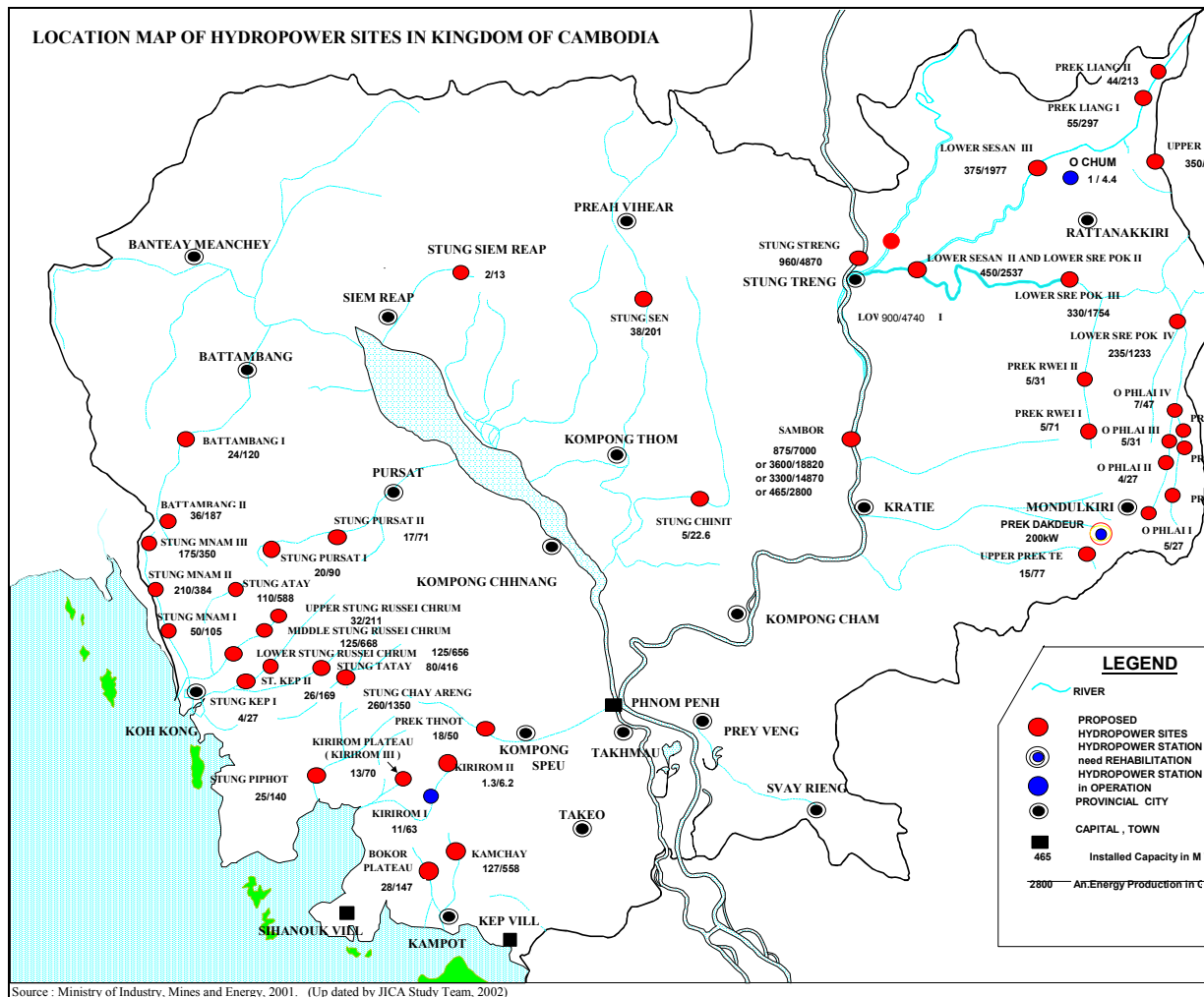


Figure I.3.6 Location Map of Hydropower Project Sites in Cambodia

I.4 ISSUES ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT

I.4.1 Structure of Problems in Water Resources Management

(1) The Legal Basis

The Constitution (Article 58) vests water ownership in the State, and (Article 59) assigns to the State the task of planning the management of water resources. It states that “*the control, use and management of State properties shall be determined by law*”, and therefore provides the basis for water law. Several laws and sub-decrees have relevance to water resources management are summarized in **Table I.4.1**.

¹² Source : JICA Study Team. Rehabilitation works of the Kirirom Power Station and Dam by "CETIC International Hydropower Development Co., Ltd.", and new construction of transmission line (115 kV) by EDC (completed in May 2002).

Table I.4.1 The Legal Basis for Water Resources Management.

Laws and Sub-Decrees	Date	Responsible Agency
Law on Water Resources Management in Cambodia	draft, 2001	Ministry of Water Resources and Meteorology (MOWRAM)
Law on Environmental Protection and Natural Resources Management	1996	Ministry of Environment
Law on Fisheries Management and Administration	1987	Ministry of Agriculture, Fisheries and Forests
Law on Land	1992	Ministry of Planning
Sub-decree on Water Pollution Control	6 April 1999	Ministry of Environment
Sub-decree on organizing and functioning of the MOWRAM	6 May 1999	MOWRAM

Source : MOWRAM

The *Law on Environmental Protection and Natural Resources Management* provides that natural resources (including water) “shall be preserved, developed and managed to use in a rational and sustainable manner”. It has provisions that relate to environmental impact assessment, natural resources (including water) management, environmental monitoring, and pollution. In implementing the Law, the Ministry of Environment (MOE) is required to work in consultation with other relevant ministries. The Sub-decree (6 April 1999) on *Water Pollution Control* assigns control of pollutant sources to the MOE; Annexes list dangerous substances, set general effluent standards, list activities subject to licensing, set ambient quality standards, and set quality standards for public water supply sources.

The *Law on Land* (1992), Article 5, states the principle of State ownership of land, by which rivers and lakes may not be privately owned. Articles 113-140, dealing with easements, regulate the relationship between upstream and downstream land with regard to natural water flow, and the establishment of easements for the purpose of irrigating or draining land.

The *Law on Fisheries Management and Administration* (1987) regulates fishing and aquaculture in inland waters. It is being reviewed and revised, with a view to stimulating investment in the fisheries sector and providing better protection of the fishery.

Prime Minister’s Circular No. 01 SR (11 January 1999) on the *Implementation Policy of Sustainable Irrigation Systems*, contains model statutes for Farmer Water user Communities, and provisions on the assessment and collection of irrigation fees.

A *Law on Water Resources Management in Cambodia* has just been drafted by the MOWRAM, and was submitted by the Minister in March 2001 to the Council of Ministers for review and approval. The draft Law includes chapters on Water resources inventory and planning, Water resources use and development, Groundwater, Protection of water resources, Flood control, Servitudes (rights and obligations), Incentives and penalties, and International rivers.

(2) The Institutional Base

To reverse the effects of three decades of social disorder, the basic framework for good governance and the rule of law is being developed, with extensive assistance from international organisations. There are at present major gaps in the legal framework relating to governance, administration, investment, and property rights, and there is a high level of public mistrust of the law and the civil and military authorities. Recent

evaluations of political and governmental circumstances in Cambodia by international organisations identify many areas in which action is required, to provide all citizens equal access to the law and to basic human rights. Nevertheless, rapid progress is being made; for example, civil, criminal and commercial codes have been prepared, a Labour Law was enacted in 1997, and key legislation relating to water resources, land and forestry are being considered. The Royal Government's Socio-Economic Development Requirements and Proposals includes three (of seven) key actions that would directly reinforce democracy and the rule of law in Cambodia.

Several The Royal Government of the Cambodia (RGC) institutions have responsibilities in the water sector (**Table I.4.2**). The principal vehicles for inter-agency co-operation are the Cambodian National Mekong Committee (CNMC), the Ministry of Economy and Finance, and the Council for the Development of Cambodia. In practice, it appears that there is limited inter-agency coordination at national level, either in planning or operational matters. Arrangements for exchanging information are rather hierarchical and controlled, so that many staff may not have easy access to information from other agencies that would assist them in their duties. As a result, ministries and their constituent departments often may act largely in isolation from others, even where their responsibilities are closely related. On the other hand, because the corps of senior, skilled administrators is small, there is an extensive informal network of contacts, which assists in information exchange and gathering.

At provincial level, operational activity is focused through Provincial governors, who are responsible to the Minister of the Interior. Provincial departments receive their budget allocations from their parent ministries, and in principle receive technical support from and report to them. However, in practice, linkages to national parent ministries appear to be weaker than within the provinces. Coordination among ministry/departmental staff at provincial level may be stronger than at national level, because of more immediate oversight by governors. Coordination is particularly strong in the context of project implementation at Provincial and more local levels, e.g. of projects like PRASAC. Provincial Rural Development Committees also provide a coordinating mechanism, at provincial level.

(3) Institutional Issues

Institutional issues relate to water resources management are described in the "National Water Resources Strategy" (MOWRAM, 2001) as follows:

The existing policies and strategies are merely sectoral, and there are no mechanisms for coordination. Likewise, the water-related legislation in force takes into consideration sectoral aspects of water resources management, mainly relating to the functions of sectoral institutions. Important aspects, such as those relating to the use of water resources, are not regulated.

A further issue relates to inter-agency coordination and is very important, as weaknesses in this respect might lead to misunderstandings, duplication of functions/

powers and, consequently, to a non-optimal use of human and financial resources. As regards, in particular, the collection, processing and analysis of data and information on water resources, water resources policy-making and water resources planning. Institutional coordination facilitates the sustainable management and development of water resources.

Before 1999, year of creation of the Ministry of Water Resources and Meteorology (MOWRAM), water management functions were scattered among various ministries and agencies. So were the data and information on water resources. The MOWRAM's predecessor was the General Directorate of Irrigation, Meteorology and Hydrology of the Ministry of Agriculture, Forestry and Fisheries. Now that functions have been centralized in the MOWRAM, data and information on water resources are still in possession of different ministries and agencies, although efforts are ongoing at the MOWRAM to strengthen the data and information systems available and the existing institutional capacity. As the MOWRAM is the authority responsible for water resources management countrywide, all data should be available to, and accessible by it, including data on groundwater and on water quality. This would enable it to determine the quantity of resources available for use and the quality of these resources.

In the Draft Law on Water Resources Management has already mentioned about data and information related with water must be submitted to MOWRAM.

To provide a solution to the issues outlined in this section, it is necessary in the first place to strengthen the capacity of MOWRAM staff, at both the national, the provincial and, in the future, the district level. With regard to some of these measures, the capacity is already present. However, because of the new technologies available, it is to be updated. As far as measures such as water resources planning and the granting of licences are concerned, these are completely new. Therefore, capacity needs to be completely built. Once capacity is strengthened or built, the personnel trained under the capacity building programme needs to be retained in order to ensure sustainability. Hence, there is a need to provide incentives to this effect, which is to be addressed at the highest level and at an early stage.

Finally, a crucial issue, which is particularly important from a social viewpoint, is that of a general lack of awareness of the importance of water resources conservation and protection, particularly in rural areas.

Table I.4.2 Institutional Basis for Water Resources Management.

Institution	Water-related Responsibilities
Cambodia National Mekong Committee (CNMC)	Advise the Cambodian representative to the MRC Council on all matters relating to activities within the Mekong River basin that could affect Cambodian interests. Review proposals prepared by RGC agencies in the light of the Mekong Agreement. Liaise between MRC and RGC agencies.
Ministry of Water Resources and Meteorology (MOWRAM)	Responsibilities defined by RGC Sub-Decree on 30 June 1999 include (in abbreviated form): <ul style="list-style-type: none"> - Define policies relating to and strategic development of water resources - Research and investigations of water resources - Prepare plans for water resources development and conservation - Manage direct and indirect water resource use, and mitigate water-related disasters - Draft water law and monitor its implementation - Gather and manage hydrological, meteorological and groundwater data and information - Provide technical advice - Administer international collaboration, including that within the Mekong River basin
Ministry of Industry, Mines and Energy (MIME)	Water-related responsibilities include: <ul style="list-style-type: none"> - Planning industrial water uses and hydropower - Water supply provision to provincial towns - Administration of single-purpose schemes involving hydro-power
Ministry of Rural Development (MRD)	Water-related responsibilities include: <ul style="list-style-type: none"> - Hydrogeological data collection and archiving - Water supply, sanitation, land drainage in rural areas.
Ministry of Public Works and Transport (MPWT)	Water-related responsibilities include: <ul style="list-style-type: none"> - Land drainage and sewerage in Phnom Penh and provincial towns - Study, survey, construction and maintenance of river works for navigation and water transport
Phnom Penh Water Supply Authority (PPWSA) and Municipality of Phnom Penh (under the Minister of the Interior)	Water supply in Phnom Penh Water resources in the Phnom Penh region
Ministry of Environment (MoE)	The MoE has a mandate to protect Cambodia's natural resources and environmental quality from degradation. Its legal mandate includes water in the list of media for which it is responsible. It is responsible for water quality and pollution control, including monitoring wastewater discharges and issuing permits. The Natural Environmental Action Plan includes six focal areas, one of which is fisheries and floodplain agriculture in the Tonle Sap region; otherwise, water receives limited mention.
Ministry of Agriculture, Fisheries and Forests (MAFF)	MAFF is engaged in development of policies and strategies for agriculture, forestry and fisheries that have significant implications for the management of the water resources required for irrigation and capture fisheries/aquaculture. MAFF responsibilities for forestry also have relevance to catchment condition, hydrological regime and water quality issues.
Ministry of Economics and Finance (MEF)	MEF is responsible for compiling the RGC's <i>Socio-Economic Development Programme</i> and <i>Public Investment Programme</i> . To the extent that water-related investments are proposed in a number of different components of the programmes, MEF has the role of harmonising proposals, and matching them against RGC investment priorities.
Ministry of Health	MoH is responsible for controlling the quality of surface and ground water used for public water supply, as well as for health education and other matters related to public health.
Provincial governments	Provincial governments have an oversight and coordinating role with regard to the provincial departments of ministries with water-related responsibilities. They provide the framework for provincial and sub-provincial development committees, some of which are engaged in water-related development (mostly water supply, sanitation, small scale irrigation).
Municipalities	Some municipalities operate public water supply systems. Municipalities are responsible for drainage and sewerage within their area of jurisdiction.
Development committees	Development committees at provincial, district, commune and village levels have responsibility for socio-economic development initiatives. In some, water-related initiatives may be included, particularly with regard to water supply and sanitation.

Source : MOWRAM (2001)

I.4.2 Issues on Water Infrastructures

Issues relating to the use of water, i.e., water quantity issues, refer primarily to the

potential for conflict. Since water resources are abundant in Cambodia, and economic development is still limited, there is still little scope for such conflicts. Some problems, however, are gradually emerging as regards the use of reservoirs for irrigation and fisheries purposes, for instance, among water users within different irrigation command areas and between navigation and uses requiring the construction of hydraulic works (dams or weirs) in the rivers, such as irrigation. This occurs in particular in the Takeo and Kandal Provinces. (The conflict occurred between the people who wish to catch fish in the reservoir area and the people who want to keep the water for their rice irrigation purposes).

(1) Irrigation

The high water losses and floods are occurring because of the current status of "Pol Pot" irrigation schemes and of the schemes that are not completed yet. Poor hydraulic design and irrigation layout stemming from the Khmer Rouge regime, together with lack of financial resources for operation and maintenance, have caused a number of irrigation schemes to deteriorate. Drainage requirements, also, have been overlooked, with the result that there is a potential for waterlogging, salinization and, in general, environment degradation. There is an urgent need, therefore, to proceed to the rehabilitation of these schemes.

The irrigated rice areas account only to 16.6% of the total cultivated area in the Cambodia, which was 473,000 ha in 1998 of the total rice-growing area (1.93 million ha), that is 8% as supplementary irrigation in the wet season and 10% in the dry season.

Hence, almost all the rice area is single-cropped, resulting in low production - although Cambodia now is achieving self-sufficiency in average to good years. There are many other constraints to raising agricultural production and rural incomes, such as property rights, transport systems, availability of rural finance, agricultural extension, and levels of education.

While, the total irrigation potential is estimated at 1,667,300 ha in the Cambodia. However, due to lack of infrastructure - diversion structures, dams, etc. - to store wet season water for dry season irrigation, large amounts of water are lost to the sea.

Irrigation schemes are owned and operated by the Government, but funds are sufficient only to cover staff salaries and about 10% O&M costs, according to the National Water Sector Profile (MOWRAM, 2001). Farmers receive water for no charge, in addition to interest free emergency loans. In other words, cost recovery is lacking, which renders irrigation management unsustainable. In fact, the rehabilitation and maintenance of irrigation schemes rely heavily on external financial assistance. The MOWRAM, however, is in the process of introducing cost recovery measures through the formation of Farmer Water User Communities according to the Circular 1 (1999) and in the Draft Law on Water Resources Management (MOWRAM, 2001) also stipulated and shall develop in detail by sub-decree when the Draft Law adopted by the National Assembly. The above introduction will lead to the

management of medium and large scale projects.

(2) Water Supply, Sewerage and Sanitation

Water supply and sanitation are very poor, with only about 500,000 people out of 9 million living in rural areas having access to safe drinking water. Public funds are insufficient to cover the costs of rehabilitation of the existing infrastructure and of an expansion of the services. The water supplied is often not treated.

Because of the above, human health deterioration has become a preoccupying issue.

Conflicts are also recorded among the users of neighboring wells, due to the over-extraction of groundwater in some areas of the country (Takeo and Prey Veng Provinces), where there is a remarkable well density resulting in two wells per family in some instances. This, apparently, leads to the lowering of the water table and is at the origin of the intrusion of salts. Given the scarcity of data and information on the subject, however, there is no clear evidence of such occurrence, except for some wells being exhausted.

Issues on water supply project were also mentioned by the Phnom Penh Water Supply Authority (PPWSA, 2002) as follows.

- Lack of operation technology (suitable technology ?)
- Shortage of working fund and lack of maintenance (need institutional capacity building)
- Lack of assistance for soft component (need aid principal : self-reliant efforts, burden sharing for the recipient countries)
- Short of engineers because of the Civil War.

Although the Phnom Penh Water Supply Authority (PPWSA) has made significant progress towards the achievement of financial sustainability with high rates of revenue collection. And revenues that are now sufficient to cover service costs, the repayment of loans and future investments, provincial water supply and sanitation systems are not financially sustainable due to shortcomings in the collection of revenue.

(3) Hydropower

In spite of her 15,000 MW hydro-power potential, out of which only 1.0 MW at the Rattanakiri station and 70 MW at the Kirirom station¹³ are generated at present.

Cambodia depends on diesel engines for energy generation. This results to be very expensive for the consumers, which include industries, water supply plants, irrigated agriculture, telecommunications and eco-tourism. Therefore, the Government, through the MIME, has formulated a short and long term plan to develop 358 MW, and seeks long term development of an additional 2,785 MW. In addition,

¹³ Source : JICA Study Team. Rehabilitation works of the Kirirom Power Station and Dam by "CETIC International Hydropower Development Co., Ltd.", and new construction of transmission line (115 kV) by EDC (completed in May 2002).

multi-purpose (including hydro-power) development projects are planned for future implementation under the responsibility of the MOWRAM, such as the Prek Thnot multi-purpose project. The Royal Government of Cambodia has strongly concerned and strictly considered on socio-environmental issues derived from aforementioned development.

(4) Flood Mitigation and Control

Flood protection works are inadequate, and there are no means of control of those human activities that are at the origins or aggravate the effects of floods. These activities include, amongst other things, the filling of reservoirs, the construction of the banks of rivers, the obstruction of rivers, the cutting of trees, poor land drainage, the extraction of sand/gravel from the beds and banks of water bodies.

The Mekong has experienced serious environment degradation due to deforestation. It was estimated that the forest cover in the basin declined from about 50% (1970) to about 27% (1985). This decline continues, and is due to population growth, slash-and-burn agriculture in upland areas, the collection of fuel-wood, logging operations, the extraction of sand, gravel, rock and other materials from the beds and banks of water bodies and the construction of structures. There is an urgent need to introduce measures to prevent the negative effects of these activities on watersheds. As far as international relations are concerned, it is felt that deforestation and watershed degradation upstream are the major source of changes in the regime of the Mekong River and the main cause of sedimentation of the Tonle Sap Lake.

(5) Other Problems

The inland fisheries are undergoing a process of degradation, mainly due to over fishing and the sedimentation of rivers and lakes. Reportedly, fish are also infected with skin disease due to the inadequate use of fertilizers and pesticides in agriculture. Water resources development such as hydro-power upstream and the decline of the forests of the floodplains of the Great Lake and the Tonle Sap and Mekong Rivers as a consequence of agricultural expansion and of the demand of fuel-wood are also a cause of the degradation of fish resources. The forests serve as spawning and nursery ground for fish.

(6) Summary of Issues on Water Resources in the Study Area

1) Summary of General Technical Affairs on Water Resources in the Study Area

- a) Phnom Penh : groundwater potential low, groundwater quality are bad
- b) Kandal : Some parts of the province are flooded, the population density high, groundwater potential low groundwater quality are bad.
- c) Takeo : groundwater potential low, groundwater quality are bad
- d) Kampong Speu : Lack of irrigation system, somewhere groundwater

potential low, groundwater quality are salty, surface soil is low fertility and most rural area population have lack of health

- e) Kampot : Lack of irrigation system, somewhere groundwater quality are salty, lack of water supply system and sewerage
- f) Koh Kong : Lack of irrigation system, lack of water supply system and sewerage
- g) Sihanoukville : Lack of irrigation system, somewhere groundwater potential low groundwater quality are salty, lack of water supply system and sewerage

I.5 THE GROWTH CORRIDOR DEVELOPMENT STRATEGIES ON WATER RESOURCES DEVELOPMENT AND MANAGEMENT

I.5.1 Approach for Water Resources Development

As was mentioned in the "National Water Resources Strategy" (MOWRAM, 2001), the overall national goal of the Royal Government of Cambodia is poverty reduction/eradication through socio-economic development. The water sector will contribute to the achievement of this goal within a strategic framework promoting the sustainable use and management of water resources, the protection thereof, and the abatement or reduction of the effects of harmful situations such as floods and drought.

Since water plays a key role in all sectors of the national economy and therefore it is difficult to provide only one response to all issues that may arise, it is difficult to define a single overall strategy. Thus, the strategic framework, which applies to the water sector as a whole, will be detailed into the following strategies:

A. Strategies relating to the use of water resources in general:

To prevent conflicts among water uses for different purposes and in different areas, and create an environment conducive to the satisfaction of present and foreseeable demands consistent with environment protection.

B. Strategies relating to water resources development:

B.1 Irrigation and Drainage:

To expand the existing irrigated area from 16.62% to 20% by the year 2003, in addition to the existing irrigated area, and, given the high irrigation potential (1,667,300 ha) even more in the future, to enhance food security, provide job opportunities and increase the income of the rural population; through irrigation improvement, to mitigate the effects of floods and other emergency situations.

B.2 Water Supply, Sewerage and Sanitation:

To provide sufficient and safe water supplies to urban and rural areas through the expansion of water storage capacity; to protect the health of the urban and rural population.

B.3 Hydropower:

To exploit the country's potential to improve the standards of living of the population and reduce the present cost of energy, consistent with environment protection requirements.

B.4 Financial Sustainability of Hydraulic Infrastructure:

To ensure the financial sustainability of hydraulic infrastructure.

C. Protection of Water Resources:

To improve water quality so as to be able to satisfy present and future demands and ensure that water bodies have the capacity to sustain aquatic and fish life; to protect human and animal health.

D. Flood Control and Other Harmful Situations:

To prevent the damage that may occur as a result of floods, drought, watershed degradation, erosion and sedimentation; to protect aquatic and fish resources.

E. Policy, Legal and Institutional Capacity Building:

To create the "enabling environment" for integrated water resources management and development.

I.5.2 Development Scenarios

(1) Water Demand forecast in Sihanoukville City

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

Table I.5.1 Future Water Demand Projections by Earlier Studies

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

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

The wide gap in demand projections between the Fraser Thomas and Sogreah is largely due to more optimistic assumption in the growth of tourism used by Fraser Thomas. Parsons ES estimated the future water demand of Central Sihanoukville by following method.

- Present Population (1999) : 55,000
- Annual Population Growth Rate : 5.2 % (last 20 years averaged)
- Projected Population : 118,000 (2015), 152,000 (2020)
- Domestic Consumption : 100 - 200 [l/capita/day]
- Commercial/Industrial/Tourism Demand : 30% - 50% of domestic demand

In this study, preliminary future water demand in the Sihanoukville City is estimated by using updated data/information. As the future water demand in the Sihanoukville City at 2020 level is projected at 86,000 m³/day in this Study. It is included the water demand for 2-sites of proposed industrial area (IA). There will be a substantial deficit in the water supply capacity in this city (see **Table I.5.2** and **Figure I.5.1**). Water sources are not sufficient to supply water for the large demands without water an impounding reservoir in this area.

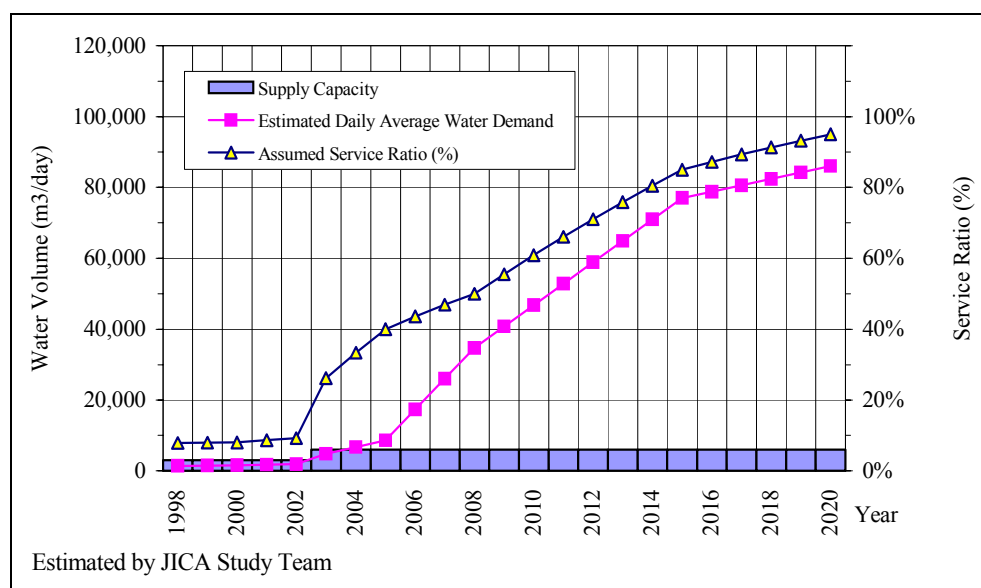


Figure I.5.1 Water Demand Projection of Sihanoukville Water Supply System

Table I.5.2 Water Demand Projection of Sihanoukville Water Supply System

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

Source : JICA Study Team.

Notes *) : Estimated population in 2005 : Source: Physical Framework Plan Sihanoukville, Environmental Management in the Coastal ~ Cambodia, MOE and DANIDA, Apr.2002.

*) : Estimated population in 2008 and 2015 : Source: General Population Census of Cambodia 1998, Report 6 - Population Projections 2001-2021.

*) : Population in 2000 and 2002 are estimated by using 1998 and 2005 data.

*) : Assumed (Case Study), *) : (No. Connected Population) = (Population in Service Area) x (Service Ratio)

*) : Unit Water Consumption in 1998-2000 was actual data to be 135 l/c/d. (Source : MIME & SWSA, 2001), *) : Assumed increase to be 150 - 200 l/c/d in future.

*) : Water demand of Beer Brewery of the "Cambrew Angkor Beer" is at 300 m³/d at present. However, the original contract is 1700 m³/d. (Source: SWSA, 1999)

*) - 11) : Case Study. *) 12) : Assumed.

*) 13) : Source: M/P for Coastal Zone Area, Draft Final Report, Thailand Institute of Scientific and Technological Research (TISTR), 2002.

*) 14) : 75% of domestic tourists are assumed as day use tourist. And 100% of international tourists are assumed as stay over tourist.

*) 15) : Average number of tourist are assumed that the tourists come Sihanoukville on the week-end. 2 days (Saturday and Sunday) x 4/month x 12 months = 96 days/year.

*) 16) : Unit water consumption for tourists are assumed as 50 l/c/d for day-use and 300 l/c/d for stay-over tourists.

*) 17) : Source : SWSA (1999). *) 18) : assumed 100 little/table for restaurant, 3 pers./table, x 3 times/day.

(2) Water Demand forecast in Phnom Penh City

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

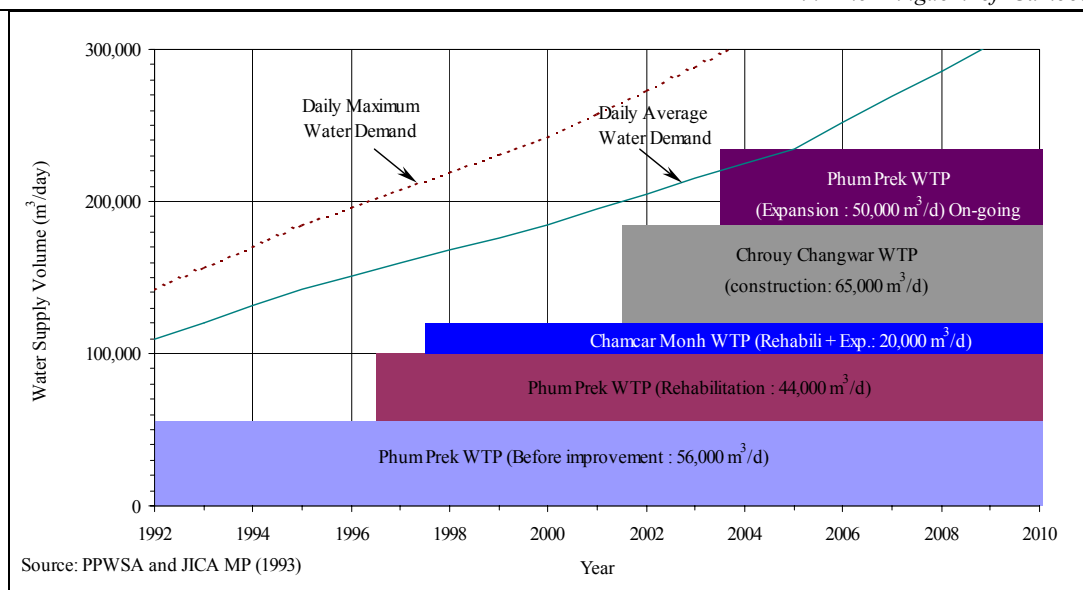


Figure I.5.2 Water Demand and Development Plan of PPWS System (Master Plan)

Based on the above master plan, the water supply capacity of the PPWS will be not enough to daily average water demand after 2005. It will be required to construct additional water treatment system to achieve water demand in the future.

I.6 WATER RESOURCES DEVELOPMENT AND MANAGEMENT PROJECTS

I.6.1 Proposed Projects

Based on the above issues and strategy, following projects for on the water resources development and management are proposed as shown in **Table I.6.1**.

Table I.6.1 Issues, Strategy and Proposed Projects on Water Sector

Sub Sector	Major Issues / Problems	Strategy (MOWRAM, 2001)	No.	Required Projects (MOWRAM, 2001)
A. General Water Utilization	Lack of master planning on water resources development and management no regulations and no licencing of water uses Low groundwater potential Poor quality / polluted groundwater Lack of safe water supply system (especially in rural area)	To prevent conflicts among water uses for different purposes and in different areas, and create an environment conducive to the satisfaction of present and foreseeable demands consistent with environment protection.	A-1	Master Plan Study on Water Resources Development and Management
			A-2	Licensing of Water Uses
			A-3	Groundwater Monitoring and Controlling
			A-4	Mekong River Water Utilization Programme (WUP)
B. Water Resources Development B.1 Irrigation and Drainage	Lack of irrigation and drainage system Lack of O&M for irrigation and drainage system	To expand existing irrigated area from 16.62% to 20% by the year 2003, to enhance food security, provide job opportunities and increase income of rural population; to mitigate of flood damages and other emergency situations.	B-1-1	Rehabilitation of Existing Irrigation Schemes
			B-1-2	Development of Cost-Effective, Short-Gestation Irrigation
			B-1-3	Development of Small-Scale Gravity Irrigation Systems
			B-1-4	Improvement and Expansion of Medium & Large Irrigation Systems
B-2. Water Supply, Sewerage and Sanitation	Low water and shortage of urban water supply capacity Low rate of safe water supply system (especially in rural area) Poor quality / polluted groundwater Low technology and lack of finance for O&M of water supply Low rate of urban drainage and sewerage system Low rate of sanitation service in rural area Lack of education on safe water	To provide sufficient and safe water supplies to urban and rural areas through the expansion of water storage capacity; to protect the health of the urban and rural population.	B-2-1	Urban Water Supplies (Improvement)
			B-2-2	Rural Water Supply Services (Expansion)
			B-2-3	Setting of Drinking Water Quality Standards
			B-2-4	Monitoring of Drinking Water Quality
			B-2-5	Urban Drainage and Sewerage (Improvement)
			B-2-6	Sanitation Services in Rural Area (Expansion)
			B-2-7	Organization of Health Education Programmes
B-3. Hydropower	High cost of electricity due to using diesel generation Lack of hydropower (only 2 site exist) Lack of updated master plan of hydropower Lack of F/S or EIA study on hydropower development Lack of finance for development of hydropower	To exploit the country's potential to improve the standards of living of the population and reduce the present cost of energy, consistent with environment protection requirements.	B-3-1	Review of Data and Information Hydropower Development
			B-3-2	Master Plan Study on Hydro-Power Project
			B-3-3	Assess Project Feasibility for Multiple Use
			B-3-4	F/S of Hydropower Projects
			B-3-5	EIA Study on Hydro-Power Projects
			B-3-6	Construct the Prek Thnot Multi-Purpose Project
			B-3-7	Construct the Battambang River Multi-Purpose Hydropower Project
			B-3-8	Construct the Pursat River Multi-Purpose Hydropower Project
			B-3-9	Construct the Kamchay Multi-Purpose Hydropower Project
			B-4. Financial Sustainability of Hydraulic Infrastructure	Lack of finance for O&M of water resources facilities
B-4-2	Enhancement of Community Participation of Hydraulic Infrastructure			
B-4-3	Capacity Buildings for Users in Management of Irrigation			
B-4-4	Private Sector Involvement			
C. Protection of Water	water pollution (surface water and groundwater) lack of monitoring system and guidelines Lack of protection / control of water resources	To improve water quality so as to be able to satisfy present and future demands and ensure that water bodies have the capacity to sustain aquatic and fish life; to	C-1	Prevention of Water Pollution from Point Sources
			C-2	Prevention of Water Pollution from Non Point sources
			C-3	Prevention of Groundwater Pollution
D. Flood Control and Mitigation	Lack of flood control and mitigation systems Lack of flood and drought forecasting Lack of meteorological/ hydrological observation stations Lack of meteorological/ hydrological data base	To prevent the damage that may occur as a result of floods, drought, watershed degradation, erosion and sedimentation; to protect aquatic and fish resources.	D-1	Flood Control and Mitigation
			D-2	Floods and Drought Forecasts / Warning
			D-3	Improvements to Meteorological Network
			D-4	Prevention of Watershed Degradation, Erosion and Sedimentation
			D-5	Protection of Fish Stocks
			D-6	Cooperation with GMS Countries
E. Institutional Capacity Building for Water Resource Management	Lack of institutional capacity and human resources	To create the "enabling environment" for integrated water resources management and development.	E-1	Adoption of Water Sector Policy
			E-2	Formulation of Comprehensive Legal Framework for Water Sector
			E-3	Strengthening of Institutional Capacity Building. Institutional coordination.
			E-4	Strengthening of Data Base and Information System
			E-5	Strengthening of Capacity of Staff
			E-6	Publication of Information on Water Resources

Source of strategy and proposed project : "National Water Resources Strategy", MOWRAM, September 2001.

Details of the proposed projects are shown in **Table I.6.2**. There are more than 40 of major projects are proposed on water resources development and management. These strategy and projects are based on the "National Water Resources Strategy" (MOWRAM, 2001)¹⁴.

¹⁴ National Water Resources Strategy, Kingdom of Cambodia, Ministry of Water Resources and Meteorology (MOWRAM), prepared by Task Force of the Capacity Building Subcomponent, Agricultural Hydraulics Component, Agriculture Productivity Improvement Project - ITF Credit No. 011-KH, September 2001.

Table I.6.2 Proposed Water Resources Development and Management Projects (1/3)

Sub Sector	No.	Required Projects (MOWRAM, 2001)	Description of Proposed Projects	Project Period		
				Short-Term	Midium-Term	Long-Term
				2003 ~ 2005	2003 ~ 2008	2009 ~ 2015
A. General Water Utilization	A-1	Master Plan Study on Water Resources Development and Management	Planning water resources use and development for the various different purposes within priority areas. (1) Identification of priority areas (basins or aquifers) (2) Formulation of planning procedures (3) Establishment of mechanisms for public participation			
	A-2	Licencing of Water Uses	(1) Adoption of Water Legislation (2) Establishment and Staffing of a Licencing Unit at MOWRAM (3) Establishment of a System for the Issuance, Administration and Registration of Licences			
	A-3	Groundwater Monitoring and Controlling	(1) Identification, through Pumping Tests, Modelling, etc., Well Density shall be Contained (2) Setting Minimum Distances Among Wells. (3) Introduction of the Concept of Well Sharing (4) Setting up of Groundwater User Communities (GUCs)			
	A-4	Mekong River Water Utilization Programme (WUP)	Cooperation with the other Parties to the "Mekong Agreement"(1995) in the implementation of the provisions.			
B. Water Resources Development						
B.1 Irrigation and Drainage	B-1-1	Rehabilitation of Existing Irrigation Schemes				
	B-1-2	Development of Cost-Effective, Short-Gestation Irrigation	Appropriate and Private Irrigation Technologies (i.e., Shallow Tube Wells and Low-Lift Pump Systems)			
	B-1-3	Development of Small-Scale Gravity Irrigation Systems				
	B-1-4	Improvement and Expansion of Medium & Large Irrigation Systems	as the institutional capacity for planning, construction and O&M of such systems is enhanced			
B-2. Water Supply, Sewerage and Sanitation	B-2-1	Urban Water Supplies (Improvement)				
	B-2-2	Rural Water Supply Services (Expansion)				
	B-2-3	Setting of Drinking Water Quality Standards				
	B-2-4	Monitoring of Drinking Water Quality				
	B-2-5	Urban Drainage and Sewerage (Improvement)				
	B-2-6	Sanitation Services in Rural Area (Expansion)				
	B-2-7	Organization of Health Education Programmes				
B-3. Hydropower	B-3-1	Review of Data and Information Hydropower Development				
	B-3-2	Master Plan Study on Hydro-Power Project	Investigation of Country's Potential for Hydro-Power Development and Setting of Priorities			
	B-3-3	Assess Project Feasibility for Multiple Use	Assess Project Feasibility for Multiple Use			
	B-3-4	F/S of Hydropower Projects	Planning of Hydro-Power Development within the Framework of Overall Water Resources Plans			
	B-3-5	EIA Study on Hydro-Power Projects	Assess the Impact of Each Hydro-Power Development Project on the Watershed Concerned			
	B-3-6	Construct the Prek Thnot Multi-Purpose Project	The construction of these multi-purpose projects will provide a large benefit for the rural areas (hydropower, irrigation, water supply and flood control).			
	B-3-7	Construct the Battambang River Multi-Purpose Hydropower Project				
	B-3-8	Construct the Pursat River Multi-Purpose Hydropower Project				
	B-3-9	Construct the Kamchay Multi-Purpose Hydropower Project				

continue;

Table I.6.2 Proposed Water Resources Development and Management Projects (2/3)

Sub Sector	No.	Required Projects (MOWRAM, 2001)	Description of Proposed Projects	Project Period		
				Short-Term	Medium-Term	Long-Term
				2003 ~ 2005	2003 ~ 2008	2009 ~ 2015
B-4. Financial Sustainability of Hydraulic Infrastructure	B-4-1	Collection of Water Use Fees for O&M	Introduction of the Concept of Water Use Fees to Cover the Costs of Service Delivery and O&M			
	B-4-2	Enhancement of Community Participation of Hydraulic Infrastructure	Enhancement of Community Participation in Design, Construction, Operation & Management of Infrastructure			
	B-4-3	Capacity Buildings for Users in Management of Irrigation	(1) Collect Water Use Fees, etc. (2) Water Use Licences (3) Irrigation Management Transfer (4) Strengthening of Capacity of Local Government Units (5) Promotion of Crop Diversification (6) Improvement of Rural Credit Facilities (7) Implementation of Land Titling Legislation			
	B-4-4	Private Sector Involvement	Promotion of Private Sector Involvement in Construction of Hydraulic Infrastructure			
C. Protection of Water Resources	C-1	Prevention of Water Pollution from Point Sources	(1) Provision of Sewerage and Sanitation (2) Setting of Technical Standards for Wastewater Discharges (3) Licencing of Wastewater Discharges			
	C-2	Prevention of Water Pollution from Non Point sources	(1) Control the Import and Sale of Fertilizers and Pesticides (2) Introduction of a Code of Good Agricultural Practices (3) Dissemination of Information on Fertilizers and Pesticides (4) Monitoring of Impact of Fertilizers and Pesticides on Water Resources (5) Improvement of Urban Drainage			
	C-3	Prevention of Groundwater Pollution	(1) Establishment of Protected Areas or Perimeters around Wells for Drinking (2) Control of Use of Fertilizers and Pesticides (3) Introduction of a Code of Good Agricultural Practices (4) Health Education Programmes			
D. Flood Control and Mitigation	D-1	Flood Control and Mitigation	(1) Establishment of State Ownership and Control of Watercourses (2) Construction/Rehabilitation of Bank Protection Works, Dykes, etc (3) Rehabilitation of Irrigation & Drainage, and Provision of Water Storage Facilities (4) Promotion of Flood Awareness in Risk-Prone Communities (5) Adoption of Reforestation Measures (6) Designation of Flood Control Areas (7) Regulation of River Beds and Banks, through a Licencing System (8) Prohibition/ Licencing of Filling Reservoirs, Flows/Drainage			
	D-2	Floods and Drought Forecasts / Warning				
	D-3	Improvements to Meteorological/ Hydrological Network				
	D-4	Prevention of Watershed Degradation, Erosion and Sedimentation	(1) Definition and Mapping of Watersheds (2) Land Use Planning and other Activities within Watersheds (3) Adoption of Reforestation Measures (4) Protection of Watersheds (5) Prohibition/Licencing of Sand Mining on River Beds/Banks (6) Promotion of Sustainable Use of Natural Resources within Watersheds			

continue;

Table I.6.2 Proposed Water Resources Development and Management Projects (3/3)

Sub Sector	No.	Required Projects (MOWRAM, 2001)	Description of Proposed Projects	Project Period		
				Short-Term	Medium-Term	Long-Term
				2003 ~ 2005	2003 ~ 2008	2009 ~ 2015
D. Flood Control and Mitigation	D-5	Protection of Fish Stocks	(1) Regulate Fishing and Aquaculture (2) Implement Fisheries Legislation (3) Take Fishery Resources into Planning Water Resources Development (4) Construct/Rehabilitate Drainage Infrastructure (5) Take Reforestation Measures on Fisheries (6) Control Import and Sale of Fertilizers and Pesticides (7) Introduce a Code of Good Agricultural Practices			
	D-6	Cooperation with GMS Countries	Cooperation with GMS Countries, to Prevent Floods, Watershed Degradation, Erosion, Sedimentation and Drought			
E. Institutional Capacity Building for Water Resource Management	E-1	Adoption of Water Sector Policy	Formulation and adoption of a coherent policy for the water sector as a whole			
	E-2	Formulation of Comprehensive Legal Framework for Water Sector	Formulation of a comprehensive legal framework for the water sector, covering, amongst other things:			
	E-3	Strengthening of Institutional Capacity Building. Institutional coordination.	strengthening of MOWRAM to take the lead role and coordinate water management activities, particularly with regard to water resources			
	E-4	Strengthening of Data Base and Information System	To facilitate integrated management of water quantity and quality and determination of balance			
	E-5	Strengthening of Capacity of Staff	Strengthening of the capacity of staff both at the central and at decentralized levels.			
	E-6	Publication of Information on Water Resources	Dissemination of information on water resources through public meetings, radio broadcasts & printed materials			

Source of strategy and proposed project : "National Water Resources Strategy", MOWRAM, September 2001.

I.6.2 Priority Projects

(1) Selection Criteria

The proposed projects were scrutinized in view of following 10 evaluation criteria.

- Effective-ness
- Importance
- Time Span
- Cost
- Benefit
- Sustainability
- Environmental Negative Impact
- Effect for Rural Development
- Effect for Self-help
- Project Realization

(2) Preliminary Evaluation for the Selection of Priority Projects

Based on the above evaluation criteria, the preliminary evaluation for the selection of priority projects was conducted as shown in **Table I.6.3**.

Table I.6.3 Preliminary Evaluation for Selection of Priority Projects on Water Resources Development and Management (1/2)

Sub Sector	No.	Required Projects (MOWRAM, 2001)	Preliminary Evaluation of Proposed Projects									Overall Evalu- ation (Total)	Priority of Project (Sorted)	
			Effective- ness	Import- ance	Time Span	Cost	Benefit	Sustaina- bility	Environ- mental Negative Impact	Effect for Rural Dev.	Effect for Self-help			Project Realiza- tion
			1: Feir 2: High 3: V.High	1: Feir 2: High 3: V.High	1: Long 2: Mid. 3: Short	1: High 2: Mid. 3: Low	1: Feir 2: High 3: V.High	1: Feir 2: High 3: V.High	1: Big 2: Mid. 3: Small	1: Feir 2: High 3: V.High	1: Feir 2: High 3: V.High			1: Difficult 2: Mid. 3: Easy
A. General Water Utilization	A-1	Master Plan Study on Water Resources Development and Management	2	3	2	3	3	3	3	3	3	3	23	1
	A-2	Licensing of Water Uses	2	2	2	3	1	2	3	1	2	2	16	23
	A-3	Groundwater Monitoring and Controlling	2	3	2	3	2	3	3	1	1	2	17	19
	A-4	Mekong River Water Utilization Programme (WUP)	2	2	1	3	2	2	2	2	1	1	14	33
B.1 Irrigation and Drainage	B-1-1	Rehabilitation of Existing Irrigation Schemes	2	3	2	3	2	2	2	3	2	3	19	10
	B-1-2	Development of Cost-Effective, Short-Gestation Irrigation	2	2	2	2	2	2	2	3	2	3	18	14
	B-1-3	Development of Small-Scale Gravity Irrigation Systems	2	2	1	2	2	2	2	3	2	2	16	23
	B-1-4	Improvement and Expansion of Medium & Large Irrigation Systems	3	2	1	1	2	2	1	3	1	1	12	43
B-2. Water Supply, Sewerage and Sanitation	B-2-1	Urban Water Supplies (Improvement)	3	3	3	2	3	3	2	1	2	3	19	10
	B-2-2	Rural Water Supply Services (Expansion)	2	3	2	2	2	1	1	3	1	3	15	26
	B-2-3	Setting of Drinking Water Quality Standards	2	3	1	3	1	2	3	1	1	3	15	26
	B-2-4	Monitoring of Drinking Water Quality	1	2	1	3	1	1	3	1	1	3	14	33
	B-2-5	Urban Drainage and Sewerage (Improvement)	2	3	2	2	3	1	2	1	1	2	14	33
	B-2-6	Sanitation Services in Rural Area (Expansion)	2	2	2	2	2	1	2	1	1	3	14	33
	B-2-7	Organization of Health Education Programmes	3	3	3	3	3	3	3	1	2	3	21	3
B-3. Hydropower	B-3-1	Review of Data and Information Hydropower Development	2	3	1	3	1	3	3	2	2	3	18	14
	B-3-2	Master Plan Study on Hydro-Power Project	3	3	3	3	2	3	3	2	2	3	21	3
	B-3-3	Assess Project Feasibility for Multiple Use	3	3	2	3	3	3	3	2	2	3	21	3
	B-3-4	F/S of Hydropower Projects	2	2	2	2	1	1	3	1	2	2	14	33
	B-3-5	EIA Study on Hydro-Power Projects	2	2	1	3	1	3	3	1	2	3	17	19
	B-3-6	Construct the Prek Thnot Multi-Purpose Project	3	3	1	1	3	2	1	3	2	1	14	33
	B-3-7	Construct the Battambang River Multi-Purpose Hydropower Project	3	3	1	2	1	2	3	2	2	2	15	26
	B-3-8	Construct the Pursat River Multi-Purpose Hydropower Project	3	3	1	2	1	2	2	2	2	2	14	33
	B-3-9	Construct the Kamchay Multi-Purpose Hydropower Project	3	3	1	1	3	2	2	2	2	1	14	33
B-4. Financial Sustainability of Hydraulic Infrastructure	B-4-1	Collection of Water Use Fees for O&M	3	3	3	3	1	3	3	3	3	2	21	3
	B-4-2	Enhancement of Community Participation of Hydraulic Infrastructure	3	3	2	3	1	3	3	3	3	3	21	3
	B-4-3	Capacity Buildings for Users in Management of Irrigation	2	3	2	3	1	3	3	3	3	2	20	8
	B-4-4	Private Sector Involvement	2	2	2	3	1	1	2	2	2	1	14	33
C. Protection of Water Resources	C-1	Prevention of Water Pollution from Point Sources	2	3	2	2	2	2	3	1	1	2	15	26
	C-2	Prevention of Water Pollution from Non Point sources	2	3	2	2	2	2	3	1	1	2	15	26
	C-3	Prevention of Groundwater Pollution	2	3	2	2	2	2	3	1	1	2	15	26
D. Flood Control and Mitigation	D-1	Flood Control and Mitigation	3	3	2	2	3	2	2	3	3	2	19	10
	D-2	Floods and Drought Forecasts / Warning	3	3	2	3	3	3	3	3	3	3	23	1
	D-3	Improvements to Meteorological/ Hydrological Network	3	3	3	3	2	3	3	2	1	3	20	8
	D-4	Prevention of Watershed Degradation, Erosion and Sedimentation	2	3	2	2	1	2	3	1	2	1	14	33
	D-5	Protection of Fish Stocks	2	2	2	3	1	2	3	1	2	2	16	23
	D-6	Cooperation with GMS Countries	1	2	3	2	2	2	3	1	1	1	15	26

continue;

Table I.6.3 Preliminary Evaluation for Selection of Priority Projects on Water Resources Development and Management (2/2)

Sub Sector	No.	Required Projects (MOWRAM, 2001)	Preliminary Evaluation of Proposed Projects									Overall Evalu- ation (Total)	Priority of Project (Sorted)	
			Effective- ness	Import- ance	Time Span	Cost	Benefit	Sustaina- bility	Environ- mental Negative Impact	Effect for Rural Dev.	Effect for Self-help			Project Realiza- tion
			1: Feir 2: High 3: V.High	1: Feir 2: High 3: V.High	1: Long 2: Mid. 3: Short	1: High 2: Mid. 3: Low	1: Feir 2: High 3: V.High	1: Feir 2: High 3: V.High	1: Big 2: Mid. 3: Small	1: Feir 2: High 3: V.High	1: Feir 2: High 3: V.High			1: Difficult 2: Mid. 3: Easy
E. Institutional Capacity Building for Water Resource Management	E-1	Adoption of Water Sector Policy	2	3	3	3	1	2	3	1	2	3	18	14
	E-2	Formulation of Comprehensive Legal Framework for Water Sector	2	3	3	3	1	2	3	1	2	3	18	14
	E-3	Strengthening of Institutional Capacity Building. Institutional coordination.	2	2	3	3	1	2	3	1	2	2	17	19
	E-4	Strengthening of Data Base and Information System	2	3	3	3	2	2	3	1	2	3	19	10
	E-5	Strengthening of Capacity of Staff	2	2	2	3	1	2	3	1	3	2	17	19
	E-6	Publication of Information on Water Resources	3	2	3	3	1	1	3	2	2	3	18	14

Note: Evaluation by JICA Study Team.

(3) Selected Priority Projects

Following projects seven-(7) are selected as a priority projects for the water resources development and management. The details of the proposed projects are shown in the project sheets attached in **Annex of Main Report**.

Table I.6.4 Development Projects for Water Resources Development and Management

Project	Objective	Executing Agency
K-1: Master Plan Study on Water Resources Development and management	- To prepare inventory of water users for all the river system and groundwater, - To formulate master plan for integrated water resources development for the whole country.	MOWRAM, CNMC
K-2: Improvement to Meteorological / Hydrological Network	- To establish of data/information system, monitoring networks and mechanisms (including legally binding instructions), - To improvement / rehabilitation of Meteorological / Hydrological	MOWRAM, CNMC
K-3: Strengthening of Database and Information Systems (Drought Forecasting and Early Warning System)	- To mitigate flood damages at the flood prone area, - To mitigate draught damages particularly for rain-fed rice field	MOWRAM, MRC, CNMC, CNCMD, RGC ministries, etc.
K-4: Improvement of Urban Water Supply	- To increase plant capacity and increase water supply service ratio for 9 cities/towns were identified limited capacity of the water sources to increase the service ratio of piped water supply, which are Ta Khmau (Takaev), Chbar Mou (Kampong Spueu), Kampong Bay (Kampot) and Sihanoukville. - The four towns (Ta Khmau, Chbar Mou, Kampong Bay and Sianoukville) are identified as the priority areas for improvement of urban water supply system. - To improve the operation and maintenance of water supply system,	MIME, and other water supply authorities/company
K-5: Rehabilitation of Irrigation Schemes	- To increase the total irrigated area for part of the overall national goal of poverty reduction. - To implement the rehabilitation works including construction supervision / management.	MOWRAM, MOAFF
K-6: Flood Control and Mitigation	- To mitigate flood damages at the flood prone area	MOWRAM, MRC, CNMC, CNCMD, MoPW&T.

Project	Objective	Executing Agency
K-7: Community Enhancement of Water management	- Organization of Health Education Programs - Enhancement of Community Participation of Hydraulic Infrastructure - Capacity building for users in management of irrigation	MRD, MOWRAM

(4) Evaluation of Proposed Priority Projects

The proposed projects were evaluated in view of following six-(6) criteria.

- I : Conformity to Basic Strategy
- II : Conformity to Regional Strategy
- III : Relevance to Industrial Development
- IV : Sustainability and use of local resource
- V : Admissibility of implementation
- VI : Impact on social dimension

(5) Implementation Program

Based on the evaluation of the proposed projects, the implementation program is formulated as shown in **Table I.6.5**.

Table I.6.5 Implementation Program of the Priority Projects

No.	Projects	Executing Agency	Evaluation						Project Period		
			I	II	III	IV	V	VI	Short-Term 2003 ~ 2005	Midium-Term 2006 ~ 2008	Long-Term 2009 ~ 2015
K-1	Master Plan Study on Water Resources Development and Management	MOWRAM, CNMC	A	A	A	A	A	A			
K-2	Improvements to Meteorological/ Hydrological Network	MOWRAM, CNMC	B	B	C	B	A	C			
K-3	Strengthening of Database and Information Systems (Drought Forecasting and Early Warning System)	MOWRAM, MRC, CNMC, CNCMD, RGC ministries, etc.	B	B	C	B	A	C			
K-4	Urban Water Supplies (Improvement)	MIME, and other water supply authorities / company	A	A	A	B	A	A			
K-5	Rehabilitation of Existing Irrigation Schemes	MOWRAM, MOAFF	A	A	C	B	A	A			
K-6	Flood Control and Mitigation	MOWRAM, MRC, CNMC, CNCMD, MoPW&T.	A	A	B	B	B	A			
K-7	Community Enhancement of Water management (Organization of Health Education Programmes, Collection of Water Use Fees for O&M, Enhancement of Community Participation of Hydraulic Infrastructure, Capacity Buildings for Users in Management of Irrigation)	MRD, MOWRAM	A	A	C	A	A	A			

In general, the meteorological or hydrological data are most basic and important information for all planning/design of water resources development and management projects. However, in Cambodia, the meteorological or hydrological stations are quite few at present. It is strongly requested to improve of the meteorological and hydrological observation networks, urgently.

(6) Implementing Bodies

Proposed implementing bodies of selected priority projects are summarized in **Table I.6.6**.

Table I.6.6 Implementation Matrix for Growth Corridor Master Plan

						Implementing Bodies											Implementation		
						Central Government Agencies			Local Authorities			Others					Urgent	Short	
						Ministry of Agriculture and Forestry	Ministry of Industry, Mining and Energy	Ministry of Public Works (Port Authority)	Ministry of Rural Development	Ministry of Water Resources and Meteorology	Provincial Government	PHN Municipality	SNV Municipality	Other Authority, Committee	Private Sector	NGOs			
Sec- tor	Sector Goal	Area	Area-wise Goal	Strategy	Project	XXX: Primary responsibility, XX: Secondary responsibility, X: Supplementary											2003- 2005	2006- 2008	
K. Water Resources	- Formulation of Axis of Development for Cambodia	Overall	Formulation of Axis Development for Cambodia	- Development of Economical, Competitive and Sustainable Infrastructure	K-1 Master Plan Study on Water Resources Development and management	X		X	X	XXX	X	X	X	XX			MOWRAM, CNMC		
		Overall	Formulation of Axis Development for Cambodia	- Development of Economical, Competitive and Sustainable Infrastructure	K-2 Improvement to Meteorological / Hydrological Network	X		X	X	XXX	X	X	X	XX			MOWRAM, CNMC		
		Overall	Formulation of Axis Development for Cambodia	- Development of Economical, Competitive and Sustainable Infrastructure	K-3 Strengthening of Database and Information Systems (Flood and Drought Forecasting and Early Warning System)	X		X	X	XXX	X	X	X	XX			MOWRAM, MRC, CNMC, CNCDM, RGC ministries, etc		
		Overall	Formulation of Axis Development for Cambodia, Promotion of Strategic Development of Industries	- Improvement of water supply systems for provincial capitals. - Stable and safer water supply for industrial municipal users.	K-4 Improvement of Urban Water Supply (include Water Supply Development for SPZ)		XX				X	X	X	XXX			MIME, and other water supply authorities / company		
		Intermediate Area	Establishment of Stable and Sustainable Rural Society	- Planning of Integrated water resources management	K-5 Rehabilitation of Irrigation Schemes	XX				XXX	X					X	MOWRAM, MOAFF		
		Greater Capital + Intermediate Area	Creation of Economically Active Suburbs with Sustainable Environment	- Effective urban drainage and sewerage system	K-6 Flood Control and Mitigation			X		XXX	X	X		XX			MOWRAM, MRC, CNMC, CNCDM, MoPW&T		
		Intermediate Area	Establishment of Stable and Sustainable Rural Society	- Improvement of rural water supply.	K-7 Community Enhancement of Water management				XXX	XX	X	X				X	MRD, MOWRAM		
		Greater Capital + Intermediate Area	Establishment of Stable and Sustainable Rural Society	- Planning of Integrated water resources management	K-8 Preak Thnot River Basin Development	X		X	X	XXX	X	X		XX			MOWRAM, MOAFF		

I.6.3 Proposed Urgent Projects

Every selected priority projects are very important for the development of Cambodia. However, in this section, priority urgent projects were selected by following points of view.

- Project what requires enforcement and emergency for a short term,
- An enterprise effect agrees in the local industrial development, and an effect is concrete,
- Project what creates abundant employment,
- Project what required talented people can appoint,
- Project what has easy enterprise budget-izing,

- Project what has high cost effectiveness,
- Project what has the low negative impact to an area.

The following two projects were selected as a water-resources-related Urgent Project.

- (1) National Water Resources Development and Management Master Plan Study
- (2) Improvement of Urban Water Supply in Sihanoukville

The reason for selection is as follows.

(1) National Water Resources Development and Management Master Plan Study

- The national water resources master plan is most basic and important for the development of every country. However, it is not prepared in the Cambodia until now.
- In the Cambodia, all water infrastructures, such as irrigation system, potable water supply system in town, rural water supply, sewer, flood measures, and hydropower generation, is not sufficient. For the future development of this country, it is important to correspond for a measure on these problems with a best policy and with a long-term view, and to cope with it one by one according to the synthetic master plan. Individually and extemporaneously actions are not valid economically.
- It is required to clear that potential of water resources by area-wise and its quantity first. It is economically advantageous to forecast of future water demand and to implement the measure corresponding by priority. Therefore, before implementation of individual measures, without special urgent projects, the synthetic water resources “development” and “management” plan is selected as a "priority urgent" project.
- The term of the project (study) will be short period (about three - four years). The final effect of this project (study) will reach all over the country. The water is indispensable in every sector and the purposed of this project also agrees in local industrial development.
- To carry out of this study, the implementing organization will be established with cooperation of MOWRAM (Ministry of Water Resources and Meteorology), MAFF (Ministry of Agriculture, Forestry and Fisheries), MIME (Ministry of Industry, Mine and Energy), MRD (Ministry of Rural Development), CNMC (Cambodia National Mekong Committee), MRC (Mekong River Commission), the local governments, and many other organizations. For this reason, technology transfer and the capacity building on many fields will conduct with a great effect.
- The budget of the study will be not expensive and making the budget is easy in comparison.

- This project does not have the negative impact to the environment due to conduct only study and planning.

(2) Improvement of Urban Water Supply in Sihanoukville

- Development of the future Sihanoukville City is expected and the effect is having expectations great as realization of the "growth corridor" of investigation hold.
- However, the water supply capability in the Sihanoukville City is alike and low, and a future serious water shortage will be occurred. If the water supply is not improved, development of Special Promotion Zone or Industrial Zone in the Sihanoukville City can not be realized, either, but it becomes impossible the water supply for the increasing population, industrial and tourist demand.
- For this reason, it is urgent (indispensable) and the improvement of cost effectiveness in the water supply capability of this city is high.
- While, the potential of surface water and groundwater is very low, and its construction of a reservoir is indispensable in order to correspond to future water demand. It is great expense and a long-period are required for construction of reservoir. To correspond to future demand, it is necessary to start investigation and a detail design immediately now, and is urgent.
- The development of the Sihanoukville City attains to a national economic activity, and the big enterprise effect is expected.
- It also agrees in local industrial development.
- The technology transfer and the capacity building on many fields will conduct with a great effect though this project. Especially reservoir construction is not performed in this country in recent years; the technology of reservoir construction and water supply can be transferred.
- The negative impact to an area is comparatively small.