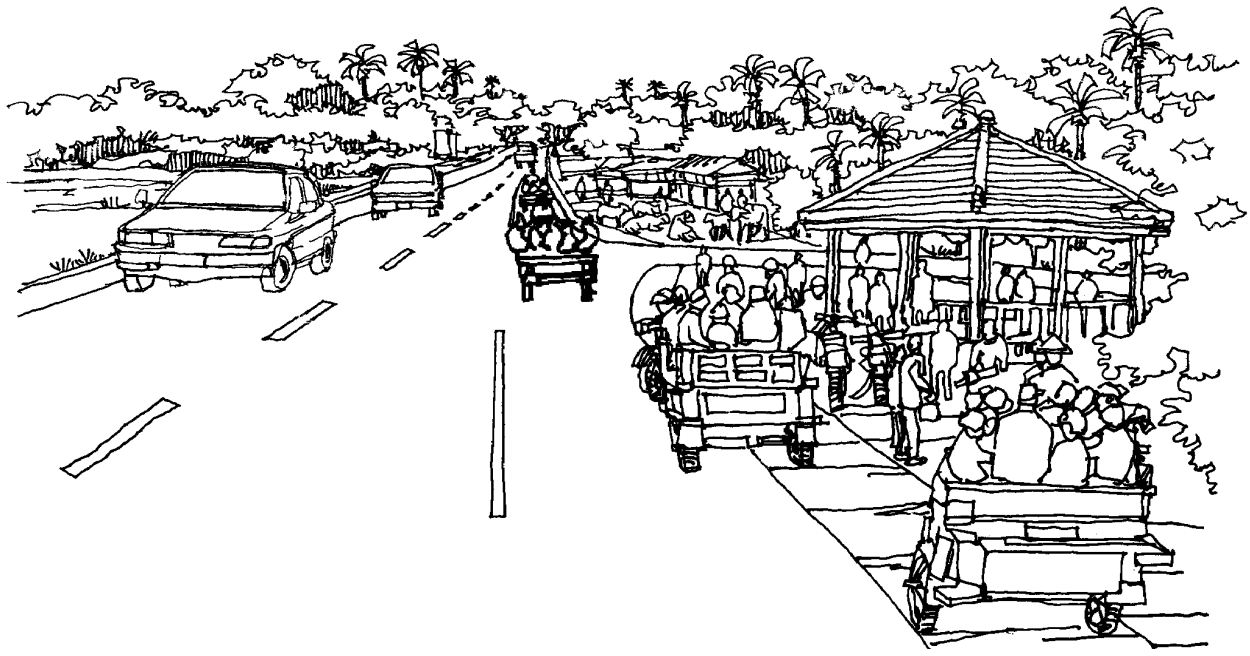
CHAPTER 14 PROPOSED ROAD OPERATION AND MAINTENANCE PLAN



CHAPTER 14 PROPOSED ROAD OPERATION AND MAINTENANCE PLAN

14.1 Road Maintenance Practices

14.1.1 Road Maintenance Works

Road maintenance works are classified into three types: namely, routine, periodic and emergency. Routine maintenance is based on routine (daily) inspection of the condition of pavement, cut and fill slopes, drainage, bridges and other structures and facilities to monitor any defects and damage. The results of routine inspection will be promptly reported to the operation office for follow-up maintenance works to be undertaken either continually throughout a year or at certain intervals every year. The term "preventive maintenance" refers to repair that addresses causes of deterioration leading to the need for costly rehabilitation work in future.

Periodic maintenance is based on detailed inspection performed at certain time intervals such as seasonally or yearly depending on the type and kind of facilities. It includes checking and testing the conditions of various structures and facilities. Defects and damage will be reported for repairs or remedies. Maintenance plans covering several years will be developed.

Emergency maintenance basically comprises works to restore road and road related facilities to their normal operating conditions after they are damaged by road accidents or natural causes. It is impossible to foresee the frequency, but such maintenance requires immediate action. Table 14-1-1 summarizes typical activities of each type of maintenance work.

Table 14-1-1 Typical Maintenance Activities

Type	Activity
Routine includingPreventive	Clearing of pavement
	Mowing and maintenance of plants
	Clearing of ditches and culverts
	Repair of traffic signs and road markings
	Shoulder grading
	Pothole patching and crack sealing
	Repair of sealants and expansion joints of bridges
	Repair of cut and fill slopes
Periodic	Regraveling
	Resealing/surface dressing
	Overlay
	Maintenance of traffic signs and road markings
Emergency	Removal of debris or obstacles from natural causes
	Repair of damage caused by traffic accidents

For routine maintenance activities, an appropriate mix of labor and equipment is required to provide works of adequate quality in a cost-effective manner. In a "labor-based" economy, the aim is to apply a labor/equipment mix that gives priority to labor, but supplements it with light/intermediate equipment where necessary for reasons of quality or cost. The term

"labor-based" thus indicates that flexible and optimal use is made of labor as the predominant resource in so far as cost-effectiveness and quality aspects are ensured. It is important to distinguish between an optimal use of labor and maximum use of labor. The latter could degenerate into a "make work" approach where cost-effectiveness and quality aspects are ignored.

Equipment-based is the opposite of labor-based in that most of the work is done by labor-replacing equipment, supported by a small labor force.

14.1.2 Present Financial Situation

In the present budgetary system, the operation expenditure is categorized into construction and maintenance even though the indicators are that a majority of the maintenance funds probably are spent on emergencies by provincial level and results in leaving very little for conventional maintenance activities.

MPWT budget comprises seven chapters, namely salaries and benefit (chapter 10), administrative expenses (chapter 11), field of economic input (chapter 30), field of social and cultural input (chapter 31), field of international input (chapter 32), investment by internal financing (chapter 50) and investment by external financing (chapter 51). It is noted that MPWT budget does not include the loan proceeds from international lending agencies but comprises the fund allocated from the national budget including the counter fund to the loan that is usually planned as chapter 51 "Investment By External Financing".

Since the budgets are drastically changed in 1996 to 2001 depending upon the fluctuation of chapters 50 and 51, the budget of MPWT for the study purpose is prepared excluding chapters 50 and 51. Fig. 14-1-1 shows the budget of MPWT in 1996 – 2001.

	1996	1997	1998	1999	2000	2001
Plan	4,760	4,125	3,493	4,187	16,039	19,200
Outlay	3,259	3,423	3,213	3,922	14,834	14,664
Official Exchange Rate	2640	2991	3774	3814	3859	3924
Thousand US$	1,235	1,144	851	1,028	3,844	3,737

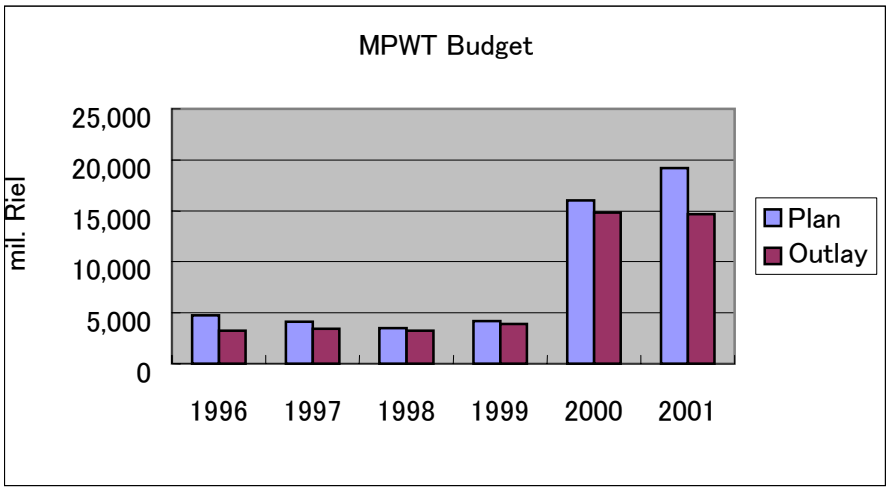


Fig. 14-1-1 Budget of MPWT

The budgets of 2000 and 2001 suddenly increase about 10 billion Riel because the road maintenance fund of 10 billion Riel equivalent to 2.5 million $ is added annually in chapter 30 "Field of Economic Input". The budget for 2002 is planned 16,180 million Riel including the road maintenance fund of 10.5 billion Riel.

However, the road maintenance fund "Fund for Repair and Maintaining of Road (FRMR)" is transferred under the direct management of the Prime Minister and MEF according to the Sub-decree No. 39 dated May 6, 2002. The fund will use for routine and periodic maintenance and repair of the national, provincial and other roads under the management and responsibility of MPWT, Ministry of Rural Development and Ministry of Water Resource and Meteorology to drive up the use of fund effectively, according to Minister's Order No. 3567 of MEF dated July 24, 2002. Therefore, MPWT should request to MEF the allocation of budget for road maintenance together with planning, technical standard and financing objective from the fiscal year of 2003.

In addition to the above-mentioned administrative change, MPWT through MEF officially requests to the Government of Japan in July 2002 the approval of utilization of the counterpart fund of non-project grant aid 1996 for the project "Road Maintenance Catch-up Program". The project will cover the road maintenance of 1,187.31 km, amounting $1.75 million.

14.2 Present Situation of Road Maintenance

The maintenance situation for existing roads has received attention in a number of recent studies under the sponsorship of the World Bank, the Asian Development Bank and Japan. It is a well-established finding that the maintenance attention given to the existing roads in Cambodia is inadequate because of very limited fund availability and institutional weakness. Furthermore, the road maintenance fund is used mostly for road rehabilitation but not for road maintenance.

The road inventory and its condition in Cambodia are summarized by the study "Strengthening the Maintenance Planning and Management Capabilities at the MPWT" funded by ADB in July 2002. Based on the final report, the inventory of road is as shown in Table 14-2-1.

Table 14-2-1 Road Length under MPWT

Type of Road		Length (Km)	
		Kandal	National
N1	Primary National Roads	165.3	2,002
N2	Secondary National Roads	111.2	2,754
N3-1	Provincial Roads	237.8	5,700
N3-2	Urban Roads under MPWT	0	1,700
Total		514.3	12,156

Notes: N1 Roads are the primary national roads with single digit.
N2 Roads are the secondary national roads with double digit.
N3-1 Roads are the provincial roads.
N3-2 Roads are the urban roads under the jurisdiction of MPWT.

MPWT is responsible for maintenance of 12,156 km long road, and the source of fund for road maintenance is the revenue accrued from fuel taxes and vehicle registrations.

The following jurisdictions are set forth on NR-1 C-1 Section (Phnom Penh to Neak Loueng) under current road maintenance system in the study area:

i) NR-1 C-1 Section from the beginning point to Veal Sbov, L= 3.5 km is under jurisdiction of DPWT of Phnom Penh Municipality.
ii) NR-1 C-1 Section from Veal Sbov to Neak Loueng, L= 52.5 km is under jurisdiction of DPWT of Kandal province.
iii) Emergency flood rehabilitation project under PMU-I maintains NR-1 C-1 Section.

The concept of road maintenance system and its organization is that MPWT manages the overall maintenance program and annual activities of national and provincial roads, and provincial DPWT executes them. However, one of fundamental problems of road maintenance lies in the fact that the maintenance work available in provincial DPWT is too small to sustain even resourceful road maintenance organizations.

14.3 Evaluation of Road Maintenance System

14.3.1 System Improvement Measures

The maintenance quality depends on supervision of maintenance works. The following is the situation with regard to effectiveness of supervision, work quality and task allocation:

i) Supervising engineers are responsible for maintenance of roads and road facilities in a certain area. They are able to implement or execute maintenance works, to supervise and control their quality and progress, and to certificate the completion of works using drawings, photographs and other necessary documents.
ii) Maintenance costs of roads and road facilities are reimbursed according to actual works that are carried out referring to preliminary repair and maintenance plan/drawing and its estimated costs.
iii) Taking into consideration the fact that damaged roads are a major cause of traffic accidents, the Government has the policy to prevent traffic accidents and implemented the program to take necessary measures to maintain national roads.

Present road maintenance system will be able to meet incremental demand brought about by the governmental policy of road improvement, provided that fund will be increased and skilled operators will be brought up.

14.3.2 Capacity Building of Road Maintenance

Meeting the increasing requirement for service of the road system is critical to the country's economic development. The Government gives highest priority to arterial road improvement. Roads are deteriorated largely and they require both paving and improving vertical alignment to cope with flood. Moreover, many bridges, which also play an important role as a part of the road system, remain in serious condition and deteriorated due to lack of repair and maintenance and recent increase of heavy traffic. Accordingly, damaged bridges become

traffic bottlenecks, jeopardize road safety, and hinder smooth road transportation.

Both legal entities of DPWT and PMU have the same issues to solve: namely,

- Ways by which adequate funds can be allocated for routine and periodic maintenance such that the project road can be properly maintained during its design life.
- Measures to ensure the efficient delivery of road maintenance-periodic maintenance using equipment-based methods supported by light equipment such as tractor/trailers.
- Initiatives to encourage routine maintenance activities being carried out by local people/villages under contract with provincial DPWT, particularly in areas where local labor is readily available.
- Ways to boost road maintenance training capacity, both for equipment-based methods and for labor-based/light equipment methods.
- Inventory of roads and bridges on all National Roads and its update

Moreover, these two entities as well as other local contractors have similar problems as follows:

i) Shortage of road and bridge construction equipment and machinery
ii) Shortage of local engineers qualified in managing and supervising the operation of road and bridge construction equipment and machinery
iii) Lack of skillful construction equipment operators, mechanics, and electricians
iv) Lack of repair facilities and tools
v) Lack of managerial capability and research ability

In order to strengthen road maintenance capability and to cope with incremental demand brought about by the governmental policy of road improvement, it is necessary to enhance funding availability and to remedy institutional weakness.

It is expected that the proposed Road Maintenance Management Organization (RMMO) as an executing body of "Road Maintenance Catch-up Program" will undertake actual practice as a pilot model to train operators, mechanics and managers, and that such trained skills will eventually contribute to deliver effective construction equipment and to strengthen the road maintenance system.

14.3.3 Increase of Road Maintenance Fund

The total project cost rises up to US$ 42.6 million (equivalent to 168 billion Riels), including costs of resettlement and utility relocation, and it is obvious that it will be heavy financial burden to the Government, compared with the local fund for capital investment of 511.4 billion Riels in 2002. Moreover, upon the completion of the project, the routine maintenance will require 66.5 million Riels every year according to the average National Road's maintenance unit cost of 1.2 million Riels /km, and the periodic maintenance will require approximately 6.3 billion Riels every 10 years. Even the costs of road maintenance will be heavy burden to the Government, compared with the budgetary level that the total road maintenance fund is reported 10 billion Riels in 2002 to maintain all the state roads.

Therefore, in order to secure the annual fund required for road maintenance, it is necessary to increase the road maintenance fund by strengthening road user cost recovery practices and to

draw up a long-term strategy for cost recovery from road users.

The following measures are envisaged to ensure financing mechanism for road maintenance that is indispensable to strengthen road maintenance capability and to cope with incremental demand brought about by the governmental policy of road improvement:

i) to appropriate necessary fund from "Fund for Repair and Maintenance of Road (FRMR) to MPWT
ii) to follow up Road Maintenance Catch-up Program officially requested to Japan
iii) to realize the concept "Fee-for-Service" to contribute to increasing the road maintenance fund such a way;
   - to examine possibility to surcharge additional toll to heavy vehicles at Neak Loueng ferry
   - to build a toll plaza together with weighbridge station and administration office just in case of shortage of fund. (the conceptual layout of toll plaza together with weighbridge station and administration office is shown in the drawing No. D-03 of Vol.3: Drawings.)

For example, the revenue from the proposed toll levying from bridge crossing is estimated as shown in Table 14-3-1, and it seems to contribute to increasing the road maintenance fund considerably.

Table 14-3-1 Estimated Revenue from Bridge Crossing

at 2002 constant price

Toll Revenue	Riel / trip	500	2,000	Total Revenue (mil. Riel)
	Unit	Light Veh	Heavy Veh	
Traffic in 2010	Veh/day	3232	707	1,106.1
Yearly Revenue	mil. Riel/yr	589.8	516.3	
Traffic in 2015	Veh/day	4136	879	1,396.8
Yearly Revenue	mil. Riel/yr	754.8	642.0	

Note: Light vehicles denote sedan, pick-up, light van, mini bus and light truck.
Heavy vehicles denote large bus, heavy truck and trailer truck.

The following points should be taken into consideration:

1) Bridge crossing is the best place to chapter long-distance road users because no alternative bridge exists and the river is wide enough to avoid escape.
2) Since the tollgate will be located at the center of NR-1 C-1, non-motorized traffic and pedestrian who are usually short-distance road users should be exempted from toll.

14.4 Neak Loueng Ferry

14.4.1 Present Situation

(1) Neak Loueng Ferry

The Plain Region, having a population of 6.6 million (2001) that accounts for more than a half of the national population, is severed by the Mekong River into two, Phnom Penh Municipality and provinces of Kandal and Takeo in the west and provinces of Prey Veng

and Svay Rieng in the east. National Road No. 1 (NR-1) is located in the center of Plain Region where the C-1 Section of NR-1 is located in Kandal province and the C-2 Section of NR-1 runs in provinces of Prey Veng and Svay Rieng. Provinces of Kandal, Prey Veng and Svay Rieng are productive for agricultural crops such as paddy, maize and vegetables and for fisheries and livestock & poultry, and they are mainly transported to Phnom Penh by road traffic on NR-1.

Three ferry crossings under the MPWT exist in Cambodia, namely Neak Loueng and Prek Tamaek on the Mekong River and Prek Kdam on the Tonle Sap River. Other ferry services are operated by the private, and they accommodate only pedestrian passengers and light vehicles such as 2-wheel vehicles and passenger cars. Neak Loueng Ferry is only one ferry service on NR-1 crossing the Mekong River, which is operated by the autonomy under jurisdiction of the MPWT.

Ferry terminal exists on both sides of the Mekong River, namely Neak Loueng East and Neak Loueng West. Neak Loueng East is located in the town of Phum Banam of Prey Veng province where the commercial activities are potentially high because the inter-modal facilities between NR-1 and NR-11 exist and many products accumulate and distribute to consuming centers by road transport.

Neak Loueng East (Prey Veng & Svay Rieng side)

Neak Loueng West (Phnom Penh side)

(2) Ferry Terminal Facilities and Operation

Ferry terminal facilities consist of ticket cage, approach bridge and waiting spaces such as passenger car parking, bus parking, truck parking and pedestrian/motorcycle/bicycle waiting room. Two approach bridges in both sides exist so as to operate two ferries simultaneously, and one is movable and another is fixed. Except serious congestion, one ferryboat plies three times every two hours on condition that embarking and disembarking take usually 30 minutes. However, there are three ferryboats, two ferryboats are in operational conditions but one ferryboat is not in operational condition. A ferryboat that has 60 ton capacity can accommodate 30 passenger car units (PCU) plus 2-wheel vehicles and hundred of pedestrians. Animal carts and push-carts also go on board.

These ferry services are operating for 12 hours from 6 a.m. to 9 p.m. due to securing traffic safety during the night, and peak hours are of 8 a.m. to 9 a.m. Ferry is operated through a year but it is apt to be interrupted by storm.

Traffic accidents take place often and there were serious accidents such as collision against boat and car falling.

(3) Organization and Toll Rates

The organization for ferry boat operation comprises as follows:

- Board Members
- Administrative Sector
- Accounting and Financial Sector
- Material Supply Sector
- Technical Sector
- Planning Sector
- Production and Corporation Sector

Two technical staffs are responsible for operating two ferryboats and their tasks and duties are:

- Look after the machine, fuel oil
- Battery and power supply
- Machine operation, etc.

Totaling 140 employees are working at Neak Loueng Ferryboat Division and they comprise as shown in Table 14-4-1.

Table 14-4-1 Organization of Ferry Operation

Position	No.
1. Board Members	4
2. Administrative Officer	2
3. Accounting and Financial Officer	4
4. Material Supply Officer	3
5. Technical Officer	2
6. Planning Officer	1
7. Production & Corporation Officer	124
Total	140

Toll rates as of August 2002 are shown in Table 14-4-2.

Table 14-4-2 Toll Rates as of August 2002

Type of vehicle/Others	Toll (Riel)
Truck-lorry	52,800
Truck	44,500
Bus	39,600
Micro-bus	23,600
Minibus	12,600
Pick-up	8,500
Passenger Car	5,800
Motorcycle	800
Bicycle	200
Pedestrian	100
Animal Cart	1,000
Push-cart	200

(4) Traffic

Annual vehicular traffic at Neak Loueng Ferry for last 14 years is shown in Fig. 14-4-1.

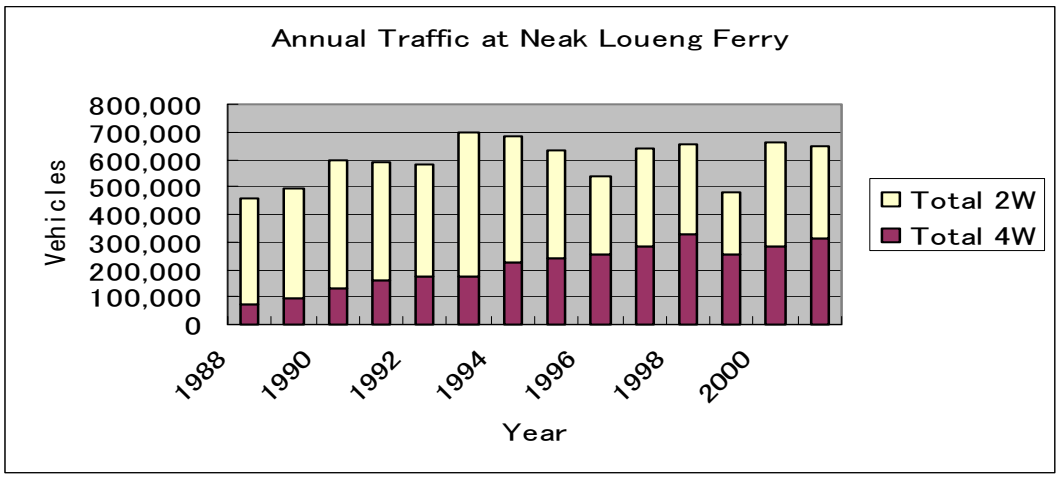


Fig. 14-4-1 Annual Vehicular Traffic at Neak Loueng Ferry

Besides vehicular traffic, many pedestrian passengers use the ferry because they use local buses, moto-remorks and moto-dops after crossing. It is reported that pedestrian passengers prefer crossing on foot to riding on vehicle because they can save time as well as cost. However, middle to long-distance travelers prefer keeping on riding due to travel time and inconvenience of changing luggage.

Annual pedestrian passengers at Neak Loueng Ferry for last 14 years are shown in Fig. 14-4-2.

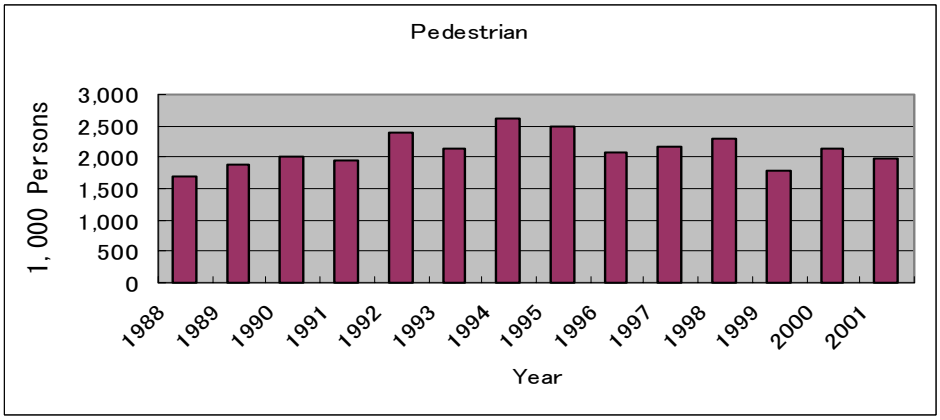


Fig. 14-4-2 Annual Pedestrian Passengers at Neak Loueng Ferry

It may be pointed out that considerable passenger volume occupy the capacity and motorized vehicles may reach to traffic capacity even though present operating system has been improved by the foreign assistance from Danish until 1999 and the operation and management are still in fair level. Moreover, it usually takes more than one hour to cross the Mekong River even though the weather condition is good and no serious congestion happens.

(5) Financial Status

The operation body has well cash-flow balance since total income exceeds total expenditure significantly in August 2002. However, it is difficult to demonstrate sound financial status because one breakdown ferryboat still is not in use due to lack of fund.

14.4.2 Problems related to Ferry Operation

(1) Fluctuation of Water Level

Approximately 7-meter high fluctuation of water level takes place annually at Neak Loueng Ferry.

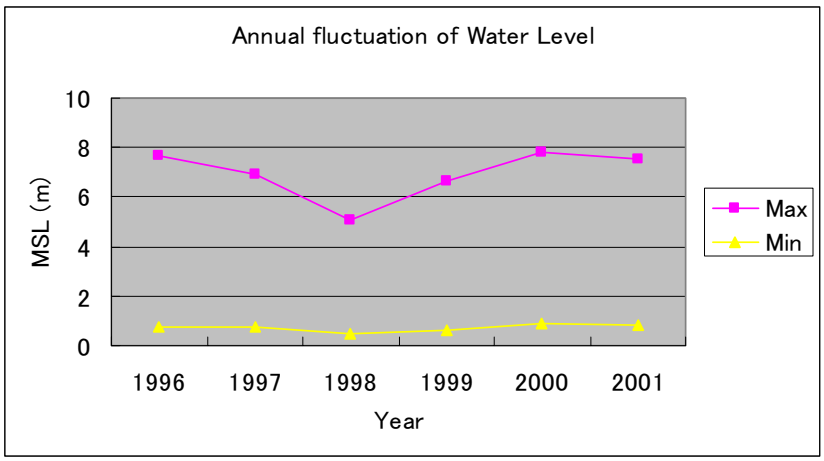


Fig. 14-4-3 Annual Fluctuation of Water Level

The position of ferry approach bridge always vary in dry and wet season, and it cause to make traffic congestion worse. Furthermore, slope of approach bridge and its related facilities face physical difficulties to cope with such high fluctuation, especially steep slope on approach bridge. It sometimes causes to let over-loaded vehicles or push-cart be stuck on the way.

(2) Embarking and Disembarking

Mixed traffic of passengers and motorized vehicles share the common access bridge and road. It is due to one access that entrance traffic should wait to embark until exit traffic should disembark completely. However, it is often observed at peak hours that both directions of traffic conflict on approach bridge once late traffic try to push through.

(3) Approach Road and Terminal Plaza

There is terminal plaza in the vicinity of ferry terminal. The terminal plaza has two access roads to connect to each ferry approach bridge respectively. Many shops and street venders occupy space along access roads and terminal plaza, and a number of moto-dops and moto-remorks wait for passengers at terminal plaza.

Such mixed traffic situation makes traffic congestion worse during peak hours.

(4) Traffic Movement at Neak Loueng Ferry

Traffic movement at Neak Loueng Ferry is studied in implication with traffic surveys at both sides of the ferry. Following features are found;

1) A large number of moto-dops and moto-remorks exist at Neak Loueng West, while high volume of buses is found at Neak Loueng East. Trip length of users may explain this change of modes as short trips use moto-dops and moto-remorks, and medium and long trips may use local bus.
2) Many local buses cross the Mekong River by ferry because their origin and destination of bus passengers are rather far, namely Phnom Penh, Prey Veng and Svay Rieng.
3) Only one peak traffic is observed in morning, and it reveals commuter is limited.

14.4.3 Necessity of Improvement for Ferry Operation and Facilities

(1) All the ferry users use the common approach bridge and access road, and it makes considerable passengers exposed to risk and inconvenience. It is necessary to improve the approach bridge to provide additional space for pedestrian for traffic safety and smooth traffic flow.

(2) Since no lighting system is provided, ferry service is limited to daytime due to securing traffic safety. It is a matter of course that half-day operation causes to disrupt community and to make road transport unreliable. Although traffic demand during the night is rather small compared with that of daytime, it is necessary to

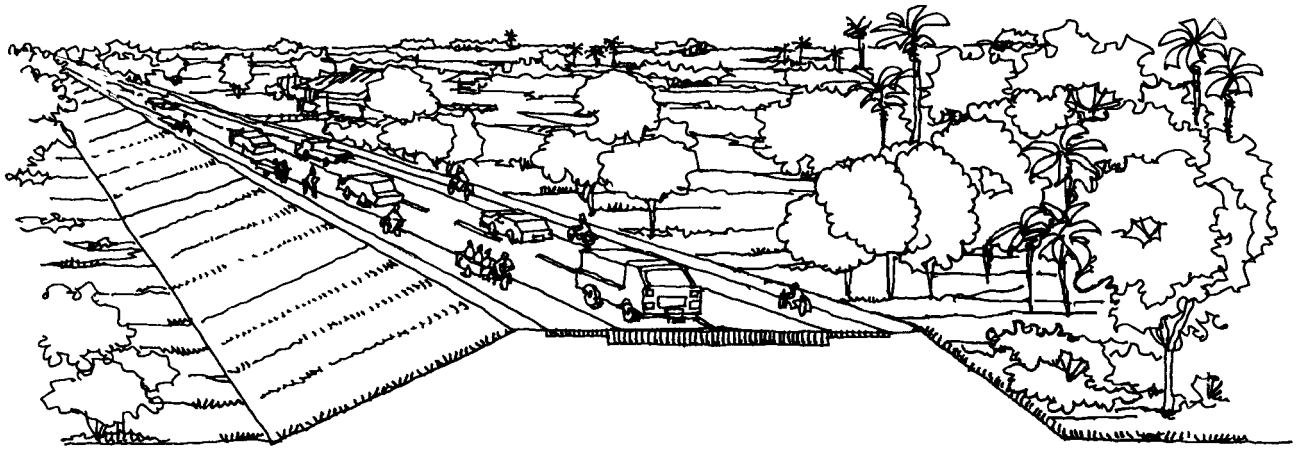
install lighting system at ferry terminal including approach bridge to secure traffic safety and to enable extension of operating hours.

(3) Totaling five ferryboats are in operation under the MPWT, namely two ferryboats at Neak Loueng, two ferryboats at Prek Tamaek and one ferryboat at Prek Kdam. Once one ferryboat is in need of repair or maintenance, usual operation of ferry service cannot be maintained in any ferry crossings. Additional ferryboats are required badly for repair and maintenance.

(4) Figs 14-4-1 and 14-4-2 indicate that both vehicular users and pedestrian passengers reach to the capacity of ferry service even though Kizuna Bridge is open to the public and it lets some traffic from the central part of Prey Veng Province divert to NR-6 & 7.

It is necessary to deliberate scheme of bridge crossing since such considerable passengers are always exposed to risk and inconvenience.

CHAPTER 15 PROJECT IMPLEMENTATION PLAN



CHAPTER 15 PROJECT IMPLEMENTATION PLAN

15.1 Introduction

The project implementation plan is required to provide the succeeding economic analysis with the proposed time schedule based on due procedures such as basic/detailed design, resettlement of PAPs, relocation of utilities, tendering process and construction works stemming from a study of the expected construction planning. The following objectives are also taken into account:

- to provide reasonable construction planning and time schedule for whole project
- to provide basic data and information for the economic analysis
- to make a reasonable scale of improvement plan to reflect the result of the demand forecast analysis
- to reflect the study results to the conclusion and recommendation

15.2 Road Improvement Plan

The road improvement plan aims to secure the traffic of NR-1 (National Road No.1) throughout the year to avert flood damage. The improvement plan also aims to provide an international standard to NR-1 to be a part of Asian National Highway A-1. The following components are proposed to improve the project road in term of both long-tem and short-term improvement:

1) Improvement of vertical alignment more than 2000 Flood level plus 50 cm and pavement thickness
2) New construction of asphalt concrete pavement whose structure consists of roadbed embankment including sub-grade, sub-base course, base course and surface course
3) Provision of space for slow-moving vehicles
4) Provision of sidewalk and drainage together with street lighting up to the intersection to Tiger beer factory
5) Provision of space for future widening up to Kokir Market
6) Improvement of existing intersection to Tiger beer factory by channelization with traffic signal
7) Existing two temporary bridges replaced by new pre-stressed concrete bridge with protection against erosion and local scouring;
8) Existing two pipe culverts replaced by new pipe culvert with protection against erosion
9) Existing two water gates replaced by new box culvert with protection against erosion
10) Construction of one new pre-stressed concrete bridge with protection against erosion and local scouring
11) Construction of nine new box culverts with protection against erosion
12) Protection of slope surface of road embankment: 900-meter long revetment and 2,900-meter long green belt
13) Traffic safety measures and control facilities installed by road markings, guard posts/rails, regulatory & warning signs, guide signs, kilometer posts and traffic signal at intersection

14) Road related facilities such as moto-remork stops cum livestock refuge during flood, bus stops, pedestrian bridges, weighbridge station, approach slopes for local road and Road Station
15) Provision of space for toll plaza and administration office if necessary

(1) Road and Pavement Structure

The study area was divided into five sections referring the results of traffic survey. Road and Pavement preliminary design was executed in each section. Common features of road and pavement structures are listed as follows:

1) Design Speed : 80 km/h
2) Through-traveled lane width : 3.5 m/lane
3) Space for slow-moving vehicles : 2.5 meters
4) Crossfall (Through-traveled lane) : 2%
5) Crossfall (Shoulder) : 4%

Each section differs in width and component of pavement structure.

Table 15-2-1 Road Design Features in each Section

Section	1	2	3	4	5	6	7
Chainage (St)	0+000 ~ 0+300	0+300 ~ 3+500	3+500 ~ 7+000	7+000 ~ 13+500	13+500 ~ 14+000	14+000 ~ 36+000	36+000 ~ 55+300
Type of Cross Section	Type I	Type II	Type II	Type III	Type IV	Type V	Type V
Type of Pavement	Overlay	Type A	Type B	Type C	Type C	Type D	Type E

- Details of Cross Section Unit: m

Type	Total Width	Soft Shoulder	Sidewalk	Hard Shoulder	Through-lane	Median	Through-lane	Hard Shoulder	Sidewalk	Soft Shoulder
I	24.0	-	2.5	2.0*	6.5	2.0	6.5	2.0*	2.5	-
II	24.0	-	2.5	2.5	3.5	7.0**	3.5	2.5	2.5	-
III	21.0	1.0	-	2.5***	3.5	7.0**	3.5	2.5***	-	1.0
IV	24.0	-	2.5	2.0*	6.5	2.0	6.5	2.0*	2.5	-
V	14.0	1.0	-	2.5***	3.5	-	3.5	2.5***	-	1.0

* Hard shoulder is for stopping lane.
** Median is space for future widening.
*** Hard shoulder is space for slow-moving vehicles.

- Details of Pavement Unit: cm

Type	Surface Course	Base Course	Sub-base Course	Sub-grade
A	10	15	30	Design CBR: 9 Improved sub-grade Selected Materials: 30 Additional Embankment: 20
B	10	15	27	
C	10	15	24	
D	5	25	29	
E	5	20	32	

The horizontal alignments are selected to secure driving safety.

The design embankment level is the 2000 Flood level plus 50 cm at the lowest section to secure the stability of road bed.

The pavement thickness is designed by applying AASHTO design method on the basis of each design CBR of subgrade, and ESAL is calculated based on the results of traffic survey, traffic demand forecast and axle load survey.

(2) Traffic Safety Measures and Control Facilities

1) Road Markings

Road markings are particularly important to help in regulating traffic and warning or guiding road users. Road markings should be uniform in design, position and application so that they may be recognized and understood immediately by all road users.

Principal road markings will be of Centerline, Dividing line between driving through lane and lane for slow vehicles and Roadside line. They will be painted on pavement.

2) Guard Posts and Rails

Guard posts are to function to redirect vehicles away from the roadside hazard such as high embankment and safety zone for pedestrians etc.

Road sections with horizontally sharp curves warrant installing guard posts to secure the traffic safety. Traffic volume is also taken into account when deciding where to install them.

Guard Rails are installed on box culverts to prevent pedestrian and vehicles to fall down to river bed (4.6 ~ 6.3-meter high). On bridges, hand rails are installed for the same purpose.

3) Regulatory & Warning Signs

Regulatory & Warning signs are to inform road users of traffic rules and regulations and to appeal for enforcement and caution that would not otherwise be apparent.

Regulatory & Warning signs are planned to be installed at the locations where enforcement appeals and caution is needed, such as vicinity of intersections, markets, schools, Pagoda (Buddhist temple), bus stops, moto-remork stops, pedestrian overpasses, bridges, culverts, toll plaza, sharp curves and Road Station etc.

4) Guide Signs

Guide signs are to convey information to drivers such as destination and distance, service facilities and route confirmation.

Guide signs are planned to install in the vicinity of major intersections, markets, toll plazas, weigh bridges stations, gas stations and Road Station.

5) Kilometer Posts

Kilometer posts are to give information to road users as well as to locate and orient themselves. They also serve a useful function for inspection and maintenance work.

6) Traffic Signal at Intersection

Traffic Signals are planned to be installed at the intersection to Tiger Beer factory. The intersection is planned to be improved by channelization. It could be installed on other major intersections for the traffic, in front of the major markets, schools and pagodas for the pedestrians.

(3) Road Related Facilities

1) Moto-remork Stop cum Spaces for Livestock Refuge

This space is planned as moto-remork stop throughout the year to avoid hampering through traffic from on-road parking of moto-remorks. This space can also provide enough flat space for local traffic to wait merging to through traffic.

Since livestock occupy the existing road during flood and it hampers the smooth movement of traffic, it may be used as a place of livestock refuge during flood.

It is planned at minor intersections to local roads leading to villages, where small number of traffic is expected daily.

2) Bus Stop

Bus stops are planned to construct in the vicinity of major intersections, nearby the villages, local markets, schools and pagodas. A bus bay comprising ramps and bus stop will be provided besides the space for slow-moving vehicle to avoid bus passengers from through traffic as well as to ensure traffic safety.

3) Pedestrian Bridge

A pedestrian bridge is planned to construct where pedestrian are expect to be enough big to disturb vehicular traffic. Since a pedestrian bridge forces pedestrian to use upward staircase first, it is rather hard to make it utilize effectively. However, it is necessary to ensure traffic safety of pedestrian as well as to keep traffic movement smoothly. The following places are appropriate to provide a pedestrian bridge;

i) At bus stop in the vicinity of factory and public facilities such school and pagoda where road width is enough wide and peak demand both road traffic and pedestrian is predominant.
ii) At the place where it is necessary to enforce no pedestrian crossing.

4) Weighbridge Station

For the purpose of prevent an overloaded heavy vehicle from passing NR-1 C-1, a weighbridge station is planned to construct in the vicinity of new bridge to inspect axle load of heavy vehicle.

5) Approach Slope for Local Road

Since the designed road surface of NR-1 C-1 is at least 1.0 meter higher than the ground level, it is necessary to provide approach slope for local traffic to merge to through traffic on NR-1. Some accidents are reported that an animal cart had a collision with vehicle because the cart dashed to climb the slope of embankment and no space for waiting besides road was prepared. Improvement of approach slope is required for local traffic to connect local road to NR-1 safely.

6) Road Station

Road Station is the functional and desirable elements of road to rest from their drive at periodic intervals and care for them by provision of relaxation and recreation. It will also provide road users with the traffic safety, convenience and opportunity to come in

touch with local products and culture. Road Station is located at a roadside together with parking facilities, rest facilities, gas station, repair shop and kiosk separated from the roadway, and provide the motorist to stop and rest for a short time.

(4) Type of Structures for Opening for Floodwater Discharge

The improvement plan of opening for floodwater discharge includes construction and replacement of bridges, box culverts and pipe culverts. The type, dimension and location of each structure are determined based on the preliminary design referring to the results of hydrologic and hydraulic studies and engineering site survey.

The outline of bridge and structure improvement plan is envisaged as follows:

1) Replacement of Two Temporary Bridges

Two temporary bridges (Bailey bridges) are planned to replace with new PC (pre-stressed concrete) bridges. The location will be the existing Cut-offs No.1 and 2. The bridge at Cut-off No.1 (Bridge No.2) will be as same place as the existing place. The bridge at Cut-off No.2 (Bridge No.3) will be removed 470 meters towards Neak Loueng from the exiting location, where the surroundings are lowest level referring to the topographic survey.

Bridge No.2 is 100-meter long with 4 spans and each span is 25.0 meters. Bridge No. 3 is 66-meter long with 3 spans and each span is 22.0 meters. The girder will be PC I shaped and foundation will be RC (reinforced concrete) cast-in-situ pile.

2) Construction of One New PC Bridge

PC bridge (Bridge No.1) is planned at 700 meters towards Phnom Penh from Bridge No.2. It is planned to install for the purpose of flood mitigation. It is 66-meter long with 3 spans and each span is 22.0 meters. The girder will be PC I shaped and foundation will be RC (reinforced concrete) cast-in-situ pile.

3) Replacing Two Existing Water Gates

Two existing water gates are planned to replace with RC box culvert with water gate slots. Kampong Phnom water gate will be 3-cell box culvert with water gate slots for flood and irrigation control. The other will be 2-cell box culvert with water gate slots. Slots for the water gates are included in the design. Water gates will be installed and operated by local authorities.

4) Construction of Six New Box Culverts with Water Gate Slots

Six box culverts with water gate slots are planed for flood control and irrigation. The type, dimension and location are determined mainly by the hydrologic and hydraulic studies and topographic survey. Slots for the water gates are included in the design. Water gates will be installed and operated by local authorities.

5) Construction of Three New Box Culverts without Water Gate Slots

Three box culverts without water gate slots are planed for flood mitigation. These culverts are with two cells and planned to place at the same flood area of new PC bridges. It is useless to install water gate because the floodwater flows through the

bridges to the side of Colmatage area. Dimension and location are determined mainly by the hydrologic and hydraulic studies and topographic survey.

6) Replacement of Two Pipe Culverts for Floodwater drainage

Two existing pipe culverts are planned to replace with RC pipe culvert. Pipe culvert will be covered by cast-in-situ RC to prevent non-uniform settlement and leakage of water. Dimension is determined by the hydrologic and hydraulic studies.

(5) Slope Protection against Erosion

Slope of road embankment is planned to protect against erosion where the embankment faces directly water from the Mekong River. Sod facing is judged as an insufficient protection in these areas. Revetment or 1:3-slope with green belt is proposed for the protection. Revetment is planned for 900 meters from St. 18+600 to St. 19+500 and 1:3-slpoe for 4 places, 2,900 meters.

(6) Improvement of Intersection to Tiger Beer Factory

The existing intersection to Tiger beer factory is planned to improve a channelized intersection with traffic signal, keeping space for future development of grade separation structure.

15.3 Construction Planning

(1) Quantities of Major Construction Works

Construction planning should be made based on quantities of each main construction work item and selection of construction methods in a site condition. The selection of construction method and details of quantities are discussed in Chapter 13.4. Quantities of main construction works are summarized in Table 15-3-1.

Table 15-3-1 Quantities of Major Construction Works

Classification	Item	Unit	Quantity
Earth Work	Excavation	m^3	1,564,852
	Removal of existing pavement	m^2	333,000
	Embankment work	m^3	1,259,102
	Sub-Grade work	m^3	396,400
	Trimming work of Slope	m^2	743,064
	Embankment Material*	m^3	1,259,102
	Sub-Grade Material*	m^3	296,500
	Revetment work	LS	1
	Planting	LS	1
	Miscellaneous Work	LS	1
Pavement Work	Sub-Base	m^2	769,980
	Base Course	m^2	827,620
	Surface course (As)	m^2	695,000
	Side Walk work	LS	1
Structure Work (Bridge Construction)	L=66.0m (3@22m) Width=14m	m^2	924
	L=100.0m (3@25m) Width=14m	m^2	1,400
	L=66.0m (3@22m) Width=14m	m^2	924
Structure Work (Culvert construction)	Pipe culvert 1.0m	LS	1
	Box culvert (2 cells)	Plc.	10
	Box culvert (3 cells)	Plc.	1
Drainage Work	RC pipe installation	m	1,400
	Catch Basin	LS	1
Road Facility Work	Road making	m	240,500
	Connecting road work	m^3	39,845
	Guide post installation	nos	6,000
	Miscellaneous Work	LS	1
Temporary Work	Stock yard work	Plc	14
	Asphalt plant yard	Plc	1

*Including Hauling cost LS: Lump-sum, Plc: Places

(2) Construction Time Schedule

Construction time schedule is prepared based on quantity of works and selected construction method considering the following conditions in the project area.

1) Earth works (embankment and sub-grade work) are limited to the dry season (6 months, November to April)
2) Asphalt pavement works (sub-base course, base-course and surface course) can be conducted throughout the year.
3) Foundation, substructure and protection works under HWL are limited to dry season (6 months, November to April) while constructing the bridges.
4) Constructing culvert will be conducted in dry season (6 months, November to April).

36 months of construction period are estimated to attain optimum investment schedule as shown in Table 15-3-2.

Table 15-3-2 Construction Time Schedule

Section: Phnom Penh ~ Neak Loueng

		Quantity	Progress Rate	Year One												Year Two												Year Three											
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	Road Length (km)	56.0 km																																					
1	Preparatory Works																																						
2	Earth Work																																						
	Embankment	1,259,102 m^3	114,464 m^3/month																																				
	Sub-grade work	396,400 m^3	36,036 m^3/month																																				
3	Pavement																																						
	Surface Course	769,980 m^2	128,330 m^2/month																																				
	Base Course	827,620 m^2	87,118 m^2/month																																				
	Sub-base Course	695,000 m^2	99,286 m^2/month																																				
4	Bridge																																						
	Foundation Work	2,885 m	721 m/month																																				
	Substructure Work	7 nos	- nos																																				
	Protection Work	-	-																																				
	Superstructure Work	232.0 m	13 m/month																																				
5	Culverts																																						
	No. of Location (Pipe)	2 nos	- nos																																				
	No. of Location (Box)	11 nos	- nos																																				
6	Incidental Works																																						

15.4 Implementation Time Schedule

15.4.1 Time Requirements

(1) Basic Design

A basic design will be conducted based on this feasibility study, and it aims to make it clear the short-term improvement from the proposed road improvement plan. It is usual that a lending agency or donor country will define the specification of facilities designed in the preliminary design. Seven months will be required to complete it although some additional detailed surveys are necessary, such as plane-table survey at major structures, supplemental cross sectional survey, river cross section survey and additional borehole investigation.

(2) Detailed Design

It is indispensable to conduct a detailed design at a certain level of accuracy to prepare following necessary maps and documents;

1) Bill of Quantity of each project package based on designing works;
2) Tender documents for tendering; and
3) Agency estimates for fund allocation.

It will take five months after contracting with a consultant to complete a detailed design even though a professional consultant familiar with Cambodian conditions is procured and advanced technology such as computer aided design (CAD) and global positioning system (GPS) be fully utilized.

Since no basis is found in preparation of required fund for detailed design, time requirement between the end of feasibility study and the beginning of detailed design is ignored.

(3) Resettlement of PAPs and Relocation of Utilities

The proposed plan will require not acquisition of land but evacuation of dwellers within Road Right-of-Way (ROW). The consummation of resettlement of PAPs and relocation of utilities always becomes crucial in a road project, and it fully depends upon the allocation of required funds and the competence of executing agency.

As old saying of "strike while the iron is hot", uninterrupted process of project implementation could facilitate most of well-known difficulties such as resettlement problem, cost overrun and so forth. On the contrary, slow process of documentation could expose increase of risk against the approved plan.

According to prevailing procedure, 1,805 houses are located within tentative ROW of 30 m, and they should move outside the tentative ROW. Since the permanent ROW is designated 60 meters, it is socially feasible to vacate the land by a due procedure taken as the fair and just compensation to make Project Affected Persons (PAPs) resettled voluntarily within the ROW.

Under such circumstances, it may take one year to complete resettlement of PAPs and

relocation of utilities along NR-1 C-1.

(4) Tendering Process

After the completion of detailed design, it usually requires sufficient time to consummate due procedure to select a responsible and bona fide contractor through a competitive bid. Pre-qualification of contractor is usually executed before the tendering process.

It will take four months to complete tendering process from the completion of detailed design including pre-qualification of contractors.

Since no commitment is found for project implementation, time requirement for funding arrangement is neglected.

(5) Construction Time Schedule

It will take 36 months to complete construction of bridge and road, referring to the construction planning as discussed in Section 15.2.

15.4.2 Implementation Time Schedule

For the purpose of economic analysis, project implementation time schedule is prepared as shown in table 15-4-1.

Table 15-4-1 Implementation Time Schedule

		2003										2004												2005		2006		2007	
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1st term	2nd term	1st term	2nd term	1st term	2nd term
1)	Basic Design	═══	═══	═══	═══	═══	═══	═══	═══	═══	═══																		
2)	Detailed design/Preparation of tender documents										═══	═══	═══	═══	═══														
3)	Pre-qualification of Contractors															═══	═══												
4)	Tender notice																★												
5)	Tendering/Tender evaluation																	═══	═══										
6)	Signing of contract																			★									
7)	Construction																				═══	═══	═══	═══	═══	═══	═══	═══	═══
8)	Completion of work																												★

CHAPTER 16 ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 16 ECONOMIC AND FINANCIAL ANALYSIS

16.1 Economic Evaluation

16.1.1 General

(1) Objective of the Economic Analysis

In this chapter, it is described the economic analysis conducted on the Project Road of the National Road No.1 from Monivong Bridge to Neck Loueang Ferry Terminal. The objective of the economic analysis is to evaluate whether the investments to the Project Road is worth to implement or not from view of national economic point.

(2) Implementation Plan of the Project

According to the implementation plan, it is assumed that the basic design of the project road will start at second quarter of 2003 after completion of this feasibility study and finished at the end of that year. The detailed engineering design and tendering will start at early 2004 and finish at third quarter of 2004. Therefore the construction of the project road is expected to start at fourth quarter of 2004 and completed at end of first quarter of 2007. Actual opening to the traffic is therefore expected to be in second quarter of 2007.

(3) Evaluation Period

The evaluation period is assumed to be 24 years from 2003 to 2026.

(4) Evaluation method

The economic evaluation method is principally employed benefit cost analysis which is evaluated investment efficiency through comparison between costs and benefits derived from the Project Road. It is expressed the benefit cost stream during evaluation period and the economic indicators used in this study are as follows:

- Net Present Value (NPV),
- Benefit Cost (B/C) Ratio, and
- Economic Internal Rate of Return (EIRR).

(5) Benefits and Costs

The benefits and costs derived from the Project Roads can be defined as those with and without Project principal. The project being completed can be defined as with project while the project being not implemented can be defined as without project. Even if this without project case, it is assumed that minimum maintenance works such as patching destroyed pavement, etc will be done. There are various benefits derived from the project, amongst tangible benefits are taken into account in this study:

- reduction of vehicle operating costs
- reduction of travel time costs

16.1.2 Project Cost

(1) Project Cost

The project cost, which was already calculated in the previous section, is expressed as the financial cost. It is necessary to covert from financial cost to economic cost using conversion factor. In this study, it is assumed the following conversion factors;

- For unskilled labour, conversion factor is 0.48, which extracted from VOC model developed in this study
- For fuel / oil cost, conversion factor is 0.80 since 20 % is assumed as fuel tax
- For imported construction materials which are asphalt, steel bars etc., 0.85 conversion factor is set according to rate of average import tax and VAT of these materials
- For tax and duties, conversion factor is 0.00 because they are just financially transferred to the government.
- For housing relocation compensation and land acquisition cost , conversion factor of 0.768 is applied

Table 16-1-1 Construction Cost Estimate

		Financial Cost	Economic Cost
1	Construction Cost	38,338	32,933
2	Land Acquisition Cost	1,396	974
3	Utility Relocation Cost	655	457
4	Engineering Fee	2,949	2,491
5	Environmental Cost	70	49
Total Cost		43,408	36,904

Unit: US$ '000

Table 16-1-2 Project Cost Estimation

Work Item	Financial Cost	Foreign Cost	Local Cost	Tax	Economic Cost
1 Construction Cost					
1) Direct cost					
Earth Work	7,194,800	4,611,300	2,160,170	423,330	6,270,311
Pavement Work	13,074,450	8,195,100	3,838,850	1,040,500	11,143,337
Structure Work	6,858,200	4,397,800	2,060,020	400,380	5,979,895
Drainage Work	386,200	243,200	113,800	29,200	330,598
Road Facility Work	1,646,000	965,300	452,250	228,450	1,312,628
Temporary Work	331,300	217,600	101,900	11,800	295,859
S-Total	29,490,950	18,630,300	8,726,990	2,133,660	25,332,628
2) Indirect Cost					
Temporary Facility Cost	1,179,638	745,212	349,080	85,346	1,013,305
Field Expenses	5,013,462	3,167,151	1,483,588	362,722	4,306,547
Overhead Cost	2,654,186	1,676,727	785,429	192,029	2,279,937
S-Total	8,847,285	5,589,090	2,618,097	640,098	7,599,788
Total	38,338,235	24,219,390	11,345,087	2,773,758	32,932,417
2 Consultant Fee					
Detailed Engineering	1,179,638	745,212	349,080	85,346	1,013,305
Construction Supervision	1,769,457	1,117,818	523,619	128,020	1,519,958
Total	2,949,095	1,863,030	872,699	213,366	2,491,373
3 Land Acquisition and Compensation	1,395,322	0	1,268,475	126,847	974,188
4 Environmental Monitoring Cost	69,810	0	63,464	6,346	48,740
5 Utility Relocation Cost					
1) Electricity	286,157	0	260,143	26,014	199,790
2) Communication Cable	368,940	0	335,400	33,540	257,587
3) Removal of UXO	0	0	0	0	0
Total	655,097	0	595,543	59,554	457,377
Grand Total	43,407,559	26,082,420	14,145,267	3,179,872	36,904,095

Source: JICA Study Team's Estimation Unit: US $

Note: Removal cost of UXO includes earth work.

(2) Maintenance Cost as Agency Cost

In case of asphalt concrete pavement being applied to the National Road No.1, it is generally said that annual maintenance costs is reduced compared with the present road. According to the maintenance study made in this study, the present maintenance cost for main national roads in 2002 are estimated and required for about US $ 300 per kilometer. After implementation of the asphalt concrete pavement to the project road, the required maintenance cost to keep good condition would be required to US $1,530 per kilometer. The difference between the present maintenance cost (without project) and after implementation of the project (with project), can be defined as the additional cost of the maintenance cost as the agency cost.

16.1.3 Vehicle Operating Costs and Time Cost

(1) Vehicle Operating Cost

The vehicle operating costs (VOC) and time cost are presented in detail in Appendix K. The characteristics and unit costs of each vehicle are summarized in Table 16-1-3. Based

on those characteristics and unit costs, it is estimated VOC as shown in Table 16-1-4. This VOC have already expressed as economic costs. Table 16-1-5 shows the VOC by roughness index.

Table 16-1-3 Unit Cost of Vehicle Operating Cost by Vehicle Types

	Motor Cycles	Cars	Pickups	Minibus	Buses	2-3 axle trucks	4 axle trucks	Articulated trucks
Representative Vehicle	Honda 100	Toyota Corolla	Toyota Hi-lux	Toyota Hi-ace		Hyundai	Hino (8 t)	Benz 2024
New Vehicle Prices	681	20,023	13,758	23,692	62,350	31,425	49,810	54,620
Service Life (yrs)	10	12	12	10	10	12	14	14
Hours Driven per Year	400	550	1,200	1,200	1,750	1,200	2,050	2,050
Kilometers Driven per Year	10,000	25,000	30,000	30,000	70,000	40,000	86,000	86,000
Life time Running Kilometers	100,000	300,000	360,000	300,000	700,000	480,000	1,204,000	1,204,000
Tire Cost	16.3	67.9	104.3	84.7	736.3	234.7	1,140.7	1,140.7
Running Kilometers	20,000	40,000	50,000	40,000	50,000	50,000	50,000	50,000
Tire Cost per 1000 Kilometer	0.82	1.70	2.09	2.12	14.73	4.69	22.81	22.81
Fuel Type Used	Petrol	Petrol	Diesel	Petrol	Diesel	Diesel	Diesel	Diesel
Fuel Costs (US$/L)	0.3087	0.3087	0.2982	0.3087	0.2982	0.2982	0.2982	0.2982
Fuel Consumption Rate (l/km)	0.02	0.14	0.17	0.15	0.3	0.17	0.3	0.3
Oil Costs	4.86	9.72	12.15	12.15	48.6	34.02	75.33	75.33
Distance between Oil Changes	5000	10000	7500	7500	8000	9000	10000	10000
Annual Maintenance Cost- Spare Parts	6.8	166.9	114.7	236.9	623.5	261.9	355.8	390.1
Annual Maintenance Cost- Labour	3.3	28.9	28.9	46.2	89.7	89.7	89.7	89.7
Insurance Cost per year	114	616	528	616	572	528	352	352
Crew Cost	78	143	469	1,162	1,695	1,162	1,985	1,985
Relicted Value	34.1	2,002.3	1,375.8	2,369.2	6,235.0	3,142.5	4,981.0	5,462.0
Time Related Depreciation	35%	35%	35%	35%	35%	35%	35%	35%
Distance Related Depreciation	65%	65%	65%	65%	65%	65%	65%	65%
Overhead Cost(%)	0	0	10	10	10	10	10	10

Table 16-1-4 Vehicle Operating Cost by Vehicle Types

		Motor Cycles	Cars	Pickups	Minibus	Buses	2-3 axle trucks	4 axle trucks	Articulated trucks
Time Related VOC (US$/yr)	Crew cost	78.0	143.0	469.2	1,162.2	1,694.9	1,162.2	1,985.4	1,985.4
	Maintenance Cost	3.3	28.9	28.9	46.2	89.7	89.7	89.7	89.7
	Insurance Cost	114	616	528	616	572	528	352	352
	Depreciation Cost	23	526	361	746	1,964	825	1,121	1,229
	Sub-Total	218	1,313	1,387	2,571	4,321	2,605	3,548	3,656
	Overhead Cost	22	131	139	257	432	260	355	366
	Total	240	1,445	1,526	2,828	4,753	2,865	3,903	4,022
	US$ / Hour	0.027	0.165	0.174	0.323	0.543	0.327	0.446	0.459
Distance Related VOC (US$)	Fuel Cost	61.7	1,080.5	1,520.8	1,389.2	6,262.2	2,027.8	7,693.6	7,693.6
	Oil Cost	9.7	24.3	48.6	48.6	425.3	151.2	647.8	647.8
	Tire Cost	8.2	42.4	62.6	63.5	1,030.8	187.8	1,962.0	1,962.0
	Maintenance Cost	6.8	166.9	114.7	236.9	623.5	261.9	355.8	390.1
	Depreciation Cost	42.1	976.1	670.7	1,386.0	3,647.5	1,532.0	2,081.3	2,282.3
	Sub-Total	128.5	2,290.2	2,417.4	3,124.2	11,989.3	4,160.7	12,740.5	12,975.8
	Overhead Cost	12.9	229.0	241.7	312.4	1,198.9	416.1	1,274.1	1,297.6
	Total	141.4	2,519.2	2,659.1	3,436.6	13,188.2	4,576.8	14,014.6	14,273.4
	US$ / 000km,	14.1	100.8	88.6	114.6	188.4	114.4	163.0	166.0

Table 16-1-5 Unit Cost of Vehicle Operating Cost by Roughness Index

Roughness	2	3	4	5	6	7	8	9	10
Motor Cycles	14.1	14.2	14.5	14.8	15.1	15.4	16.0	16.7	17.5
Cars	100.8	101.0	103.3	105.5	107.8	110.1	113.9	119.3	124.7
2-3 axle trucks	114.4	114.6	117.7	120.8	124.0	127.1	130.2	133.4	138.7
4axle trucks	163.0	163.0	171.4	179.9	188.3	196.8	207.4	220.0	232.7
Buses	188.4	188.4	197.8	207.1	216.5	225.9	235.2	246.4	259.4

(2) Time Costs

The time cost in this study is estimated on the basis of the monthly household income in 1999 surveyed in the socio-economic survey. It is assumed that the car users used for the top decile among the household income deciles, the motor cycle users belong to the following three lower deciles (7^{th} to 9^{th} deciles) and the other mini-bus, bus, moto-dop and moto-remork users is used for the average household income.

Each household income in 1999 is escalated to that in 2002 using growth rate of GDP per capita. Assuming number of working hours per month and household members, time value of each vehicle users is estimated in Table 16-1-6.

Using composition of work and business trip purposes, vehicle occupancy and growth rate of GDP per capita, the time cost of each vehicle user is estimated in Table 16-1-8.

Table 16-1-6 Calculation of Time Value, 2002 Prices

		Cars & Pickups	motorcycles	Trucks & Buses
Household Income	Riel/mo/HH	1,384,860	544,330	465,407
Monthly Working Hours	hr/mo	192	192	192
Hourly Income	Riel/hr/HH	7,213	2,835	2,424
No. of Household Member	Persons/HH	5.2	5.2	5.2
Hourly Income/Capita	Riel/hr/Person	1,387	545	466
Hourly Income/Capita	US$/hr/Person	0.348	0.137	0.117

HH: Household

Table 16-1-7 Composition of Trip Purpose

Purpose	Composition
To Work	0.246
To School	0.098
Shop	0.161
Business	0.395
Private	0.101
Total	1.000

Source: Traffic Surveys conducted inthis study

Table 16-1-8 Time Value by Types of Vehicle and Years

	Motorcycles	Light Vehicles	Heavy Vehicles	Bicycles
2002	0.160	0.499	0.269	0.054
2005	0.179	0.558	0.301	0.060
2010	0.213	0.663	0.358	0.072
2020	0.258	0.801	0.432	0.087

16.1.4 Estimation of Economic Benefits

(1) Traffic Demand on the Project Road

In order to estimate the economic benefits, it is used for the results of the traffic demand forecasts in cases of with and without the project road as shown in Tables 16-1-9 to 16-1-11 (Details are shown in Appendix K)

Table 16-1-9 Traffic Volume in cases of with and without Project by Year

	With Project	Without Project	With – Without
2005	197,426	195,566	1,860
2010	286,470	280,734	5,736
2015	367,138	359,746	7,392

Unit: Veh. / Day

Table 16-1-10 Travel Time in cases of with and without Project by Year

	With Project	Without Project	With – Without
2005	562,127	833,414	-271,287
2010	820,290	1,206,931	-386,641
2015	1,051,283	1,589,650	-538,366

Unit: Veh-hr/Day

Table 16-1-11 Vehicle Kilometers in cases of with and without Project by Year

	With Project	Without Project	With – Without
2005	474,843	469,245	5,598
2010	696,632	678,615	18,017
2015	893,183	870,199	22,984

Unit: Veh-km/Day

(2) Benefit Estimation

1) Vehicle Operating Costs

The saving in vehicle operating costs is quantified on the annual basis by means of the following formula:

$$SVOC = ((VK^{WO} \times VOC^{WO} - VK^{W} \times VOC^{W}) + (VH^{WO} - VH^{W}) \times VFC)) \times AF$$

Where:

SVOC: Saving in vehicle operating costs
VK^{WO}: Vehicle traffic on the project road (vehicle-kms) without project
VK^{W}: Vehicle traffic on the project road (vehicle-kms) with project
VOC^{WO}: vehicle operating cost without project under roughness index 8
VOC^{W}: vehicle operating cost with project under roughness index 2.5
VH^{WO}: Vehicle hours on the project road without project
VH^{W}: Vehicle hours on the project road with project
VFC: Fixed cost
AF: Annualized factor

2) Saving in Time Costs

The saving in travel time costs is quantified on the annual basis by means of the following formula:

$STTC = (VH^{WO} - VH^{W}) \times TTC \times AF$

Where:

STTC: Saving in travel time costs
VH^{WO}: Vehicle hours on the project road without project
VH^{W}: Vehicle hours on the project road with project
TTC: Time Value
AF: Annualized factor

Savings in vehicle operating costs and travel time costs are estimated and are shown in Table 16-1-12.

Table 16-1-12 Estimation of Time Saving and VOC Saving

	Saving in Time Cost	Saving in VOC		
		Saving in Fixed Cost	Saving in VOC Cost	Total Saving in VOC
2005	606,424	330,505	2,688,948	3,019,454
2010	1,044,896	483,057	3,672,314	4,155,370
2015	1,745,169	648,042	4,618,931	5,266,974

Unit: US$

16.1.5 Benefit Cost Analysis

Based on the above mentioned benefit and cost estimations, the economic analysis of the project is made. Table 16-1-14 shows the benefit - cost stream of the project during the project life period. The results of the economic analysis show that a net present value (NPV) of US$ 3.9 million and B/C ratio of 1.14 over 20year life of the project using social discount rate of 12 %. The economic internal rate of return (EIRR) is computed at 13.6 percent.

Table16-1-13 Results of Benefit Cost Analysis

	NPV (‘000US$)	B/C Ratio	EIRR
Indicators	3,115	1.106	13.3%

Notes: 1) Project life of the project is 20 years
2) Discount Rate is 12 %

Table 16-1-14 Benefit - Cost Stream

	Year	Undiscounted Benefit			Undiscounted Cost			Benefit-Cost	Discounted Benefit	Discounted Cost
		Time Cost	VOC	Total	Construction Cost	Maintenance Cost	Total			
1	2003	0	0	0	0	0	0	0	0	0
2	2004	0	0	0	5,193	0	5,193	-5,193	0	4,636
3	2005	0	0	0	17,925	0	17,925	-17,925	0	14,290
4	2006	0	0	0	13,832	0	13,832	-13,832	0	9,845
5	2007	754	3,431	4,185	0	68	68	4,116	2,659	43
6	2008	841	3,657	4,497	0	68	68	4,429	2,552	39
7	2009	937	3,898	4,835	0	68	68	4,767	2,450	35
8	2010	1,045	4,155	5,200	0	68	68	5,132	2,352	31
9	2011	1,158	4,357	5,515	0	68	68	5,447	2,227	28
10	2012	1,283	4,568	5,851	0	68	68	5,783	2,110	25
11	2013	1,421	4,790	6,212	0	68	68	6,144	2,000	22
12	2014	1,575	5,023	6,598	0	68	68	6,530	1,897	20
13	2015	1,745	5,267	7,012	0	68	68	6,944	1,800	17
14	2016	1,839	5,395	7,234	0	2,138	2,138	5,096	1,658	490
15	2017	1,939	5,526	7,465	0	68	68	7,397	1,527	14
16	2018	2,044	5,660	7,704	0	68	68	7,636	1,407	12
17	2019	2,154	5,798	7,952	0	68	68	7,884	1,297	11
18	2020	2,270	5,939	8,209	0	68	68	8,141	1,196	10
19	2021	2,393	6,084	8,477	0	68	68	8,408	1,102	9
20	2022	2,522	6,232	8,754	0	68	68	8,686	1,016	8
21	2023	2,658	6,383	9,042	0	68	68	8,974	937	7
22	2024	2,802	6,539	9,341	0	68	68	9,273	865	6
23	2025	2,953	6,698	9,651	0	68	68	9,583	798	6
24	2026	3,113	6,861	9,974	1,847	68	-1,779	11,753	736	-131
Total		36,692	102,832	139,524	38,797	3,433	38,535	100,988	32,587	29,472

Unit: '000 US$

16.1.6 Sensitivity Analysis

(1) Alternative Scenarios of Economic Growth

In the Chapter 3, it has presented alternative scenarios of economic growth, i.e. high and low growth scenarios. Following these alternative scenarios, the sensitivity analyses of both cases are made in this paragraph.

Table 16-1-15 presents the forecasted traffic demand of the both alternative scenarios. Based on the projected traffic demand, the benefits of both cases are forecasted and shown in Tables 16-1-16 and 16-1-17.

Table 16-1-15 Forecasted Traffic Volume of Alternative Scenarios

	Traffic Volume (Base)		Traffic Volume (High Growth)		Traffic Volume (Low Growth)	
	Veh.-km	Growth Rate (%)	Veh.-km	Growth Rate (%)	Veh.-km	Growth Rate (%)
2005	474,843	-	474,843	-	474,843	-
2010	696,632	1.467	764,879	1.611	633,346	1.334
2015	893,183	1.282	1,076,761	1.408	738,270	1.166

Table 16-1-16 Forecasted Benefit in case of High Growth Scenario

	Time Cost	VOC-Fixed Cost	VOC-Distance Related	VOC
2005	606,424	330,505	2,688,948	3,019,454
2010	1,147,261	530,380	4,032,081	4,562,461
2015	2,103,858	781,236	5,568,271	6,349,508

Table 16-1-17 Forecasted Benefit in case of Lower Growth Scenario

	Time Cost	VOC-Fixed Cost	VOC-Distance Related	VOC
2005	606,424	330,505	2,688,948	3,019,454
2010	949,971	439,173	3,338,698	3,777,871
2015	1,442,488	535,646	3,817,827	4,353,473

Based on the above mentioned benefits, results of the benefit cost analysis are shown in Table16-1-18.

Table 16-1-18 Results of Sensitivity Analysis of Alternative Economic Growth Rate

	EIRR
Base Case (Medium Growth Rate)	13.3%
High GDP Growth Rate	15.3%
Low Economic Growth Rate	11.3%

Notes: 1) Project life of the project is 20 years
2) Discount Rate is 12 %

(2) Increase and/or Decrease of Cost and Benefit

The sensitivity analysis is conducted under a worst case scenario incorporating increase and/or decrease of project cost and benefits. Tables 16-1-19 show the results of the results of the sensitivity analysis.

Table 16-1-19 Sensitivity Analysis regarding Cost and Benefit

		Benefit				
		20 % Down	10 % Down	Base case	10 % Up	20 % Up
Construction cost	20 % Up	8.4%	9.8%	11.0%	12.0%	13.3%
	10 % Up	9.4%	10.8%	12.1%	13.3%	14.4%
	Base Case	10.5%	11.9%	13.3%	14.6%	15.8%
	10 % Down	11.8%	13.3%	14.7%	16.0%	17.3%
	20 % Down	13.3%	14.9%	16.4%	17.8%	19.1%

Note: Project life of the project is assumed to be 20 years

(3) Reduction of Saving in Travel Time Cost

As the sensitivity analysis, the saving in travel time cost is taken into account the following assumptions:

1) Travel time costs will be reduced into 50 percent of original ones,
2) Present unit time value will be maintained in future (No growth of present travel time), and
3) Travel time costs are reduced into zero.

The results of the sensitivity analysis changing in travel time cost are shown in Table 16-1-20. This results show that three cases are economically feasible except the case of reduction of travel time into zero.

Table 16-1-20 Sensitivity Analysis regarding Time Value

	EIRR
Base Case	13.3%
Reduction of Travel Time Cost to 50 %	11.7%
Reduction of Travel Time Cost to 0	9.9%
No Growth of Unit Time Value	12.2%

Notes: 1) Project life of the project is assumed to be 20 years
2) Discount Rate is 12 %

16.1.7 Summary of Economic Evaluation

It can be justified implemantaion of the project road since the economic indicators of most cases are over cut-off level which can be considerd as 12 % of EIRR.

16.2 Financial Analysis

16.2.1 Financial Capability of the Government

(1) Current Financial Capability of the Government

In order to construct the project road, it is necessary to provide the investment funds both for foreign and local. These funds are utilized as construction cost, engineering cost, right-of-way acquisition and compensation costs, utility relocation cost, removal cost of UXO, etc. The investment funds are usually born from Government budget including

foreign aid. Table 16-2-1 shows relation between GDP and Government budget. In Cambodia, about 13 % - 18 % of GDP are shared by the Government budget. Taking into account its share being comparatively large at early period of nation's restoration, about 16-18 % of GDP would be appropriate to spend as the Government budget.

Table 16-2-1 GDP and Government Budget by Year

	Government Budget	GDP	Percent
1996	1,441.5	8,886	16.2%
1997	1,259.7	9,778	12.9%
1998	1,571.2	11,364	13.8%
1999	1,825.0	12,587	14.5%
2000	2,085.5	12,932	16.1%
2001	2,451.0	13,357	18.3%

Unit: Billion Riels

Source: Cambodia Statistical Yearbook 2001, National Institute of Statistics

The funds for capital investment for constructing and/or reconstructing infrastructures are largely in proportion with the Government budget. It is generally said that at the early period of the nation's restoration, the capital investment is comparatively large due to rehabilitate and reconstruct the destroyed or deteriorated infrastructures. According to past statistical data, its share is ranging from 36 % to 75 % as shown in Table 16-2-2. Table 16-2-3 shows relation between the capital investment and local fund. About 303 billion Riels or US$ 78 million in 2000 and 325 billion Riels or US$ 83 million in 2001 are available for local investment funds.

Table 16-2-2 Government Budget and Capital Investment by Year

	Capital Investment	Government Budget	Percent
1996	628.6	1,441.5	43.6%
1997	451.9	1,259.7	35.9%
1998	630.0	1,571.2	40.1%
1999	727.8	1,825.0	39.9%
2000	895.9	1,189.6	75.3%
2001	1,025.0	1,426.0	71.9%

Unit: Billion Riels

Source: Cambodia Statistical Yearbook 2001, National Institute of Statistics

Table 16-2-3 Capital Investment and Local Fund for Capital Investment by Year

	Local Fund for Capital Investment	Capital Investment	Percent
1996	61.6	628.6	9.8%
1997	110.3	451.9	24.4%
1998	120.4	630.0	19.1%
1999	223.6	727.8	30.7%
2000	303.4	895.9	33.9%
2001	325.0	1,025.0	31.7%

Unit: Billion Riels

Source: Cambodia Statistical Yearbook 2001, National Institute of Statistics

(2) Future Fund Availability

The future fund availability is examined in this section. Based on GDP which has already projected in the Chapter 3 and was employed as the medium growth scenario, the future fund for capital investment is estimated in Tables 16-2-4 to 16-2-5.

As for the capital investment, about 7,905 billion Riels or US $1,996 million are expected to be available from 2003 to 2006 of the construction period of the project road.

	Capital Investment	Local Fund
2003 – 2006	7,905 billion Riels	2,371 billion Riels
	1,996 million US$	599 billion US$

Table 16-2-4 Projected GDP and Government Budget by Year

	Government Budget	GDP	Percent
2001	2,451.0	13,357	17.2%
2002	2,435.2	14,158	17.2%
2003	2,581.4	15,008	17.2%
2004	2,736.2	15,908	17.2%
2005	2,900.4	16,863	17.2%
2006	3,074.4	17,875	17.2%
2007	3,258.9	18,947	17.2%

Source: JICA Study Team Unit: Billion Riels
Note: GDP is used as the medium growth scenario

Table 16-2-5 Projected Capital Investment and Local Fund for Capital Investment

	Local Fund for Capital Investment	Capital Investment	Percent
2001	325.0	1,025.0	31.7%
2002	511.4	1,704.7	30.0%
2003	542.1	1,807.0	30.0%
2004	574.6	1,915.4	30.0%
2005	609.1	2,030.3	30.0%
2006	645.6	2,152.1	30.0%
2007	684.4	2,281.2	30.0%

Source: JICA Study Team Unit: Billion Riels

16.2.2 Public Investment Program (PIP) for 2003 - 2005 and Capital Investment Requirements

In Cambodia, the Second Five Year Socio Economic Development Plan (SEDP-2) (2000 - 2004) has been formulated for nation's development and its plan has been identified a broad framework of the capital investment infrastructure projects. Based on the SEDP-2, projects to be implemented in the relevant year is formulated and identified by the Public Investment Program (PIP) at the every end of physical year in the five year period. Table 16-2-6 shows the proposed PIP of road sector for 2002 – 2004 and Table 16-2-7 shows the draft Public Investment Program for 2003 - 2005. As shown in Table 16-2-7, the capital investment for the road projects would be required a large amount of about US $ 570 million for coming

several years. Amongst the on-going projects including this project are required for US $ 145 million while the high priority projects are for US $ 425 million.

Table 16-2-6 Public Investment Program, 2002-2004

No.		Amount	Percent
1	Agriculture		
	Agricultural Product	40,641	2.3
	Destroyed Mine	15,300	0.9
	Fishery	25,475	1.5
	Forestry	7,477	0.4
	Hydolology	19,985	1.1
	Livestock	6,327	0.4
	Research & Development	31,497	1.8
	Sub-Total	146,702	8.4
2	Transport		
	Aviation	17,072	1.0
	Waterway & Port	61,480	3.5
	Railway	25,300	1.4
	Road	279,820	16.1
	Sub-Total	383,672	22.0
3	Telecommunication		
	Information	26,965	1.5
	Telecommunication	44,532	2.5
	Sub-Total	71,497	4.0
4	Energy	42,780	2.4
5	Commercial and Industry	23,225	1.3
6	Tourism	4,363	0.2
7	Education	233,460	13.4
8	Culture and Religious	13,100	0.7
9	Administration	97,731	5.6
10	Water Supply, etc	216,352	12.4
11	Health	311,935	17.9
12	Environment	45,760	2.6
13	Social Aid	132,391	7.6
14	Special Program	27,032	1.5
Total		1,750,000	100.0

Source: Pubic Investment Program 2002, Ministry of Planning Unit: US$ '000

Table 16-2-7 Public Investment Program (PIP) for 2003-2005

Unit : US $ '000

No.	MPWT	Project Cost	Expenses before 2003		PIP				Remaining Amount	Remarks
			before 2002	2002 (estimated)	2003	2004	2005	Total (2003-2005)		
Road Sector - On Going Project										
246	Reconstruction of National Road No 48	7,600	1,600	2,500	3,500	0	0	3,500	0	
278	Renovation of National Project	41,000	15,818	11,521	5,128	1,852	0	6,980	6,681	
327	Project Development Province and City	8,600	1,800	2,000	2,000	1,800	1,000	4,800	0	
35	Maintenance of National Roads	700	0	200	500	0	0	500	0	
459	Improvement of National Road No. 6	11,000	3,000	8,000	0	0	0	0	0	
460	Construction of Bridge No 26 on National road No 6A	11,000	4,500	3,000	3,500	0	0	3,500	0	
284	Rehavilitation of Main National Roads	88,200	29,000	18,600	14,700	0	0	14,700	25,900	
458	Rehavilitation of National Road No 7 (Kompog Cham - Thal To Toung)	14,708	0	6,000	8,000	0	0	8,000	708	
16	Construction of Asian Highway NR No.1(PP - Neak Loueng - Bavet)	25,400	18,400	5,000	2,000	0	0	2,000	0	
16	Construction of Asian Highway NR No.1(PP - Neak Loueng)	42,000	0	0	0	2,000	10,000	12,000	30,000	Preliminary estimation
660	Emergency Rehabilitation of Road after flood	41,000	0	15,000	15,000	11,000	0	26,000	0	
Sub Total		291,208	74,118	71,821	54,328	16,652	11,000	81,980	63,289	
High Priority Projecct										
647	Strengthening Compatibility and Maintenance, Road Transport	1,000	0	0	500	500	0	1,000	0	
473	Emergency Rehabilitation National Road and Province	20,000	0	0	3,000	3,000	3,000	9,000	11,000	
467	Renovate of National Road No 5	45,000	0	0	3,000	3,000	3,000	9,000	36,000	
463	Construction of National Bridge No 5	10,000	0	0	2,000	2,000	2,000	6,000	4,000	
700	Reconstruction of National Road No 76 A, 169 k.m Banlong - Triangle Section (Cambodia - Laos - Vietnam)	24,000	0	0	2,000	4,000	5,000	11,000	13,000	
764	Purchasing of Balley Bridge amount 6,000m	25,200	0	0	2,000	2,000	2,000	6,000	19,200	
763	Reconstruction of PC Concrete Brigdes amount 6 places	570	0	0	200	200	170	570	0	
762	Construction of National Road No 76 B	1,500	0	0	600	900	0	1,500	0	
759	Construction of Neak-Loueng Bridge on NR 1	70,000	0	0	0	10,000	10,000	20,000	50,000	
695	Rehabilitation of National Road No 51	7,600	0	0	3,000	4,600	0	7,600	0	
699	Reconstruction of National Road No 7, Cracheh-Stoeung Treng-Border	34,000	0	0	5,000	5,000	5,000	15,000	19,000	
699	Emergency Maintenance and reconstruction National Road (480 km)	1,000	0	0	1,000	0	0	1,000	0	
698	Reconstruction of National No 76, Ksep –Sain Monorom-Border	31,350	0	0	5,000	5,000	5,000	15,000	16,350	
697	Construction of National Road No 57, Batambang –Paillin-Thai Border	14,550	0	0	2,000	2,526	3,000	7,526	7,024	
696	Reconstruction of National Road No 64, Kampong Thom-Phah Vihear	23,550	0	0	1,700	2,500	3,000	7,200	16,350	
768	Program of maintenance system on National Road during 5 year	13,130	0	0	1,500	2,000	2,000	5,500	7,630	
222	Construction of National road No 76, Au Pung Moun-Balung-Au yor	52,000	0	0	3,000	5,000	5,000	13,000	39,000	
235	Construction National road No 2, Takeo –V/N border	10,000	0	0	1,000	2,000	2,000	5,000	5,000	
461	Construction of National road No Kampong Bay Bridge –Ang Ta Nau-and National Road No 3.	41,000	0	0	3,000	5,000	6,000	14,000	27,000	
Sub Total		425,450	0	0	39,500	59,226	56,170	154,896	270,554	
Total		716,658	0	0	78,500	117,952	112,340	308,792	541,108	

Source: Budget Plan of Financial Management for Year 2003 (Draft), Ministry of Economy and Finance

Notes: 1) Budget plan of Project No.16 NR 1 is divided into two; PP to Neak Loueng and Neak Loueng to Vietnam Boader
2) Budget plan of the NR 1 from PP to Neak Loueng is used for the estimated project cost by JICA study.

16.2.3 Comparison between Capital Investment Availability and Requirements

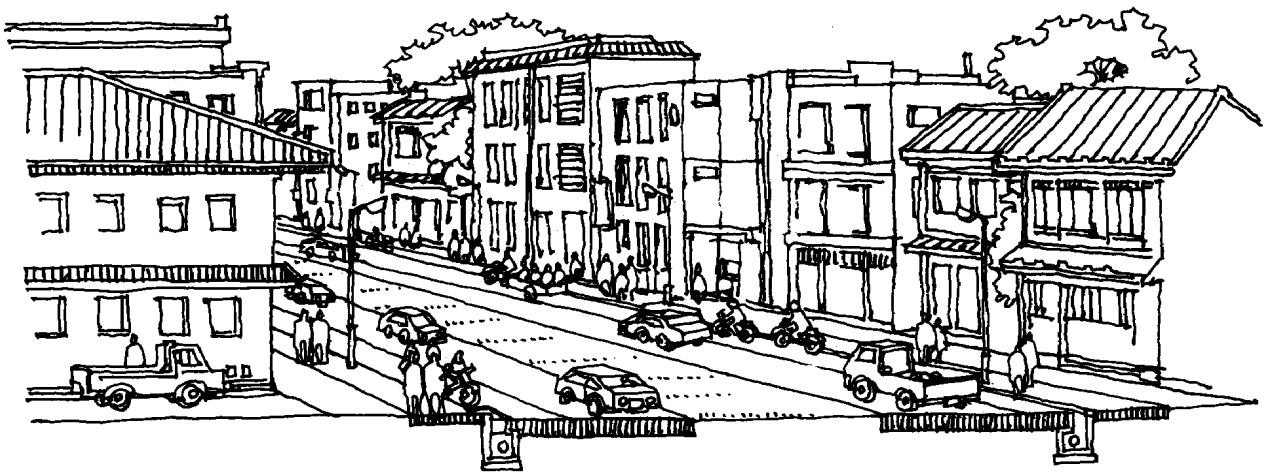
The capital investment budget during 2003 – 2007 will be provided for US S 1,996 million as mentioned in 16-2-1. Taking into accounts the road sector share to the capital investment being 16 %, the capital investment budget for road sector will be available at US $ 319 million. Since the capital investment requirement between 2003 and 2007 is US$ 145 million for on-going projects and US$ 425.5 million for high priority projects, it is expected to be provided the funds for on-going projects including the project road. However, the high priority projects may not be implemented due to lack of available funds.

Table 16-2-8 Comparison between Capital Investment Availability and Requirements

Capital Investment Budget for 2003 to 2007	US$ mil	1,996.0
Share of Road Sector	%	16
Capital Investment Budget for Road Sector for 2003 to 2006	US$ mil	319.4
Necessary Fund to implement the On-going Projects	US$ mil	145.3
Necessary Fund to implement the High Priority Projects	US$ mil	425.5
Balance	US$ mil	- 251.4

As conclusions of the financial analysis, the implementation of the project road of the National Road No. 1 from Phnom Penh to Neak Loueng identified as the on-going project group in the PIP, will be provided the necessary fund.

CHAPTER 17 CONCLUSION AND RECOMMENDATIONS



CHAPTER 17 CONCLUSION AND RECOMMENDATIONS

17.1 Feasibility of the Project

17.1.1 Technical Feasibility

Technical risks of the project have been minimized to the extent possible by having a technical design based on various engineering site surveys, full-scaled natural condition surveys and social/environmental surveys. Such technical design and associated cost estimates are based on results from a series of meetings with MPWT counterparts, presentation/workshops and individual discussions with the agencies concerned. Emphasis was given to the selection of alternative plans where flood mitigation measures were carefully examined not to induce adversely in the aspects of environmental and social impacts. Due study and consideration was also given to the selection of major design elements such as the location and scale of openings, the design embankment level due to the design high water level, the type of bridge superstructure to meet with international standard, the type and dimension of culverts, the location of borrow pits/ quarry sites, and the selection of pavement type.

Accordingly, the technical feasibility for the project is confirmed from all aspects.

17.1.2 Environmental and Social Impact

The IEIA was conducted in accordance with the environmental rules and regulations of Cambodia as well as environmental guidelines of JICA, and it concluded that there are neither substantial nor irreversible adverse environmental and social impacts arising from the Project.

No adverse social impact is expected because the project only involves the improvement of existing roads and no land acquisition for road right-of-way is required additionally.

In the course of the Study, the activities design to identify and predict the impact on the biogeographically environment and other matters was prepared based on the MOE's comments on IEIA. Appropriate mitigation measures on environmental impact are incorporated in the design such as adequate drainage system, crossing facilities for pedestrian and domestic animals and green belt along the road embankment slope.

MPWT as the executing agency for the project has submitted the final report of IEIA to MOE, and due procedure was carried out in November 2002. MOE has issued an approval letter to the project. Therefore, it is obvious that environmental justification for the project will be confirmed officially in a short time.

17.1.3 Economic Feasibility

The major quantifiable benefits accruing from the project are mainly savings of transport cost and time for existing and future traffic in the eastern part of the country, especially between Phnom Penh and Neak Loueng. The economic analysis includes such benefits comprised from generated and induced traffic that are forecasted in the future socio-economic framework. The annual traffic growth rate in the planning period is forecasted to be 6.6% as a whole. The base EIRR for the project is 13.3%, with various sensitivity scenarios giving results that range from 8.4% to 19.1%.

Therefore, high priority should be given to the implementation of the project because the project will promote economic and social development and shows expectation of a sufficient economic return. The project will also contribute to reduce poverty in the Plain Region through increased employment opportunities both during and after construction, accelerated agricultural and inland fishery development induced by lower transport costs and improved accessibility of goods and people to markets.

17.2 Conclusion

(1) Justification of the Project

The project will realize the strategic transport axis in East-south Asia as a part of Asian Highway No. A-1 by improvement of major arterial road to an all-weather international standard.

The significant benefits of the project are summarized as the enhancement of traffic safety and environmental conservation by well-designed paved road; the integration of producing and consuming centers in terms of regional context; and the reduction of transport cost to provide better market accessibility for more competition toward low prices and to increase job opportunities for the local poor especially in the development corridor between Phnom Penh and Neak Loueng. It is also anticipated that local people will have better access to social facilities including schools, Pagodas and other public facilities.

The project will also stimulate the development of the Asian Highway No. A-1 and induce incremental demand of domestic cargo as well as international trade to Vietnam.

Such transformation will accrue considerable degrees of both direct and indirect benefits in the Plain Region, especially by relieving transport constraints such as traffic bottlenecks by temporary bridges and traffic accident, and strengthening social and cultural links between settled areas in the country.

(2) Implementation of the Project

1) It is recommended that the improvement of National road No. 1 C-1 Section (Phnom Penh - Neak Loueng L=56 km) be given the highest priority in the Second Socio-Economic Development Plan (SEDP-2) due to its necessity and urgency. The project is located in the surroundings of urbanized and settled area and enough economic return is anticipated due to the higher traffic volumes.

2) Two openings exist on NR-1 C-1, which have been built artificially to prevent Phnom Penh from submergence during 2000 Flood, and temporary bridges crossing openings become serious traffic bottleneck because of one-lane width and load limit control. Well-designed bridges and culverts in the project will contribute to decreasing the floodwater level along NR-1 C-1 and at Phnom Penh, and accordingly flood risk will be reduced not only NR-1 C-1 and Phnom Penh but also along NR-1 C-2 and NR-11 if 2000 Flood should occur. By the inflow of floodwater to the Colmatage area through the proposed openings, the water level inside the Colmatage area will slightly increase. However, any adverse impacts will be brought about neither to the agriculture in the

Colmatage nor to the Bassac River. Therefore, it is recommended that the project be given the highest priority due to high feasibility.

3) The pavement condition on NR-1 C-1 is so deteriorated that it is hard to maintain normal traffic function through a year and to secure traffic safety as well. Since the road structure is highly vulnerable to flood and floodwater, road users incur high transport costs even though the road maintenance might be carried out in the usual way. The proposed road improvement plan consists of appropriate flood mitigation measures, flood-free embankment level and strong as well as durable pavement structure. Accordingly it is technically feasible to cope with flood, floodwater and incremental demand of traffic and maintenance.

4) The proposed plan will require not acquisition of land but evacuation of dwellers within Road Right-of-Way (ROW). According to prevailing procedure, 1,805 houses are located within tentative ROW of 30 meters, and they should move outside the tentative ROW. Since the permanent ROW is designated 60 meters, it is socially feasible to vacate the land by a due procedure taken as the fair and just compensation to make Project Affected Persons (PAPs) resettled voluntarily within the ROW.

Accordingly, it may be concluded that the institutional and administrative arrangement for project implementation should be taken without interruption.

17.3 Recommendations

The following recommendations are made for the implementation of the project:

(1) Appropriation of Fund for Project Implementation

The development fund for the project will comprise direct and indirect costs.

The former consists of construction cost and consultant fee, it is recommended that the Government request a donor country to assist funding for them, using bilateral ODA or loan from a multi-lateral lending agency so as to alleviate the financial burden of the Government.

The later consists of compensation for resettlement and utility relocation, and the Government should appropriate the necessary fund for them timely.

(2) Evacuation of Road Right-of-Way for the Project

It is necessary to evacuate PAPs from 30-meter wide ROW and to relocate utilities such as electricity and communication cables to proper location before the construction works commence. These resettlement and relocation require due and time-consuming procedures. Accordingly, it is recommended that such procedures should be taken timely to secure the necessary space for construction work.

(3) Control of Development along NR-1 C-1

The required fund for compensation will be appropriated on the basis of the cost estimate that would have been carried out at the stage of design. However, many activities such

as installation of utilities, construction of houses/buildings and land reclamation might occur during the pre-construction period unless otherwise controlled, and it will affect the budget.

It is recommended that any development within and along NR-1 C-1 should be effectively controlled to prevent indiscriminate activities and to facilitate the realization of project.

(4) Maintenance of Detour Road at Cut-off No. 1 and No.2

Two temporary bridges at Cut-off No.1 and No.2 will be used until the construction work commences. Since it takes more than two years to start the construction work, it is necessary for MPWT to maintain detour roads and bridges properly.

The following maintenance works are carried out at tow temporary bridges on National Road No. 6A;

1) 4.5-meter high steel portal gate is installed at both ends of bridge for the purpose to prevent an overloaded heavy vehicle from passing the bridge.
2) Traffic sign of speed limit of 10 km/h and humps are installed at both ends of bridge to control vehicular speed.
3) Not private guards but policemen enforce regulation.
4) Routine inspection such as bolt loosing, gaps in steel covering plate and wooden plate is conducting at a few times every week. Wooden plate is replaced every 6 months according to actual practice.
5) It is necessary to monitor defects and damages on embankment slope during flood.

Furthermore, a new detour road with temporary bridge should be constructed at Cut-off No.1 because a new bridge will be built at the same location.

(5) Control of Over-loaded Truck

It is very sure that pavement and bridge structure suffer damage from over-loaded trucks, and it is more serious to temporary bridges at Cut-off No.1 and No.2. It takes action immediately that a weighbridge station at Cut-off No.2 should be built to control over-loaded trucks.

(6) Ensuring Financing Mechanism for Road Maintenance

The following measures are recommended to ensure financing mechanism for road maintenance that is indispensable to strengthen road maintenance capability and to cope with incremental demand brought about by the governmental policy of road improvement:

i) to appropriate necessary fund from “Fund for Repair and Maintenance of Road (FRMR) to MPWT
ii) to follow up Road Maintenance Catch-up Program officially requested to Japan
iii) to realize the concept “Fee-for-Service” to contribute to increasing the road maintenance fund such a way;
   - to examine possibility to surcharge additional toll to heavy vehicles at Neak Loueng ferry
   - to build a toll plaza together with weighbridge station and administration office just in case of shortage of fund

(7) Improvement of Outlet Channel of Colmatage Water Gates

Outlet channels of Colmatage water gates constructed by Japan's grant aid are eroded partially by strong current. Not only for the function for agricultural water use but also the existing water gates along NR-1 C-1 have the function to mitigate flood. In order to utilize this flood mitigation function, it is recommended to improve the existing outlet channels including bank protection against erosion.

The existing water gates and channels along the left bank of the Bassac River also have function to mitigate flood. However, many channels have no gate or no function if any because the structures of existing gates are deteriorated and damaged. Therefore, in order to utilize the function of flood mitigation and water use fully, it is also recommended to improve the Colmatage water gates and channels along the left bank of the Bassac River.

(8) Countermeasure against the Bank Erosion of the Mekong River

It is recommended to conduct observation of the bank erosion every year, and provide some countermeasure beforehand, so that the bank erosion will not be really serious problem to NR-1 C-1.

(9) Study on Bridge over the Mekong River at Neak Loueng

Since the project will realize the strategic transport axis in East-south Asia as a part of Asian Highway No. A-1 by improvement of National Road No.1 to an all-weather international standard, it is indispensable to avoid river interruption.

It is necessary to deliberate scheme of bridge crossing since such considerable passengers are always exposed to risk and inconvenience. Therefore, it is recommended that a study on bridge over the Mekong River at Neak Loueng should be conducted.

(10) Comprehensive Study on Improvement of Chbar Ampov Intersection

Congested Chbar Ampov Intersection is one of major traffic bottlenecks on National Road No. 1 C-1 together with Neak Loueng Ferry and Kokir Market. Accordingly, it is desirable to improve it simultaneously if NR-1 C-1 is improved to a flood-free road to an all-weather standard. However, physical constraints such as close location to the bridge, steep slope, staggered shape and lack of land availability in the vicinity are so severe and complicated that it is difficult to solve the problems only by an engineering design without the construction of 2nd Monivong Bridge.

It is recommended that the in-depth investigations and more comprehensive study covering Chbar Ampov Market, Kbal Ntal Intersection and its surroundings in Mean Chey District of Phnom Penh Municipality should be conducted for the improvement plan at Chbar Ampov Intersection.

JICA Secretariat, Advisory Committee and Study Team

JICA Secretariat Members

1)	Mr. Toshio HIRAI	:	Director, First Development Study Division
2)	Mr. Satoshi UMENAGA	:	Deputy Director, First Development Study Division
3)	Mr. Akihito SANJO	:	Staff, First Development Study Division

JICA Advisory Committee Members

1)	Mr. Yukitoshi FUJISHIMA	:	Chairperson/Road Planning, Deputy Director of Highway Environment Division, Planning Department, Japan Highway Public Corporation
2)	Mr. Makato TAKESHIMA	:	Member/Hydrology/Hydraulics, Deputy Director of River Environment Division, River Bureau, Ministry of Land, Infrastructure and Transport

JICA Study Team Members

1)	Mr. Kenji MARUOKA	:	Team Leader/Road Planning
2)	Mr. Takashi FURUKAWA	:	Deputy Team Leader/River and Flood Countermeasure
3)	Mr. Tatsuyuki SAKURAI	:	Deputy Team Leader/Road Design
4)	Dr. Tadanori Kitamura	:	Hydrology Analysis
5)	Mr. Kenji ISOMOTO	:	Traffic Survey/Traffic Demand Forecast
6)	Mr. Yoshimi TAKAI	:	Structure Design
7)	Mr. Ryohei WATANABE	:	Construction Program/Cost Estimate
8)	Mr. Shin-ichi MATSUNAGA	:	Agriculture/Irrigation/Colmatage Survey
9)	Mr. Toshio KIMURA	:	Economical and Financial Analysis
10)	Mr. Hiroshi TANAKA	:	Environmental Assessment
11)	Mr. Hidetoshi NAKANO	:	Coordinator / Hydrological Structure Planning, Design

Cambodian Counterpart Team Members

1)	Mr. Chhin Kong Hean	:	Team Leader, Director General, Directorate of Public Works
2)	Mr. Tauch Chankosal	:	Coordinator, First Director General, Directorate of Public Works
3)	Dr. Yit Bunna	:	Coordinator, Director, Public Works Research Center
4)	Mr. Phy Sophort	:	Coordinator, Deputy Director, Public Works Research Center
5)	Mr. Khun Srun	:	Traffic Engineer, Public Works Research Center
6)	Mr. Kong Sophal	:	Pavement Specialist, Public Works Research Center
7)	Mr. You Dara	:	Highway Engineer, Department of Road and Bridge
8)	Mr. Nop Kilarith	:	Bridge and Structure Engineer, Department of Road and Bridge
9)	Mr. Mak Samnang	:	Hydrological and Hydraulic Analysis, Department of Waterway